CDM

County of Dare

Dare County
Construction and Demolition Debris
Landfill Cell No. 4

July 2009

APPROVED
DIVISION OF WASTE MANAGEMENT
SOLID WASTE SECTION
DATE 03/10/2010 BY
DIN 9831

RECEIVED
JUL 30 2009
SOLID WASTE SECTION

Fac/Perm/Co ID #	Date	Doc ID#
28-03	08/12/09	DIN ~~8476~~ 9831

Permit Application

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919-325-3500
fax: 919-781-5730

March 18, 2010

Mr. Ming-Tai Chao, P.E.
Environmental Engineer II
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Permitting Branch, Solid Waste Section
1646 Mail Service Center
Raleigh, NC 27699-1646

Subject: Dare County, North Carolina
Dare County Construction and Demolition Debris Landfill (C&DLF)
Permit to Construct Application
Response to Comments

Dear Mr. Chao:

On behalf of Dare County, CDM is pleased to submit response to comments for the Dare County C&DLF Permit to Construct Application as discussed in recent phone conversations and e-mails. The responses are included in **Attachment No. 1**, and are regarding the recent notice of violation, white goods management and tire management. The responses were provided by Mr. Clyde Gard, Dare County Assistant Public Works Director.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

W. Michael Brinchek, P.E.
Project Manager
Camp Dresser & McKee

cc: Ed Mussler, NCDENR DWM
Edward Mann, Dare County
Kevin Irby, CDM

Attachment No. 1

From: Clyde Gard Assistant Public Works Director

To: Mike Brinchek C.D.M. Project Manager

Date: 14, March 2010

Re: Dare County PTC-Cell 4

Mike, here is our response to the NCDENR request to the three areas of concern on our cell 4 project.

1. Dare County's current outstanding NOV in the white goods area is being worked on by County employees we are grading the site to make better drainage for the area as to eliminate the standing water problem. The refrigerators are being separated and stored in an upright position until all refrigerant is removed and the units are marked before being added to the scrape pile. Construction and Demolition materials are beings removed and disposed of in the properly permitted area. Work to bring Dare County back into compliance should be complete by March 26, 2010

2. Mr. Carl Walker Dare County recycling coordinator is in contact with Mr. Bill Patrakis, Solid Waste Section in regards to a grant application and requirements to construct a concrete permanent pad for white goods and scrape metal. A site has been identified for the placement of the pad. The site is between the dirt stock pile and the transfer station. We are going to ask for a grant for a 200 by 150 foot pad 8" thick.

3. Dare County has been in touch with Thomas Womble with Carolina Tire Recycling and has made arrangements for us to use his services when we stop disposal in the C&D Landfill. There will be a single collection point at the Dare County Public Works compound in Manteo. Any tires that show up at other places like the landfill or transfer stations will be brought to Manteo by county employees. The current cost to us will be 77.50 to 144.00 per ton and mileage to the mid state disposal site operated by Carolina Tire Co. Dare County will begin this process at the conclusion of cell-4 construction and permits to operate cell-4 are issued.

Thanks for your help in this matter if this does not meet the needs for this project to move forward please let me know. Clyde

CDM

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Fac/Perm/Co ID #	Date	Doc ID#
Mingtai Chao 28-03	01/06/2010	DIN 9246

DIVISION OF WASTE MANAGEMENT RECEIVED JAN 4 2010 SOLID WASTE SECTION

December 31, 2009

Mr. Ming-Tai Chao, P.E.
Environmental Engineer II
North Carolina Department of Environmental and Natural Resources
Division of Waste Management
Permitting Branch, Solid Waste Section
1646 Mail Service Center
Raleigh, NC 27699-1646

Subject: Dare County
Dare County Construction and Demolition Landfill (C&DLF)
Permit to Construct Application
Response to Comments

Dear Mr. Chao:

On behalf of Dare County, CDM is pleased to submit revisions to the Dare County Construction and Demolition Landfill Permit to Construction Application per your review comments received on August 24, 2009. For your convenience, CDM has formatted this letter correspondence to present your comment followed immediately by our response in *italics*.

Section One – Facility Plan

1. (Section 1.3.2.1) The last sentence stated "The gross capacity of Cells 1 through 5 is approximately 1,571,800 million cubic yards." Pleases delete "million," likely a typographic error, from the sentence.

   The reference to "million," in the last sentence of Section 1.3.2.1 is a typographic error and should be deleted. A revised Facility Plan is included as part of ***Attachment # 1.***

2. (Section 1.3.2.4) The 2-feet thick final cover system is likely a typographic error? Please verify.

   The reference to 2-foot thick final cover system is a typographic error and should read 3-foot thick. A revised Facility Plan is included as part of ***Attachment # 1.***

Section Three – Construction Quality Control Plan (CQA Plan)

3. Regarding the response to the Comment 30 dated March 6, 2009, is this vegetative cover stated in Section 5 same as the erosion layer described in

Section 1.3.3.1.1 (Facility Plan) and Section 1.1.1 (Closure Plan)? If so, the minimum thickness of the constructed layer specified in Section 5.3.A shall be 18-inches overlain the low permeability soil liner. Additionally, to meet the safety factor requirements of slope stability analysis described in the Attachment B-4, the soil used for the erosion layer must have a unit weight greater than or equal to 120 pound per cubic feet and internal friction angle greater than or equal to 30 degree tested by an acceptable ASTM method. Please revise Section 5 by specifying the testing methods and frequencies to ensure the as-built erosion layer has the adequate strength which meet the above-mentioned design criteria.

The material properties and placement methods for vegetative cover specified in Section 5 of the CQA plan should meet or exceed the strength properties used in slope stability calculations for this layer. The unit weights and strength properties for this layer are typical and actually conservative values based on literature for similar types of soil. In addition, there are no strength testing requirements on the vegetative cover and/or erosion layers.

A revised Section 3 – Construction Quality Assurance Plan is included as part of ***Attachment # 2.*** *Additionally, Section 2 – Engineering Plan, Appendix B – Design Geotechnical Evaluation, Appendix B-6 and Attachment B-4 have been revised and are included in* ***Attachment # 3.***

4. (Section 6.1) Please specify the soil types and as-built thickness for the base pad of Cell 4 which must meet the criteria stated in the Rule .0540(2) and consistent with the Section 1.1 of the Engineering Plan, the Grading Plan C-3 and drawing Sheet D-2.

   Section 6.1 has been revised to include the required soil types for the upper two feet of the base pad and the as-built thickness requirements for the base pad. A revised Section 3 – Construction Quality Assurance Plan incorporating these comments is included in ***Attachment # 2.***

5. (Sections 4.4.1 & 6.4.1) Please confirm the testing frequency for final liner thickness. It is likely the frequency of 4/acre/lift is a typographic error.

   In section 4.4.1 the reference to testing method and frequency for final liner thickness has been revised to read topographic survey for method and 2 – existing and post liner installation for frequency. A revised Section 3 – Construction

Quality Assurance Plan incorporating the aforementioned changes is included as part of ***Attachment # 2.***

Section 6.4.1 the reference to testing method and frequency for base pad thickness has been revised to read topographic survey for method and 3 Surveys for frequency, where the astrik denotes, "* Three topographic surveys shall be conducted to verify the base pad thickness. The first survey shall be performed prior to the start of any construction activities, then after the initial three feet of compacted fill is installed and a final survey after the upper two feet of compacted fill is installed. These topographic surveys shall be compared to determine the as-built thickness of the base pad."*

A revised Section 3 – Construction Quality Assurance Plan incorporating the aforementioned changes is included as part of ***Attachment # 2.***

6. Is the landfill facility located within a 100-year floodplain? Has the Dare County Board of Commissioners adopted a resolution to grant a variance to the Dare County's flood hazard ordinance for the C&DLF facility in accordance with Rule .0536(c)(4)? Please provide a copy of the resolution approving the variance.

   Yes, it is in the 100-yr floodplain. Included in the Facility Plan as Appendix A – Site Location Restrictions under Section 2.9.2 - Characterization Study, Floodplains, reference is made to an approved resolution by the Dare County Board of Commissioners on August 2, 2004. This resolution is included as Attachment 2-1 in Appendix A of the Facility Plan, just after Page 2-3 in Section 2 – Characterization Study.

Section Four - Operations Plan

7. (Sections 2.2 & 7.7) Rule 15A NCAN 13B .1105(f) prohibits whole scrap tires to be disposed in a C&DLF. Therefore, please remove the scrap tires from the list of acceptable wastes to be disposed of in the C&DLF. However, the existing rules encourage a C&D landfill facility providing a designated area, as a temporary storage unit within the landfill property boundaries, to collect scrap tires from the approved service areas for properly recycling or final disposal. To manage scrap tire, the section 7.7 of the Operations Plan must be prepared in accordance with Solid Waste Management Rule – Section 1100. The plan needs to describe, but not limited, the brief description of collection/storage area (shown the location on the existing

facility plan map) such as structure, size, physical features, etc., the maximum amount of tires to be allowably stored at any time at the facility, the estimated tire amount per month, fire prevention measures and notification procedures, the contact information of a contractor or recycler to handle of-site transportation [the qualification/ certification of a tire transporter], and the frequency or schedule to remove the waste off-site.

Management of recyclables is being reviewed and a permit modification will be submitted for approval prior to acceptance of the aforementioned materials in Phase 4.

8. (Section 7.7) Regarding the responses to the Comment 34 dated March 6, 2009, the special wastes including white goods are listed as recyclable wastes at the C&DLF. Therefore, the Operations Plan needs to address provisions to manage white goods in accordance with North Carolina General Statutes Part 2D - Management of Discarded White Goods (130A-309.80 -.87). The plan needs to describe furthermore, but not limited, by including the following information: the maximum tonnage allow to be stored at any time at the facility, the estimated tonnage per month, the procedures of removal and storage chlorofluorocarbon refrigerants, the contact information of a contractor or recycler to handle, off-site transportation, and the frequency or schedule to remove the waste off-site. Please revise the Section 7.7 of the Operations Plan accordingly.

   Management of recyclables is being reviewed and a permit modification will be submitted for approval prior to acceptance of the aforementioned materials in Phase 4.

9. (Section 7.7) Will areas stockpiled the recyclable waste in the C&DLF be used to store the same type wastes collected and removed from the adjacent solid waste transfer facility (Permit # 28-05T)? If so, please include the waste management practices to this section.

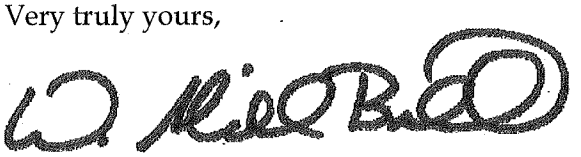
   Management of recyclables is being reviewed and a permit modification will be submitted for approval prior to acceptance of the aforementioned materials in Phase 4.

10. (Section 9) For Comment 36 dated March 6, 2009, the reviewer inadvertently cited Rule .0542(I)(5); the correct one shall be .0542(i)(5). Please provide provisions in the Operations Plan

    After discussions by phone with the reviewer Rule .0542(l)(5) was identified as the rule that needed to be incorporated into the Operations Plan. Rule .0542(i)(5) has already been addressed in the Operations Plan. Section 9.4 – Discharge of Pollutants and Section 9.5 – Discharge of Nonpoint Source Pollution have been incorporated into Section 9 in the Operations Plan to address Rule .0542(l)(5). A revised Section 9 is included in ***Attachment # 4.***

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,



W. Michael Brinchek, P.E.
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Camp Dresser & McKee

cc: Ed Mussler, NCDENR DWM
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July 29, 2009

Mr. Ming-Tai Chao, P.E.
Environmental Engineer II
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Raleigh, NC 27699-1646

Subject: Dare County
Dare County Construction and Demolition Landfill (C&DLF)
Permit to Construct Application
Response to Comments

Dear Mr. Chao:

On behalf of Dare County, CDM is pleased to submit revisions to the Dare County Construction and Demolition Landfill Permit to Construction Application per your review comments received on March 6, 2009. For your convenience, CDM has formatted this letter correspondence to present your comment followed immediately by our response in *italics*.

Section One – Facility Plan

1. (Section 1.3.1.4) Please describe the waste recycling program (recyclable wastes, such as white goods, concrete rubbles, scrap tires, scrap metals, cardboard box, etc.) conducting at the landfill facility and requiring waste segregated management.

   White goods and scrap metal are the only recyclables accepted at the C&D LF, and once accepted they are stockpiled in a designated area near the active cell of the landfill until the recyclables are collected by a local recycling company.

2. Is the landfill facility located within a 100-year floodplain? Has the Dare County Board of Commissioners adopted a resolution to grant a variance to the Dare County's flood hazard ordinance for the C&DLF facility in accordance with Rule .0536(c)(4)? Please provide a copy of the resolution approving the variance.

Yes, it is in the 100-yr floodplain. Included in the Facility Plan as Appendix A – Site Location Restrictions is a copy of the resolution approving the variance for the new cells at the Dare County C&D Facility.

3. (Section 1.3.2.4 & Sheet D-2) There is discrepancy of the thickness of the final cover between this section and Detail E of Sheet D-2 and the Section 1.3.3 and the Closure Plan. Please clarify.

   The final cover thickness of 3 feet as identified in the Facility Plan and the Closure Plan are correct, and the final cover thickness shown in Detail E on Sheet D-2 has been revised to reflect the minimum final cover thickness of 3 feet as required per rules 0.543(c)(1)(B) and 0.543(c)(1)(C).

4. (Section 1.3.2.6) The Table 3-3 mentioned in the section is likely a typographic error of Table 1-3. Please clarify.

   The reference to Table 3-3 in Section 1.3.2.6 is a typographic error and should be deleted and revised to read Table 1-3.

5. (Section 1.3.3.1.1, Page 1-8) This section proposes" the closure cap post-settlement surface slope must be between 5 to 25 percent." However, the figures in permit application document show the top surface slope of the final cap is 2 percent and side slope is 33.3 percent [3 (horizontal) to 1 (vertical)]. Please clarify.

   The top surface slope has been revised to be no less than 5% on all figures and drawings, and the side slopes will be a maximum of 3 (horizontal) to 1 (vertical) as an accepted alternative per Rule 0.543(c)(3)(C). Refer to Section 1, Paragraph 1.1.1 – Final Cover System for supporting documentation regarding the 3 (horizontal) to 1 (vertical) side slopes. The supporting documentation is detailed further in Appendix B – Design Geotechnical Evaluation, which is part of Section 2 – Engineering Plan.

Section Two – Engineering Plan

6. (Section 1.2) The section proposes that the post-settlement grades of the top surface slope will not be less than 5 percent (to prevent ponding). But the Sheets SD-3 and C-4 show the top surface slope of the final cover of Cell No. 4 is 2 percent from crown to the edge of the top surface of the final cover. Please clarify.

Sheets SD-3 and C-4 have been revised to show the top surface slope with a minimum slope of 5%.

7. (Section 1.3, the first sentence) The Cell No. 3 mentioned in this section is apparently a typo of the Cell No. 4. Please correct the typographic error.

   The reference to Cell No. 3 in Paragraph 1.3 – Erosion and Sedimentation Control is a typographic error and should be deleted and revised to read Cell No. 4.

8. (Section 1.3, on page 1-2) Please provide a copy of approval letter, issued by Division of Land Resources, Land Quality Section, of the Sedimentation and Erosion Control Permit Application. The approval letter shall be a portion of the Cell No.4 Permit to Construction Permit Application.

   A copy of the approval letter from the North Carolina Department of Environment and Natural Resources (NCDENR) Division of Land Resources, Land Quality Section, for the Sedimentation and Erosion Control Plan and Permit will be submitted to the NCDENR DWM upon approval from the NCDENR DLQ.

9. (Section 2.1, the second paragraph) Please provide the soil loss calculations, which are not presented in Appendix A.

   The corresponding soil loss calculations for Cell No. 4 are included in Section 2 – Engineering Plan, Appendix A - Calculations.

10. (Section 2.2) This section indicated that designs of site drainage structures and sediment ponds are based on a 25-year, 24-hour storm event. However, designs of drainage structures - filter basins and canal crossing in Appendix A are based on a 10-year storm event. Please clarify.

    The site drainage structures have been revised to include a design based on a 25-year, 24-hour storm event, and the revised calculations are attached.

11. (Section 2.4, page 2-2) The pertinent documents of the location restrictions for the entire proposed C&D landfill expansion are not provided in Section 1 – Facility Plan, Appendix B. Please clarify.

    The site location restrictions are included in Section 1 – Facility Plan, Appendix A.

12. (Section B-2) The Sheet OP-6 is not available in the document. Please provide the Sheet OP-6.

    The reference to Sheet OP-6 in Section B-2, Paragraph B-2.1 is a typographic error and should be revised to read OP-1.

13. (Section B-6.3, page 6-1) The final cover thickness is 3 feet thick, not 2 feet, as described in Section 1.2 of the Engineering Plan. Please correct the typographic error.

    The reference to a final cover thickness of 2 feet is a typographic error and a revised Section 1.2 of the Engineering Plan is included as part of the revised Permit to Construct.

14. (Section B-6.4 & Appendix B-4) Has the presence of groundwater in the subsurface been considered in the slope stability analysis? Please clarify.

    The presence of groundwater was considered for both slope stability and settlement analyses. The groundwater was assumed to be at the top of the existing ground surface (at the bottom of the 5-foot-thick compacted fill).

15. (Section B-6.4 & Appendix B-4) Please provide the input data summary sheets and summary of the analysis results from the slope stability modeling software SLOPE/W 2004.

    Input and output data summary sheets for slope stability analyses are included at the end of Appendix B in Section 2 – Engineering Plan.

16. (Sections B-6.4.3 & B-6.4.4) Please provide Appendix D mentioned in both sections.

    Appendix D, should have been identified as Appendix B-4. Appendix title has been corrected to read Appendix B-4 throughout this report. Also, please note that the last sentence of section B-6.4.4 should read "The slope stability analyses are presented in Appendix B-4", rather than "The slope stability analyses, including estimated strength gain calculations are presented in Appendix D" as it currently reads.

Section Three - Construction Quality Control Plan (CQA Plan)

17. The CQA Plan needs to specify material, construction procedures, QA/QC testing items, methods, and frequencies to ensure that the as-built 5- feet thick compacted landfill sugrade for Cell No. 4 meets the design requirements of material as described in Section 1.1 of the Engineering Plan and the minimum engineering parameters – unit weight 120 pcf and internal friction angle 35 degrees as described in Table 6-1 in Appendix B of the Engineering Plan.

    The CQA plan is updated to address the requirements for the compacted fill layer.

18. Please provide material (pipe, fitting, backfill material) and construction specifications (including disposal deco water and soil cuttings) for installing perimeter gas probes and passive gas vents in the CQA Plan.

    Landfill gas vents will be constructed per the detail provided in the revised Closure Plan. Perimeter gas wells will be constructed in accordance with the revised Operations Plan. The revised Closure Plan and Operations Plan are included as part of the revised attached Permit to Construct.

19. Please provide material and construction specifications for installing the erosion and sediment control measures as described in the Section 1.3 of the Engineering Plan and the Section 8 of the Operations Plan.

    Erosion and sediment control devices and measures will be installed and performed in accordance with the approved NCDENR Sedimentation and Erosion Control Plan and Permit.

20. To meet the safety factor requirements of slope stability analysis described in the Section B-6 of Appendix B, the compacted soil used as landfill cap must have a unit weight greater than or equal to 120 pound per cubic feet and internal friction angle greater than or equal to 30 degree tested by ASTM method D4767. Please make necessary revision in the Sections 4 and 5 of the CQA Plan.

    The material properties and placement methods for low-permeability soil liner and vegetative cover specified in Sections 4 and 5 of the CQA plan, respectively, should meet or exceed the strength properties used in slope stability calculations for the

associated layers. The unit weights and strength properties for these layers are typical and conservative values based on literature for similar types of soil. In addition, the strength properties of the low permeability soil liner will be tested in accordance with ASTM D4767.

21. (Section 2) Please describe the responsibility and authorities of the owner/operator and the responsibility, qualification, and submittals of the quality control laboratory (QCL) mentioned in Sections 4.2 and 4.3 and surveyors who will conduct as-built final grade survey and confirm the thickness of each layer of the final soil cover system.

    A section on the Owner's responsibility, qualifications, and submittals has been added under Section 2.5 in the attached revised Closure CQA Plan. As identified in Section 2.1.1 of the CQA Plan, the Quality Control Laboratory (QCL) and the Surveyors are sub-contractors of the Contractor. The Contractor is responsible for ensuring that the QCL and Surveyor's responsibility, qualification, and submittals meet the intent of the Contractor.

22. (Section 4.1) Please define the passing/failure criteria of the QA/QC testing of compaction effort – density and moisture content and internal friction angle.

    Initial passing/failure criteria for compaction effort, dry density, and moisture content will be based upon an acceptance zone developed by following the procedures described in Paragraph 4.2B. For soil-bentonite mixes, the procedures described in Paragraph 4.2.C will be followed to determine the acceptance zone. The acceptance zone developed through testing described in Paragraph 4.2B&C will be confirmed in the field by the test pad program described in Paragraph 4.3.1.

23. (Section 4.1 A) The acceptable soil types based on soil classification has two "CH." Please correct this typographic error.

    Paragraph 4.1.A has been revised and the revised Section 4 is included as part of the attached Closure CQA Plan.

24. (Sections 4.1 A & 4.1 B) Please explain why the ASTM Method 2488 is proposing to be used for classifying soil type. If the soil index tests are proposed to run for this project, will the ASTM Method 2487 be more appropriate method for classifying soil type?

ASTM Method 2488 has been deleted from Paragraph 4.1.A, and soil classification will be performed as part of the conformance test per ASTM Method 2487.

25. (Sections 4.1 A, 4.2 A, & 4.2 D) Please add the test for organic content (see Section 4.1 A) to the conformance test list in Section 4.2 A. The specifications of the test item, method and frequency stated in Section 4.2 D need to match those in the Section 4.2 A. Please revise the Sections 4.2 A and 4.2 D accordingly.

    The revised Closure CQA Plan is attached as part of the revised Permit to Construct.

26. (Section 4.2 A) If the shear test (ASTM D4767) is not applicable to a low permeability soil liner consisting of the soil-bentonite mixture, please clarify what assurance is there, and how to confirm if the constructed liner has adequate shear strength, in term of an internal friction angle, exceeding the minimum engineering property stated in Section 4.1 A.

    Paragraph 4.2.A is intended to indicate that the soil component of the soil-bentonite mix will not be tested separately. However, the soil-bentonite mix will be tested in accordance with ASTM D4767 to assure adequate shear strength (internal friction angle) of the soil liner. As indicated in Paragraph 4.2.C, the procedures for determining an acceptance zone for both natural low permeability soil sources and soil bentonite mix soil liners is the same, except that the samples for soil bentonite will be extracted from a pug mill. Paragraph 4.2.A will be revised to clarify.

27. (Section 4.3.1) Please specify (i) the testing methods for testing in-place density and moisture at the test pad (ii) how to repair test holes.

    Testing methods and repair procedures are outlined in the attached Closure CQA Plan under Paragraph 4.4.1 – Field Quality Control.

28. (Section 4.3.2) Are there any requirements / specifications for the subgrade (12-inch-thick intermediate soil cover) preparation to be achieved and confirmed, accepted, & documented by the EFR or Engineer prior to installing soil liner? Please clarify.

Refer to Section 3 – Intermediate Cover, which has been included in the attached Closure CQA Plan.

29. (Section 4.4.1) To ensure the constructed soil liner has an internal friction angle greater than or equal to the criterion specified in Section 4.1, please add the QC testing of internal friction angle with adequate test frequency to this Section.

    QAL's testing method and frequency for shear testing are added to Paragraph 4.4.1.A. The QCL may perform tests as needed. However, only the results of the QAL's tests will be recognized for determining the performance of the soil liner installation.

30. (Section 5.4) Please specify the minimum thickness of the constructed vegetative cover.

    A revised Section 5 – Vegetative Cover Material has been included in the attached Closure CQA Plan, which notes that a minimum of 6-inches of vegetative material must be placed over the low-permeability soil liner.

31. The final acceptable zone, consisting moisture contents, dry unit weights and compaction for which hydraulic conductivities less then or equal to 1.0 x 10-5 cm/sec and discussed in Sections 4.2 B or 4.2 C needs to be a portion of the CQA report. Please add this to the Section 6.

    A revised Section 6 – Documentation, has been included in the attached Closure CQA Plan.

Section Four - Operations Plan

32. The Operations Plan needs include a contingency plan to address the management and handling procedures for the unexpected events & conditions including, but not limited to, equipment breakdown, spills, unusual traffic patterns, long-term power outages and natural disasters affecting operations. Please clarify.

    Section 12 – Contingency Plan in the Operations Plan has been included as part of the revised attached Permit to Construct.

33. (Section 2.3) Please add the asbestos wastes to the list of acceptable wastes and also describe the provisions to manage the disposal of asbestos wastes at the C&DLF facility in accordance with Rules .0542(b) and (c).

    Non-friable asbestos waste has been added to Section 2.2 of Operations Plan and a Section discussing acceptable waste requiring special handling has been inserted after Section 2.2 and all subsequent sections in Section 2 have been renumbered. The new Section 2.3 – Acceptable Waste Requiring Special Handling includes the necessary provisions to manage the disposal of asbestos wastes at the facility.

34. (Section 7.6) The scrap tires (Appendix C, Section 4 - The Operations Plan) and white goods (Facility Compliance Audit Report dated December 20, 2007) are listed as a recyclable waste at the C&DLF. Therefore, the Operations Plan needs to address provisions to manage white goods, scrap tires, and other recyclable wastes (scrap metals, cardboard box, etc.), if present at the C&DLF. The plan may include, but not limited to, the physical features of each type waste storage area, practices to prevent surface water from contacting wastes, the maximum allowable tonnage to be stored at any time at the facility, the estimated tonnage per month, the contact information of a contractor or recycler to handle, off-site transportation, and the frequency or schedule to remove the waste tires off-site. The temporary storage areas of the recyclable wastes must be shown on the site plan.

    Section 7.7 – Managing Recyclables has been included in the operations permit discussing managing recyclables.

35. (Section 8) Please describe the approaches to dispose of the removed sediment from the filter basins.

    Sediment removed from the filter basins will be hauled to the borrow area, dewatered, and stockpiled.

36. (Section 9) What are provisions in the Plan to ensure the C&DLF units not to violate the requirements stated in Rule .0542(I)(5)? Please clarify.

    Rule .0542(I)(5) does not exist, is this a typographic error?

37. (Appendix A – Water Quality Monitoring Plan) The Section 3.1.2 proposes to abandon existing monitoring wells GW-6 & GW-7 prior to construction of new Cell No.4. What are provisions there for well abandonment and notification in the monitoring plan? Please clarify.

    The existing monitoring wells GW-6 and GW-7 will be abandoned prior to construction along with the existing piezometers in the planned Cell 4 area. All piezometers and groundwater wells will be abandoned per 15A NCAC 2C .0113. Well abandonment records (form GW-30) will be submitted to the SWS within 2 weeks of abandonment.

38. (Appendix B – Gas Control Plan) The Section 3 needs to describe the rationality to select the locations, spacings, and depths of perimeter gas wells/probes. Please clarify.

    Section 3 has been revised to describe landfill gas monitoring well locations and planned depths. The revised Appendix B – Gas Control Plan is attached.

39. (Appendix B – Gas Control Plan) Please describe the schedules for installing the proposed 12 perimeter methane monitoring wells and for initiating the quarterly monitoring program. The well completion report could be submitted as a portion of the CQA report. Otherwise, the Gas Control Plan needs provide the schedule of the report submittal (The DWM suggests that within 30 days upon completion of wells). The written report that is signed, sealed and dated by a Professional Engineer or Professional Geologist registered in the State of North Carolina includes, but not limited to, a scaled as-built drawing depicting the locations of the gas probes which are surveyed by surveyors register in the State of North Carolina, well construction records (completed GW-1form), well & boring logs, groundwater tables, and descriptions of any deviations from the original plan. The report will also describe the schedules for the first methane gas sampling event and the follow-up quarterly sampling events.

    The 12 proposed perimeter methane monitoring wells will be installed at the same time as the proposed groundwater monitoring wells (GW-16 and GW-17). Following installation, the proposed perimeter methane monitoring wells will be allowed to sit for a period of 24-hours before initial methane monitoring data are collected. Following the initial monitoring, subsequent landfill gas monitoring events will be on a quarterly basis. A well completion report with well construction

diagrams and surveyed well locations will be forwarded to the Division within 30 days of well installation completion.

40. (Appendix B – Gas Control Plan) Please provide the typical details of the proposed 12 perimeter gas probes on the figures.

    Perimeter gas wells will be constructed in accordance with the revised Operations Plan. The revised Closure Plan and Operations Plan are included as part of the revised attached Permit to Construct. A typical methane monitoring well detail is provided on Figure 1 in Appendix B – Gas Control Plan.

41. (Appendix C – Section 3.2) Please add the asbestos wastes to the list of acceptable wastes and add the wastewater treatment sludge to the list of the prohibit wastes.

    Non-friable Asbestos waste is included in Section – 4 Operation Plan under Section 2.2 – Acceptable Waste. Septage and sludge as outlined in Section 3.2 item nos. 10 and 11 respectively are included in the list of prohibited waste at the Dare County Facility.

42. (Appendix C – Section 6, 2nd paragraph, bullet item 2) Is there a Waste Screening Plan for the Subtitle D landfill placing at the C&DLF facility? Or is this referencing the Dare County MSW transfer station facility (permit # 28-05T)? Please Clarify.

    Section 6, 2nd paragraph, bullet item no. 2 has been revised to read, "determined to contain waste prohibited, as summarized in Section 3.2, from disposal in the C&D landfill and then is diverted to the Dare County Transfer Station; or".

43. (Appendix C – Section 7) What provisions are there to prevent the repeat violation of disposal of unauthorized wastes at the C&DLF facility?

    Refer to the last paragraph in Section 7.3 – Procedures of the Waste Acceptability Plan, Appendix C in the Operations Plan.

44. (Appendix C – Section 7) Please provide the detail descriptions of the random inspection procedures including, but not limited to, inspection location, inspector's qualification/ training requirement, random sample selection process, requirements for wastes isolation and containment, and

protocols for managing the found prohibit wastes (especially for hazardous wastes and PCB wastes).

A revised Section 7 is included as part of Appendix C in the Operations Plan.

45. (Appendix C – Section 9) Could the Contingency Plan be associated and consistent with the "Hazardous Waste Management Plan annexed to the Dare County Emergency Operation Plan (http://www.co.dare.nc.us/EmgyMgmt/eop.pdf). Please clarify.

    The Contingency Plan is only included in the Dare County Cell No. 4 Permit to Construct.

Section Five – Closure Plan

46. (Section 1.1.1) The Closure Plan proposes the post-settlement grade of top surface slope will not be less than 5 percent. However, the figures in permit application document show the top surface slope of the final cap is 2 percent. Please clarify.

    All figures and drawings will be revised to show the top surface slope with a minimum slope of 5%.

47. (Section 1.1.1) The descriptions of slope stability of the final cover system in the last paragraph on Page1-1 are not consistent with those described in the Engineering Plan associated with Cell No.4 construction. Please clarify.

    The last paragraph on page 1-1 in the Engineering Plan has been revised per comments received in reference to the Post-Closure Plan Permit Modification. The revised Engineering Plan is part of the attached revised Permit to Construct and coincides with the Construction of Cap System section in the Closure Plan.

48. (Section 1.3) It is likely a typographic error of the maximum available net air space in Cells 1 through 4. Please verify.

    Section 1.3 has been revised and is included as part of this permit application.

Figure

49. It appears that the buffer distance from the east side of the waste footprint to the center line of a canal is 260 feet, not 210 feet. Please correct this typographic error on the figures –SD-1, SD-2, and C-1.

    The buffer distance from the east side of the waste footprint to the center line of the canal on Sheets SD-1, SD-2, and C-1 are a typographic errors and should read 260 feet. Revised Sheets SD-1, SD-2, and C-1 are included as part of the revised Permit to Construct.

50. The Division's record shows that the landfill property is recorded in Deed Book No. 530 Page No. 733. The notes on Figures SD-1 & SD-2 are likely wrong. Please make necessary correction.

    Sheets SD-1 and SD-2 have been revised to read Deed Book No. 530, Page No. 733. The revised Sheets SD-1 and SD-2 are included as part of the revised Permit to Construct.

51. According to the Division's Facility Compliance Audit Report dated December 20, 2007, white goods are received and temporarily stockpiled at the C&DLF facility. The temporary storage areas of the recyclable wastes (including white goods areas) need to be present on Figures SD-1 & SD-2 (see Comments 1, 32, & 33).

    Recyclables are received and stockpiled in accordance with Section 7.7 in the Operations Plan. The recyclables stockpiles locations are not provided on the Sheets SD-1 and SD-2 because there move throughout the life of the cell. They are generally located adjacent to the working cell inside the limits of the landfill.

52. The Cell No. 3 (Phase 3) is the active cell; please correct the typographic errors on Figure OP-01 & OP-02.

    Sheets OP-1 and OP-2 have been revised to read, "ACTIVE CELL NO. 3 (PHASE III)." The revised Sheets OP-1 and OP-2 are attached.

53. Please add the note of the proposed Cell No. 4 to Sheet C-1.

    Sheet C-1 has been revised to include a note that reads, "PROPOSED CELL NO. 4 (PHASE IV)." The revised Sheet C-1 is attached.

54. On Sheets C-3 and C-4 the locations of the monitoring well GW-09 and piezometers P-3 & P-6 (Sheet C-3) and P-1 (Sheet C-4) are associated with Cell No. 3, not at Cell No.4. Please add wells GW-06 & GW-07 to Sheet C-3 and update the Note 5 by including abandoned monitoring wells inside the landfill cell.

    Revised Sheets C-3 and C-4 are included in the Engineering Plan as part of the revised attached Permit to Construct.

55. The Detail E of Sheet D-2 shows the landfill base pad is typically 4 feet thick, which is different from the proposal, discussed in the Section 1.3.2.8 that proposes to construct a 5-feet thick compacted pad accounting for settlement that may occur. Please clarify.

    The reference to a 4 foot thick landfill base pad is incorrect and should read 5 feet thick. Sheet D-2 has been revised and is included as part of the revised attached Permit to Construct.

56. There are discrepancies of the gross capacity of Cells 1 & 2 between the tabulated data on Figure SD-2 and data on Figure OP-03. The final grade lines shown Figures OP-01 & OP-02 are not consistent with these on Figure OP-03. Please make necessary corrections.

    Revised facility and operations plan drawings have been included as part of this revised permit application.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

W. Michael Brinchek, P.E.
Project Manager
Camp Dresser & McKee

cc: Ed Mussler, DWM
Edward Mann, Dare County

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Dexter R. Matthews
Director

Beverly Eaves Perdue
Governor

Dee Freeman
Secretary

May 29, 2009

Mr. Edward Mann, Public Works Director
Dare County
P.O. Box 1000
Manteo, NC 27954

RE: Design Hydrogeologic Report and Water Quality Monitoring Plan
Permit to Construct Application Construction and Demolition Debris
Landfill Cell No. 4 Dare County, North Carolina
Permit N. 28-03 Document ID No. 7630

Dear Mr. Mann:

I have reviewed the Design Hydrogeologic Report for the proposed Dare County C&D Landfill Cell No. 4 expansion. The Water Quality Monitoring Plan is amended to include two new groundwater monitoring wells associated with Cell No. 4. The two new groundwater monitoring wells to be installed are GW-16, located 125 feet north of the proposed Cell No. 4 area, and GW-17, located 125 feet south of the proposed Cell No. 4 area. The current monitoring system consists of one background well, GW-1, and compliance wells GW-2, GW-3, GW-4, GW-5, GW-6, GW-7, GW-8, GW-9, GW-10, GW-11, GW-12, GW-13, GW-14, AND GW-15. Existing monitoring wells GW-6 and GW-7 are located within the proposed Cell No. 4 footprint and will be abandoned prior to construction of the new cell. There are currently three surface water sampling locations at the site, SW-1, SW-2, and SW-3. Existing surface sampling locations will remain the same.

Both the Design Hydrogeologic Report and the Water Quality Monitoring Plan meet the criteria required in 15A NCAC 13B .0538(b), 15A NCAC 13B.0540(2), and 15A NCAC 13B .0544 and therefore, this portion of the Permit to Construct application is approved. An electronic pdf format copy of the approved Hydrogeologic Report and Water Quality Monitoring Plan (Tracking Document No. 6910) can be obtained on the Solid Waste Section's website located at: http://wastenotnc.org/sw/swfacilitylist.asp

Piezometers, groundwater monitoring wells, and borings, located in proposed Cell No. 4 may be abandoned now or after a Permit to Construct is issued by the Solid Waste Section. Please adhere to the following conditions:

Prior to construction of the phase or cell(s) within the phase, all piezometers, groundwater monitoring wells, and borings located within the footprint must be properly abandoned by overdrilling first (exception of non-cased borings) and sealed with grout in accordance with 15A NCAC 2C.0113(b)(1) entitled "Abandonment of Wells".

a. In areas where soil is to be undercut, abandoned piezometers, monitoring wells, and borings must not be grouted to pre-grade land surface, but to the proposed base grade surface to prevent having to cut excess grout and potentially damaging the wells.

b. Well abandonment records (GW-30 form) for each decommissioned piezometer, boring, and groundwater monitoring well must be certified by a Licensed Geologist in accordance with rule .1623(b)(2)(1) and submitted to the Solid Waste Section in accordance with 15A NCAC 02C.0114(b).

The new groundwater monitoring wells associated with Cell No. 4 must be sampled for the Appendix I constituent list, including Mercury, Chloride, Manganese, Sulfate, Iron, specific conductance, pH, temperature, Alkalinity, and Total Dissolved Solids, prior to the Solid Waste Section issuing the Permit to Operate. In addition to a hard copy report, provide the Solid Waste Section with an electronic copy of the groundwater and surface water monitoring data collected at the landfill facility. Guidelines for sampling groundwater and surface water, and submitting data electronically can be located at the Solid Waste Section's web site: http://wastenotnc.org/swhome/technical_assistance.asp

Additional Geologic, Ground Water and Monitoring Requirements will be included in the Permit to Construct.

If you have any questions, please do not hesitate to call me at (919) 508-8506.

Sincerely,

Christine Ritter

Christine Ritter
Hydrogeologist
NC Solid Waste Section

cc: W. Michael Brinchek, P.E., Camp Dresser & McKee
Ming-Tai Chao, P.E., NC Solid Waste Section
Chuck Boyette, NC Solid Waste Section
Ed Mussler, NC Solid Waste Section

Dare County C&D Debris Landfill Cell No. 4 Permit Application Contents

Section 1 - **Facility Plan**

Section 2 - **Engineering Plan**

Section 3 - **Construction Quality Assurance Plan**

Section 4 - **Operations Plan**

Section 5 - **Closure Plan**

Section 6 - **Post-Closure Plan**

Facility Plan
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Appendices

Appendix A – Local Governmental Resolution

Attachment No. 1

Section 1
Facility Plan

1.1 Introduction

This facility plan has been prepared for the proposed development of the existing construction and demolition (C&D) landfill in Dare County, North Carolina and in accordance with North Carolina Solid Waste Rule 15A NCAC 13B .0536 (c)(2).

Rule .0536 (c)(2) requires that a conceptual plan for the development of the facility including drawings and a report must be prepared which includes the drawings and reports described in Subparagraphs (d)(1), (e)(1), (e)(2), and (e)(3) of Rule .0537. The facility plan includes the following drawings and reports:

- Site Development drawings, Rule .0537 (d)(1): The Site Development drawings must locate or delineate the following:

  (A) Delineate the areal limits of all landfill units, and incorporate the buffer requirements set forth in Item (1) of Rule .0540;

  (B) Locate all solid waste management facilities and facility infrastructure, including landfill units;

  (C) Delineate the areal limits of grading, including borrow and stockpile areas;

  (D) Define phases of development, which do not exceed approximately five years of operating capacity;

  (E) Delineate proposed final contours for the C&DLF unit(s) and facility features for closure; and

  (F) Delineate physical features including floodplains, wetlands, unstable areas, and cultural resource areas as defined in Rule .0536.

- Landfill Operation, Rule .0537 (d)(2): The Landfill Operation drawings shall relate long-term operation of the C&D landfill unit(s) including:

  (A) proposed transitional contours for each phase of development including operational grades for existing phase(s) and construction grading for the new phase; and

  (B) stormwater segregation features and details for inactive landfill subcells, if included in the design or required.

- Waste Stream, Rule .0537 (e)(1): The report shall include a discussion of the characteristics of the wastes received at the facility and facility specific management plans must incorporate:

  (A) the types of waste specified for disposal;

(B) average yearly disposal rates in tons and a representative daily rate that is consistent with the local government approval in accordance with Rule .0536 of this Section;

(C) the area served by the facility;

(D) procedures for segregated management at different on-site facilities; and

(E) equipment requirements for operation of the C&DLF unit(s).

- Landfill Capacity, Rule .0537 (e)(2): An analysis of landfill capacity and soil resources must be performed. The data and assumptions used in the analysis must be included with the facility drawings and disposal rates specified in the facility plan and representative of operational requirements and conditions. The conclusions must provide:

  (A) estimates of gross capacity of the C&DLF unit;

  (B) gross capacity for each phase of development of the C&DLF unit;

  (C) the estimated operating life of all C&DLF units in years;

  (D) required quantities of soil for landfill construction, operation, and closure;

  (E) and available soil resources from on-site.

  Gross capacity is defined as the volume of the landfill calculated from the elevation of the initial waste placement through the top of the final cover, including any periodic cover.

- Special engineering features, Rule .0537 (e)(3).

1.2 Facility Drawings

A set of facility drawings have been prepared in compliance with Rule .0537 (d). These drawings include conceptual site development and landfill operation sheets.

1.2.1 Site Development

Three drawings were prepared on topographic maps representative of existing site conditions. The first drawing, SD-1, provides the following:

1. Subparagraph (d)(1)(A) - The areal limits of all landfill units, and the buffer requirements set forth in Item (1) of Rule .0540.
2. Subparagraph (d)(1)(B) - Location of all solid waste management facilities and facility infrastructure, including landfill units.
3. Subparagraph (d)(1)(C) - The areal limits of borrow and stockpile areas.
4. Subparagraph (d)(1)(F) - Delineate physical features including floodplains, wetlands, unstable areas, and cultural resource areas as defined in Rule .0536.

Drawing SD-2 illustrates the proposed development plan for the C&D landfill (Subparagraph (d)(1)(D)). Also shown is a phase development table that depicts the planned progression for construction and operation of the C&D landfill. Each phase does not exceed approximately five years of operating capacity.

The third drawing, SD-3, depicts the areal limits of grading per Subparagraph (d)(1)(C) and delineates proposed final contours for the C&D landfill unit(s) as required by Subparagraph (d)(1)(E).

1.2.2 Landfill Operation

Three drawings, including a cross-section of the facility, were prepared detailing the long-term operation of the C&D landfill unit. Proposed transitional contours and final grades for each phase of development (Phases IV through V) are shown on Drawings OP-1 through OP-2. Also included on Drawings OP-1 and OP-2 are approximate operation grades for existing the phase (Cell No. 3). Drawing OP-3 illustrates a cross-section for the final landfill contours.

1.3 Facility Report

Rule .0537(e): This facility report contains discussions of the characteristics of the waste stream to be received at the landfill facility and of the landfill capacity.

1.3.1 Waste Stream

Per Rule .0537 (e)(1), a discussion of the characteristics of the waste received at the facility and facility specific management plans is as follows.

1.3.1.1 Types of Waste Specified for Disposal

Per the Cell No. 3 Permit to Operate, dated November 30, 2006, the County is permitted to dispose of construction or demolition debris, inert debris, land-clearing debris, asphalt, and scrap tires.

The C&D landfill units shall not receive yard trash, municipal solid waste, hazardous waste, or liquid waste.

The County will continue to dispose of waste types as specified in the current Permit to Operate.

1.3.1.2 Disposal Rates

Table 1-1 presents yearly disposal rates from the NC Annual Solid Waste Management Report and includes a representative daily rate assuming 310 operating days.

Table 1-1 – Disposal Rates

FY	Tons Disposed	Daily Rate (tons/day)
99-00	32,495	105
00-01	25,215	81
01-02	24,306	78
02-03	31,038	100
03-04	40,225	130
04-05	32,390	104
05-06	37,472	212
06-07	29,880	96
07-08	21,462*	69
Average	30,500	

* Estimated based on data from July 1, 2007 through April 31, 2008

1.3.1.3 Areas Served by the Facility

Based on the US Census Bureau, the 2000 population of Dare County was estimated to be 29,967. The North Carolina State Demographics estimates the July 2005 population to be 34,790, a 16% growth from 2000. Additionally, the North Carolina State Demographics project the population to be 38,458 and 46,455 for the years 2010 and 2020, respectively.

The Dare County C&D landfill will serve only waste streams originating from Dare County. Dare County, approximately 800 square miles in area of which 391 miles is land, includes the incorporated municipalities of Duck, Kill Devil Hills, Kitty Hawk, Manteo, Nags Head, and Southern Shores.

1.3.1.4 Segregated Management

Per Subparagraph (e)(1)(D), a discussion on procedures for segregated management at different on-site facilities must be included. There will be no C&D segregation operations since only approved C&D waste streams will be accepted and disposed.

White goods and scrap metal are accepted at the C&D landfill for recycling. All white good and scrap metal deliveries are directed to the end of the active cell after being inspected at the scale house where they are stockpiled temporarily, until a local

recycling company collects them. The stockpile area for recyclables will be properly drained to prevent standing water in the stockpile area.

1.3.1.5 Landfill Equipment

Equipment currently owned by the County and utilized at the C&D landfill includes the following:

- 1 - D6 CAT dozer
- 1 - 320 CAT excavator
- 1 - John Deere 650 dozer
- 1 - Daewu 220
- 3 - Mac dump trucks
- 1 - Gallon motor grader
- 1 - Kabota 105 Farm tractor
- 1 - WRS grinder

No additional equipment purchases are anticipated as a result of expanding the C&D disposal capacity.

1.3.2 Landfill Capacity

1.3.2.1 Gross Capacity

The Earthworks Module of Softdesk software was used to estimate the gross capacity between the base grades and the top of the proposed final cover grades for the proposed C&D landfill (Cells 1 through 5). The gross capacity (waste and daily, intermediate, and final cover) of Cells 1 through 5 is approximately 1,571,800 cubic yards (yd^3).

1.3.2.2 Phased Gross Capacity

The Earthworks Module of Softdesk software was used to estimate the phased gross capacity and is presented in Table 1-2.

Table 1-2 – Phased Gross Capacity

Phase	Gross Capacity (yd^3)
IV	326,900
V	326,900
Total	653,800

1.3.2.3 Soil Required for Landfill Construction

Soil is required for landfill construction to establish the required minimum four feet separation between the bottom elevation of waste and seasonal high groundwater table. The above gross capacity is calculated from the top of five feet, accounting for any potential settlement that may occur. Based on the Geotechnical Evaluation, the proposed landfill configuration is not anticipated to experience settlement greater than 12 inches.

1.3.2.4 Soil Required for Final Cover

The final cover material volume required to construct the three-foot thick cover system for each phase is determined by delineating final slopes (see Table 1-3).

Required Final Cover = Final Cover Area x 3-foot Thick Cover System

1.3.2.5 Soil Required for Operations

It is anticipated that a 4:1 waste to cover ratio will be achieved. Table 1-3 presents the daily and intermediate cover soil required is, therefore, calculated as:

Required Daily and Intermediate Cover = (Gross Capacity – Final Cover) x 20% Cover

1.3.2.6 Net Capacity

Table 1-3 presents the net capacity available for C&D debris disposal is calculated as:

Net Capacity = Gross Capacity – Final Cover – Daily and Intermediate Cover

1.3.2.7 C&D Landfill Operating Life

The first step in calculating the operating life of each C&D landfill phase is to convert available net airspace to available C&D debris tonnage. Assuming the C&D in-place density is 1,000 lbs/cy

Available Tonnage = Net Capacity x 1,000 lb/ yd^3 x 1 ton/2,000 lb

The average disposal rate for the C&D landfill from FY99-00 to FY07-08 is approximately 30,500 tons per year from Table 1-1. An average disposal rate of 30,500 tons per year is used in the following calculation. Table 1-3 presents the estimated operating life for the C&D disposal unit is, therefore, calculated as:

Operating Life = Available Tonnage/Average Disposal Rate

Table 1-3 – Operating Life

Phase	Final Cover Area (Acre)	Soil Required (yd^3)			Available Net Airspace (yd^3)	Operating Life (Yrs)
		Final Cover	Operations	TOTAL		
IV	11.3	54,690	54,442	109,132	217,768	3.5
V	11.3	54,690	54,442	109,132	217,768	3.5
TOTAL				**218,264**	**435,536**	**7.0**

1.3.2.8 Net Balance of On-site Soils

Earthwork fill volume associated with the construction of each phase of the C&D landfill was estimated based on the five feet thick pad construction. It is assumed that Phases IV and V construction will require three feet of subgrade fill in addition to the two feet pad. Table 1-4 presents the net soil required for construction and operation of each phase and was calculated by the following:

Fill + Final Cover + Daily and Intermediate Cover = Net Soil Required

Table 1-4 – Net Soils Balance

Phase	Base Grade Area (Acre)	Net Soil Required (yd^3)			
		Construction	Final Cover	Operations	TOTAL
IV	11.3	91,200	54,690	54,442	200,332
V	11.3	91,200	54,690	54,442	200,332

Soil materials for construction of the landfill base and cap will be obtained from the on-site borrow pit in accordance with the previously approved excavation plan submitted within the June 1994 Construction Plan.

1.3.3 Special Engineering Features

1.3.3.1 Containment and Environmental Control Systems

1.3.3.1.1 Closure Cap System

A closure cap will be designed and constructed to reduce the infiltration and erosion per Rule .0543(c)(1). The cap system must be designed and constructed to:

(A) have a permeability less than or equal to soils underlying the landfill, or the permeability specified for the final cover in the effective permit, or a permeability no greater than 1.0×10^{-5} cm/sec, whichever is less;

(B) minimize infiltration through the closed C&DLF unit by the use of a low-permeability barrier that contains a minimum 18 inches of earthen material; and

(C) minimize erosion of the cap system and protect the low-permeability barrier from root penetration by use of an erosion layer that contains a minimum of 18 inches of earthen material that is capable of sustaining native plant growth.

The closure cap post-settlement surface slopes must be between 5 and 33 percent. A gas venting or collection system must be installed below the low-permeability barrier to minimize pressures exerted on the barrier.

1.3.3.1.2 Sedimentation and Erosion Control

A Sedimentation and Erosion Control Plan was submitted and approved on May 8, 2002 by the Department of Environment and Natural Resources, Land Quality Section for 81-acre area of disturbance. Internal stormwater berms will be utilized to minimize the amount of stormwater that comes in contact with waste. Temporary erosion control measures, such as silt fences, fast germinating vegetation, rock check dams, etc. will be installed as necessary to reduce the amount of sedimentation and erosion during construction activities. The Erosion Control Plan for the Cell No. 4 Expansion will be submitted to the Department of Environment and Natural Resources, Land Quality Section, and upon approval a copy of the approval letter will be forwarded to the Division of Waste Management, Solid Waste Section.

1.3.3.2 Landfill Base

Per Rule .0540(2), each proposed phase will be constructed so that the post-settlement bottom elevation of waste is a minimum of four feet above the seasonal high groundwater table as established in the Design Hydrogeological Report. Additionally, in-situ or modified soils for the upper two feet of separation for the four foot separation requirement will consist of the following: SC, SM, ML, CL, MH, or CH soils per Unified Soil Classification System.

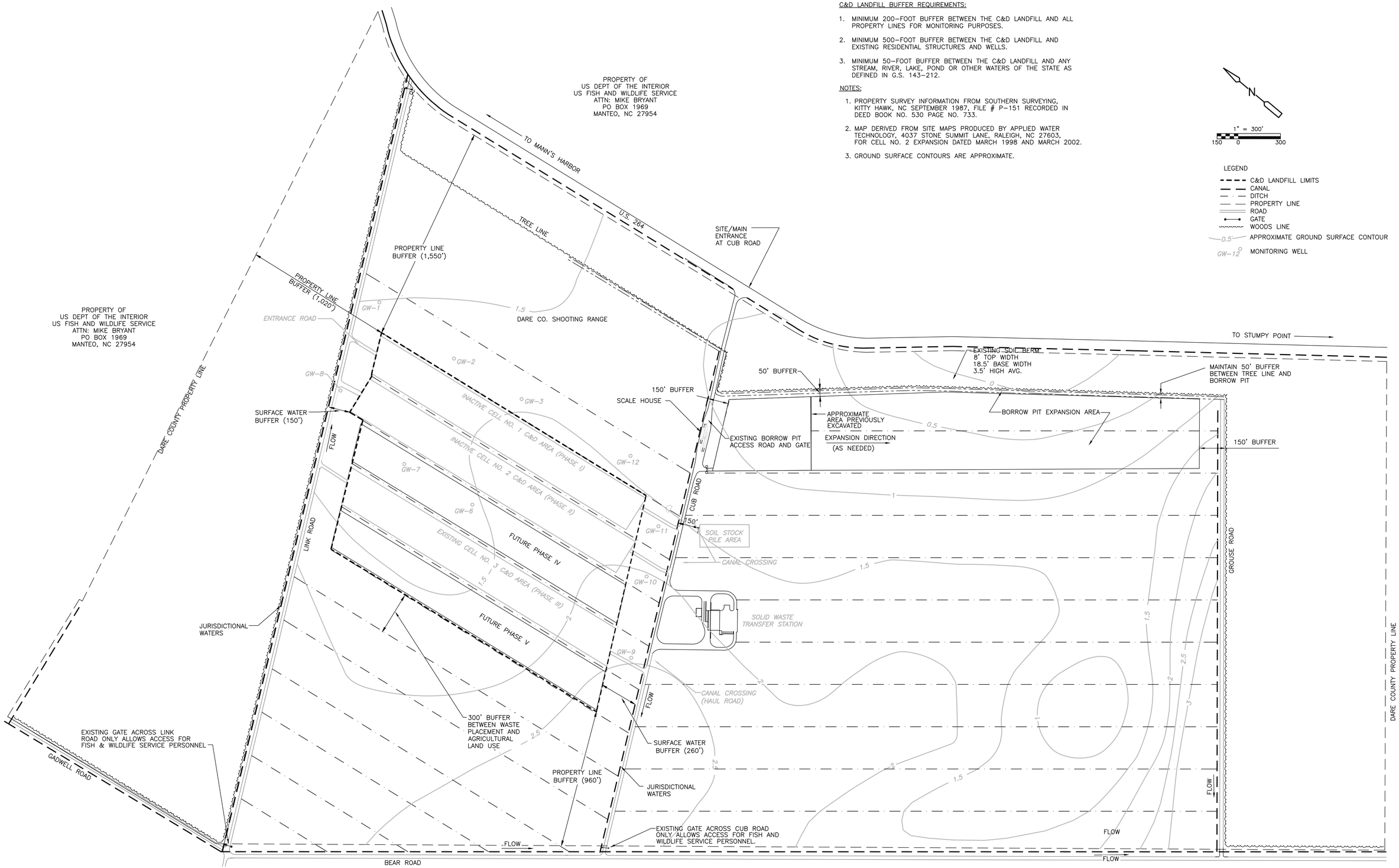
Facility Plan Drawings

C&D LANDFILL BUFFER REQUIREMENTS:

1. MINIMUM 200-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ALL PROPERTY LINES FOR MONITORING PURPOSES.
2. MINIMUM 500-FOOT BUFFER BETWEEN THE C&D LANDFILL AND EXISTING RESIDENTIAL STRUCTURES AND WELLS.
3. MINIMUM 50-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ANY STREAM, RIVER, LAKE, POND OR OTHER WATERS OF THE STATE AS DEFINED IN G.S. 143-212.

NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 733.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. GROUND SURFACE CONTOURS ARE APPROXIMATE.



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

CDM
Camp Dresser & McKee
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consulting • engineering • construction • operations

DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

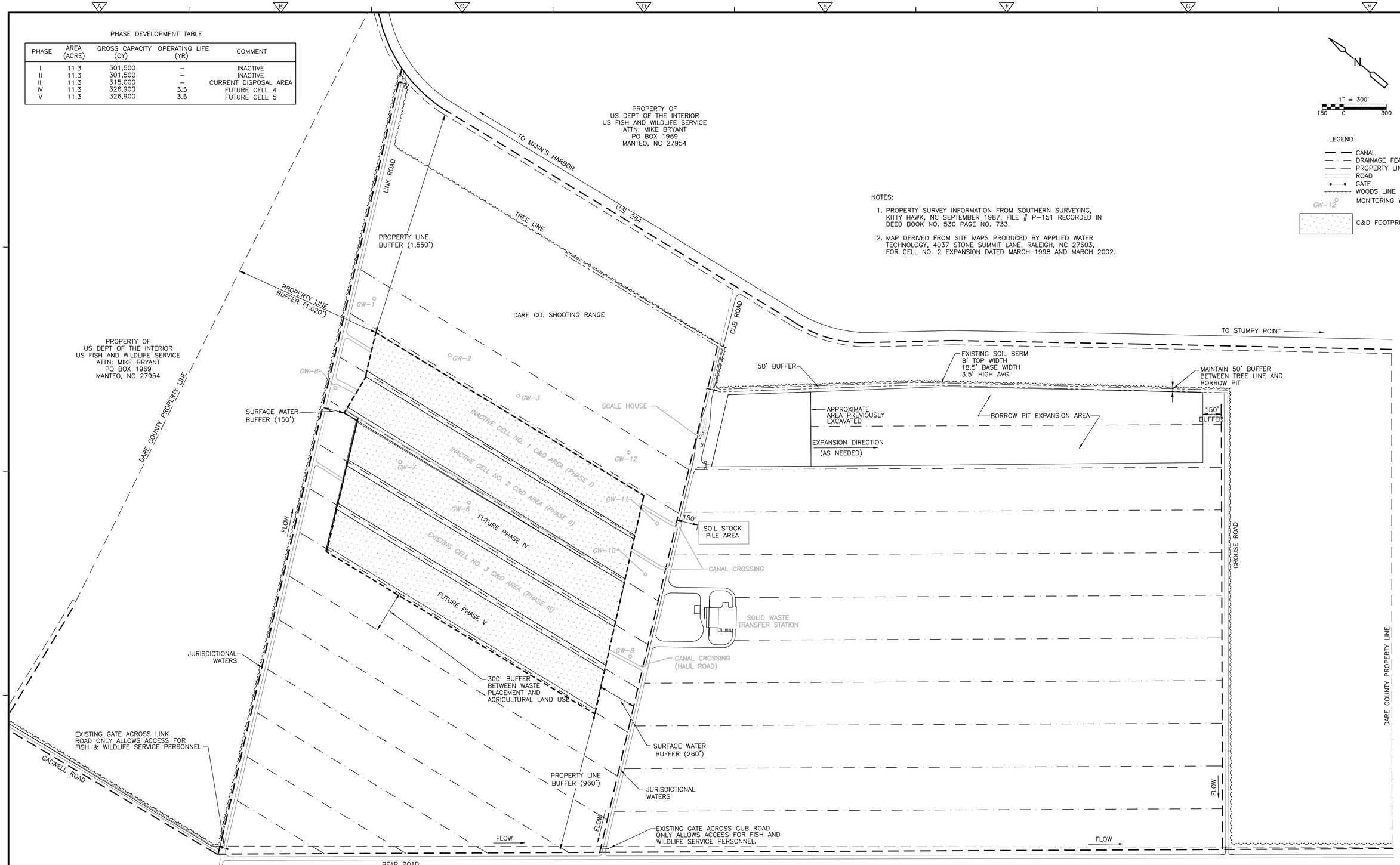
EXISTING CONDITIONS

PROJECT NO. 17952-56960
FILE NAME: SD-1
SHEET NO.
SD-1

NOT FOR CONSTRUCTION

PHASE DEVELOPMENT TABLE

PHASE	AREA (ACRE)	GROSS CAPACITY (CY)	OPERATING LIFE (YR)	COMMENT
I	11.3	301,500	–	INACTIVE
II	11.3	301,500	–	INACTIVE
III	11.3	315,000	–	CURRENT DISPOSAL AREA
IV	11.3	326,900	3.5	FUTURE CELL 4
V	11.3	326,900	3.5	FUTURE CELL 5



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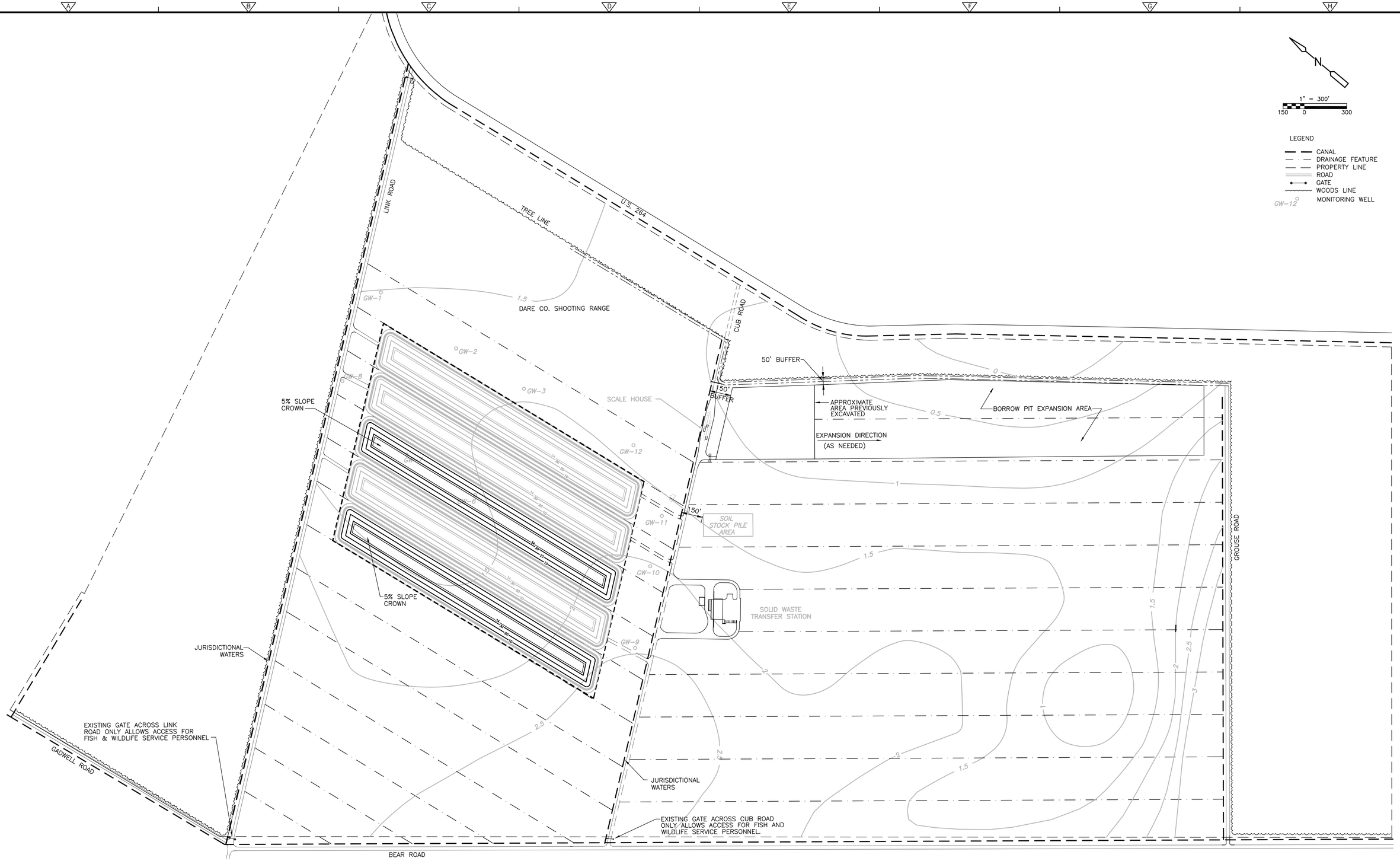
DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

PROPOSED CONDITIONS

PROJECT NO. 17952-56960
FILE NAME: SD-2
SHEET NO.
SD-2

NOT FOR CONSTRUCTION



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

CDM
Camp Dresser & McKee
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Raleigh, NC 27612
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consulting • engineering • construction • operations

DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

PROPOSED FINAL CLOSURE PLAN

PROJECT NO. 17952-56960
FILE NAME: SD-3
SHEET NO.
SD-3

NOT FOR CONSTRUCTION

Appendix A
Site Location Restrictions

Section 2
Characterization Study

2.1 Introduction

Rule .0536 (c)(1) of the North Carolina Solid Waste Management Rules requires that a site characterization study including a 2,000-foot perimeter area measured from the proposed boundary of the landfill facility be submitted with the site study. The study must include an aerial photograph taken within one year of the original submittal date, a report, and a local map. The map and photograph must be at a scale of at least one inch equals 400 feet. The characterization study must include a report and maps identifying the following:

- The entire property proposed for the disposal site and any on-site easements;
- Existing land use and zoning;
- The location of residential structures and schools;
- The location of commercial and industrial buildings, and other potential sources of contamination;
- The location of potable wells and public water supplies;
- Historic sites;
- State nature and historic preserves;
- The existing topography and features of the disposal site including: general surface water drainage patterns and watersheds, 100-year floodplains, perennial and intermittent streams, rivers and lakes; and
- The classification of the surface water drainage from landfill site in accordance 15A NCAC 02B .0300.

2.2 Proposed Disposal Site

The proposed landfill facility site is shown on Figure 2-1. The aerial photograph was obtained from the County. There are no public utility easements within the 2,000-foot perimeter of the existing facility boundary.

2.3 Existing Land Use and Zoning

The C&D landfill property is owned by the County. The site of the C&D landfill is cleared cropland that has a naturally high water table and is currently ditched and drained through a pumping station belonging to the US Fish and Wildlife Service (USFWS). The artificial drainage system maintains the groundwater level approximately 1-2 feet below the ground surface during the wetter months of the year. The non-cleared land on the 836 acre tract (approximately 311 acres) is Section 404 wetlands. However, the remaining 525 acres of cropland has been designated "prior converted cropland" and is not considered "wetlands".

2.4 Residential Structures and Schools

Based on NC OneMap program data (updated December 2006) from NCDENR Center for Geographic Information and Analysis (CGIA), there are no residential structures or schools within the 2,000-foot perimeter as shown on Figures 2-2. The nearest school, Manteo Middle located in Manteo, is approximately 11 miles away from the facility boundary.

2.5 Potential Sources of Contamination

Based on the aerial photograph presented in Figure 2-1, there are no commercial or industrial buildings located within the 2,000-foot perimeter of the facility boundary. There were no existing buildings within the 2,000-foot perimeter prior to the C&D landfill facility. From NC OneMap program data (updated October 2003) from NCDENR, CGIA, no nearby livestock farms (e.g. hog farms, etc.) were identified up- or down-gradient of the facility boundary.

2.6 Potable Wells and Public Water Supplies

Based on NC OneMap program data (updated May 2005) from NCDENR, CGIA, there are no potable wells or public water supply sources within 2,000 feet of the facility boundary. The closest public water supply source is a camp ground well west of the Croatan Sound Bridge approximately 4 miles away from the facility boundary.

2.7 Historic Sites

Based on Figure 2-3 provided by the North Carolina Historic Sites Section website, there are no National Register buildings or sites within the 2,000-foot perimeter of the proposed facility boundary. There are also no historic districts or zones within that area. The closest National Register Historic Place is the Roanoke Island Festival Park which is approximately 11 miles northeast of the facility boundary.

2.8 State Nature and Historic Preserves

Based on NC OneMap program data (updated March 2006) from NCDENR, CGIA, there are no state nature or historic preserves within the 2,000-foot perimeter of the facility boundary. The closest state nature preserve is the NC Wildlife Resources Commission Roanoke Island Marshlands approximately 10 miles away from the facility boundary.

2.9 Topography and Features of the Disposal Site

Section 3: Facility Plan drawings present the existing topography of the site. The topography for the site is generally flat with elevations from 1.5 to 2.5 feet above mean sea level. The highest elevations occur in the west-central to north-western areas of the site. The lowest areas are located along the tree line on the eastern edge of the cleared area. The typical surface gradient across the site is 0.2 feet per 1000 feet.

2.9.1 Surface Water Drainage Patterns

As stated in Section 2.3, the USFWS operates a pump station to the west of the facility to maintain the groundwater level. Therefore, surface water generally flows westward along channels parallel to Cub and Link Roads.

2.9.2 Floodplains

As stated in Section 1, the Dare County C&D landfill facility site has been previously approved as a MSW landfill facility and all landfill siting criteria have been met. The Site Plan was approved in January 1993, but the County decided to construct a C&D landfill instead of the planned MSW landfill.

Since the facility lies within a 100-year floodplain, the Dare County Board of Commissioners adopted a resolution on August 2, 2004 granting a variance to the County's flood hazard ordinance for the facility (see Attachment 2-1).

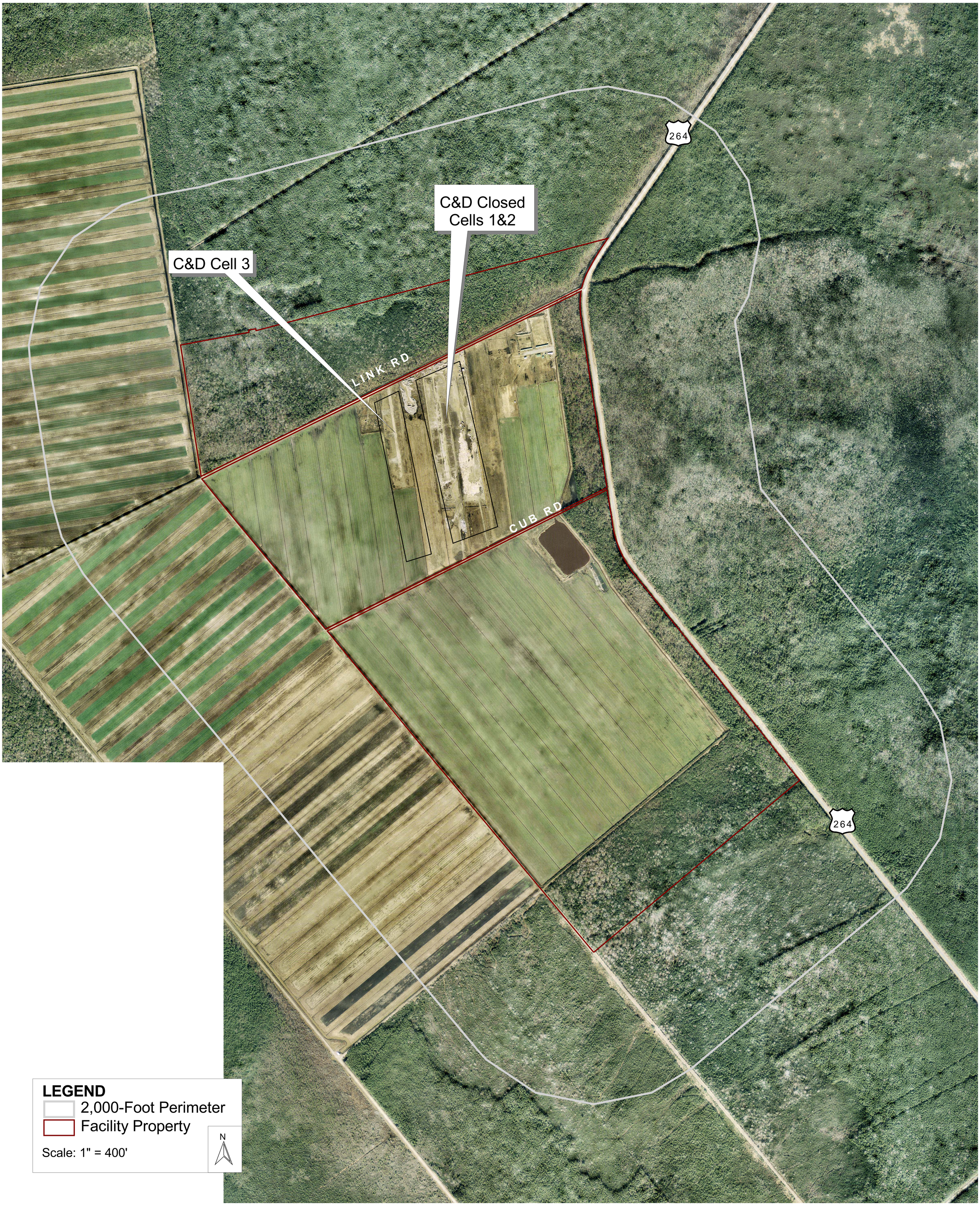
The Dare County Board of Commissioners have passed a revised resolution, dated August 2, 2004 issuing a variance to include the C&D landfill expansion in the 100-year floodplain in accordance with N.C.G.S. 143-215.54A (see Attachment 2-1).

2.9.3 Streams, Rivers, and Lakes

There are no jurisdictional or waters-of-the-state within the 2,000-foot perimeter area.

2.10 Classification of the Surface Water Drainage

Based on the NCDENR Division of Water Quality NC Waterbodies Listed by County data (see Attachment 2-2), surface water drainage from the landfill site will eventually lead to the Long Shoal River (Page 6). The current surface water classification is Class C and SW (Swamp Waters), which are not restrictive classifications for landfill siting. The Dare County C&D landfill operates under National Pollutant Discharge Elimination System (NPDES) General Permit NCG120000 and, therefore, is required to perform surface water monitoring and reporting.



CDM

Figure 2-1
Aerial Photograph

drained through a pumping station belonging to the US Fish and Wildlife Service (USFWS). The artificial drainage system maintains the groundwater level approximately 1-2 feet below the ground surface during the wetter months of the year. The non-cleared land on the 836 acre tract (approximately 311 acres) is Section 404 wetlands. However, the remaining 525 acres of cropland has been designated "prior converted cropland" and is not considered "wetlands".

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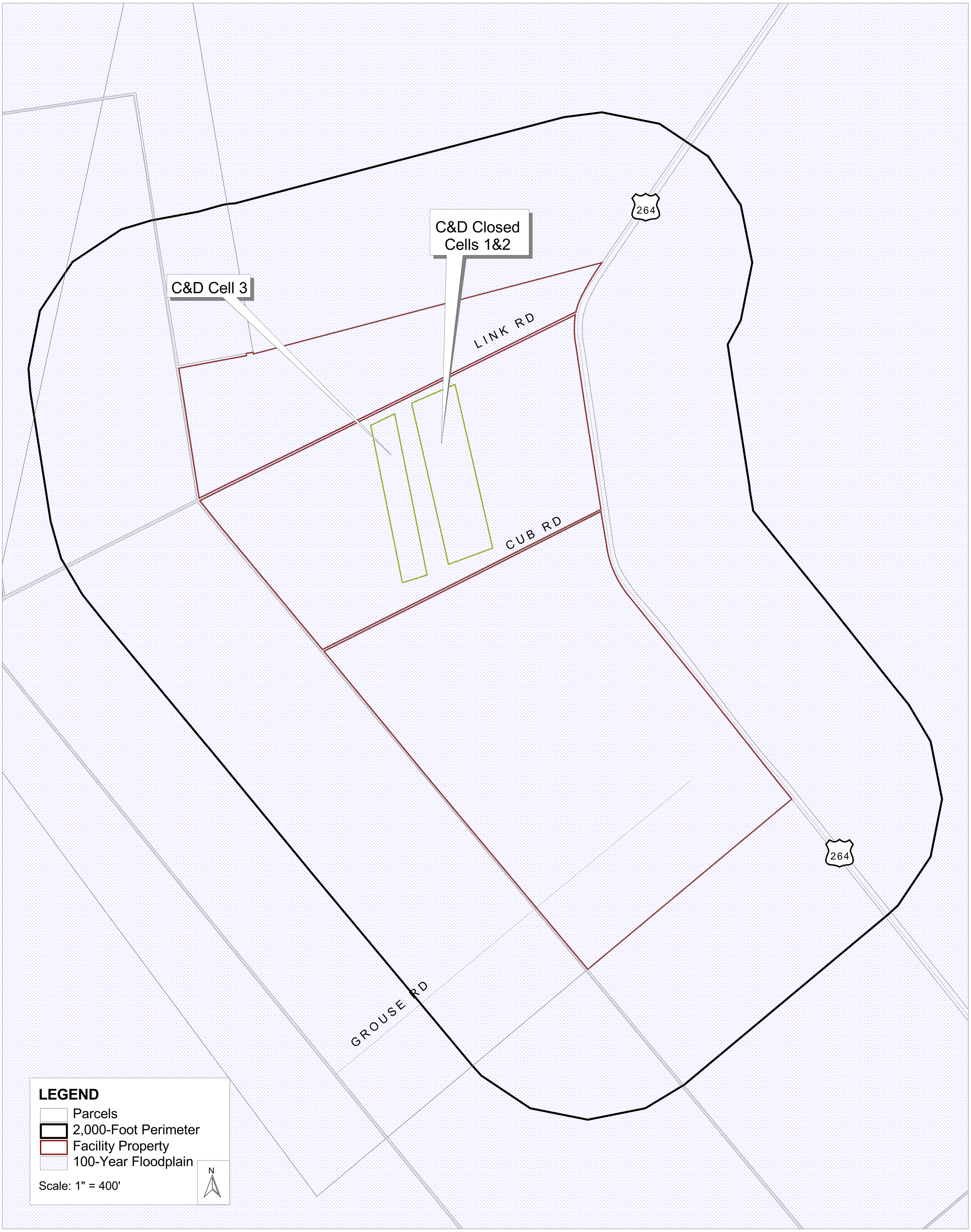

CDM

Figure 2-2
Characterization Map

Figure 2-3
North Carolina Historic Sites

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The Dare County Board of Commissioners have passed a revised resolution, dated August 2, 2004 issuing a variance to include the C&D landfill expansion in the 100-year floodplain in accordance with N.C.G.S. 143-215.54A (see Attachment 2-1).

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There are no jurisdictional or waters-of-the-state within the 2,000-foot perimeter area.

2.10 Classification of the Surface Water Drainage

Based on the NCDENR Division of Water Quality NC Waterbodies Listed by County data (see Attachment 2-2), surface water drainage from the landfill site will eventually lead to the Long Shoal River (Page 6). The current surface water classification is Class C and SW (Swamp Waters), which are not restrictive classifications for landfill siting. The Dare County C&D landfill operates under National Pollutant Discharge Elimination System (NPDES) General Permit NCG120000 and, therefore, is required to perform surface water monitoring and reporting.

ATTACHMENT 2-1

Dare County Board of Commissioners Resolution dated August 2, 2004

DARE COUNTY BOARD OF COMMISSIONERS

RESOLUTION
Approving Permits for Expansion of C&D Cells
at the Dare County Landfill

WHEREAS, the Dare County Board of Commissioners has previously authorized and funded the expansion of solid waste disposal storage capacity at the Dare County landfill in Stumpy Point by constructing new C&D disposal cells; and

WHEREAS, the Dare County landfill is located in an area identified as being in a 100 year floodplain; and

WHEREAS, the Dare County Board of Commissioners has adopted a land use plan and ordinances regulating uses in flood hazard areas (Chapter 151 of the Dare County Code of Ordinances), and that the County may grant variances to its flood hazard ordinance pursuant to §151.47 of the Dare County Code of Ordinances; and

WHEREAS, pursuant to N.C.G.S. § 143-215.54A(b), the Dare County Board of Commissioners finds that constructing new C&D cells at the Dare County landfill serves a critical need of the County in providing additional disposal areas for the County's growing resident and visitor population; that there is no feasible location elsewhere in Dare County for additional C&D cells; that the design of all additional C&D cells will comply with N.C.G.S. § 143-215.54A(b)(3); and that these cells otherwise comply with all other applicable county laws and ordinances.

NOW, THEREFORE, BE IT RESOLVED that the Dare County Board of Commissioners hereby grants prior approval for the issuance of a sanitary landfill permit for new C&D disposal cells by the Division of Waste Management to Dare County, said new cells to be established at the existing Dare County landfill located in Stumpy Point, North Carolina, within the territorial jurisdiction of Dare County. The Dare County Board of Commissioners hereby approves of the following items related to this proposed expansion:

1. The population and area to be served consists of the residents and visitors of Dare County, including the County's incorporated municipalities;

2. The type of debris to be disposed of consists of C&D debris collected by the County's Department of Public Works, the County's incorporated municipalities, and private contractors and citizens;

3. The airspace of existing C&D cells #1 and #2 may be increased by an additional ten feet of vertical height expansion; and

4. The airspace of proposed new cells #3, #4, and #5 may be increased by an additional ten feet of vertical height expansion.

Adopted this the 2nd day of August, 2004.

DARE COUNTY BOARD OF COMMISSIONERS

By: _____
Warren Judge, Chairman

ATTEST:

_____
Fran Harris, Clerk to the Board

PRINTED ON RECYCLED PAPER

ATTACHMENT 2-2

Surface Water Classification

North Carolina Waterbodies Listed by County

Report Date: 02/26/07
Records Found: 107

Note: Waterbodies are listed in more than one county if they cross county lines.

Search Parameters:
County: Dare
Class:
SpDes:
Name:
Desc:
Index#:

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Dare County						
ALBEMARLE SOUND	All waters south and east of a line running in a southerly direction from Horniblow Point (North end of Norfolk-Southern Railroad Bridge) to a point of land on the east side of Roanoke River (a line running along the railroad to the Chowan-Washington County Line, thence west along the Chowan-Washington County Line to the Bertie-Washington County Line, thence along the Bertie-Washington County Line to a point 0.1 mile above the mouth of Roanoke River, thence south east 0.1 mile to the east side of Roanoke River	SB	07/01/73		Pasquotank	30
Currituck Sound	From source to Wright Memorial Bridge at Albemarle Sound	SC	04/06/61		Pasquotank	30-1
Jean Guite Creek	From source to Currituck Sound	SC	04/06/61		Pasquotank	30-1-17
Alligator River	From mouth of Northwest Fork to U. S. Hwy. 64	SC;Sw,ORW	01/01/90		Pasquotank	30-16-(7)
Swan Creek (Swan Creek Lake)	From source to Alligator River	C;Sw,ORW	01/01/90		Pasquotank	30-16-15
Whipping Creek (Whipping Creek Lake)	From source to Alligator River	C;Sw,ORW	01/01/90		Pasquotank	30-16-16
Milltail Creek	From source to Alligator River	SC;Sw,ORW	01/01/90		Pasquotank	30-16-20
Boat Bay	Entire Bay	SC;Sw,ORW	01/01/90		Pasquotank	30-16-20-1

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Sandy Ridge Gut (Sawyer Lake)	From source to Milltail Creek	C;Sw,ORW	01/01/90		Pasquotank	30-16-20-2
Alligator River	From U.S. Hwy. 64 to Albemarle Sound	SC;Sw	04/06/61		Pasquotank	30-16-(21.5)
East Lake	Entire Lake	SC;Sw	04/06/61		Pasquotank	30-16-23
The Frying Pan	From source to East Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-1
South Lake	From source to East Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2
Northeast Prong South Lake	From source to South Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2-1
Liehue Gut	From source to Northeast Prong South Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2-1-1
Hooker Gut	From source to South Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2-2
Billys Ditch	From source to Hooker Gut	C;Sw	07/01/73		Pasquotank	30-16-23-2-2-1
Deer Creek	From source to South Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2-3
Deep Bay	Entire Bay	SC;Sw	04/06/61		Pasquotank	30-16-23-2-4
Broad Creek	From source to South Lake	SC;Sw	04/06/61		Pasquotank	30-16-23-2-5
Tom Mann Creek	From source to Albemarle Sound	SC	04/06/61		Pasquotank	30-17
Peter Mashoes Creek	From source to Albemarle Sound	SC	04/06/61		Pasquotank	30-18
Gar Gut (Davis Pond)	From source to Peter Mashoes Creek	SC	04/06/61		Pasquotank	30-18-1
Spence Creek	From source to Peter Mashoes Creek	SC	04/06/61		Pasquotank	30-18-2
Poster Gut	From source to Spence Creek	SC	04/06/61		Pasquotank	30-18-2-1
Kitty Hawk Bay	Entire Bay	SC	04/06/61		Pasquotank	30-19
Colington Creek	From Kill Devil Hills Bridge north to Kitty Hawk Bay	SC	04/06/61		Pasquotank	30-19-1
Duck Pond Creek	From source to Kitty Hawk Bay	SC	04/06/61		Pasquotank	30-19-2
Croatan Sound	From a line running from a point of land on the southern side of mouth of Peter Mashoes Creek on Dare County mainland to Northwest Point on Roanoke Island to a line west to Reeds Point on the Dare County mainland	SB	08/01/90		Pasquotank	30-20-(1)

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Croatan Sound	From Northwest Point on Roanoke Island following a line west to Reeds Point on the Dare County mainland to a line running from a point of land just below Long Wretch Creek on Dare County mainland to the Southern tip of Smith Island south of Roanoke Island	SA;HQW	08/01/90		Pasquotank	30-20-(2)
Spencer Creek	From source to Croatan Sound	SA;HQW	04/06/61		Pasquotank	30-20-3
Unnamed Canal at Manns Harbor	From source to Spencer Creek	SC	04/06/61		Pasquotank	30-20-3-1
Callaghan Creek	From source to Croatan Sound	SA;HQW	04/06/61		Pasquotank	30-20-4
Baum Creek	From source to Croatan Sound	SA;HQW	04/06/61		Pasquotank	30-20-5
Oyster Creek	From source to Croatan Sound	SA;HQW	04/06/61		Pasquotank	30-20-6
Cedar Bush Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-20-7
Cut Through	Entire Area of the Cut Through	SA;HQW	04/06/61		Pasquotank	30-20-8
Hog I Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-20-9
Long Wretch Creek	From source to Croatan Sound	SA;HQW	04/06/61		Pasquotank	30-20-10
Smith Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-20-11
Roanoke Sound	From a line running from Northwest Point on Roanoke Island northward to Rhodoms Point on Colington Island, thence a line running eastward through Wright Memorial Monument, to a line running from the southern tip of Smith Island south of Roanoke Island to southern tip of Bodie Island at North Point.	SA;HQW	07/01/73		Pasquotank	30-21
Buzzard Bay	Entire Bay	SC	04/06/61		Pasquotank	30-21-1
Colington Creek	From Kill Devil Hills Bridge south to Buzzard Bay	SC	04/06/61		Pasquotank	30-21-1-1
Otis Cove	Entire Bay	SC	04/06/61		Pasquotank	30-21-2
Shallowbag Bay	Entire Bay	SC	04/06/61		Pasquotank	30-21-3
Scarboro Creek	From source to the narrows	SC;HQW	08/01/90		Pasquotank	30-21-3-1-(1)

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Scarboro Creek	From the narrows to Shallowbag Bay	SC	04/01/61		Pasquotank	30-21-3-1-(2)
Doughs Creek	From source to Shallowbag Bay	SC;HQW	08/01/90		Pasquotank	30-21-3-2
Pond Island	The waters surrounding the Island within 1,000 feet from shore	SA;HQW	12/13/79		Pasquotank	30-21-4
Johns Creek	From source to Roanoke Sound	SA;HQW	04/06/61		Pasquotank	30-21-5
Sand Beach Creek	From source to Johns Creek	SA;HQW	04/06/61		Pasquotank	30-21-5-1
Rockhall Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-21-6
Broad Creek	From source to Roanoke Sound	SA;HQW	04/06/61		Pasquotank	30-21-7
Mill Landing Creek (Mill Creek)	From source to Roanoke Sound	SC	04/06/61		Pasquotank	30-21-8
Georges Creek	From source to Roanoke Sound	SA;HQW	04/06/61		Pasquotank	30-21-10
Lighthouse Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-21-11
Blossie Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-21-12
Motts Creek	From source to Roanoke Sound	SC	04/06/61		Pasquotank	30-21-13
Pamlico Sound	From Croatan and Roanoke Sounds to a line running from Sandy Point south of Stumpy Point Bay to the northeast tip of Ocracoke Island	SA;HQW	04/06/61		Pasquotank	30-22
Oregon Inlet	Entire Inlet	SA;HQW	04/06/61		Pasquotank	30-22-1
Eagle Nest Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-2
Goat Island Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-3
The Trench	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-4
Pea Island Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-22-5
Pea Island Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-6
Terrapin Creek Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-7
Terrapin Creek	From source to Terrapin Creek Bay	SA;HQW	04/06/61		Pasquotank	30-22-7-1
Stumpy Point Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-8
Back Lake	Entire Lake and connecting canal to Stumpy Point Bay	C;Sw	09/01/74		Pasquotank	30-22-8-1
Beach Slue	Entire area of Beach Slue	SA;HQW	04/06/61		Pasquotank	30-22-9
Wreck Creek	Entire Creek	SA;HQW	04/06/61		Pasquotank	30-22-10
Round Hammock Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-11
Pauls Ditch	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-12

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Blackmar Gut	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-13
North Drain	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-14
Midgett Cove	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-15
Clarks Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-16
No Ache Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-17
Gull Island Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-18
Phipps Cove	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-19
The Drain	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-20
Spencer Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-21
Mill Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-22
Peters Ditch	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-23
Askins Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-24
Boat Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-25
Long Point Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-26
Cape Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-27
Brooks Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-28
Joe Saur Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-29
Sandy Bay	Entire Bay	SA;HQW	04/06/61		Pasquotank	30-22-30
The Slash	From source to Sandy Bay	SA;HQW	04/06/61		Pasquotank	30-22-30-1
Duck Ponds and Isaac Pond	Entire ponds and connecting streams to The Slash	SA;HQW	04/06/61		Pasquotank	30-22-30-1-1
Austin Creek (Clubhouse Creek)	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-31
Goose Creek	From source to Pamlico Sound	SA;HQW	04/06/61		Pasquotank	30-22-32
Fresh Water Lake at Kill Devil Hills	Entire Lake	WS-III;CA	08/03/92		Pasquotank	30-23

Section 5
Location Restrictions

5.1 Introduction

Rule .0536 (b) states that new C&DLF unit(s) and lateral expansions must comply with the siting criteria set forth in Paragraph (c) of this Rule, Subparagraphs (4) through (10). In order to demonstrate compliance with specific criteria for each of the respective location restrictions, documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section may be required. The scope of demonstrations including design and construction performance must be addressed in the site study. The location restriction criteria include:

- Floodplains;
- Wetlands;
- Unstable Area;
- Cultural Resources;
- State Nature and Historic Preserves;
- Water Supply Watersheds; and
- Endangered and Threatened Species.

CDM has reviewed available information pertaining to location restriction criteria relative to the proposed Dare County C&D landfill expansion. The following sections summarize the findings.

5.2 Floodplains

Rule .0536 (c)(4), floodplain location restrictions, states:

(A) C&DLF units or constructed embankments used to construct a C&DLF unit must not be located in a 100-year floodplain unless a variance for the facility has been issued in accordance with N.C.G.S. 143-215.54A.

(B) C&DLF units must not be located in floodplains unless the owners or operators demonstrate that the unit will not restrict the flow of the flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.

As stated in Section 1, the facility is currently accepting and disposing of C&D waste per the 1993 approved Site Plan. The facility is within the 100-year floodplain, but an August 2004 Dare County Board of Commissioners Resolution issued a variance to solid waste operations within the location restriction (see Attachment 5-1).

The Dare County Board of Commissioners have passed a revised resolution, dated August 2, 2004 issuing a variance to include the C&D landfill expansion in the 100-year floodplain in accordance with N.C.G.S. 143-215.54A (see Attachment 5-1).

5.3 Wetlands

5.3.1 Regulatory Background

Rule .0536 (c)(5) requires that new C&DLF units or lateral expansions must not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

(A) Where applicable under Section 404 of the Clean Water Act or applicable State wetlands laws, the presumption that a practicable alternative to the proposed landfill facility is available which does not involve wetlands is clearly rebutted.

(B) The construction and operation of the C&DLF unit(s) will not cause or contribute to violations of any applicable State water quality standards and will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.

(C) The construction and operation of the C&DLF unit(s) will not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. The construction and operation of the C&DLF unit(s) will not violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(D) The construction and operation of the C&DLF unit(s) will not cause or contribute to significant degradation of wetlands.

(E) The owner or operator must demonstrate the integrity of the C&DLF unit(s) and its ability to protect ecological resources by addressing the following factors: (1) erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the C&DLF unit; (2) erosion, stability, and migration potential of dredged and fill materials used to support the C&DLF unit; the volume and chemical nature of the waste managed in the C&DLF unit; (3) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste; (4) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and (5) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected to the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws.

(F) The owner or operator must demonstrate that steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and

function) by first avoiding impacts to wetlands to the maximum extent practicable as required by Part (c)(5)(A) – (D) of this Rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands).

(G) The owner or operator must also demonstrate that sufficient information is available to make a reasonable determination with respect to each of the demonstrations required by this Rule.

5.3.2 Compliance Issues

The site of the C&D landfill is cleared cropland. The non-cleared land on the 836 acre tract (approximately 311 acres) is Section 404 wetlands. However, the remaining 525 acres of cropland has been designated "prior converted cropland" and is not considered "wetlands".

5.4 Unstable Area

5.4.1 Regulatory Background

Rule .0536 (c)(6) states that owners and operators of new C&DLF unit(s) and lateral expansions proposed for location in an unstable area must demonstrate that engineering measures have been incorporated in the C&DLF unit's design to ensure that the integrity of any structural components of the C&DLF unit will not be disrupted. The owner and operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(A) On-site or local soil conditions that may result in significant differential settling;

(B) On-site or local geologic or geomorphologic features; and

(C) On-site or local human-made features or events (both surface and subsurface).

The North Carolina Solid Waste Rules define unstable areas (UAs) as locations which are susceptible to natural or human-induced events or forces capable of impairing the integrity of some or all of the landfill structural components responsible for preventing releases from a landfill. These regulations describe UAs as characterized by localized or regional ground subsidence, settling of overburden (either slowly or very rapidly by catastrophic events), or by general slope failure.

5.4.2 Compliance Issues

Based on the site hydrogeological and geotechnical investigation completed for this report and previously approved reports, the geological and soil conditions that are presumed to be throughout the site are not prone to unstable conditions.

5.5 Cultural Resources

Rule .0536 (c)(7) states that a new C&DLF unit or lateral expansion must not damage or destroy a property of archaeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places.

Correspondence with the State Historic Preservation Office in the Department of Cultural Resources is included in Attachment 5-3.

Based on the correspondence, there is no documentation that significant cultural resources exist within or in the vicinity of the site. No cultural resources are expected to be adversely affected by the C&D landfill development.

5.6 State Nature and Historic Preserves

Rule .0536 (c)(8) states that a new C&DLF unit or lateral expansion must not have an adverse impact, considering the purposes for designation of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve.

The NC Natural Heritage Program (NHP) was contacted to determine if any state natural preserves exist within or in the vicinity of the proposed C&D landfill expansion (see Attachment 5-4). Based on the NHP correspondence and Section 2.7 of this report no state nature or historical preserves would be impacted by development within the facility boundary.

5.7 Water Supply Watersheds

Rule .0536 (c)(9)(A) states that a new C&DLF unit or lateral expansion must not be located in the critical area of a water supply watershed, or in the watershed for a stream segment classified as WS-I, or in watersheds of other water bodies which indicate that no new landfills are allowed in accordance with the rules codified at 15A NCAC 02B Section .0200 entitled "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

The State has classified all surface waters and watersheds throughout the state as required by 15A NCAC 2B .0311 as referenced by Rule 2B .0200. These classifications are made available by NCDENR Division of Water Quality. A list of Dare County watershed classification is provided in Attachment 2-2 of this appendix.

Based on the classification list and NC OneMap program data (updated March 2007) from NCDENR, CGIA, the only classified water supply watershed in Dare County is the Fresh Water Lake (WS-III) at Kill Devil Hills which is approximately 13 miles northeast of the Dare County C&D landfill boundary. Overall, the landfill site is not located in an area that will impact or discharge to a WS-I, WS-II, WS-III, WS-IV watershed.

Rule .0536 (c)(9)(B) states that any new C&DLF unit or lateral expansion, which proposes to discharge leachate to surface waters must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management pursuant to Section 402 of the United States Clean Water Act, must not be located within watersheds classified as WS-II or WS-III, or in watersheds of other water bodies which indicate that no new discharging landfills are allowed, in accordance with the rules codified at 15A NCAC 02B Section .0200.

The C&D landfill facility is not located within any of these classified watersheds and currently operates under General Permit NCG120000 and, there, is required to perform surface water monitoring and reporting.

5.8 Endangered and Threatened Species

Rule .0536 (c)(10) states that a new C&DLF unit or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

CDM contacted NHP and US Fish and Wildlife Service (US FWS) offices to determine whether there was any documentation that endangered or threatened species existed within the site or its vicinity. Correspondence with each agency is included in Attachments 5-4 and 5-5.

Based on the US FWS, there are no federally-listed endangered or threatened species, their formally designated critical habitat, or species currently proposed for listing under the Endangered Species Act within the proposed facility boundary. Based on the NHP response, there is no record of rare species within facility boundary.

Section 5 – Location Restrictions
ATTACHMENT 5-1

Dare County Board of Commissioners Resolution dated August 2, 2004

DARE COUNTY BOARD OF COMMISSIONERS

RESOLUTION
Approving Permits for Expansion of C&D Cells
at the Dare County Landfill

WHEREAS, the Dare County Board of Commissioners has previously authorized and funded the expansion of solid waste disposal storage capacity at the Dare County landfill in Stumpy Point by constructing new C&D disposal cells; and

WHEREAS, the Dare County landfill is located in an area identified as being in a 100 year floodplain; and

WHEREAS, the Dare County Board of Commissioners has adopted a land use plan and ordinances regulating uses in flood hazard areas (Chapter 151 of the Dare County Code of Ordinances), and that the County may grant variances to its flood hazard ordinance pursuant to §151.47 of the Dare County Code of Ordinances; and

WHEREAS, pursuant to N.C.G.S. § 143-215.54A(b), the Dare County Board of Commissioners finds that constructing new C&D cells at the Dare County landfill serves a critical need of the County in providing additional disposal areas for the County's growing resident and visitor population; that there is no feasible location elsewhere in Dare County for additional C&D cells; that the design of all additional C&D cells will comply with N.C.G.S. § 143-215.54A(b)(3); and that these cells otherwise comply with all other applicable county laws and ordinances.

NOW, THEREFORE, BE IT RESOLVED that the Dare County Board of Commissioners hereby grants prior approval for the issuance of a sanitary landfill permit for new C&D disposal cells by the Division of Waste Management to Dare County, said new cells to be established at the existing Dare County landfill located in Stumpy Point, North Carolina, within the territorial jurisdiction of Dare County. The Dare County Board of Commissioners hereby approves of the following items related to this proposed expansion:

1. The population and area to be served consists of the residents and visitors of Dare County, including the County's incorporated municipalities;

2. The type of debris to be disposed of consists of C&D debris collected by the County's Department of Public Works, the County's incorporated municipalities, and private contractors and citizens;

3. The airspace of existing C&D cells #1 and #2 may be increased by an additional ten feet of vertical height expansion; and

4. The airspace of proposed new cells #3, #4, and #5 may be increased by an additional ten feet of vertical height expansion.

Adopted this the 2nd day of August, 2004.

DARE COUNTY BOARD OF COMMISSIONERS

By: _____
Warren Judge, Chairman

ATTEST:

_____
Fran Harris, Clerk to the Board

PRINTED ON RECYCLED PAPER

Section 5 – Location Restrictions
ATTACHMENT 5-2

US Army Corps of Engineers Expansion Determination

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

COPY

ORM ID: **SAW-2007-1238-128** County: **Dare**

NO DEPARTMENT OF THE ARMY AUTHORIZATION REQUIRED

Property Owner / Agent: **Clyde Gard**
Address: **Post Office Box 1000**
Manteo, North Carolina 27954
Telephone Number: **252-473-6339**

Size and Location of Property (waterbody, road name/number, town, etc.): **837 acre landfill located between Link Road and Borrow Pit Road off US 264 in Manns Harbor, Dare County, North Carolina.**

Description of Activity: **Fill in drainage laterals F1-F4. Fill not encroach on 50' buffer north of Cub Road ditch or 260' buffer south of Link Road..**

Your work as proposed does not require Department of the Army authorization for the following reason(s):

_ There are no jurisdictional waters or wetlands within the boundaries of the property.
X The proposed project does not impact jurisdictional waters or wetlands.
_ The proposed project is exempt from Department of the Army regulation.
Specify: _____.

This Department of the Army determination does not relieve the permittee of the responsibility to obtain any other required Federal, State, or local approvals/permits. The permittee may need to contact appropriate State and local agencies before beginning work.

For any activity within the twenty coastal counties, before beginning work, you must contact the N.C. Division of Coastal Management in Washington, North Carolina, at (252) 956-6481 to discuss any required State authorization.

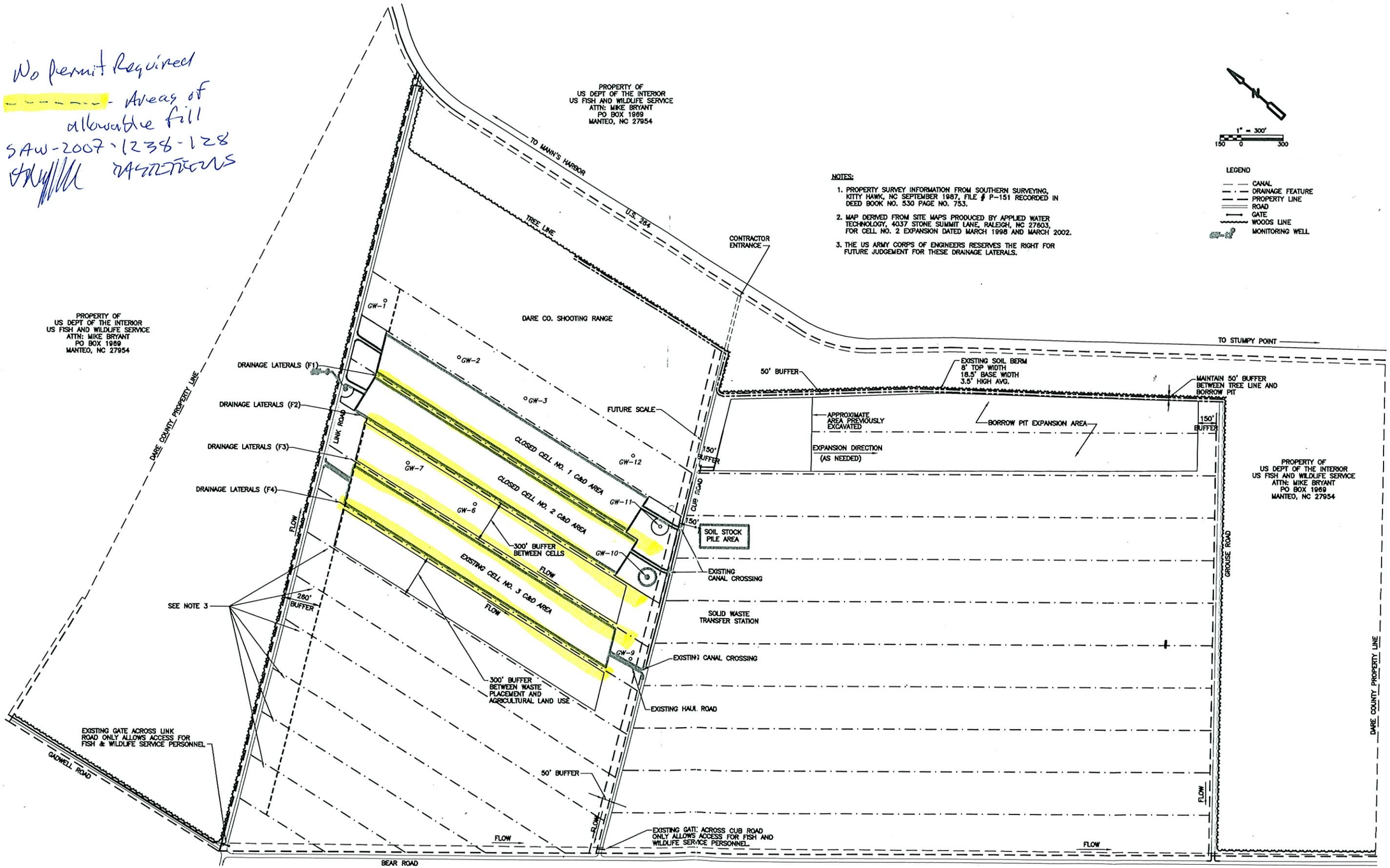
Any changes in the above described work must be coordinated with the Corps of Engineers prior to commencement. If you have any questions regarding the Corps of Engineers regulatory program, please contact **Tom Steffens** at telephone number (252) 975-1616 ext. **25**.

Regulatory Project Manager Signature TMSTEFFENS

Date: **04/09/2007**

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORM, ETC., MUST BE ATTACHED TO THE YELLOW (FILE) COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

No Permit Required
- - - - - - - - Areas of allowable fill
SAW-2007-1238-128
DAGRETTICUS



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
US ARMY CORPS OF ENGINEERS SITE VISIT

SITE MAP

PROJECT NO. 17952-58980
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

Section 5 – Location Restrictions
ATTACHMENT 5-3

Division of Cultural Resources – State Historic Correspondence

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

November 6, 2007

Ms. Renee Gledhill-Earley
Environmental Review Coordinator
North Carolina Department of Cultural Resources
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Subject: Site Study Amendment
Dare County, North Carolina
Presence of Historical/Architectural Structures
CDM Project Number: 17952-56960
ER 07-0831

Dear Ms. Gledhill-Earley:

In a letter dated April 12, 2007, CDM requested the North Carolina Department of Cultural Resources (NC DCR) conduct a file search of structures of historical or architectural importance located within the planning area. NC DCR responded in a letter dated May 23, 2007, that no structures were found resulting from their historical and architectural file search (see attached).

As part of the response letter, NC DCR requested that CDM photograph any structures more than fifty years old or older, on or adjacent to the project site. If no structures more than fifty years old or older, on or adjacent to the project site are found, then CDM shall notify the NC DCR. This letter is to serve as notification that no structures more than fifty years old or older are located on or adjacent to the project site.

Please feel free to contact me at (919)-787-5620, should you have any questions.

Very truly yours,

W. Michael Brinchek, P.E.
Camp Dresser & McKee

cc: E. Mann - Dare County
K. Yang - CDM

North Carolina Department of Cultural Resources

State Historic Preservation Office

Peter B. Sandbeck, Administrator

Michael F. Easley, Governor
Lisbeth C. Evans, Secretary
Jeffrey J. Crow, Deputy Secretary

Office of Archives and History
Division of Historical Resources
David Brook, Director

May 23, 2007

W. Mike Brinchek, P. E.
Camp Dresser & McKee
5400 Glenwood Avenue
Raleigh, NC 27612

Re: C & D Landfill Expansion, Highway 264, Project #17952-56960, Dare County, ER 07-0831

Dear Mr. Brinchek:

Thank you for your letter of April 12, 2007, concerning the above project.

We have conducted a search of our files and are aware of no structures of historical or architectural importance located within the planning area. However, since a comprehensive historical architectural inventory of this area has never been conducted, there may be structures of which we are unaware of located within the planning area.

Therefore, if there are any structures more than fifty years old or older, on or adjacent to the project site, please send us photographs (digital snapshots are fine) of each structure. These photographs should be keyed to a map that clearly shows the site location of these structures in relation to the project site. If there are no buildings over fifty years or older on or adjacent to the project site, please notify us of this in writing.

There are no known archaeological sites within the proposed project area. Based on our knowledge of the area, it is unlikely that any archaeological resources that may be eligible for inclusion in the National Register of Historic Places will be affected by the project. We, therefore, recommend that no archaeological investigation be conducted in connection with this project.

The above comments are made pursuant to Section 106 of the National Historic Preservation Act and the Advisory Council on Historic Preservation's Regulations for Compliance with Section 106 codified at 36 CFR Part 800.

Thank you for your cooperation and consideration. If you have questions concerning the above comment, contact Renee Gledhill-Earley, environmental review coordinator, at 919-733-4763, ext. 246. In all future communication concerning this project, please cite the above referenced tracking number.

Sincerely,

Renee Gledhill-Earley

Peter Sandbeck

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

April 12, 2007

Ms. Renee Gledhill-Earley
Environmental Review Coordinator
North Carolina Department of Cultural Resources
State Historic Preservation Office
4617 Mail Service Center
Raleigh, NC 27699-4617

Subject: Site Study Amendment
Dare County, North Carolina
CDM Project Number: 17952-56960

Dear Ms. Gledhill-Earley:

Dare County (County) currently operates a construction and demolition (C&D) landfill located off Highway 264 in Dare County (see Figures 1-1 and 1-2). A Site Plan for the construction of a municipal solid waste (MSW) landfill facility was approved by the North Carolina Department of Environment, Solid Waste Section (NCDENR SWS) in January 1993, but the County elected to dispose of MSW in a commercial regional facility in Bertie County. Thusly, the MSW facility was not developed, but the existing C&D landfill was designed and constructed and has since then been accepting and disposing C&D waste. The approved C&D Site Plan includes five individual C&D disposal cells separated by drainage laterals (see Sheet 1). The drainage laterals (F1 through F4) have been determined non-jurisdictional by the US Army Corps of Engineers (see Attachment 1). Currently, Cells No. 1 and 2 are closed and Cell No. 3 is receiving and disposing of C&D waste.

The County has contracted CDM to evaluate the feasibility of expanding their existing C&D landfill to include drainage laterals (F1 through F4) as additional disposal cells, thusly creating one mound instead of five stand-alone mounds as depicted in Sheet 1. This will provide the County with additional disposal volume and a potential public post-closure use for the C&D landfill (i.e., dog park, bird watching station, etc.). The inclusion of the drainage laterals will not increase the overall footprint of the previously approved C&D landfill, but will increase the acreage by approximately 2 acres for each drainage lateral. The proposed increase of the C&D landfill capacity results in expanding the landfill which, per North Carolina Solid Waste Management Rule 15A NCAC 13B .0533 (a) (1) (B), requires C&D landfill owners or operators to submit an amended site study.

CDM

Per Rule 15A NCAC 13B .0536, a C&D landfill site study must include a characterization study and a report demonstrating compliance with location restrictions including documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section.

Paragraph (c) (1) (F) of the aforementioned Rule states that the site study must include a characterization study which identifies any historic sites within a 2000-foot perimeter from the facility boundary. Furthermore, Paragraph (c) (7) requires that a new C&D landfill or lateral expansion must not damage or destroy a property of archeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places. Pertinent regulation sections are enclosed as Attachment 2.

Per your request is a completed Borrow Pit/Waste Area Information Form for State Historic Preservation Office Review worksheet (see Attachment 3).

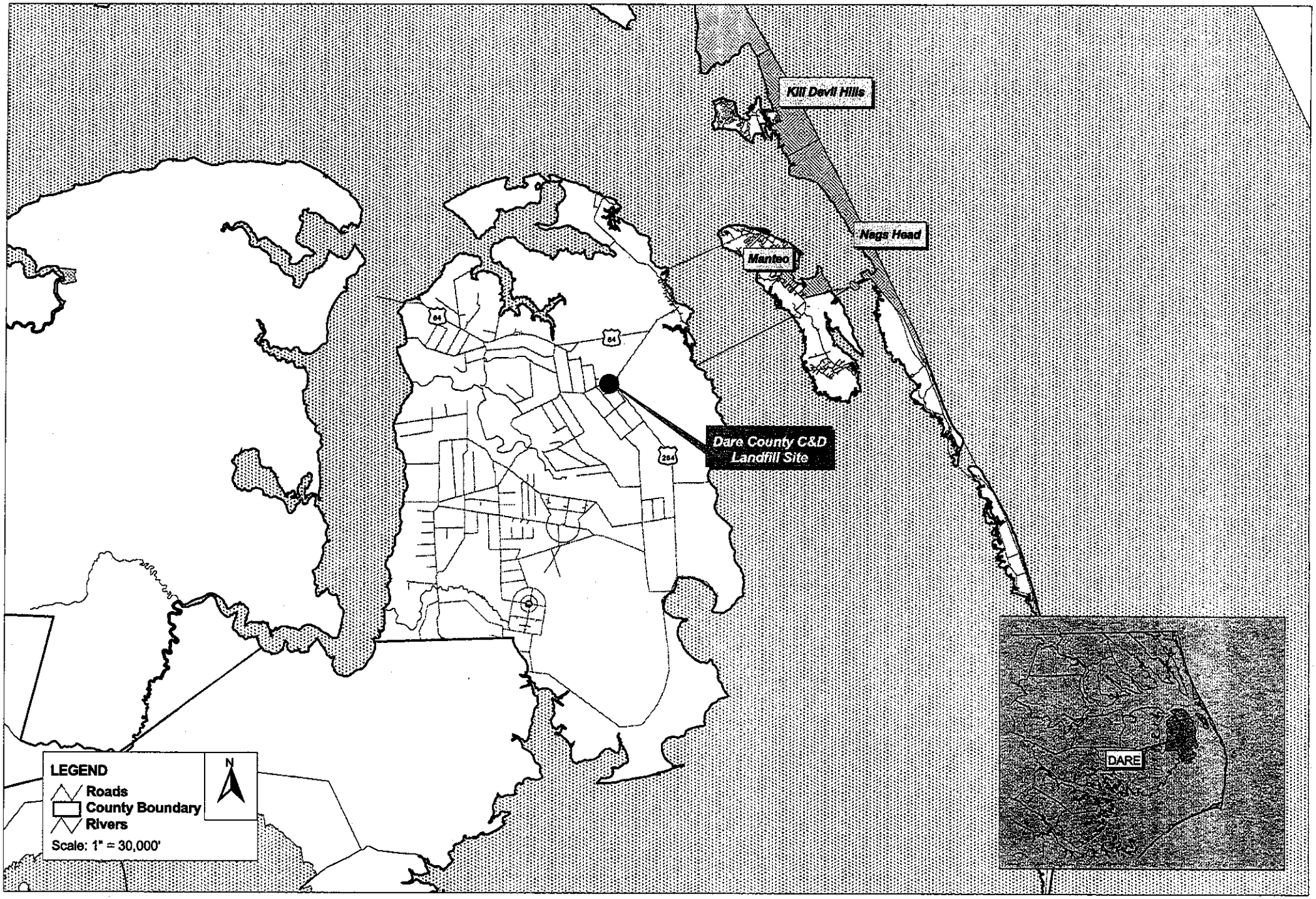
Through this letter, CDM is requesting, in writing, an official evaluation and opinion from the North Carolina State Historic Preservation Office as to whether the proposed C&D landfill expansion satisfies the above referenced Rules.

We sincerely appreciate your prompt attention in this request. Please feel free to contact me at (919)-787-5620, should you have any questions.

Very truly yours,

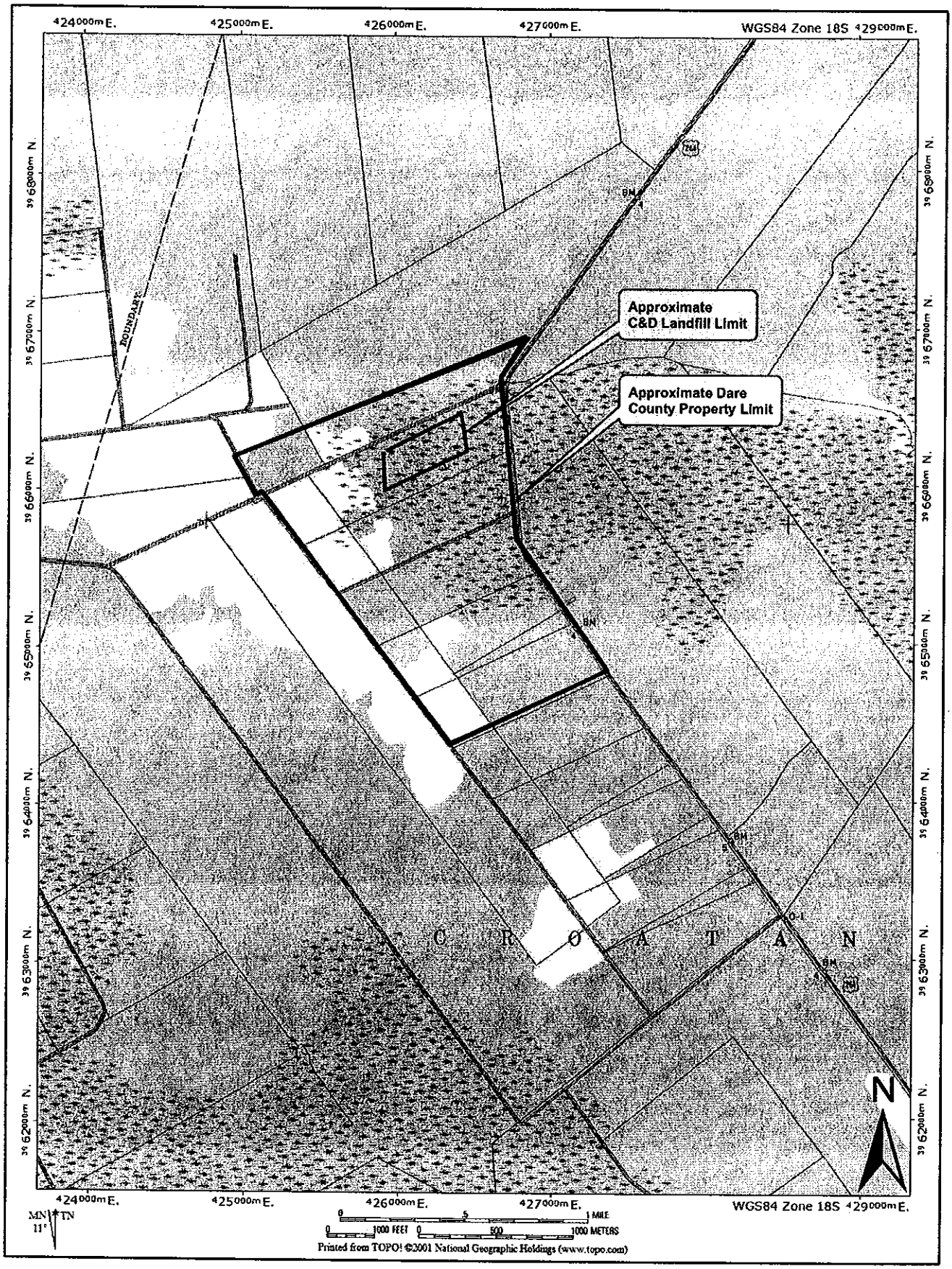
W. Mike Brinchek, P.E.
Camp Dresser & McKee

cc: E. Mann - Dare County
K. Yang - CDM



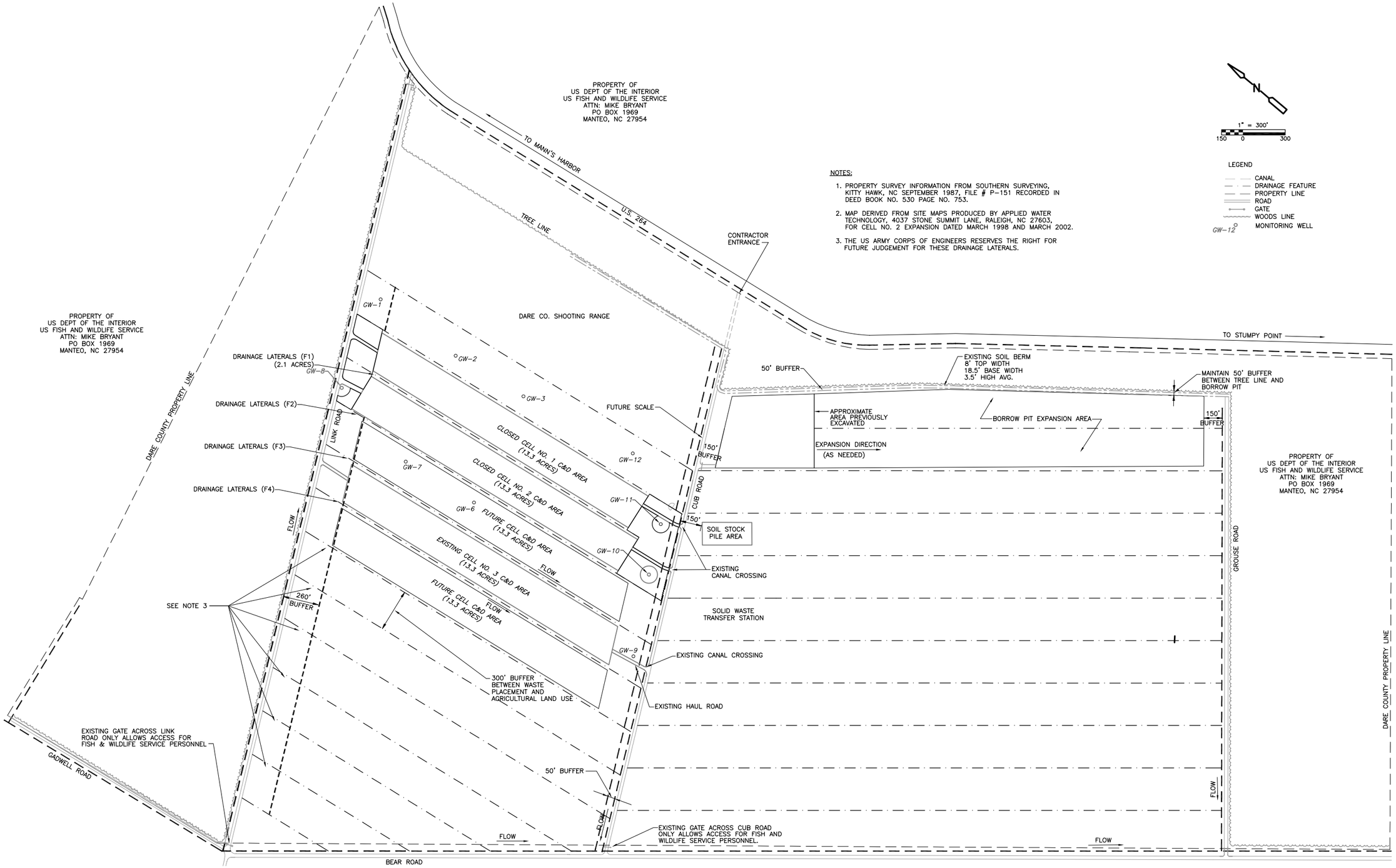
CDM

Figure 1-1
Location Map



CDM

Figure 1-2



NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. THE US ARMY CORPS OF ENGINEERS RESERVES THE RIGHT FOR FUTURE JUDGEMENT FOR THESE DRAINAGE LATERALS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
SITE STUDY

SITE MAP

PROJECT NO. 17952-56960
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 1

US Army Corps of Engineers Documentation

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

COPY

ORM ID: **SAW-2007-1238-128** County: **Dare**

NO DEPARTMENT OF THE ARMY AUTHORIZATION REQUIRED

Property Owner / Agent: **Clyde Gard**
Address: **Post Office Box 1000**
Manteo, North Carolina 27954
Telephone Number: **252-473-6339**

Size and Location of Property (waterbody, road name/number, town, etc.): **837 acre landfill located between Link Road and Borrow Pit Road off US 264 in Manns Harbor, Dare County, North Carolina.**

Description of Activity: **Fill in drainage laterals F1-F4. Fill not encroach on 50' buffer north of Cub Road ditch or 260' buffer south of Link Road..**

Your work as proposed does not require Department of the Army authorization for the following reason(s):

_ There are no jurisdictional waters or wetlands within the boundaries of the property.
X The proposed project does not impact jurisdictional waters or wetlands.
_ The proposed project is exempt from Department of the Army regulation.
Specify: _____.

This Department of the Army determination does not relieve the permittee of the responsibility to obtain any other required Federal, State, or local approvals/permits. The permittee may need to contact appropriate State and local agencies before beginning work.

For any activity within the twenty coastal counties, before beginning work, you must contact the N.C. Division of Coastal Management in Washington, North Carolina, at (252) 956-6481 to discuss any required State authorization.

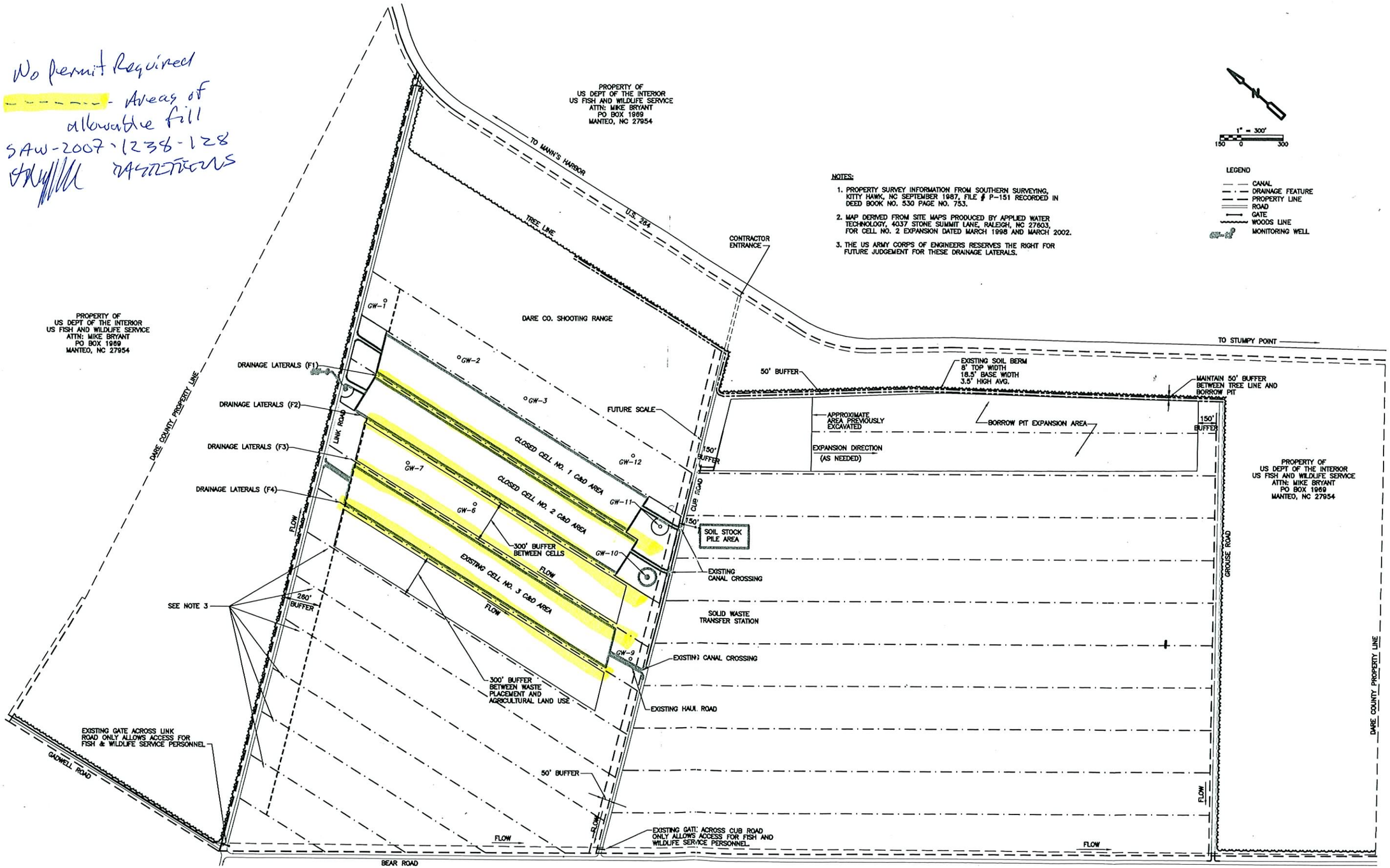
Any changes in the above described work must be coordinated with the Corps of Engineers prior to commencement. If you have any questions regarding the Corps of Engineers regulatory program, please contact **Tom Steffens** at telephone number (252) 975-1616 ext. **25**.

Regulatory Project Manager Signature TMSTEFFENS

Date: **04/09/2007**

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORM, ETC., MUST BE ATTACHED TO THE YELLOW (FILE) COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

No Permit Required
- - - - - - - - Areas of allowable fill
SAW-2007-1238-128
DAGRETTICUS



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
US ARMY CORPS OF ENGINEERS SITE VISIT

SITE MAP

PROJECT NO. 17952-58980
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 2

Pertinent North Carolina Solid Waste Rules

15A NCAC 13B .0533 GENERAL APPLICATION REQUIREMENTS AND PROCESSING FOR C&DLF FACILITIES

(a) Applicability. Owners or operators of a proposed or existing C&DLF unit or facility shall submit an application document as detailed in Rule .0535 of this Section in accordance with the criteria and scheduling requirements set forth as follows:

(1) New facility. Owners or operators proposing to establish a C&DLF facility or unit in accordance with the following criteria shall submit a Site Study and subsequently an application for a permit to construct as set forth in Paragraph (a) of Rule .0535 of this Section. A new facility permit application is required when:

(A) The owner or operator proposes to establish a new facility not previously permitted by the Division.

(B) The owner or operator proposes to expand the landfill facility in order to expand the C&DLF unit(s) boundary approved in accordance with Subparagraph (a)(1) of Rule .0536 of this Section.

(2) Amendment to the permit. For any subsequent phase of landfill development the owner or operator shall prepare an application to amend the permit to construct in accordance with Paragraph (b) of Rule .0535 of this Section and submit the application at the earlier of the following dates:

(A) at least 180 days prior to the date scheduled for commencing construction; or

(B) five years from the issuance date of the initial permit to operate or as specified in the effective permit.

(3) Substantial amendment to the permit. A permit issued in accordance with Paragraph (c) of this Rule approves a facility plan for the life of the C&DLF facility and a set of plans for the initial phase of landfill development. The owner or operator shall prepare an application in accordance with Paragraph (c) of Rule .0535 of this Section and submit the application when there is:

(A) a substantial change in accordance with N.C.G.S. 130A-294 (b1)(1); or

(B) a proposed transfer of ownership of the C&DLF facility.

(4) Modifications to the permit. An owner or operator proposing changes to the plans approved in the permit shall request prior approval from the Division in accordance with Paragraph (d) of Rule .0535 of this Section.

(b) Application format guidelines. All applications and plans required by Rules .0531 through .0547 of this Section shall be prepared in accordance with the following guidelines:

(1) The initial application shall:

(A) contain a cover sheet stating the project title and location, the applicant's name and address, and the engineer's name, address, signature, date of signature and seal; and

(B) contain a statement defining the purpose of the submittal signed and dated by the applicant.

(2) The text of the application shall:

(A) be submitted in a three ring binder;

(B) contain a table of contents or index outlining the body of the application and the appendices;

(C) be paginated consecutively; and

(D) identify revised text by noting the date of revision on the page.

(3) Drawings. The engineering drawings for all landfill facilities shall be submitted using the following format.

(A) The sheet size with title blocks shall be at least 22 inches by 34 inches.

(B) The cover sheet shall include the project title, applicant's name, sheet index, legend of symbols, and the engineer's name, address, signature, date of signature, and seal.

(C) Where the requirements do not explicitly specify a minimum scale, maps and drawings shall be prepared at a scale that adequately illustrates the subject requirement(s).

(4) Number of copies. An applicant shall submit a minimum of three copies of each original application document and any revisions to the Division. The Division shall request additional copies as necessary. The Division shall require submittal of relevant documents in electronic format.

(c) Permitting and Public Information Procedures.

(1) Purpose and Applicability.

(A) Purpose. During the permitting process the Division shall provide for public review of and input to permit documents containing the applicable design and operating conditions. The

15A NCAC 13B .0536 SITE STUDY FOR C&DLF FACILITIES

(a) Purpose. As required under Rule .0535 of this Section, the owner or operator must prepare a site study which meets the requirements of this Rule. The Division shall review the site study for a proposed new facility prior to consideration of an application for a permit to construct. Following review of the site study, the Division shall notify the applicant that either:

(1) the site is deemed suitable and the applicant is authorized to prepare an application for a permit to construct in accordance with Rule .0535 of this Section; or

(2) the site is deemed unsuitable for establishing a C&DLF unit(s) and shall specify the reasons that would prevent the C&DLF unit(s) from being operated in accordance with N.C.G.S.130A Article 9, or this Subchapter, and any applicable federal laws and regulations.

(b) Scope. The site is the land which is proposed for the landfill facility. The site study presents a characterization of the land, incorporating various investigations and requirements pertinent to suitability of a C&DLF facility. The scope of the site study includes criteria associated with the public health and welfare, and the environment. The economic feasibility of a proposed site is not within the scope of this study. The information in the site study must accurately represent site characteristics and must be prepared by qualified environmental professionals as set forth in Subparagraph (a)(3) of Rule .0202 of this Subchapter. New C&DLF unit(s) and lateral expansions must comply with the siting criteria set forth in Paragraph (c) of this Rule, Subparagraphs (4) through (10). In order to demonstrate compliance with specific criteria for each of the respective location restrictions, documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section may be required. The scope of demonstrations including design and construction performance must be addressed in the site study.

(c) The site study prepared for a C&DLF facility must include the information required by this Paragraph.

(1) Characterization study. The site characterization study area includes the landfill facility and a 2000-foot perimeter measured from the proposed boundary of the landfill facility. The study must include an aerial photograph taken within one year of the original submittal date, a report, and a local map. The map and photograph must be at a scale of at least one inch equals 400 feet. The study must identify the following:

(A) the entire property proposed for the disposal site and any on-site easements;

(B) existing land use and zoning;

(C) the location of residential structures and schools;

(D) the location of commercial and industrial buildings, and other potential sources of contamination;

(E) the location of potable wells and public water supplies;

(F) historic sites;

(G) state nature and historic preserves;

(H) the existing topography and features of the disposal site including: general surface water drainage patterns and watersheds, 100-year floodplains, perennial and intermittent streams, rivers, and lakes; and

(I) the classification of the surface water drainage from landfill site in accordance with 15A NCAC 02B .0300.

(2) Proposed Facility Plan. A conceptual plan for the development of the facility including drawings and a report must be prepared which includes the drawings and reports described in Subparagraphs (d)(1), (e)(1), (e)(2), and (e)(3) of Rule .0537 of this Section.

(3) Site Hydrogeologic Report. The study must be prepared in accordance with the requirements set forth in Paragraph (a) of Rule .0538 of this Section.

(4) Floodplain Location Restrictions;

(A) C&DLF units or constructed embankments used to construct a C&DLF unit must not be located in a 100-year floodplain unless a variance for the facility has been issued in accordance with N.C.G.S. 143-215.54A.

(B) C&DLF units must not be located in floodplains unless the owners or operators demonstrate that the unit will not restrict the flow of the flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.

(5) Wetlands Location Restriction. New C&DLF units and lateral expansions must not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

(A) Where applicable under Section 404 of the Clean Water Act or applicable State wetlands laws, the presumption that a practicable alternative to the proposed landfill facility is available which does not involve wetlands is clearly rebutted.

(B) The construction and operation of the C&DLF unit(s) will not cause or contribute to violations of any applicable State water quality standards and will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.

(C) The construction and operation of the C&DLF unit(s) will not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. The construction and operation of the C&DLF unit(s) will not violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(D) The construction and operation of the C&DLF unit(s) will not cause or contribute to significant degradation of wetlands.

(E) The owner or operator must demonstrate the integrity of the C&DLF unit(s) and its ability to protect ecological resources by addressing the following factors: (1) erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the C&DLF unit; (2) erosion, stability, and migration potential of dredged and fill materials used to support the C&DLF unit; the volume and chemical nature of the waste managed in the C&DLF unit; (3) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste; (4) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and (5) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected to the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws.

(F) The owner or operator must demonstrate that steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by Part (c)(5)(A) – (D) of this Rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands).

(G) The owner or operator must also demonstrate that sufficient information is available to make a reasonable determination with respect to each of the demonstrations required by this Rule.

(H) For purposes of this Rule, wetlands means those areas that are defined in 40 CFR 232.2(r).

(6) Unstable Area Location Restrictions. Owners and operators of new C&DLF unit(s) and lateral expansions proposed for location in an unstable area must demonstrate that engineering measures have been incorporated in the C&DLF unit's design to ensure that the integrity of any structural components of the C&DLF unit will not be disrupted. The owner and operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(A) On-site or local soil conditions that may result in significant differential settling;

(B) On-site or local geologic or geomorphologic features; and

(C) On-site or local human-made features or events (both surface and subsurface).

X (7) Cultural Resources Location Restrictions. A new C&DLF unit or lateral expansion must not damage or destroy a property of archaeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places. To aid in making a determination as to whether the property is of archeological or historical significance, the State's Historic Preservation Office in the Department of Cultural Resources may request the owner and operator to perform a site-specific survey which must be included in the Site Study.

(8) State Nature and Historic Preserve Location Restrictions. A new C&DLF unit or lateral expansion must not have an adverse impact, considering the purposes for designation of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve.

(9) Water Supply Watersheds Location Restrictions;

(A) A new C&DLF unit or lateral expansion must not be located in the critical area of a water supply watershed, or in the watershed for a stream segment classified as WS-I, or in watersheds of other water bodies which indicate that no new landfills are allowed in accordance with the rules codified at 15A NCAC 02B Section .0200 entitled "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

(B) Any new C&DLF unit or lateral expansion, which proposes to discharge leachate to surface waters and must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management pursuant to Section 402 of the United States Clean Water Act, must not be located within watersheds classified as WS-II or WS-III, or in watersheds of other water bodies which indicate that no new discharging landfills are allowed, in accordance with the rules codified at 15A NCAC 02B Section .0200.

(10) Endangered and Threatened Species Location Restrictions. A new C&DLF unit or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

(11) Local government approvals for C&DLFs.

(A) If the permit applicant is a unit of local government in which jurisdiction the proposed C&DLF site is located, the approval of the governing board shall be required. Approval may be in the form of either a resolution or a vote on a motion. A copy of the resolution or the minutes of the meeting where the vote was taken must be submitted to the Division as part of the site study.

(B) A permit applicant other than the unit of local government with jurisdiction over the proposed landfill site must obtain a franchise in accordance with N.C.G.S 130A-294(b1)(3) from each unit of local government in whose jurisdiction the site is located. A copy of the franchise must be submitted to the Division as part of the site study.

(C) Prior to issuance of approval or a franchise, the jurisdictional local government(s) where the landfill is to be located shall hold at least one public meeting to inform the community of the proposed waste management activities as described in the proposed facility plan prepared in accordance with Subparagraph (2) of this Paragraph. The local government where the landfill is to be located shall provide a public notice of the meeting at least 30 days prior to the meeting. For purposes of this Part, public notice must include a legal advertisement placed in a newspaper or newspapers serving the county and provision of a news release to at least one newspaper serving the county. Public notice must include time, place, and purpose of the meetings required by this Part. The application for a franchise or other documentation as required by the appropriate local government(s), must be placed at a location that is accessible by the public. This location must be noted in the public notice. The permit applicant must notify the property owners of all property that shares a common border with the proposed facility by means of a U.S. Postal Service registered letter, return receipt requested. The notice must give the date, time and place of the public meeting, and must describe the facility plan for the landfill, including the areal location and final elevation of all waste disposal units, the type and amount of waste to be disposed at the landfill, any other waste management activities to be conducted at the facility, and the proposed location of the entrance to the facility. Mailings must be postmarked a minimum of 30 days prior to the public meeting which is being noticed. The applicant must provide documentation of the content and mailing of the notices in the site study.

(D) Public notice of the meeting must be documented in the site study. A tape recording or a written transcript of the meeting, all written material submitted representing community concerns, and all other relevant written material distributed or used at the meeting must be submitted as part of the site study.

(E) A letter from the unit of local government(s) having zoning jurisdiction over the site which states that the proposal meets all the requirements of the local zoning ordinance, or that the site is not zoned, must be submitted to the Division as part of the site study.

(d) Site suitability applications for a new C&DLF facility or unit submitted in accordance with Rule .0504(1) of this Section must be submitted to the Division prior to December 31, 2006.

ATTACHMENT 3

State Historic Preservation Office Review Form

BORROW PIT/WASTE AREA INFORMATION FORM FOR STATE HISTORIC PRESERVATION OFFICE REVIEW

See Attached Memo

Please Print or Type

County DARE Pit Name DARE COUNTY C and D Landfill Acreage

ER

Highway Project No. and Description N/A

Contractor CDM, Kenton J. Yang
Company and Contact Name

5400 Glenwood Ave
Street Address or P.O. Box

Raleigh, NC, 27612-3228
Town, State, Zip Code

Tel: 919-787-5620 Fax: 919-781-5730
Telephone/Fax Numbers

April 12, 2007
Date Submitted

ARCHITECTURAL RESOURCES

1. Are there any buildings or structures on the project site? (Include abandoned barns, farmhouses, tobacco sheds, bridges, etc.)

   NO

2. If yes, submit one set of photographs of any structures which appear to have been built before World War II (Polaroid-type snapshots are okay). Photos should show the front and one side of structure and area behind structure. N/A

ARCHAEOLOGICAL RESOURCES

1. Present and previous land uses of the proposed borrow area.

   The site was previously a cropland. Currently, the site is used as C and D landfill and Cropland

2. What kind of site preparation, if any, has taken place on the project site?

   Clearing and tillage were done for cropping purpose

3. Have any artifacts (arrowheads, pottery, etc.) been found on the site?

   NO

4. Are any marked or unmarked cemeteries located within the proposed pit area?

   NO

5. Has the area been surveyed by an archaeologist? If yes, give the name of the archaeologist and the date of the survey, if know.

   NO

Please attach a copy of a map showing the exact location of the proposed borrow pit/waste area. A portion of an identified USGS quad sheet is preferred and will ensure timely review of your project. Submit the completed form and map to: Renee Gledhill-Earley, Environmental Review Coordinator, State Historic Preservation Office, 4617 Mail Service Center, Raleigh, NC 27699-4617 (telephone 919/733-4763).
****Allow at least two weeks for our review and comment****

_____ We have no comment on the project as proposed.

_____ Additional information is needed to complete our review.

_____ An archaeological survey is recommended.

Signed: _____ Date: _____
Renee Gledhill-Earley

May 2001

CDM

Memorandum

To: *Ms. Renee Gledhill-Early*

From: *Mr. Kenton Yang, P.E.*

Date: *April 12, 2007*

Subject: *Facility Acreage Description*

The Dare County C&D landfill property covers a total of approximately 836 acres. Uncleared land on the 836-acre tract (approximately 311 acres) is Section 404 wetlands. However, the remaining 525 acres of cropland has been designated "prior converted cropland" and is not considered "wetlands." In the approved C&D Site Study, the five individual C&D disposal cells were 10.6 acres each for a total of 53 acres. The proposed expansion will increase the C&D landfill area to approximately 62 acres. The balance of the 525 acres of cropland will remaining in crops.

Section 5 – Location Restrictions
ATTACHMENT 5-4

National Heritage Program Correspondence

NCDENR
North Carolina Department of Environment and Natural Resources

Michael F. Easley, Governor

William G. Ross Jr., Secretary

April 26, 2007

Mr. W. Mike Brinchek
Camp Dresser & McKee
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612

Subject: Expansion of Existing C&D (Construction & Demolition) Landfill; off US 264, Dare County
CDM Project Number: 17952-56960

Dear Mr. Brinchek:

The Natural Heritage Program has no record of rare species, significant natural communities, or significant natural heritage areas at the site. However, the Federally Endangered (nonessential experimental population) red wolf (*Canis rufus*) occurs across the entire Dare County mainland, and we thus presume that it occurs occasionally on the tract owned by Dare County. Of course, the Dare County tract is surrounded on all sides by the Federally-owned Alligator River National Wildlife Refuge, administered by the U.S. Fish and Wildlife Service. It is very important, therefore, that any proposed expansion of the landfill be reviewed by, and coordinated with, staff of the Fish and Wildlife Service located at that refuge, even if there is no expansion of the boundary of the Dare County tract (at the expense of Federal land).

You may wish to check the Natural Heritage Program database website at www.ncnhp.org for a listing of rare plants and animals and significant natural communities in the county and on the quad map.

NC OneMap now provides digital Natural Heritage data online for free. This service provides site specific information on GIS layers with Natural Heritage Program rare species occurrences and Significant Natural Heritage Areas. The NC OneMap website provides Element Occurrence (EO) ID numbers (instead of species name), and the data user is then encouraged to contact the Natural Heritage Program for detailed information. This service allows the user to quickly and efficiently get site specific NHP data without visiting the NHP workroom or waiting for the Information Request to be answered by NHP staff. For more information about data formats and access, visit <www.nconemap.com/data.html>, or email NC OneMap at <dataq@ncmail.net>.

Please do not hesitate to contact me at 919-715-8697 if you have questions or need further information.

Sincerely,

Harry E. LeGrand, Jr.

Harry E. LeGrand, Jr., Zoologist
Natural Heritage Program

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-733-4984 \ FAX: 919-715-3060 \ Internet: www.enr.state.nc.us/ENR/

An Equal Opportunity / Affirmative Action Employer - 50 % Recycled \ 10 % Post Consumer Paper

One NorthCarolina Naturally

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

April 12, 2007

Mr. Harry LeGrand
Zoologist
North Carolina Natural Heritage Program
1601 Mail Service Center
Raleigh, NC 27699-1601

Subject: Site Study Amendment
Dare County, North Carolina
CDM Project Number: 17952-56960

Dear Mr. LeGrand:

Dare County (County) currently operates a construction and demolition (C&D) landfill located off Highway 264 in Dare County (see Figures 1-1 and 1-2). A Site Plan for the construction of a municipal solid waste (MSW) landfill facility was approved by the North Carolina Department of Environment, Solid Waste Section (NCDENR SWS) in January 1993, but the County elected to dispose of MSW in a commercial regional facility in Bertie County. Thusly, the MSW facility was not developed, but the existing C&D landfill was designed and constructed and has since then been accepting and disposing C&D waste. The approved C&D Site Plan includes five individual C&D disposal cells separated by drainage laterals (see Sheet 1). The drainage laterals (F1 through F4) have been determined non-jurisdictional by the US Army Corps of Engineers (see Attachment 1). Currently, Cells No. 1 and 2 are closed and Cell No. 3 is receiving and disposing of C&D waste.

The County has contracted CDM to evaluate the feasibility of expanding their existing C&D landfill to include drainage laterals (F1 through F4) as additional disposal cells, thusly creating one mound instead of five stand-alone mounds as depicted in Sheet 1. This will provide the County with additional disposal volume and a potential public post-closure use for the C&D landfill (i.e., dog park, bird watching station, etc.). The inclusion of the drainage laterals will not increase the overall footprint of the previously approved C&D landfill, but will increase the acreage by approximately 2 acres for each drainage lateral. The proposed increase of the C&D landfill capacity results in expanding the landfill which, per North Carolina Solid Waste Management Rule 15A NCAC 13B .0533 (a) (1) (B), requires C&D landfill owners or operators to submit an amended site study.

Per Rule 15A NCAC 13B .0536, a C&D landfill site study must include a characterization study and a report demonstrating compliance with location restrictions including documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section.

CDM

Paragraph (c) (1) (G) of the aforementioned Rule states that the site study must include a characterization study which identifies any state nature and historic preserves within a 2000-foot perimeter from the facility boundary. Furthermore, Paragraph (c) (8) states that a new C&D landfill or lateral expansion must not have an adverse impact, considering the purposes of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve. Pertinent regulation sections are enclosed as Attachment 2.

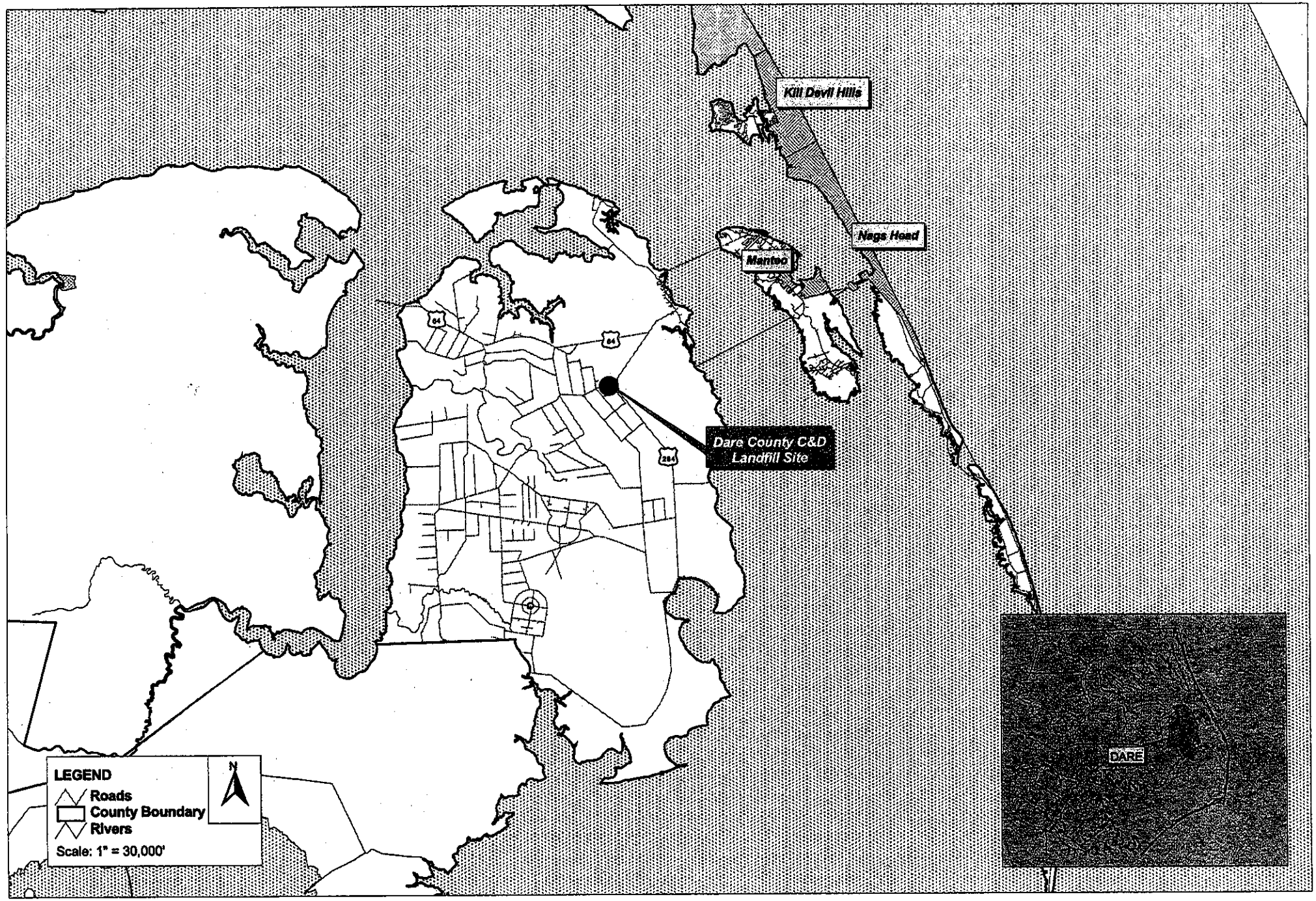
Through this letter, CDM is requesting, in writing, an official evaluation and opinion from the North Carolina Natural Heritage Program as to whether the proposed C&D landfill satisfies the above referenced Rules.

We sincerely appreciate your prompt attention in this request. Please feel free to contact me at (919)-787-5620, should you have any questions.

Very truly yours,

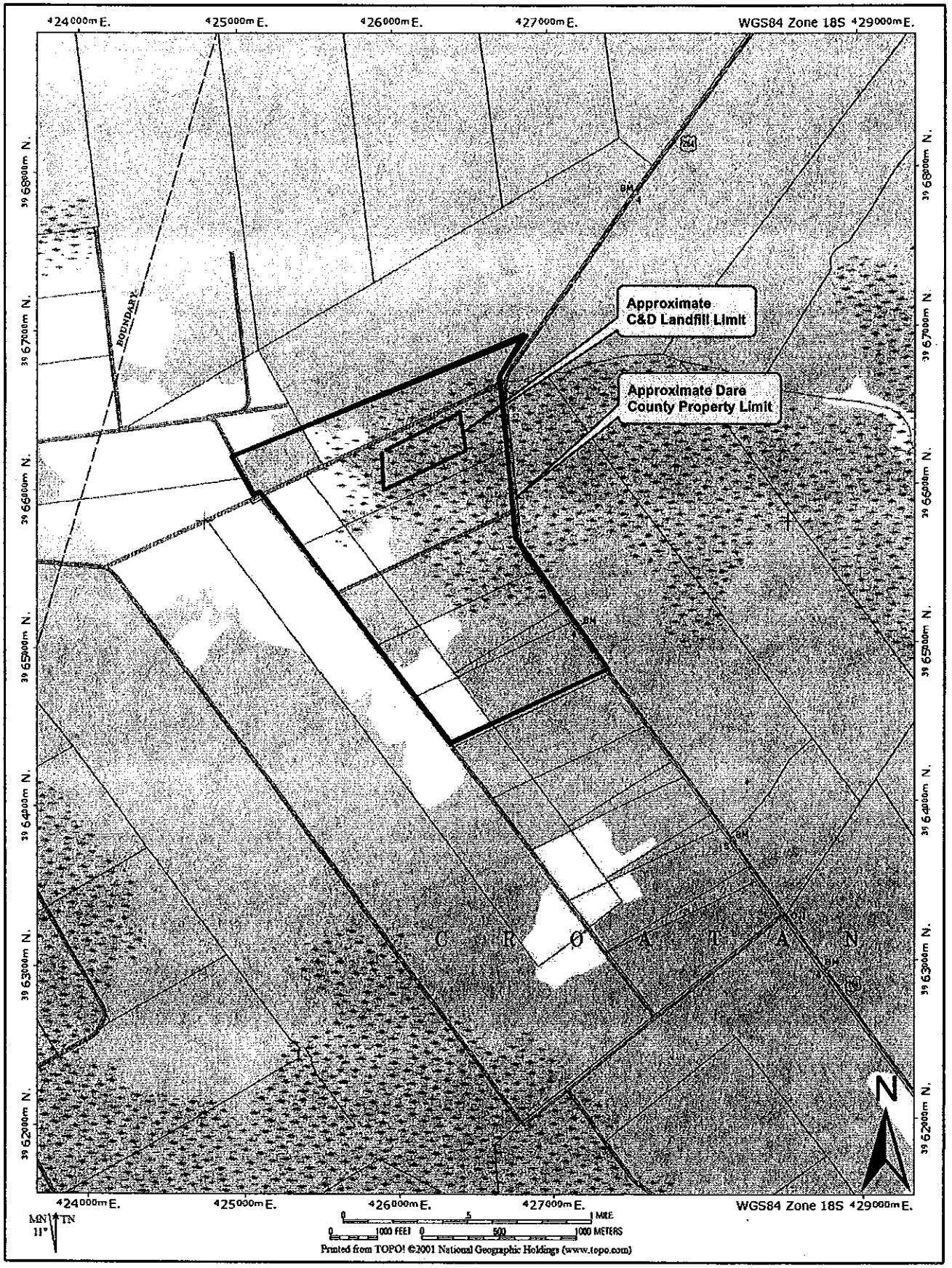
W. Mike Brinchek, P.E.
Camp Dresser & McKee

cc: E. Mann - Dare County
K. Yang - CDM



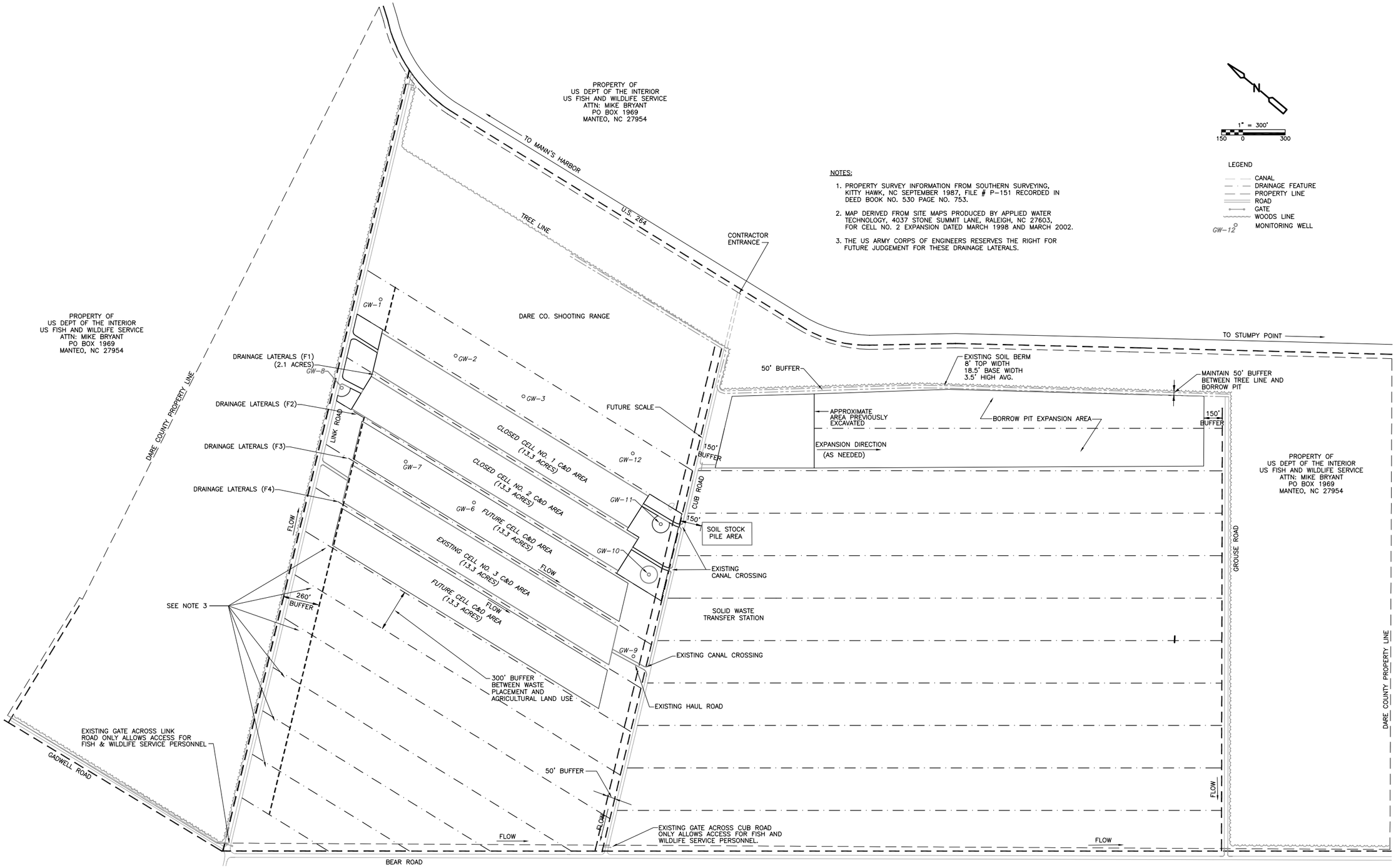
CDM

Figure 1-1
Location Map



CDM

Figure 1-2



NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. THE US ARMY CORPS OF ENGINEERS RESERVES THE RIGHT FOR FUTURE JUDGEMENT FOR THESE DRAINAGE LATERALS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
SITE STUDY

SITE MAP

PROJECT NO. 17952-56960
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 1

US Army Corps of Engineers Documentation

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

COPY

ORM ID: **SAW-2007-1238-128** County: **Dare**

NO DEPARTMENT OF THE ARMY AUTHORIZATION REQUIRED

Property Owner / Agent: **Clyde Gard**
Address: **Post Office Box 1000**
Manteo, North Carolina 27954
Telephone Number: **252-473-6339**

Size and Location of Property (waterbody, road name/number, town, etc.): **837 acre landfill located between Link Road and Borrow Pit Road off US 264 in Manns Harbor, Dare County, North Carolina.**

Description of Activity: **Fill in drainage laterals F1-F4. Fill not encroach on 50' buffer north of Cub Road ditch or 260' buffer south of Link Road..**

Your work as proposed does not require Department of the Army authorization for the following reason(s):

_ There are no jurisdictional waters or wetlands within the boundaries of the property.
X The proposed project does not impact jurisdictional waters or wetlands.
_ The proposed project is exempt from Department of the Army regulation.
Specify: _____.

This Department of the Army determination does not relieve the permittee of the responsibility to obtain any other required Federal, State, or local approvals/permits. The permittee may need to contact appropriate State and local agencies before beginning work.

For any activity within the twenty coastal counties, before beginning work, you must contact the N.C. Division of Coastal Management in Washington, North Carolina, at (252) 956-6481 to discuss any required State authorization.

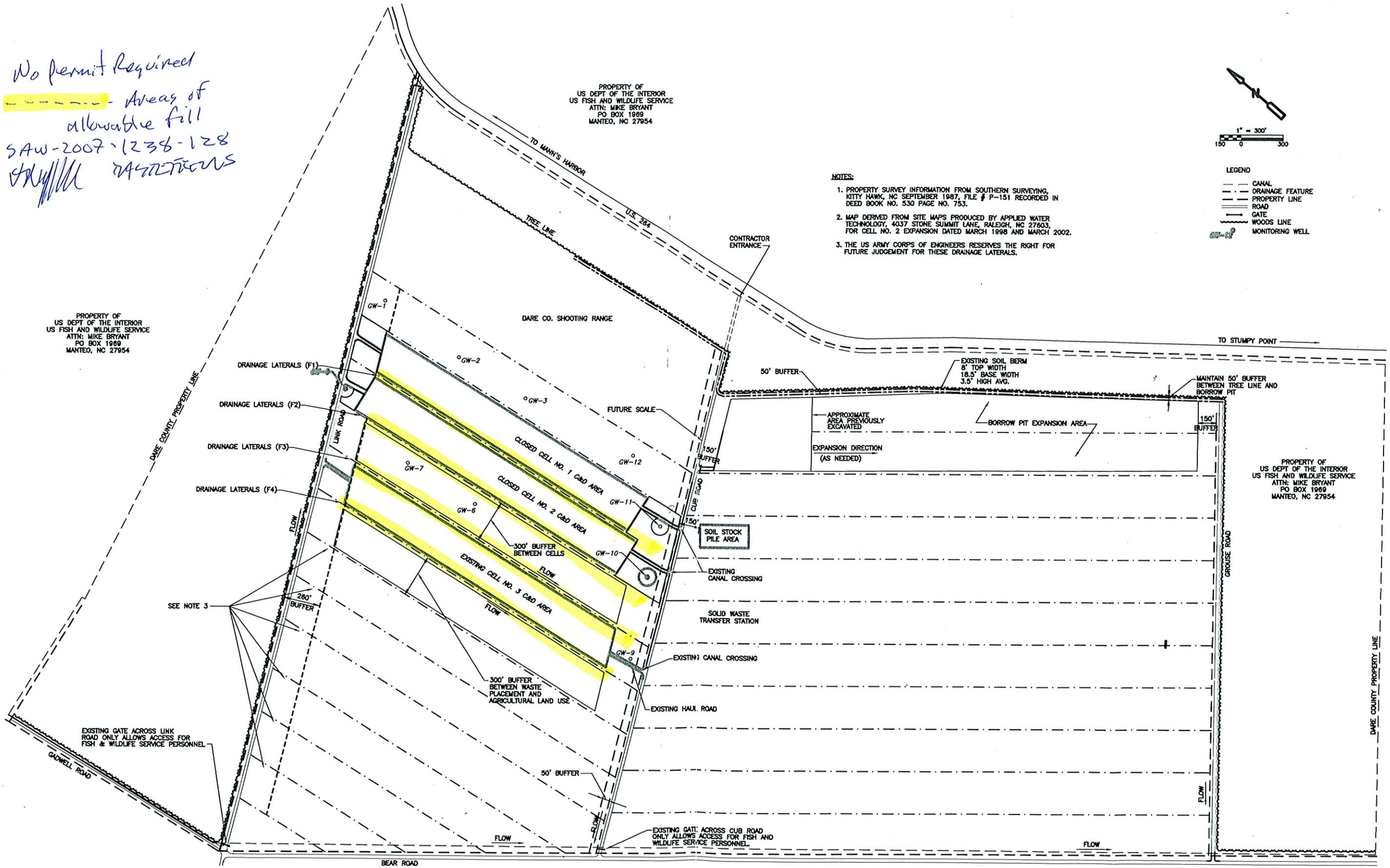
Any changes in the above described work must be coordinated with the Corps of Engineers prior to commencement. If you have any questions regarding the Corps of Engineers regulatory program, please contact **Tom Steffens** at telephone number (252) 975-1616 ext. **25**.

Regulatory Project Manager Signature TMSTEFFENS

Date: **04/09/2007**

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORM, ETC., MUST BE ATTACHED TO THE YELLOW (FILE) COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

No Permit Required
- - - - - - - - Areas of allowable fill
SAW-2007-1238-128
DAGRETTICUS



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
US ARMY CORPS OF ENGINEERS SITE VISIT

SITE MAP

PROJECT NO. 17952-58980
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 2

Pertinent North Carolina Solid Waste Rules

15A NCAC 13B .0533 GENERAL APPLICATION REQUIREMENTS AND PROCESSING FOR C&DLF FACILITIES

(a) Applicability. Owners or operators of a proposed or existing C&DLF unit or facility shall submit an application document as detailed in Rule .0535 of this Section in accordance with the criteria and scheduling requirements set forth as follows:

(1) New facility. Owners or operators proposing to establish a C&DLF facility or unit in accordance with the following criteria shall submit a Site Study and subsequently an application for a permit to construct as set forth in Paragraph (a) of Rule .0535 of this Section. A new facility permit application is required when:

(A) The owner or operator proposes to establish a new facility not previously permitted by the Division.

(B) The owner or operator proposes to expand the landfill facility in order to expand the C&DLF unit(s) boundary approved in accordance with Subparagraph (a)(1) of Rule .0536 of this Section.

(2) Amendment to the permit. For any subsequent phase of landfill development the owner or operator shall prepare an application to amend the permit to construct in accordance with Paragraph (b) of Rule .0535 of this Section and submit the application at the earlier of the following dates:

(A) at least 180 days prior to the date scheduled for commencing construction; or

(B) five years from the issuance date of the initial permit to operate or as specified in the effective permit.

(3) Substantial amendment to the permit. A permit issued in accordance with Paragraph (c) of this Rule approves a facility plan for the life of the C&DLF facility and a set of plans for the initial phase of landfill development. The owner or operator shall prepare an application in accordance with Paragraph (c) of Rule .0535 of this Section and submit the application when there is:

(A) a substantial change in accordance with N.C.G.S. 130A-294 (b1)(1); or

(B) a proposed transfer of ownership of the C&DLF facility.

(4) Modifications to the permit. An owner or operator proposing changes to the plans approved in the permit shall request prior approval from the Division in accordance with Paragraph (d) of Rule .0535 of this Section.

(b) Application format guidelines. All applications and plans required by Rules .0531 through .0547 of this Section shall be prepared in accordance with the following guidelines:

(1) The initial application shall:

(A) contain a cover sheet stating the project title and location, the applicant's name and address, and the engineer's name, address, signature, date of signature and seal; and

(B) contain a statement defining the purpose of the submittal signed and dated by the applicant.

(2) The text of the application shall:

(A) be submitted in a three ring binder;

(B) contain a table of contents or index outlining the body of the application and the appendices;

(C) be paginated consecutively; and

(D) identify revised text by noting the date of revision on the page.

(3) Drawings. The engineering drawings for all landfill facilities shall be submitted using the following format.

(A) The sheet size with title blocks shall be at least 22 inches by 34 inches.

(B) The cover sheet shall include the project title, applicant's name, sheet index, legend of symbols, and the engineer's name, address, signature, date of signature, and seal.

(C) Where the requirements do not explicitly specify a minimum scale, maps and drawings shall be prepared at a scale that adequately illustrates the subject requirement(s).

(4) Number of copies. An applicant shall submit a minimum of three copies of each original application document and any revisions to the Division. The Division shall request additional copies as necessary. The Division shall require submittal of relevant documents in electronic format.

(c) Permitting and Public Information Procedures.

(1) Purpose and Applicability.

(A) Purpose. During the permitting process the Division shall provide for public review of and input to permit documents containing the applicable design and operating conditions. The

15A NCAC 13B .0536 SITE STUDY FOR C&DLF FACILITIES

(a) Purpose. As required under Rule .0535 of this Section, the owner or operator must prepare a site study which meets the requirements of this Rule. The Division shall review the site study for a proposed new facility prior to consideration of an application for a permit to construct. Following review of the site study, the Division shall notify the applicant that either:

(1) the site is deemed suitable and the applicant is authorized to prepare an application for a permit to construct in accordance with Rule .0535 of this Section; or

(2) the site is deemed unsuitable for establishing a C&DLF unit(s) and shall specify the reasons that would prevent the C&DLF unit(s) from being operated in accordance with N.C.G.S.130A Article 9, or this Subchapter, and any applicable federal laws and regulations.

(b) Scope. The site is the land which is proposed for the landfill facility. The site study presents a characterization of the land, incorporating various investigations and requirements pertinent to suitability of a C&DLF facility. The scope of the site study includes criteria associated with the public health and welfare, and the environment. The economic feasibility of a proposed site is not within the scope of this study. The information in the site study must accurately represent site characteristics and must be prepared by qualified environmental professionals as set forth in Subparagraph (a)(3) of Rule .0202 of this Subchapter. New C&DLF unit(s) and lateral expansions must comply with the siting criteria set forth in Paragraph (c) of this Rule, Subparagraphs (4) through (10). In order to demonstrate compliance with specific criteria for each of the respective location restrictions, documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section may be required. The scope of demonstrations including design and construction performance must be addressed in the site study.

(c) The site study prepared for a C&DLF facility must include the information required by this Paragraph.

(1) Characterization study. The site characterization study area includes the landfill facility and a 2000-foot perimeter measured from the proposed boundary of the landfill facility. The study must include an aerial photograph taken within one year of the original submittal date, a report, and a local map. The map and photograph must be at a scale of at least one inch equals 400 feet. The study must identify the following:

(A) the entire property proposed for the disposal site and any on-site easements;

(B) existing land use and zoning;

(C) the location of residential structures and schools;

(D) the location of commercial and industrial buildings, and other potential sources of contamination;

(E) the location of potable wells and public water supplies;

(F) historic sites;

(G) state nature and historic preserves;

(H) the existing topography and features of the disposal site including: general surface water drainage patterns and watersheds, 100-year floodplains, perennial and intermittent streams, rivers, and lakes; and

(I) the classification of the surface water drainage from landfill site in accordance with 15A NCAC 02B .0300.

(2) Proposed Facility Plan. A conceptual plan for the development of the facility including drawings and a report must be prepared which includes the drawings and reports described in Subparagraphs (d)(1), (e)(1), (e)(2), and (e)(3) of Rule .0537 of this Section.

(3) Site Hydrogeologic Report. The study must be prepared in accordance with the requirements set forth in Paragraph (a) of Rule .0538 of this Section.

(4) Floodplain Location Restrictions;

(A) C&DLF units or constructed embankments used to construct a C&DLF unit must not be located in a 100-year floodplain unless a variance for the facility has been issued in accordance with N.C.G.S. 143-215.54A.

(B) C&DLF units must not be located in floodplains unless the owners or operators demonstrate that the unit will not restrict the flow of the flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.

(5) Wetlands Location Restriction. New C&DLF units and lateral expansions must not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

(A) Where applicable under Section 404 of the Clean Water Act or applicable State wetlands laws, the presumption that a practicable alternative to the proposed landfill facility is available which does not involve wetlands is clearly rebutted.

(B) The construction and operation of the C&DLF unit(s) will not cause or contribute to violations of any applicable State water quality standards and will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.

(C) The construction and operation of the C&DLF unit(s) will not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. The construction and operation of the C&DLF unit(s) will not violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(D) The construction and operation of the C&DLF unit(s) will not cause or contribute to significant degradation of wetlands.

(E) The owner or operator must demonstrate the integrity of the C&DLF unit(s) and its ability to protect ecological resources by addressing the following factors: (1) erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the C&DLF unit; (2) erosion, stability, and migration potential of dredged and fill materials used to support the C&DLF unit; the volume and chemical nature of the waste managed in the C&DLF unit; (3) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste; (4) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and (5) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected to the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws.

(F) The owner or operator must demonstrate that steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by Part (c)(5)(A) – (D) of this Rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands).

(G) The owner or operator must also demonstrate that sufficient information is available to make a reasonable determination with respect to each of the demonstrations required by this Rule.

(H) For purposes of this Rule, wetlands means those areas that are defined in 40 CFR 232.2(r).

(6) Unstable Area Location Restrictions. Owners and operators of new C&DLF unit(s) and lateral expansions proposed for location in an unstable area must demonstrate that engineering measures have been incorporated in the C&DLF unit's design to ensure that the integrity of any structural components of the C&DLF unit will not be disrupted. The owner and operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(A) On-site or local soil conditions that may result in significant differential settling;

(B) On-site or local geologic or geomorphologic features; and

(C) On-site or local human-made features or events (both surface and subsurface).

X (7) Cultural Resources Location Restrictions. A new C&DLF unit or lateral expansion must not damage or destroy a property of archaeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places. To aid in making a determination as to whether the property is of archeological or historical significance, the State's Historic Preservation Office in the Department of Cultural Resources may request the owner and operator to perform a site-specific survey which must be included in the Site Study.

(8) State Nature and Historic Preserve Location Restrictions. A new C&DLF unit or lateral expansion must not have an adverse impact, considering the purposes for designation of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve.

(9) Water Supply Watersheds Location Restrictions;

(A) A new C&DLF unit or lateral expansion must not be located in the critical area of a water supply watershed, or in the watershed for a stream segment classified as WS-I, or in watersheds of other water bodies which indicate that no new landfills are allowed in accordance with the rules codified at 15A NCAC 02B Section .0200 entitled "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

(B) Any new C&DLF unit or lateral expansion, which proposes to discharge leachate to surface waters and must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management pursuant to Section 402 of the United States Clean Water Act, must not be located within watersheds classified as WS-II or WS-III, or in watersheds of other water bodies which indicate that no new discharging landfills are allowed, in accordance with the rules codified at 15A NCAC 02B Section .0200.

(10) Endangered and Threatened Species Location Restrictions. A new C&DLF unit or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

(11) Local government approvals for C&DLFs.

(A) If the permit applicant is a unit of local government in which jurisdiction the proposed C&DLF site is located, the approval of the governing board shall be required. Approval may be in the form of either a resolution or a vote on a motion. A copy of the resolution or the minutes of the meeting where the vote was taken must be submitted to the Division as part of the site study.

(B) A permit applicant other than the unit of local government with jurisdiction over the proposed landfill site must obtain a franchise in accordance with N.C.G.S 130A-294(b1)(3) from each unit of local government in whose jurisdiction the site is located. A copy of the franchise must be submitted to the Division as part of the site study.

(C) Prior to issuance of approval or a franchise, the jurisdictional local government(s) where the landfill is to be located shall hold at least one public meeting to inform the community of the proposed waste management activities as described in the proposed facility plan prepared in accordance with Subparagraph (2) of this Paragraph. The local government where the landfill is to be located shall provide a public notice of the meeting at least 30 days prior to the meeting. For purposes of this Part, public notice must include a legal advertisement placed in a newspaper or newspapers serving the county and provision of a news release to at least one newspaper serving the county. Public notice must include time, place, and purpose of the meetings required by this Part. The application for a franchise or other documentation as required by the appropriate local government(s), must be placed at a location that is accessible by the public. This location must be noted in the public notice. The permit applicant must notify the property owners of all property that shares a common border with the proposed facility by means of a U.S. Postal Service registered letter, return receipt requested. The notice must give the date, time and place of the public meeting, and must describe the facility plan for the landfill, including the areal location and final elevation of all waste disposal units, the type and amount of waste to be disposed at the landfill, any other waste management activities to be conducted at the facility, and the proposed location of the entrance to the facility. Mailings must be postmarked a minimum of 30 days prior to the public meeting which is being noticed. The applicant must provide documentation of the content and mailing of the notices in the site study.

(D) Public notice of the meeting must be documented in the site study. A tape recording or a written transcript of the meeting, all written material submitted representing community concerns, and all other relevant written material distributed or used at the meeting must be submitted as part of the site study.

(E) A letter from the unit of local government(s) having zoning jurisdiction over the site which states that the proposal meets all the requirements of the local zoning ordinance, or that the site is not zoned, must be submitted to the Division as part of the site study.

(d) Site suitability applications for a new C&DLF facility or unit submitted in accordance with Rule .0504(1) of this Section must be submitted to the Division prior to December 31, 2006.

Section 5 – Location Restrictions
ATTACHMENT 5-5

US Fish and Wildlife Service Correspondence

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919 787-5620
fax: 919 781-5730

April 12, 2007

Mr. Pete Benjamin
Field Supervisor
US Fish and Wildlife Service
Raleigh ES Field Office
PO Box 33726
Raleigh, NC 27636-3726

Subject: Site Study Amendment
Dare County, North Carolina
CDM Project Number: 17952-56960

Dear Mr. Benjamin:

Dare County (County) currently operates a construction and demolition (C&D) landfill located off Highway 264 in Dare County (see Figures 1-1 and 1-2). A Site Plan for the construction of a municipal solid waste (MSW) landfill facility was approved by the North Carolina Department of Environment, Solid Waste Section (NCDENR SWS) in January 1993, but the County elected to dispose of MSW in a commercial regional facility in Bertie County. Thusly, the MSW facility was not developed, but the existing C&D landfill was designed and constructed and has since then been accepting and disposing C&D waste. The approved C&D Site Plan includes five individual C&D disposal cells separated by drainage laterals (see Sheet 1). The drainage laterals (F1 through F4) have been determined non-jurisdictional by the US Army Corps of Engineers (see Attachment 1). Currently, Cells No. 1 and 2 are closed and Cell No. 3 is receiving and disposing of C&D waste.

The County has contracted CDM to evaluate the feasibility of expanding their existing C&D landfill to include drainage laterals (F1 through F4) as additional disposal cells, thusly creating one mound instead of five stand-alone mounds as depicted in Sheet 1. This will provide the County with additional disposal volume and a potential public post-closure use for the C&D landfill (i.e., dog park, bird watching station, etc.). The inclusion of the drainage laterals will not increase the overall footprint of the previously approved C&D landfill, but will increase the acreage by approximately 2 acres for each drainage lateral. The proposed increase of the C&D landfill capacity results in expanding the landfill which, per North Carolina Solid Waste Management Rule 15A NCAC 13B .0533 (a) (1) (B), requires C&D landfill owners or operators to submit an amended site study.

Per Rule 15A NCAC 13B .0536, a C&D landfill site study must include a report demonstrating compliance with location restrictions including documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section.

CDM

Paragraph (c) (10) of the aforementioned Rule states that a new C&D landfill or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. Pertinent regulation sections are enclosed as Attachment 2.

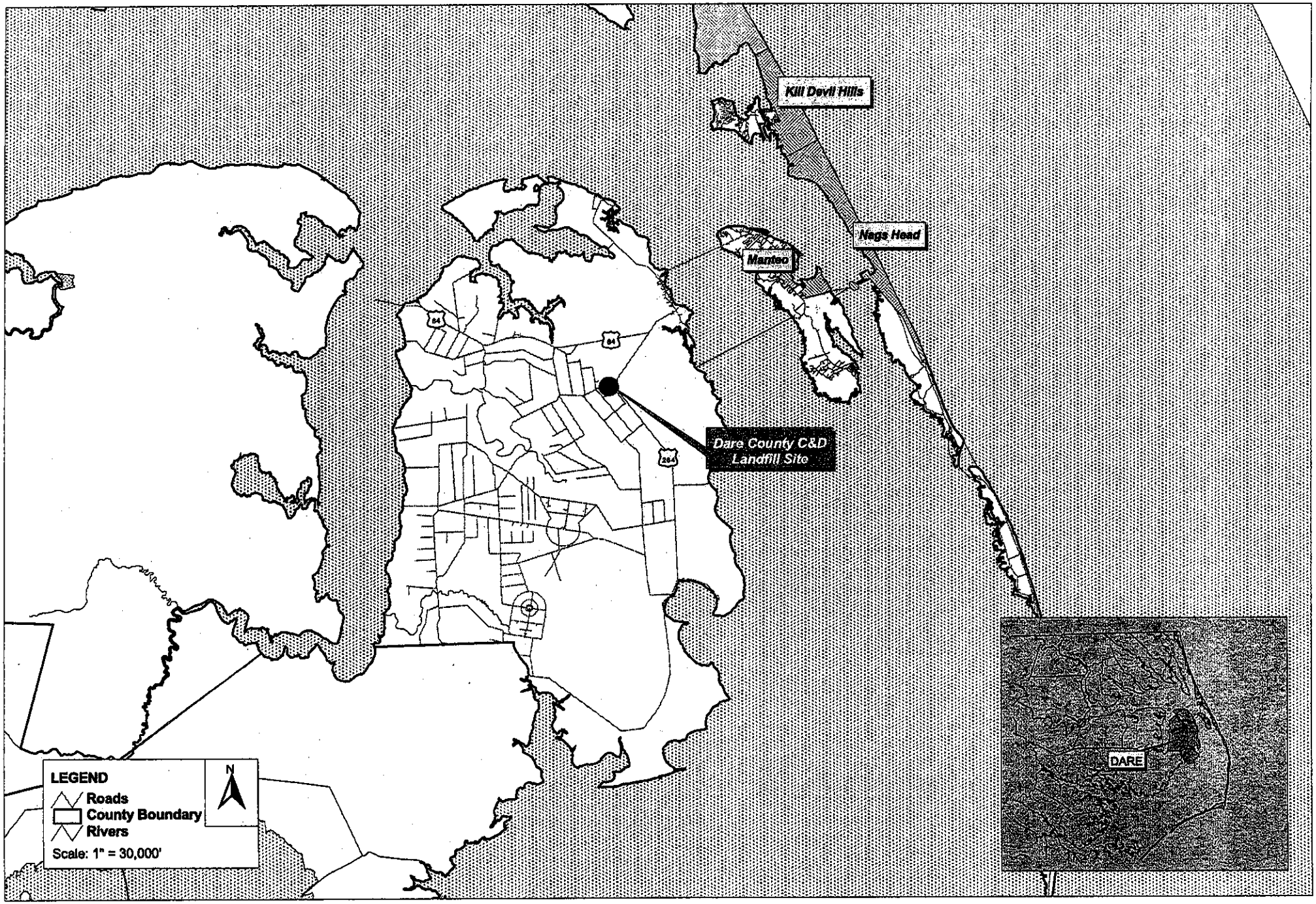
Through this letter, CDM is requesting, in writing, an official evaluation and opinion from the US Fish and Wildlife Service as to whether the proposed C&D landfill expansion satisfies the above referenced Rule.

We sincerely appreciate your prompt attention in this request. Please feel free to contact me at (919)-787-5620, should you have any questions.

Very truly yours,

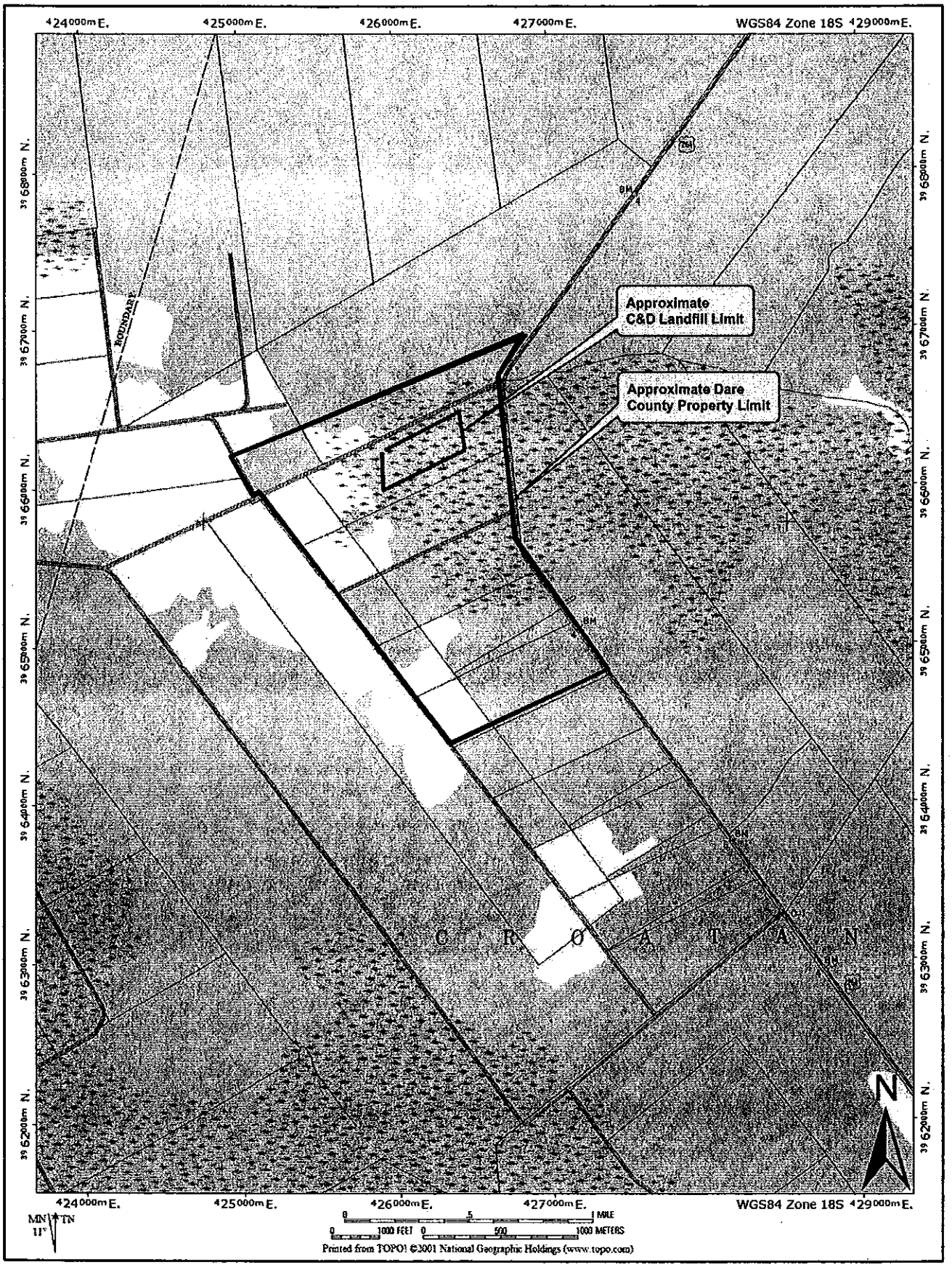
W. Mike Brinchek, P.E.
Camp Dresser & McKee

cc: E. Mann - Dare County
K. Yang - CDM



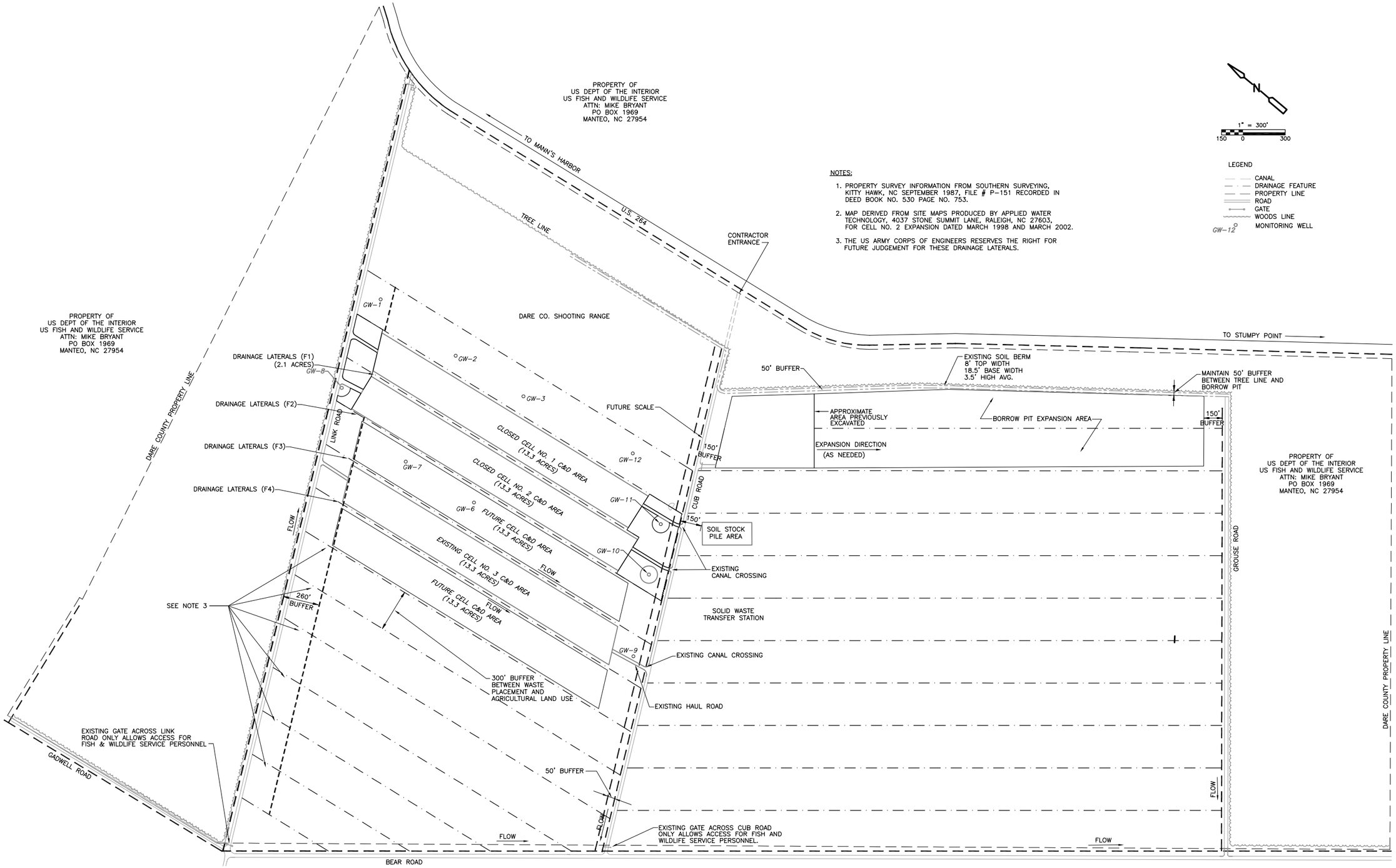
CDM

Figure 1-1
Location Map



CDM

Figure 1-2



NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. THE US ARMY CORPS OF ENGINEERS RESERVES THE RIGHT FOR FUTURE JUDGEMENT FOR THESE DRAINAGE LATERALS.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
SITE STUDY

SITE MAP

PROJECT NO. 17952-56960
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 1

US Army Corps of Engineers Documentation

U.S. ARMY CORPS OF ENGINEERS
WILMINGTON DISTRICT

COPY

ORM ID: **SAW-2007-1238-128** County: **Dare**

NO DEPARTMENT OF THE ARMY AUTHORIZATION REQUIRED

Property Owner / Agent: **Clyde Gard**
Address: **Post Office Box 1000**
Manteo, North Carolina 27954
Telephone Number: **252-473-6339**

Size and Location of Property (waterbody, road name/number, town, etc.): **837 acre landfill located between Link Road and Borrow Pit Road off US 264 in Manns Harbor, Dare County, North Carolina.**

Description of Activity: **Fill in drainage laterals F1-F4. Fill not encroach on 50' buffer north of Cub Road ditch or 260' buffer south of Link Road..**

Your work as proposed does not require Department of the Army authorization for the following reason(s):

_ There are no jurisdictional waters or wetlands within the boundaries of the property.
X The proposed project does not impact jurisdictional waters or wetlands.
_ The proposed project is exempt from Department of the Army regulation.
Specify: _____.

This Department of the Army determination does not relieve the permittee of the responsibility to obtain any other required Federal, State, or local approvals/permits. The permittee may need to contact appropriate State and local agencies before beginning work.

For any activity within the twenty coastal counties, before beginning work, you must contact the N.C. Division of Coastal Management in Washington, North Carolina, at (252) 956-6481 to discuss any required State authorization.

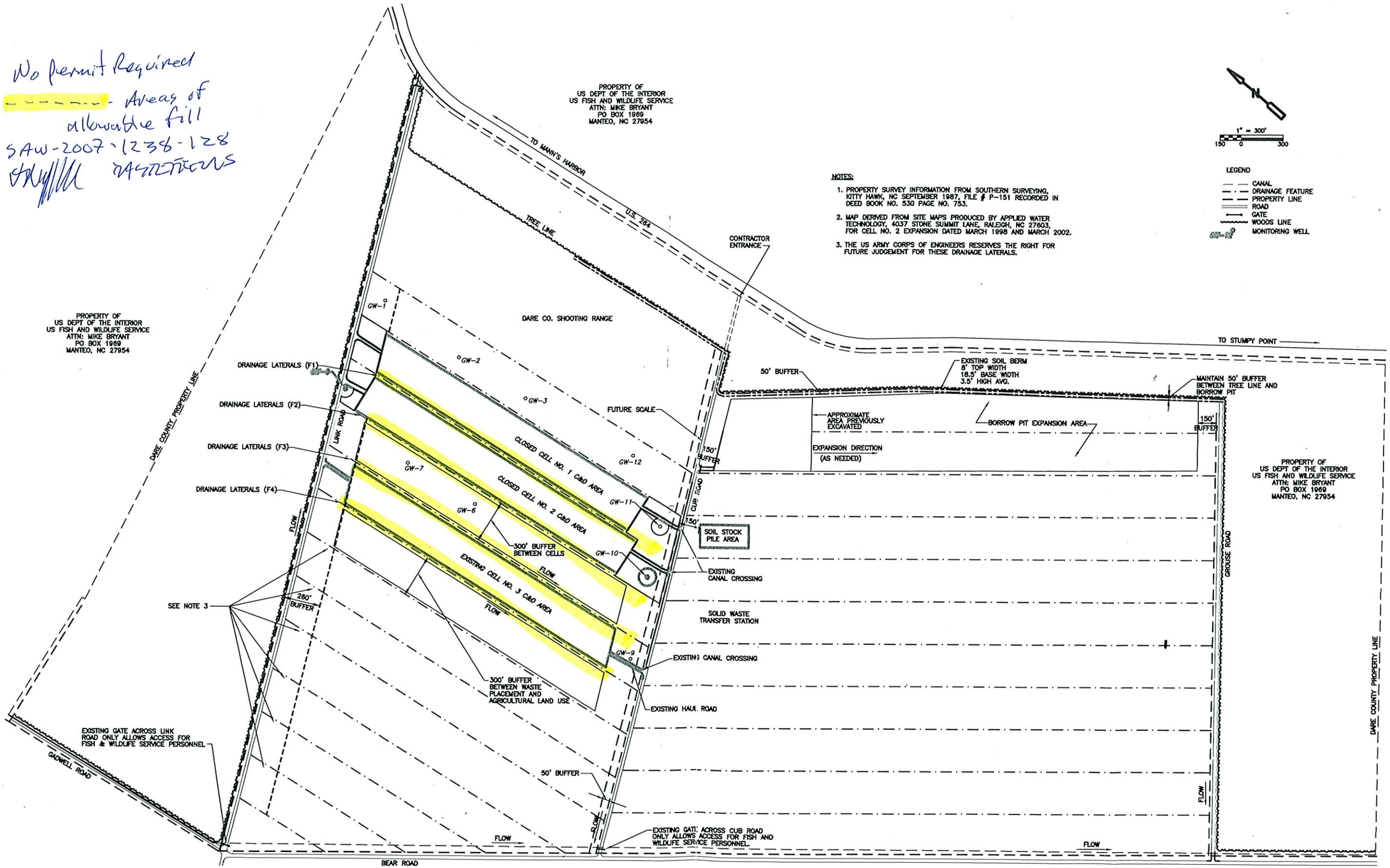
Any changes in the above described work must be coordinated with the Corps of Engineers prior to commencement. If you have any questions regarding the Corps of Engineers regulatory program, please contact **Tom Steffens** at telephone number (252) 975-1616 ext. **25**.

Regulatory Project Manager Signature TMSTEFFENS

Date: **04/09/2007**

SURVEY PLATS, FIELD SKETCH, WETLAND DELINEATION FORM, ETC., MUST BE ATTACHED TO THE YELLOW (FILE) COPY OF THIS FORM, IF REQUIRED OR AVAILABLE.

No Permit Required
- - - - - - - - Areas of allowable fill
SAW-2007-1238-128
DAGRETTICUS



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: K. YANG
DRAWN BY: K. YANG
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY:
APPROVED BY:
DATE: FEBRUARY 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL
US ARMY CORPS OF ENGINEERS SITE VISIT

SITE MAP

PROJECT NO. 17952-58980
FILE NAME: SHEET1.DWG

SHEET NO.
SHEET 1

ATTACHMENT 2

Pertinent North Carolina Solid Waste Rules

15A NCAC 13B .0533 GENERAL APPLICATION REQUIREMENTS AND PROCESSING FOR C&DLF FACILITIES

(a) Applicability. Owners or operators of a proposed or existing C&DLF unit or facility shall submit an application document as detailed in Rule .0535 of this Section in accordance with the criteria and scheduling requirements set forth as follows:

(1) New facility. Owners or operators proposing to establish a C&DLF facility or unit in accordance with the following criteria shall submit a Site Study and subsequently an application for a permit to construct as set forth in Paragraph (a) of Rule .0535 of this Section. A new facility permit application is required when:

(A) The owner or operator proposes to establish a new facility not previously permitted by the Division.

(B) The owner or operator proposes to expand the landfill facility in order to expand the C&DLF unit(s) boundary approved in accordance with Subparagraph (a)(1) of Rule .0536 of this Section.

(2) Amendment to the permit. For any subsequent phase of landfill development the owner or operator shall prepare an application to amend the permit to construct in accordance with Paragraph (b) of Rule .0535 of this Section and submit the application at the earlier of the following dates:

(A) at least 180 days prior to the date scheduled for commencing construction; or

(B) five years from the issuance date of the initial permit to operate or as specified in the effective permit.

(3) Substantial amendment to the permit. A permit issued in accordance with Paragraph (c) of this Rule approves a facility plan for the life of the C&DLF facility and a set of plans for the initial phase of landfill development. The owner or operator shall prepare an application in accordance with Paragraph (c) of Rule .0535 of this Section and submit the application when there is:

(A) a substantial change in accordance with N.C.G.S. 130A-294 (b1)(1); or

(B) a proposed transfer of ownership of the C&DLF facility.

(4) Modifications to the permit. An owner or operator proposing changes to the plans approved in the permit shall request prior approval from the Division in accordance with Paragraph (d) of Rule .0535 of this Section.

(b) Application format guidelines. All applications and plans required by Rules .0531 through .0547 of this Section shall be prepared in accordance with the following guidelines:

(1) The initial application shall:

(A) contain a cover sheet stating the project title and location, the applicant's name and address, and the engineer's name, address, signature, date of signature and seal; and

(B) contain a statement defining the purpose of the submittal signed and dated by the applicant.

(2) The text of the application shall:

(A) be submitted in a three ring binder;

(B) contain a table of contents or index outlining the body of the application and the appendices;

(C) be paginated consecutively; and

(D) identify revised text by noting the date of revision on the page.

(3) Drawings. The engineering drawings for all landfill facilities shall be submitted using the following format.

(A) The sheet size with title blocks shall be at least 22 inches by 34 inches.

(B) The cover sheet shall include the project title, applicant's name, sheet index, legend of symbols, and the engineer's name, address, signature, date of signature, and seal.

(C) Where the requirements do not explicitly specify a minimum scale, maps and drawings shall be prepared at a scale that adequately illustrates the subject requirement(s).

(4) Number of copies. An applicant shall submit a minimum of three copies of each original application document and any revisions to the Division. The Division shall request additional copies as necessary. The Division shall require submittal of relevant documents in electronic format.

(c) Permitting and Public Information Procedures.

(1) Purpose and Applicability.

(A) Purpose. During the permitting process the Division shall provide for public review of and input to permit documents containing the applicable design and operating conditions. The

15A NCAC 13B .0536 SITE STUDY FOR C&DLF FACILITIES

(a) Purpose. As required under Rule .0535 of this Section, the owner or operator must prepare a site study which meets the requirements of this Rule. The Division shall review the site study for a proposed new facility prior to consideration of an application for a permit to construct. Following review of the site study, the Division shall notify the applicant that either:

(1) the site is deemed suitable and the applicant is authorized to prepare an application for a permit to construct in accordance with Rule .0535 of this Section; or

(2) the site is deemed unsuitable for establishing a C&DLF unit(s) and shall specify the reasons that would prevent the C&DLF unit(s) from being operated in accordance with N.C.G.S.130A Article 9, or this Subchapter, and any applicable federal laws and regulations.

(b) Scope. The site is the land which is proposed for the landfill facility. The site study presents a characterization of the land, incorporating various investigations and requirements pertinent to suitability of a C&DLF facility. The scope of the site study includes criteria associated with the public health and welfare, and the environment. The economic feasibility of a proposed site is not within the scope of this study. The information in the site study must accurately represent site characteristics and must be prepared by qualified environmental professionals as set forth in Subparagraph (a)(3) of Rule .0202 of this Subchapter. New C&DLF unit(s) and lateral expansions must comply with the siting criteria set forth in Paragraph (c) of this Rule, Subparagraphs (4) through (10). In order to demonstrate compliance with specific criteria for each of the respective location restrictions, documentation or approval by agencies other than the Division of Waste Management, Solid Waste Section may be required. The scope of demonstrations including design and construction performance must be addressed in the site study.

(c) The site study prepared for a C&DLF facility must include the information required by this Paragraph.

(1) Characterization study. The site characterization study area includes the landfill facility and a 2000-foot perimeter measured from the proposed boundary of the landfill facility. The study must include an aerial photograph taken within one year of the original submittal date, a report, and a local map. The map and photograph must be at a scale of at least one inch equals 400 feet. The study must identify the following:

(A) the entire property proposed for the disposal site and any on-site easements;

(B) existing land use and zoning;

(C) the location of residential structures and schools;

(D) the location of commercial and industrial buildings, and other potential sources of contamination;

(E) the location of potable wells and public water supplies;

(F) historic sites;

(G) state nature and historic preserves;

(H) the existing topography and features of the disposal site including: general surface water drainage patterns and watersheds, 100-year floodplains, perennial and intermittent streams, rivers, and lakes; and

(I) the classification of the surface water drainage from landfill site in accordance with 15A NCAC 02B .0300.

(2) Proposed Facility Plan. A conceptual plan for the development of the facility including drawings and a report must be prepared which includes the drawings and reports described in Subparagraphs (d)(1), (e)(1), (e)(2), and (e)(3) of Rule .0537 of this Section.

(3) Site Hydrogeologic Report. The study must be prepared in accordance with the requirements set forth in Paragraph (a) of Rule .0538 of this Section.

(4) Floodplain Location Restrictions;

(A) C&DLF units or constructed embankments used to construct a C&DLF unit must not be located in a 100-year floodplain unless a variance for the facility has been issued in accordance with N.C.G.S. 143-215.54A.

(B) C&DLF units must not be located in floodplains unless the owners or operators demonstrate that the unit will not restrict the flow of the flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human health and the environment.

(5) Wetlands Location Restriction. New C&DLF units and lateral expansions must not be located in wetlands, unless the owner or operator can make the following demonstrations to the Division:

(A) Where applicable under Section 404 of the Clean Water Act or applicable State wetlands laws, the presumption that a practicable alternative to the proposed landfill facility is available which does not involve wetlands is clearly rebutted.

(B) The construction and operation of the C&DLF unit(s) will not cause or contribute to violations of any applicable State water quality standards and will not violate any applicable toxic effluent standard or prohibition under Section 307 of the Clean Water Act.

(C) The construction and operation of the C&DLF unit(s) will not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973. The construction and operation of the C&DLF unit(s) will not violate any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.

(D) The construction and operation of the C&DLF unit(s) will not cause or contribute to significant degradation of wetlands.

(E) The owner or operator must demonstrate the integrity of the C&DLF unit(s) and its ability to protect ecological resources by addressing the following factors: (1) erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the C&DLF unit; (2) erosion, stability, and migration potential of dredged and fill materials used to support the C&DLF unit; the volume and chemical nature of the waste managed in the C&DLF unit; (3) impacts on fish, wildlife, and other aquatic resources and their habitat from release of the solid waste; (4) the potential effects of catastrophic release of waste to the wetland and the resulting impacts on the environment; and (5) any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected to the extent required under Section 404 of the Clean Water Act or applicable State wetlands laws.

(F) The owner or operator must demonstrate that steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent practicable as required by Part (c)(5)(A) – (D) of this Rule, then minimizing unavoidable impacts to the maximum extent practicable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and practicable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands).

(G) The owner or operator must also demonstrate that sufficient information is available to make a reasonable determination with respect to each of the demonstrations required by this Rule.

(H) For purposes of this Rule, wetlands means those areas that are defined in 40 CFR 232.2(r).

(6) Unstable Area Location Restrictions. Owners and operators of new C&DLF unit(s) and lateral expansions proposed for location in an unstable area must demonstrate that engineering measures have been incorporated in the C&DLF unit's design to ensure that the integrity of any structural components of the C&DLF unit will not be disrupted. The owner and operator must consider the following factors, at a minimum, when determining whether an area is unstable:

(A) On-site or local soil conditions that may result in significant differential settling;

(B) On-site or local geologic or geomorphologic features; and

(C) On-site or local human-made features or events (both surface and subsurface).

X (7) Cultural Resources Location Restrictions. A new C&DLF unit or lateral expansion must not damage or destroy a property of archaeological or historical significance which has been listed or determined eligible for a listing in the National Register of Historic Places. To aid in making a determination as to whether the property is of archeological or historical significance, the State's Historic Preservation Office in the Department of Cultural Resources may request the owner and operator to perform a site-specific survey which must be included in the Site Study.

(8) State Nature and Historic Preserve Location Restrictions. A new C&DLF unit or lateral expansion must not have an adverse impact, considering the purposes for designation of the Preserve lands and the location, access, size and operation of the landfill, on any lands included in the State Nature and Historic Preserve.

(9) Water Supply Watersheds Location Restrictions;

(A) A new C&DLF unit or lateral expansion must not be located in the critical area of a water supply watershed, or in the watershed for a stream segment classified as WS-I, or in watersheds of other water bodies which indicate that no new landfills are allowed in accordance with the rules codified at 15A NCAC 02B Section .0200 entitled "Classifications and Water Quality Standards Applicable To Surface Waters Of North Carolina."

(B) Any new C&DLF unit or lateral expansion, which proposes to discharge leachate to surface waters and must obtain a National Pollution Discharge Elimination System (NPDES) Permit from the Division of Environmental Management pursuant to Section 402 of the United States Clean Water Act, must not be located within watersheds classified as WS-II or WS-III, or in watersheds of other water bodies which indicate that no new discharging landfills are allowed, in accordance with the rules codified at 15A NCAC 02B Section .0200.

(10) Endangered and Threatened Species Location Restrictions. A new C&DLF unit or lateral expansion must not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Federal Endangered Species Act of 1973.

(11) Local government approvals for C&DLFs.

(A) If the permit applicant is a unit of local government in which jurisdiction the proposed C&DLF site is located, the approval of the governing board shall be required. Approval may be in the form of either a resolution or a vote on a motion. A copy of the resolution or the minutes of the meeting where the vote was taken must be submitted to the Division as part of the site study.

(B) A permit applicant other than the unit of local government with jurisdiction over the proposed landfill site must obtain a franchise in accordance with N.C.G.S 130A-294(b1)(3) from each unit of local government in whose jurisdiction the site is located. A copy of the franchise must be submitted to the Division as part of the site study.

(C) Prior to issuance of approval or a franchise, the jurisdictional local government(s) where the landfill is to be located shall hold at least one public meeting to inform the community of the proposed waste management activities as described in the proposed facility plan prepared in accordance with Subparagraph (2) of this Paragraph. The local government where the landfill is to be located shall provide a public notice of the meeting at least 30 days prior to the meeting. For purposes of this Part, public notice must include a legal advertisement placed in a newspaper or newspapers serving the county and provision of a news release to at least one newspaper serving the county. Public notice must include time, place, and purpose of the meetings required by this Part. The application for a franchise or other documentation as required by the appropriate local government(s), must be placed at a location that is accessible by the public. This location must be noted in the public notice. The permit applicant must notify the property owners of all property that shares a common border with the proposed facility by means of a U.S. Postal Service registered letter, return receipt requested. The notice must give the date, time and place of the public meeting, and must describe the facility plan for the landfill, including the areal location and final elevation of all waste disposal units, the type and amount of waste to be disposed at the landfill, any other waste management activities to be conducted at the facility, and the proposed location of the entrance to the facility. Mailings must be postmarked a minimum of 30 days prior to the public meeting which is being noticed. The applicant must provide documentation of the content and mailing of the notices in the site study.

(D) Public notice of the meeting must be documented in the site study. A tape recording or a written transcript of the meeting, all written material submitted representing community concerns, and all other relevant written material distributed or used at the meeting must be submitted as part of the site study.

(E) A letter from the unit of local government(s) having zoning jurisdiction over the site which states that the proposal meets all the requirements of the local zoning ordinance, or that the site is not zoned, must be submitted to the Division as part of the site study.

(d) Site suitability applications for a new C&DLF facility or unit submitted in accordance with Rule .0504(1) of this Section must be submitted to the Division prior to December 31, 2006.

Name of Stream	Description	Curr. Class	Date	Prop. Class	Basin	Stream Index #
Atlantic Ocean	The waters of the Atlantic Ocean contiguous to that portion of Pasquotank River Basin that extends from the North Carolina-Virginia State Line to the northeast tip of Ocracoke Island.	SB	04/06/61		Pasquotank	99-(7)
PAMLICO RIVER AND PAMLICO SOUND	From a line across Pamlico River from Roos Point to Persimmon Tree Point to Pamlico Sound and Pamlico Sound within a line beginning at Sandy Point and extending southerly to northeast tip of Ocracoke Island, thence along the Ocean Side of Ocracoke Island to its southwest tip, thence northwesterly to Little Propoise Point, exclusive of the ORW area described below	SA;HQW	06/06/62		Tar-Pamlico	29-(40.5)
Long Shoal River	From source to U.S. Hwy. 264	C;Sw	06/06/62		Tar-Pamlico	29-73-(1)
Long Shoal River	From U.S. Hwy. 264 to Pamlico Sound	SA;HQW	06/06/62		Tar-Pamlico	29-73-(2)
Deep Creek	From source to Long Shoal River	SA;HQW	06/06/62		Tar-Pamlico	29-73-4
Muddy Creek	From source to Long Shoal River	SA;HQW	06/06/62		Tar-Pamlico	29-73-5
Clark Creek	From source to Long Shoal River	SA;HQW	06/06/62		Tar-Pamlico	29-73-6
Pains Bay	Entire Bay	SA;HQW	06/06/62		Tar-Pamlico	29-74
Pains Creek	From source to Pains Bay	SA;HQW	06/06/62		Tar-Pamlico	29-74-1
Parched Corn Bay	Entire Bay	SA;HQW	06/06/62		Tar-Pamlico	29-75
Sandy Bay	Entire Bay	SA;HQW	06/06/62		Tar-Pamlico	29-76

Engineering Plan
Contents

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1.1 Landfill Subgrade 1-1
1.2 Final Cap System 1-1
1.3 Erosion and Sediment Control 1-1

Section 2 – Analysis of the Facility Design - Summary

2.1 Analytical Methods Used to Evaluate the Design 2-1
2.2 Critical Conditions Evaluated and Assumptions Made 2-1
2.3 Technical References 2-1
2.4 Location Restrictions 2-1

Section 3 – Description of Materials and Construction Practices

Appendices

Appendix A - Calculations
Appendix B - Design Geotechnical Evaluation
Appendix C - Design Hydrogeological Report

Section 1
Analysis of the Facility Design – Overview

The purpose of this section is to provide a brief description of the landfill subgrade and final cover for Cell 4 of the Dare County C&D landfill.

1.1 Landfill Subgrade

The proposed landfill subgrade for Cell 4 is designed in conformance with Title 15A of the North Carolina Administrative Code, Subchapter 13B, Section .0540 (2) and will be constructed according to the following:

- Post-settlement bottom elevations of waste will be a minimum four feet above the seasonal high ground-water table and the bedrock datum plane contours as established in Appendix C – Design Hydrogeological Report; and
- In-situ or modified soils making up the upper two feet of separation will consist of the SC, SM, ML, CL, MH, or CH soils per Unified Soil Classification System.

1.2 Final Cap System

The final cap system has been designed to minimize the amount of stormwater infiltration into the landfill and to resist erosive forces. The final cap system consists of the following layers (listed from top to bottom), which meet the requirements of Rule 0.543(c)(1):

- An 18-inch erosion layer consisting of earthen material that is capable of sustaining native plant growth; and
- An 18-inch low permeability barrier of earthen material with a permeability no greater than 1.0×10^{-5} cm per second.

The post-settlement grades of the top surface slopes will not be less than 5 percent (to prevent ponding).

Closure side slopes are designed at 3:1(Horizintal:Vertical) slopes for Cell 4 as provided in Appendix B – Design Geotechnical Evaluation. Post-settlement slopes are expected to be less than 3:1. Rule 0.543(c)(3)(C) allows for alternative side slopes (those greater than 25%) to be approved by the North Carolina Department of Environment and Natural Resources Solid Waste Section (NCDENR SWS) if the design is certified (by a licensed professional engineer in the State of North Carolina) to be stable, encourage runoff, and be safe to construct, operate and maintain.

1.3 Erosion and Sediment Control

Erosion control measures for Cell No. 4 are shown on the Grading Plan, Sheet C-3 and Detail Sheet D-1 of the Engineering Plans. Measures include installation of silt fence and maintaining a 250-foot buffer to protect the canals adjacent to Link Road and Cub Road. In addition, gravel and riprap filter basins will be constructed on the south end of the drainage ditches bordering the east and west sides of Cell No. 4. Calculations

for the filter basins are included in Appendix A. Temporary and permanent vegetation will be established at the site in accordance with the North Carolina Sediment and Erosion Control Manual.

The filter basins have been designed in such a manner that releases will not overload downstream drainage features or damage adjacent property. Sediment accumulated in the pond shall be removed as the sediment pool becomes filled (approximately two feet above the bottom of the basins). Silt gages shall be installed in both basins. Ditches require frequent inspection for sediment buildup. At a minimum, the sediment buildup should be assessed after all significant rain events.

Temporary stormwater control devices such as silt fencing, etc. will be used during construction to control sediment laden stormwater runoff. These devices will remain in use until construction has been completed, areas have been stabilized, and all stormwater is diverted into and controlled by the permanent stormwater control devices. Prior to construction, the engineer will submit for approval a Sedimentation and Erosion Control Permit Application to NCDENR Division of Land Resources, Land Quality Section prepared in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual, which will include all temporary stormwater control devices.

Section 2
Analysis of the Facility Design - Summary

2.1 Analytical Methods Used to Evaluate the Design

The stormwater erosion and sedimentation controls and structures are designed in accordance with the North Carolina Erosion and Sediment Control Planning and Design Manual. The entire set of design calculations for the erosion and sedimentation control system is contained in Appendix A of this Engineering Plan. The County will apply for an erosion and sediment control permit prior to construction.

Soil loss calculations are included in Appendix A of this report addressing the vegetative cover soil layer's resistance to erosion of the final cap system.

The design geotechnical report is included in Appendix B and contains descriptions of the geotechnical methods used to analyze the design of the facility and associated calculations. Calculations include cap component (slope) stability for the final cap system.

2.2 Critical Conditions Evaluated and Assumptions Made

The following assumptions and critical conditions were made to design the various landfill components:

- A maximum horizontal acceleration of 0.10 g was used to perform the seismic slope stability analysis.
- The 25-year, 24-hour storm event was assumed in the design of site drainage structures and sediment ponds.

2.3 Technical References

The following references were used for the design and evaluation of the different landfill components.

- North Carolina Erosion and Sediment Control Planning and Design Manual
- AutoCAD Civil 3D Design Software

2.4 Location Restrictions

Rule .0539(d)(1)(D) requires that a report be prepared and submitted demonstrating compliance with the location restrictions in Rule .0536. Rule .0536(c)(4) through (10) requires documentation or approvals by agencies other than the Division of Solid Waste Management that demonstrate compliance with specific location criteria.

Pertinent documentation is included in Section 1 – Facility Plan, Appendix A: Location Restrictions for the entire proposed C&D landfill expansion.

Section 3
Description of Materials and Construction Practices

A detailed description of the materials and construction practices that will be used during the construction of the Dare County C&D landfill is provided in the Construction Quality Assurance (CQA) Plan. The design calculations and evaluations used in determining material specifications are located in Appendices A through C of the Engineering Plan.

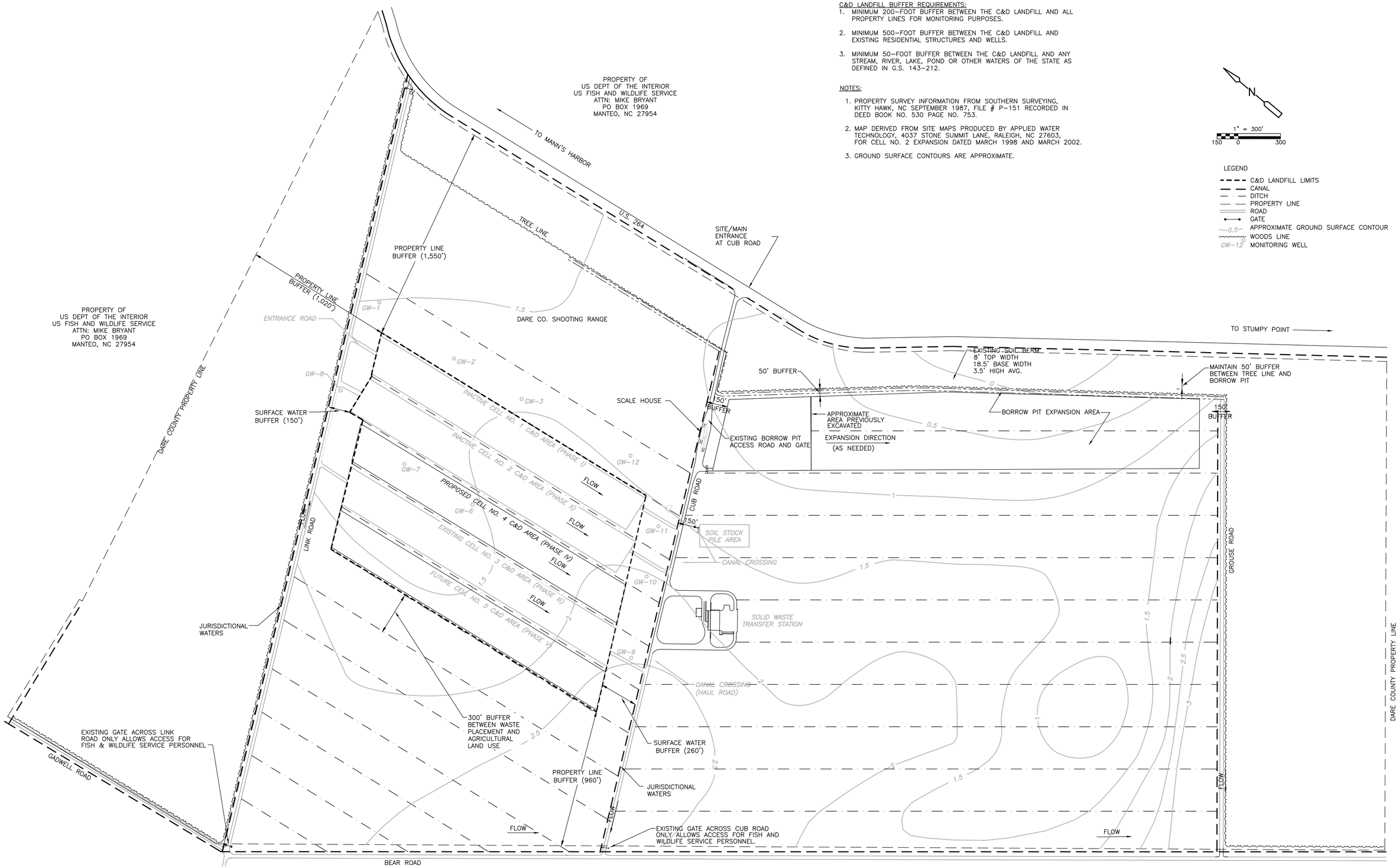
Engineering Plan Drawings

C&D LANDFILL BUFFER REQUIREMENTS:

1. MINIMUM 200-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ALL PROPERTY LINES FOR MONITORING PURPOSES.
2. MINIMUM 500-FOOT BUFFER BETWEEN THE C&D LANDFILL AND EXISTING RESIDENTIAL STRUCTURES AND WELLS.
3. MINIMUM 50-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ANY STREAM, RIVER, LAKE, POND OR OTHER WATERS OF THE STATE AS DEFINED IN G.S. 143-212.

NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. GROUND SURFACE CONTOURS ARE APPROXIMATE.



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

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Camp Dresser & McKee
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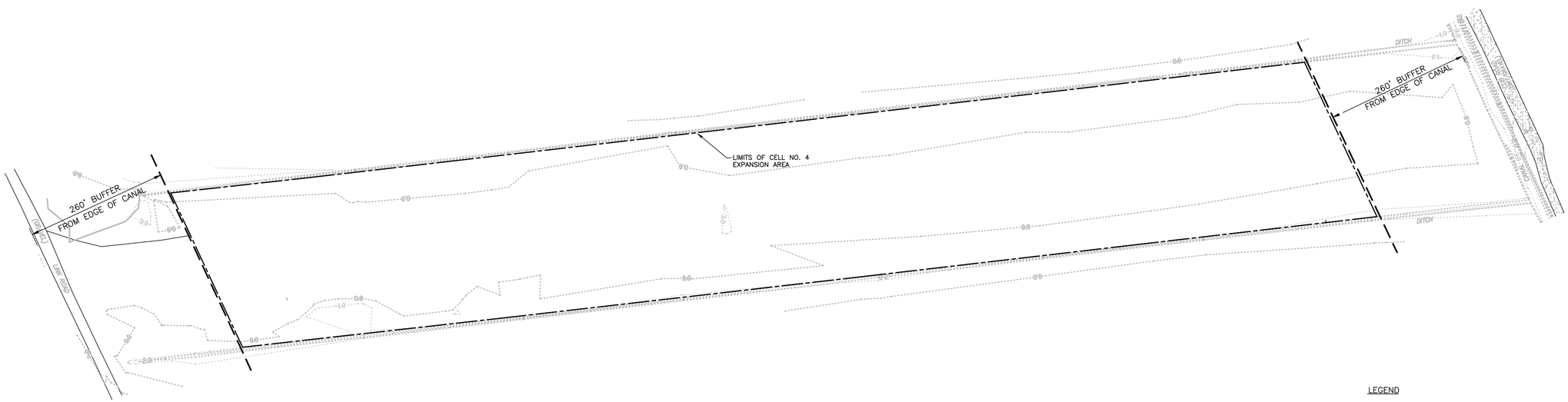
DARE COUNTY
NORTH CAROLINA

CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

SITE MAP

PROJECT NO. 17952-56960
FILE NAME: C-1
SHEET NO.
C-1

NOT FOR CONSTRUCTION



LEGEND

GW-9	EXISTING MONITORING WELL
P-1	EXISTING PIEZOMETER
0.0	EXISTING GROUND SURFACE CONTOUR

NOTES:

1. TOPOGRAPHIC SURVEY DATE 11/29/04 BY QUIBLE & ASSOCIATES, PC, PO DRAWER 870, KITTY HAWK, NC 27947, REFERENCE DB 530, PG 733 AND PL C, SL 32B.
2. VERTICAL DATUM BASED ON GPS RAPID STATIC SESSION, OPUS REPORT #000237065. DATUM NAVD '88, FEET.
3. PROPERTY LIES WITHIN A PORTION OF PIN 9747-00-32-5320 1531 LINK ROAD MANNS HARBOR, NORTH CAROLINA.
4. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGED SINCE DATE OF SURVEY.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: –
APPROVED BY:
DATE: JULY 2009

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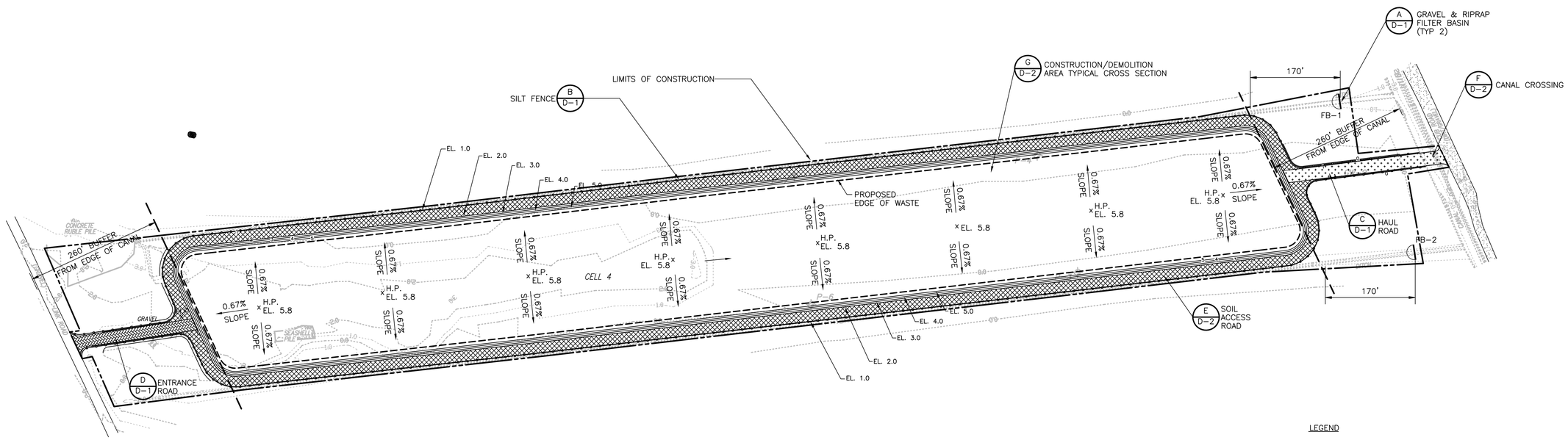
EXISTING CONDITIONS

PROJECT NO. 17952 56960
FILE NAME: C-2

SHEET NO.
C-2

NOT FOR CONSTRUCTION



LEGEND

GW-9	EXISTING MONITORING WELL
P-1	EXISTING PIEZOMETER
0.0	EXISTING CONTOUR
	PROPOSED CONTOUR
H.P. EL. 4.8	HIGH POINT
FB-1	FILTER BASIN
	SILT FENCE
	HAUL ROAD
	PROPOSED SOIL ACCESS ROAD
	ENTRANCE ROAD
	LIMITS OF CONSTRUCTION

NOTES:

1. TOPOGRAPHIC SURVEY DATE 11/29/04 BY QUIBLE & ASSOCIATES, PC, PO DRAWER 870, KITTY HAWK, NC 27947, REFERENCE DB 530, PG 733 AND PL C, SL 32B.
2. VERTICAL DATUM BASED ON GPS RAPID STATIC SESSION, OPUS REPORT #000237065. DATUM NAVD '88, FEET.
3. PROPERTY LIES WITHIN A PORTION OF PIN 9747-00-32-5320 1531 LINK ROAD MANNS HARBOR, NORTH CAROLINA.
4. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGED SINCE DATE OF SURVEY.
5. PIEZOMETERS LOCATED WITHIN THE CELL NO. 4 FOOTPRINT SHALL BE ABANDONED PER NCDENR REQUIREMENTS PRIOR TO CELL CONSTRUCTION.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: M. BRINCHEK
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: JULY 2009

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CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
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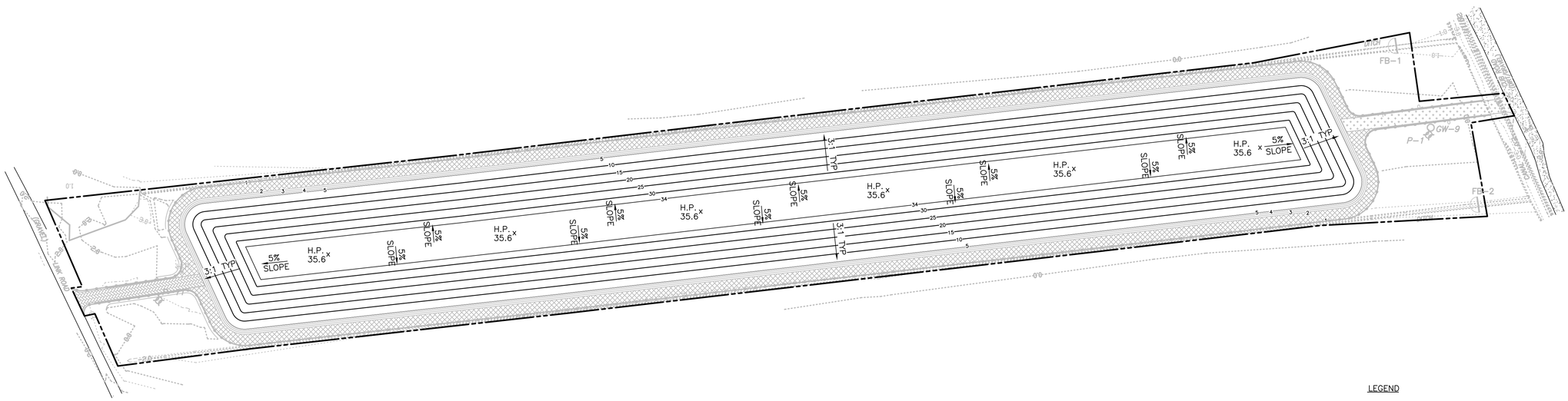
GRADING PLAN

PROJECT NO. 17952 56960
FILE NAME: C-3
SHEET NO.
C-3

NOT FOR CONSTRUCTION



LEGEND

GW-9	EXISTING MONITORING WELL
P-1	EXISTING PIEZOMETER
0.0	EXISTING CONTOUR
	PROPOSED CONTOUR
H.P. EL. 4.8	HIGH POINT
FB-1	FILTER BASIN
	SILT FENCE
	HAUL ROAD
	PROPOSED SOIL ACCESS ROAD
	ENTRANCE ROAD
	LIMITS OF CONSTRUCTION

NOTES:

1. TOPOGRAPHIC SURVEY DATE 11/29/04 BY QUIBLE & ASSOCIATES, PC, PO DRAWER 870, KITTY HAWK, NC 27947, REFERENCE DB 530, PG 733 AND PL C, SL 32B.
2. VERTICAL DATUM BASED ON GPS RAPID STATIC SESSION, OPUS REPORT #000237065. DATUM NAVD '88, FEET.
3. PROPERTY LIES WITHIN A PORTION OF PIN 9747-00-32-5320 1531 LINK ROAD MANNS HARBOR, NORTH CAROLINA.
4. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGED SINCE DATE OF SURVEY.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
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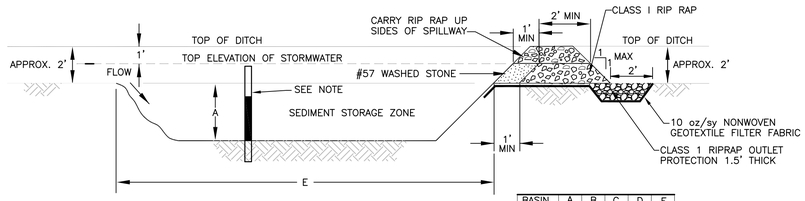
CLOSURE GRADING PLAN

PROJECT NO. 17952 56960
FILE NAME: C-4
SHEET NO.
C-4

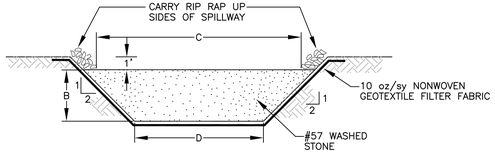
NOT FOR CONSTRUCTION



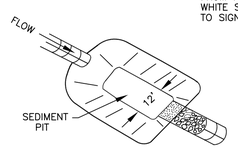
SECTION THRU BASIN & FILTER

BASIN	A	B	C	D	E
1	3'	1'	25'	19'	170'
2	3'	1'	25'	19'	170'

NOTE:
PROVIDE TREATED 6x6 POST PLACED 50' FROM FILTER BERM. MARK POST WITH WHITE STRIPE 2' FROM BOTTOM OF BASIN TO SIGNIFY CLEANOUT DEPTH.



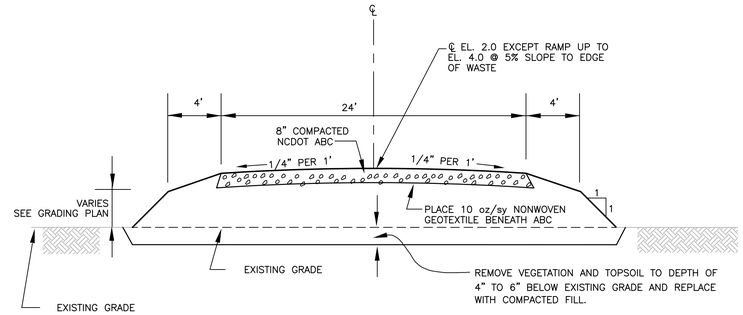
SECTION THRU FILTER



PERSPECTIVE VIEW

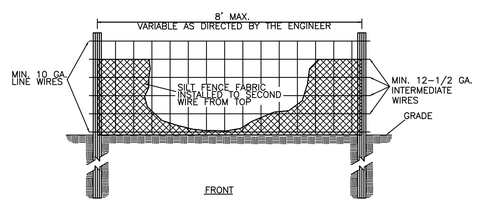
GRAVEL & RIPRAP FILTER BASIN

DETAIL A
NOT TO SCALE C-3



ENTRANCE ROAD

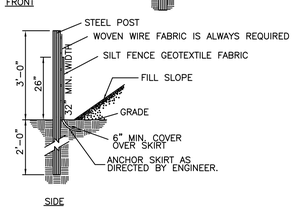
DETAIL D
NOT TO SCALE C-3



FRONT

NOTES:

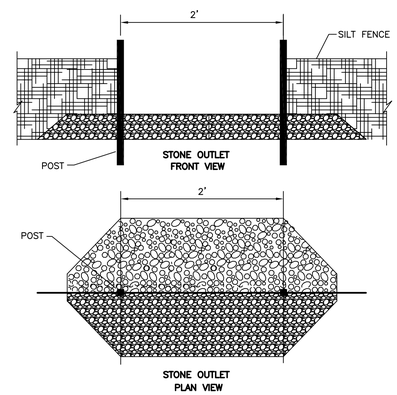
1. END OF SILT FENCE SHOULD BE TURNED UPHILL SEE NCDENR PRACTICE STANDARDS & SPECIFICATIONS SEDIMENT FENCE SET FOR CONDITIONS WHERE PRACTICE APPLIES; PLANNING CONSIDERATIONS & DESIGN CRITERIA. (HOWEVER FLOW SHALL NOT RUN PARALLEL WITH THE TOE OF THE FENCE).
2. FOR REPAIR OF SILT FENCE FAILURES, USE No. 57 WASHED STONE. IN EACH CASE THE SILT FENCE IS TO BE PROPERLY ENTRENCHED & THE STONE SHALL BE AT A MINIMUM OF 16" ABOVE GRADE AT THE DIRECTION OF FLOW & BETWEEN 60 – 45 DEGREES.



SIDE

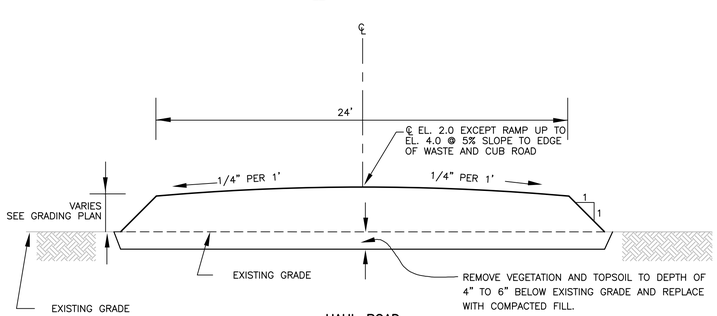
SILT FENCE

DETAIL B
NOT TO SCALE C-3



SILT FENCE OUTLET

DETAIL E
NOT TO SCALE C-3



HAUL ROAD

DETAIL C
NOT TO SCALE C-3

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

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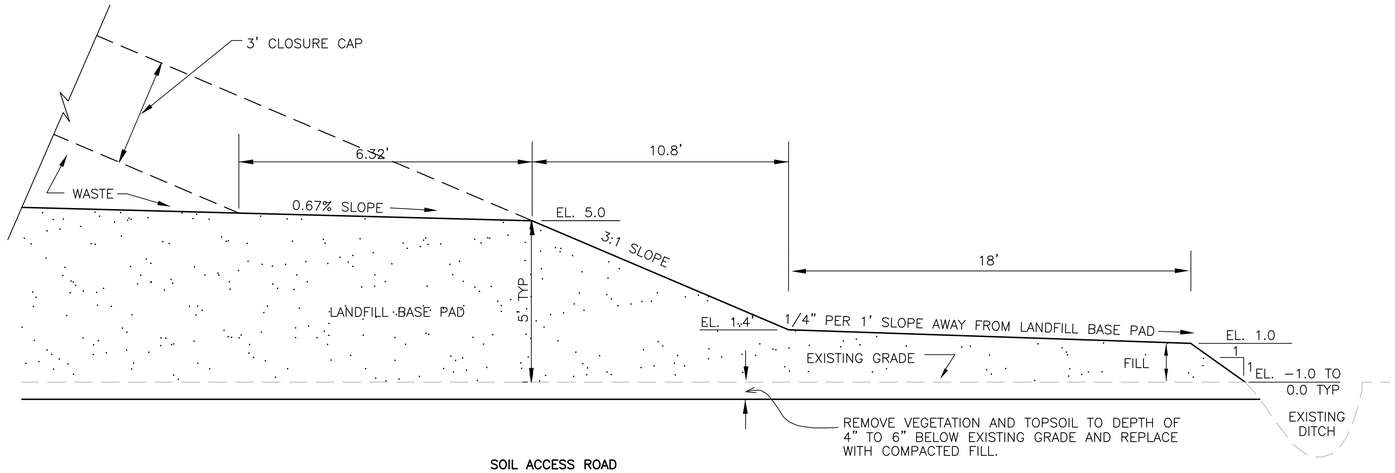
DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

DETAILS

PROJECT NO. 17952 56960
FILE NAME: D-1
SHEET NO.
D-1

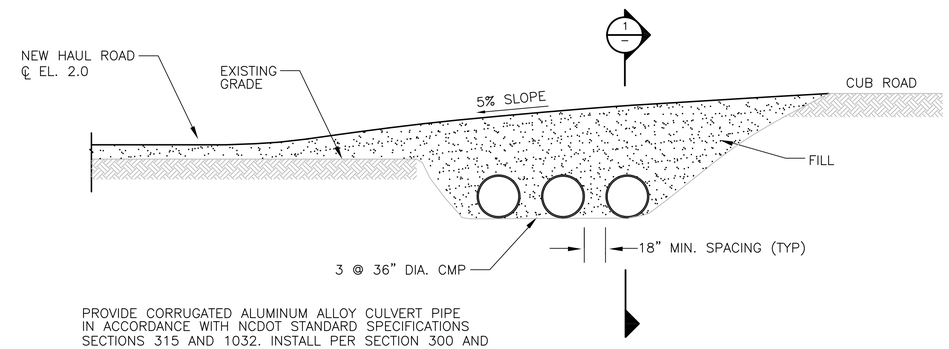
NOT FOR CONSTRUCTION



SOIL ACCESS ROAD

DETAIL E / C-3

NOT TO SCALE

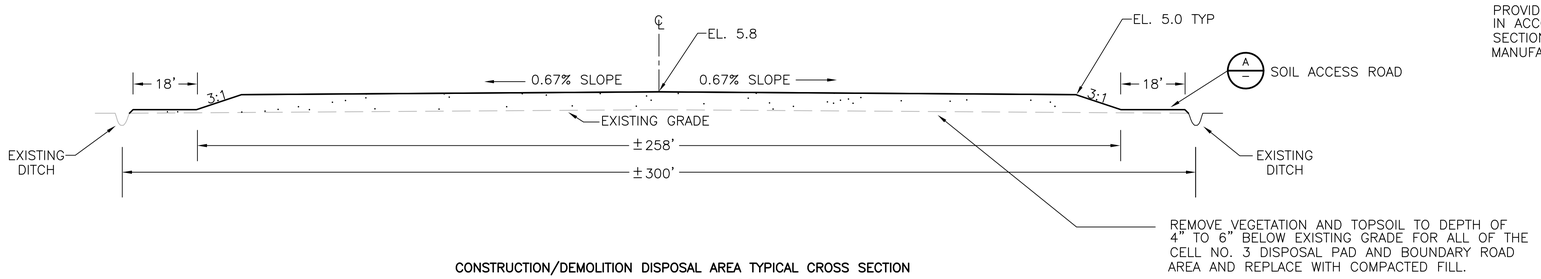


PROVIDE CORRUGATED ALUMINUM ALLOY CULVERT PIPE IN ACCORDANCE WITH NCDOT STANDARD SPECIFICATIONS SECTIONS 315 AND 1032. INSTALL PER SECTION 300 AND MANUFACTURERS RECOMMENDATIONS.

CANAL CROSSING

DETAIL F / C-3

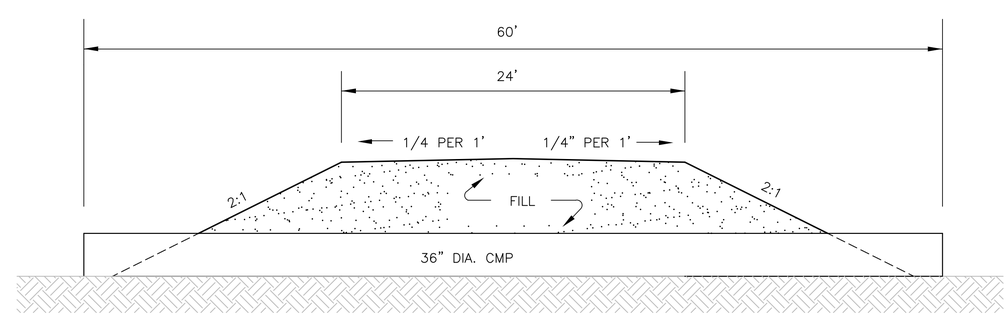
NOT TO SCALE



CONSTRUCTION/DEMOLITION DISPOSAL AREA TYPICAL CROSS SECTION

DETAIL G / C-3

NOT TO SCALE



CANAL CROSSING

SECTION 1 / –

NOT TO SCALE

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

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DARE COUNTY
NORTH CAROLINA

CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

DETAILS

PROJECT NO. 17952 56960
FILE NAME: D-2

SHEET NO.
D-2

NOT FOR CONSTRUCTION

Appendix A
Calculations

CDM	CLIENT	Dare County	COMPUTED BY / DATE	WPS 01/21/09
	PROJECT	Dare County Cell 4 C&D LF	CHECKED BY / DATE	WMB -
	DETAIL	Filter Basin #'s 1 &2	REVISION NO. / DATE	- -
	PROJECT NO.	17952-56960	REVIEWED BY / DATE	- -

Calculation Brief Title: Filter Basin #'s 1 & 2

1.0 Objective

Design Gravel & Riprap Filter Basins for Dare County Cell No. 4 epansion.

2.0 Procedure

1. Determine total area draining to each filter basin.
2. Determine Disturbed area draining to each filter basin.
3. Determine required pond volume.
4. Determine required surface area for pond behind berm.
5. Determine time of concentration.
6. Determine dimensions of pond.
7. Determine length of spillway.

3.0 References / Data Sources

1. Dare County C&D Landfill Cell # 4 Expansion
2. North Carolina Erosion and Sediment Control Planning and Design Manual

4.0 Assumptions / Limitations

1. Assume base design on 25-yr Storm

5.0 Calculations

Filter berms will be placed in the existing drainage ditches located east and west of Cell No. 4, downstream of cell construction, as shown in Sheet C-3, Grading Plan, of the permit application. FB-1 and FB-2 will serve same total and disturbed areas, so design will be the same.

1.) Total Area Draining to Each Filter Basin:

= 2,500 ft X 300 ft = 750,000 ft^2 = **17.22 AC**

2.) Disturbed Area Draining to Each Filter Basin (including cell & roads):

= 1/2*(2,300 ft X 300 ft) = 345,000 ft^2 = **7.9 AC**

3.) Determine reqd. pond volume behind berm:

V = 3,600 ft^3 / disturbed acre
V = 3,600*(7.9) = **14,220 ft^3**

4.) Determine reqd. surface area for pond behind berm:

Use Area (A) = 0.01 acres per cfs based on 25 yr storm (disturbed area only)

$Q_{25D} = C_D I_{25} A_D$ where:

Q_{25D} = 25yr peak runoff from disturbed area (cfs)
I_{25} = $_{25}$yr rainfall intensity (in/hr)
A_D = Disturbed Area (AC)
C_D = Runoff Coeificient for disturbed area, dimensionless

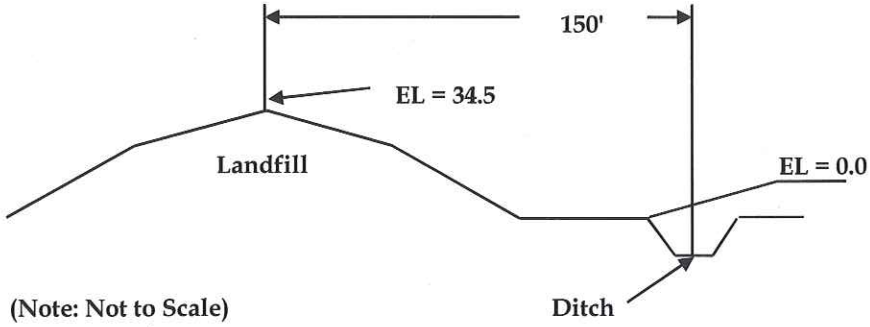
From Attachment A, use $\mathbf{C_D = 0.45}$ for bare packed smooth soil

5.) Determine Time of Concentration:

Assume two components

1.) Overland flow from top of landfill to ditch.
2.) Ditch flow to filter basin.

1.) Use Attachment B for Overland Flow:



(Note: Not to Scale)

Conclusion:

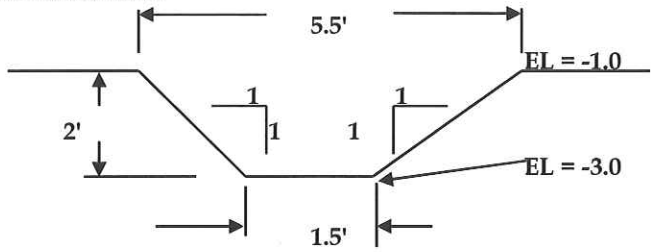
H = 34.5 ft
L = 150 ft

From Attachment B, T_{C1} = 0.5 min

CLIENT	Dare County	COMPUTED BY / DATE	WPS	01/21/09
PROJECT	Dare County Cell 4 C&D LF	CHECKED BY / DATE	WMB	-
DETAIL	Filter Basin #'s 1 &2	REVISION NO. / DATE	-	-
PROJECT NO.	17952-56960	REVIEWED BY / DATE	-	-

1.) Length of flow in ditch = **2100 ft**

Typical Dimensions of ditch:



(Note: Not to Scale)

Avg. Slope along ditch:

Slope (S) = 1'/2100' = 0.0005 = 0.05%

Determine Velocity in ditch using Manning's Eqn.

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n_{Total}}$$

Where: r = hydraulic radius
s = Slope
n = Manning's Coeff.

	n = 0.02	for channels in earth (basic)
	0.010	
+	0.005	Low vegetative effect
n_{Total} =	0.035	

V = 0.94 ft/s

Conclusion:

T_{C2} = 2100'/0.94 ft/s =2,234 sec = **37.2 min**

$T_{CTotal} = T_{C1} + T_{C2}$ = 0.5 min + 37.2 min = **37.7 min**

From Attachment C, for T_C = 37.7 min.

25yr intensity = **5.31 in/hr** (Hatteras)

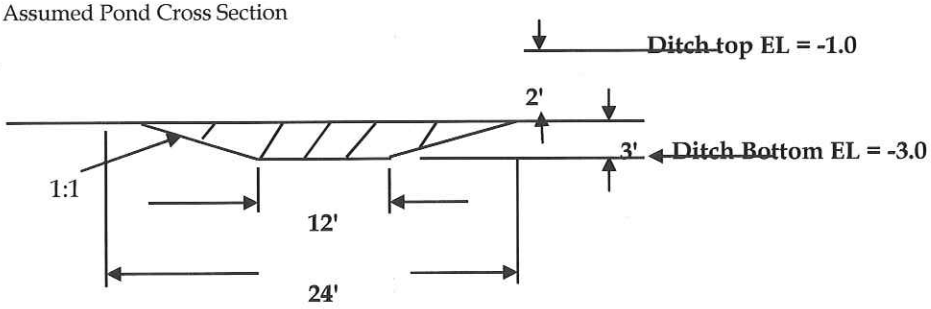
Conclusion:

$Q_{25D} = C_D I_{25} A_D = 0.45*(5.31)*(7.9) =$ **18.9 cfs**

Reqd. Surface Area of Pond = 0.01*(18.9 cfs) = **0.19 AC**

6.) Determine Dimensions of Pond:

Assumed Pond Cross Section



(Note: Not to Scale)

Sediment Storage Volume per foot of cross-section

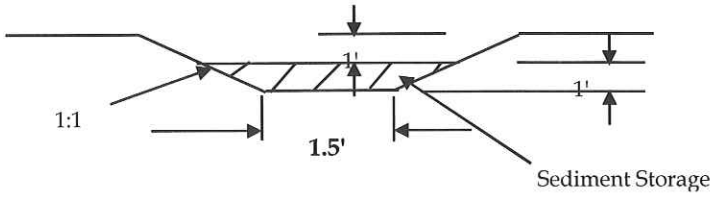
$V = (12' + 6')*(3') = 54\ ft^3/ft$

Reqd. Volume = 14,220 ft^3

$$\text{Reqd. Length of Pond} = \frac{14{,}220\ ft^3}{54ft^2} = \textbf{263 ft (Too Long)}$$

Account for sediment storage capacity of existing ditch or 1.0' between spillway and ditch bottom:

Typcial Dimensions of ditch



Sediment storage volume per ft of ditch

$= (1.5' + 1')*(1') = 2.5\ ft^3/ft$

Length of ditch =2,100 ft

Conclusion:

Sediment storage capacity per ditch

$V = 2.5ft^3/ft\ (2{,}100ft) =$ **5,250 ft^3**

Reqd. length of pond after accounting for sediment storage within ditch:

$$\frac{14{,}220\ ft^3 - 5{,}250\ ft^3}{54} = 166' \quad \textbf{(Use 170')}$$

Check surface Area Requirement:

Reqd. Surface Area = **0.19 AC**

Surface Area of Pond at ditch bottom elev.

$A_1 = 24'(170') =$ **4,080 ft^2**

Surface area of ditch w/ 1' of ponded water:

$A_2 = 2.5'(2{,}100') =$ **5,250 ft^2**

Total Surface Area = $A_1 + A_2$ = 9,350 ft2 = **0.21 AC**

0.21 AC > 0.19AC OK!

7.) Determine Length of Spillway:

Total Area draining to each basin = 17.22 AC of which 7.9 AC is disturbed:

Undisturbed area = 17.22 AC - 7.9 AC = **9.32 AC**

Use C = 0.30 (Pasture heavy soil) (See Attachment A)

Disturbed Area = **7.9 AC**

Use C = 0.45 (Base Packed Soil, Smooth)

$$\text{Composite } C_C = \frac{9.32*(0.30)+7.9*(0.45)}{17.22} = \mathbf{0.37}$$

Flow through spillway: $Q_{25} = C_C I_{25} A_T$

$Q_{25} = CLH^{1.5}$

Where:
- Q = discharge (cfs)
- C = Coefficient = 2.6
- L = Length of weir (ft)
- H = Depth of flow over weir = 0.5

Try L = 10' :

$Q = 2.6*(10)*(0.5)^{1.5} = 9.19$ cfs < 23 cfs (No Good!)

Solve for L:

$$L_{reqd} = \frac{Q}{CH^{1.5}} = \frac{23}{2.6(0.5)^{1.5}} = \mathbf{25'}$$

6.0 Conclusion

Based on the above calculations filter basin # 1 & 2 need to be built at a minimum to the above highlighted dimensions to treat the 25-yr storm and meet the requirements of the NC Erosion and Sediment Control Planning and Design Manual.

ATTACHMENT A

Table 8.03a
Value of Runoff Coefficient (C) for Rational Formula

Land Use	C
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.50-0.70
Residential:	
Single-family areas	0.30-0.50
Multi units, detached	0.40-0.60
Multi units, attached	0.60-0.75
Suburban	0.25-0.40
Industrial:	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard areas	0.20-0.40
Unimproved areas	0.10-0.30
Streets:	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.85
Roofs	0.75-0.85

Land Use	C	
Lawns:		
Sandy soil, flat, 2%	0.05-0.10	
Sandy soil, ave., 2-7%	0.10-0.15	
Sandy soil, steep, 7%	0.15-0.20	
Heavy soil, flat, 2%	0.13-0.17	
Heavy soil, ave., 2-7%	0.18-0.22	
Heavy soil, steep, 7%	0.25-0.35	
Agricultural land:		
Bare packed soil		
Smooth	0.30-0.60	Avg. = 0.45
Rough	0.20-0.50	
Cultivated rows		
Heavy soil no crop	0.30-0.60	
Heavy soil with crop	0.20-0.50	
Sandy soil no crop	0.20-0.40	
Sandy soil with crop	0.10-0.25	
Pasture		
Heavy soil	0.15-0.45	Avg. = 0.30
Sandy soil	0.05-0.25	
Woodlands	0.05-0.25	

NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

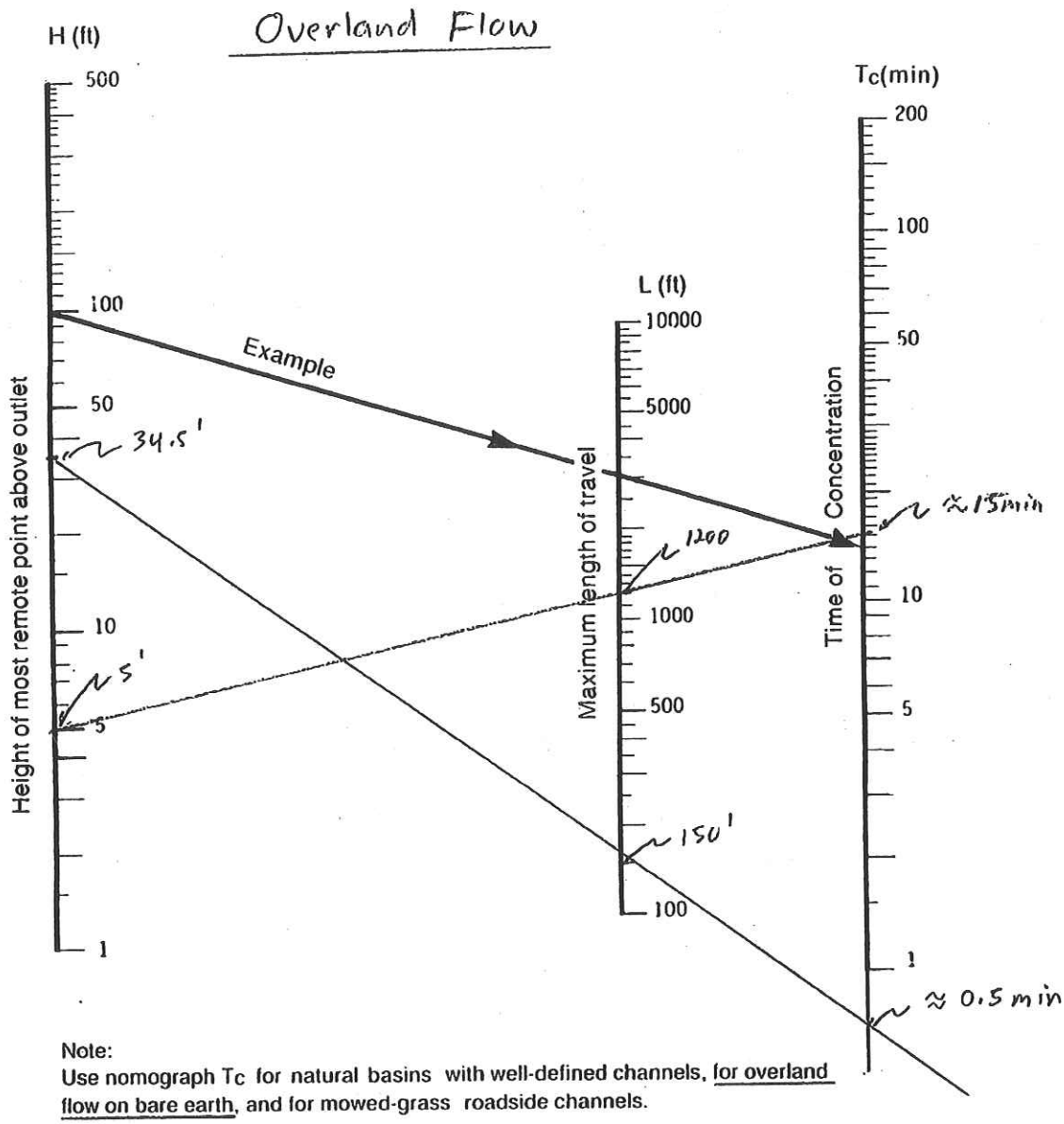
Source: American Society of Civil Engineers

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

Step 4. Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration, T_C. Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor, i, in inches per hour.

Step 5. Determine peak discharge, Q (ft^3/sec), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).

ATTACHMENT B



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

ATTACHMENT C

Raleigh, North Carolina 35.8706N, 78.7864W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	6.86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

Fayetteville, North Carolina 35.0583N, 78.8583W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.11	4.88	4.09	2.83	1.77	1.04	0.74	0.44	0.26	0.15
10	7.96	6.36	5.36	3.88	2.53	1.54	1.10	0.66	0.39	0.23
25	8.94	7.13	6.02	4.46	2.97	1.83	1.32	0.80	0.47	0.28
100	10.44	8.29	6.99	5.35	3.69	2.29	1.69	1.03	0.62	0.36

Wilmington, North Carolina 34.2683N, 77.9061W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.39	5.92	4.96	3.42	2.15	1.28	0.91	0.56	0.33	0.19
10	9.70	7.75	6.54	4.74	3.08	1.94	1.39	0.87	0.51	0.30
25	10.98	8.75	7.40	5.48	3.65	2.38	1.73	1.08	0.64	0.38
100	12.92	10.27	8.65	6.63	4.56	3.18	2.37	1.49	0.89	0.53

Washington, North Carolina 35.5333N, 77.0167W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.41	5.12	4.29	2.96	1.86	1.10	0.78	0.47	0.27	0.16
10	8.38	6.70	5.65	4.09	2.66	1.64	1.19	0.72	0.42	0.25
25	9.48	7.55	6.38	4.73	3.15	1.99	1.46	0.88	0.52	0.31
100	11.16	8.87	7.47	5.72	3.94	2.58	1.93	1.18	0.70	0.42

Manteo Airport, North Carolina 35.9167N, 75.7000W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.46	5.16	4.32	2.99	1.87	1.08	0.79	0.48	0.29	0.17
10	8.47	6.77	5.71	4.14	2.69	1.62	1.20	0.74	0.44	0.27
25	9.56	7.62	6.44	4.77	3.17	1.96	1.47	0.91	0.54	0.33
100	11.26	8.95	7.54	5.77	3.98	2.54	1.95	1.21	0.73	0.44

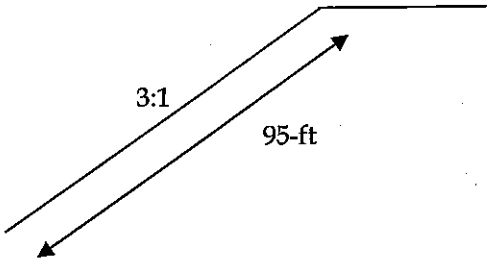
Cape Hatteras, North Carolina, 35.2322N, 75.6225W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.20	5.75	4.82	3.33	2.09	1.29	0.94	0.58	0.34	0.20
10	9.41	7.52	6.35	4.60	2.99	1.93	1.43	0.89	0.53	0.31
25	10.66	8.49	7.18	5.31	3.54	2.33	1.75	1.09	0.65	0.38
100	12.53	9.95	8.39	6.42	4.42	3.03	2.32	1.45	0.88	0.51

Task: 1 Design permanent/temporary stabilization for the Cell No. 4 closure slopes.

Reference North American Green ECMDS® version 4.3- slope protection design

Given
Slope length: 95 ft
Side slope: 3:1
Vegetation coverage: Fair condition
Project location: Dare County NC, US
Soil Type: sand



1- Permanent slope stability

The following assumptions were made for the permanent slope stability analysis
- Reinforcement material SC250
- Bunch-type vegetatic
- Fairly dense vegetation
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 4.9 (*See Attachment 1*)

2- Temporary slope stability

The following assumptions were made for the temporary slope stability analysis
- Reinforcement material SC250
- Bunch-type vegetation
- Fairly dense vegetation
- Duration 12 months
- Beginning month is December
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 3.5 (*See Attachment 2*)

Conclusion: SC250 reinforcement material is capable of providing both temporary and permanent stabilization for the Dare County Cell No. 4 closure slope.

Attachment 1
North American Green Permanent Slope Protection Analysis

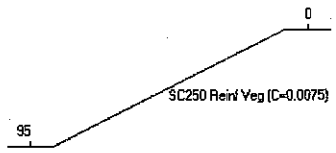
CDM

North American Green - ECMDS Version 4.3 | 7/16/2009 | 02:28 PM | COMPUTED BY: Patrick Stout

PROJECT NAME: Dare County Cell No 4 | PROJECT NO.: 17952-56960 | SLOPE DESCRIPTION: Landfill Closure Sideslopes

Country	United States
State/Region	Virginia
City	Norfolk
Annual R Factor	260
Total Slope Length (ft)	95
Protection Type	Permanent
Protection Period (months)	
Beginning Month	
Adjusted R Value	260.
Slope Gradient (H:1)	3
Soil Type	Sand
K Factor	0.1
Soil Loss Tolerance (in)	0.03

Slope Gradient = 3:1



Not to Scale

Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)			SLT (in)	SF	Remarks
1	0	95	SC250 Reinf.	Bunch Type	50-75%	0.830	0.006			0.03	4.819	STABLE
2												
3												
	0	95		**Composite**		0.830	0.006					

Vegetation Density=Percentage of soil coverage provided by vegetation
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
MSLbare=Maximum Soil Loss potential on unprotected soil (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Composite=Average soil loss from total slope length (uniform inches)

C=Cover material performance factor (Fraction of soil loss of unprotected)
ASLmat=Average Soil Loss potential w/material (uniform inches)
MSLmat=Maximum Soil Loss potential w/material (uniform inches)
SF=Safety Factor

"

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NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3
NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.
USER SPECIFIED - PERMANENT BACK-UP COMPUTATIONS
****

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960
COMPUTED BY: Patrick Stout DATE: 7/16/2009
SLOPE DESCRIPTION: Landfill Closure Sideslopes

***** INPUT PARAMETERS *****

Slope Gradient: 3:1
Slope Degrees = tan^(-1) (1/3) = 18.43 degrees
Slope Length: 95 feet (29.0 meters)
Soil Type: Sand
K Factor: K= 0.10 t*ac*h/100*ac*ft*tonf*in (K= 0.01 t*ha*h/ha*MJ*mm)
Annual R Factor: 260 100ft*t*in/ac*hr*yr (4425 MJ*mm/ha*h*y)
for United States, Virginia, Norfolk
PRECIPDIST = 100

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL	TYPE	Density FACTOR	C
1	95 feet/29.0 meters	SC250 Reinf. Ve	Bunch Type		0.008

SLT = 0.03 inches (0.08 centimeters)
ADJR = 260 * 100.0 / 100 =260.0 100ft*tonf*in/ac*hr*yr (4425.2 MJ*mm/ha*h*yr)
Soil Loss Factor (SLF) = 1.46 inches (3.72 cm)

***** CALCULATIONS *****

REACH NUMBER: ***1***
CUMHORZL1 =95 * cos(18.4) = 90.1 feet (27.5 meters)
LS 1 Factor = 5.36
Cumulative LS 1 Factor = 5.36
ASLBARE 1 = .00595 * 260 * 0.10 * 5.36 =0.830 in (2.108 cm)
MSLBARE 1 = .00595 * 260 * 0.10 * 1.46 *5.36 =1.215 in (3.085 cm)
ASLMAT 1 = 0.0075 * 0.830 =0.006 in (0.016 cm)
MSLMAT 1 = 0.0075 * 1.215 =0.009 in (0.023 cm)
SF 1 = 0.030 / 0.006 =4.819

COMPASLBARE 1 =0.830 * [(95 - 0) / 95] = 0.830 in (2.108 cm)

TOTCOMPASLBARE = 0.830 in (2.108 cm)

COMPASLMAT 1 =0.006 * [(95 - 0) / 95] = 0.006 in (0.016 cm)
TOTCOMPASLMAT = 0.006 in (0.016 cm)

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.
"

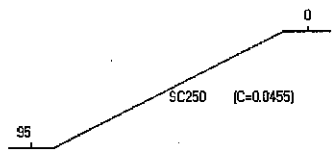
Attachment 2
North American Green Temporary Slope Protection Analysis

CDM

North American Green - ECMDS Version 4.3		7/16/2009 02:28 PM	COMPUTED BY: Patrick Stout
PROJECT NAME: Dare County Cell No 4	PROJECT NO.: 17952-66960		SLOPE DESCRIPTION: Landfill Closure Sideslopes

Country	United States
State/Region	Virginia
City	Norfolk
Annual R Factor	260
Total Slope Length (ft)	95
Protection Type	Temporary
Protection Period (months)	12
Beginning Month	December
Adjusted R Value	260.
Slope Gradient (H:1)	3
Soil Type	Sand
K Factor	0.1
Soil Loss Tolerance (in)	0.25

Slope Gradient = 3:1



Not to Scale

Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)	MSL bare (in)	MSL mat (in)	SLT (in)	SF	Remarks	Staple
1	0	95	SC250			0.886	0.040	1.531	0.070	0.25	3.590	STABLE	D
2													
3													
	0	95		Composite		0.886	0.040						

Vegetation Density=Percentage of soil coverage provided by vegetation
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
MSLbare=Maximum Soil Loss potential on unprotected soil (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Composite=Average soil loss from total slope length (uniform inches)

C=Cover material peiformance factor (Fraction of soil loss of unprotected)
ASLmat=Average Soil Loss potential w/material (uniform inches)
MSLmat=Maximum Soil Loss potential w/material (uniform inches)
SF=Safety Factor

"

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NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3
NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.
USER SPECIFIED - TEMPORARY BACK-UP COMPUTATIONS
****

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960
COMPUTED BY: Patrick Stout DATE: 7/16/2009
SLOPE DESCRIPTION: Landfill Closure Sideslopes

***** INPUT PARAMETERS *****

Slope Gradient: 3:1
Slope Degrees = tan^(-1) (1/3) = 18.43 degrees
Slope Length: 95 feet (29.0 meters)
Soil Type: Sand
K Factor: K= 0.10 t*ac*h/100*ac*ft*tonf*in (K= 0.01 t*ha*h/ha*MJ*mm)
Annual R Factor: 260 100ft*t*in/ac*hr*yr (4425 MJ*mm/ha*h*y)
for United States, Virginia, Norfolk
Protection Period: 12 months from December to December, over 1 whole year(s)
Cumulative Annual R Factor For The Beginning Month: 97.0 %
Cumulative Annual R Factor For The End Month: 97.0 %

PRECIPDIST = 97.0 - 97.0 + (100 * 1) = 100.0

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL	C FACTOR
1	95 feet/29.0 meters	SC250	0.046

SLT = 0.25 inches (0.64 centimeters)
ADJR = 260 * 100.0 / 100 =260. 100ft*tonf*in/ac*hr*yr (4425.2MJ*mm/ha*h*yr)
Soil Loss Factor (SLF) = 1.73 inches (4.39 cm)

***** CALCULATIONS *****

REACH NUMBER: ***1***
CUMHORZL1 =95 * cos(18.4) = 90.1 feet (27.5 meters)
LS 1 Factor = 5.72
Cumulative LS 1 Factor = 5.72
ASLBARE 1 = .00595 * 260 * 0.10 * 5.72 =0.886 in (2.250 cm)
MSLBARE 1 = .00595 * 260 * 0.10 * 1.73 *5.72 =1.531 in (3.888 cm)
ASLMAT 1 = 0.0455 * 0.886 =0.040 in (0.102 cm)

MSLMAT 1 = 0.0455 * 1.531 =0.070 in (0.177 cm)
SF 1 = 0.250 / 0.070 = 3.590

COMPASLBARE 1 =0.886 * [(95 - 0) / 95] = 0.886 in (2.250 cm)
TOTCOMPASLBARE = 0.886 in (2.250 cm)

COMPASLMAT 1 =0.040 * [(95 - 0) / 95] = 0.040 in (0.102 cm)
TOTCOMPASLMAT = 0.040 in (0.102 cm)

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.
"

Appendix B
Design Geotechnical Evaluation

Dare County
C & D Landfill Cell No. 4
Mann's Harbor, North Carolina

Geotechnical Evaluation

June 2009

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06-26-09

CDM

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Appendix B-1
Introduction

B-1.1 Purpose

Camp Dresser and McKee (CDM) has been retained to perform a site study for the expansion of the Dare County Construction and Demolition (C&D) Landfill located west of Mann's Harbor, North Carolina. A location of the site is shown in **Figure 1-1**. As part of the design services for the proposed expansion, CDM conducted a geotechnical subsurface investigation and performed geotechnical analyses as presented in this report.

The purpose of CDM's geotechnical work was to evaluate the existing subsurface conditions and perform geotechnical analyses for the proposed landfill configuration.

B-1.2 Scope

The scope of the geotechnical work for the C&D Landfill expansion includes the following;

- Review available data and previous reports;
- Conduct four (4) test borings to a depth of 100 feet below ground surface;
- Perform laboratory tests on selected soil samples;
- Estimate settlement based upon final proposed waste heights within the landfill;
- Perform global slope stability analyses of the proposed landfill mass under static conditions; and
- Prepare this report presenting the results of CDM's analyses and data collected as part of the field and laboratory investigation.

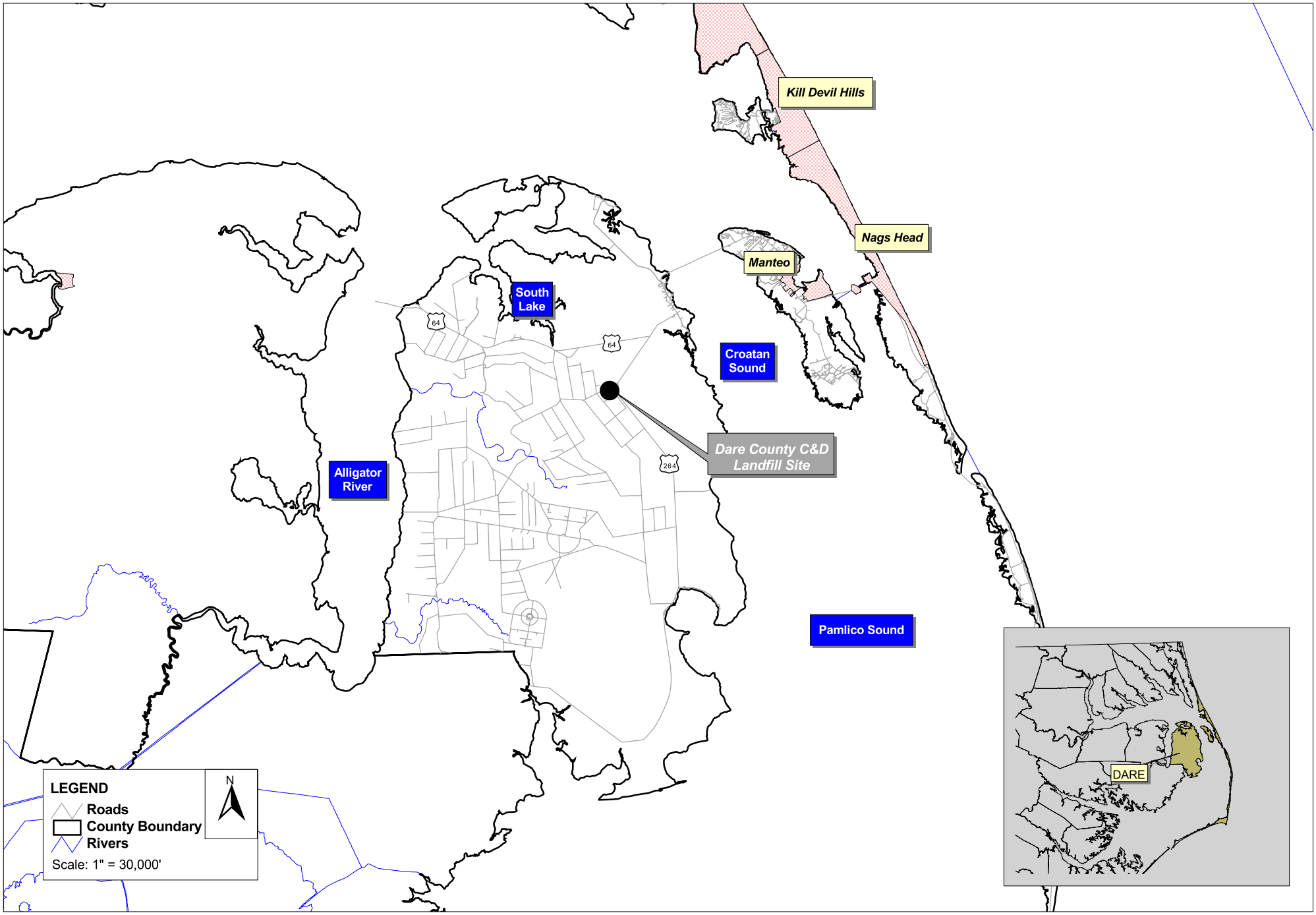
B-1.3 Elevation Datum

Elevations noted herein are referenced to the North American Vertical Datum (NAVD) of 1988.

B-1.4 Report Limitations

This report has been prepared for specific application to the subject project in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. In the event that any changes in the nature, design, or location of structures are planned, the conclusions and preliminary recommendations presented in this report should not be considered valid, unless changes are reviewed and conclusions of this memorandum are modified or verified in writing.

The recommendations submitted in this report are based in part upon the data obtained from the referenced borings. The nature and extent of variations between the explorations may not become evident until construction. If variations then appear evident, it may be necessary to re-evaluate the recommendations of the report.



CDM

Figure 1-1
Location Map

Appendix B-2
Project Information and Site Description

B-2.1 Project Information

The Dare County C&D Landfill serves as the disposal site for all construction and demolition debris in Dare County, North Carolina. The total area of the landfill site is approximately 836 acres. Three landfill cells (Cells No. 1, 2, and 3) have been constructed to date and Cell No. 3 is currently active.

The intent of current investigation is to evaluate the design of the proposed expansion area. Cell No. 4 will be constructed in between existing Cells No. 2 and No. 3 as shown in **Sheet SD-2**. Construction of Cell No. 4 will include placement of approximately 5 feet of fill material over the entire Cell No. 4 footprint to reach base grades. Waste placement will begin after completion of fill placement. Upon completion of Cell No. 4, the channels between each cell will be filled and the final grading with 2 percent slope will raise the crest elevation of the landfill to EL. 44. At the end of the final grading, the landfill will have a maximum waste height of 40 feet and sideslopes graded at three horizontal to one vertical (3H:1V). **Sheet OP-1** shows the final grading of the proposed expansion area.

B-2.2 Site Location and Description

The existing facility is located on Cub Road in west of Mann's Harbor, North Carolina. Figure 1-1 in Appendix B-1 presents a site location map. With the exception of the existing cells, the site is flat and currently used as farmland that was converted from wetlands.

Appendix B-3
Field and Laboratory Investigation

B-3.1 Geological Setting

The site is located in the Coastal Plain Physiographic Province of eastern North Carolina. Coastal Plain consists of two subdivisions: the Tidewater region and the Inner Coastal Plain. The proposed landfill site is located within the Tidewater region, which is generally of low relief and contains swampy areas. The surficial deposits consist of undifferentiated marine and non-marine clastic sediments including fine to medium sand with common shell beds and minor amounts of silt and clay. In the proposed area the surficial deposits were found to be 67 to 78 feet thick. Yorktown formation underlies surficial deposits and the thickness of this formation ranges from 300 to 500 feet.

B-3.2 Previous Investigations

A total of two (2) site investigations were performed prior to the current investigation at the landfill site. The previous investigations were conducted on 1993 and 2004. the 1993 report presented subsurface information and geotechnical analyses for Cells No. 1 and 2 and the 2004 report provided information for Cell No. 3. Selected information from previous investigations that pertain to the current investigation is presented below.

B-3.2.1 Geo-Hydro Investigation - 1993

A geotechnical and hydrogeologic investigation was conducted by Geo-Hydro Engineers, Inc. in 1993 at Cells No. 1 and 2 of the Dare County C&D landfill. As part of that investigation, a total of 12 borings were advanced (B-1/1a through B-6/6a) in the area of Cells No. 1 and 2. Six borings were advanced to 50 feet below ground surface (ft-bgs) and six borings were advanced to 7 ft-bgs. In addition, one boring was advanced to 30 ft-bgs in the borrow area. Piezometers were installed in each of the borings in Cells No. 1 and 2 areas with screening intervals ranging from 2 to 7 ft-bgs to 40 to 50 ft-bgs. Geotechnical testing, in-situ hydraulic conductivity testing, and water level data were evaluated. It was determined that the site was suitable for landfill development.

Following construction of Cell No. 1, a groundwater Quality Monitoring Plan was developed. Groundwater monitoring wells GW-1 through GW-8 were installed as part of this monitoring plan. Following the construction of Cell No. 2, wells GW-9 through GW-12 were installed as per the revised groundwater quality monitoring plan. The revised Groundwater Monitoring Plan also called for three additional wells (GW-13, GW-14, and GW-15) as landfill development progressed.

B-3.2.2 CDM Investigation - 2004

In December 2004, a hydrogeologic investigation at the Cell No. 3 area was completed by CDM. A total of thirteen (13) boreholes were drilled at 11 locations during the

investigation. Boreholes were drilled using direct push (GeoProbe ®) drilling techniques. Two borings were advanced to 50 ft-bgs and the remaining were advanced to 8 to 12 feet-bgs. Select soil samples were tested for grain-size analysis and USCS classification.

Piezometers were installed in each of the 13 boreholes, providing three nested piezometer pairs: B-1s and existing monitoring well GW-9, P-2s and P-2, and P-8s and P-8. The screening intervals for the piezometers installed for this investigation ranged from 3 to 8 ft-bgs to 40 to 50 ft-bgs.

Evaluation of the piezometer and the monitoring well groundwater elevation data in the Cell No. 3 area suggests that groundwater movement is generally from north to the south and west, with flow toward the drainage canal along Cub Road.

B-3.3 Current CDM Investigation - 2007

CDM conducted a geotechnical subsurface investigation for the proposed expansion during May 2007. The investigation included four geotechnical soil borings, labeled B-101 through B-104. The depths of borings were ranged from 98.9 to 100 feet below ground surface (ft-bgs).

B-3.3.1 Test Borings

A total of four (4) soil test borings were drilled near the proposed Cell No. 4 location. All the borings were advanced to 98.9 to 100 ft-bgs using mud rotary with continuous Standard Penetration Test (SPT) split spoon sampling in the top ten feet below ground surface and at five-foot intervals thereafter.

Borings were drilled by Fishburne Drilling, Inc. of Chesapeake, Virginia, between April 30 and May 1, 2007 using a CME 550 all-terrain-vehicle (ATV) via mud rotary.

SPT samples were collected in accordance with ASTM D1586 (2-inch-diameter sampler driven 24 inches by blows from a 140-pound hammer falling freely for a 30-inch drop). The number of blows required to drive the sampler each 6-inch increment was recorded and the Standard Penetration Resistance (N-value) was determined as the sum of the blows over the 2nd and 3rd 6-inch-increments of the 24-inch drive.

Pocket Penetrometer and Torvane tests were conducted in the field on selected split–spoon samples.

A total of eight (8) undisturbed soil samples were collected in accordance with ASTM D1452 (2.75-inch-diameter tube sampler). These samples were collected as specified in ASTM D1452 by attaching an empty 30-inch-long, 3-inch-diameter galvanized steel thin-walled tube to the sampling rod, lowering it to the bottom of the hole and hydraulically pushing the tube into the undisturbed, unconsolidated formation below the bottom of the borehole. After the tube was retrieved, the ends were sealed with paraffin wax and capped. The Shelby Tubes were maintained in an upright position

and protected from shock and temperature extremes for delivery to the geotechnical laboratory.

A CDM geotechnical engineer observed the test borings in the field and visually classified the soil samples in accordance with the Burmeister soil identification system. The soil samples were also classified in accordance with the Unified Soil Classification System (USCS - ASTM D2488).

Representative (disturbed) soil samples from the test borings were collected and stored in jars for review and laboratory testing. A summary of subsurface conditions encountered in the borings is shown in **Table 3-1**. The test boring logs for the current geotechnical investigation are presented in **Attachment B-1**.

B-3.3.2 Laboratory Testing Program

As a part of the current investigation, geotechnical laboratory testing was conducted on selected split–spoon (disturbed) and Shelby tube (undisturbed) samples collected in the test borings. The total number of tests conducted is as follows:

- Fifteen (15) grain size analyses, sieve only, in accordance with ASTM D422;
- Twenty (20) moisture contents in accordance with ASTM D2216;
- Twelve (12) Atterberg limits in accordance with ASTM D4318;
- Two (2) one-dimensional consolidation tests in accordance with ASTM D2435;
- Two (2) two-point consolidated undrained strength triaxial tests in accordance with ASTM D4767; and
- Three (3) one-point unconsolidated undrained strength triaxial tests in accordance with ASTM D2850.

The summary of laboratory test results for the landfill expansion investigation is presented in **Table 3-2**. The laboratory test results are contained in **Attachment B-2**.

Table 3-1: Summary of Subsurface Conditions

Dare County C&D Cell No. 4

Manns Harbor, NC

Boring No.	Approximate Ground Surface Elevation (ft) [1]	Total Drilling Depth (ft)	Approximate Strata Thickness (ft)						
			Fill / Organic Topsoil	CL/ML	ML/SM/SC	SP/SP-SM with Shell	CL/ML/SM	SP/SP-SM/SM	Yorktown
B-101	20.0	100.0	6.0	2.0	5.0	15.0	6.0	39.0	>27
B-102	20.0	98.9	7.2	2.8	3.0	15.0	5.0	40.0	>25.9
B-103	14.0	100.0	1.0	1.0	6.0	15.0	4.0	41.0	>32
B-104	14.0	100.0	0.8	1.2	16.0	7.0	4.0	49.0	>22

Note:

1. Elevations based on the North American Vertical Datum (NAVD) of 1988.

Abbreviations:

-	Not Encountered
SP	Poorly Graded Sand
SP-SM	Poorly Graded Sand with Silt
SM	Silty Sand
SC	Clayey Sand
ML	Silt
CL	Low Plasticity Clay

Table 3-2: Summary of Laboratory Test Results

Dare County C&D Cell No. 4

Manns Harbor, NC

Test Boring Number	Sample No.	Sample Depth (ft)	Grain Size Analysis (1)			Atterberg Limits (2)		Moisture Content (%) (3)	USCS Classification (4)
			Gravel (%)	Sand (%)	Fines (%)	LL (%)	PI (%)		
B-101	S-4	6.0-8.0	--	--	--	--	--	37.8	--
B-101	S-5	8.0-10.0	0.0	46.0	54.0	NP	NP	22.9	ML
B-101	S-9	28.0-30.0	0.0	53.5	46.5	--	--	26.1	--
B-101	S-13	48.0-50.0	2.0	84.8	13.2	--	--	16.0	--
B-101	S-17	68.0-70.0	0.0	84.3	15.7	--	--	24.3	--
B-101	ST-2	75.0-77.0	0.0	11.3	88.7	27	7	34.7	CL/ML
B-102	S-4/B	7.2-8.0	0.0	24.6	75.4	33	11	24.7	CL
B-102	ST-1	8.0-10.0	0.0	63.8	36.2	23	9	18.4	SC
B-102	S-9	28.0-30.0	--	--	--	NP	NP	31.6	--
B-102	ST-2	31.0-33.0	0.0	26.7	73.3	30	13	35.4	CL
B-102	S-12	43.0-45.0	0.0	100.0	--	--	--	20.6	SP
B-102	S-17	68.0-70.0	0.0	82.9	17.1	--	--	29.8	--
B-103	S-1/B	1.0-2.0	--	--	--	43	21	36.7	CL
B-103	ST-1	2.0-4.0	0.0	84.9	15.1	NP	NP	24.6	SM
B-103	S-2	4.0-6.0	--	--	--	--	--	22.0	--
B-103	ST-2	25.0-27.0	0.0	20.7	79.3	32	16	38.1	CL
B-104	S-1/B	0.8-2.0	0.0	13.6	86.4	45	22	21.8	CL
B-104	S-5	13.0-15.0	--	--	--	33	13	59.3	CL
B-104	ST-4	27.0-29.0	2.0	48.5	49.5	22	6	43.1	CL/ML
B-104	S-15	63.0-65.0	0.1	86.3	13.6	--	--	24.0	--

Test Boring Number	Sample No.	Sample Depth (ft)	Consolidated Undrained Triaxial Test (5)				
			Confining pressure (psi)	p' @ R_{max} (psi)	q @ R_{max} (psi)	ε @ R_{max} (%)	f' (degrees)
B-102	ST-2	31.9-32.4	15.0	11.0	6.9	7.58	36.0
B-102	ST-2	32.4-32.9	30.0	17.0	10.5	8.28	36.2
B-103	ST-1	2.9-3.4	10.0	25.4	15.1	2.67	36.4
B-103	ST-1	3.4-3.9	20.0	64.1	38.7	2.25	37.2

Table 3-2 (cont'd): Summary of Laboratory Test Results

Dare County C&D Cell No. 4

Manns Harbor, NC

Test Boring Number	Sample No.	Sample Depth (ft)	Permeability [6]		Consolidation [7]				Unconsolidated Undrained Triaxial Test[8]
			(cm/sec)	(ft/day)	e_0	s_c' (psf)	c_c	c_r	s_u (psf)
B-101	ST-1	5.0-7.0			--	--	--	--	--
B-101	ST-2	76.4-76.9			--	--	--	--	18.95
B-102	ST-2	40.5-42.5			--	--	--	--	--
B-103	ST-1	2.4-2.9			--	--	--	--	3.97
B-104	ST-1	3.7-3.9			0.68	4,200	0.048	0.009	--
B-104	ST-4	28.2-28.9			0.91	2,400	0.252	0.024	3.86

Notes:

1. Grain size analysis tests were conducted in accordance with ASTM D422.
2. Atterberg Limit tests were conducted in accordance with ASTM D4318.
3. Moisture contents were determined in accordance with ASTM D2216.
4. USCS classifications were performed in accordance with ASTM D2488.
5. Consolidated Undrained Triaxial Tests were performed in accordance with ASTM D4767.
6. Flexible Wall Permeability Test was performed in accordance with ASTM D5084.
7. One Dimensional Consolidation Tests were performed in accordance with ASTM D2435.
8. Unconsolidated Undrained Triaxial Tests were performed in accordance with ASTM D2850.

Abbreviations:

---	Test Not Conducted
SP	Poorly Graded Sand
SM	Silty Sand
SC	Sandy Clay
CL	Lean Clay
LL	Liquid Limit
PI	Plasticity Index
S-	Jar Sample
ST-	Shelby Tube
R_{max}	Effective Principal Stress Ratio
p'	Average Principal Effective Stress
q	Deviator Stress
e_0	Initial Void Ratio
s_c'	Effective Preconsolidation Pressure
c_c	Compression Index
c_r	Recompression Index
s_u	Undrained Shear Strength

Appendix B-4
Subsurface Conditions

B-4.1 General

This section presents the generalized subsurface conditions of the Cell No. 4 and C&D Landfill expansion area investigation based upon the borings and field observations. The regional geology has been previously discussed in Section 3 of this report.

B-4.2 Subsurface Soil Conditions

Based upon the soil test borings, the site generally consists of the following strata in order of increasing depth: topsoil and organic silt; interbedded silt and clay; silty to clayey sand to silt; sand and sand with silt and shell fragments with interbedded clay and silt layers; and Yorktown formation. General cross sections of the borings are shown on **Figures 4-1a** and **4-1b** and a summary of the subsurface conditions is provided in Table 3-1.

B-4.2.1 Upper Silt and Clay Layer

The upper portion of the surficial aquifer is formed by very soft to very stiff silt and clay layer with varying amounts of fine sand that has a thickness of 0.8 to 2.8 feet. This layer will be removed before placing the fill to the site.

B-4.2.2 Upper Silty to Clayey Sand and Silt Layer

A 3- to 16-foot-thick very loose to loose silty to clayey fine sand and stiff to very stiff silt layer with varying amounts of sand was encountered. At soil boring SPT-104, this layer was followed by a 5-foot-thick very soft clay layer with sand, which was not encountered in the remaining soil borings.

B-4.2.3 Middle Sand and Sand with Silt and Shell Layer

The next layer had a thickness of 7 to 15 feet of very loose to medium dense fine to medium sand with varying amounts of silt and shell fragments especially near the bottom of the layer.

B-4.2.4 Middle Silt & Clay and Silty Sand Layer

A 4- to 6-foot-thick very soft to medium stiff silt and clay layer with varying amounts of sand and loose silty fine sand was encountered below the previous layer.

B-4.2.5 Lower Sand to Silty Sand Layer

The last surficial layer overlaying the Yorktown formation was a 39- to 49-foot-thick very loose to dense fine to medium sand to silty sand layer with varying amounts of shell fragments mainly near the top of the layer.

LEGEND

- Fill (made ground)
- USCS Silt
- USCS Sandy Silt
- USCS Poorly-graded Sand
- USCS Poorly-graded Sand with Shell
- SM/ML
- USCS Silty Sand
- USCS Low Plasticity Silty Clay
- USCS Low Plasticity Sandy Clay
- Water Level

0 100

Horizontal Scale (ft.)

CDM

Figure 4-1a
Dare County
C&D Landfill Cell No. 4
Manns Harbor, NC

LITHOLOGY & STRATUM DARE COUNTY.GPJ CDM_CORP.GDT 1/23/09

Camp Dresser & McKee

LEGEND

- USCS Low Plasticity Organic silt or clay
- USCS Low Plasticity Clay
- USCS Silty Sand
- USCS Poorly-graded Sand
- USCS Poorly-graded Sand with Silt
- SM/ML
- USCS Low Plasticity Sandy Clay
- USCS Poorly-graded Sand with Shell
- USCS Poorly-graded Sand with Silt and Shell
- Water Level

0 200

Horizontal Scale (ft.)

CDM

Figure 4-1b
Dare County
C&D Landfill Cell No. 4
Manns Harbor, NC

LITHOLOGY & STRATUM DARE COUNTY.GPJ CDM_CORP.GDT 1/23/09

Camp Dresser & McKee

B-4.2.6 Yorktown

Yorktown formation underlies the surficial deposits. This formation is mainly composed of clay, silt, clayey to silty fine sand, and shell fragments. The top of this formation ranged from EL. -54 to EL. -64.

B-4.3 Groundwater Levels

Groundwater levels measured in the near-by piezometers during the hydrogeologic investigation typically averaged about 2 feet below ground surface. Based upon the groundwater contour map developed during this investigation, the seasonal high groundwater level is assumed to be at ground surface for design. Refer to the hydrogeologic report for further details.

B-4.4 Expected Variation in Subsurface Conditions

Interpretation of general soil conditions presented herein is based on soil and groundwater conditions observed at the test boring locations. However, subsurface conditions may vary between borehole locations.

Water levels measured in monitoring wells/piezometers should not necessarily be considered to represent stabilized groundwater levels. Groundwater levels are expected to fluctuate with season, temperature, climate, construction in the area, and other factors. Actual conditions during construction may be different from those observed at the time of exploration.

Appendix B-5
Settlement Analyses

B-5.1 General

CDM performed settlement analyses for final proposed geometry of the landfill to estimate the amount of settlement of foundation soils under the load from the proposed fill, waste, and final cap materials. Upon completion of Cell No. 4, the channels between each cell will be piggy-backed and the final grading with 2 percent slope will raise the crest elevation of the landfill from approximately EL. 34 to EL. 44. At the end of the final grading, the landfill will have a maximum waste height of 40 feet. The foundation settlement analyses were calculated at the center of the landfill. The purpose of the foundation settlement analyses is to assure that the minimum specified separation of groundwater and the landfill is satisfied under post-settlement conditions. It is expected that some portion of the foundation settlement will occur during construction, however, settlements calculated are assumed to occur after landfill construction is complete. The settlement analyses are described herein.

B-5.2 Foundation Settlement Analyses

The foundation soils at the site consist of compressible sands interbedded with silts and clays. Total foundation settlement under the final loads will have two components; immediate (elastic) settlement of the sands and consolidation settlement of the compressible silts and clays. Foundation settlements were calculated using the Schmertmann Method and SPT N-values for sands and consolidation testing results for compressible silts and clays. Some of the elastic settlement of the sand is expected to occur during fill placement. However, settlement during construction will be ignored in the determination of total settlement since the loads during fill placement are expected to be less than the final waste height load of the landfill.

Based on test boring information and the regional geology, the design profile is assumed to consist of very loose to loose silty to clayey fine sand underlain by silt and low plasticity clay, underlain by loose sand with fines, underlain by very loose to medium dense fine to medium sand with varying amounts of silt and shell fragments, underlain by very soft to medium stiff silt and clay, underlain by very loose to dense fine to medium sand to silty sand. Yorktown formation underlies the surficial deposits. Design soil properties for the soil layers are based upon SPT N-values and laboratory testing, as shown in **Table 5-1**. In the analyses, the Yorktown formation was modeled for two conditions. First, it was assumed to be incompressible and not subject to settlement. Second, the entire depth of the 500-foot thick formation was conservatively assumed to be compressible.

Settlement was calculated for the center of the landfill under final waste loading from construction of Cell No. 4. The final waste thickness in the center of the landfill will be approximately 40 feet and finished side slopes will be graded to 3H:1V. Settlement was estimated to be on the order of 6 to 7 inches for the case where the Yorktown formation is incompressible and approximately 17 inches for when in it is assumed to

Table 5-1: Design Soil Properties

Dare County Cell No. 4

Manns Harbor, NC

Soil Layer	Approximate Elevation (ft)	Approximate Thickness (ft)	Total Unit Weight (pcf)	N-value[1]	Effective Friction Angle, f' (degrees)	Initial Void Ratio, e_0[2]	Compression Index, c_c[2]	Recompression Index, c_r[2]
SM/SC	14.0	8.0	115	3	30	-	-	-
CL	6.0	2.0	110	-	28	0.96	0.207	0.021
SP/SP-SM	4.0	13.0	120	4	32	-	-	-
ML/CL/SM	-9.0	5.0	110	3	29	0.91	0.252	0.024
SP/SM	-14.0	38.0	120	12	34	-	-	-
Yorktown	-52.0	500.0	120	25	-	-	-	-

Notes:

1. Average N-value for the each layer
2. Based upon one-dimensional consolidation test results and literature review

Abbreviations:

- Not Applicable

compressible. It is reasonable to assume that settlement will be within the range of these two estimates, the average of which would be about 12 inches. The settlement calculations are contained in **Attachment B-3.**

The foundation soils will tend to settle differentially with the maximum settlement occurring in the center of the landfill. However, the expected magnitudes of settlements will satisfy minimum groundwater-landfill separation requirements.

Appendix B-6
Slope Stability Analyses

B-6.1 General

Slope stability analyses were performed for the Cell No. 4 expansion. The Cell No. 4 expansion will be constructed in a 250-foot-wide strip in between Cells No. 2 and 3. Approximately 5 feet of fill will be placed in this area to reach base grades for construction of the liner system. Upon completion of Cell No. 4, the channels between each cell will be piggy-backed and the final grading with 2 percent slope will raise the crest elevation of the landfill from approximately EL. 34 to EL. 44. At the end of the final grading, the landfill will have a maximum waste height of 40 feet and a fill height of 5 feet with side slopes of 3H:1V. Stability analyses were run for the following cases:

- End of waste placement in Cell No. 4, and
- End of final grading.

B-6.2 Subsurface Design Properties

Based on test boring information and the regional geology, the design profile is assumed to consist of very loose to loose silty to clayey fine sand underlain by silt and low plasticity clay, underlain by loose sand with fines, underlain by very loose to medium dense fine to medium sand with varying amounts of silt and shell fragments, underlain by very soft to medium stiff silt and clay, underlain by very loose to dense fine to medium sand to silty sand. Yorktown formation underlies the surficial deposits. The assumed design properties are based upon SPT N-values and laboratory testing and listed in Table 5-1.

B-6.3 Landfill Design Properties

The final landfill components will consist of the following in order of their occurrence below final closure grade;

- 18-inch-thick erosion layer,
- 18-inch-thick low-permeability soil liner,
- C&D waste, and
- 5-foot-thick compacted fill pad.

The assumed design properties of the components are listed in **Table 6.1**.

Table 6-1: Summary of Material Design Properties

Layer No.	Materials	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)	Basis for Parameter Selection
1	Erosion Layer	120	30	0	From Previous Report
2	Low-permeability Soil Liner	110	19	0	
3	C&D (Waste)	65	27.5	0	
4	Compacted Fill Layer	120	35	0	

B-6.4 Global Stability Analyses - Static Conditions

B-6.4.1 General

Analyses for overall (global) stability was performed using the SLOPE/W 2007 modeling software package from Geo-Slope International. This computer program uses the inputted slope geometry, soil and waste properties, and groundwater conditions and calculates a factor of safety failure of the overall landfill mass. The minimum acceptable factor of safety against overall slope failure before, during, and after waste placement is 1.5.

B-6.4.2 Cell No. 4 Final Grades

Slope stability analyses were performed for the Cell No. 4 final grade conditions based upon design soil strength and material properties from Table 6-1 and Table 5-1. The minimum factor of safety against overall slope failure for this case was approximately 1.6. Figures provided in **Attachment B-4** illustrate the slope stability section with failure surface for the minimum factor of safety.

B-6.4.3 Finished Grades after Piggy-Back

Slope stability analyses were performed for the landfill finished grade conditions based upon design soil strength and material properties from Table 6-1. The minimum factor of safety against overall slope failure for this case was 1.5. Figures presented in Attachment B-4 illustrate the slope stability section with failure surface for the minimum factor of safety.

B-6.4.4 Results

The computed overall global stability factors of safety for long-term static conditions equal or exceed the minimum factors of safety required. The slope stability analyses are presented in Attachment B-4.

Appendix B-7
Conclusions and Recommendations

B-7.1 Conclusions

Based on the results of the settlement analysis presented in Appendix B-5 and the slope stability analysis presented in Appendix B-6 we have the following conclusions:

- The results of the foundation settlement analysis indicate that post-settlement grades will be adequate to provide the required separation from the seasonal high groundwater for the proposed waste heights.
- The results of the global stability analysis indicate all cases exceed the long-term static slope stability requirements.

B-7.2 Recommendations

Prior to construction of the landfill, laboratory testing should be performed for the actual cap/cover soils materials proposed for use in the landfill. Based upon these testing results, the material properties used in the stability analyses should be verified.

The landfill should be operated in the same manner as the previous three cells. The fill layer should be placed over the Cell No. 4 footprint to a thickness of 5 feet. Fill should be placed in an even manner across the Cell No. 4, and additional fill may be placed after the initial 5 feet to reach base grades. Waste placement should also continue in an even manner, bringing the entire landfill up to finished grade at one time.

Attachment B-1
Test Boring Logs

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Raleigh, NC 27612

BOREHOLE LOG
B-101

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 4-30-07 **End:** 4-30-07
Borehole Coordinates:
N 774,340.20 E 2,943,092.10

Surface Elevation (ft.): 20
Total Depth (ft.): 100
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			20.0 / 0					
SS	S-1	24/22			3 6 9 16		FILL	Moist, medium dense, gray, fine, SAND, little to some gravel, brick, little woods, silt. **-FILL-**
SS	S-2	24/23			17 14 12 13			Moist, very stiff, dark gray to black, ORGANIC SILT, some woods, sand, gravel.
SS	S-3	24/19	15.0 / 5		12 15 15 10			Moist to wet, very stiff to hard, dark gray to black, ORGANIC SILT, some woods, sand, gravel.
SS	S-4	24/22			7 7 7 6		ML	Moist to wet, stiff, dark gray, SILT, trace roots.
SS	S-5	24/19		PP= 1.0 (t), 0.8 (m), 0.8 (b)	3 5 9 9		ML/SM	Moist to wet, stiff, greenish gray and brown, SILT and fine SAND.
ST	ST-1	24/0	10.0 / 10					
SS	S-6	24/15	5.0 / 15		2 8 10 12		SP	Wet, medium dense, gray, fine, SAND.
SS	S-7	24/11	0.0		3 3 4 5			Wet, loose, gray, fine, SAND.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: PMC 02/07/09 **Date:**

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Raleigh, NC 27612

BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			0.0					
			20				SP	
SS	S-8	24/13	-5.0		1 2 3 2			Wet, loose, gray, fine to medium, SAND, little to some shell fractures (coarse sand to gravel size), trace gravel, silt, clay.
			25					
SS	S-9	24/13	-10.0		3 5 5 12		SM/ML	Wet, loose to medium dense, gray, fine, SAND and SILT.
			30					
SS	S-10	24/24	-15.0	Tor= 2.2 (t), 2.1 (m)	WOH WOH 2 7		ML	Wet, very soft to soft, gray, SILT, some clay.
			35				SP	Wet, very loose, gray, fine, SAND, little shell fractures (fine sand size).
SS	S-11	24/10	-20.0		2 5 6 7			Wet, medium dense, gray, fine, SAND, some shell fractures (fine to coarse sand size), trace silt.
			40					
SS	S-12	24/14	-25.0		4 10 12 12		SM	Wet, medium dense, gray, fine to medium, SAND, little silt, trace shell fractures.
			45					
SS	S-13	24/14	-30.0		7 9 15 16			
			50					
SS	S-14	24/21	-35.0		1 2 2 1		SP	Wet, very loose to loose, gray, fine, SAND and SHELL FRACTURES (sand to gravel size).
			55					
SS	S-15	24/12	-40.0		10 11 17 18			Wet, medium dense, gray, fine, SAND.

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BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-40.0 / 60					
SS	S-16	24/16	-45.0 / 65		2 10 28 32			Wet, dense, gray, fine, SAND.
SS	S-17	24/14	-50.0 / 70		5 8 9 11		SM	Wet, medium dense, gray, fine, SAND, little silt.
SS	S-18	24/24	-55.0 / 75		1 2 2 4		CL/ML	Moist, soft to medium stiff, gray, CLAY and SILT, trace sand. **-YORKTOWN-**
ST	ST-2	24/24						
SS	S-19	24/15	-60.0 / 80	PP= 1.3 (m)	5 9 12 14			Moist, very stiff, gray, CLAY and SILT, trace to little sand.
SS	S-20	24/24	-65.0 / 85	PP= 1.8 (t), 2.3 (m), 1.8 (b)	2 2 4 6			Moist, medium stiff, gray, CLAY and SILT, trace to little shell fragments (gravel size), trace sand.
SS	S-21	24/24	-70.0 / 90	PP= 1.0 (t), 1.8 (m), 1.3 (b)	2 3 3 5			Moist, medium stiff, gray, CLAY and SILT, little sand.
SS	S-22	24/20	-75.0 / 95		2 11 15 13		SM	Wet, medium dense, light gray to gray, fine, SAND, some silt.
SS	S-23	24/24	-80.0		1 2 5 7		ML	Wet, medium stiff, gray, SILT, little to some sand.

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BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-80.0 / 100					Boring terminated at 100 feet below ground surface.
			-85.0 / 105					
			-90.0 / 110					
			-95.0 / 115					
			-100.0 / 120					
			-105.0 / 125					
			-110.0 / 130					
			-115.0 / 135					
			-120.0					

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Raleigh, NC 27612

BOREHOLE LOG
B-102

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 4-30-07 **End:** 5-1-07
Borehole Coordinates:
N 773,613.20 E 2,943,245.90

Surface Elevation (ft.): 20
Total Depth (ft.): 98.9
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			20.0					
SS	S-1	24/24	0		1 2 2 4		FILL	Moist, very loose to loose, light greenish gray and brown, fine, SAND, trace silt. -FILL-
SS	S-2	24/12			2 4 4 7			Moist, very loose to loose, gray to dark gray, fine, ORGANIC SAND, some silt, little to some woods. Moist, medium stiff to stiff, gray to dark gray, ORGANIC SILT, some woods, little sand.
SS	S-3	24/16	15.0 / 5		4 19 14 9			Moist, dense, gray and dark gray, fine to medium, SAND, some brick, little silt, gravel.
SS	S-4	24/22			7 9 7 10		SP	Wet, medium dense, light gray to gray, fine, SAND, trace silt.
							CL	Moist, very stiff, dark gray and greenish gray, CLAY, some sand, little silt.
ST	ST-1	24/10	10.0				SC/CL	Moist, dark gray and greenish gray, fine, SAND and CLAY, little silt.
SS	S-5	24/18	10		3 4 5 5		SM	Wet, loose, light gray to gray, fine, SAND, little to some silt.
SS	S-6	24/13	5.0 / 15		5 6 5 3		SP	Wet, medium dense, light gray to gray, fine, SAND.
SS	S-7	24/13	0.0		3 2 1 1		SP-SM	Wet, very loose, gray, fine, SAND, trace to little silt.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: PMC 02/07/08 **Date:**

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			0.0					
			20				SP-SM	
SS	S-8	24/15	-5.0		14 20 26 14			Wet, dense, gray, fine, SAND, little shell fractures (coarse sand to gravel size), trace to little silt.
			25					
SS	S-9	24/15	-10.0		3 2 3 3		ML	Wet, medium stiff, gray to dark gray, SILT, some fine sand.
			30					
ST	ST-2	24/23					CL	Wet, dark gray, CLAY, some fine sand.
SS	S-10	24/22	-15.0		1 2 1 1		SM	Wet, very loose, gray to dark gray, fine, SAND, some shell fractures (sand to gravel size), little silt.
			35					
SS	S-11	24/18	-20.0		4 5 8 9		SP	Wet, medium dense, gray, fine, SAND, little to some shell fractures (sand to fine gravel size), trace silt.
			40					
SS	S-12	24/16	-25.0		8 10 11 16			Wet, medium dense, gray, fine, SAND.
			45					
SS	S-13	24/21	-30.0		5 4 7 7			Wet, medium dense, gray, fine, SAND, trace to little shell fractures (sand to fine gravel size), trace silt.
			50					
SS	S-14	24/20	-35.0		3 3 3 4		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace to little silt.
			55					
SS	S-15	24/18	-40.0		14 18 28 37		SP	Wet, dense, light gray to gray, fine, SAND, trace shell fractures.

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-40.0 / 60				SP	
SS	S-16	24/15	-45.0 / 65		11 9 9 12		SM	Wet, medium dense, gray, fine, SAND, little silt.
SS	S-17	24/23	-50.0 / 70		2 3 5 7			Wet, loose, gray, fine, SAND, little silt.
SS	S-18	24/20	-55.0 / 75	PP= 0.5 (t), 0.5 (b)	4 3 2 4		CL/ML	Wet, medium stiff, gray, CLAY and SILT, trace to little sand, trace shell fractures. **-YORKTOWN-**
SS	S-19	24/24	-60.0 / 80		5 3 7 6			Wet, stiff, gray, CLAY and SILT, some shell fractures (sand to gravel size), little to some fine sand.
SS	S-20	24/24	-65.0 / 85	PP= 1.5 (t), 1.8 (m), 2.0 (b)	2 2 3 7			Wet, medium stiff, gray, CLAY and SILT, trace sand, shell fractures.
SS	S-21	24/24	-70.0 / 90	PP= 1.5 (t), 1.8 (m), 1.8 (b)	2 3 4 6			
SS	S-22	24/24	-75.0 / 95		1 3 3 4		SM	Moist, loose, gray, fine, SAND, some silt.
SS	S-23	11/11	-80.0		25 50/5"		SP	Wet, very dense, light gray to gray, fine, SAND, trace silt.

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-80.0					
			100					Boring terminated at 98.9 feet below ground surface.
			-85.0 / 105					
			-90.0 / 110					
			-95.0 / 115					
			-100.0 / 120					
			-105.0 / 125					
			-110.0 / 130					
			-115.0 / 135					
			-120.0					

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BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Surface Elevation (ft.): 14
Drilling Method/Rig: Mud Rotary/CME 550
Total Depth (ft.): 100
Drillers: Tim Donahue
Depth to Initial Water Level (ft. BGS):
Drilling Date: Start: 5-1-07 **End:** 5-1-07
Abandonment Method:
Borehole Coordinates:
Field Screening Instrument:
N 774,360.00 E 2,942,685.20
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			14.0					
SS	S-1	24/23	0	PP= 0.8 (m), 1.0 (b)	WOH 1 1 2		OL	Moist, very soft to soft, dark gray to black, ORGANIC SILT, little sand, woods.
							CL	Moist, very soft to soft, grayish brown, CLAY, trace sand.
ST	ST-1	24/24					SM	Moist, light gray to gray, fine, SAND, little silt.
SS	S-2	24/17	9.0 / 5		3 3 2 1			Wet, loose, gray, fine, SAND, some silt.
SS	S-3	24/16			WOH 1 2 3			Wet, very loose, gray, fine, SAND, little silt.
SS	S-4	24/21	4.0 / 10		4 4 4 6		SP	Wet, loose, light gray to gray, fine, SAND, trace silt.
SS	S-5	24/10	-1.0 / 15		1 2 2 3			Wet, very loose to loose, light gray to gray, fine, SAND.
SS	S-6	24/15	-6.0		3 6 6 7		SP-SM	Wet, medium dense, gray, fine, SAND, trace to little silt.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: PMC 02/07/08 **Date:**

CAMP DRESSER & McKEE
CDM
5400 Glenwood Avenue Suite 300
Raleigh, NC 27612

BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-6.0 / 20				SP-SM	
SS	S-7	24/10	-11.0 / 25		3 3 4 4		SM/ML	Wet, loose, gray, fine, SAND and SILT.
ST	ST-2	24/24					CL	Wet, gray, CLAY, some fine sand.
SS	S-8	24/15	-16.0 / 30		1 2 4 2		SP	Wet, loose, gray, fine to medium, SAND, some shell fractures (coarse sand to gravel size), trace silt.
SS	S-9	24/16	-21.0 / 35		5 4 5 6		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace to little silt.
SS	S-10	24/22	-26.0 / 40		6 6 8 7		SP	Wet, medium dense, gray, fine, SAND, little shell fractures (fine to coarse sand size).
SS	S-11	24/12	-31.0 / 45		4 10 16 19			Wet, medium dense, gray, fine, SAND, trace shell fractures.
SS	S-12	24/24	-36.0 / 50		4 3 4 4			Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace silt.
SS	S-13	24/21	-41.0 / 55		9 13 31 33			Wet, dense, light gray to gray, fine to medium, SAND, trace shell fractures.
SS	S-14	24/16	-46.0		5 8 9 10		SM	Wet, medium dense, gray, fine, SAND, little silt.

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BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-46.0 / 60				SM	
SS	S-15	24/14	-51.0 / 65		6 7 11 15		SP-SM	Wet, medium dense, gray, fine, SAND, trace to little silt, trace shell fractures.
SS	S-16	24/24	-56.0 / 70	PP= 0.8 (t), 0.8 (m), 1.0 (b)	3 3 6 7		CL/ML	Moist, stiff, gray, CLAY and SILT, trace shell fractures. **-YORKTOWN-**
SS	S-17	24/20	-61.0 / 75		9 13 22 37		SM	Moist, dense, gray, fine, SAND, some silt, little shell fractures (sand to fine gravel size).
SS	S-18	24/24	-66.0 / 80	PP= 1.5 (t), 1.5 (m), 1.8 (b)	2 3 3 6		CL/ML	Moist, medium stiff, gray, CLAY and SILT, trace shell fractures.
SS	S-19	24/23	-71.0 / 85		3 4 7 17		SM	Moist, medium dense, gray, fine, SAND, some silt.
SS	S-20	24/20	-76.0 / 90		10 14 13 16			Wet, medium dense, gray, fine, SAND, little silt, clay.
SS	S-21	24/21	-81.0 / 95		23 35 28 28		SP	Wet, very dense, light gray to gray, fine, SAND.
SS	S-22	24/10	-86.0		15 22 28 32			Wet, dense to very dense, light gray to gray, fine, SAND.

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Raleigh, NC 27612

BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-86.0					
			100					Boring terminated at 100 feet below ground surface.
			-91.0					
			105					
			-96.0					
			110					
			-101.0					
			115					
			-106.0					
			120					
			-111.0					
			125					
			-116.0					
			130					
			-121.0					
			135					
			-126.0					

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Raleigh, NC 27612

BOREHOLE LOG
B-104

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 5-1-07 **End:** 5-1-07
Borehole Coordinates:
N 772,817.30 E 2,942,277.90

Surface Elevation (ft.): 14
Total Depth (ft.): 100
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			14.0					
SS	S-1	24/20	0	PP= 1.5 (t), 2.5 (m)	3 2 3 3		OL	Moist, medium stiff, dark gray, ORGANIC SILT, trace clay, sand.
							CL	Moist, medium stiff, gray and brown, CLAY, little sand.
ST	ST-1	24/23					SC	Moist, brownish gray, fine, SAND, some clay.
SS	S-2	24/21	9.0 / 5		3 2 1 2		SM	Wet, very loose, gray, fine, SAND, some silt.
SS	S-3	24/24			2 2 1 2		SP-SM	Wet, very loose, gray, fine, SAND, trace silt.
SS	S-4	24/24	4.0 / 10		1 2 2 2		SM	Wet, very loose to loose, gray, fine, SAND, little to some silt.
SS	S-5	24/24	-1.0 / 15		WOH WOH WOH WOH		CL	Wet, very soft, gray, CLAY, trace to little sand.
ST	ST-2	24/0						
SS	S-6	24/24	-6.0		5 3 4 5		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to gravel size), trace to little silt.
							SM	Wet, loose, gray, fine, SAND, some silt, clay, shell fractures (sand

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: PMC 02/07/08 **Date:**

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BOREHOLE LOG
B-104

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-6.0					
			20				SM	to gravel size).
SS	S-7	24/13	-11.0		2 6 6 7			Wet, medium dense, gray, fine, SAND, some silt.
			25				CL/ML	
ST	ST-3	24/24						Wet, gray, CLAY and SILT.
ST	ST-4	24/24						Wet, gray, CLAY and SILT, shell fractures.
SS	S-8	24/18	-16.0		WOH WOH WOH 1		SM	Wet, very loose, gray, fine, SAND, some silt, little to some shell fractures (sand to gravel size).
			30					
SS	S-9	24/20	-21.0		3 5 7 9		SP-SM	Wet, medium dense, gray, fine, SAND, some shell fractures (sand to gravel size), trace to little silt.
			35					
SS	S-10	24/17	-26.0		8 10 13 14		SP	Wet, medium dense, gray, fine, SAND.
			40					
SS	S-11	24/16	-31.0		10 11 19 23			Wet, medium dense to dense, gray, fine, SAND, trace shell fractures.
			45					
SS	S-12	24/24	-36.0		3 4 3 4		SM	Wet, loose, gray, fine to medium, SAND, little silt, shell fractures (sand to fine gravel size).
			50					
SS	S-13	24/17	-41.0		12 19 20 23		SP	Wet, dense, gray, fine to medium, SAND.
			55					
SS	S-14	24/20	-46.0		5 2 5 14		SM	Wet, loose, gray, fine, SAND, little silt.

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BOREHOLE LOG
B-104

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-46.0					
			60				SM	
SS	S-15	24/18	-51.0		1 4 11 14			Wet, medium dense, gray, fine, SAND, little silt.
			65					
SS	S-16	24/16	-56.0		7 14 10 10			Wet, medium dense, gray, fine, SAND, little silt, shell fractures (sand to fine gravel size).
			70					
SS	S-17	24/12	-61.0		25 21 13 13			Wet, dense, gray, fine, SAND, little to some silt.
			75					
SS	S-18	24/24	-66.0	PP= 1.8 (t), 2.3 (m), 2.5 (b)	2 3 4 5		CL/ML	Wet, medium stiff, gray, CLAY and SILT, trace shell fractures. -YORKTOWN-
			80					
SS	S-19	24/24	-71.0	PP= 1.8 (t), 2.0 (m), 2.0 (b)	2 3 4 5			
			85					
SS	S-20	24/24	-76.0		2 3 2 4			Wet, medium stiff, gray, CLAY and SILT, little sand, trace shell fractures.
			90					
SS	S-21	24/18	-81.0		10 8 17 40		SP-SM	Wet, medium dense, gray, fine, SAND, little to some shell fractures (sand to fine gravel size), little silt.
			95					
SS	S-22	24/24	-86.0		1 1 2 4		SM/ML	Wet, very loose, gray, fine, SAND and SILT.

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BOREHOLE LOG
B-104

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-86.0					
			100					Boring terminated at 100 feet below ground surface.
			-91.0 / 105					
			-96.0 / 110					
			-101.0 / 115					
			-106.0 / 120					
			-111.0 / 125					
			-116.0 / 130					
			-121.0 / 135					
			-126.0					

Attachment B-2
Laboratory Test Results

CDM

Geotechnical Engineering Laboratory

Standard Test Method for Laboratory Determination of
Water Content of Soil and Rock by Mass (ASTM D2216)

Client: Dare County
Project Name: C&D Cell No.4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Location:	B-101	B-103	-	-	-	-
Sample Number:	S-4	S-2	-	-	-	-
Sample Depth(ft):	6-8	4-6	-	-	-	-
Sample Date:	4/30/07	5/1/07	-	-	-	-
Lab ID Number:	1724	1734	-	-	-	-
Moisture Content:	37.8%	22.0%	-	-	-	-

Sample Location:	-	-	-	-	-	-
Sample Number:	-	-	-	-	-	-
Sample Depth(ft):	-	-	-	-	-	-
Sample Date:	-	-	-	-	-	-
Lab ID Number:	-	-	-	-	-	-
Moisture Content:	-	-	-	-	-	-

Sample Location:	-	-	-	-	-	-
Sample Number:	-	-	-	-	-	-
Sample Depth(ft):	-	-	-	-	-	-
Sample Date:	-	-	-	-	-	-
Lab ID Number:	-	-	-	-	-	-
Moisture Content:	-	-	-	-	-	-

Sample Location:	-	-	-	-	-	-
Sample Number:	-	-	-	-	-	-
Sample Depth(ft):	-	-	-	-	-	-
Sample Date:	-	-	-	-	-	-
Lab ID Number:	-	-	-	-	-	-
Moisture Content:	-	-	-	-	-	-

Sample Location:	-	-	-	-	-	-
Sample Number:	-	-	-	-	-	-
Sample Depth(ft):	-	-	-	-	-	-
Sample Date:	-	-	-	-	-	-
Lab ID Number:	-	-	-	-	-	-
Moisture Content:	-	-	-	-	-	-

CDM

Geotechnical Engineering Laboratory

Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

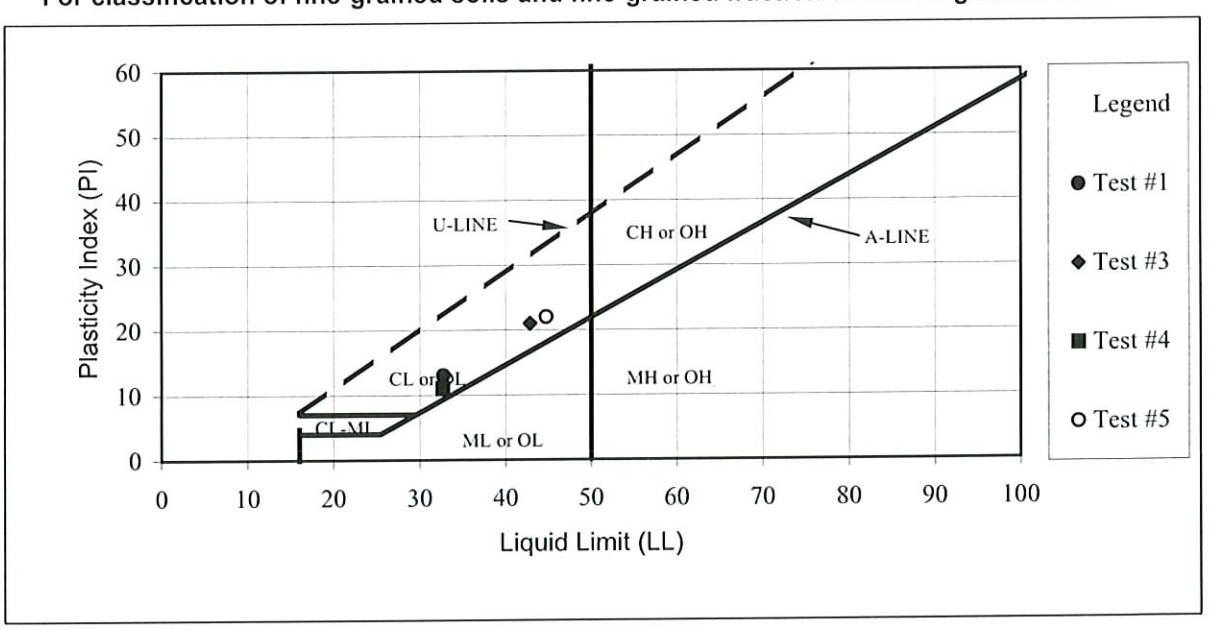
Client:	Dare County
Project Name:	C&D Cell No.4
Project Location:	Manns Harbor, NC
Project Number:	17592-56960

Results

Test Number:	**1**	**2**	**3**	**4**	**5**
Sample Location:	B-104	B-102	B-103	B-102	B-104
Sample Number:	S-5	S-9	S-1B	S-4B	S-1B
Lab ID Number:	1739	1730	1733	1729	1737
Tested By:	RC	RC	RC	RC	RC
Test Date:	5/16/2007	5/14/2007	5/14/2007	5/18/2007	5/18/2007
Sample Depth (ft):	13-15	28-30	1-2	7.2-8	0.8-2
As Rec'd Water Cont. (%):	59.3	31.6	36.7	24.7	21.8
Liquid Limit (LL)	33	NP	43	33	45
Plastic Limit (PL)	20	NP	22	22	23
Plasticity Index (PI)	13	NP	21	11	22

Plasticity Chart

For classification of fine-grained soils and fine-grained fraction of coarse-grained soils.



Reference: ASTM D 2487

CDM

Geotechnical Engineering Laboratory

Liquid Limit, Plastic Limit and Plasticity Index of Soils (ASTM D4318)

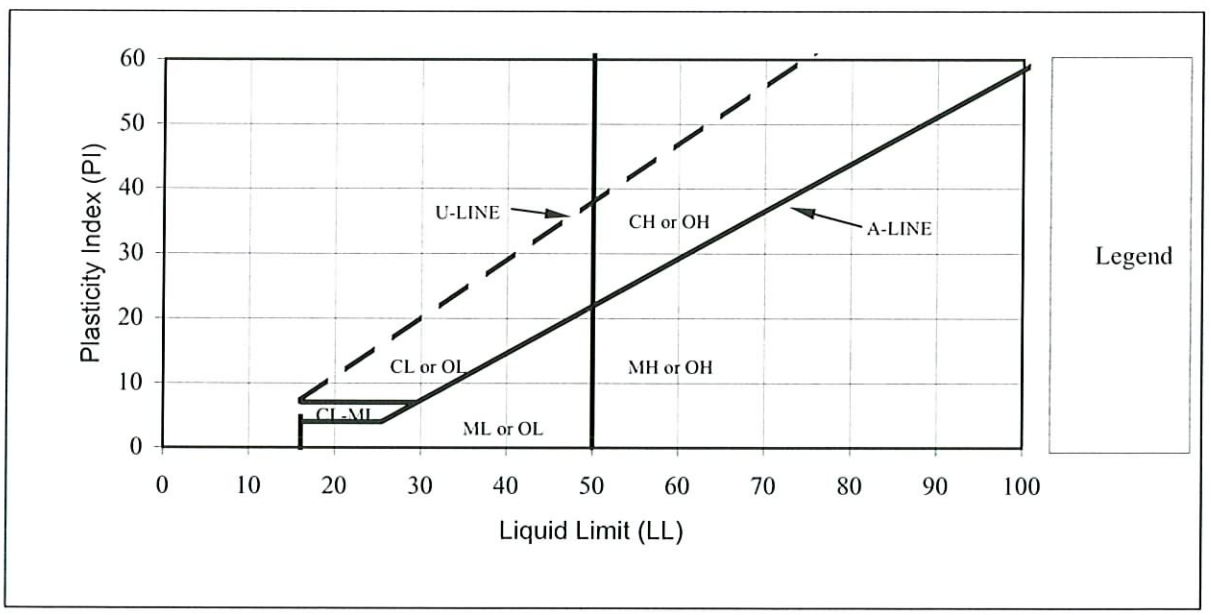
Client:	Dare County
Project Name:	C&D Cell No.4
Project Location:	Manns Harbor, NC
Project Number:	17592-56960

Results

Test Number:	1
Sample Location:	B-101
Sample Number:	S-5
Lab ID Number:	1725
Tested By:	RC
Test Date:	5/16/2007
Sample Depth (ft):	8-10
As Rec'd Water Cont. (%):	22.9
Liquid Limit (LL)	NP
Plastic Limit (PL)	NP
Plasticity Index (PI)	NP

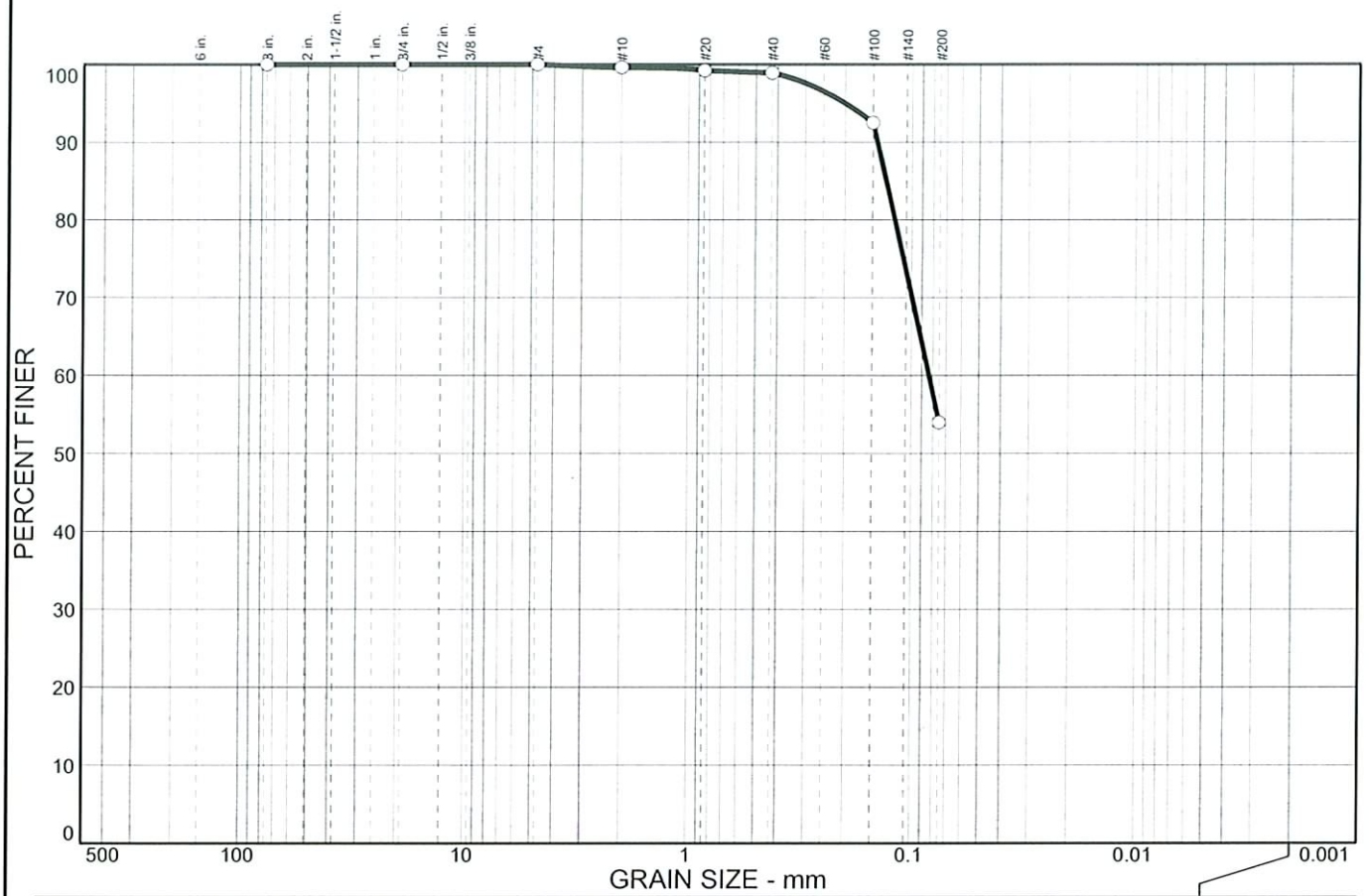
Plasticity Chart

For classification of fine-grained soils and fine-grained fraction of coarse-grained soils.



Reference: ASTM D 2487

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.4	0.7	44.9	54.0	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.6		
#20	99.2		
#40	98.9		
#100	92.5		
#200	54.0		

* (no specification provided)

Soil Description

Sandy silt

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.131 D_{60}= 0.0834 D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= --

Remarks

As received moisture content = 22.9%

Sample No.: S-5 **Source of Sample:** **Date:** 4/30/07
Location: B-101 **Elev./Depth:** 8-10

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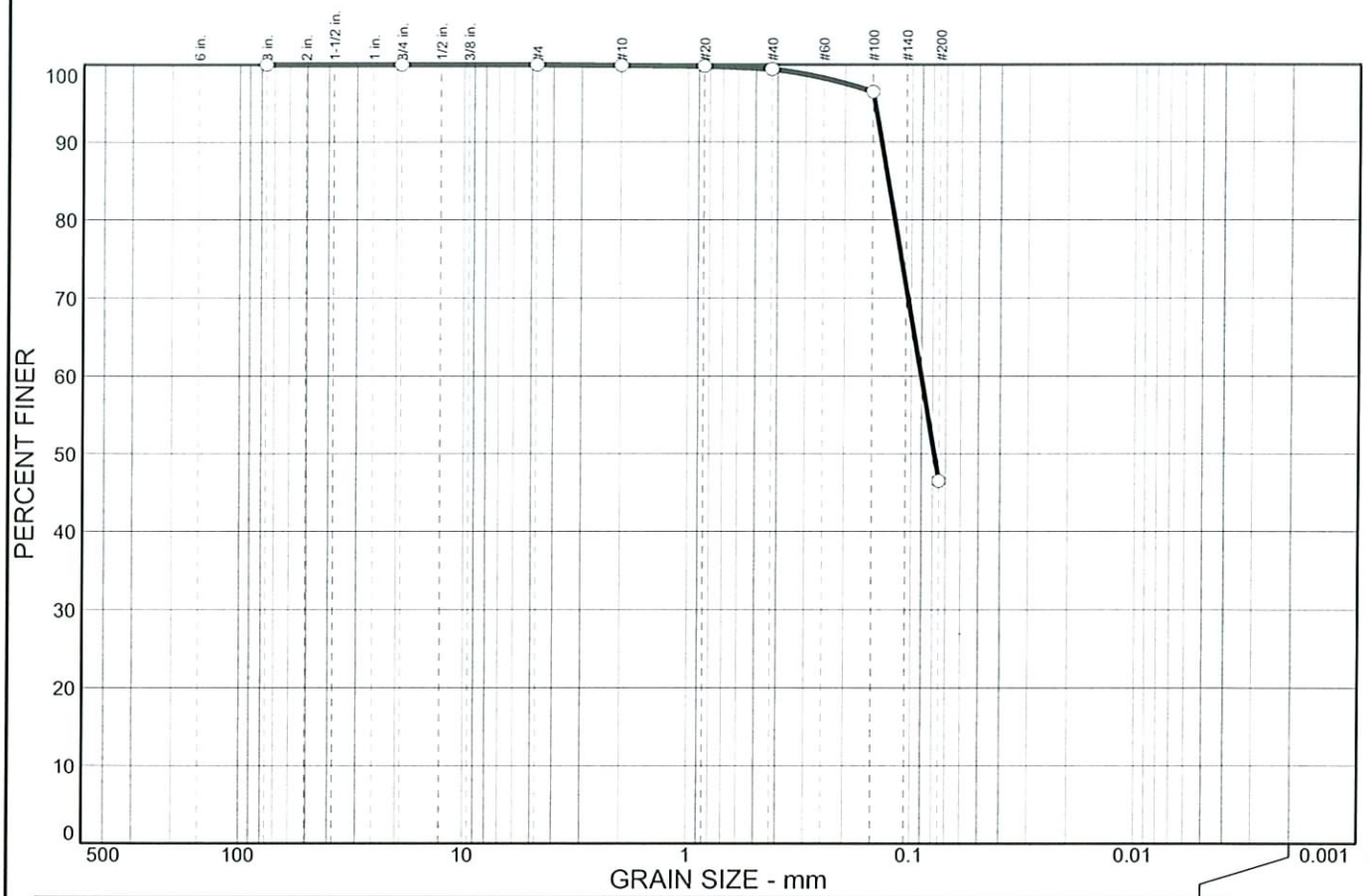
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.5	52.9	46.5	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.8		
#40	99.4		
#100	96.5		
#200	46.5		

* (no specification provided)

Soil Description

Silty sand
Shells found on #10 sieve.

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.128 D_{60}= 0.0904 D_{50}= 0.0787
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 26.1%

Sample No.: S-9 **Source of Sample:** **Date:** 4/30/07
Location: B-101 **Elev./Depth:** 28-30

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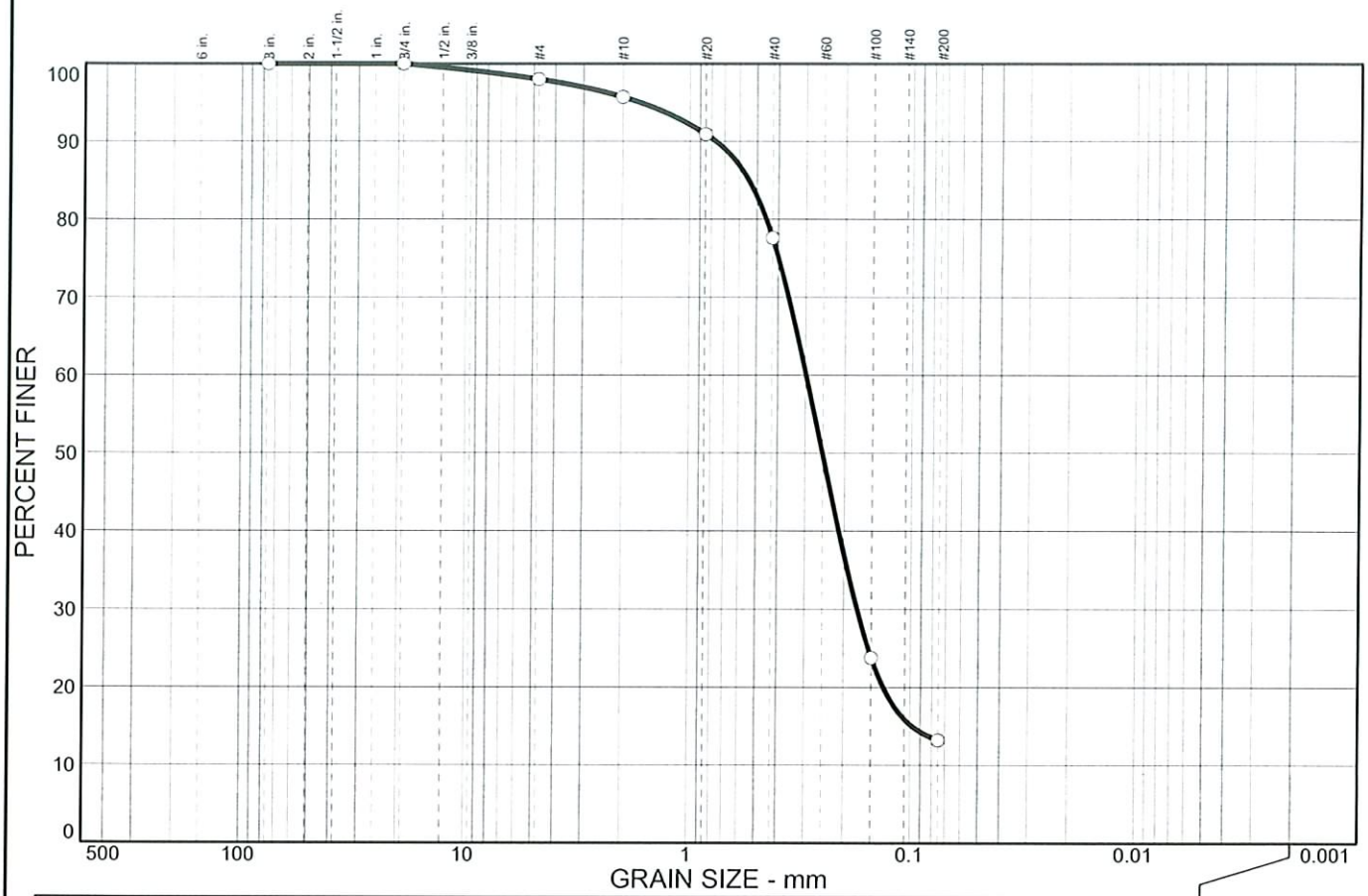
PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	2.0	2.3	18.1	64.4	13.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	98.0		
#10	95.7		
#20	90.9		
#40	77.6		
#100	23.8		
#200	13.2		

* (no specification provided)

Soil Description

Silty sand
Shells found on #4, #10 sieves.

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.545 D_{60}= 0.298 D_{50}= 0.251
D_{30}= 0.174 D_{15}= 0.0980 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

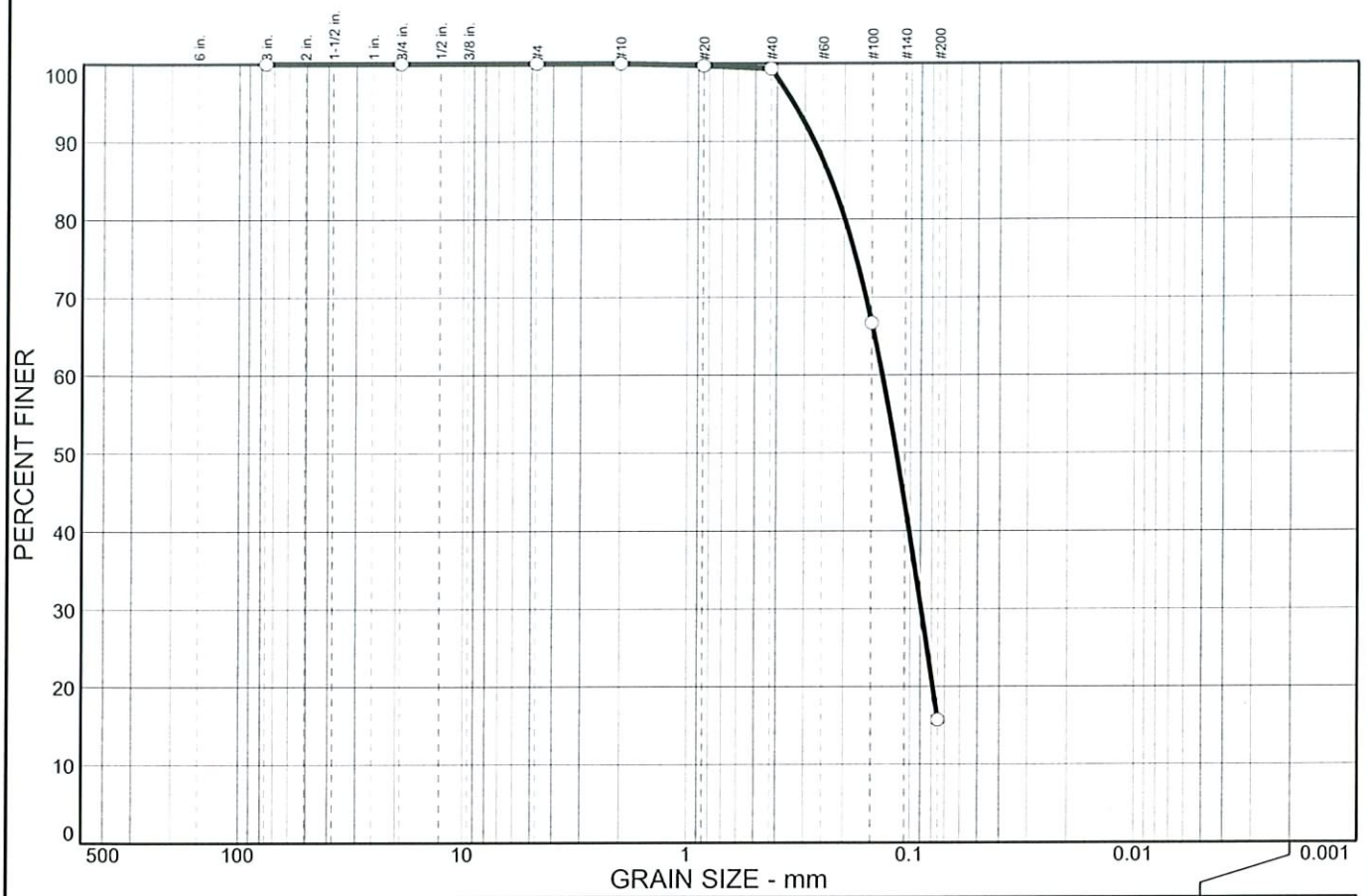
Remarks

As received moisture content = 16.0%

Sample No.: S-13 **Source of Sample:** **Date:** 4/30/07
Location: B-101 **Elev./Depth:** 48-50

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.7	83.6	15.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	100.0		
#20	99.7		
#40	99.3		
#100	66.7		
#200	15.7		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.229 D_{60}= 0.134 D_{50}= 0.116
D_{30}= 0.0894 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

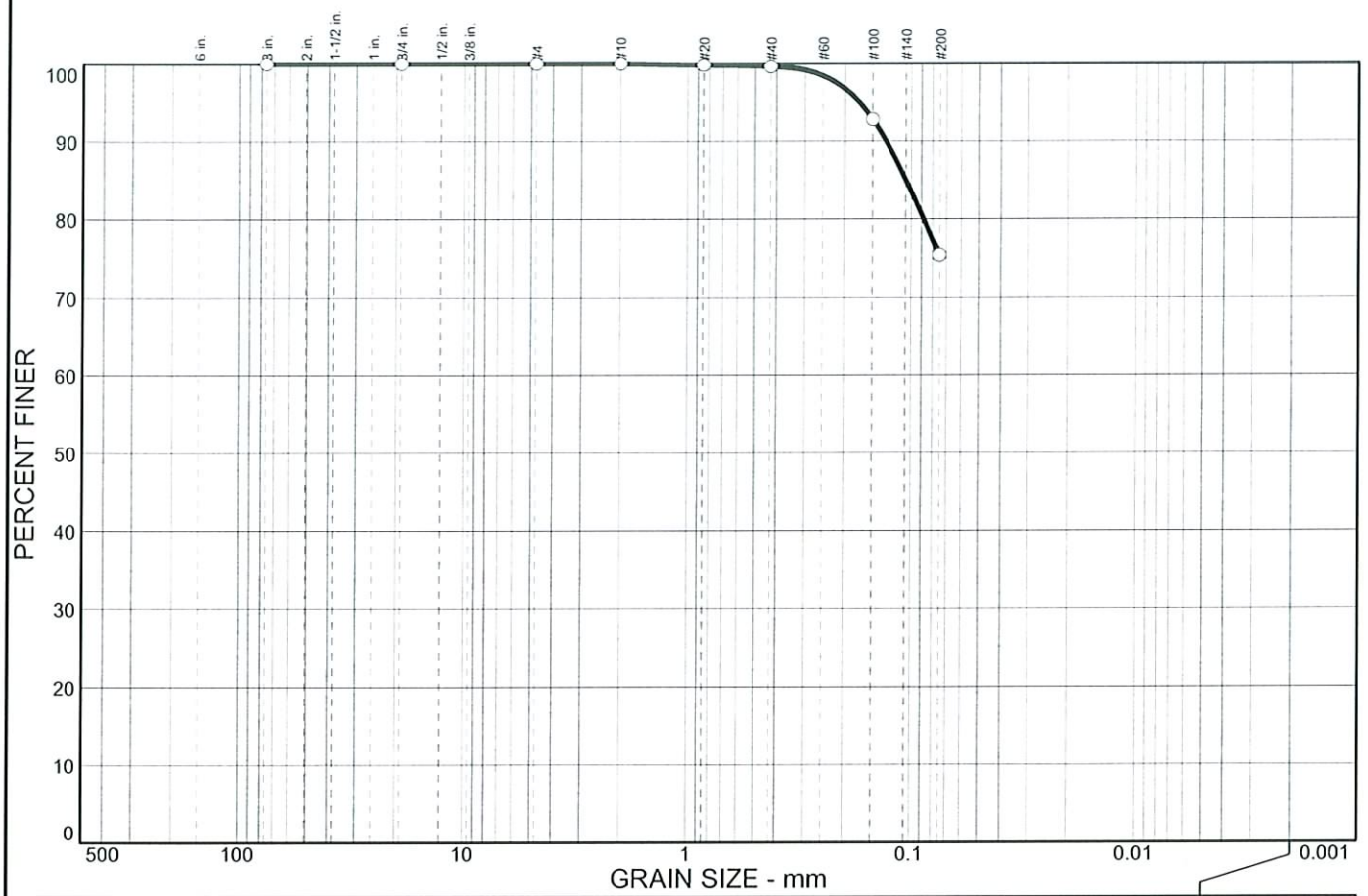
Remarks

As received moisture content = 24.3%

Sample No.: S-17 **Source of Sample:** **Date:** 4/30/07
Location: B-101 **Elev./Depth:** 68-70

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.4	24.2	75.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	100.0		
#20	99.8		
#40	99.6		
#100	92.8		
#200	75.4		

* (no specification provided)

Soil Description

Lean clay with sand

Atterberg Limits

PL= 22 LL= 33 PI= 11

Coefficients

D_{85}= 0.106 D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= --

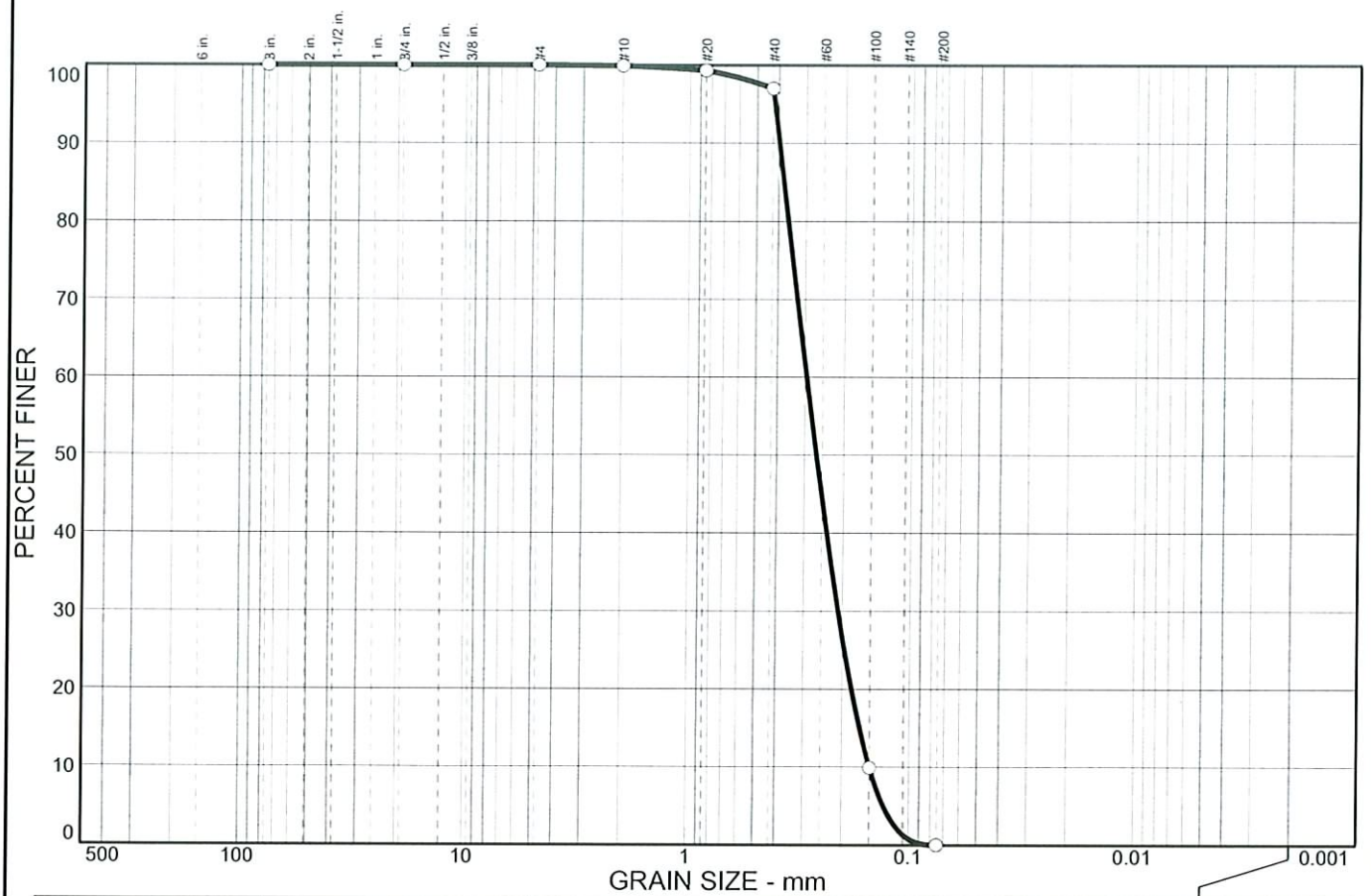
Remarks

As received moisture content = 24.7%

Sample No.: S-4B **Source of Sample:** **Date:** 4/30/07
Location: B-102 **Elev./Depth:** 7.2-8

CDM Jessberger Geotechnical Engineering Laboratory	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	2.9	97.0	0.0	0.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.3		
#40	97.0		
#100	9.9		
#200	0.0		

* (no specification provided)

Soil Description

Poorly graded sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.378 D_{60}= 0.295 D_{50}= 0.265
D_{30}= 0.209 D_{15}= 0.167 D_{10}= 0.150
C_u= 1.96 C_c= 0.99

Classification

USCS= SP AASHTO= --

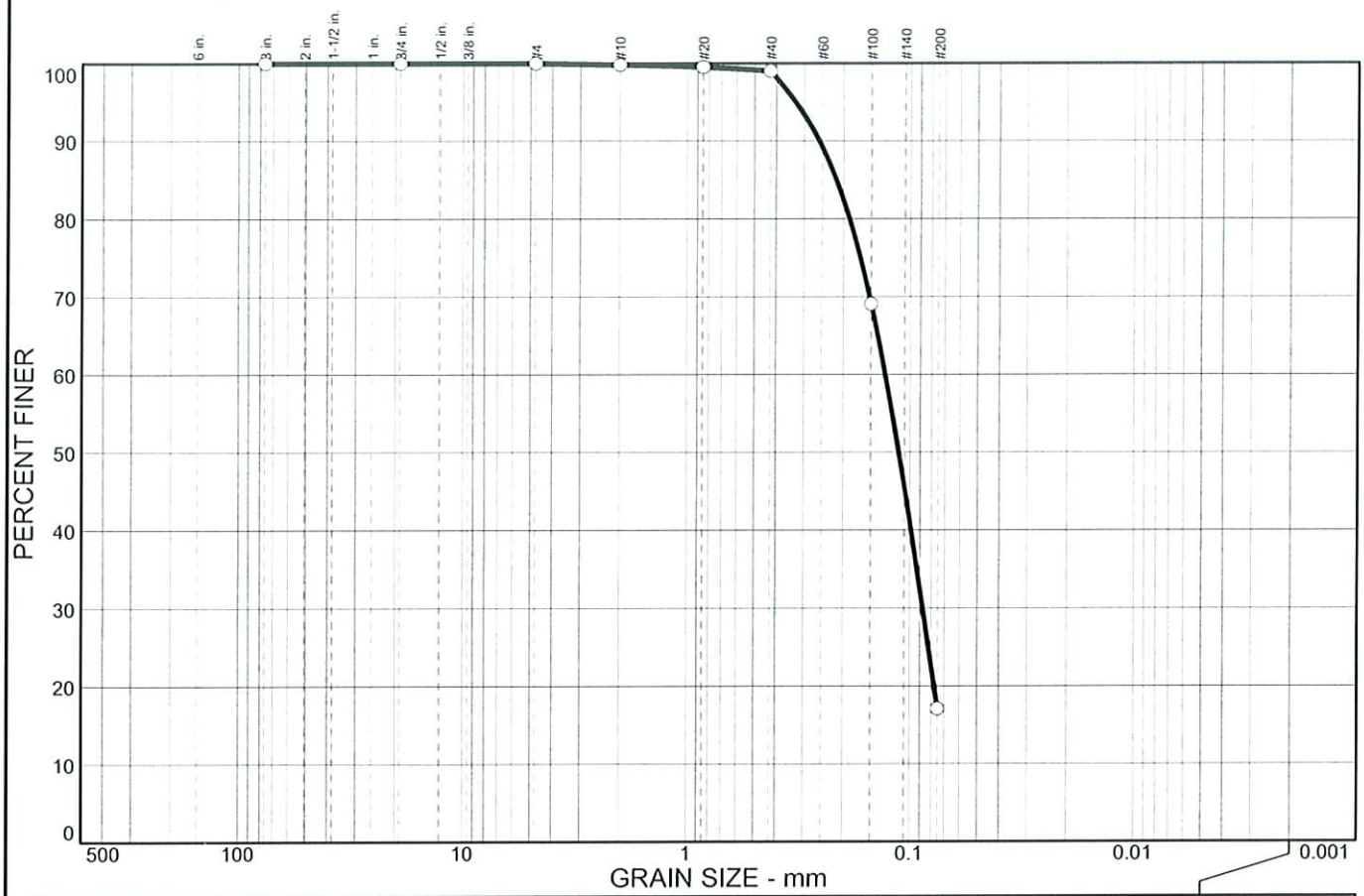
Remarks

As received moisture content = 20.6%

Sample No.: S-12 **Source of Sample:** **Date:** 5/1/07
Location: B-102 **Elev./Depth:** 43-45

CDM Jessberger Geotechnical Engineering Laboratory	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	0.8	81.9	17.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.8		
#20	99.5		
#40	99.0		
#100	69.1		
#200	17.1		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.216 D_{60}= 0.130 D_{50}= 0.113
D_{30}= 0.0875 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

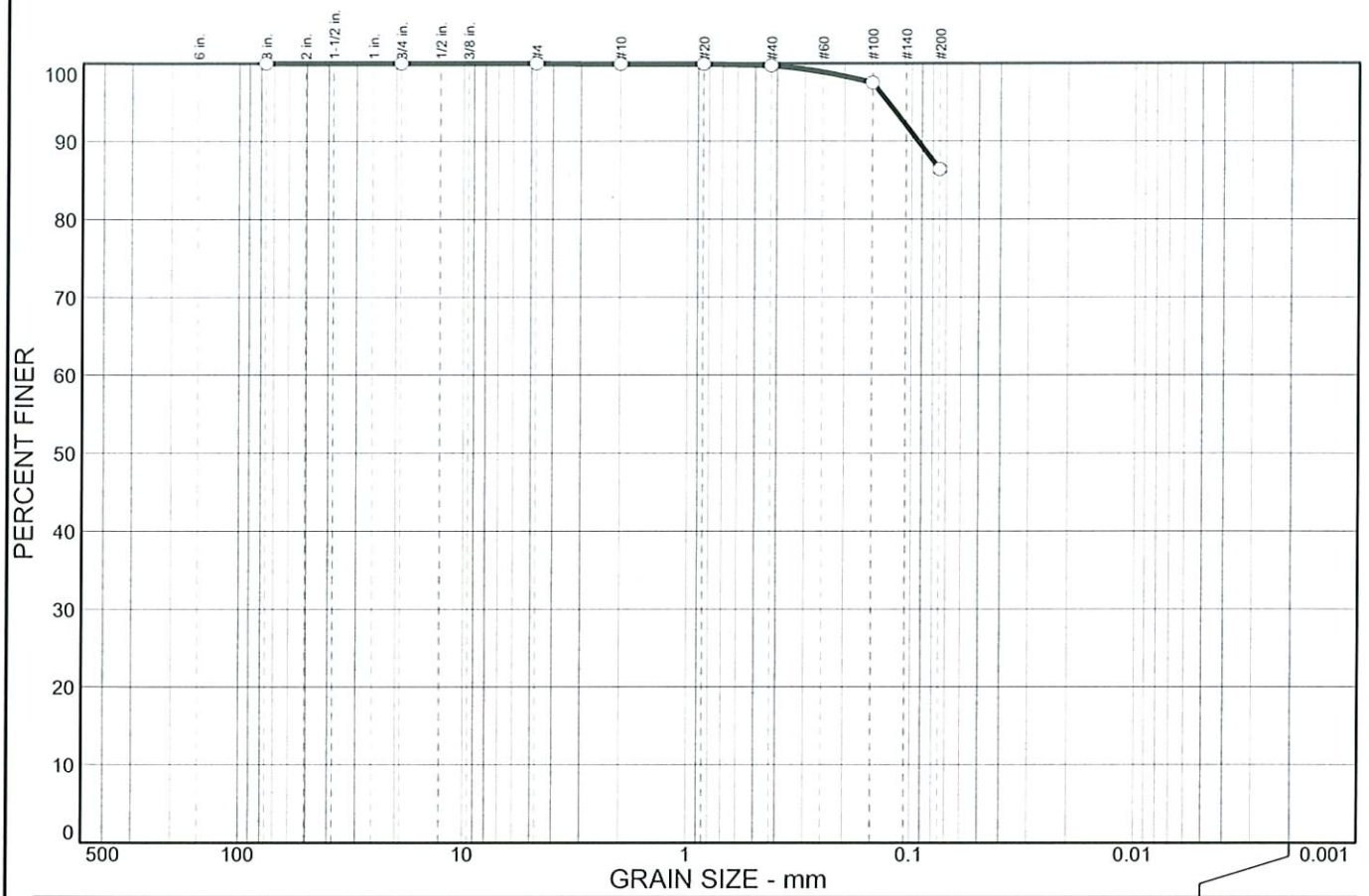
Remarks

As received moisture content = 29.8%

Sample No.: S-17 **Source of Sample:** **Date:** 5/1/07
Location: B-102 **Elev./Depth:** 68-70

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.1	0.2	13.3	86.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	100.0		
#10	99.9		
#20	99.9		
#40	99.7		
#100	97.5		
#200	86.4		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 23 LL= 45 PI= 22

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= --

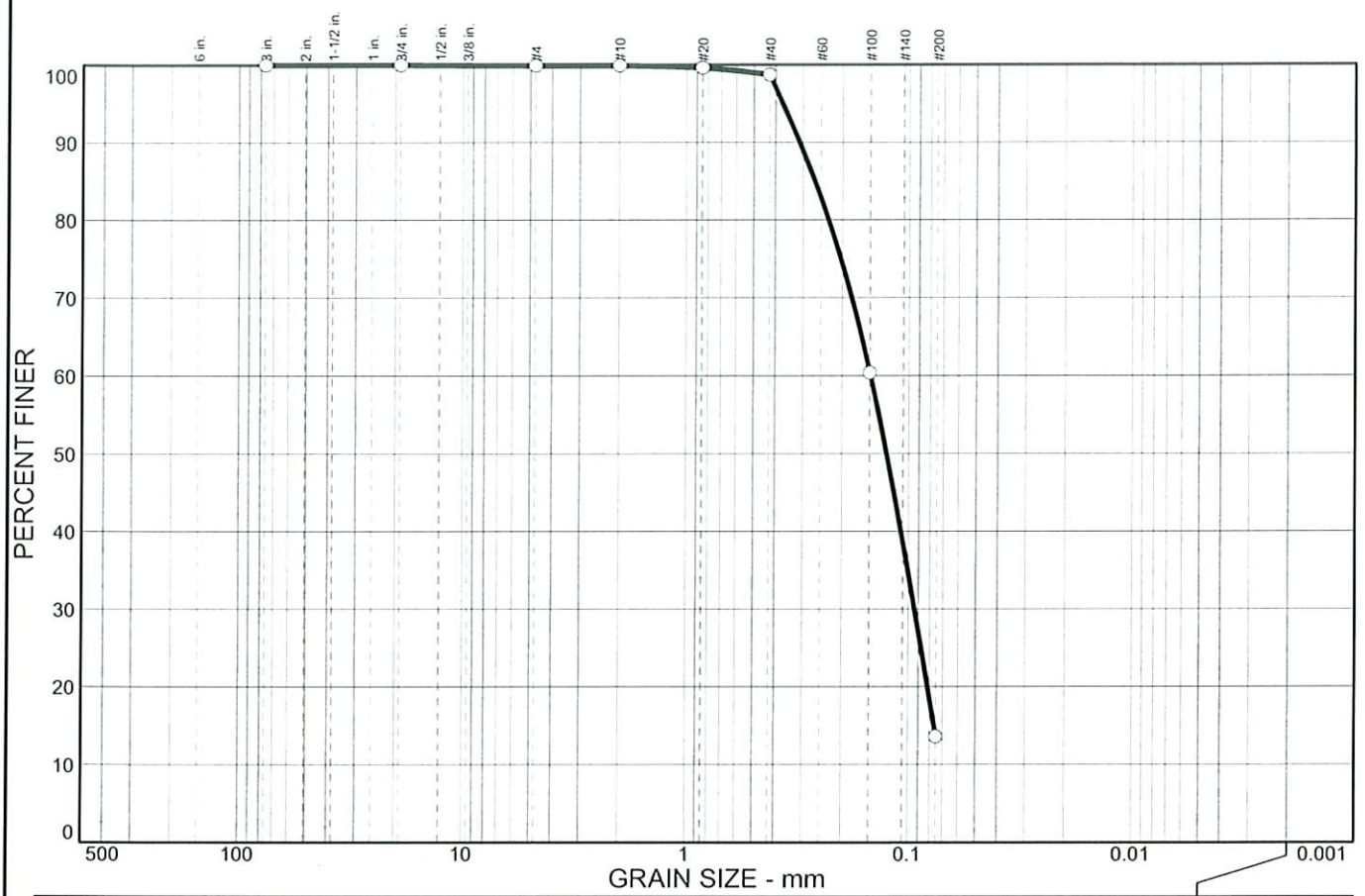
Remarks

As received moisture content = 21.8%

Sample No.: S-1B **Source of Sample:** **Date:** 5/1/07
Location: B-104 **Elev./Depth:** 0.8-2

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.0	1.2	85.1	13.6	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
3/4 in.	100.0		
#4	99.9		
#10	99.9		
#20	99.6		
#40	98.7		
#100	60.4		
#200	13.6		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D_{85}= 0.266 D_{60}= 0.149 D_{50}= 0.126
D_{30}= 0.0939 D_{15}= 0.0764 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= --

Remarks

As received moisture content = 24.0%

Sample No.: S-15 **Source of Sample:** **Date:** 5/1/07
Location: B-104 **Elev./Depth:** 63-65

CDM Jessberger **Geotechnical Engineering Laboratory**	**Client:** Dare County **Project:** C&D Cell No. 4 **Project No:** 17952-56960 **Plate**

geotechnics
INTEGRITY IN TESTING

MOISTURE CONTENT

ASTM D 2216 (SOP-S1)

Client	CDM
Client Reference	DARE COUNTY C&D CELL 4
Project No.	2007-591-01

Lab ID	.001	.002	.003	.004	.005
Boring No.	B-101	B-102	B-102	B-103	B-103
Depth (ft)	75-77	8-10	31-33	2-4	25-27
Sample No.	ST-2	ST-1	ST-2	ST-1	ST-2
Tare Number	G-13	211	G-5	212	213
Wt. of Tare & WS (gm)	604.59	667.84	599.35	671.3	636.4
Wt. of Tare & DS (gm)	488.16	590.69	481.35	572.78	508.62
Wt. of Tare (gm)	152.72	171.23	147.87	171.58	173.24
Wt. of Water (gm)	116.43	77.15	118	98.52	127.78
Wt. of DS (gm)	335.44	419.46	333.48	401.2	335.38
Water Content (%)	**34.7**	**18.4**	**35.4**	**24.6**	**38.1**

Lab ID	.007
Boring No.	B-104
Depth (ft)	27-29
Sample No.	ST-4
Tare Number	820
Wt. of Tare & WS (gm)	642.01
Wt. of Tare & DS (gm)	511.29
Wt. of Tare (gm)	208.22
Wt. of Water (gm)	130.72
Wt. of DS (gm)	303.07
Water Content (%)	**43.1**

Notes : *NA*

Tested By *RED* *Date* *5/15/2007* *Checked By* SEM *Date* 5-24-07

DCN: CT-S1 DATE 6-30-98 REVISION: 2

\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01 WATER CONTENT.XLS]Sheet1

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INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	B-101
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	75-77
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-01	Soil Description	**GRAY SILTY CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

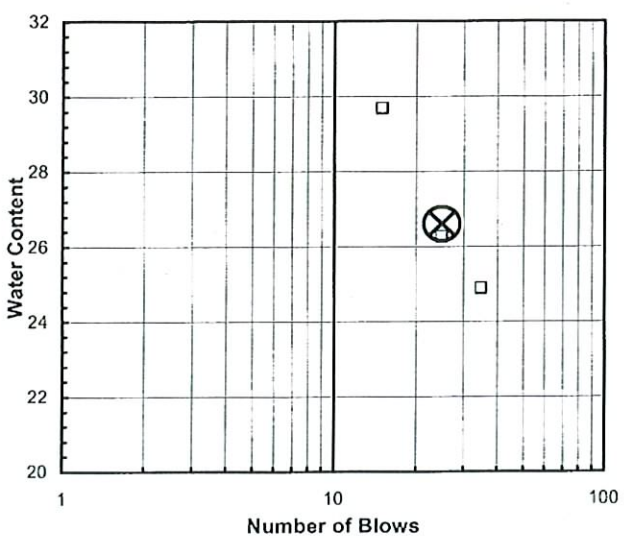
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-C	A-G	A-I	MULTIPOINT
Wt. of Tare & WS (gm)	32.71	32.94	33.85	
Wt. of Tare & DS (gm)	28.79	29.33	30.19	
Wt. of Tare (gm)	15.58	15.58	15.48	
Wt. of Water (gm)	3.9	3.6	3.7	
Wt. of DS (gm)	13.2	13.8	14.7	
Moisture Content (%)	**29.7**	**26.3**	**24.9**	
Number of Blows	**15**	**25**	**35**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-Q	B-B	
Wt. of Tare & WS (gm)	23.54	22.04	
Wt. of Tare & DS (gm)	22.21	20.98	
Wt. of Tare (gm)	15.54	15.56	
Wt. of Water (gm)	1.3	1.1	
Wt. of DS (gm)	6.7	5.4	
Moisture Content (%)	**19.9**	**19.6**	**0.4**

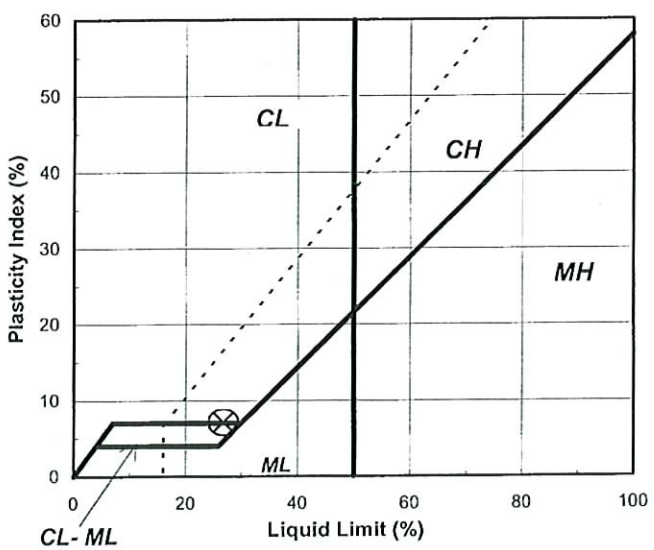
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**27**
Plastic Limit (%)	**20**
Plasticity Index (%)	**7**
USCS Symbol	**CL-ML**

Flow Curve



Plasticity Chart



Tested By JBD *Date* 5/16/2007 *Checked By* GEM *Date* 5-17-07

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INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	8-10
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-02	Soil Description	**GRAY LEAN CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

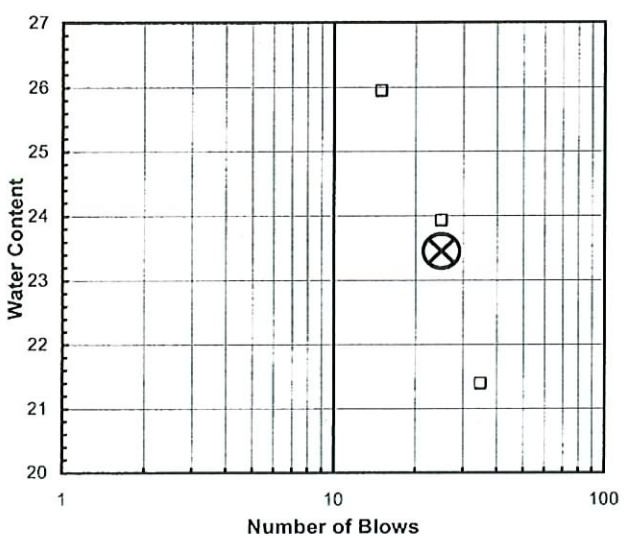
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	D	O	G	M U L T I P O I N T
Wt. of Tare & WS (gm)	32.12	35.41	34.99	
Wt. of Tare & DS (gm)	28.63	31.51	31.48	
Wt. of Tare (gm)	15.18	15.21	15.07	
Wt. of Water (gm)	3.5	3.9	3.5	
Wt. of DS (gm)	13.5	16.3	16.4	
Moisture Content (%)	**25.9**	**23.9**	**21.4**	
Number of Blows	**15**	**25**	**35**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	K	V	
Wt. of Tare & WS (gm)	21.54	21.10	
Wt. of Tare & DS (gm)	20.74	20.39	
Wt. of Tare (gm)	15.23	15.27	
Wt. of Water (gm)	0.8	0.7	
Wt. of DS (gm)	5.5	5.1	
Moisture Content (%)	**14.5**	**13.9**	**0.7**

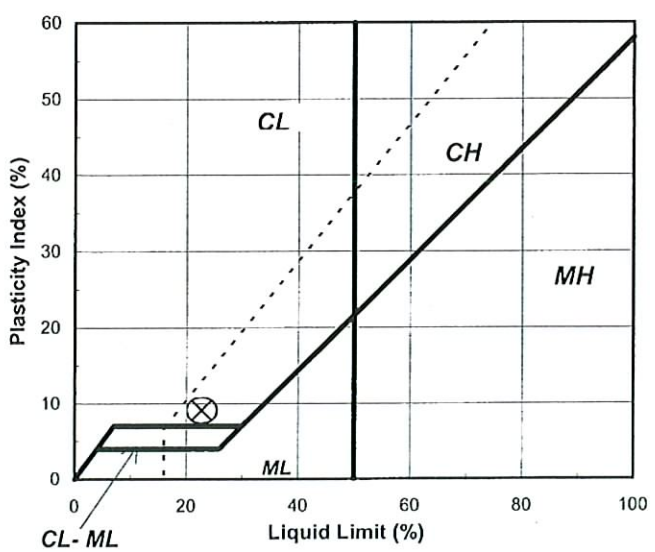
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**23**
Plastic Limit (%)	**14**
Plasticity Index (%)	**9**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



Tested By *JBD* *Date* *5/11/2007* *Checked By* GEM *Date* 5-14-07

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ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	31 - 33
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03	Soil Description	**GRAY LEAN CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

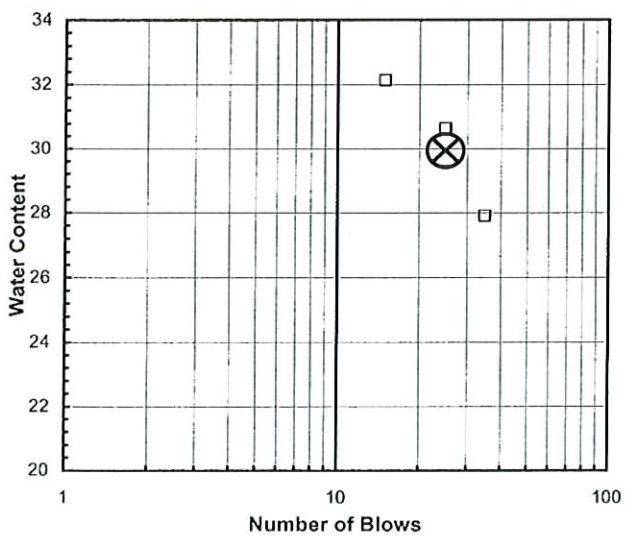
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	G	K	D	M U L T I P O I N T
Wt. of Tare & WS (gm)	35.30	34.52	36.83	
Wt. of Tare & DS (gm)	30.39	30.01	32.12	
Wt. of Tare (gm)	15.11	15.29	15.23	
Wt. of Water (gm)	4.9	4.5	4.7	
Wt. of DS (gm)	15.3	14.7	16.9	
Moisture Content (%)	**32.1**	**30.6**	**27.9**	
Number of Blows	**15**	**25**	**35**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	S	X	
Wt. of Tare & WS (gm)	21.13	21.35	
Wt. of Tare & DS (gm)	20.29	20.46	
Wt. of Tare (gm)	15.20	15.25	
Wt. of Water (gm)	0.8	0.9	
Wt. of DS (gm)	5.1	5.2	
Moisture Content (%)	**16.5**	**17.1**	**-0.6**

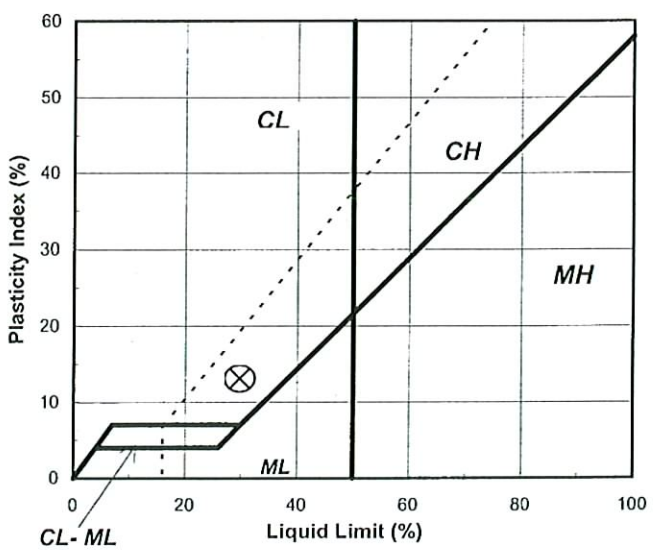
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**30**
Plastic Limit (%)	**17**
Plasticity Index (%)	**13**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



Tested By JBD *Date* 5/22/2007 *Checked By* GLM *Date* 5-23-07

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INTEGRITY IN TESTING

ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	2-4
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By *KMR* *Date* *5/24/2007* *Checked By* GEM *Date* 5-24-07

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

Z:\Data Sheets\[Limit-(NP).xls]Sheet1

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INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	25-27
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-05	Soil Description	GRAY LEAN CLAY

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description.

(Minus No. 40 sieve material, Airdried)

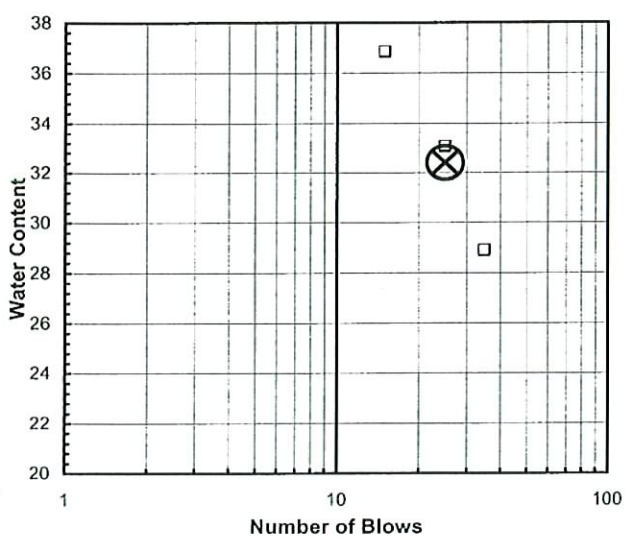
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	N	E	I	MULTIPOINT
Wt. of Tare & WS (gm)	34.29	31.52	29.83	
Wt. of Tare & DS (gm)	29.18	27.49	26.56	
Wt. of Tare (gm)	15.31	15.30	15.24	
Wt. of Water (gm)	5.1	4.0	3.3	
Wt. of DS (gm)	13.9	12.2	11.3	
Moisture Content (%)	**36.8**	**33.1**	**28.9**	
Number of Blows	**15**	**25**	**35**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A	P	
Wt. of Tare & WS (gm)	22.72	21.36	
Wt. of Tare & DS (gm)	21.70	20.52	
Wt. of Tare (gm)	15.28	15.22	
Wt. of Water (gm)	1.0	0.8	
Wt. of DS (gm)	6.4	5.3	
Moisture Content (%)	**15.9**	**15.8**	**0.0**

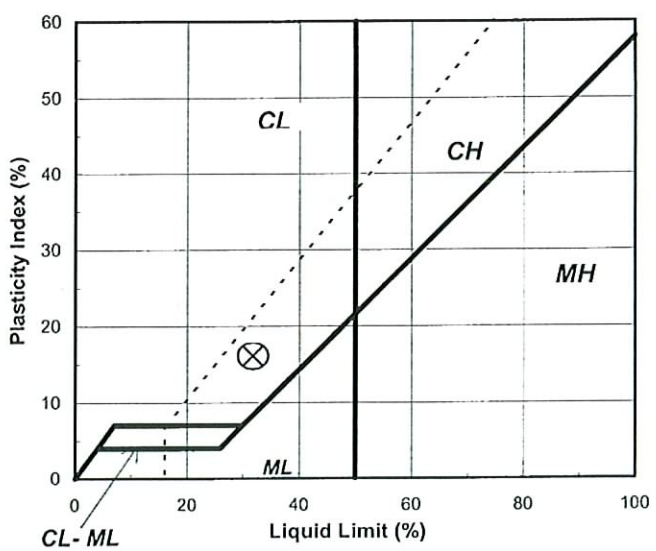
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**32**
Plastic Limit (%)	**16**
Plasticity Index (%)	**16**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



Tested By *JBD* *Date* *5/16/2007* *Checked By* GEM *Date* 5-17-07

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INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	27-29
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Soil Description	**GRAY SILTY CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

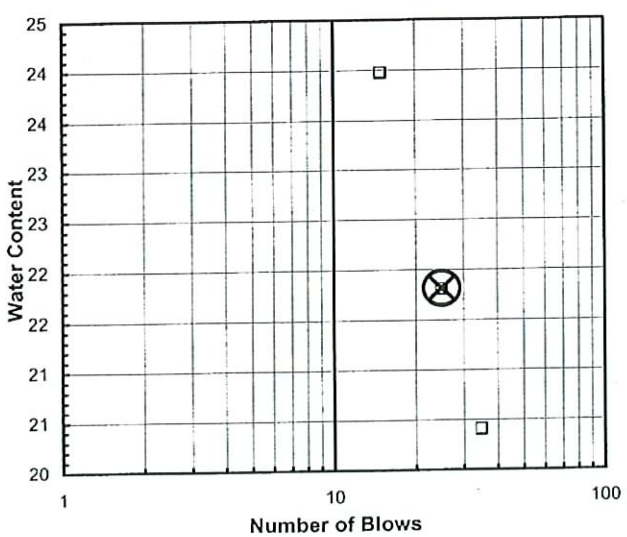
Liquid Limit Test	1	2	3	MULTIPOINT
Tare Number	A-N	Z-Y	A-F	
Wt. of Tare & WS (gm)	37.48	33.02	35.21	
Wt. of Tare & DS (gm)	33.22	29.95	31.87	
Wt. of Tare (gm)	15.45	15.87	15.50	
Wt. of Water (gm)	4.3	3.1	3.3	
Wt. of DS (gm)	17.8	14.1	16.4	
Moisture Content (%)	**24.0**	**21.8**	**20.4**	
Number of Blows	**15**	**25**	**35**	

Plastic Limit Test	1	2	Range
Tare Number	K-A	A-K	
Wt. of Tare & WS (gm)	25.16	24.99	
Wt. of Tare & DS (gm)	23.80	23.69	
Wt. of Tare (gm)	15.50	15.58	
Wt. of Water (gm)	1.4	1.3	
Wt. of DS (gm)	8.3	8.1	
Moisture Content (%)	**16.4**	**16.0**	**0.4**

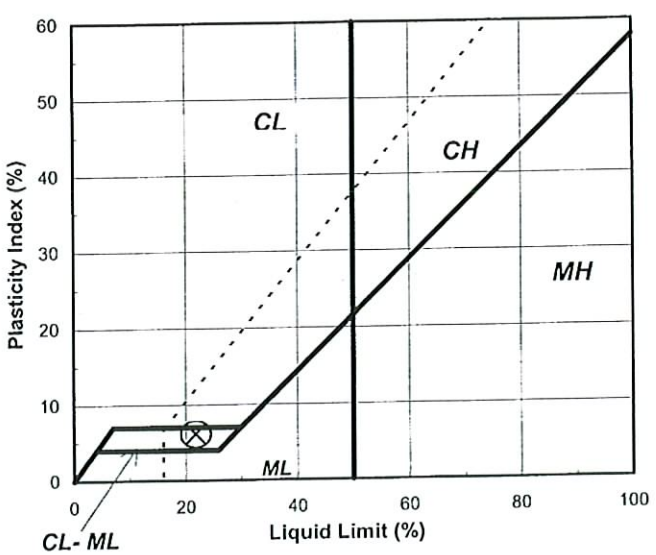
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**22**
Plastic Limit (%)	**16**
Plasticity Index (%)	**6**
USCS Symbol	**CL-ML**

Flow Curve



Plasticity Chart



Tested By *JBD* *Date* *5/16/2007* *Checked By* GRM *Date* 5/17/07

page 1 of 1 **DCN:** CT-S4B **DATE:** 10/8/2001 **REVISION:** 2

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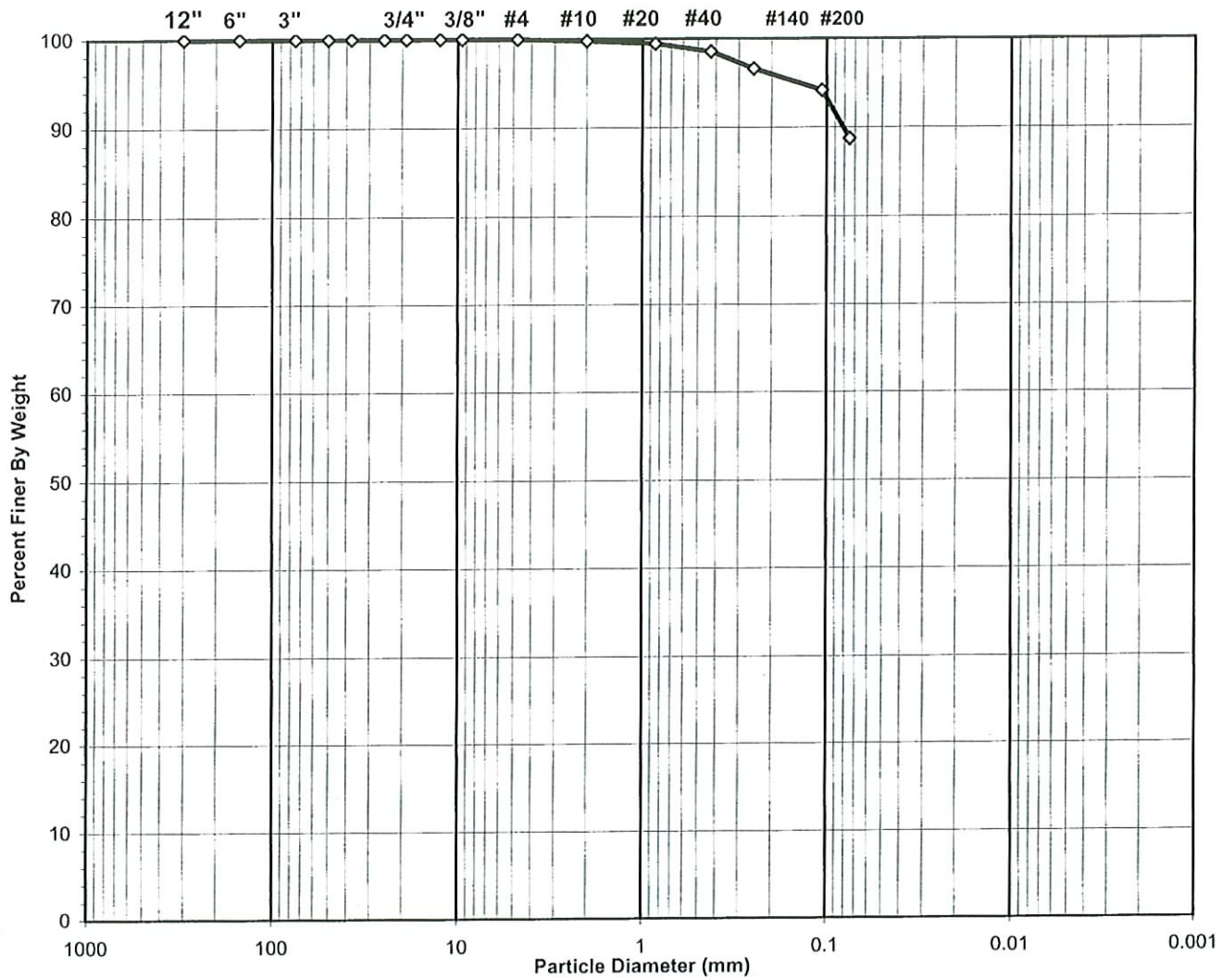
INTEGRITY IN TESTING

SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-101
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	75-77
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-01	Soil Color	GRAY

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***CL-ML, TESTED***

USCS Classification ***SILTY CLAY***

Tested By RED Date 5/14/2007 Checked By GEM Date 5-17-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-01 SIEVE.XLS]Sheet1*

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INTEGRITY IN TESTING

WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-101
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	75-77
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-01	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	G-13	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	604.59	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	488.16	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	152.72	Weight of Tare (gm)	NA
Weight of Water (gm)	116.43	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	335.44	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**34.7**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	335.44
Dry Weight - 3/4" Sample (gm)	37.8	Weight of minus #200 material (gm)	297.61
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	37.83
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated Percent Finer (%)
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.09	0.0	0.0	100.0	**100.0**
#10	2.00	0.66	0.2	0.2	99.8	**99.8**
#20	0.850	1.12	0.3	0.6	99.4	**99.4**
#40	0.425	3.08	0.9	1.5	98.5	**98.5**
#60	0.250	6.54	1.9	3.4	96.6	**96.6**
#140	0.106	8.26	2.5	5.9	94.1	**94.1**
#200	0.075	18.08	5.4	11.3	88.7	**88.7**
Pan	-	297.61	88.7	100.0	-	-

Tested By RED Date 5/14/2007 Checked By GEM Date 5-17-07

DCN: CT-S3C DATE 6-25-98 REVISION: 2

\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-01 SIEVE.XLS]Sheet1

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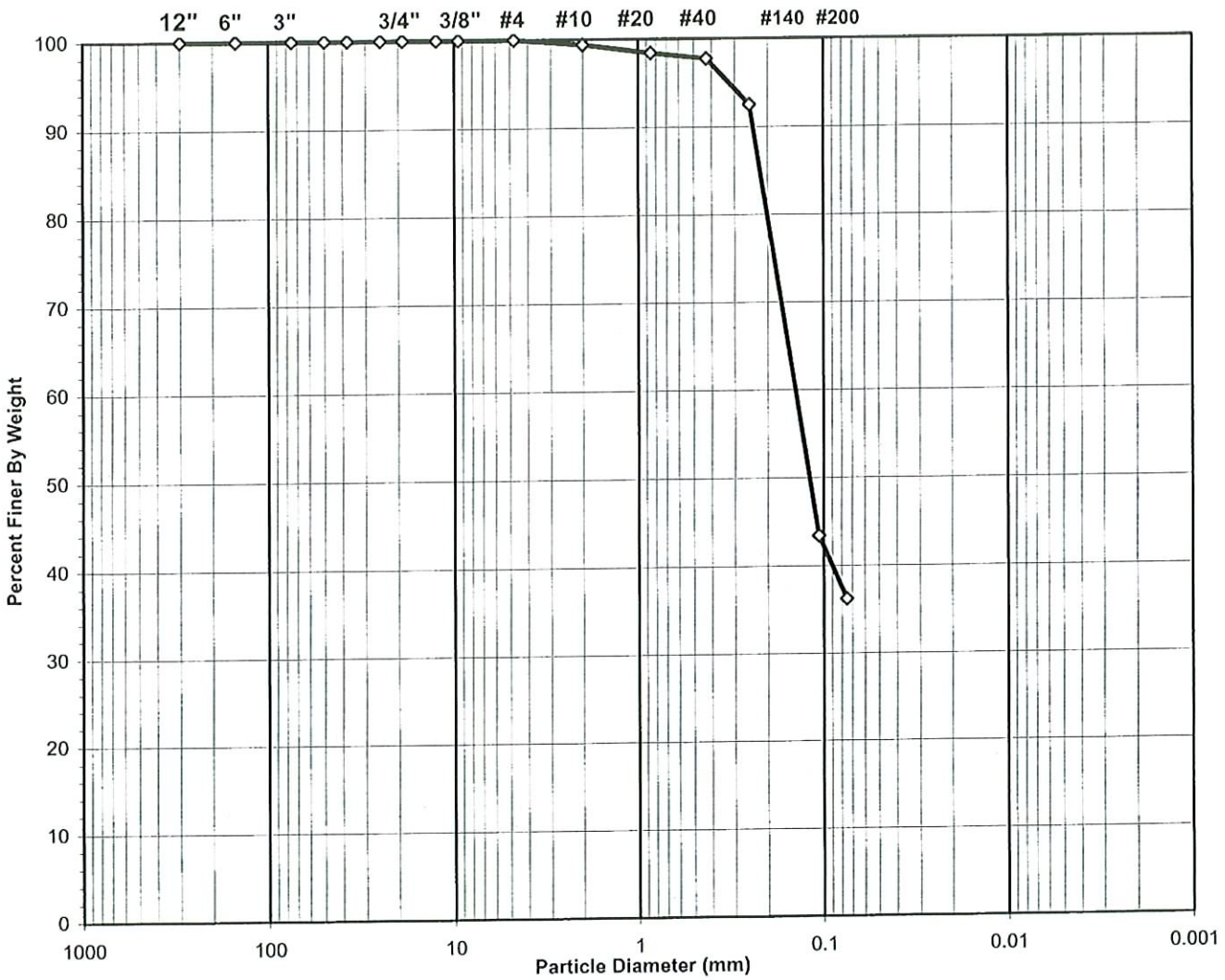
INTEGRITY IN TESTING

SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-102
Client Reference	DARE CO. C&D CELL NO. 4	Depth (ft)	8-10
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-02	Soil Color	GRAY

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***SC, TESTED***

USCS Classification ***CLAYEY SAND***

Tested By SGH Date 5/15/2007 Checked By GEM Date 5-17-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-02 SIEVE.XLS]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-102
Client Reference	DARE CO. C&D CELL NO. 4	Depth (ft)	8-10
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-02	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	211	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	667.84	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	590.69	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	171.23	Weight of Tare (gm)	NA
Weight of Water (gm)	77.15	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	419.46	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**18.4**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	419.46
Dry Weight - 3/4" Sample (gm)	267.7	Weight of minus #200 material (gm)	151.81
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	267.65
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated **Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.00	0.0	0.0	100.0	**100.0**
#10	2.00	2.49	0.6	0.6	99.4	**99.4**
#20	0.850	4.11	1.0	1.6	98.4	**98.4**
#40	0.425	2.84	0.7	2.3	97.7	**97.7**
#60	0.250	22.01	5.2	7.5	92.5	**92.5**
#140	0.106	205.84	49.1	56.6	43.4	**43.4**
#200	0.075	30.36	7.2	63.8	36.2	**36.2**
Pan	-	151.81	36.2	100.0	-	-

Tested By SGH Date 5/15/2007 Checked By GEM Date 5-17-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-02 SIEVE.XLS]Sheet1*

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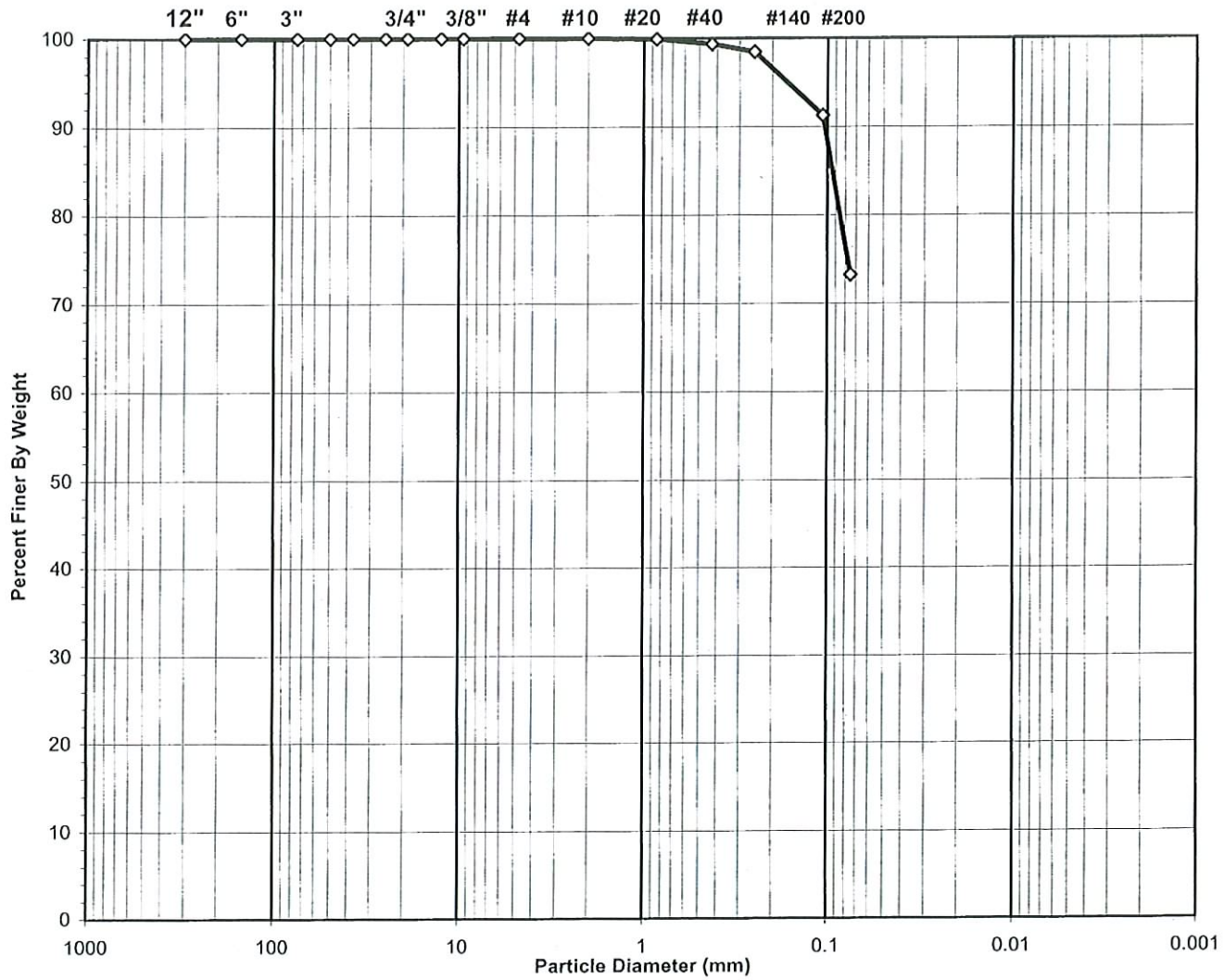
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-102
Client Reference	DARE CO. C&D CELL NO. 4	Depth (ft)	31-33
Project No.	2007-589-01	Sample No.	ST-2
Lab ID	2007-589-01-03	Soil Color	GRAY

	SIEVE ANALYSIS		HYDROMETER
USCS	gravel	sand	silt and clay



USCS Symbol ***CL, TESTED***

USCS Classification ***LEAN CLAY WITH SAND***

Tested By RED Date 5/15/2007 Checked By GEM Date 5-23-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-03 SIEVE.XLS]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-102
Client Reference	DARE CO. C&D CELL NO. 4	Depth (ft)	31-33
Project No.	2007-589-01	Sample No.	ST-2
Lab ID	2007-589-01-03	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	G-5	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	599.35	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	481.35	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	147.87	Weight of Tare (gm)	NA
Weight of Water (gm)	118.00	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	333.48	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**35.4**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	333.48
Dry Weight - 3/4" Sample (gm)	89.2	Weight of minus #200 material (gm)	244.28
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	89.20
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.00	0.0	0.0	100.0	**100.0**
#10	2.00	0.03	0.0	0.0	100.0	**100.0**
#20	0.850	0.26	0.1	0.1	99.9	**99.9**
#40	0.425	1.99	0.6	0.7	99.3	**99.3**
#60	0.250	2.90	0.9	1.6	98.4	**98.4**
#140	0.106	24.02	7.2	8.8	91.2	**91.2**
#200	0.075	60.00	18.0	26.7	73.3	**73.3**
Pan	-	244.28	73.3	100.0	-	-

Tested By RED Date 5/15/2007 Checked By CEM Date 5-23-07

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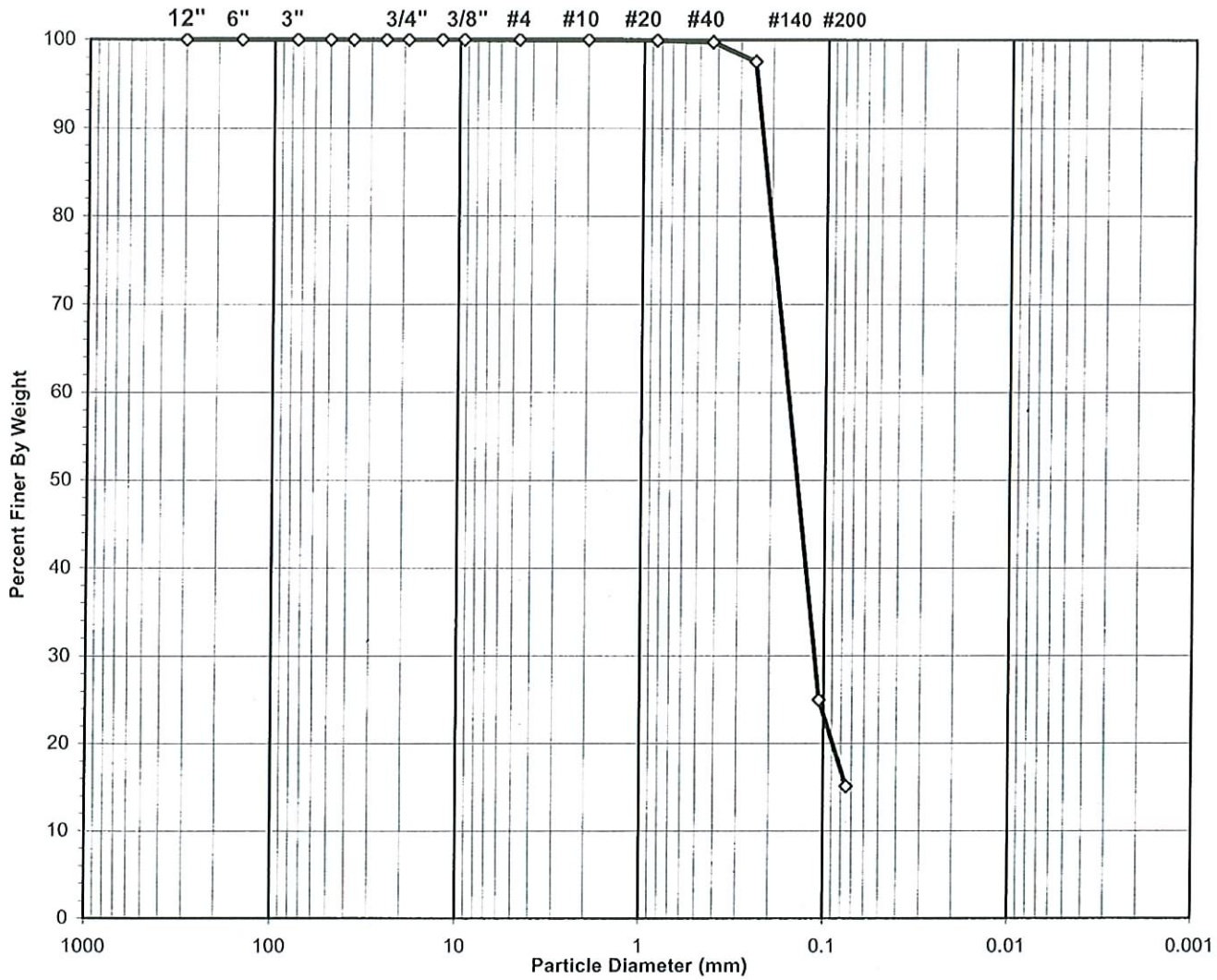
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	2-4
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04	Soil Color	GRAY

USCS	SIEVE ANALYSIS		HYDROMETER
	gravel	sand	silt and clay



USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

Tested By SGH Date 5/24/2007 Checked By GEM Date 5-24-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-04 SIEVE.XLS]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	2-4
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	212	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	671.30	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	572.78	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	171.58	Weight of Tare (gm)	NA
Weight of Water (gm)	98.52	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	401.20	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**24.6**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	401.20
Dry Weight - 3/4" Sample (gm)	340.6	Weight of minus #200 material (gm)	60.56
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	340.64
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated **Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	0.00	0.0	0.0	100.0	**100.0**
#10	2.00	0.00	0.0	0.0	100.0	**100.0**
#20	0.850	0.28	0.1	0.1	99.9	**99.9**
#40	0.425	0.85	0.2	0.3	99.7	**99.7**
#60	0.250	8.70	2.2	2.5	97.5	**97.5**
#140	0.106	291.08	72.6	75.0	25.0	**25.0**
#200	0.075	39.73	9.9	84.9	15.1	**15.1**
Pan	-	60.56	15.1	100.0	-	-

Tested By SGH Date 5/24/2007 Checked By GBM Date 5-24-07

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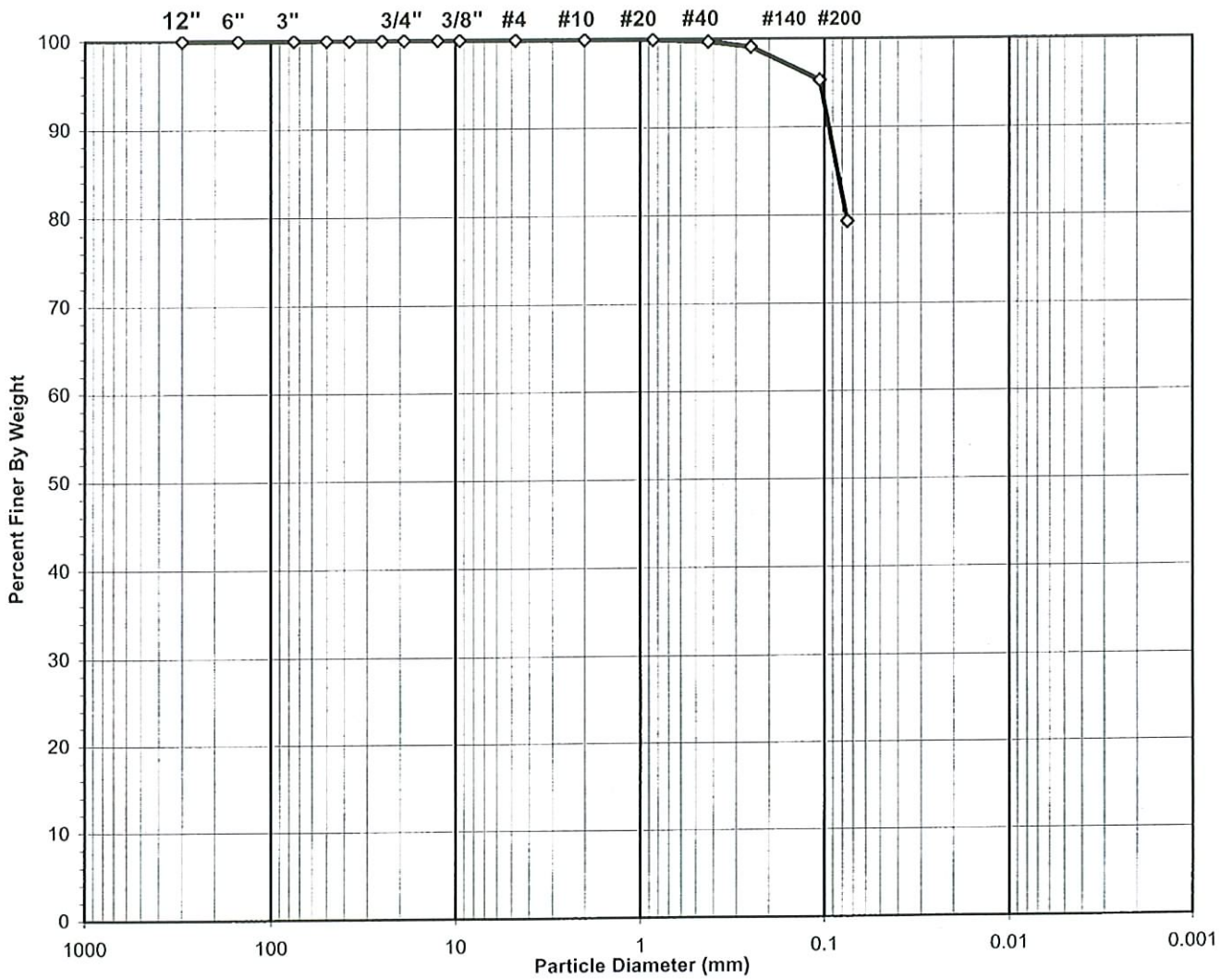
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	25-27
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-05	Soil Color	GRAY

	SIEVE ANALYSIS		HYDROMETER
USCS	gravel	sand	silt and clay



USCS Symbol ***CL, TESTED***

USCS Classification ***LEAN CLAY WITH SAND***

Tested By RED Date 5/14/2007 Checked By GEM Date 5-17-01

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-05 SIEVE.XLS]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	25-27
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-05	Soil Color	GRAY

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	213	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	636.40	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	508.62	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	173.24	Weight of Tare (gm)	NA
Weight of Water (gm)	127.78	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	335.38	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**38.1**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	335.38
Dry Weight - 3/4" Sample (gm)	69.4	Weight of minus #200 material (gm)	265.99
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	69.39
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated Percent Finer (%)
12"	300	0.00	0.0	0.0	100.0	100.0
6"	150	0.00	0.0	0.0	100.0	100.0
3"	75	0.00	0.0	0.0	100.0	100.0
2"	50	0.00	0.0	0.0	100.0	100.0
1 1/2"	37.5	0.00	0.0	0.0	100.0	100.0
1"	25.0	0.00	0.0	0.0	100.0	100.0
3/4"	19.0	0.00	0.0	0.0	100.0	100.0
1/2"	12.50	0.00	0.0	0.0	100.0	100.0
3/8"	9.50	0.00	0.0	0.0	100.0	100.0
#4	4.75	0.07	0.0	0.0	100.0	100.0
#10	2.00	0.01	0.0	0.0	100.0	100.0
#20	0.850	0.13	0.0	0.1	99.9	99.9
#40	0.425	0.83	0.2	0.3	99.7	99.7
#60	0.250	2.06	0.6	0.9	99.1	99.1
#140	0.106	12.68	3.8	4.7	95.3	95.3
#200	0.075	53.61	16.0	20.7	79.3	79.3
Pan	-	265.99	79.3	100.0	-	-

Tested By RED Date 5/14/2007 Checked By GBM Date 5-17-07

DCN: CT-S3C DATE 6-25-98 REVISION: 2

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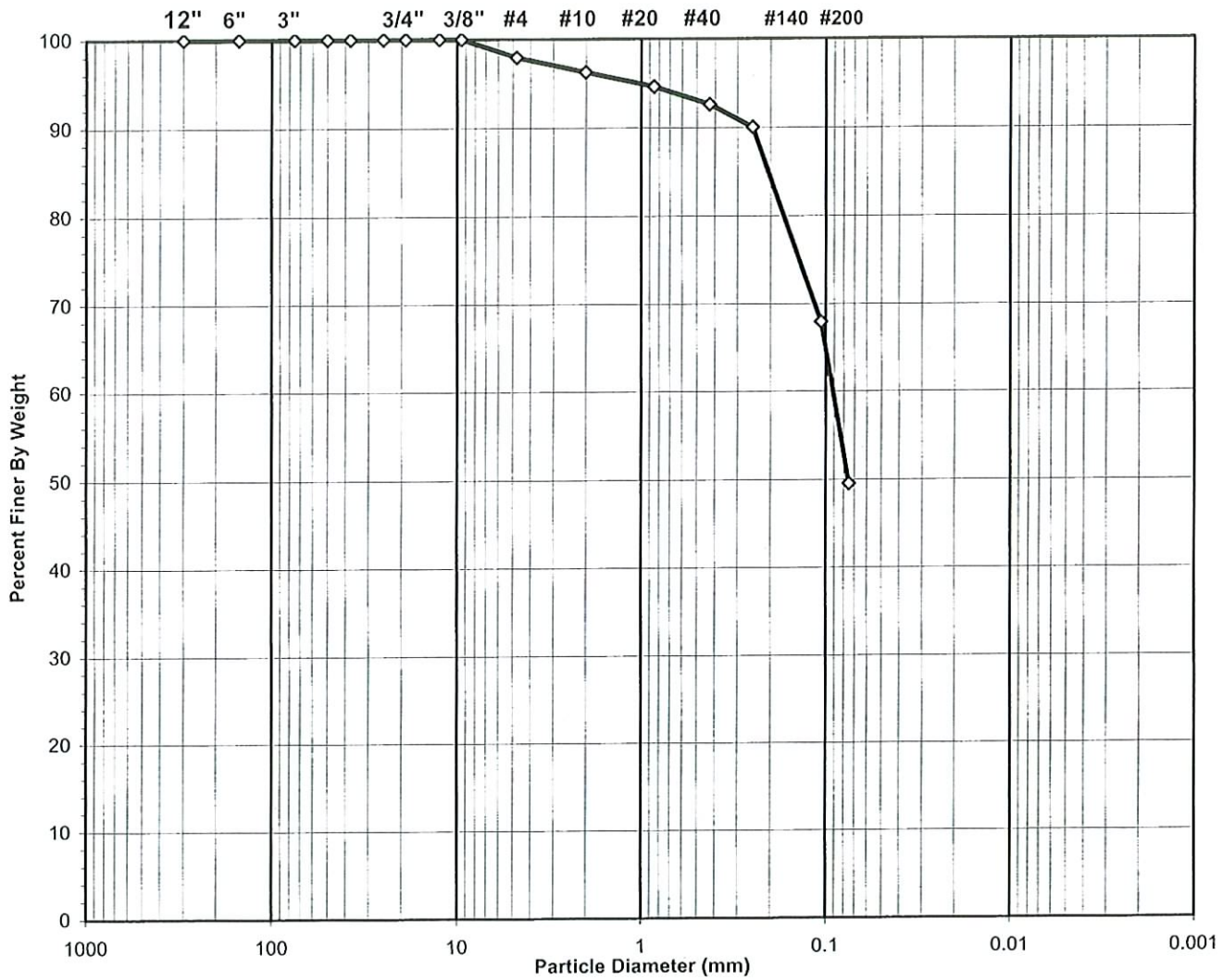
SIEVE ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	27-29
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Soil Color	GRAY

	SIEVE ANALYSIS		HYDROMETER
USCS	gravel	sand	silt and clay



USCS Symbol ***SC-SM, TESTED***

USCS Classification ***SILTY, CLAYEY SAND***

Tested By SGH Date 5/16/2007 Checked By GEM Date 5-17-07

 DCN: CT-S3C DATE 6-25-98 REVISION: 2 *\\Lab1\c\2007 PROJECTS\2007-591 CDM\[2007-591-01-07 SIEVE.XLS]Sheet1*

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WASH SIEVE ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	27-29
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Soil Color	**GRAY**

Moisture Content of Passing 3/4" Material		Water Content of Retained 3/4" Material	
Tare No.	820	Tare No.	NA
Wgt.Tare + Wet Specimen (gm)	642.01	Wgt.Tare + Wet Specimen (gm)	NA
Wgt.Tare + Dry Specimen (gm)	511.29	Wgt.Tare + Dry Specimen (gm)	NA
Weight of Tare (gm)	208.22	Weight of Tare (gm)	NA
Weight of Water (gm)	130.72	Weight of Water (gm)	NA
Weight of Dry Soil (gm)	303.07	Weight of Dry Soil (gm)	NA
Moisture Content (%)	**43.1**	**Moisture Content (%)**	**NA**

Wet Weight -3/4" Sample (gm)	NA	Weight of the Dry Specimen (gm)	303.07
Dry Weight - 3/4" Sample (gm)	153.0	Weight of minus #200 material (gm)	150.09
Wet Weight +3/4" Sample (gm)	NA	Weight of plus #200 material (gm)	152.98
Dry Weight + 3/4" Sample (gm)	0.00		
Total Dry Weight Sample (gm)	NA		

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	Accumulated **Percent Finer (%)**
12"	300	0.00	0.0	0.0	100.0	**100.0**
6"	150	0.00	0.0	0.0	100.0	**100.0**
3"	75	0.00	0.0	0.0	100.0	**100.0**
2"	50	0.00	0.0	0.0	100.0	**100.0**
1 1/2"	37.5	0.00	0.0	0.0	100.0	**100.0**
1"	25.0	0.00	0.0	0.0	100.0	**100.0**
3/4"	19.0	0.00	0.0	0.0	100.0	**100.0**
1/2"	12.50	0.00	0.0	0.0	100.0	**100.0**
3/8"	9.50	0.00	0.0	0.0	100.0	**100.0**
#4	4.75	6.20	2.0	2.0	98.0	**98.0**
#10	2.00	5.07	1.7	3.7	96.3	**96.3**
#20	0.850	5.08	1.7	5.4	94.6	**94.6**
#40	0.425	6.05	2.0	7.4	92.6	**92.6**
#60	0.250	7.90	2.6	10.0	90.0	**90.0**
#140	0.106	66.88	22.1	32.1	67.9	**67.9**
#200	0.075	55.80	18.4	50.5	49.5	**49.5**
Pan	-	150.09	49.5	100.0	-	-

Tested By SGH Date 5/16/2007 Checked By GEM Date 5-17-07

DCN: CT-S3C DATE 6-25-98 REVISION: 2

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D - 4767 (SOP-S28)

Client	CDM		
Client Reference	DARE COUNTY C & D CELL 4		
Project No.	2007-591-01		
Lab ID	2007-591-01-04	Specific Gravity (assumed)	2.70

Visual Description: GRAY SILTY SAND (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.	B-103	B-103
Depth (ft)	2.9-3.4	3.4-3.9
Sample No.	ST-1	ST-1
Test No.	T1	T2
Deformation Rate (in/min)	0.002	0.002
Back Pressure (psi)	50.7	51.3
Consolidation Time (days)	1	1
Initial State (w%)	25.6	27.3
Total Unit Weight (pcf)	127.3	123.4
Dry Unit Weight (pcf)	101.4	96.9
Final State (w%)	22.3	24.9
Initial State Void Ratio,e	0.663	0.740

Tested By TMS Date 5/20/07 Input Checked By MFI Date 5-23-07

DCN: CT-S28 DATE 6-25-98 REVISION: 1 Z:\2007 PROJECTS\2007-591 CDM\[2007-591-01-04 TRIAX SUMMARY.XLS]Sheet1

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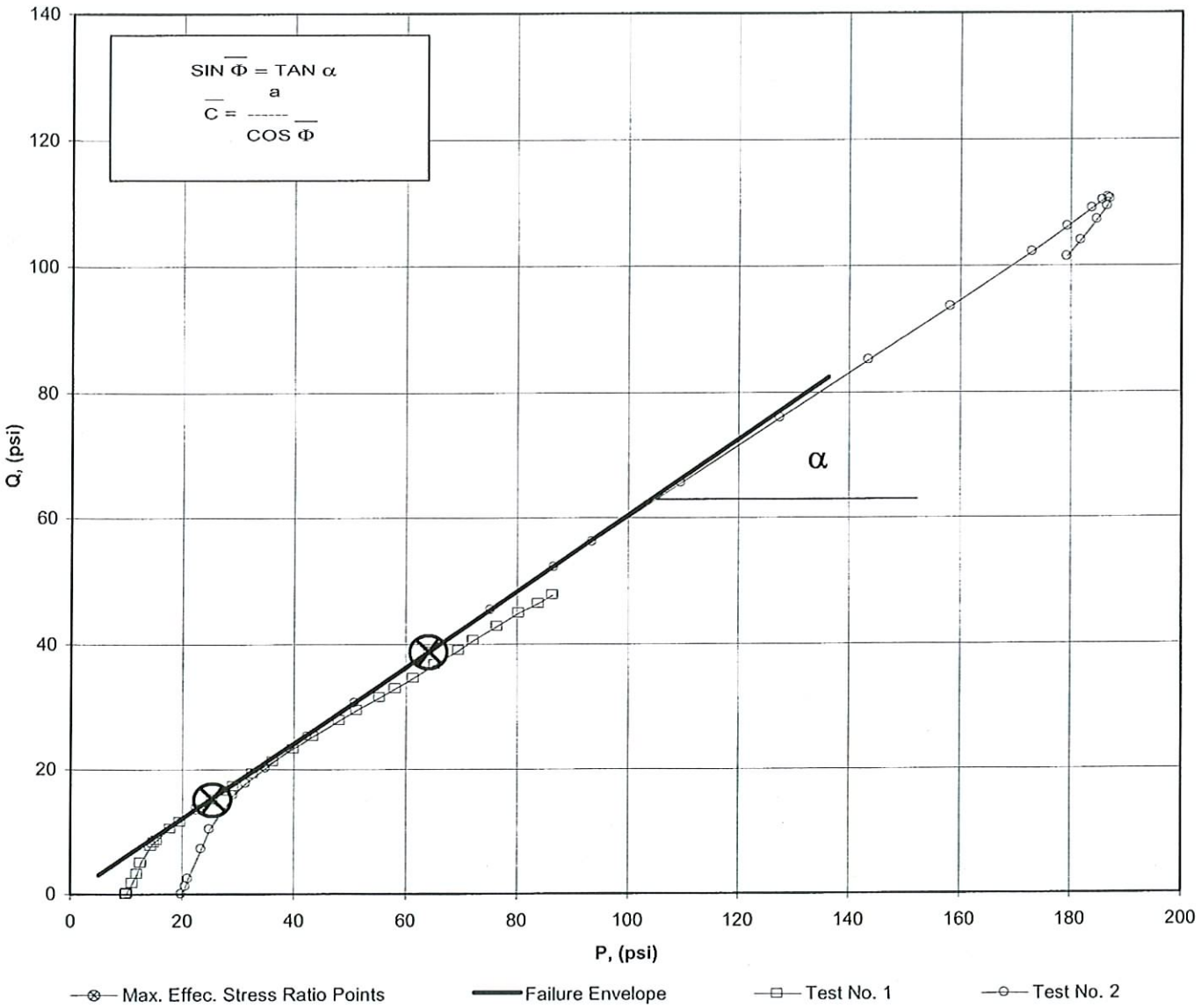
CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	2.9-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	0.00	$\overline{C}$	=	0.00
α	=	31.2	$\overline{\Phi}$	=	37.20

Tested By TMS Date 5/20/07 Approved By TM Date 5-24-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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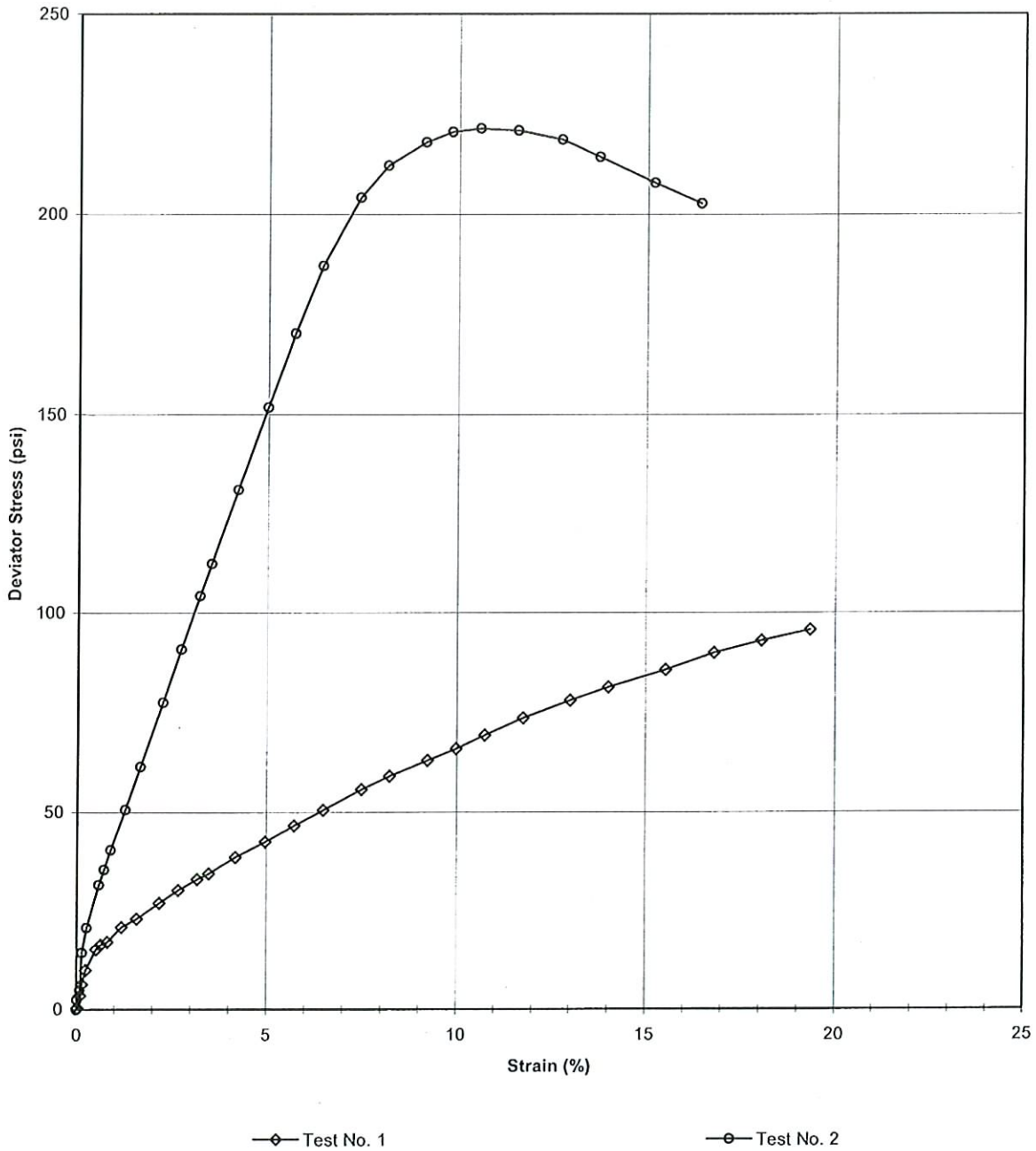
geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	2.9-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		
Visual Description:	GRAY SILTY SAND (UNDISTURBED)		



Tested By TMS Date 5/20/07 Approved By JM Date 5-24-07

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

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Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	2.9-3.4
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Stage No.	1
Test No	1

PRESSURES (psi)

Cell Pressure(psi)	60.7
Back Pressure(psi)	50.7
Eff. Cons. Pressure(psi)	10.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	25.43
Q	=	15.10

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.966	Diameter 1	2.848
Length 2	5.955	Diameter 2	2.863
Length 3	5.932	Diameter 3	2.810
Avg Leng.=	5.951	Avg. Diam.=	2.840

VOLUME CHANGE

Initial Burette Reading (ml)	23.0
Final Burette Reading (ml)	16.7
Final Change (ml)	6.3

Initial Dial Reading (D.R.), mils	130
D.R. After Saturation, mils	140
D.R. After Consolidation, mils	145

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
11.3	0.000	50.7
13.3	0.001	50.7
33.3	0.005	51.3
51.0	0.008	52.0
73.3	0.014	53.0
106.7	0.030	53.9
113.9	0.037	53.9
118.6	0.047	53.8
142.9	0.070	53.2
156.9	0.094	52.5
183.7	0.129	51.4
205.4	0.159	50.4
224.4	0.188	49.4
234.6	0.207	48.8
262.9	0.248	47.3
290.7	0.295	45.7
320.3	0.340	44.1
349.1	0.385	42.6
388.3	0.444	40.5
413.8	0.489	39.0
445.5	0.548	36.9
469.5	0.593	35.5
496.6	0.638	33.9
532.6	0.698	32.3
571.7	0.772	30.2
602.2	0.832	29.2
645.3	0.922	27.1
686.8	0.998	25.3
720.5	1.072	23.3
752.7	1.148	22.1

Tested By TMS Date 5/20/07 Input Checked By MMS Date 5-24-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

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INTEGRITY IN TESTING

Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	2.9-3.4
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	10.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.95
Initial Sample Diameter (in.)	2.84
Initial Sample Area (in^2)	6.34
Initial Sample Volume (in^3)	37.71

VOLUME CHANGE

Volume After Consolidation (in^3)	37.13
Length After Consolidation (in)	5.94
Area After Consolidation (in^2)	6.255

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.33	0.01	10.32	10.0	1.033	0.04	10.15	0.17
0.09	3.51	0.65	12.86	9.4	1.376	0.19	11.11	1.76
0.14	6.35	1.28	15.07	8.7	1.728	0.21	11.89	3.18
0.24	9.90	2.35	17.55	7.7	2.293	0.24	12.60	4.95
0.50	15.18	3.20	21.98	6.8	3.231	0.22	14.39	7.59
0.63	16.31	3.21	23.10	6.8	3.401	0.20	14.95	8.15
0.80	17.03	3.07	23.96	6.9	3.456	0.19	15.45	8.51
1.18	20.80	2.51	28.30	7.5	3.776	0.12	17.90	10.40
1.58	22.92	1.82	31.10	8.2	3.800	0.08	19.64	11.46
2.17	26.96	0.68	36.29	9.3	3.891	0.03	22.81	13.48
2.67	30.20	-0.33	40.53	10.3	3.924	-0.01	25.43	15.10
3.17	32.99	-1.32	44.31	11.3	3.914	-0.04	27.81	16.49
3.48	34.46	-1.95	46.40	11.9	3.884	-0.06	29.18	17.23
4.18	38.55	-3.37	51.92	13.4	3.883	-0.09	32.64	19.27
4.97	42.45	-5.04	57.49	15.0	3.823	-0.12	36.26	21.22
5.72	46.57	-6.59	63.17	16.6	3.807	-0.15	39.88	23.29
6.48	50.51	-8.11	68.63	18.1	3.789	-0.17	43.37	25.26
7.49	55.77	-10.23	75.99	20.2	3.757	-0.19	48.11	27.88
8.23	59.06	-11.70	80.76	21.7	3.722	-0.20	51.23	29.53
9.23	63.01	-13.85	86.86	23.8	3.643	-0.23	55.35	31.51
9.98	65.95	-15.20	91.14	25.2	3.618	-0.24	58.17	32.97
10.74	69.25	-16.81	96.06	26.8	3.583	-0.25	61.43	34.62
11.76	73.54	-18.45	101.98	28.4	3.585	-0.26	65.22	36.77
13.00	77.95	-20.54	108.49	30.5	3.553	-0.27	69.51	38.97
14.02	81.23	-21.55	112.78	31.5	3.575	-0.27	72.16	40.61
15.53	85.62	-23.61	119.23	33.6	3.547	-0.28	76.42	42.81
16.80	89.85	-25.38	125.23	35.4	3.540	-0.29	80.30	44.93
18.05	92.91	-27.41	130.33	37.4	3.483	-0.30	83.87	46.46
19.34	95.60	-28.63	134.24	38.6	3.475	-0.31	86.44	47.80

Tested By TMS Date 5/20/07 Input Checked By MMS Date 5-24-07

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	3.4-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Stage No.	1
Test No	2

PRESSURES (psi)

Cell Pressure(psi)	71.2
Back Pressure(psi)	51.3
Eff. Cons. Pressure(ps	19.9
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	64.08
Q	=	38.74

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.931	Diameter 1	2.825
Length 2	5.925	Diameter 2	2.867
Length 3	5.945	Diameter 3	2.837
Avg Leng.=	5.934	Avg. Diam.=	2.843

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	17.7
Final Change (ml)	6.3

Initial Dial Reading (D.R.), mils	124
D.R. After Saturation, mils	138
D.R. After Consolidation, mils	148

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
12.6	0.000	51.3
27.8	0.001	51.8
42.6	0.005	52.5
102.3	0.008	54.9
142.2	0.015	56.6
211.5	0.034	57.8
236.0	0.042	57.5
267.9	0.052	56.4
334.0	0.075	54.1
403.6	0.098	51.0
509.1	0.133	45.9
597.4	0.161	41.3
687.5	0.190	36.7
742.2	0.208	33.8
869.4	0.249	27.1
1013.4	0.295	19.5
1142.7	0.337	12.7
1264.3	0.379	6.4
1393.7	0.437	0.3
1459.1	0.480	-2.1
1515.2	0.539	-3.6
1544.3	0.580	-4.3
1563.4	0.624	-4.8
1577.4	0.683	-5.4
1581.8	0.752	-6.0
1568.5	0.811	-6.4
1547.2	0.897	-6.6
1531.3	0.970	-6.7

Tested By TMS Date 5/20/07 Input Checked By MPS Date 5-24-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-103
Client Reference	DARE CO. C&D CELL 4	Depth(ft.)	3.4-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	19.9	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.93
Initial Sample Diameter (in.)	2.84
Initial Sample Area (in^2)	6.35
Initial Sample Volume (in^3)	37.67

VOLUME CHANGE

Volume After Consolidation (in^3)	37.02
Length After Consolidation (in)	5.91
Area After Consolidation (in^2)	6.264

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	2.44	0.50	21.84	19.4	1.126	0.21	20.62	1.22
0.08	4.79	1.22	23.47	18.7	1.256	0.26	21.08	2.39
0.14	14.31	3.56	30.65	16.3	1.875	0.26	23.50	7.15
0.25	20.65	5.27	35.29	14.6	2.411	0.26	24.96	10.33
0.58	31.59	6.51	44.98	13.4	3.359	0.21	29.19	15.79
0.71	35.41	6.18	49.14	13.7	3.581	0.18	31.43	17.71
0.88	40.40	5.13	55.17	14.8	3.736	0.13	34.97	20.20
1.27	50.67	2.82	67.76	17.1	3.966	0.06	42.42	25.34
1.66	61.40	-0.35	81.64	20.2	4.032	-0.01	50.95	30.70
2.25	77.48	-5.44	102.82	25.3	4.057	-0.07	64.08	38.74
2.72	90.82	-9.96	120.68	29.9	4.042	-0.11	75.27	45.41
3.22	104.29	-14.62	138.81	34.5	4.021	-0.14	86.67	52.14
3.52	112.39	-17.46	149.75	37.4	4.008	-0.16	93.56	56.20
4.21	131.02	-24.19	175.11	44.1	3.972	-0.19	109.60	65.51
4.99	151.80	-31.79	203.49	51.7	3.937	-0.22	127.59	75.90
5.70	170.13	-38.62	228.65	58.5	3.907	-0.23	143.59	85.07
6.41	187.02	-44.88	251.81	64.8	3.887	-0.25	158.30	93.51
7.39	204.20	-50.96	275.06	70.9	3.882	-0.26	172.96	102.10
8.12	212.18	-53.37	285.44	73.3	3.896	-0.26	179.35	106.09
9.12	218.02	-54.90	292.83	74.8	3.915	-0.26	183.81	109.01
9.81	220.55	-55.56	296.01	75.5	3.923	-0.26	185.74	110.27
10.56	221.45	-56.06	297.41	76.0	3.915	-0.26	186.69	110.73
11.56	220.95	-56.67	297.52	76.6	3.885	-0.26	187.05	110.47
12.72	218.65	-57.31	295.86	77.2	3.832	-0.27	186.54	109.33
13.72	214.32	-57.68	291.91	77.6	3.762	-0.28	184.75	107.16
15.18	207.82	-57.93	285.66	77.8	3.670	-0.29	181.74	103.91
16.41	202.67	-58.03	280.59	77.9	3.601	-0.30	179.26	101.33

Tested By TMS Date 5/20/07 Input Checked By 5-24-07 Date MRS

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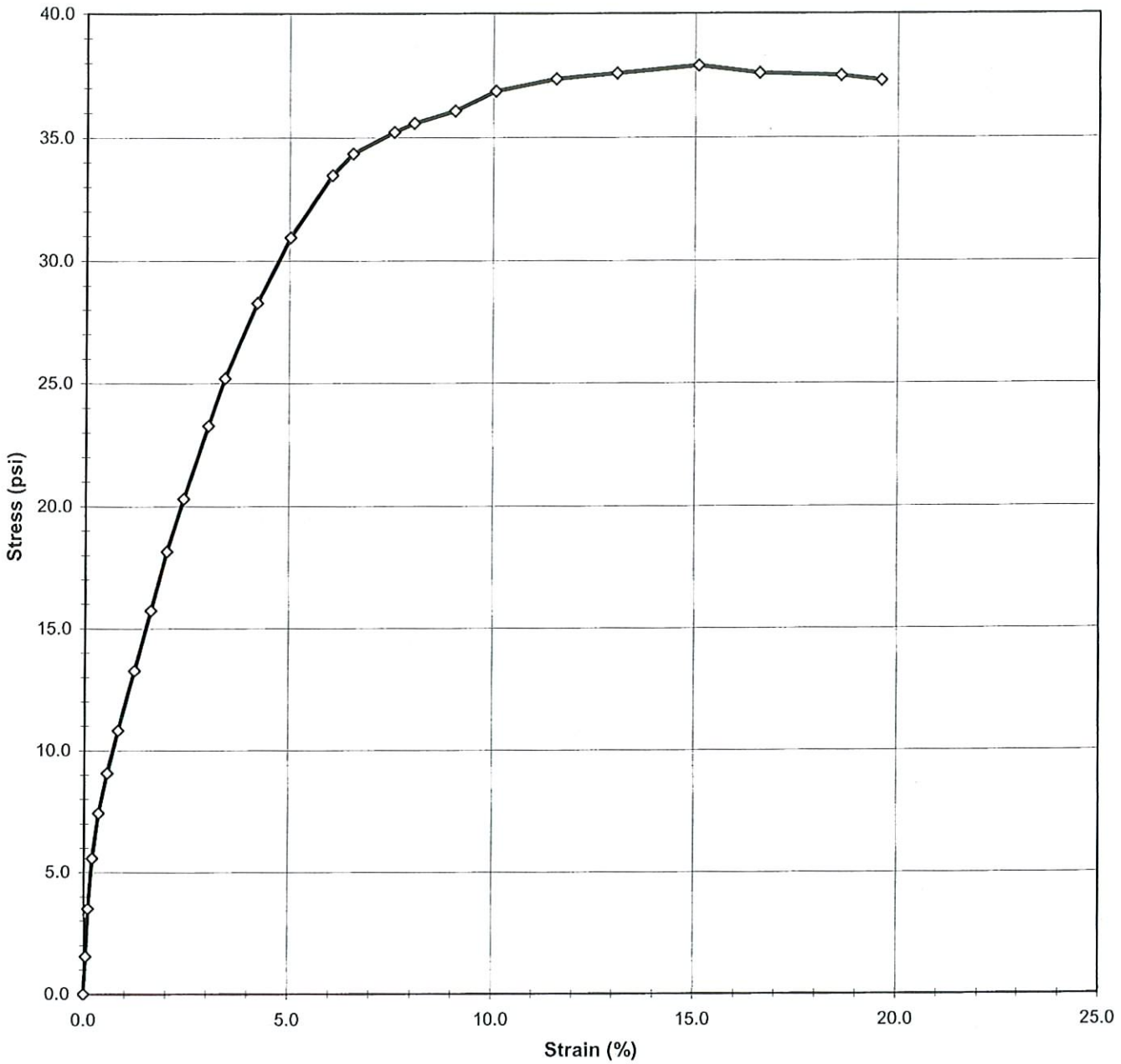
UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

Client	CDM	Boring No.	B-101
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	76.4-76.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-01	Visual	GRAY SILTY CLAY

CONFINING STRESS (psi) 24.0



Tested By MPS Date 5/22/07 Approved By GEM Date 5-24-07

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UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

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INTEGRITY IN TESTING

Client	CDM	Boring No.	B-101
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	76.4-76.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-01	Visual	GRAY SILTY CLAY

INITIAL SAMPLE DIMENSIONS

Length 1 (in)	6.051	Top Dia. (in)	2.827
Length 2 (in)	6.047	Mid. Dia. (in)	2.868
Length 3 (in)	6.049	Bot. Dia. (in)	2.836
Avg.Length (in)	6.049	Area (in^2.)	6.351

WATER CONTENT (AFTER TEST)

Total Wt. of Sample	1188.00
Tare No.	318
Wt. Tare + WS.(gms)	614.90
Wt. Tare + DS.(gms)	481.81
Wt. of Tare(gms)	86.57
% Moisture	33.7

UNIT WEIGHT

Undisturbed Specimen

Wt. Tube & WS.(gms.)	1656.65	Sample Volume(cc.)	629.6
Wt. Of Tube(gms.)	463.00	Unit Wet Wt.(gms/cc)	1.90
Wt. Of WS.(gms.)	1193.65	Unit Wet Wt.(pcf.)	118.31
Diameter (in.)	2.84	Moisture Content, %	33.7
Length (in.)	6.04	Unit Dry Wt.(pcf.)	88.5
Length (cm.)	15.36		

CONFINING STRESS (psi) **24.0**

Initial Dial Reading , mils 117

Dial Reading Before Shearing, mils 126

DEFORMATION (in)	*LOAD (lbs)*	*ELAPSED TIME (min.)*	*STRAIN (%)*	*STRESS (psi)*
0.000	0.0	0.0	0.00	0.00
0.003	9.8	0.05	0.05	1.55
0.006	22.3	0.10	0.10	3.51
0.012	35.5	0.22	0.20	5.58
0.021	47.4	0.37	0.35	7.44
0.034	57.9	0.57	0.56	9.07
0.049	69.2	0.82	0.82	10.81
0.073	85.3	1.22	1.21	13.27
0.097	101.5	1.62	1.61	15.73
0.121	117.6	2.02	2.00	18.15
0.145	132.1	2.42	2.40	20.30
0.182	152.4	3.02	3.01	23.27
0.206	165.7	3.42	3.42	25.20
0.255	187.4	4.22	4.22	28.27
0.303	206.9	5.03	5.02	30.94
0.365	226.2	6.05	6.05	33.47
0.396	233.4	6.55	6.55	34.34
0.457	242.0	7.55	7.56	35.22
0.487	245.8	8.05	8.05	35.58
0.547	251.9	9.05	9.06	36.07
0.608	260.3	10.05	10.06	36.86
0.699	268.3	11.55	11.56	37.36
0.790	274.6	13.05	13.07	37.59
0.911	283.4	15.07	15.08	37.90
1.002	286.2	16.57	16.59	37.58
1.123	292.5	18.07	18.60	37.49
1.184	294.6	19.58	19.60	37.29

Tested By MPS Date 5/22/07 Input Checked By GEM Date 5-24-07

DCN: CT-S29 DATE: 3-20-06 REVISION: 1

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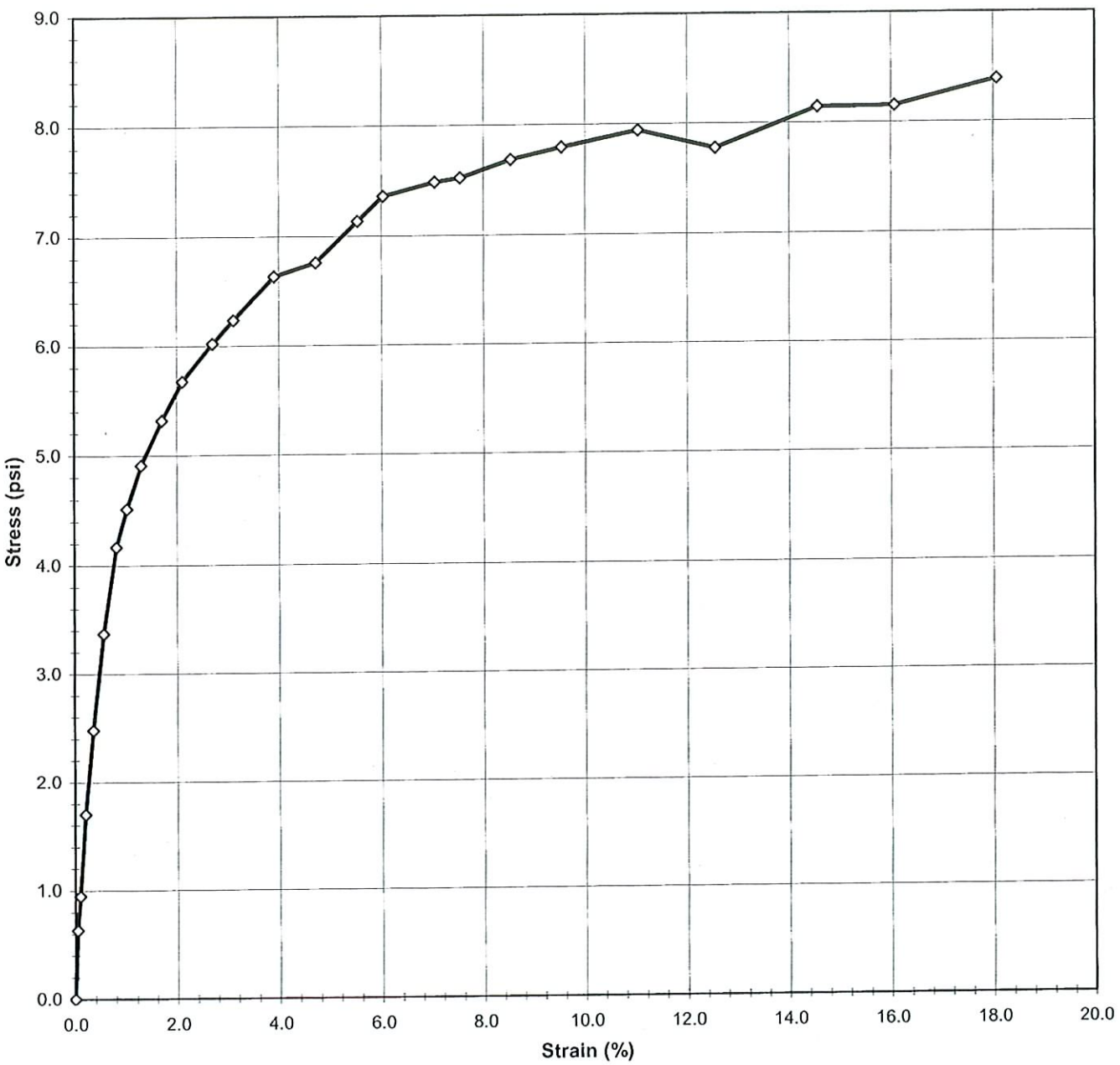
INTEGRITY IN TESTING

UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	2.4-2.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04	Visual	BROWN GRAY SILTY SAND

CONFINING STRESS (psi) **2.0**



Tested By MPS Date 5/22/07 Approved By GBM Date 5-24-07

DCN: CT-S29 DATE: 3-20-06 REVISION: 1
Z:\2007 PROJECTS\2007-591 CDM\[2007-591-01-04 SIGMAUU.xls]Sheet1

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UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-103
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	2.4-2.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-04	Visual	BROWN GRAY SILTY SAND

INITIAL SAMPLE DIMENSIONS

Length 1 (in)	6.052	Top Dia. (in)	2.830
Length 2 (in)	6.052	Mid. Dia. (in)	2.870
Length 3 (in)	6.052	Bot. Dia. (in)	2.830
Avg.Length (in)	6.052	Area (in^2.)	6.350

WATER CONTENT (AFTER TEST)

Total Wt. of Sample	1248.00
Tare No.	K-7
Wt. Tare + WS.(gms)	722.30
Wt. Tare + DS.(gms)	590.17
Wt. of Tare(gms)	110.01
% Moisture	27.5

UNIT WEIGHT

Undisturbed Specimen

Wt. Tube & WS.(gms.)	1706.84	Sample Volume(cc.)	629.7
Wt. Of Tube(gms.)	456.73	Unit Wet Wt.(gms/cc)	1.99
Wt. Of WS.(gms.)	1250.11	Unit Wet Wt.(pcf.)	123.88
Diameter (in.)	2.84	Moisture Content, %	27.5
Length (in.)	6.04	Unit Dry Wt.(pcf.)	97.1
Length (cm.)	15.37		

		Initial Dial Reading , mils	150
CONFINING STRESS (psi)	**2.0**	Dial Reading Before Shearing, mils	159

DEFORMATION (in)	*LOAD (lbs)*	*ELAPSED TIME (min.)*	*STRAIN (%)*	*STRESS (psi)*
0.000	0.0	0.0	0.00	0.00
0.003	4.0	0.05	0.05	0.63
0.006	6.0	0.10	0.10	0.95
0.012	10.8	0.20	0.21	1.70
0.022	15.8	0.35	0.36	2.48
0.034	21.5	0.57	0.56	3.37
0.049	26.7	0.82	0.81	4.17
0.062	29.0	1.02	1.02	4.51
0.079	31.6	1.30	1.30	4.91
0.103	34.3	1.70	1.71	5.32
0.127	36.8	2.10	2.11	5.67
0.164	39.3	2.70	2.71	6.02
0.188	40.8	3.10	3.12	6.23
0.236	43.9	3.92	3.91	6.64
0.285	45.0	4.72	4.72	6.76
0.335	48.0	5.53	5.54	7.14
0.365	49.7	6.03	6.04	7.36
0.426	51.1	7.03	7.04	7.49
0.456	51.7	7.53	7.54	7.53
0.516	53.4	8.53	8.54	7.69
0.577	54.7	9.53	9.54	7.80
0.668	56.7	11.03	11.05	7.94
0.758	56.5	12.53	12.55	7.78
0.880	60.5	14.55	14.56	8.14
0.971	61.6	16.05	16.07	8.15
1.092	65.0	17.55	18.07	8.39

Tested By MPS Date 5/22/07 Input Checked By CBM Date 5-24-07

DCN: CT-S29 DATE: 3-20-06 REVISION: 1
Z:\2007 PROJECTS\2007-591 CDM\[2007-591-01-04 SIGMAUU.xls]Sheet1
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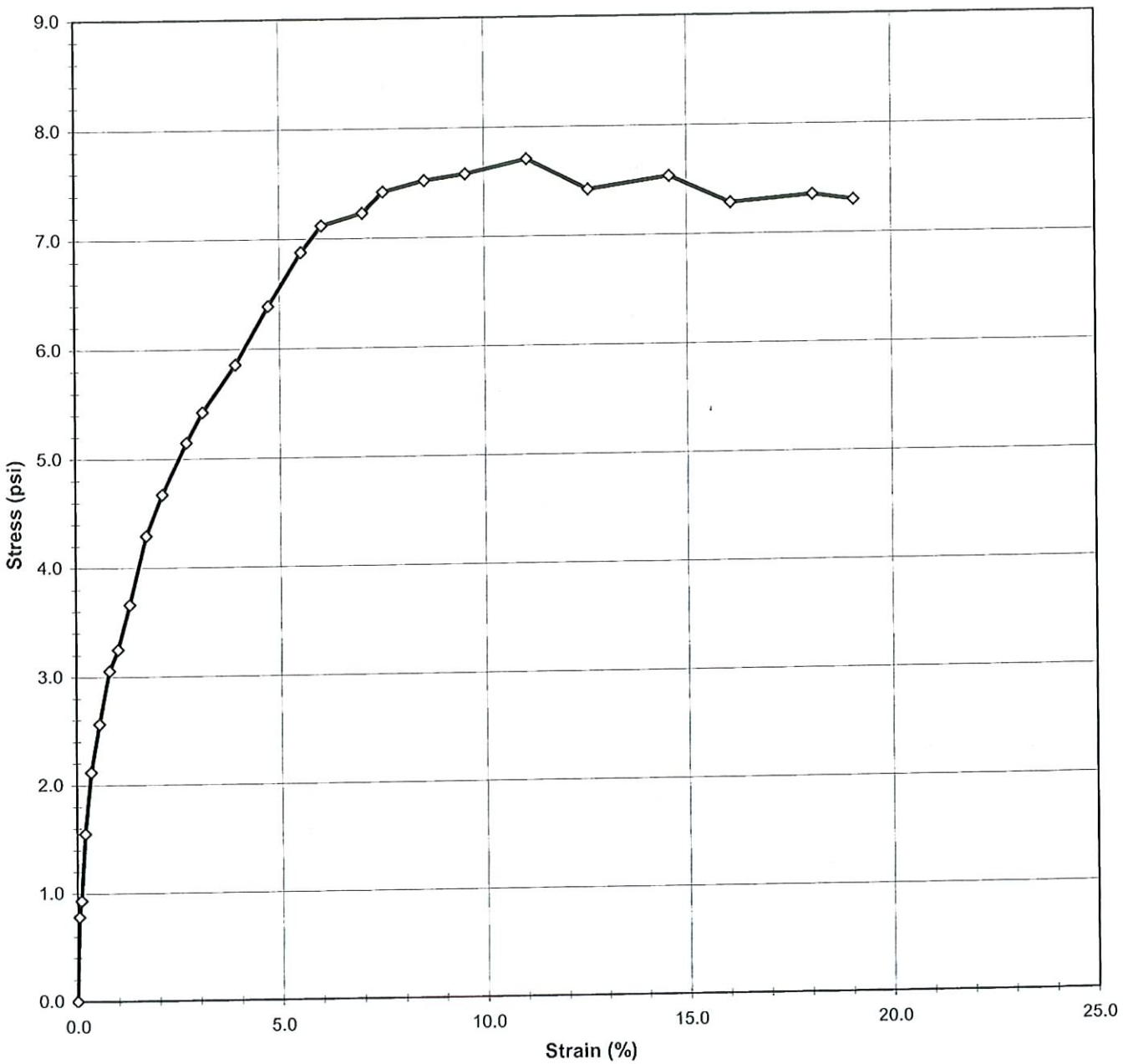
INTEGRITY IN TESTING

UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	28.2-28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual	GRAY SILTY CLAYEY SAND

CONFINING STRESS (psi) **11.0**



Tested By MPS Date 5/22/07 Approved By GBM Date 5-24-07

DCN: CT-S29 DATE: 3-20-06 REVISION: 1
Z:\2007 PROJECTS\2007-591 CDM\[2007-591-01-07 SIGMAUU.xls]Sheet1

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UNCONSOLIDATED UNDRAINED TRIAXIAL
ASTM D2850-95 (SOP S-29)

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INTEGRITY IN TESTING

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft.)	28.2-28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual	GRAY SILTY CLAYEY SAND

INITIAL SAMPLE DIMENSIONS

Length 1 (in)	6.025	Top Dia. (in)	2.842
Length 2 (in)	6.006	Mid. Dia. (in)	2.862
Length 3 (in)	6.032	Bot. Dia. (in)	2.830
Avg.Length (in)	6.021	Area (in^2.)	6.356

WATER CONTENT (AFTER TEST)

Total Wt. of Sample	1157.00
Tare No.	313
Wt. Tare + WS.(gms)	735.30
Wt. Tare + DS.(gms)	562.83
Wt. of Tare(gms)	110.69
% Moisture	38.1

UNIT WEIGHT

Undisturbed Specimen

Wt. Tube & WS.(gms.)	1609.98	Sample Volume(cc.)	627.1
Wt. Of Tube(gms.)	449.68	Unit Wet Wt.(gms/cc)	1.85
Wt. Of WS.(gms.)	1160.3	Unit Wet Wt.(pcf.)	115.46
Diameter (in.)	2.84	Moisture Content, %	38.1
Length (in.)	6.02	Unit Dry Wt.(pcf.)	83.6
Length (cm.)	15.29		

CONFINING STRESS (psi) 11.0

Initial Dial Reading , mils 78

Dial Reading Before Shearing, mils 82

DEFORMATION (in)	*LOAD (lbs)*	*ELAPSED TIME (min.)*	*STRAIN (%)*	*STRESS (psi)*
0.000	0.0	0.0	0.00	0.00
0.003	4.9	0.05	0.05	0.78
0.006	5.9	0.10	0.10	0.93
0.012	9.9	0.20	0.20	1.55
0.021	13.5	0.35	0.35	2.12
0.033	16.4	0.55	0.56	2.56
0.048	19.6	0.82	0.80	3.05
0.061	20.9	1.02	1.01	3.25
0.078	23.6	1.30	1.30	3.66
0.103	27.8	1.72	1.71	4.29
0.127	30.3	2.12	2.11	4.67
0.163	33.6	2.72	2.71	5.14
0.187	35.6	3.12	3.11	5.42
0.236	38.7	3.92	3.91	5.86
0.284	42.6	4.72	4.72	6.39
0.333	46.3	5.53	5.54	6.88
0.363	48.2	6.03	6.04	7.12
0.424	49.4	7.03	7.04	7.23
0.454	51.0	7.53	7.54	7.42
0.515	52.3	8.55	8.55	7.52
0.575	53.2	9.55	9.55	7.58
0.665	55.1	11.05	11.05	7.71
0.756	53.9	12.57	12.57	7.42
0.877	56.0	14.57	14.57	7.53
0.967	55.2	16.07	16.08	7.28
1.088	57.0	17.57	18.09	7.35
1.148	57.3	19.08	19.08	7.30

Tested By MPS Date 5/22/07 Input Checked By GEM Date 5-24-07

DCN: CT-S29 DATE: 3-20-06 REVISION: 1

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D - 4767 (SOP-S28)

Client	CDM		
Client Reference	DARE COUNTY C & D CELL 4		
Project No.	2007-591-01		
Lab ID	2007-591-01-03	Specific Gravity (assumed)	2.70

Visual Description: GRAY SILTY SAND (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.	B-102	B-102
Depth (ft)	31.9-32.4	32.4-32.9
Sample No.	ST-2	ST-2
Test No.	T1	T2
Deformation Rate (in/min)	0.002	0.002
Back Pressure (psi)	49.4	49.6
Consolidation Time (days)	1	1
Initial State (w%)	38.7	38.7
Total Unit Weight (pcf)	114.7	118.0
Dry Unit Weight (pcf)	82.7	85.0
Final State (w%)	36.0	32.9
Initial State Void Ratio,e	1.038	0.982

Tested By TMS Date 5/15/07 Input Checked By MAS Date 5-23-07

DCN: CT-S28 DATE 6-25-98 REVISION: 1 Z:\2007 PROJECTS\2007-591 CDM\[2007-591-01-03 TRIAX SUMMARY.XLS]Sheet1

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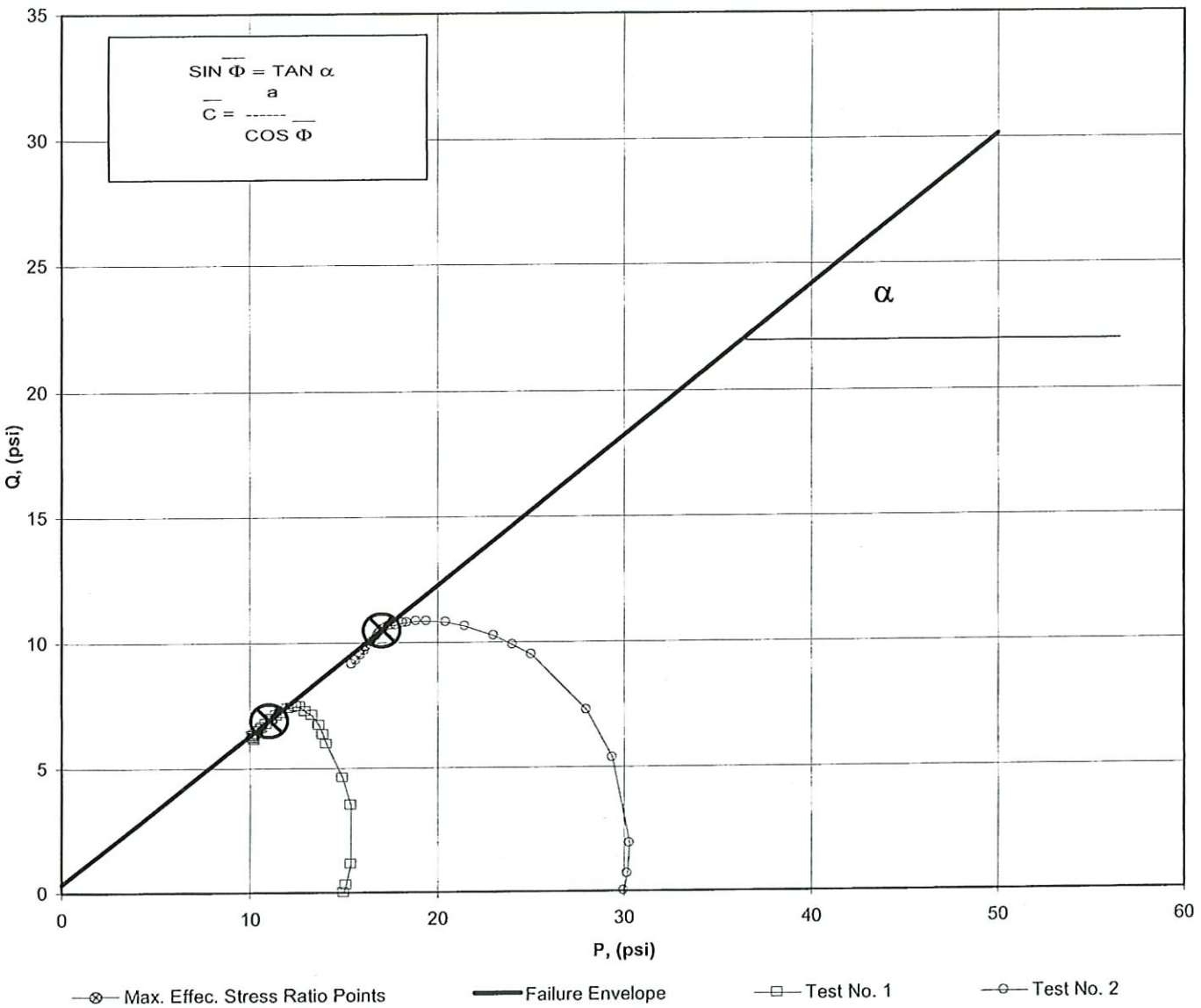
CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	31.9-32.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	0.35	$\overline{C}$	=	0.44
α	=	30.8	$\overline{\Phi}$	=	36.57

Tested By TMS Date 5/15/07 Approved By DB Date 5-23-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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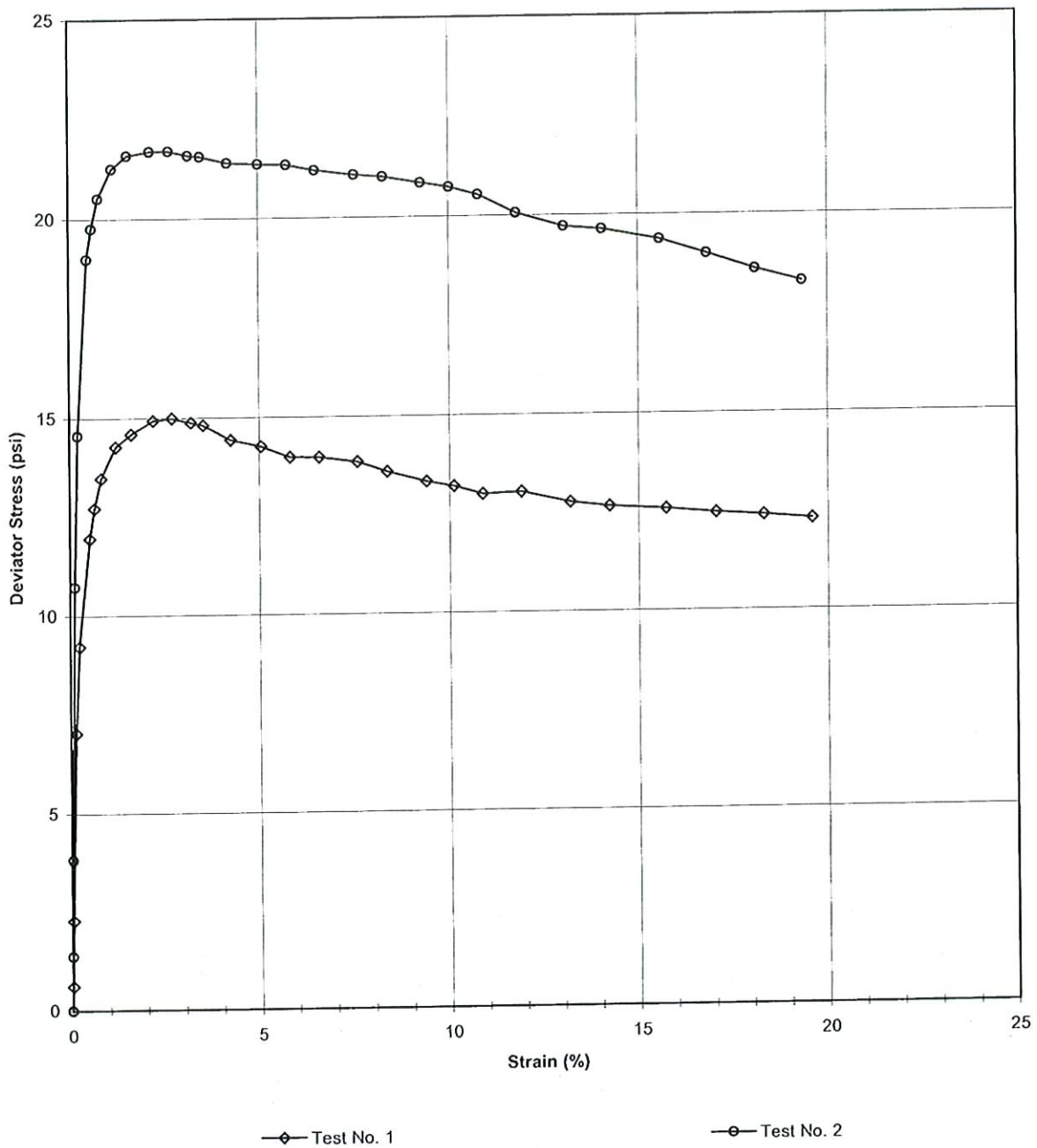
CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	31.9-32.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		
Visual Description:	GRAY SILTY SAND (UNDISTURBED)		



Tested By TMS Date 5/15/07 Approved By bb Date 5-23-07

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	31.9-32.4
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Stage No.	1
Test No	1

PRESSURES (psi)

Cell Pressure(psi)	64.4
Back Pressure(psi)	49.4
Eff. Cons. Pressure(psi)	15.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	11.02
Q	=	6.92

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.931	Diameter 1	2.835
Length 2	5.933	Diameter 2	2.872
Length 3	5.921	Diameter 3	2.832
Avg Leng.=	5.928	Avg. Diam.=	2.846

VOLUME CHANGE

Initial Burette Reading (ml)	17.8
Final Burette Reading (ml)	0.0
Final Change (ml)	17.8

Initial Dial Reading (D.R.), mils	140
D.R. After Saturation, mils	160
D.R. After Consolidation, mils	202

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
10.4	0.000	49.4
14.2	0.001	49.6
24.5	0.002	50.2
54.0	0.008	52.5
67.5	0.014	54.1
84.6	0.031	56.3
89.5	0.038	56.9
94.3	0.049	57.4
99.7	0.072	58.2
102.0	0.095	58.7
104.7	0.130	59.2
105.6	0.159	59.4
105.4	0.188	59.6
105.2	0.207	59.8
103.5	0.249	60.0
103.2	0.296	60.1
102.1	0.341	60.2
102.8	0.386	60.2
102.9	0.444	60.3
102.0	0.490	60.3
101.2	0.551	60.4
101.1	0.594	60.4
100.4	0.638	60.4
101.8	0.699	60.5
101.2	0.774	60.5
101.5	0.835	60.5
102.5	0.923	60.6
103.2	1.000	60.5
104.1	1.073	60.4
104.8	1.149	60.3

Tested By TMS Date 5/15/07 Input Checked By MMS Date 5-23-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	31.9-32.4
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	15.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.93
Initial Sample Diameter (in.)	2.85
Initial Sample Area (in^2)	6.36
Initial Sample Volume (in^3)	37.72

VOLUME CHANGE

Volume After Consolidation (in^3)	36.25
Length After Consolidation (in)	5.87
Area After Consolidation (in^2)	6.180

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.61	0.18	15.43	14.8	1.041	0.30	15.13	0.30
0.04	2.28	0.76	16.52	14.2	1.160	0.34	15.38	1.14
0.14	7.04	3.14	18.91	11.9	1.594	0.46	15.38	3.52
0.24	9.22	4.66	19.57	10.3	1.892	0.52	14.95	4.61
0.52	11.95	6.88	20.06	8.1	2.472	0.59	14.09	5.97
0.65	12.71	7.45	20.26	7.5	2.684	0.60	13.90	6.36
0.83	13.47	8.03	20.44	7.0	2.933	0.61	13.70	6.73
1.22	14.27	8.82	20.45	6.2	3.308	0.64	13.32	7.14
1.62	14.59	9.34	20.25	5.7	3.575	0.66	12.96	7.29
2.21	14.93	9.79	20.14	5.2	3.866	0.68	12.67	7.46
2.70	14.99	10.03	19.96	5.0	4.014	0.69	12.47	7.49
3.21	14.87	10.20	19.67	4.8	4.101	0.71	12.23	7.44
3.52	14.81	10.36	19.45	4.6	4.190	0.72	12.04	7.40
4.25	14.43	10.57	18.86	4.4	4.256	0.76	11.64	7.21
5.05	14.25	10.70	18.56	4.3	4.313	0.77	11.43	7.13
5.81	13.97	10.80	18.18	4.2	4.324	0.80	11.19	6.99
6.58	13.97	10.85	18.12	4.2	4.362	0.80	11.14	6.98
7.58	13.84	10.90	17.94	4.1	4.372	0.81	11.02	6.92
8.36	13.58	10.92	17.66	4.1	4.330	0.83	10.87	6.79
9.40	13.32	11.00	17.32	4.0	4.327	0.85	10.66	6.66
10.12	13.19	11.01	17.18	4.0	4.304	0.86	10.59	6.60
10.88	12.98	11.04	16.94	4.0	4.281	0.88	10.45	6.49
11.91	13.03	11.05	16.97	3.9	4.302	0.87	10.46	6.51
13.20	12.75	11.08	16.67	3.9	4.253	0.90	10.30	6.38
14.23	12.64	11.14	16.50	3.9	4.274	0.91	10.18	6.32
15.73	12.57	11.18	16.39	3.8	4.288	0.92	10.10	6.28
17.04	12.46	11.06	16.40	3.9	4.159	0.92	10.17	6.23
18.29	12.39	10.96	16.42	4.0	4.069	0.91	10.23	6.19
19.59	12.29	10.90	16.38	4.1	3.998	0.91	10.24	6.14

Tested By TMS Date 5/15/07 Input Checked By MPS Date 5-23-07

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CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	32.4-32.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Stage No.	1
Test No	2

PRESSURES (psi)

Cell Pressure(psi)	79.6
Back Pressure(psi)	49.6
Eff. Cons. Pressure(ps	30.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	17.03
Q	=	10.50

INITIAL SAMPLE DIMENSIONS (in)

Length 1	6.049	Diameter 1	2.806
Length 2	6.049	Diameter 2	2.808
Length 3	6.048	Diameter 3	2.831
Avg Leng.=	6.049	Avg. Diam.=	2.815

VOLUME CHANGE

Initial Burette Reading (ml)	43.0
Final Burette Reading (ml)	0.0
Final Change (ml)	43.0

Initial Dial Reading (D.R.), mils	150
D.R. After Saturation, mils	165
D.R. After Consolidation, mils	326

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
11.3	0.000	49.6
19.4	0.001	50.1
33.8	0.002	51.2
74.7	0.007	55.6
97.5	0.013	58.9
124.1	0.028	64.1
128.8	0.035	65.5
133.5	0.046	66.8
138.5	0.068	68.7
141.0	0.091	69.9
142.4	0.126	71.0
143.0	0.156	71.6
143.0	0.186	72.0
143.3	0.204	72.2
143.3	0.246	72.5
144.2	0.294	72.7
145.1	0.338	72.9
145.3	0.381	72.9
146.0	0.442	73.0
146.7	0.486	73.1
147.2	0.545	73.1
147.5	0.589	73.1
147.4	0.634	73.1
145.8	0.693	73.2
145.3	0.766	73.2
146.4	0.826	73.2
147.0	0.915	73.2
146.3	0.987	73.2
145.6	1.062	73.2
145.3	1.135	73.3

Tested By TMS Date 5/15/07 Input Checked By MMS Date 5-23-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

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CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-102
Client Reference	DARE COUNTY C&D CELL 4	Depth(ft.)	32.4-32.9
Project No.	2007-591-01	Sample No.	ST-2
Lab ID	2007-591-01-03		

Visual Description: GRAY SILTY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	30.0	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in.)	6.05
Initial Sample Diameter (in.)	2.82
Initial Sample Area (in^2)	6.22
Initial Sample Volume (in^3)	37.64

VOLUME CHANGE

Volume After Consolidation (in^3)	34.74
Length After Consolidation (in)	5.87
Area After Consolidation (in^2)	5.916

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.01	1.37	0.50	30.87	29.5	1.046	0.38	30.18	0.68
0.03	3.81	1.61	32.20	28.4	1.134	0.44	30.30	1.91
0.12	10.72	5.97	34.74	24.0	1.446	0.57	29.39	5.36
0.21	14.55	9.28	35.27	20.7	1.702	0.66	27.99	7.28
0.48	18.99	14.47	34.52	15.5	2.223	0.79	25.02	9.49
0.60	19.75	15.85	33.90	14.1	2.396	0.83	24.03	9.88
0.78	20.51	17.24	33.27	12.8	2.607	0.87	23.02	10.25
1.15	21.25	19.15	32.10	10.9	2.958	0.93	21.48	10.63
1.56	21.58	20.34	31.24	9.7	3.234	0.97	20.45	10.79
2.15	21.68	21.42	30.26	8.6	3.528	1.02	19.42	10.84
2.65	21.68	21.98	29.70	8.0	3.703	1.04	18.86	10.84
3.16	21.57	22.40	29.16	7.6	3.840	1.07	18.38	10.78
3.47	21.54	22.59	28.95	7.4	3.907	1.08	18.18	10.77
4.19	21.38	22.90	28.47	7.1	4.013	1.10	17.78	10.69
5.00	21.34	23.12	28.22	6.9	4.103	1.12	17.55	10.67
5.75	21.32	23.26	28.06	6.7	4.165	1.12	17.40	10.66
6.49	21.18	23.35	27.83	6.7	4.184	1.14	17.24	10.59
7.52	21.06	23.43	27.63	6.6	4.208	1.15	17.10	10.53
8.28	21.00	23.47	27.53	6.5	4.215	1.15	17.03	10.50
9.27	20.84	23.47	27.37	6.5	4.193	1.16	16.95	10.42
10.02	20.72	23.48	27.24	6.5	4.179	1.17	16.88	10.36
10.79	20.53	23.48	27.05	6.5	4.148	1.18	16.78	10.26
11.79	20.05	23.56	26.49	6.4	4.114	1.21	16.47	10.03
13.05	19.70	23.64	26.07	6.4	4.097	1.24	16.21	9.85
14.06	19.62	23.61	26.02	6.4	4.071	1.24	16.20	9.81
15.58	19.36	23.56	25.80	6.4	4.008	1.25	16.12	9.68
16.81	18.99	23.59	25.41	6.4	3.961	1.28	15.91	9.50
18.09	18.59	23.62	24.97	6.4	3.916	1.31	15.67	9.30
19.33	18.28	23.70	24.58	6.3	3.900	1.34	15.44	9.14

Tested By TMS Date 5/15/07 Input Checked By MDS Date 5-23-07

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.....GEOTECHNICAL, GEOENVIRONMENTAL, AND GEOSYNTHETIC LABORATORIES

May 30, 2007

Project No. 2007-591-01

Ms. Danielle K. Neamtu
CDM
5400 Glenwood Ave., Suite 300
Raleigh, NC 27612

Transmittal
Laboratory Test Results
Dare County C & D Cell Number 4

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was faxed to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

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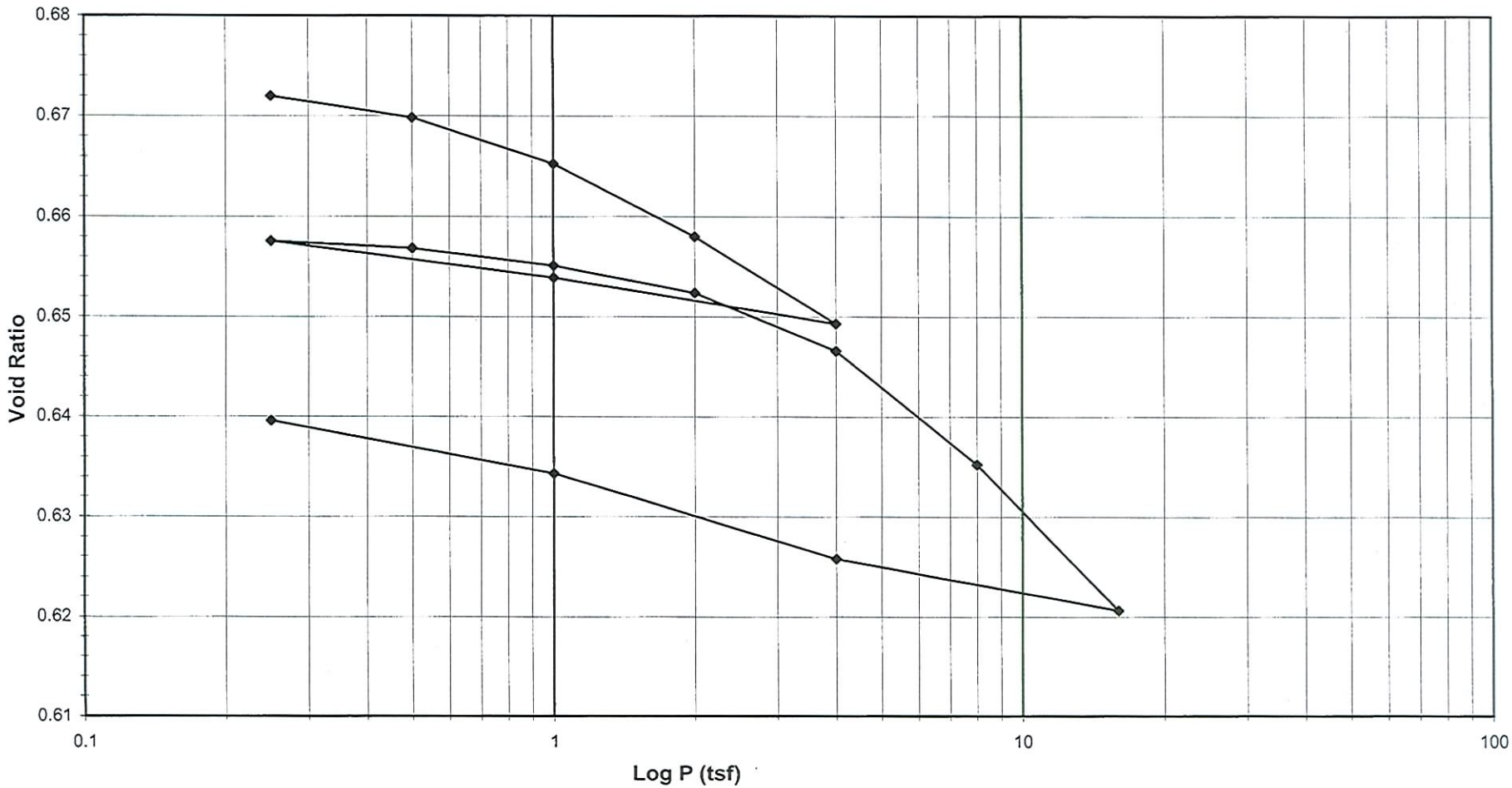
ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	3.7 - 3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY SANDY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Tested By JBD *Date* 05/21/07 *Approved By* DB *Date* 5-29-07

DCN: CT-S24F Date: 11/26/05 Revision: 5

C:\Data Sheets\[CONFINAL(RALEIGH).xls]Sheet1

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	3.7 - 3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY SANDY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED
Consolidometer No. 299
1 Division = 0.0001 (in)

Sample Properties	Initial	Final
Water Content		
Tare Number	F-4	SS-4
Wt. Tare & WS (gm)	250.32	258.04
Wt. Tare & DS (gm)	222.22	229.61
Wt. Water (gm)	28.10	28.43
Wt. Tare (gm)	100.24	100.40
Wt. DS (gm)	121.98	129.21
Water Content (%)	23.04	22.00
Sample Parameters		
Sample Diameter (in)	2.5	2.5
Sample Height (in)	1.000	0.978
Sample Volume (cc)	80.44	78.65
Wt. Wet Sample + Ring (gm)	370.60	369.26
Wt. of Ring (gm)	211.25	211.25
Wt. of Wet Sample (gm)	159.35	158.01
Wet Density (pcf)	123.61	125.37
Wet Density (g/cc)	1.98	2.01
Water Content (%)	23.04	22.00
Wt. of Dry Sample (gm)	129.51	129.51
Dry Density (pcf)	100.47	102.76
Dry Density (g/cc)	1.61	1.65
Void Ratio	0.6769	0.6396
Saturation (%)	91.88	92.89
Specific Gravity	2.70	*Assumed*

Test Data Summary

Applied Pressure (tsf)	Final Dial Reading (div)	Machine Deflection (div)	Corrected Reading (div)	Height of Sample (mm)	Volume (cc)	Dry Density (g/cc)	Void Ratio
Seating	0	0	0	25.400	80.440	1.61008	**0.67694**
0.25	39.8	10.2	29.6	25.325	80.202	1.61486	**0.67197**
0.5	65.4	22.8	42.6	25.292	80.097	1.61697	**0.66979**
1	103.7	33.9	69.8	25.223	79.878	1.62140	**0.66523**
2	159.8	47.0	112.8	25.113	79.532	1.62845	**0.65802**
4	224.9	60.1	164.8	24.981	79.114	1.63706	**0.64930**
1	183.0	45.7	137.3	25.051	79.335	1.63249	**0.65391**
0.25	145.8	30.3	115.5	25.107	79.511	1.62889	**0.65757**
0.5	153.1	33.2	119.9	25.095	79.475	1.62962	**0.65683**
1	170.6	40.4	130.2	25.069	79.392	1.63132	**0.65510**
2	197.0	50.5	146.5	25.028	79.261	1.63402	**0.65237**
4	242.4	61.4	181.0	24.940	78.984	1.63976	**0.64659**
8	322.9	74.2	248.7	24.768	78.439	1.65114	**0.63523**
16	425.8	90.1	335.7	24.547	77.739	1.66601	**0.62064**
4	375.2	70.3	304.9	24.626	77.987	1.66071	**0.62581**
1	306.5	52.2	254.3	24.754	78.394	1.65209	**0.63429**
0.25	258.7	35.8	222.9	24.834	78.647	1.64678	**0.63956**

Tested By JBD *Date* 05/21/07 *Input Checked By* [illegible] *Date* 5-24-07

DCN: CT-S24F Date: 11/26/05 Revision: 5

C:\Data Sheets\[CONFINAL(RALEIGH).xls]Sheet1

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

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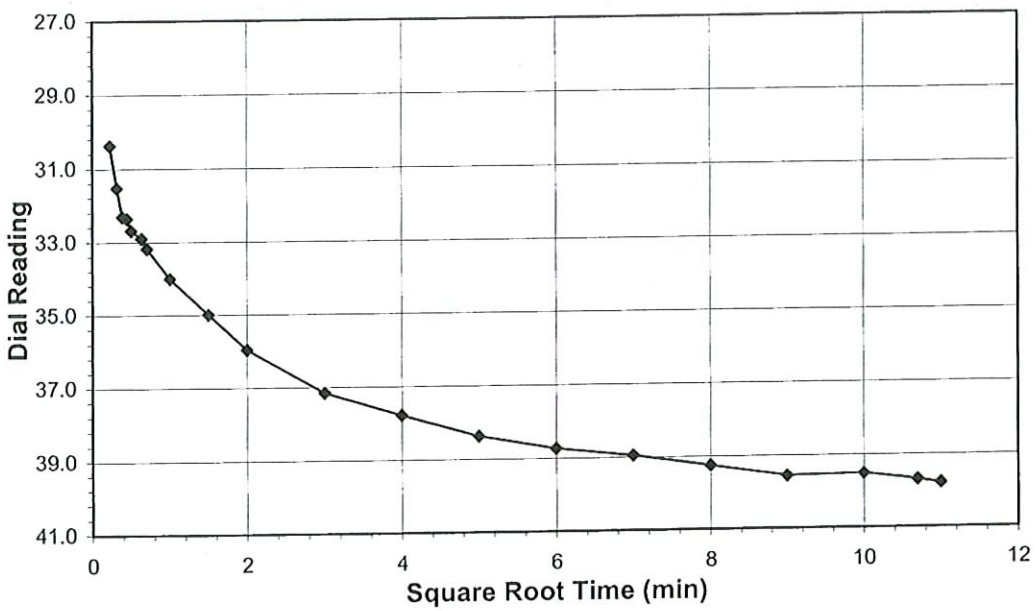
INTEGRITY IN TESTING

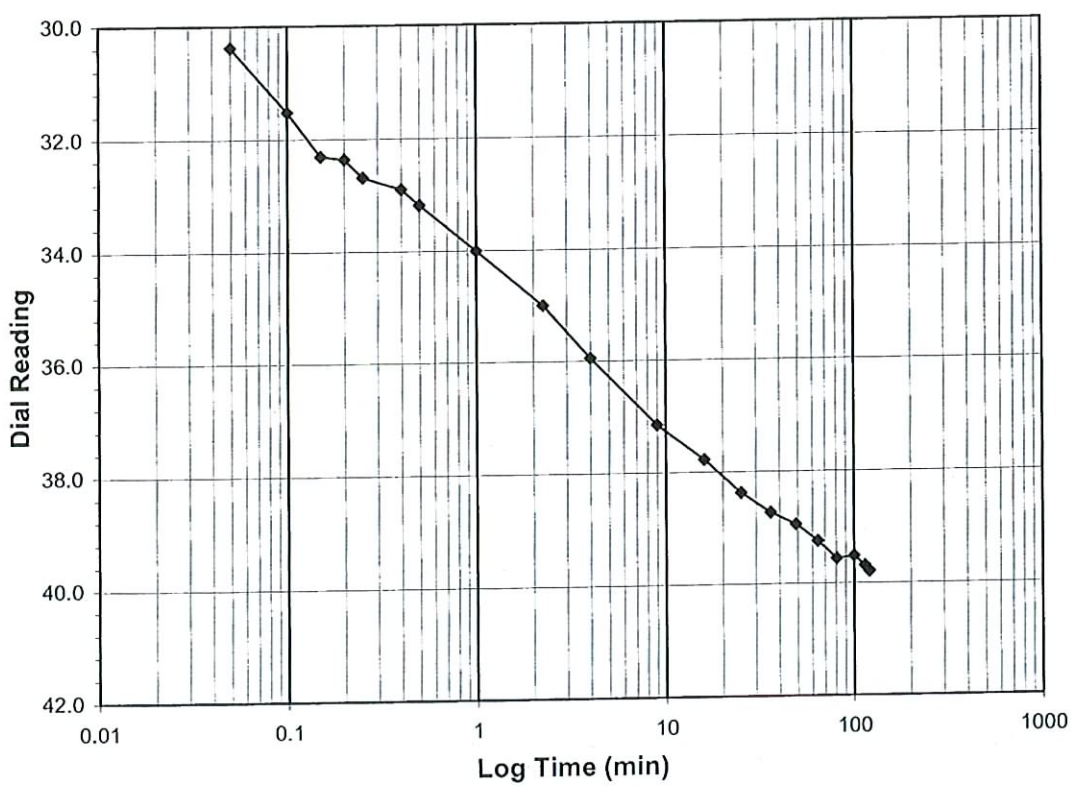
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**0-.25**
Final Reading	**(div)**	**39.8**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/11/07
Start Time		15:19:57

Elapsed Time (min)	Dial Reading (div)
Initial	**0.0**
0.05	30.4
0.10	31.5
0.15	32.3
0.20	32.4
0.25	32.7
0.40	32.9
0.50	33.2
1.00	34.0
2.25	35.0
4.00	36.0
9.00	37.2
16.00	37.8
25.00	38.4
36.00	38.7
49.00	38.9
64.00	39.2
81.00	39.6
100.00	39.5
114.48	39.7
121.00	39.8



Tested By JBD *Date* 5/11/07 *Checked By* MMS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

\\Daveb\c-drive\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 03.xls]Sheet2

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

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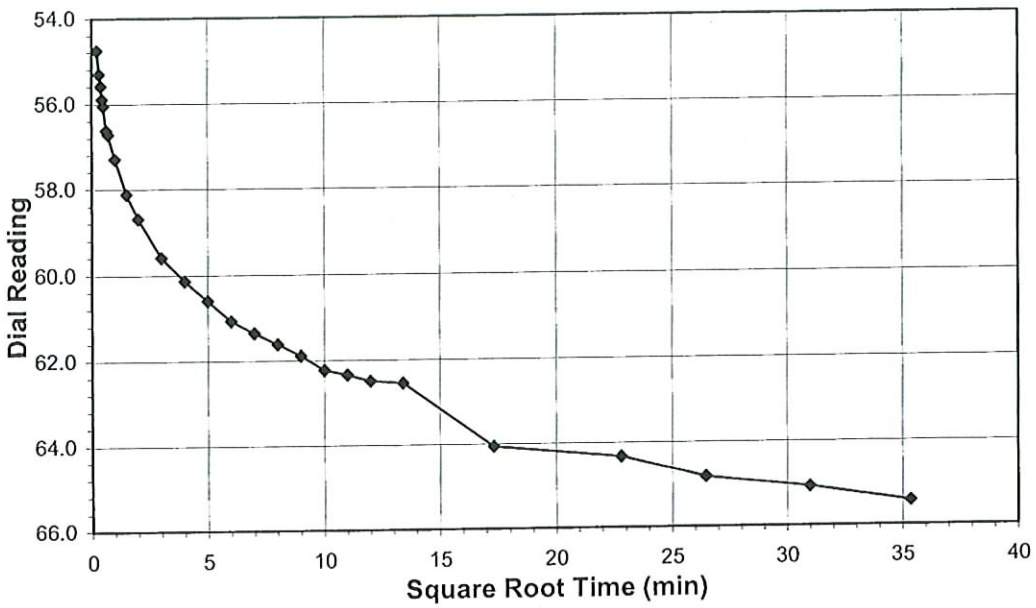
INTEGRITY IN TESTING

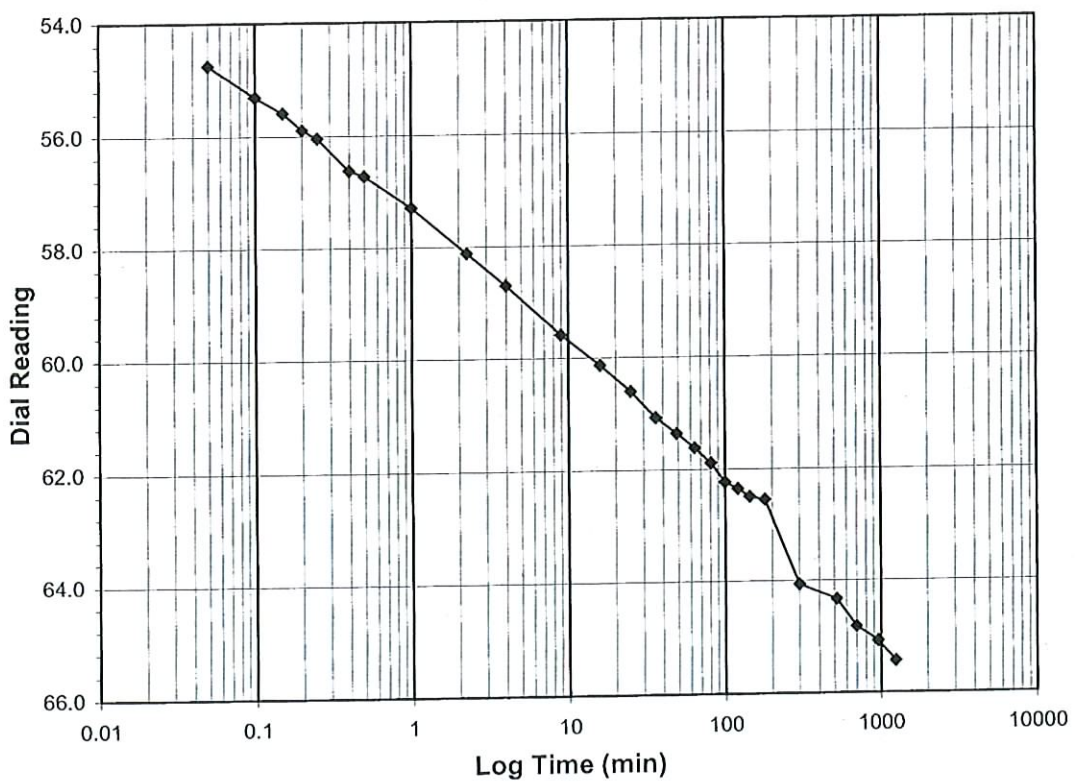
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**.25-.5**
Final Reading	**(div)**	**65.4**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/11/07
Start Time		17:39:21

Elapsed Time (min)	Dial Reading (div)
Initial	**39.8**
0.05	54.8
0.10	55.3
0.15	55.6
0.20	55.9
0.25	56.0
0.40	56.6
0.50	56.7
1.00	57.3
2.25	58.1
4.00	58.7
9.00	59.6
16.00	60.1
25.00	60.6
36.00	61.1
49.00	61.4
64.00	61.6
81.00	61.9
100.00	62.2
121.00	62.3
144.00	62.5
180.00	62.5
300.00	64.1
520.00	64.3
700.00	64.8
960.00	65.1
1250.08	65.4



Tested By JBD *Date* 5/11/07 *Checked By* MAS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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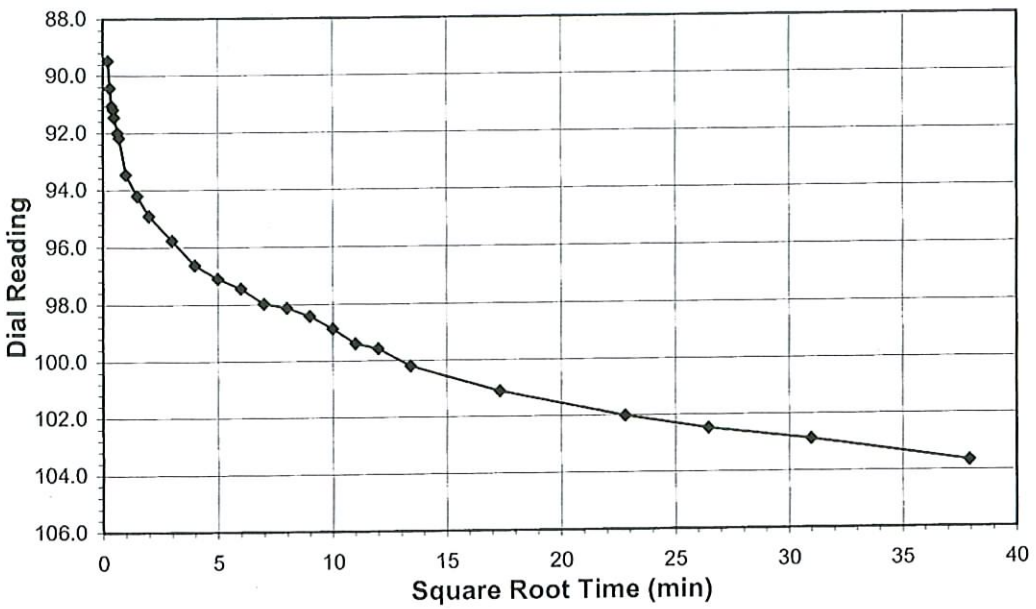
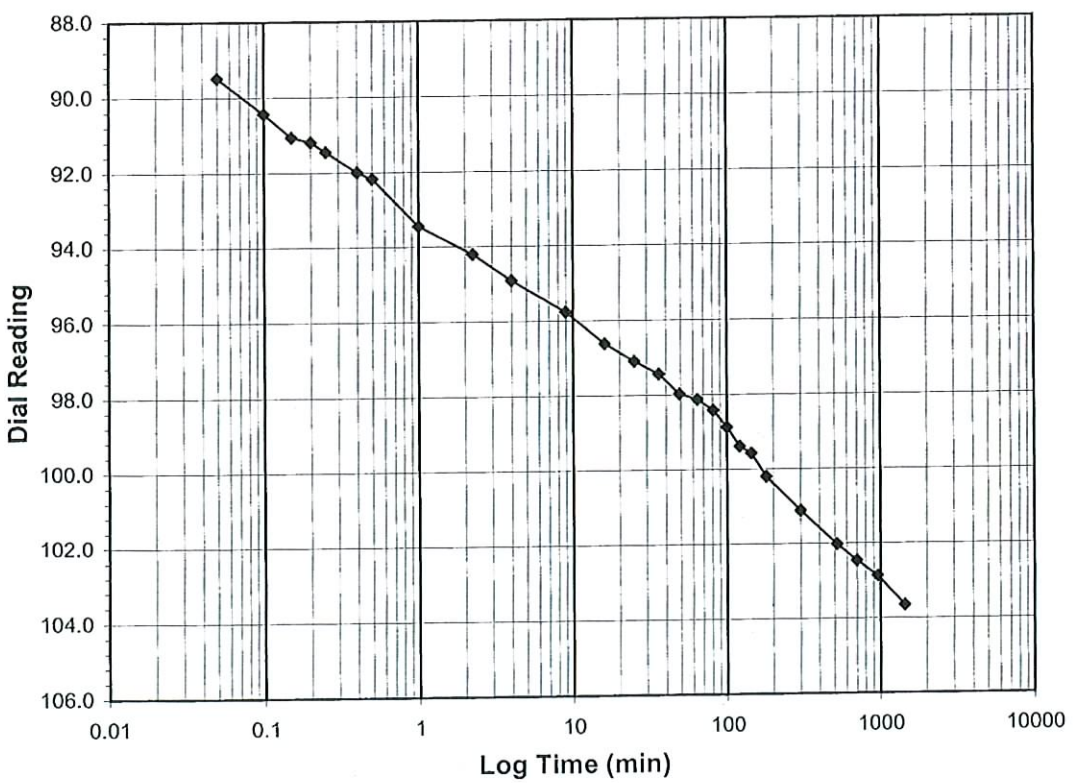
ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**.5-1**
Final Reading	**(div)**	**103.7**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/12/07
Start Time		14:32:08

Elapsed Time (min)	Dial Reading (div)
Initial	**65.4**
0.05	89.5
0.10	90.4
0.15	91.1
0.20	91.2
0.25	91.5
0.40	92.0
0.50	92.2
1.00	93.5
2.25	94.2
4.00	94.9
9.00	95.8
16.00	96.6
25.00	97.1
36.00	97.4
49.00	98.0
64.00	98.1
81.00	98.4
100.00	98.9
121.00	99.4
144.00	99.6
180.00	100.2
300.00	101.1
520.00	102.0
700.00	102.5
960.00	102.9
1440.00	103.7

Tested By JBD *Date* 5/12/07 *Checked By* MMS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

\\Daveb\c-drive\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 03.xls]Sheet2

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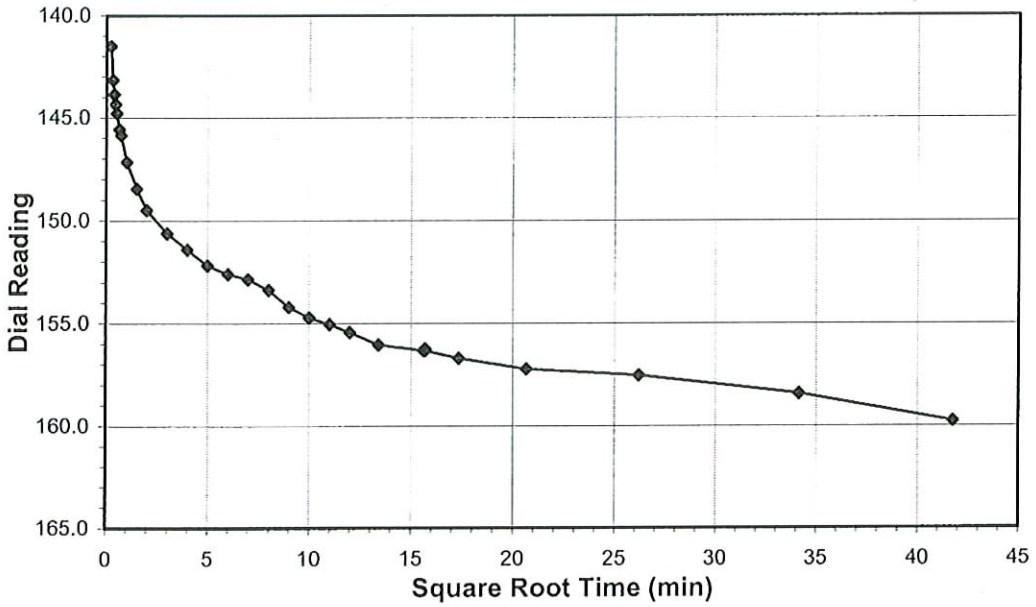
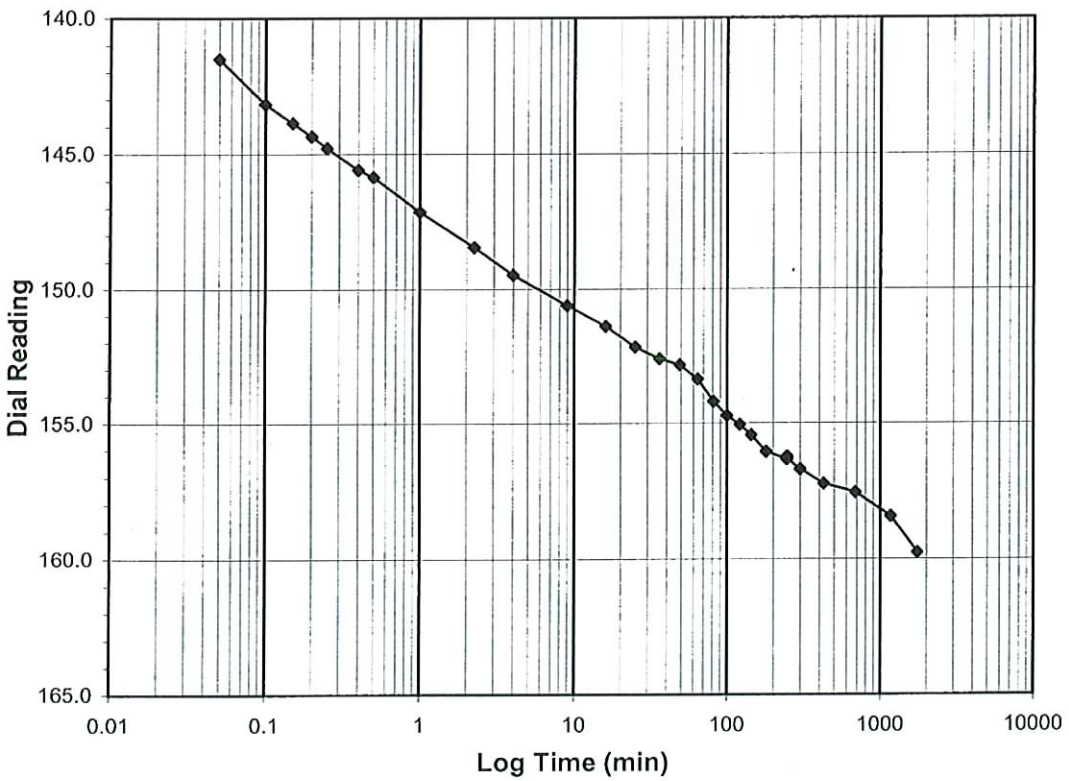
ASTM D 2435-96 (SOP-S24A)

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**1-2**
Final Reading	**(div)**	**159.8**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/14/2007
Start Time		8:28:29

Elapsed Time (min)	Dial Reading (div)
Initial	**103.7**
0.05	141.5
0.10	143.2
0.15	143.9
0.20	144.4
0.25	144.8
0.40	145.6
0.50	145.9
1.00	147.2
2.25	148.5
4.00	149.5
9.00	150.6
16.00	151.4
25.00	152.2
36.00	152.6
49.00	152.9
64.00	153.4
81.00	154.2
100.00	154.7
121.00	155.1
144.00	155.4
180.00	156.1
244.27	156.3
246.45	156.2
246.62	156.3
300.82	156.7
426.62	157.2
686.62	157.5
1166.62	158.4
1744.10	159.8

Tested By MPS *Date* 5/14/2007 *Checked By* MPS *Date* 5-24-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *C:\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 04.xls]Sheet2*

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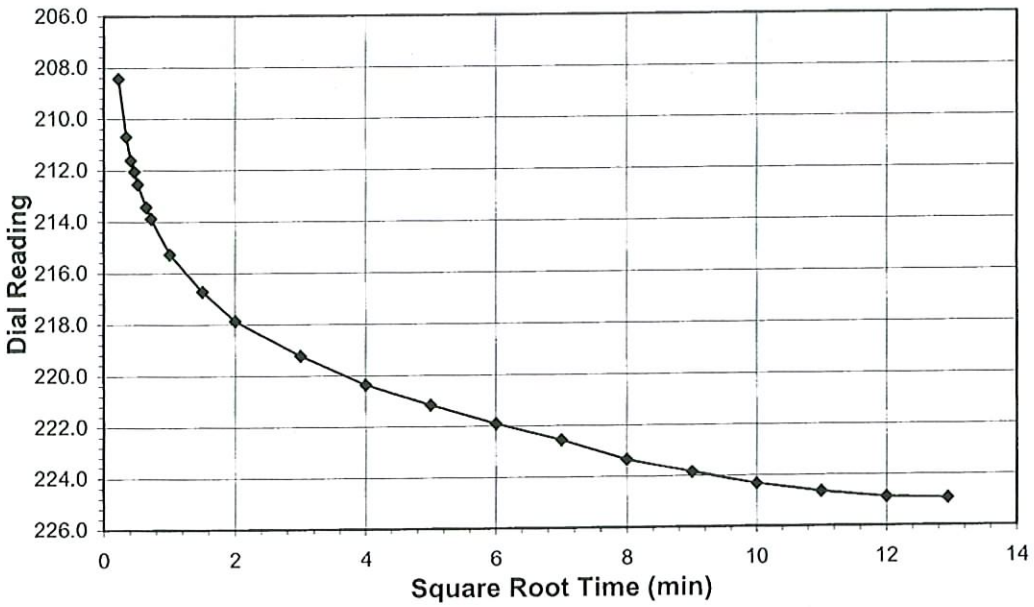
ASTM D 2435-96 (SOP-S24A)

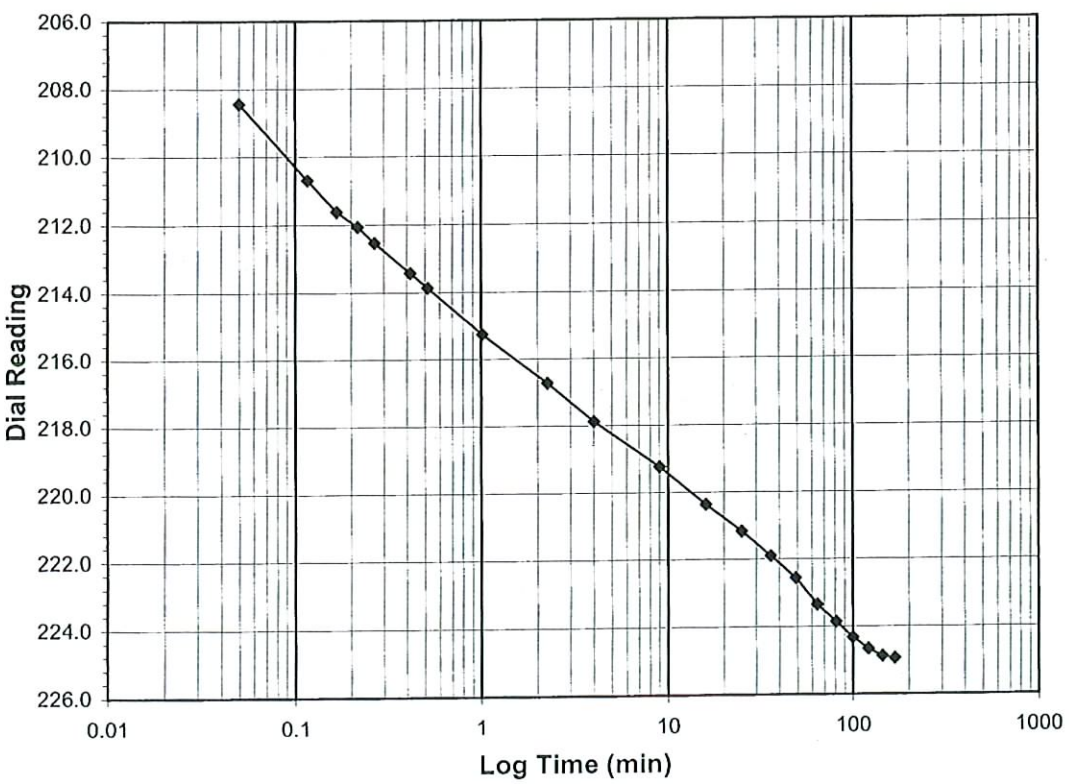
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**2-4**
Final Reading	**(div)**	**224.9**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/15/07
Start Time		14:05:04

Elapsed Time (min)	Dial Reading (div)
Initial	**159.8**
0.05	208.4
0.12	210.7
0.17	211.6
0.22	212.1
0.27	212.5
0.42	213.4
0.52	213.9
1.02	215.3
2.27	216.7
4.02	217.9
9.02	219.2
16.02	220.4
25.02	221.2
36.02	221.9
49.02	222.6
64.02	223.3
81.02	223.9
100.02	224.3
121.02	224.7
144.02	224.9
167.38	224.9



Tested By MPS *Date* 5/15/07 *Checked By* MPS *Date* 5-28-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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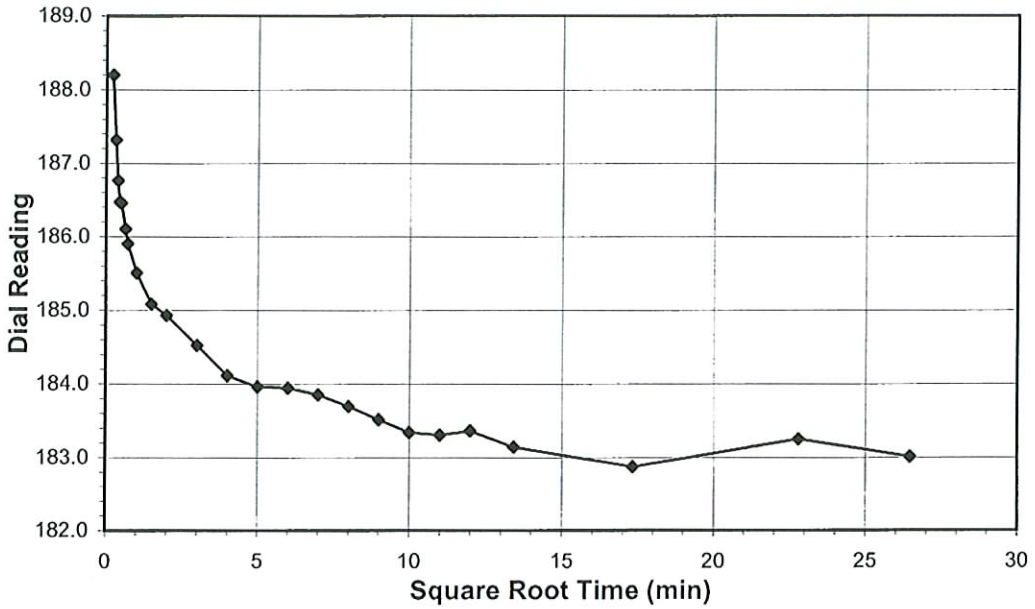
ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

geotechnics
INTEGRITY IN TESTING

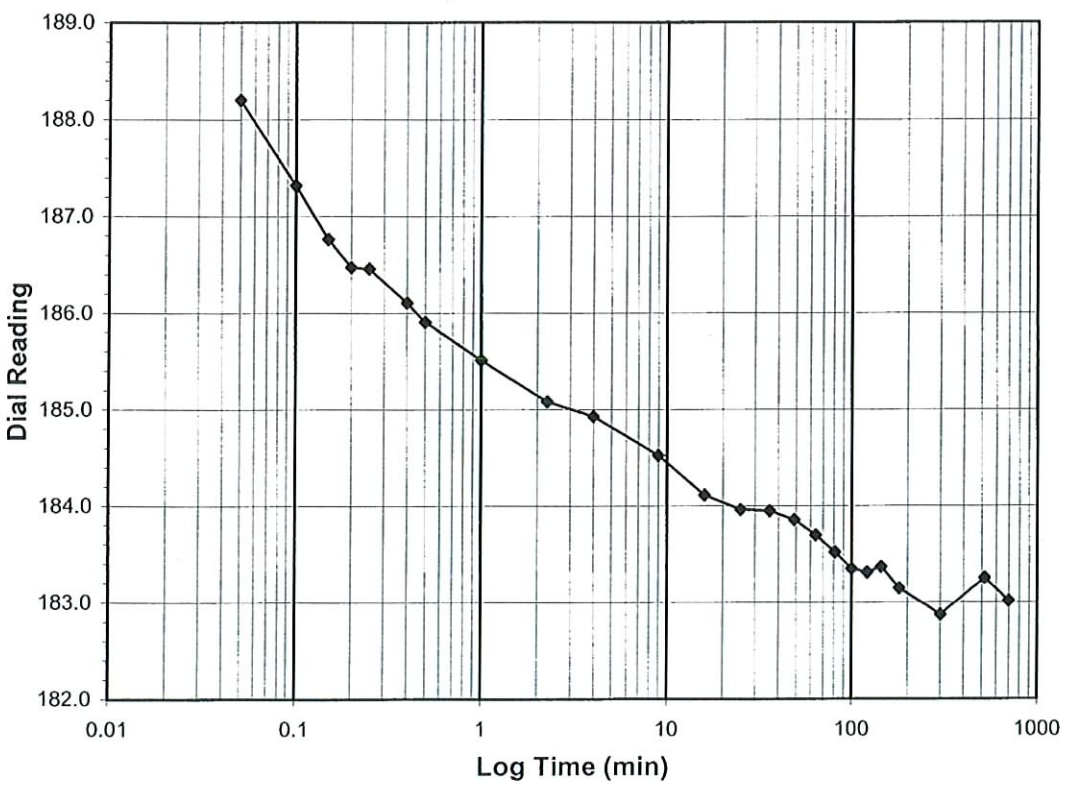
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**4-1**
Final Reading	**(div)**	**183.0**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/15/2007
Start Time		17:00:34

Elapsed Time (min)	Dial Reading (div)
Initial	**224.9**
0.05	188.2
0.10	187.3
0.15	186.8
0.20	186.5
0.25	186.5
0.40	186.1
0.50	185.9
1.00	185.5
2.25	185.1
4.00	184.9
9.00	184.5
16.00	184.1
25.00	184.0
36.00	183.9
49.00	183.9
64.00	183.7
81.00	183.5
100.00	183.3
121.00	183.3
144.00	183.4
180.00	183.1
300.00	182.9
520.00	183.3
700.00	183.0



Tested By JBD *Date* 5/15/2007 *Checked By* HMS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

C:\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 06.xls]Sheet2

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

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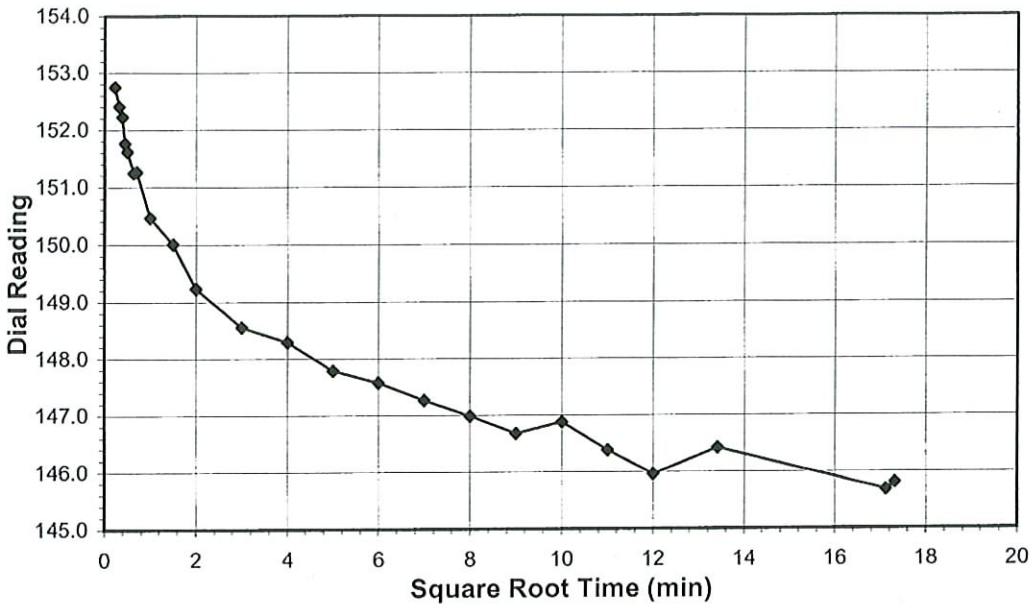
INTEGRITY IN TESTING

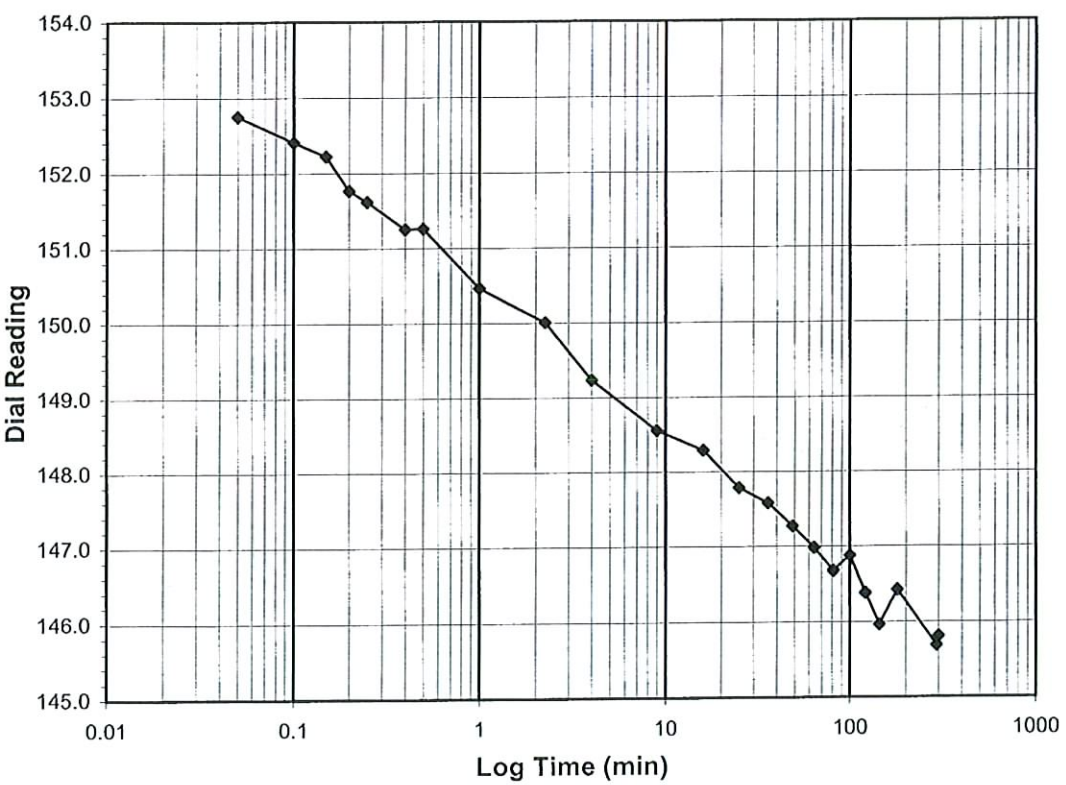
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-.25**
Final Reading	**(div)**	**145.8**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/16/2007
Start Time		8:30:16

Elapsed Time (min)	Dial Reading (div)
Initial	**183.0**
0.05	152.8
0.10	152.4
0.15	152.2
0.20	151.8
0.25	151.6
0.40	151.2
0.50	151.3
1.00	150.5
2.25	150.0
4.00	149.2
9.00	148.6
16.00	148.3
25.00	147.8
36.00	147.6
49.00	147.3
64.00	147.0
81.00	146.7
100.00	146.9
121.00	146.4
144.00	146.0
180.00	146.4
293.15	145.7
300.00	145.8



Tested By JBD *Date* 5/16/2007 *Checked By* MMS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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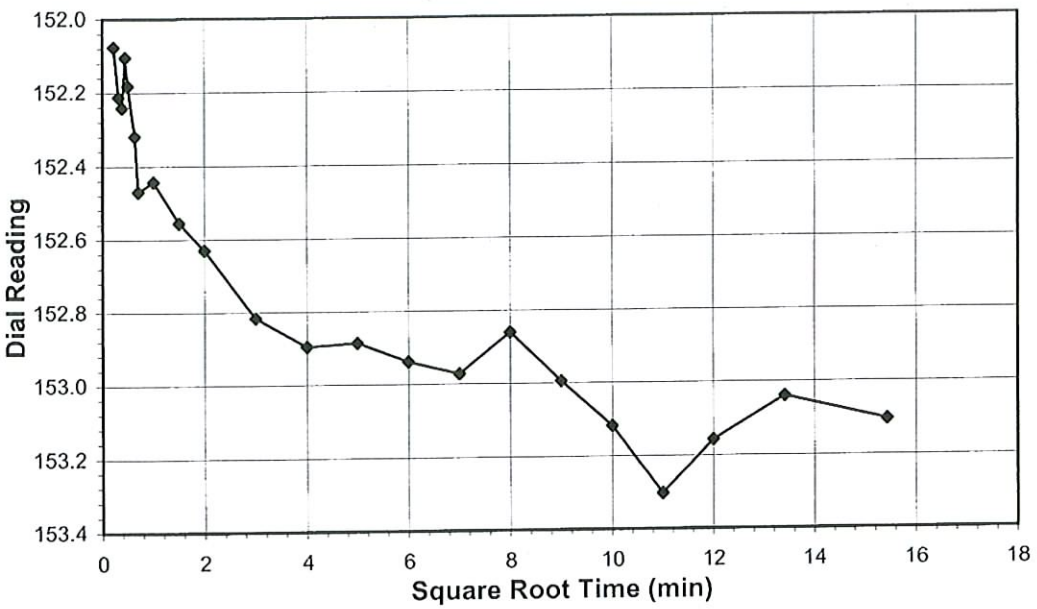
INTEGRITY IN TESTING

ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

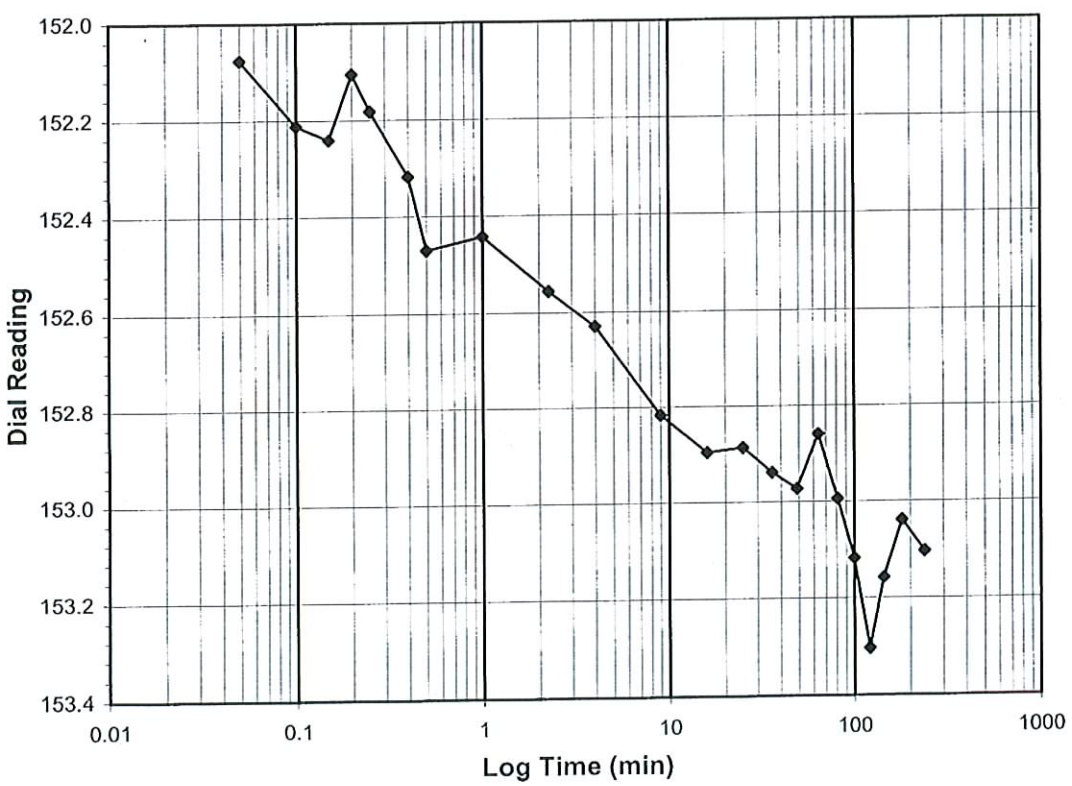
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**.25-.5**
Final Reading	**(div)**	**153.1**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/16/2007
Start Time		14:01:41

Elapsed Time (min)	Dial Reading (div)
Initial	**145.8**
0.05	152.1
0.10	152.2
0.15	152.2
0.20	152.1
0.25	152.2
0.40	152.3
0.50	152.5
1.00	152.4
2.25	152.6
4.00	152.6
9.00	152.8
16.00	152.9
25.00	152.9
36.00	152.9
49.00	153.0
64.00	152.9
81.00	153.0
100.00	153.1
121.00	153.3
144.00	153.2
180.00	153.0
238.28	153.1



Tested By JBD *Date* 5/16/2007 *Checked By* MDS *Date* 5-24-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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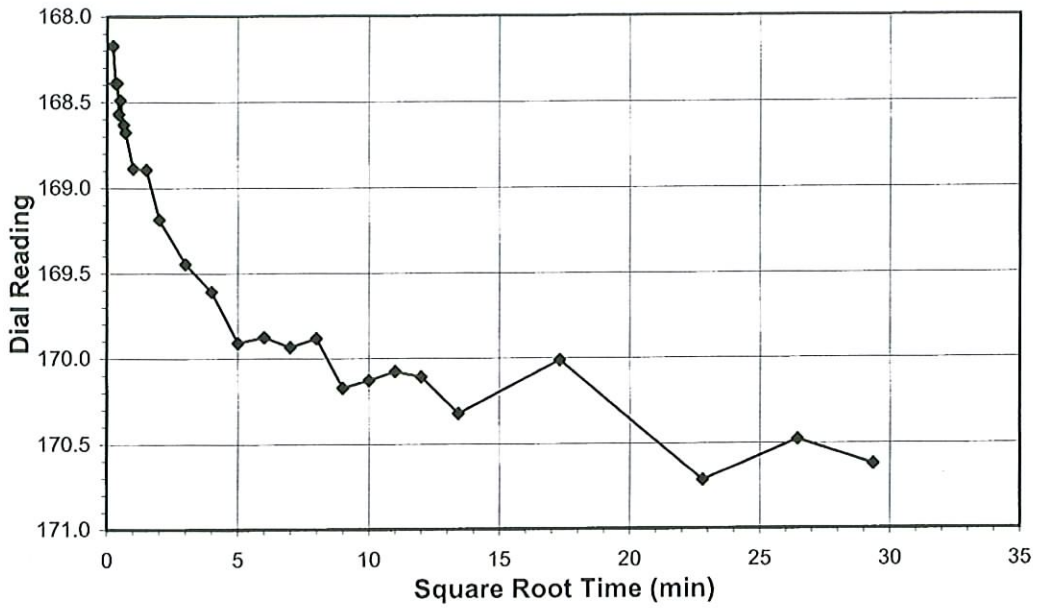
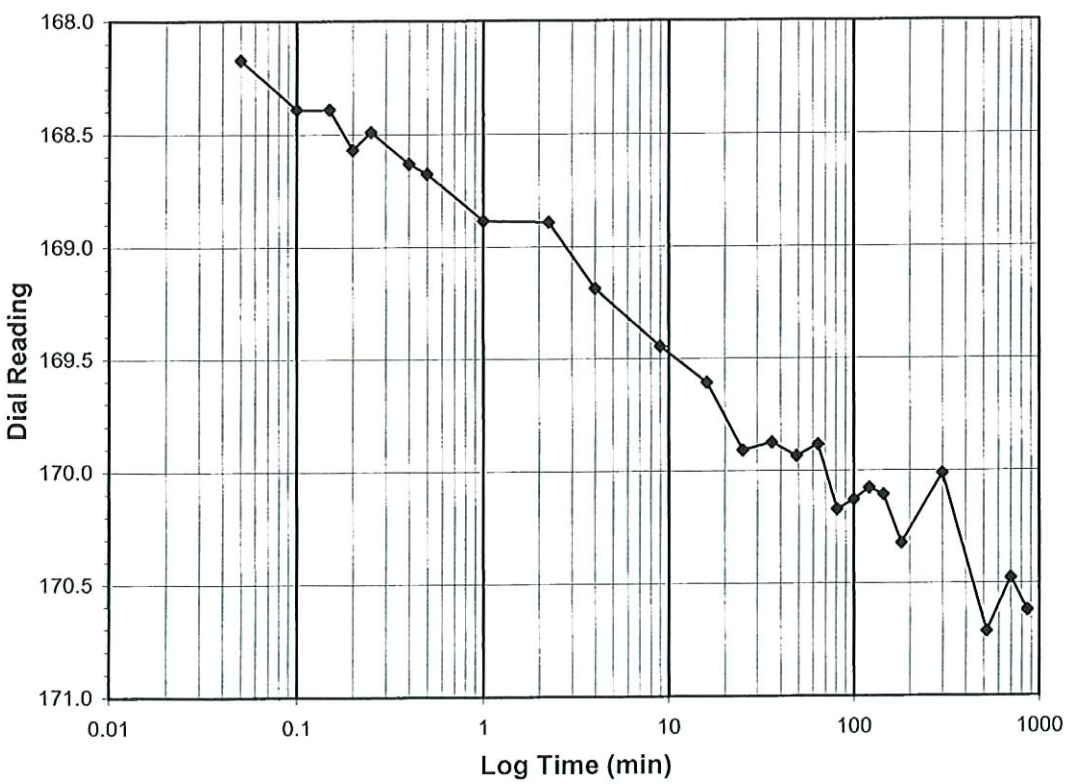
ASTM D 2435-96 (SOP-S24A)

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**.5-1**
Final Reading	**(div)**	**170.6**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/16/2007
Start Time		18:05:48

Elapsed Time (min)	Dial Reading (div)
Initial	**153.1**
0.05	168.2
0.10	168.4
0.15	168.4
0.20	168.6
0.25	168.5
0.40	168.6
0.50	168.7
1.00	168.9
2.25	168.9
4.00	169.2
9.00	169.4
16.00	169.6
25.00	169.9
36.00	169.9
49.00	169.9
64.00	169.9
81.00	170.2
100.00	170.1
121.00	170.1
144.00	170.1
180.00	170.3
300.00	170.0
520.00	170.7
700.00	170.5
862.15	170.6

Tested By JBD *Date* 5/16/2007 *Checked By* MMS *Date* 5-24-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *C:\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-09.xls]Sheet2*

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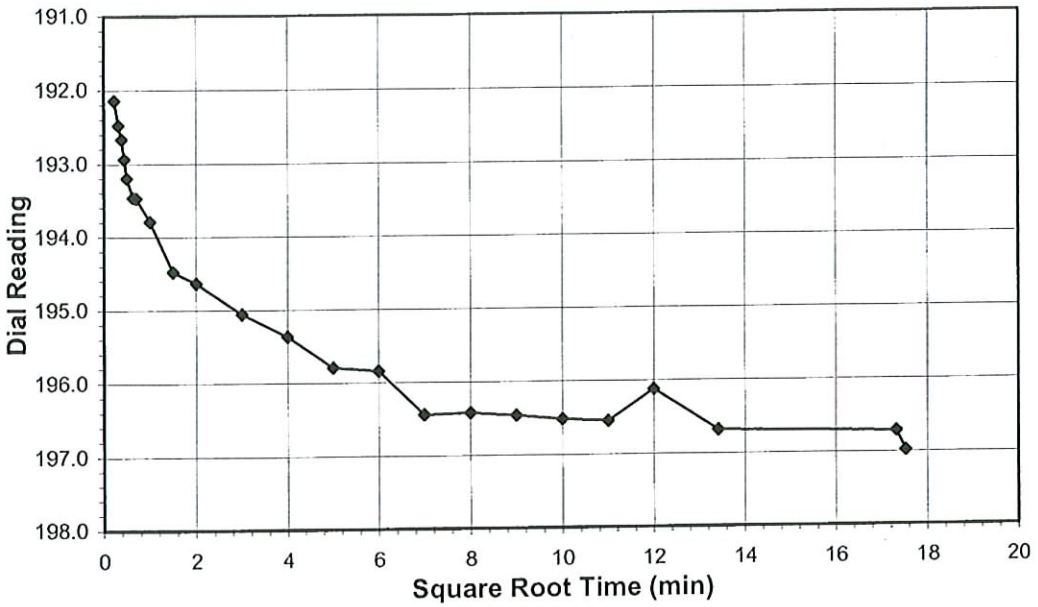
ASTM D 2435-96 (SOP-S24A)

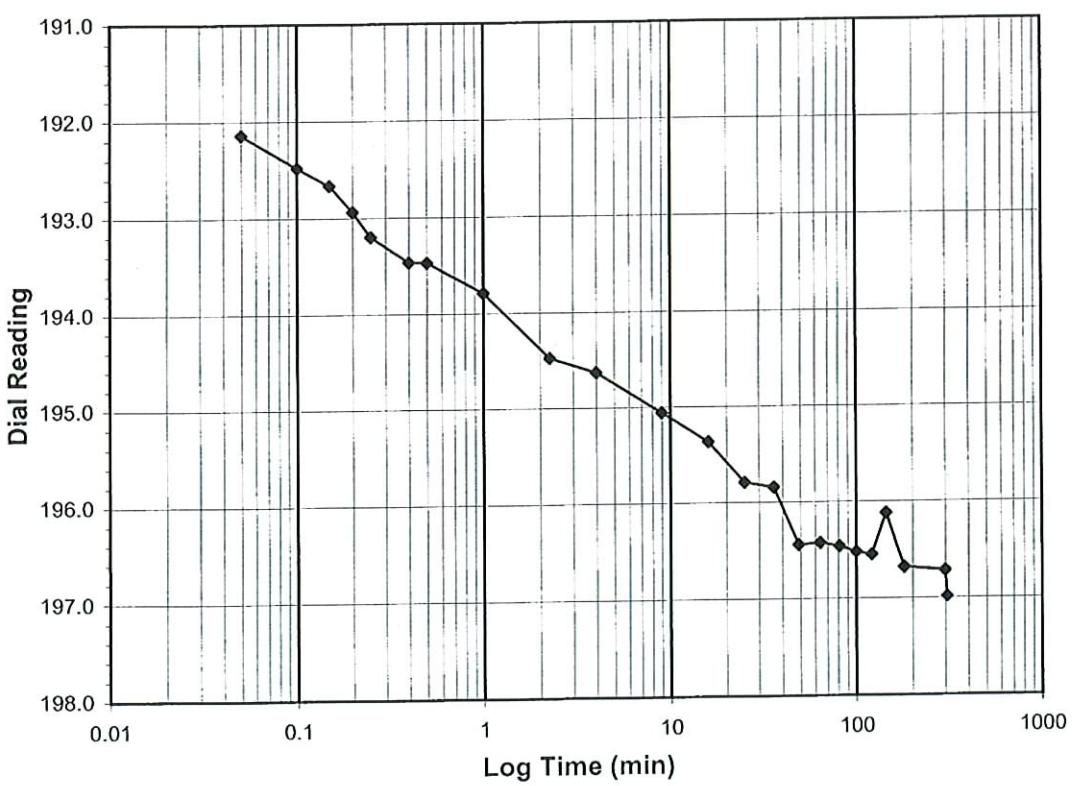
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-2**
Final Reading	**(div)**	**197.0**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/17/2007
Start Time		8:42:04

Elapsed Time (min)	Dial Reading (div)
Initial	**170.6**
0.05	192.1
0.10	192.5
0.15	192.7
0.20	192.9
0.25	193.2
0.40	193.5
0.50	193.5
1.00	193.8
2.25	194.5
4.00	194.6
9.00	195.1
16.00	195.4
25.00	195.8
36.00	195.8
49.00	196.4
64.00	196.4
81.00	196.5
100.00	196.5
121.00	196.5
144.00	196.1
180.00	196.7
300.00	196.7
306.92	197.0



Tested By JBD *Date* 5/17/2007 *Checked By* MMS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *C:\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 10.xls]Sheet2*

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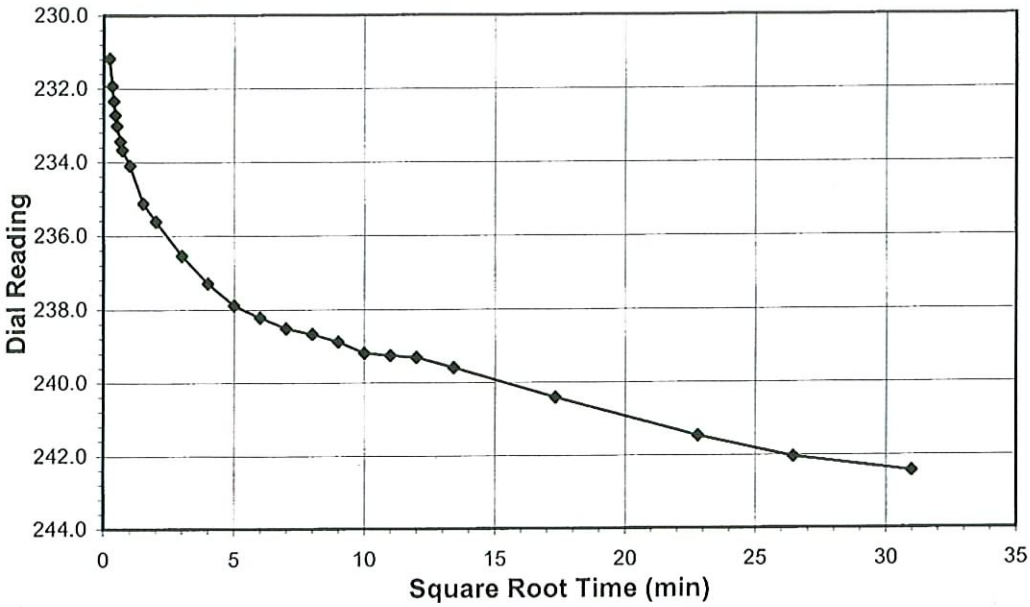
ASTM D 2435-96 (SOP-S24A)

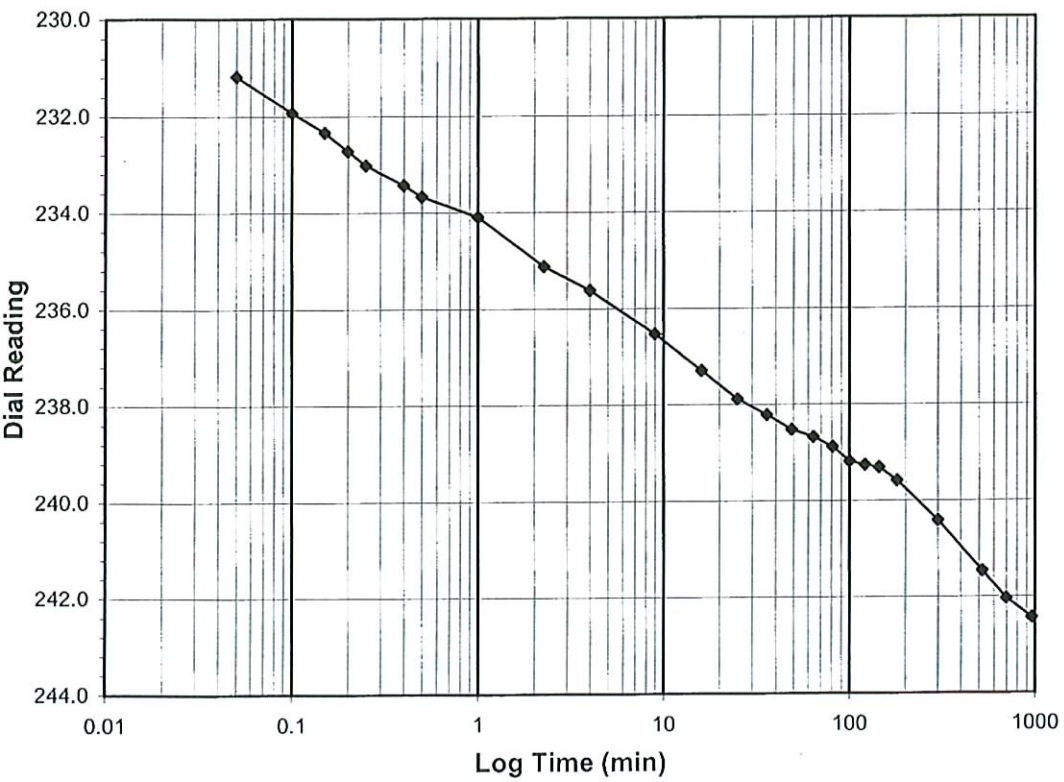
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**2-4**
Final Reading	**(div)**	**242.4**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/17/2007
Start Time		14:02:23

Elapsed Time (min)	Dial Reading (div)
Initial	**197.0**
0.05	231.2
0.10	231.9
0.15	232.3
0.20	232.7
0.25	233.0
0.40	233.4
0.50	233.7
1.00	234.1
2.25	235.1
4.00	235.6
9.00	236.5
16.00	237.3
25.00	237.9
36.00	238.2
49.00	238.5
64.00	238.7
81.00	238.9
100.00	239.2
121.00	239.3
144.00	239.3
180.00	239.6
300.00	240.4
520.00	241.5
700.00	242.0
960.00	242.4



Tested By JBD *Date* 5/17/2007 *Checked By* MBS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *C:\Program Files\TestNet 2007\2007 R299\2007-591-01-06\[2007-591-01-06 11.xls]Sheet2*

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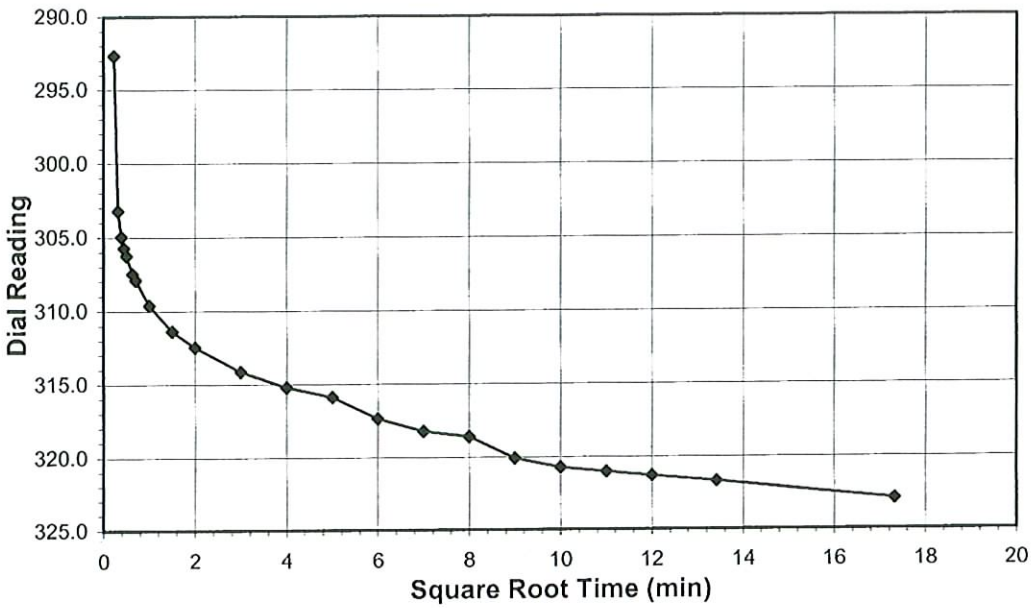
ASTM D 2435-96 (SOP-S24A)

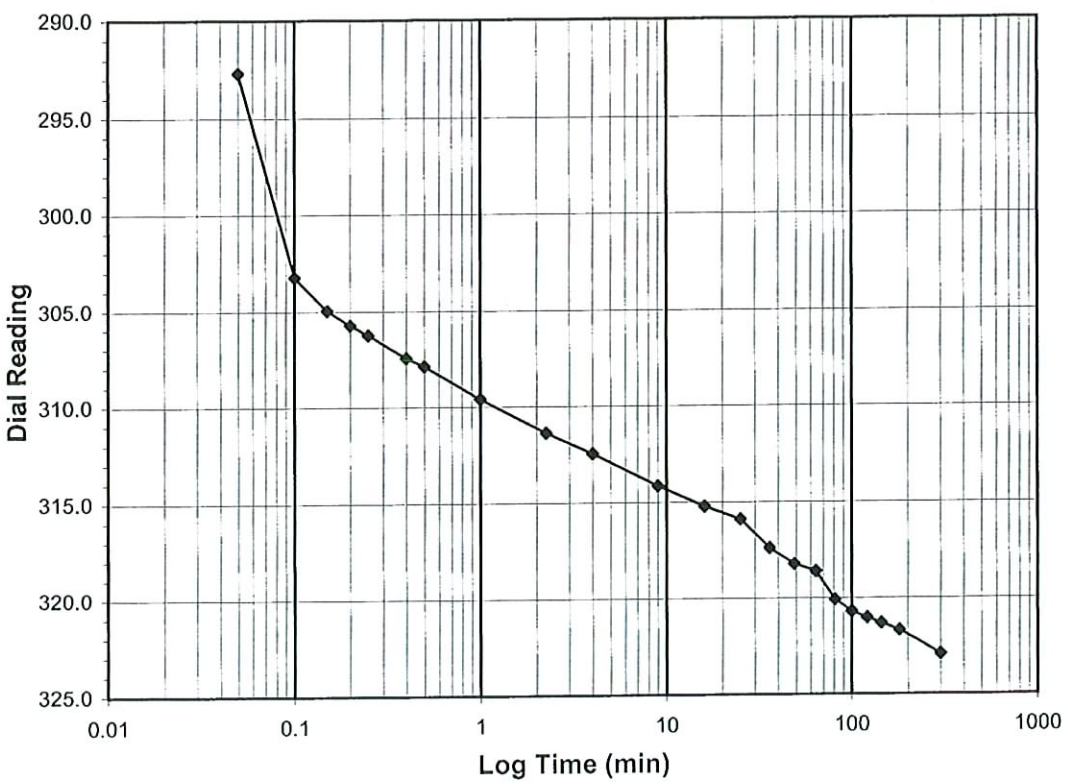
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**4-8**
Final Reading	**(div)**	**322.9**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/18/2007
Start Time		8:37:27

Elapsed Time (min)	Dial Reading (div)
Initial	**242.4**
0.05	292.7
0.10	303.2
0.15	305.0
0.20	305.7
0.25	306.3
0.40	307.5
0.50	307.9
1.00	309.6
2.25	311.4
4.00	312.5
9.00	314.1
16.00	315.2
25.00	315.9
36.00	317.4
49.00	318.2
64.00	318.6
81.00	320.1
100.00	320.7
121.00	321.0
144.00	321.3
180.00	321.7
300.00	322.9



Tested By JBD *Date* 5/18/2007 *Checked By* MKS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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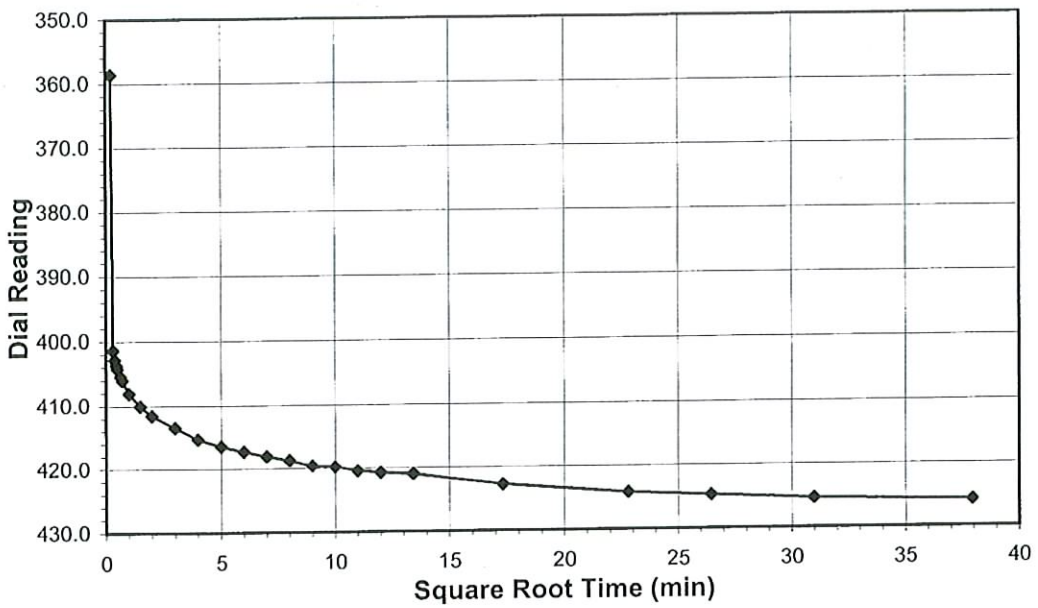
ASTM D 2435-96 (SOP-S24A)

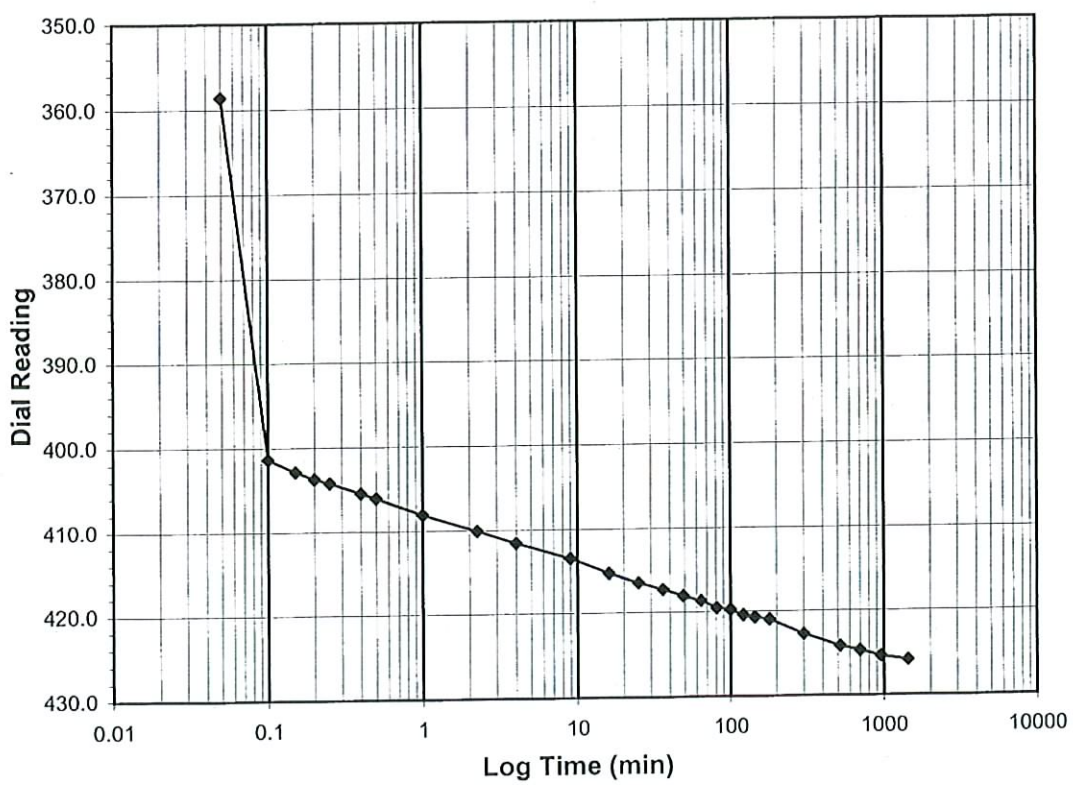
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**8-16**
Final Reading	**(div)**	**425.8**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/18/2007
Start Time		15:31:07

Elapsed Time (min)	Dial Reading (div)
Initial	**322.9**
0.05	358.6
0.10	401.4
0.15	402.8
0.20	403.7
0.25	404.2
0.40	405.4
0.50	406.0
1.00	408.1
2.25	410.1
4.00	411.6
9.00	413.4
16.00	415.3
25.00	416.5
36.00	417.3
49.00	418.1
64.00	418.7
81.00	419.6
100.00	419.8
121.00	420.5
144.00	420.7
180.00	421.0
300.00	422.8
520.00	424.2
700.00	424.7
960.00	425.4
1440.00	425.8



Tested By JBD *Date* 5/18/2007 *Checked By* [illegible] *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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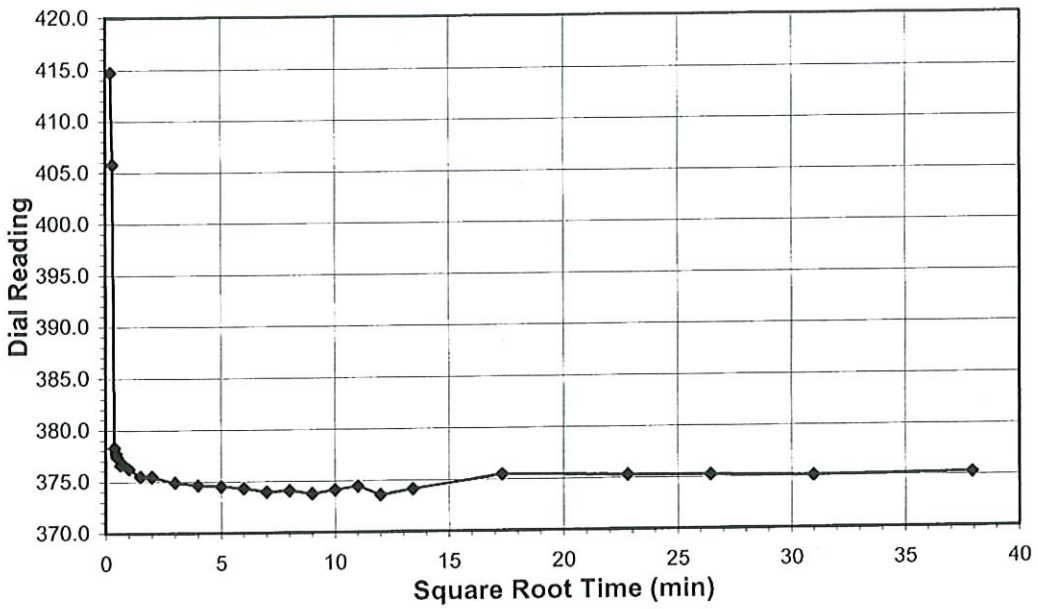
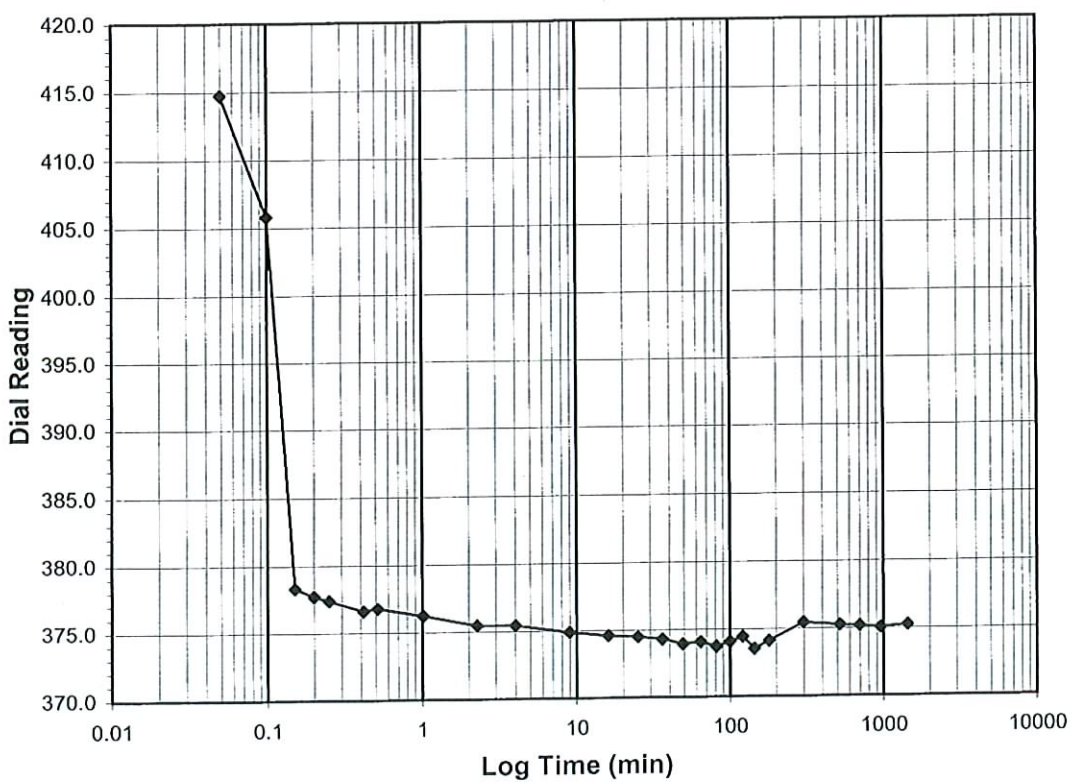
ASTM D 2435-96 (SOP-S24A)

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**16-4**
Final Reading	**(div)**	**375.2**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/19/2007
Start Time		15:56:13

Elapsed Time (min)	Dial Reading (div)
Initial	**425.8**
0.05	414.7
0.10	405.8
0.15	378.3
0.20	377.7
0.25	377.4
0.42	376.6
0.52	376.8
1.02	376.2
2.27	375.5
4.02	375.5
9.02	374.9
16.02	374.6
25.02	374.5
36.02	374.3
49.02	373.9
64.02	374.1
81.02	373.7
100.02	374.1
121.02	374.4
144.02	373.5
180.02	374.1
300.02	375.4
520.02	375.3
700.02	375.2
960.02	375.0
1440.02	375.2

Tested By JBD *Date* 5/19/2007 *Checked By* MMS *Date* 5-24-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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ASTM D 2435-96 (SOP-S24A)

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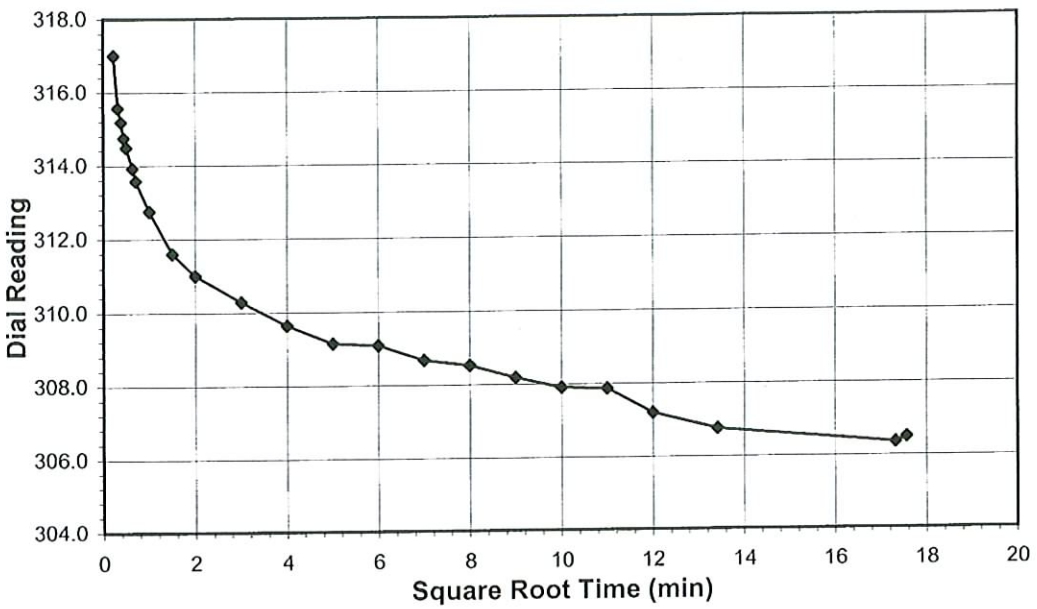
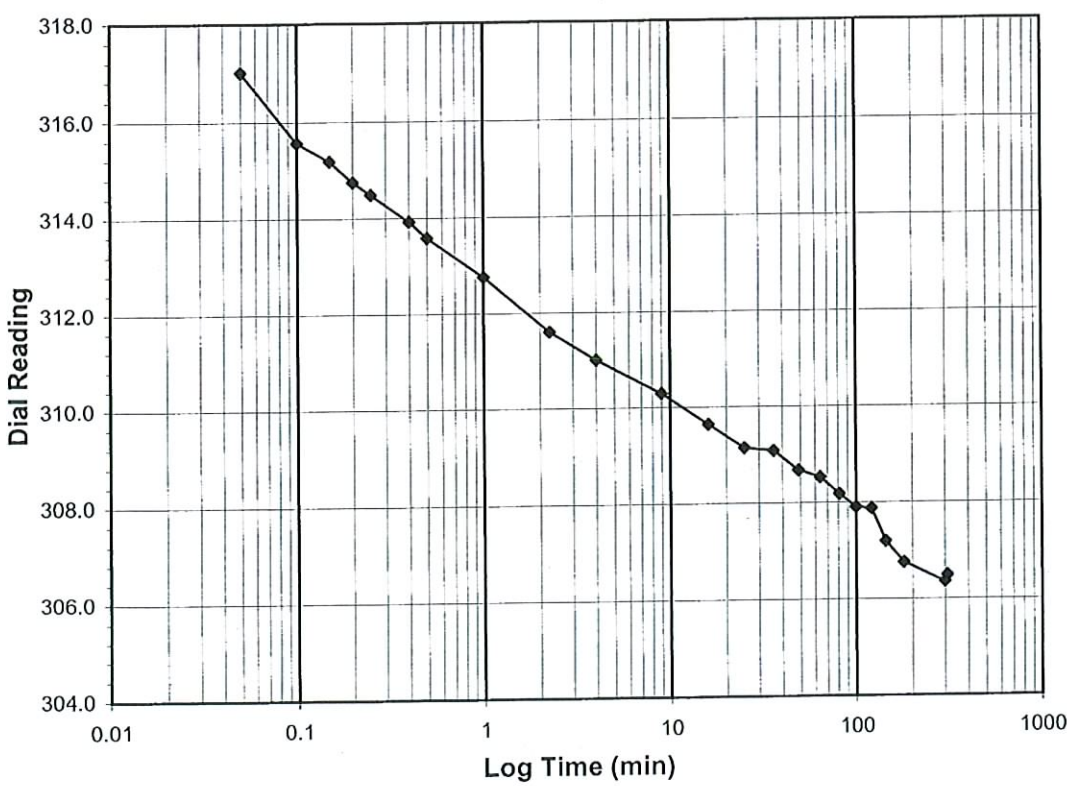
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**4-1**
Final Reading	**(div)**	**306.5**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/21/2007
Start Time		8:20:14

Elapsed Time (min)	Dial Reading (div)
Initial	**375.2**
0.05	317.0
0.10	315.6
0.15	315.2
0.20	314.7
0.25	314.5
0.40	313.9
0.50	313.6
1.00	312.8
2.25	311.6
4.00	311.0
9.00	310.3
16.00	309.6
25.00	309.1
36.00	309.1
49.00	308.7
64.00	308.5
81.00	308.2
100.00	307.9
121.00	307.9
144.00	307.2
180.00	306.8
300.00	306.4
308.52	306.5



Tested By JBD *Date* 5/21/2007 *Checked By* RHS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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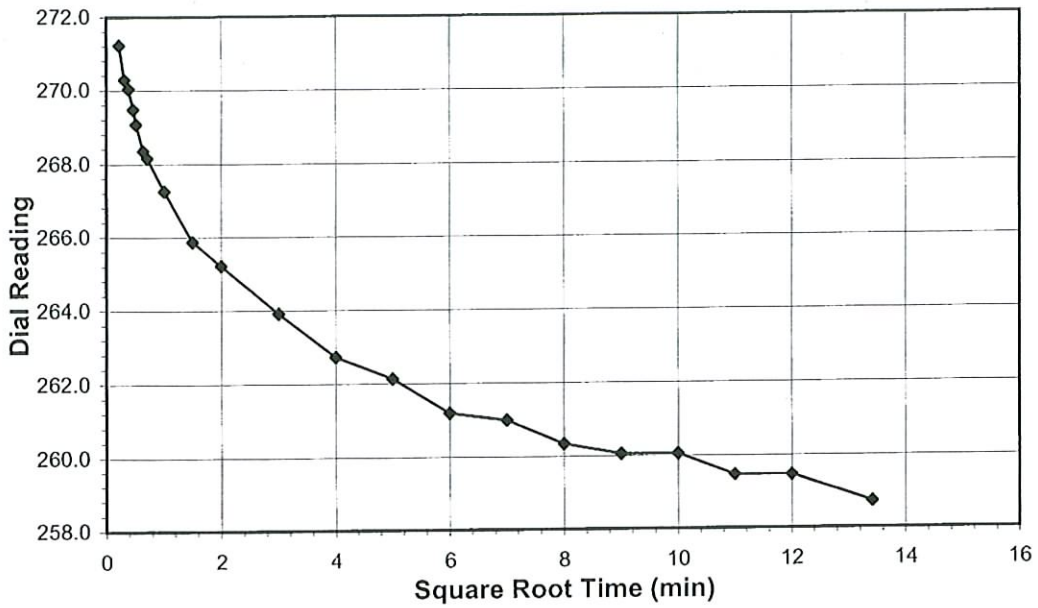
ASTM D 2435-96 (SOP-S24A)

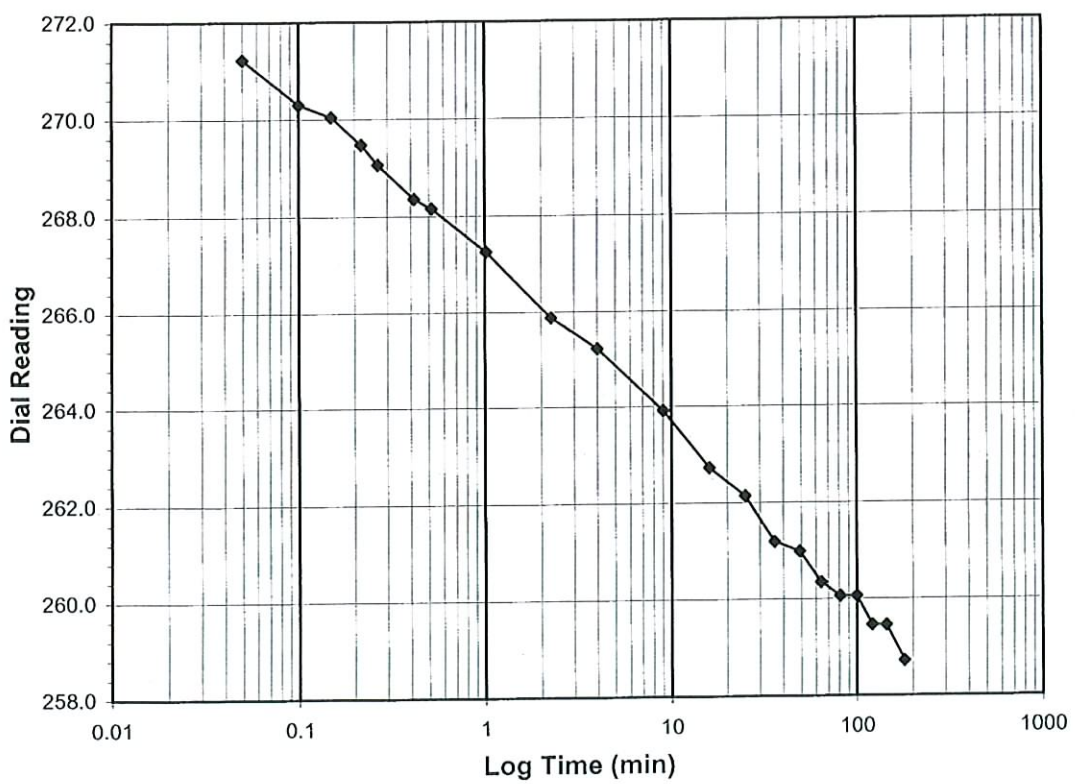
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	3.7-3.9
Project No.	2007-591-01	Sample No.	ST-1
Lab ID	2007-591-01-06	Visual Description	GRAY CLAY SAND

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-.25**
Final Reading	**(div)**	**258.7**
Consolidometer No.		**R299**
1 Division	(in)	0.0001
Start Date		5/21/2007
Start Time		13:37:05

Elapsed Time (min)	Dial Reading (div)
Initial	**306.5**
0.05	271.2
0.10	270.3
0.15	270.0
0.22	269.5
0.27	269.1
0.42	268.4
0.52	268.2
1.02	267.3
2.27	265.9
4.02	265.2
9.02	263.9
16.02	262.7
25.02	262.1
36.02	261.2
49.02	261.0
64.02	260.3
81.02	260.1
100.02	260.1
121.02	259.5
144.02	259.5
180.02	258.7



Tested By JBD *Date* 5/21/2007 *Checked By* MHM *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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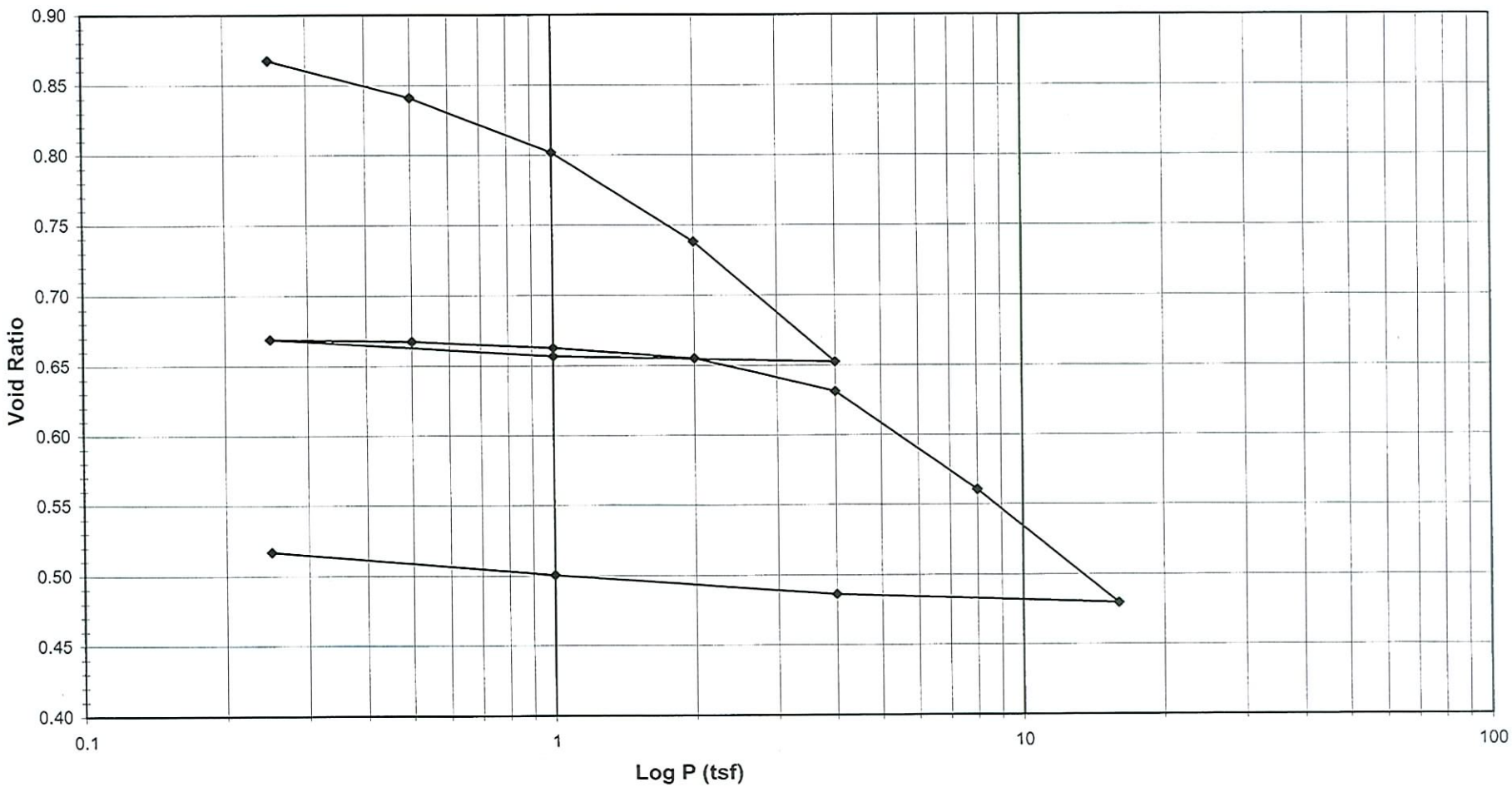
ASTM D 2435-96 (SOP-S24)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Tested By JBD *Date* 5/26/07 *Approved By* DB *Date* 5-29-07

DCN: CT-S24F Date: 11/26/05 Revision: 5

Z:\2007 PROJECTS\2007-591 CDM\[CONFINAL(RALEIGH) 2007-591-01-07.xls]Sheet1

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24)

Client	CDM	Boring No.	B-104
Client Reference	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED
Consolidometer No. 275
1 Division = 0.0001 (in)

Sample Properties	**Initial**	**Final**
Water Content		
Tare Number	B-3	Z-14
Wt. Tare & WS (gm)	188.10	223.32
Wt. Tare & DS (gm)	169.60	204.00
Wt. Water (gm)	18.50	19.32
Wt. Tare (gm)	97.75	100.36
Wt. DS (gm)	71.85	103.64
Water Content (%)	25.75	18.64
Sample Parameters		
Sample Diameter (in)	2.5	2.5
Sample Height (in)	1.000	0.796
Sample Volume (cc)	80.44	64.03
Wt. Wet Sample + Ring (gm)	354.58	346.48
Wt. of Ring (gm)	211.26	211.26
Wt. of Wet Sample (gm)	143.32	135.22
Wet Density (pcf)	111.18	131.77
Wet Density (g/cc)	1.78	2.11
Water Content (%)	25.75	18.64
Wt. of Dry Sample (gm)	113.97	113.97
Dry Density (pcf)	88.41	111.07
Dry Density (g/cc)	1.42	1.78
Void Ratio	0.9056	0.5169
Saturation (%)	76.77	97.37
Specific Gravity	2.70	*Assumed*

Test Data Summary

Applied Pressure (tsf)	Final Dial Reading (div)	Machine Deflection (div)	Corrected Reading (div)	Height of Sample (mm)	Volume (cc)	Dry Density (g/cc)	Void Ratio
Seating	0	0	0	25.400	80.440	1.41688	**0.90559**
0.25	207.3	6.7	200.6	24.890	78.826	1.44589	**0.86736**
0.5	352.4	12.6	339.8	24.537	77.706	1.46672	**0.84084**
1	565.5	20.1	545.4	24.015	76.053	1.49862	**0.80166**
2	910.0	30.3	879.7	23.166	73.364	1.55355	**0.73795**
4	1371.3	42.8	1328.5	22.026	69.753	1.63396	**0.65243**
1	1332.4	27.0	1305.4	22.084	69.939	1.62961	**0.65683**
0.25	1254.3	13.2	1241.1	22.248	70.456	1.61765	**0.66909**
0.5	1265.2	15.9	1249.3	22.227	70.390	1.61917	**0.66752**
1	1295.8	21.9	1273.9	22.164	70.193	1.62373	**0.66284**
2	1345.4	31.0	1314.4	22.061	69.867	1.63130	**0.65512**
4	1482.7	43.0	1439.7	21.743	68.859	1.65518	**0.63124**
8	1868.5	57.3	1811.2	20.800	65.871	1.73027	**0.56045**
16	2308.5	72.3	2236.2	19.720	62.452	1.82499	**0.47946**
4	2253.8	51.9	2201.9	19.807	62.728	1.81696	**0.48600**
1	2158.2	31.2	2127.0	19.997	63.330	1.79968	**0.50027**
0.25	2056.0	16.3	2039.7	20.219	64.033	1.77994	**0.51691**

Tested By JBD *Date* 5/26/07 *Input Checked By* MMS *Date* 5-29-07

DCN: CT-S24F Date: 11/26/05 Revision: 5

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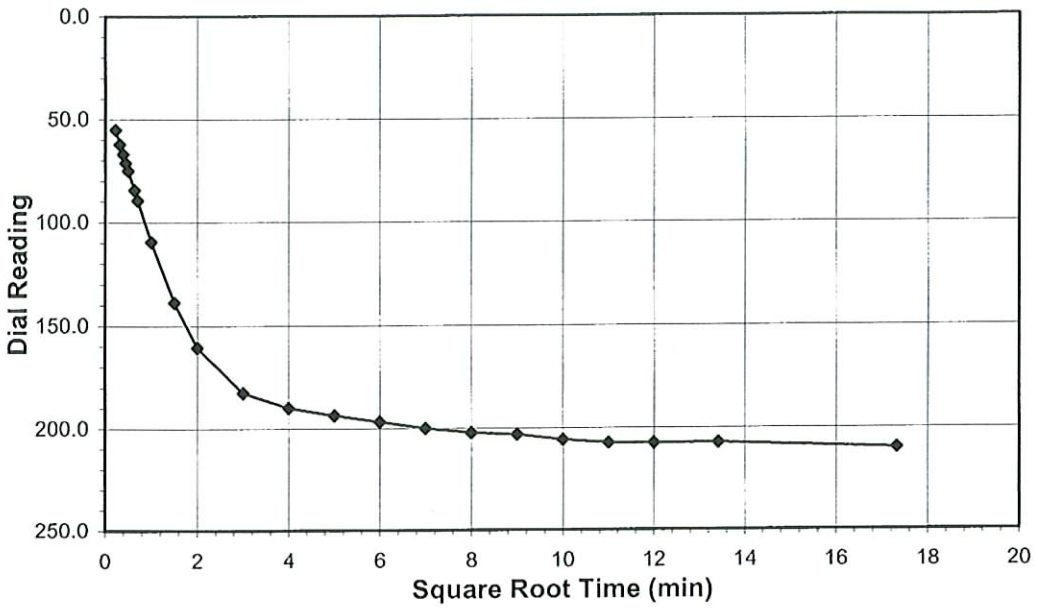
INTEGRITY IN TESTING

ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

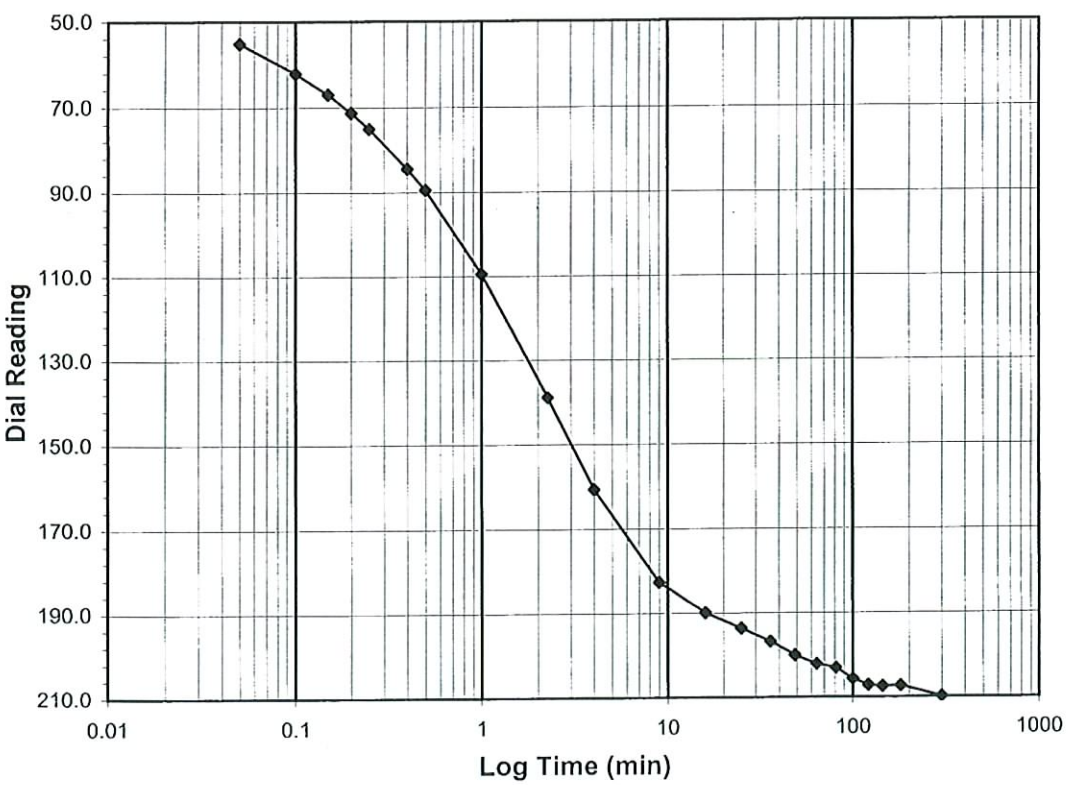
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**0-.25**
Final Reading	**(div)**	**207.3**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/18/07
Start Time		9:52:11

Elapsed Time (min)	Dial Reading (div)
Initial	**0.0**
0.05	55.1
0.10	62.1
0.15	67.0
0.20	71.3
0.25	75.1
0.40	84.5
0.50	89.5
1.00	109.5
2.25	138.8
4.00	160.6
9.00	182.6
16.00	189.9
25.00	193.6
36.00	196.7
49.00	200.0
64.00	202.1
81.00	203.1
100.00	205.7
121.00	207.2
144.00	207.5
180.00	207.3



Tested By JBD *Date* 05/18/07 *Checked By* [illegible] *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 01.xls]Sheet2*

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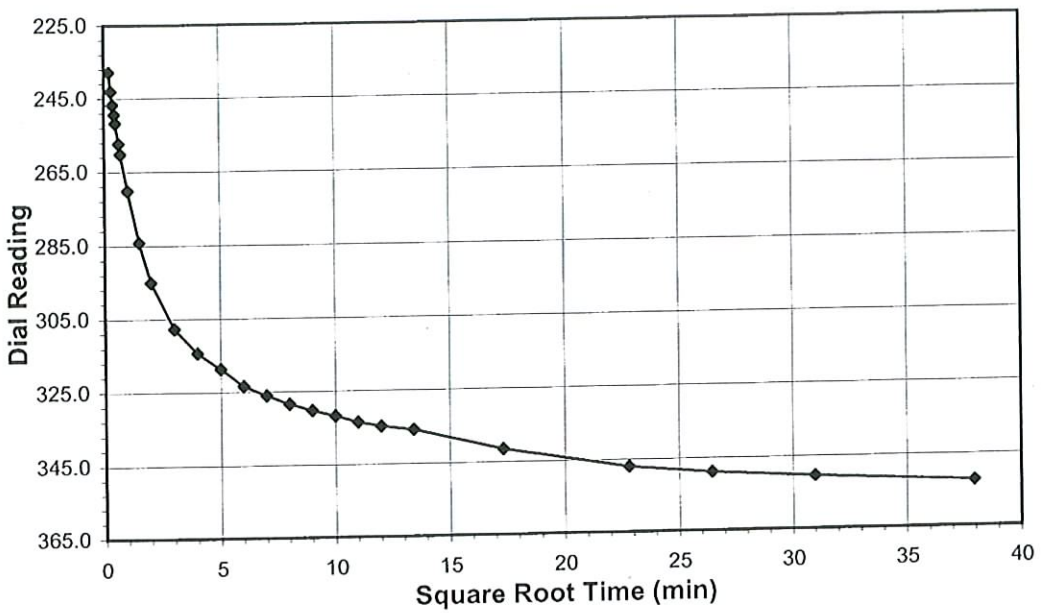
ASTM D 2435-96 (SOP-S24A)

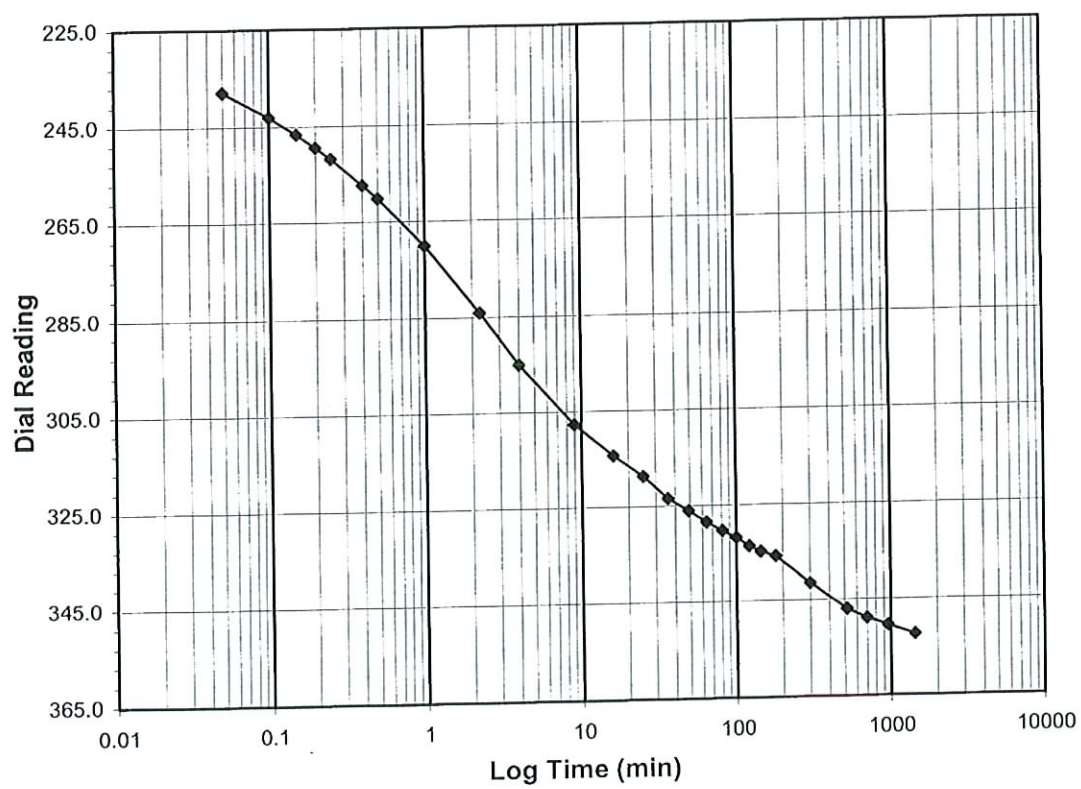
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**.25-.5**
Final Reading	**(div)**	**352.4**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/18/07
Start Time		14:59:13

Elapsed Time (min)	Dial Reading (div)
Initial	**207.3**
0.05	237.8
0.10	243.0
0.15	246.7
0.20	249.4
0.25	251.8
0.40	257.4
0.50	260.2
1.00	270.1
2.25	284.1
4.00	295.1
9.00	307.7
16.00	314.3
25.00	318.7
36.00	323.4
49.00	326.0
64.00	328.4
81.00	330.2
100.00	331.8
121.00	333.5
144.00	334.7
180.00	335.7
300.00	341.5
520.00	347.0
700.00	348.9
960.00	350.5
1440.00	352.4



Tested By JBD *Date* 05/18/07 *Checked By* MM *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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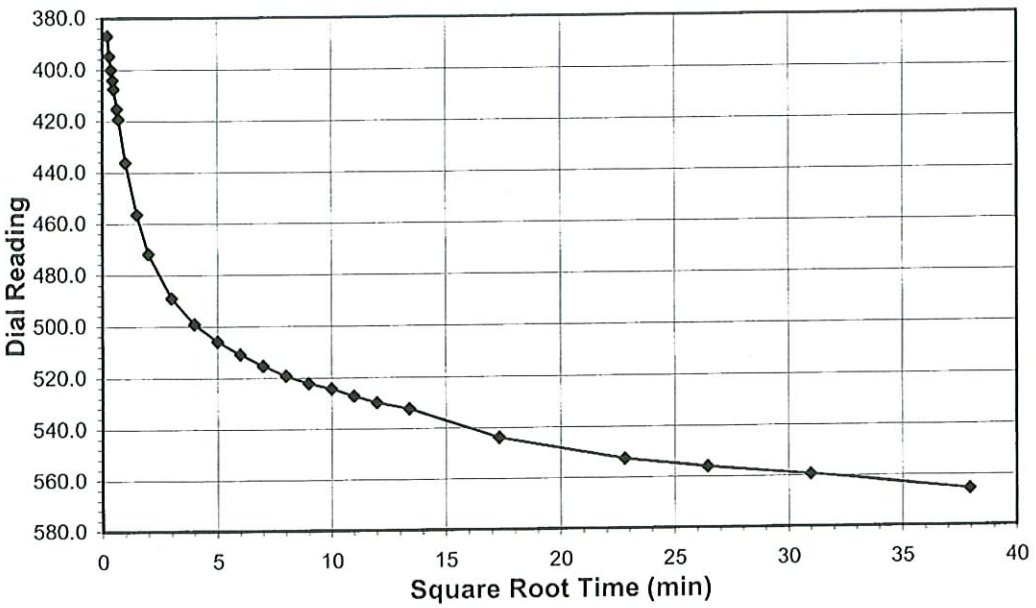
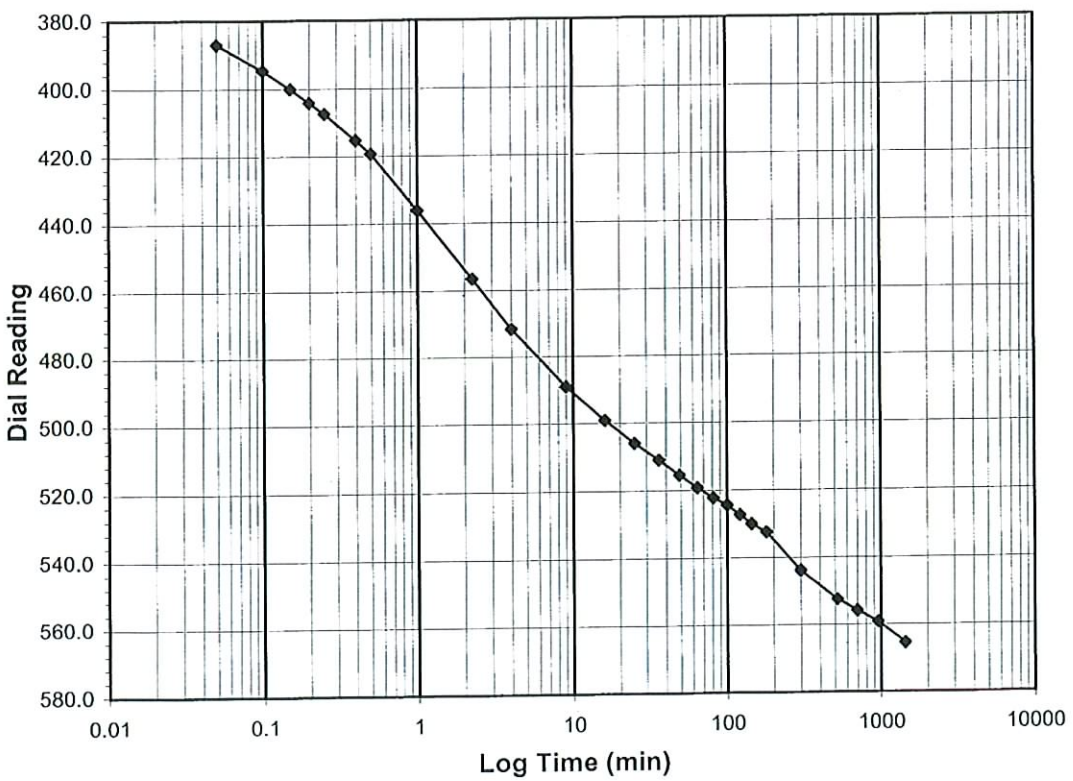
ASTM D 2435-96 (SOP-S24A)

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**.5-1**
Final Reading	**(div)**	**565.5**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/19/07
Start Time		15:55:36

Elapsed Time (min)	Dial Reading (div)
Initial	**352.4**
0.05	386.9
0.10	394.7
0.15	400.1
0.20	404.2
0.25	407.5
0.40	415.2
0.50	419.3
1.00	436.1
2.25	456.5
4.00	471.8
9.00	489.1
16.00	499.1
25.00	506.0
36.00	511.0
49.00	515.5
64.00	519.3
81.00	522.3
100.00	524.4
121.00	527.2
144.00	529.9
180.00	532.4
300.00	543.9
520.00	552.5
700.00	556.0
960.00	559.3
1440.00	565.5

Tested By JBD *Date* 05/19/07 *Checked By* MAS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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ASTM D 2435-96 (SOP-S24A)

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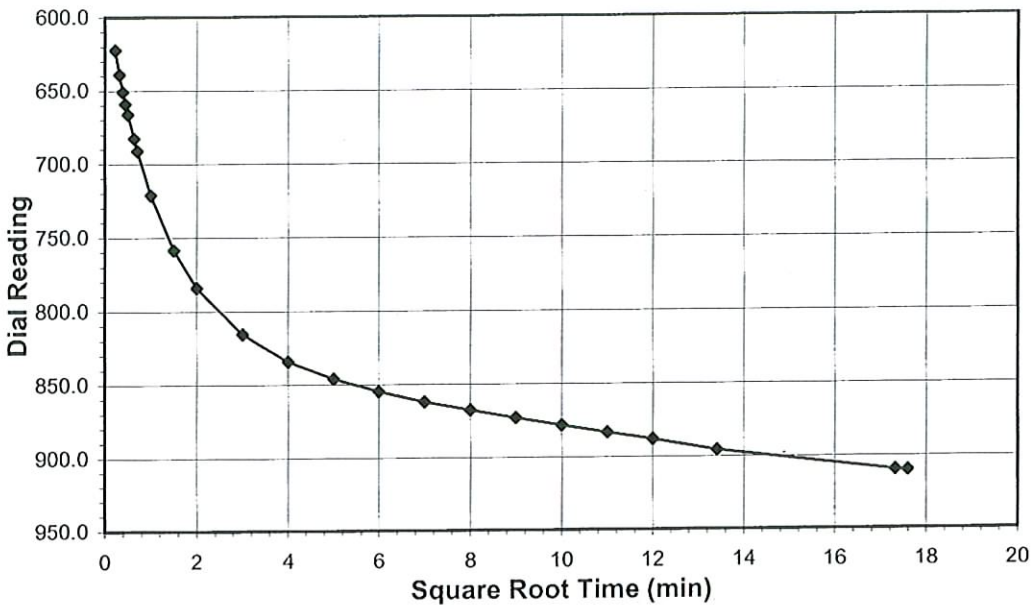
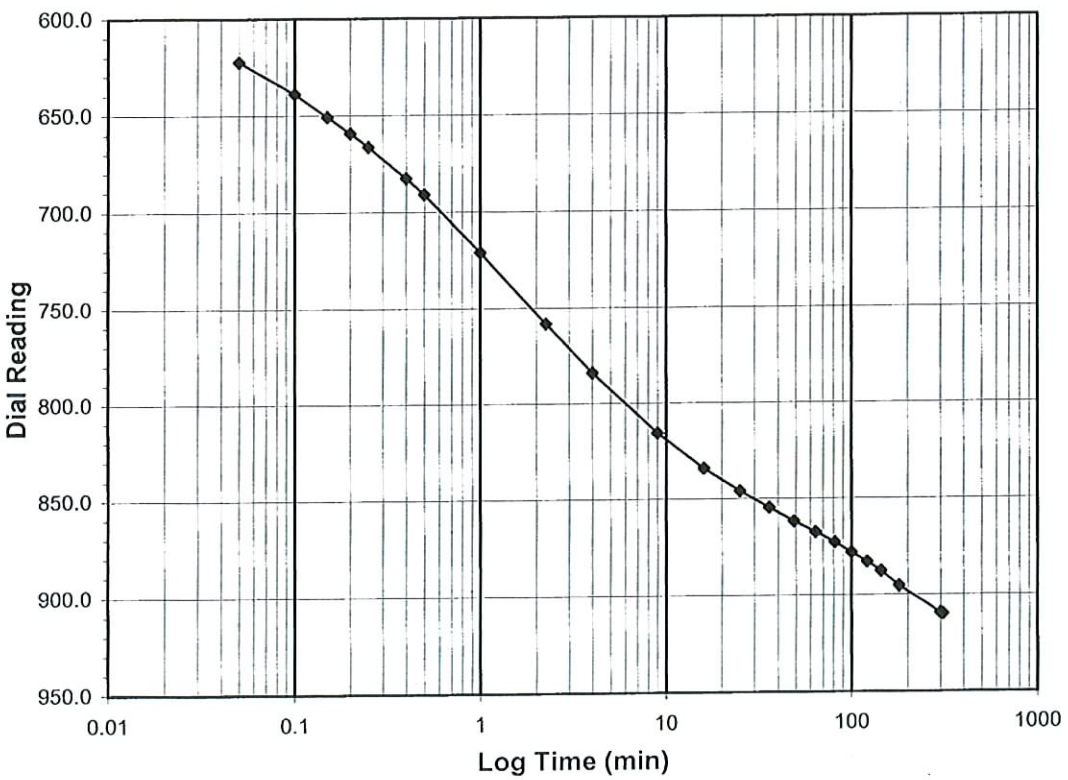
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**1-2**
Final Reading	**(div)**	**910.1**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/21/07
Start Time		8:19:19

Elapsed Time (min)	Dial Reading (div)
Initial	**565.5**
0.05	622.4
0.10	639.1
0.15	650.8
0.20	659.2
0.25	666.3
0.40	682.6
0.50	691.1
1.00	721.2
2.25	758.4
4.00	784.1
9.00	815.5
16.00	834.2
25.00	846.0
36.00	854.7
49.00	862.0
64.00	867.6
81.00	872.9
100.00	878.3
121.00	883.2
144.00	888.0
180.00	895.6
300.00	909.6
309.62	910.1

Tested By JBD *Date* 05/21/07 *Checked By* MBI *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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ASTM D 2435-96 (SOP-S24A)

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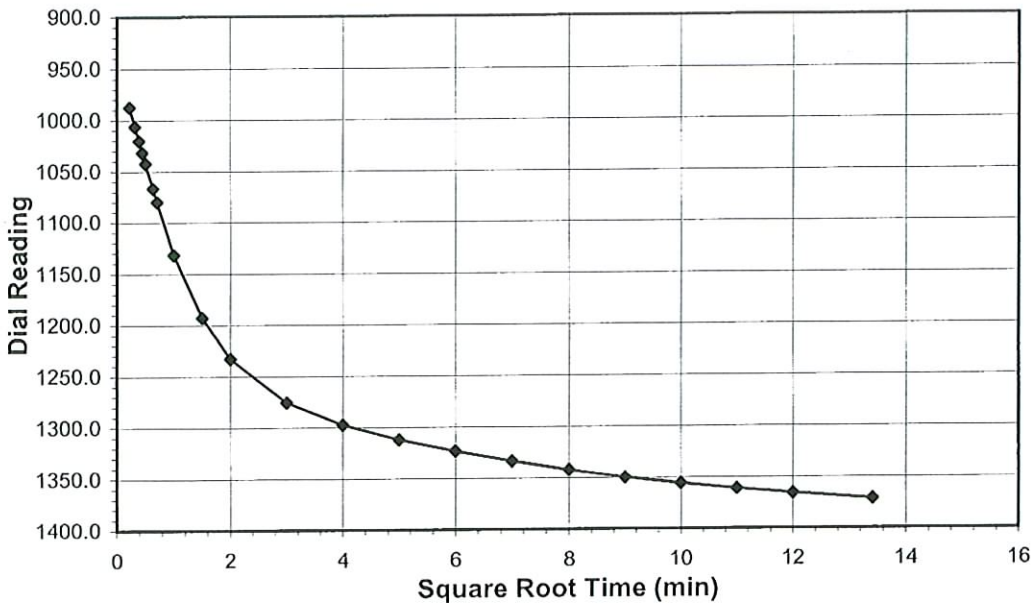
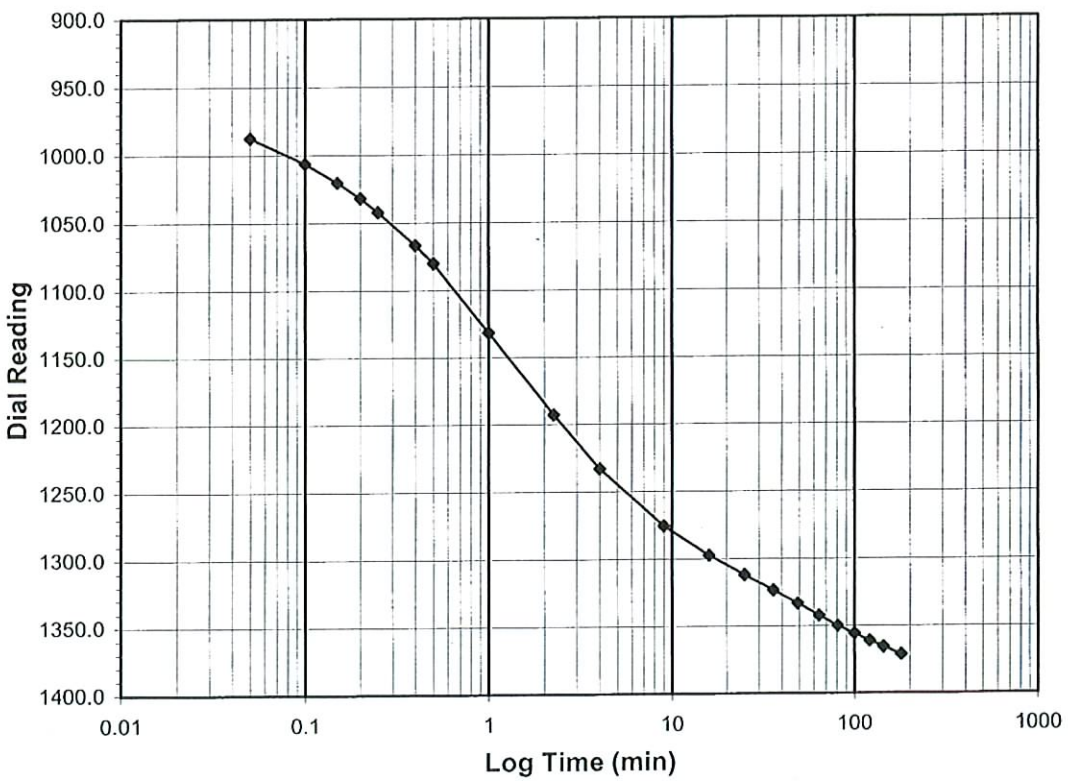
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**2-4**
Final Reading	**(div)**	**1371.3**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/21/07
Start Time		13:36:16

Elapsed Time (min)	Dial Reading (div)
Initial	**910.1**
0.05	987.5
0.10	1006.3
0.15	1020.3
0.20	1031.9
0.25	1042.3
0.40	1066.7
0.50	1080.1
1.00	1131.8
2.25	1192.9
4.00	1233.0
9.00	1275.7
16.00	1297.6
25.00	1312.1
36.00	1323.3
49.00	1333.3
64.00	1342.1
81.00	1349.9
100.00	1355.9
121.00	1361.2
144.00	1365.7
180.00	1371.3



Tested By JBD *Date* 05/21/07 *Checked By* MRS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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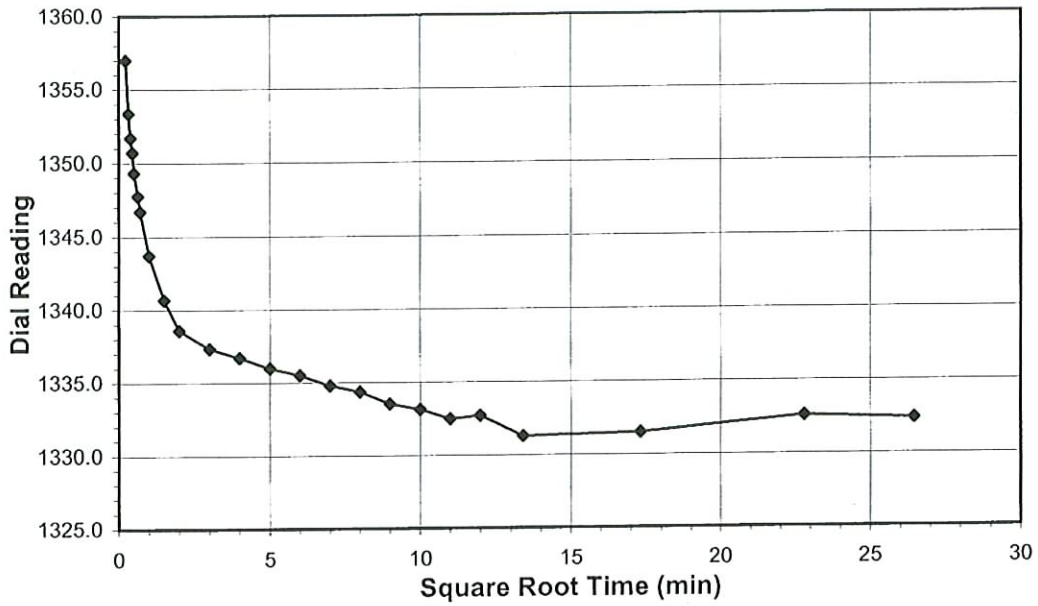
INTEGRITY IN TESTING

ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

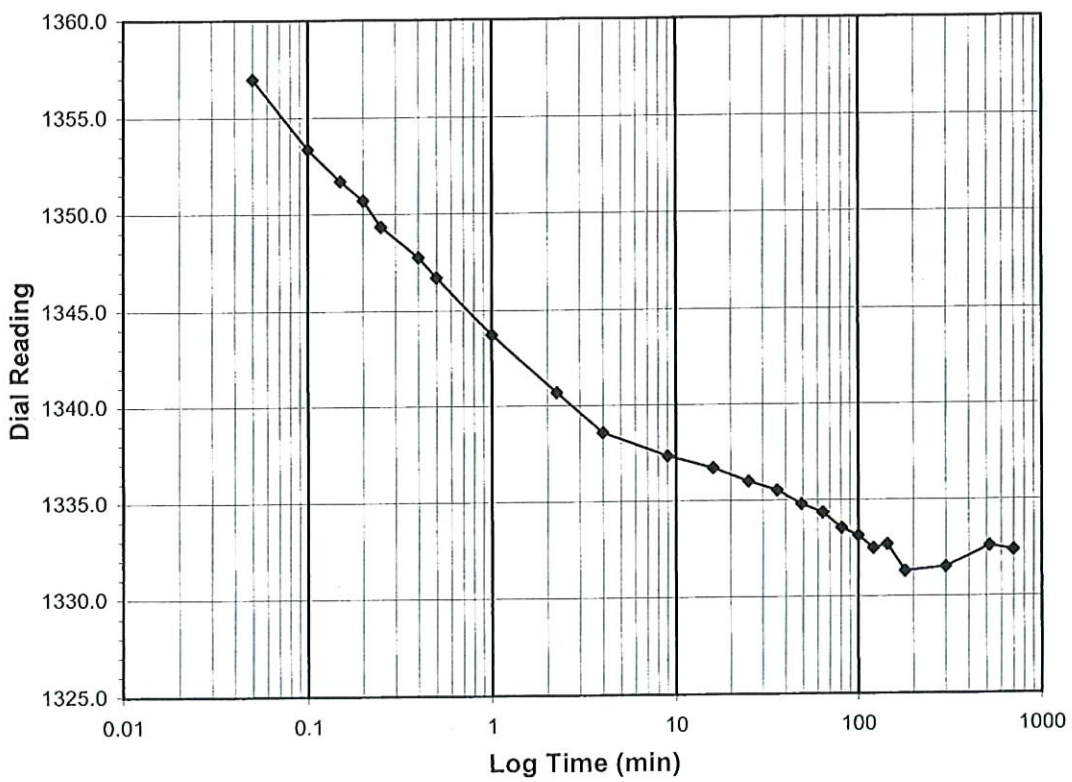
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**4-1**
Final Reading	**(div)**	**1332.4**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/21/07
Start Time		17:53:04

Elapsed Time (min)	Dial Reading (div)
Initial	**1371.3**
0.05	1357.0
0.10	1353.4
0.15	1351.7
0.20	1350.7
0.25	1349.3
0.40	1347.7
0.50	1346.7
1.00	1343.7
2.25	1340.7
4.00	1338.6
9.00	1337.3
16.00	1336.7
25.00	1336.0
36.00	1335.5
49.00	1334.8
64.00	1334.3
81.00	1333.5
100.00	1333.1
121.00	1332.5
144.00	1332.7
180.00	1331.3
300.00	1331.5
520.00	1332.6
700.00	1332.4



Tested By JBD *Date* 05/21/07 *Checked By* [illegible] *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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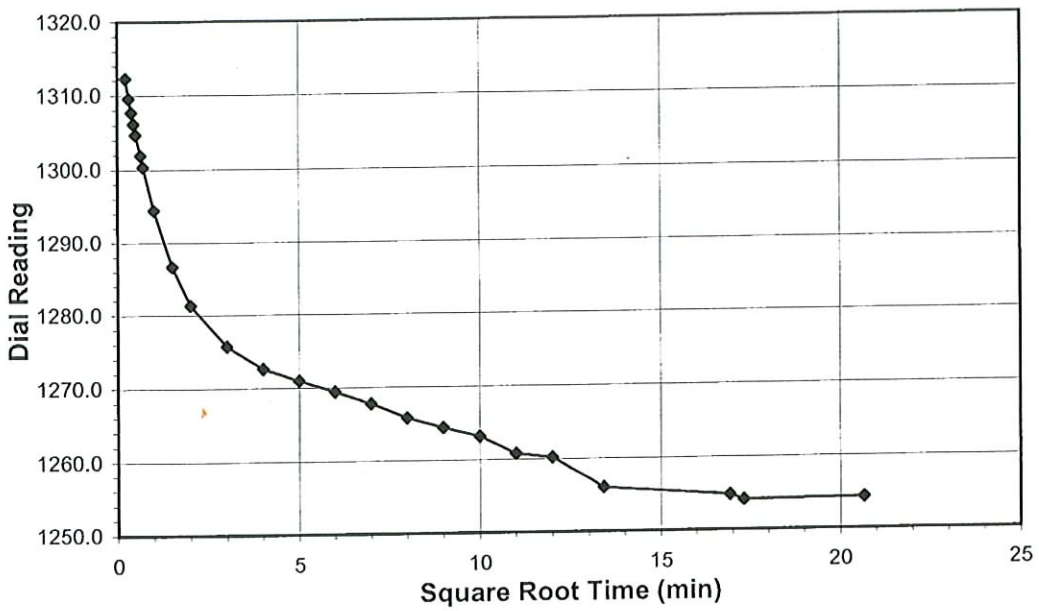
INTEGRITY IN TESTING

ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

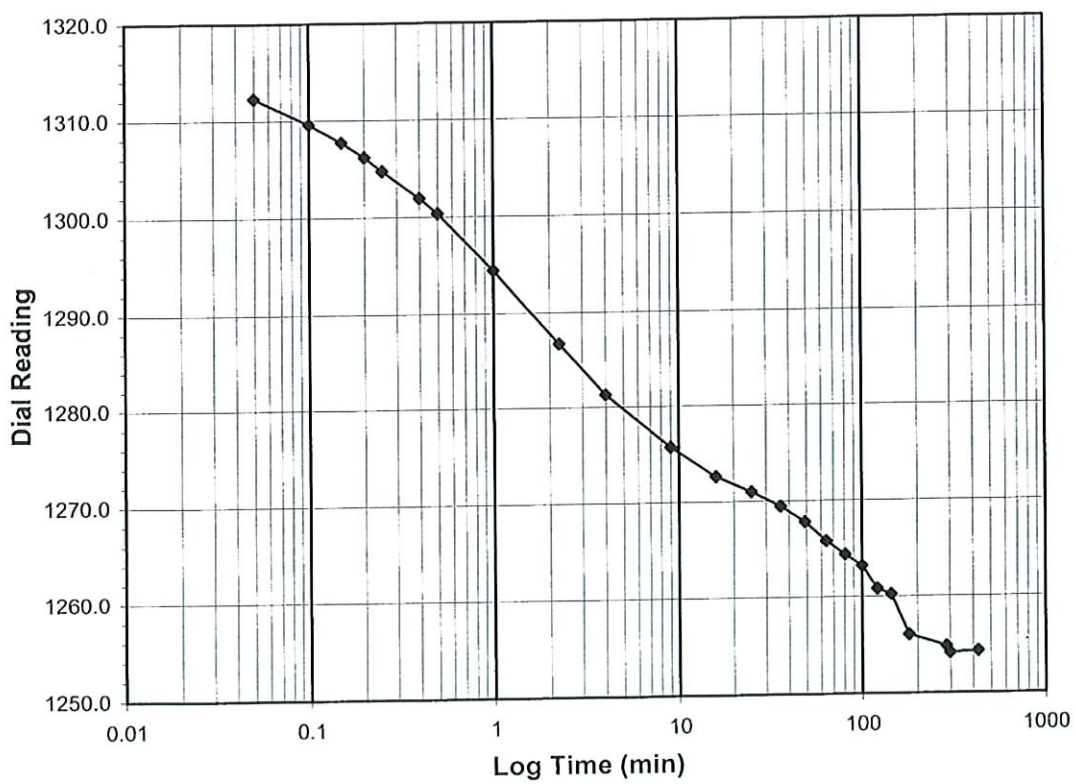
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-.25**
Final Reading	**(div)**	**1254.3**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/22/07
Start Time		8:42:13

Elapsed Time (min)	Dial Reading (div)
Initial	**1332.4**
0.05	1312.3
0.10	1309.6
0.15	1307.7
0.20	1306.1
0.25	1304.7
0.40	1301.9
0.50	1300.3
1.00	1294.4
2.25	1286.7
4.00	1281.3
9.00	1275.7
16.00	1272.6
25.00	1271.0
36.00	1269.4
49.00	1267.8
64.00	1265.8
81.00	1264.4
100.00	1263.2
121.00	1260.8
144.00	1260.2
180.00	1256.0
286.73	1254.8
300.00	1254.1
426.93	1254.3



Tested By JBD *Date* 05/22/07 *Checked By* MMS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 07.xls]Sheet2*

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ONE DIMENSIONAL CONSOLIDATION

ASTM D 2435-96 (SOP-S24A)

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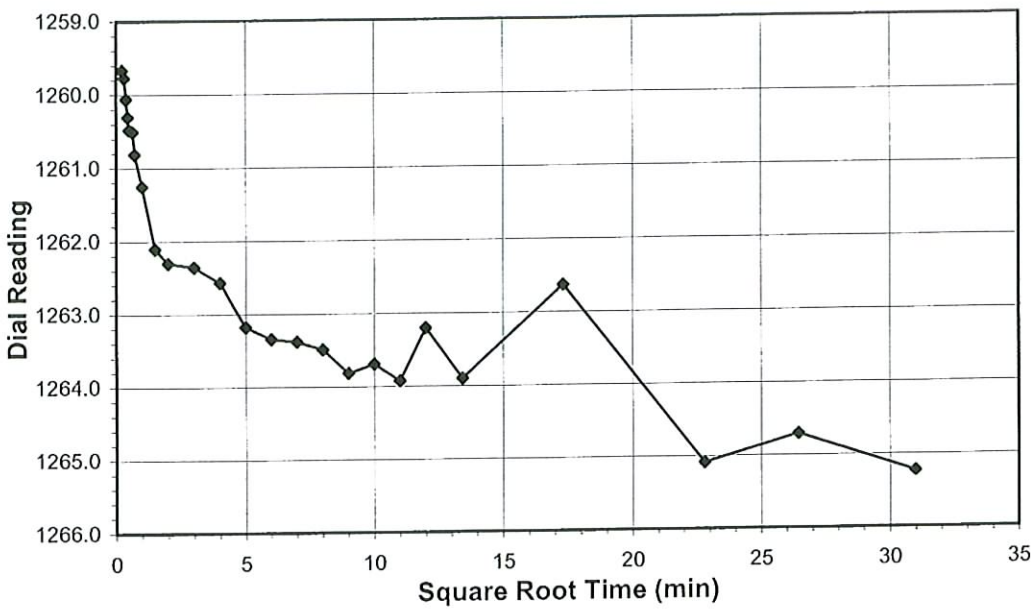
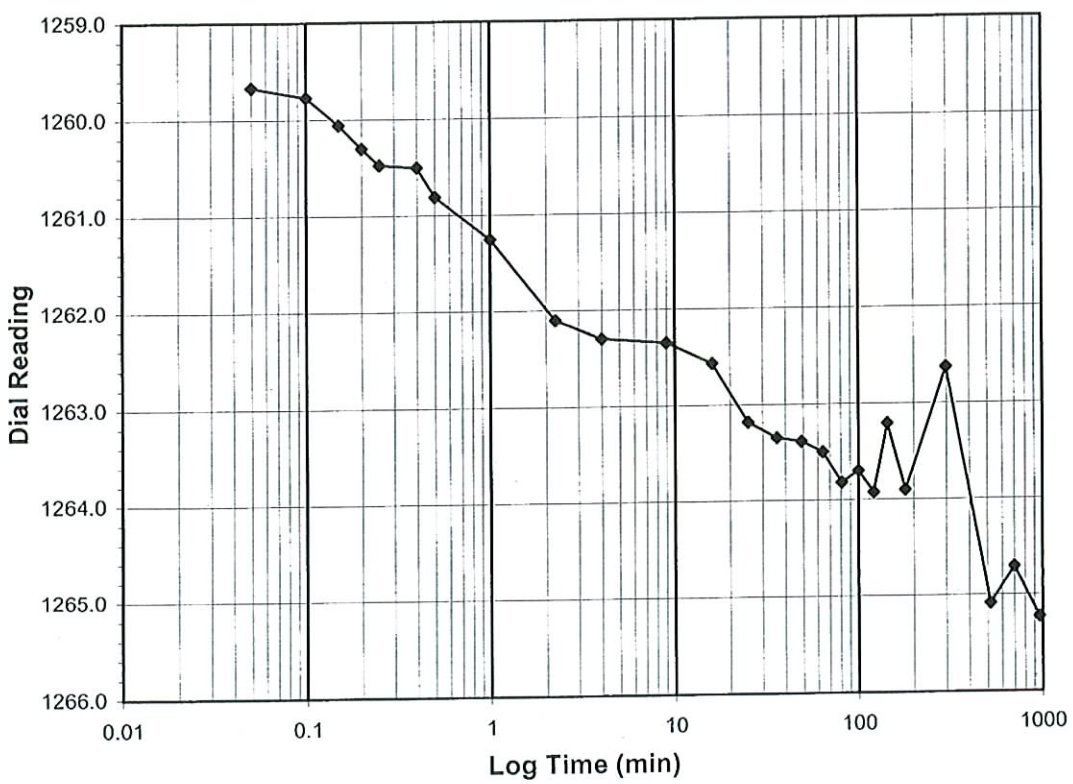
INTEGRITY IN TESTING

Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED





Test Load	**(tsf)**	**.25-.5**
Final Reading	**(div)**	**1265.2**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/22/07
Start Time		15:53:03

Elapsed Time (min)	Dial Reading (div)
Initial	**1254.3**
0.05	1259.7
0.10	1259.8
0.15	1260.1
0.20	1260.3
0.25	1260.5
0.40	1260.5
0.50	1260.8
1.00	1261.3
2.25	1262.1
4.00	1262.3
9.00	1262.4
16.00	1262.6
25.00	1263.2
36.00	1263.3
49.00	1263.4
64.00	1263.5
81.00	1263.8
100.00	1263.7
121.00	1263.9
144.00	1263.2
180.00	1263.9
300.00	1262.6
520.00	1265.1
700.00	1264.7
960.00	1265.2

Tested By JBD *Date* 05/22/07 *Checked By* MMS *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 08.xls]Sheet2

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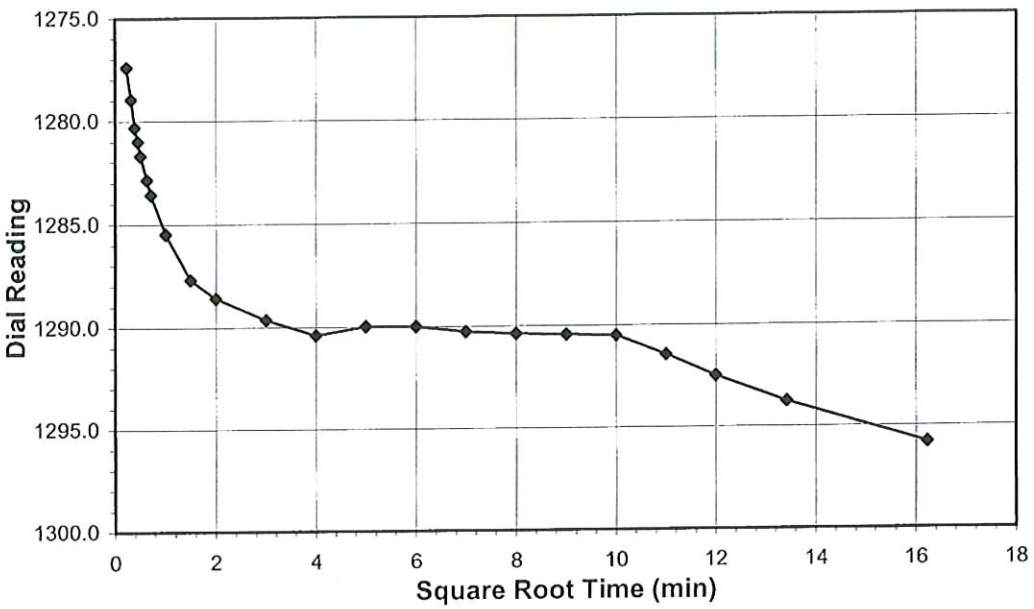
ASTM D 2435-96 (SOP-S24A)

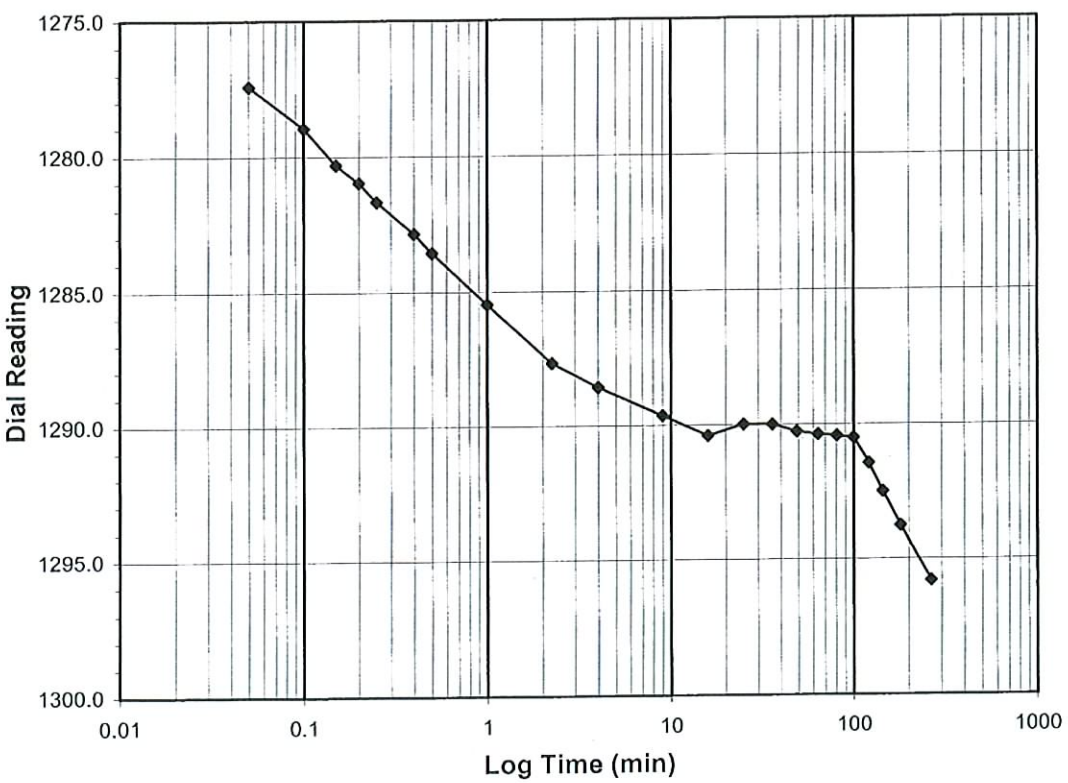
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**.5-1**
Final Reading	**(div)**	**1295.8**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/23/07
Start Time		9:17:03

Elapsed Time (min)	Dial Reading (div)
Initial	**1265.2**
0.05	1277.4
0.10	1279.0
0.15	1280.3
0.20	1281.0
0.25	1281.7
0.40	1282.9
0.50	1283.6
1.00	1285.5
2.25	1287.7
4.00	1288.6
9.00	1289.6
16.00	1290.4
25.00	1290.0
36.00	1290.0
49.00	1290.3
64.00	1290.4
81.00	1290.4
100.00	1290.5
121.00	1291.5
144.00	1292.5
180.00	1293.8
263.45	1295.8



Tested By JBD *Date* 05/23/07 *Checked By* NMS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 09.xls]Sheet2*

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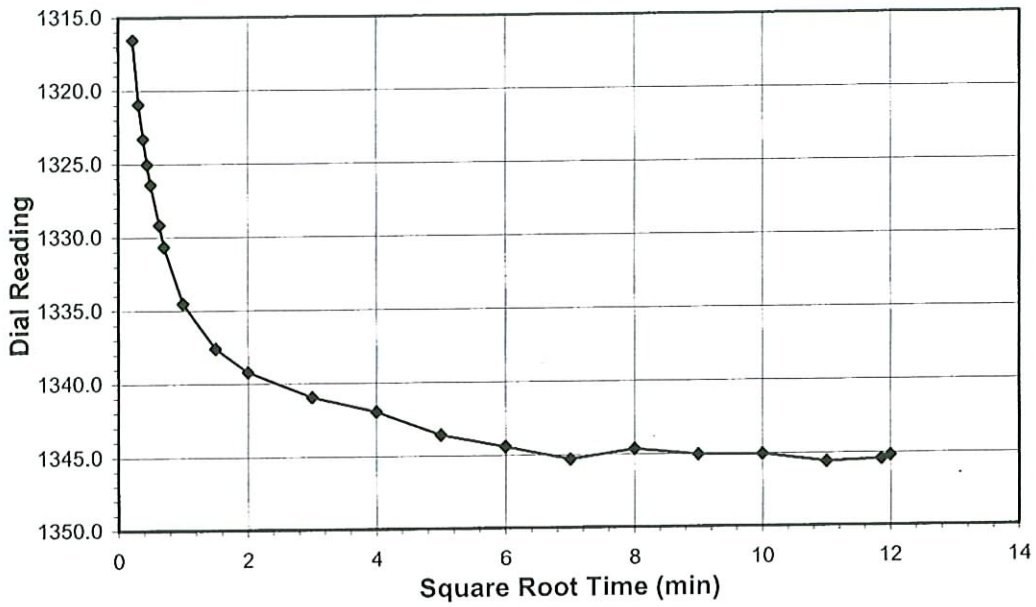
ASTM D 2435-96 (SOP-S24A)

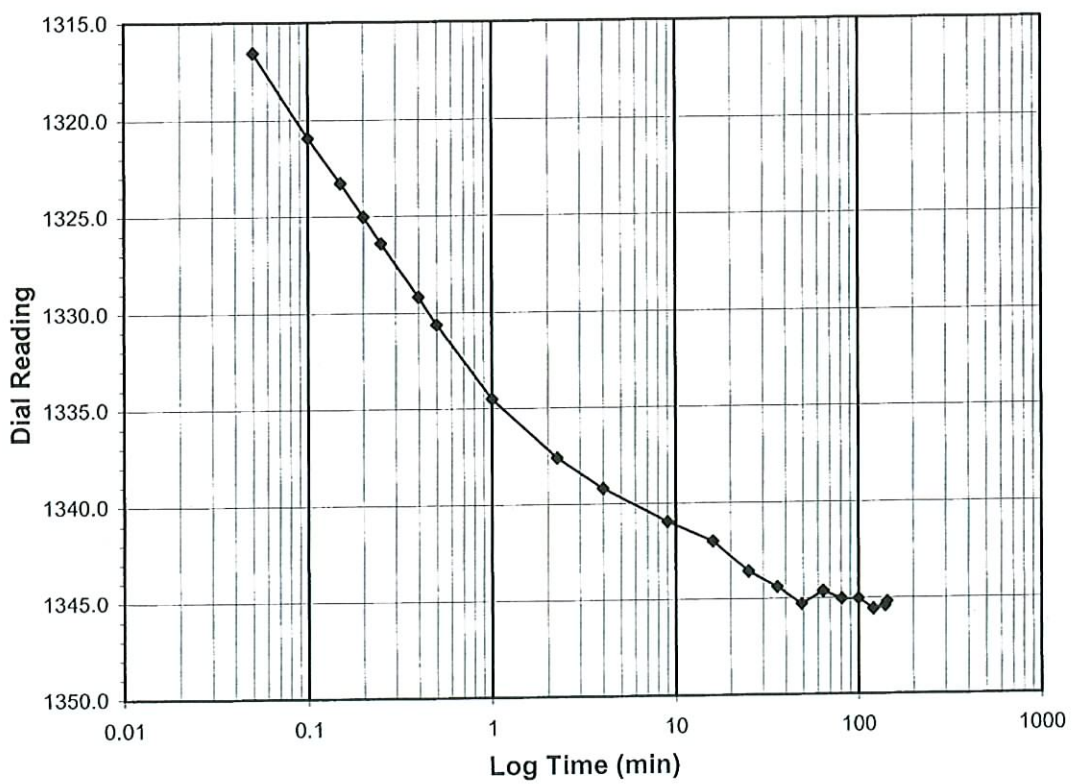
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-2**
Final Reading	**(div)**	**1345.4**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/23/07
Start Time		13:47:21

Elapsed Time (min)	Dial Reading (div)
Initial	**1295.8**
0.05	1316.5
0.10	1320.9
0.15	1323.3
0.20	1325.0
0.25	1326.4
0.40	1329.2
0.50	1330.6
1.00	1334.5
2.25	1337.6
4.00	1339.2
9.00	1341.0
16.00	1342.0
25.00	1343.6
36.00	1344.4
49.00	1345.3
64.00	1344.6
81.00	1345.1
100.00	1345.0
121.00	1345.6
140.68	1345.4



Tested By JBD *Date* 05/23/07 *Checked By* MRS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 10.xls]Sheet2*

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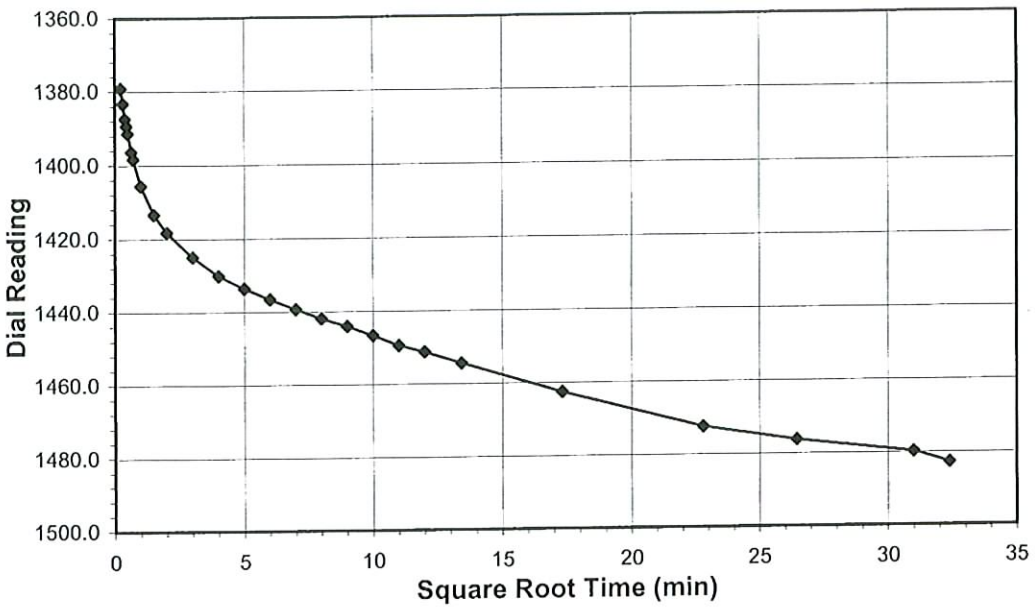
ASTM D 2435-96 (SOP-S24A)

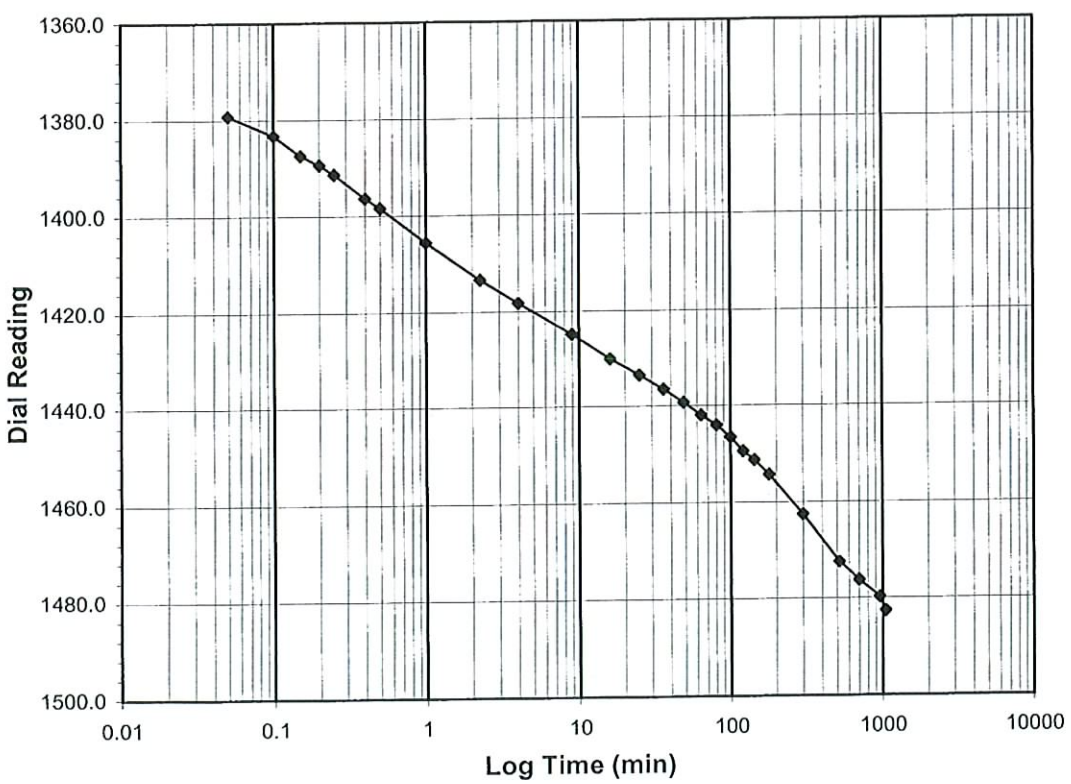
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**2-4**
Final Reading	**(div)**	**1482.7**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/23/07
Start Time		16:21:04

Elapsed Time (min)	Dial Reading (div)
Initial	**1345.4**
0.05	1379.2
0.10	1383.3
0.15	1387.4
0.20	1389.4
0.25	1391.4
0.40	1396.4
0.50	1398.4
1.00	1405.6
2.25	1413.4
4.00	1418.3
9.00	1425.0
16.00	1430.2
25.00	1433.6
36.00	1436.6
49.00	1439.3
64.00	1441.9
81.00	1444.1
100.00	1446.6
121.00	1449.4
144.00	1451.3
180.00	1454.3
300.00	1462.6
520.00	1472.5
700.00	1476.3
960.00	1479.8
1049.02	1482.7



Tested By JBD *Date* 05/23/07 *Checked By* MHS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 11.xls]Sheet2*

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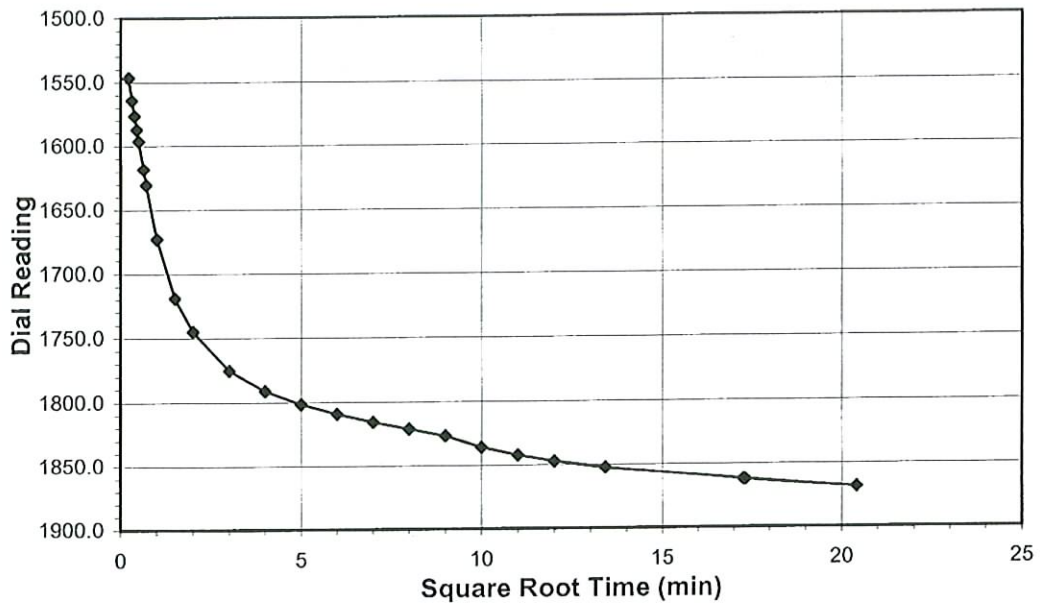
ASTM D 2435-96 (SOP-S24A)

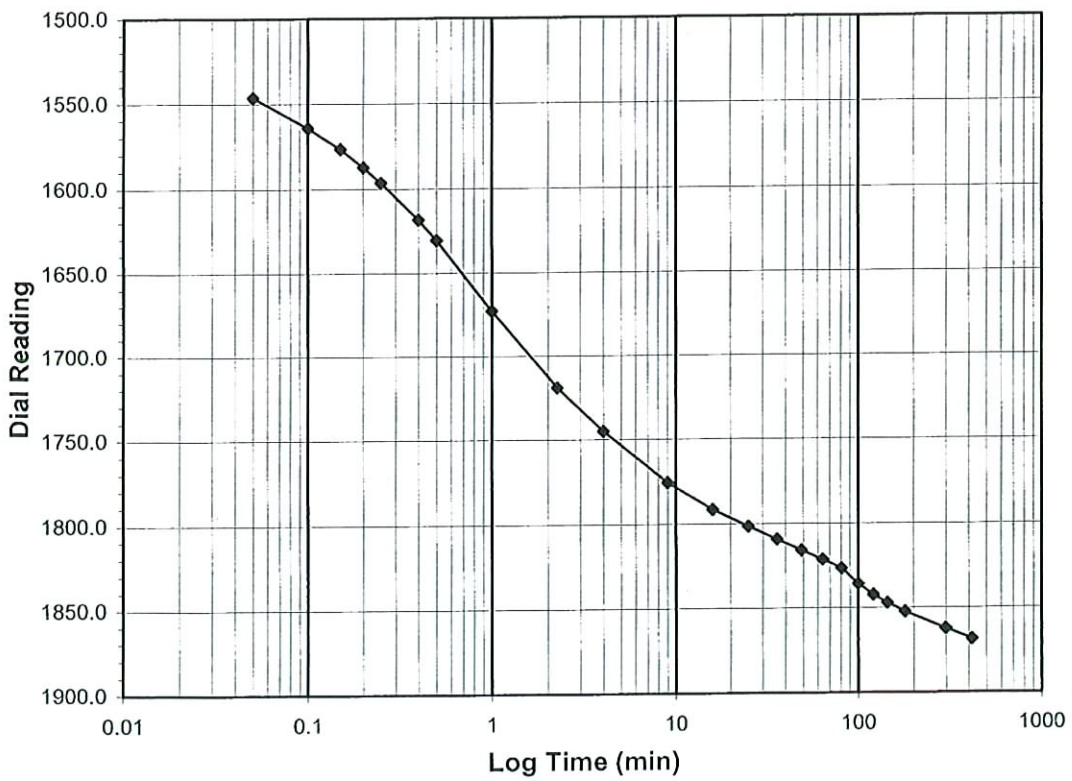
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**8-16**
Final Reading	**(div)**	**1868.5**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/24/07
Start Time		10:00:35

Elapsed Time (min)	Dial Reading (div)
Initial	**1482.7**
0.05	1546.5
0.10	1564.4
0.15	1576.5
0.20	1587.3
0.25	1596.4
0.40	1618.4
0.50	1630.6
1.00	1673.0
2.25	1719.1
4.00	1745.0
9.00	1775.4
16.00	1791.4
25.00	1801.5
36.00	1809.2
49.00	1815.8
64.00	1821.3
81.00	1826.7
100.00	1835.8
121.00	1842.3
144.00	1847.2
180.00	1852.4
298.18	1862.2
300.00	1862.4
417.10	1868.5



Tested By JBD *Date* 05/24/07 *Checked By* MAS *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveblc-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 12.xls]Sheet2*

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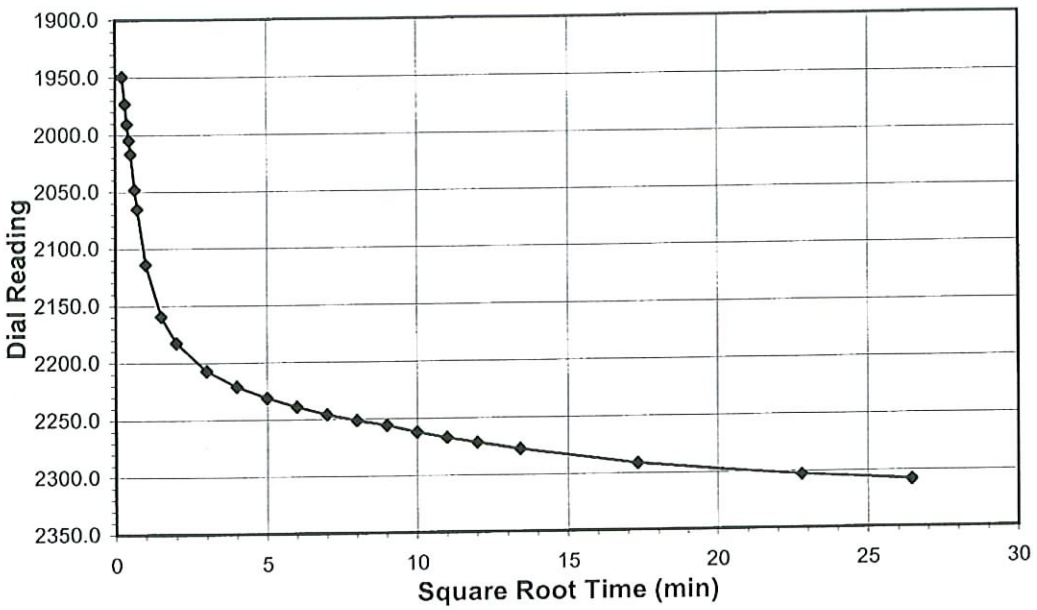
ASTM D 2435-96 (SOP-S24A)

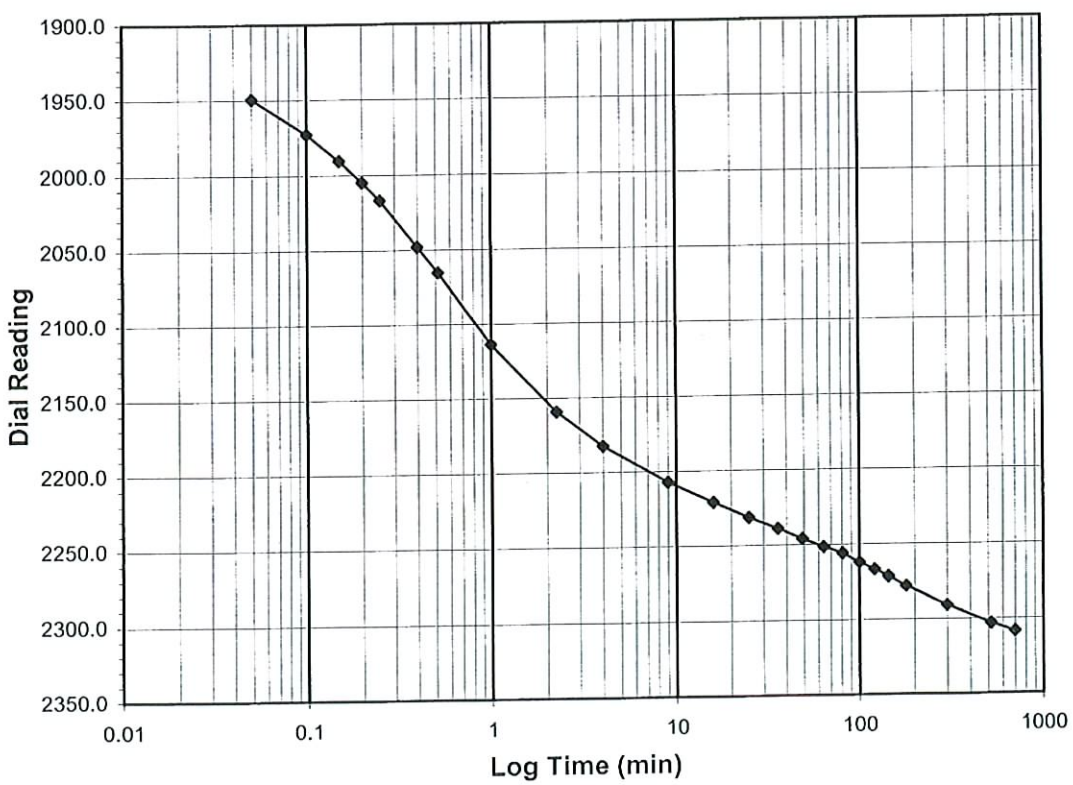
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**8-16**
Final Reading	**(div)**	**2308.5**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/24/07
Start Time		17:06:26

Elapsed Time (min)	Dial Reading (div)
Initial	**1868.5**
0.05	1949.4
0.10	1972.9
0.15	1990.6
0.20	2004.9
0.25	2017.0
0.40	2048.0
0.52	2065.1
1.00	2114.0
2.25	2159.4
4.00	2182.7
9.00	2207.3
16.00	2221.0
25.00	2231.3
36.00	2239.0
49.00	2246.0
64.00	2251.4
81.00	2255.8
100.00	2261.9
121.00	2266.9
144.00	2271.4
180.00	2277.8
300.00	2291.3
520.00	2303.2
700.00	2308.5



Tested By JBD *Date* 05/24/07 *Checked By* MM *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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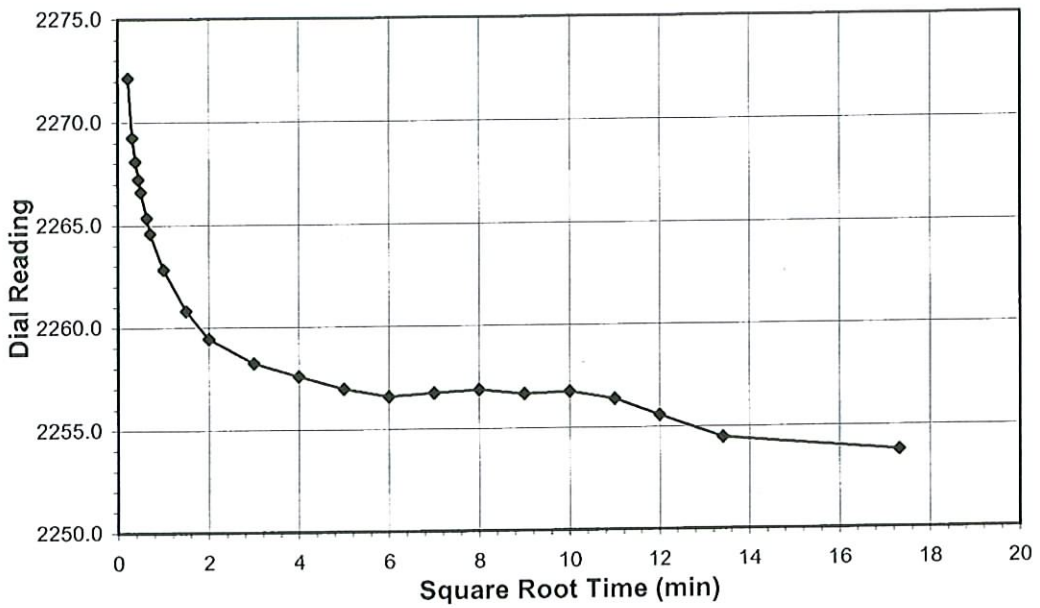
ASTM D 2435-96 (SOP-S24A)

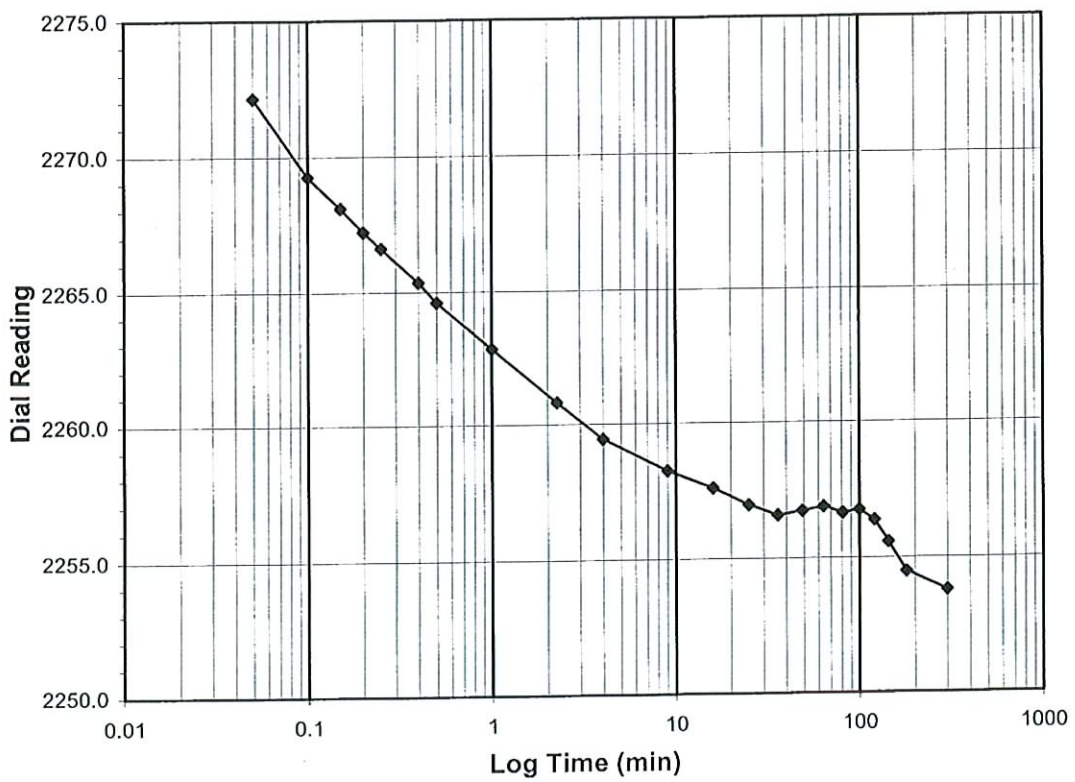
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**16-4**
Final Reading	**(div)**	**2253.8**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/25/07
Start Time		8:28:43

Elapsed Time (min)	Dial Reading (div)
Initial	**2308.5**
0.05	2272.2
0.10	2269.3
0.15	2268.1
0.20	2267.2
0.25	2266.6
0.40	2265.4
0.50	2264.6
1.00	2262.8
2.25	2260.8
4.00	2259.4
9.00	2258.2
16.00	2257.6
25.00	2257.0
36.00	2256.6
49.00	2256.7
64.00	2256.9
81.00	2256.6
100.00	2256.8
121.00	2256.4
144.00	2255.6
180.00	2254.5
300.00	2253.8



Tested By JBD *Date* 05/25/07 *Checked By* MM *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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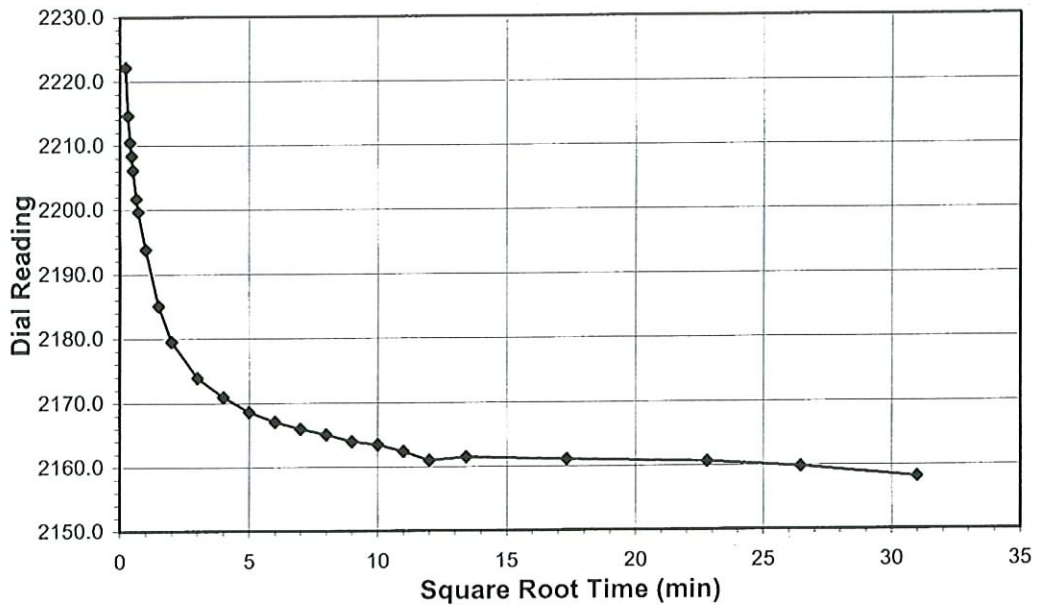
ASTM D 2435-96 (SOP-S24A)

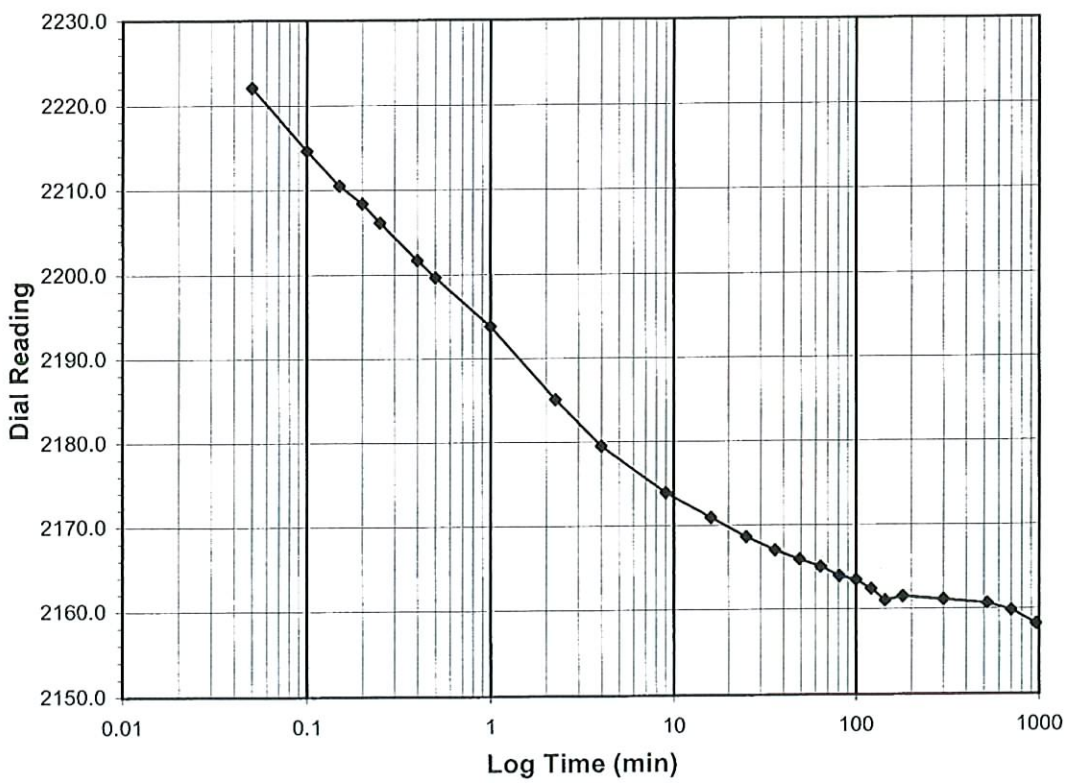
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**4-1**
Final Reading	**(div)**	**2158.2**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		05/25/07
Start Time		15:59:34

Elapsed Time (min)	Dial Reading (div)
Initial	**2253.8**
0.05	2222.1
0.10	2214.6
0.15	2210.5
0.20	2208.4
0.25	2206.1
0.40	2201.7
0.50	2199.7
1.00	2193.8
2.25	2185.1
4.00	2179.5
9.00	2173.9
16.00	2170.9
25.00	2168.6
36.00	2167.0
49.00	2165.9
64.00	2165.0
81.00	2164.0
100.00	2163.5
121.00	2162.4
144.00	2161.0
180.00	2161.5
300.00	2161.1
520.00	2160.7
700.00	2159.8
960.00	2158.2



Tested By JBD *Date* 05/25/07 *Checked By* MHI *Date* 5-29-07

 DCN: CT-24E Date: 3/2/98 Revision: 2 *\\Daveb\c-drive\Program Files\TestNet 2007\2007 R275\2007-591-01-07\[2007-591-01-07 15.xls]Sheet2*

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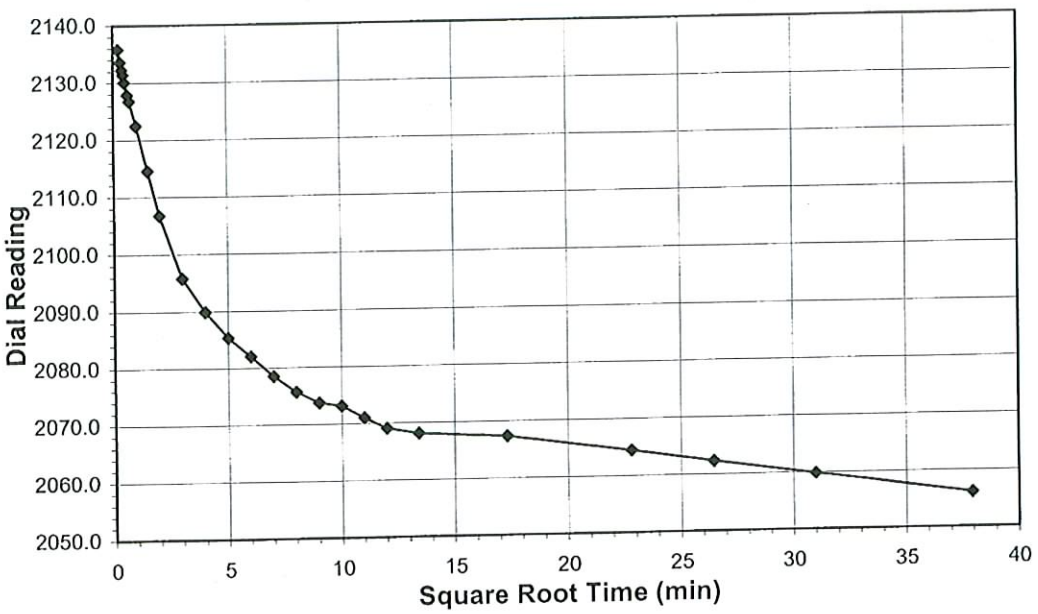
ASTM D 2435-96 (SOP-S24A)

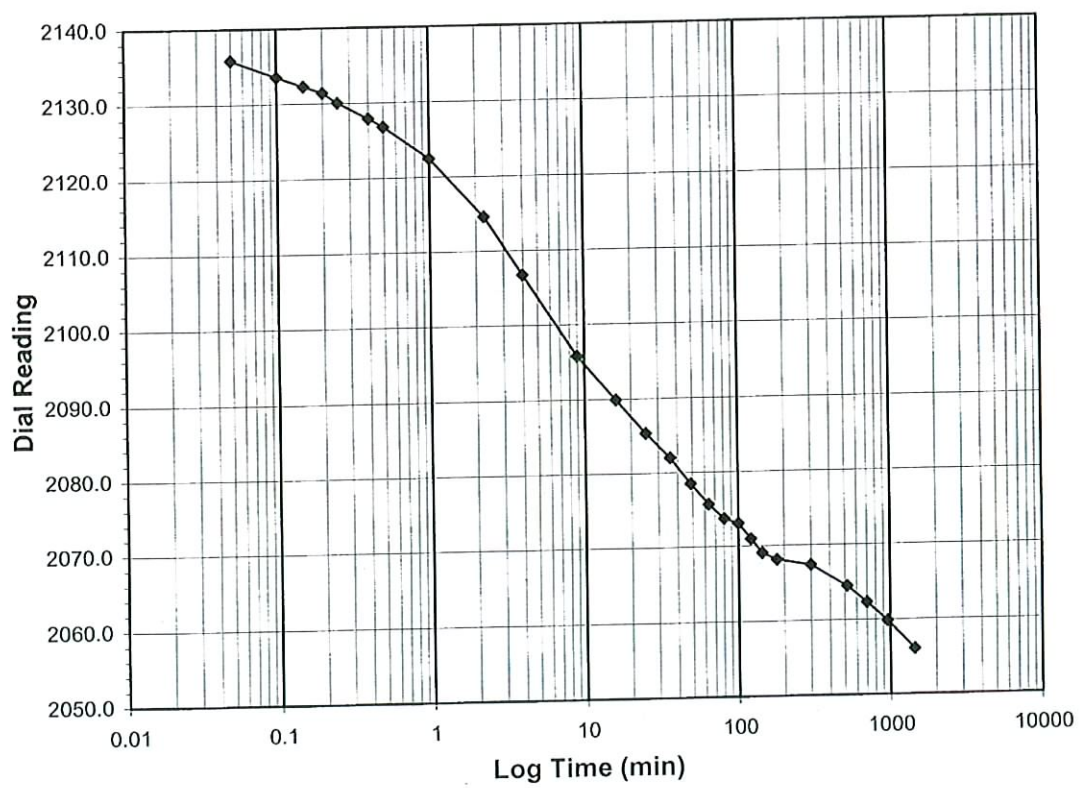
Client	CDM	Boring No.	B-104
Client Project	DARE COUNTY C&D CELL 4	Depth (ft)	28.9 - 28.7
Project No.	2007-591-01	Sample No.	ST-4
Lab ID	2007-591-01-07	Visual Description	GRAY CLAY

Sample Conditions: UNDISTURBED, INUNDATED AND DOUBLE DRAINED



Test Load	**(tsf)**	**1-.25**
Final Reading	**(div)**	**2056.0**
Consolidometer No.		**R275**
1 Division	(in)	0.0001
Start Date		5/26/07
Start Time		14:55:59

Elapsed Time (min)	Dial Reading (div)
Initial	**2158.2**
0.05	2135.9
0.10	2133.6
0.15	2132.3
0.20	2131.4
0.25	2130.1
0.40	2127.9
0.50	2126.8
1.00	2122.4
2.25	2114.5
4.00	2106.8
9.00	2095.8
16.00	2089.9
25.00	2085.3
36.00	2082.0
49.00	2078.5
64.00	2075.7
81.00	2073.7
100.00	2073.1
121.00	2071.0
144.00	2069.0
180.00	2068.1
300.00	2067.3
520.00	2064.4
700.00	2062.3
960.00	2059.8
1440.00	2056.0



Tested By JBD *Date* 5/26/07 *Checked By* MM *Date* 5-29-07

DCN: CT-24E Date: 3/2/98 Revision: 2

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Attachment B-3
Settlement Calculations

Table: Summary of Settlement Calculations

		Settlement (in)
Case	**Type**	**Center**
1	Elastic only, Yorktown is incompressible	6.2
2	Elastic and Consolidation, Yorktown is incompressible	6.7
3	Elastic only, Yorktown compressible	16.7
4	Elastic and Consolidation, Yorktown compressible	17.1

CLIENT:	Dare County	**JOB NO:**	17952-56960	**COMP BY:**	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	**DATE CHK:**	06/05/07	**DATE:**	6/5/2007
DETAIL:	Schmertmann Settlement	**CHECK BY:**	PHC	**PAGE NO:**	1 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Purpose: To estimate the amount of settlement at the site under foundation loading.

Problem: Model foundation settlement due to increase in load on foundation soils

Reference: 1. Schmertmann, John "Static Cone To Compare Static Settlement Over Sands", Journal of the Soil Mechanics and Foundations Division, ASCE, May 1970.

2. Schmertmann, John; Hartman, John Paul; Brown, Philip, "Improved Strain Influence Factor Diagrams", Journal of the Soil Mechanics and Foundations Division, ASCE, August 1978.

3. USACE, "Engineering Design - Settlement Analysis", EM 1110-1-1904, September 30, 1990.

General Equation:

Soil Information: CDM Borings in vicinity of structure

Assumptions: - Triangular strain factor distribution within subsurface soils, i.e. strain = 0 at incompressible boundary.
- All split spoon sampling was carried out according to ASTM D1556.
- Loading occurs instantaneously.
- Soils below the foundation are cohesionless.

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/05/07	DATE:
DETAIL:	Schmertmann Settlement	CHECK BY:	PMC	PAGE NO:
FILE NAME:	Assume embankment loading of 2,600 psf.			

Soil Type:	Sand	(See Reference Page)
Depth of Water Table (d) ft.	0	
Depth of Foundation (D) ft.	0	
Length of Foundation (L) ft.	2,300	
Width of Foundation (B) ft.	1,150	
L/B	2.00	
Z/B	2.22	
Iz	0.11	
Compressible Layer Thickness (H) ft.	600	(From Boring Logs)
Depth of Influence based on Strain Condition ft.	2556	
Depth of Influence Used for Calculations ft.	2556	
σ'_{Izp}	36,800	psf
Max Izp @	0.53	(H/4)
Existing overburden pressure (tsf)	0.00	(At Foundation Level)
Additional Loading (tsf)	1.30	(Based on Additional Load @ Foundation Level)
Effective overburden pressure at Izp(tsf)	18.40	tsf
Izp =	0.53	
Foundation Load	2,600	psf

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/05/07	DATE:	6/5/2007
DETAIL:	Schmertmann Settlement	CHECK BY:	PMC	PAGE NO:	3 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Strain	
slope =	0.0007
slope =	0.0003

Increments	Depth (ft.)	Strain Influence
1	1.0	0.11
2	3.0	0.11
3	7.0	0.12
4	10.5	0.12
4	17.0	0.12
5	22.5	0.13
5	25.0	0.13
6	31.0	0.13
6	38.5	0.14
6	43.5	0.14
6	48.5	0.14
6	53.5	0.15
6	58.5	0.15
6	63.5	0.15
7	316.0	0.32

CLIENT:	Dare County	**JOB NO:**	17952-56960	**COMP BY:**	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	**DATE CHK:**	06/05/07	**DATE:**	6/5/2007
DETAIL:	Schmertmann Settlement	**CHECK BY:**	PJC	**PAGE NO:**	4 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Soil Type:		
Soil	*q_c/N*	*Descrpition*
Silt	2	Combination of silts, sandy silts, slightly cohesive sand-silts.
Silty Sand	2.75	Silty sands
Sand	3.5	Clean to slightly silty sands.

Where: q_c = Average Dutch Cone Resistance
N = SPT N value

Strain Condition:		
Strain	*Es/qc*	*Descrpition*
Axisymmetric	2.5	L/B = 1
Plane	3.5	L/B > 10

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/05/07	DATE:	6/5/2007
DETAIL:	Schmertmann Settlement	CHECK BY:	PMC	PAGE NO:	5 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				
	Assume compressible soil layer is 68 feet and elastic theory applies to the whole strata.				

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)	
1	2	N/A	N/A	N/A	1.00	0.11	0.0000	Will be removed
2	8	3	10.50	27.42	4.00	0.11	0.0332	Depth of 0'
3	2	1	2.00	5.22	9.00	0.12	0.0448	
4	5	3	10.50	27.42	12.50	0.12	0.0217	
4	8	5	17.50	45.69	19.00	0.12	0.0216	
5	3	5	10.00	26.11	24.50	0.13	0.0146	
5	2	1	2.00	5.22	27.00	0.13	0.0493	
6	8	9	31.50	82.25	32.00	0.13	0.0128	
6	5	14	49.00	127.94	38.50	0.14	0.0053	
6	5	11	38.50	100.53	43.50	0.14	0.0069	
6	5	4	11.00	28.72	48.50	0.14	0.0248	
6	5	28	98.00	255.89	53.50	0.15	0.0029	
6	5	7	19.25	50.26	58.50	0.15	0.0148	
6	5	8	22.00	57.44	63.50	0.15	0.0133	
7	500	1000000	2000000.00	5222222.22	316.00	0.32	0.0000	Incompressible
	568							
					Total Settlement/tsf		0.2661	ft/tsf

Notes:

1 Refer to SPT vs. Depth for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Iz obtained from strain influence spreadsheet.
5 Represents the settlement attributed to each layer assuming C_1, C_2, and delta z all equal 1.

Settlements

1- At the center

t = 1 years	e =	4.98	Inches
t = 10 years	e =	5.81	Inches
t = 30 years	e =	6.23	Inches

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/05/07	DATE:	6/5/2007
DETAIL:	Schmertmann Settlement	CHECK BY:	PRC	PAGE NO:	5 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Assume compressible soil layer is 68 feet and consolidation theory applies to the clay/silt layers.

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)	
1	2	N/A	N/A	N/A	1.00	0.11	0.0000	Will be removed
2	8	3	10.50	27.42	4.00	0.11	0.0332	Depth of 0'
3	2	N/A	N/A	N/A	9.00	0.12	0.0000	Consolidation → 1 inch
4	5	3	10.50	27.42	12.50	0.12	0.0217	
4	8	5	17.50	45.69	19.00	0.12	0.0216	
5	3	N/A	N/A	N/A	24.50	0.13	0.0000	Consolidation } 2 inches
5	2	N/A	N/A	N/A	27.00	0.13	0.0000	Consolidation } 2 inches
6	8	9	31.50	82.25	32.00	0.13	0.0128	
6	5	14	49.00	127.94	38.50	0.14	0.0053	
6	5	11	38.50	100.53	43.50	0.14	0.0069	
6	5	4	11.00	28.72	48.50	0.14	0.0248	
6	5	28	98.00	255.89	53.50	0.15	0.0029	
6	5	7	19.25	50.26	58.50	0.15	0.0148	
6	5	8	22.00	57.44	63.50	0.15	0.0133	
7	500	1000000	2000000.00	5222222.22	316.00	0.32	0.0000	Incompressible
	568							
					Total Settlement/tsf		0.1574	ft/tsf

Notes:

1 Refer to SPT vs. Depth for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Iz obtained from strain influence spreadsheet.
5 Represents the settlement attributed to each layer assuming C_1, C_2, and delta z all equal 1.

Settlements

1- At the center

t = 1 years	e =	2.95	Inches
t = 10 years	e =	3.44	Inches
t = 30 years	e =	3.68	Inches + 3 inches = 6.7"

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/05/07	DATE:	6/5/2007
DETAIL:	Schmertmann Settlement	CHECK BY:	JMC	PAGE NO:	5 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Assume compressible soil layer consists of 68 feet surficial and 500 feet Yorktown formation and elastic theory applies to the whole strata.

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)	
1	2	N/A	N/A	N/A	1.00	0.11	0.0000	Will be removed
2	8	3	10.50	27.42	4.00	0.11	0.0332	Depth of 0'
3	2	1	2.00	5.22	9.00	0.12	0.0448	
4	5	3	10.50	27.42	12.50	0.12	0.0217	
4	8	5	17.50	45.69	19.00	0.12	0.0216	
5	3	5	10.00	26.11	24.50	0.13	0.0146	
5	2	1	2.00	5.22	27.00	0.13	0.0493	
6	8	9	31.50	82.25	32.00	0.13	0.0128	
6	5	14	49.00	127.94	38.50	0.14	0.0053	
6	5	11	38.50	100.53	43.50	0.14	0.0069	
6	5	4	11.00	28.72	48.50	0.14	0.0248	
6	5	28	98.00	255.89	53.50	0.15	0.0029	
6	5	7	19.25	50.26	58.50	0.15	0.0148	
6	5	8	22.00	57.44	63.50	0.15	0.0133	
7	20	6	12.00	31.33	76.00	0.16	0.1025	Yorktown - 500'
7	12	25	87.50	228.47	92.00	0.17	0.0090	
7	468	50	175.00	456.94	332.00	0.33	0.3349	
	568							
					Total Settlement/tsf		0.7125	ft/tsf

Notes:

1 Refer to SPT vs. Depth for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Iz obtained from strain influence spreadsheet.
5 Represents the settlement attributed to each layer assuming C_1, C_2, and delta z all equal 1.

Settlements

1- At the center

t = 1 years	e =	**13.34**	Inches
t = 10 years	e =	**15.56**	Inches
t = 30 years	e =	**16.67**	Inches

CLIENT:	Dare County	JOB NO:	17952-56960	COMP BY:	I. S. A.
PROJECT:	C&D Landfill Cell No. 4	DATE CHK:	06/07/07	DATE:	6/5/2007
DETAIL:	Schmertmann Settlement	CHECK BY:	PSK	PAGE NO:	5 of 5
FILE NAME:	Assume embankment loading of 2,600 psf.				

Assume compressible soil layer consists of 68 feet surficial and 500 feet Yorktown formation and consolidation theory applies to the clay/silt layers within surficial layer.

Layer	Delta Z	Avg. SPT (1)	Corrected qc (tsf) (2)	Es (tsf) (3)	Depth to Mid Layer	Iz (4)	(Iz/Es)*Delta Z) (5)	
1	2	N/A	N/A	N/A	1.00	0.11	0.0000	Will be removed
2	8	3	10.50	27.42	4.00	0.11	0.0332	Depth of 0'
3	2	N/A	N/A	N/A	9.00	0.12	0.0000	Consolidation → 1 inch
4	5	3	10.50	27.42	12.50	0.12	0.0217	
4	8	5	17.50	45.69	19.00	0.12	0.0216	
5	3	N/A	N/A	N/A	24.50	0.13	0.0000	Consolidation } 2"
5	2	N/A	N/A	N/A	27.00	0.13	0.0000	Consolidation } 2"
6	8	9	31.50	82.25	32.00	0.13	0.0128	
6	5	14	49.00	127.94	38.50	0.14	0.0053	
6	5	11	38.50	100.53	43.50	0.14	0.0069	
6	5	4	11.00	28.72	48.50	0.14	0.0248	
6	5	28	98.00	255.89	53.50	0.15	0.0029	
6	5	7	19.25	50.26	58.50	0.15	0.0148	
6	5	8	22.00	57.44	63.50	0.15	0.0133	
7	20	6	12.00	31.33	76.00	0.16	0.1025	Yorktown - 500'
7	12	25	87.50	228.47	92.00	0.17	0.0090	
7	468	50	175.00	456.94	332.00	0.33	0.3349	
	568							
					Total Settlement/tsf		0.6038	ft/tsf

Notes:

1 Refer to SPT vs. Depth for average N values (not corrected).
2 Refer to reference page for values.
3 Schmertmann SPT-correlations modified by Ladd, E_s = average equivalent modulus over depth z for foundation type.
4 Iz obtained from strain influence spreadsheet.
5 Represents the settlement attributed to each layer assuming C_1, C_2, and delta z all equal 1.

Settlements

1- At the center

t = 1 years	e =	**11.30**	Inches
t = 10 years	e =	**13.19**	Inches
t = 30 years	e =	**14.13**	Inches + 3 inches = 17.1"

CDM

CLIENT	Dare County	JOB NO.	17952-56960	COMPUTED BY	I.S.A.
PROJECT	CPD Landfill Cell No.4	DATE CHECKED	06/05/07	DATE	6/5/07
DETAIL	Consolidation Settlement	CHECKED BY	PMC	PAGE NO.	1/1

① Lower Clay/Silt Layer: 25'-30'

$\sigma_o' = 2\times110 + 8\times115 + 2\times110 + 13\times120 + 2.5\times110 - 27.5\times62.4$

$= 1{,}479$ psf

$q = 65\times40 = 2{,}600$ psf

Assuming influence factor is 1 for the mid depth:

$\sigma_f' = \sigma_o' + q = 4{,}079$ psf

$\sigma_c' = 2{,}400$ psf $\Rightarrow$ OC type II.

$$\rho = \frac{H}{1+e_o}\left(C_r \log\frac{\sigma_c'}{\sigma_o'} + C_c \log\frac{\sigma_f'}{\sigma_c'}\right)$$

$$= \frac{5}{1+0.91}\left(0.024 \log\frac{2400}{1479} + 0.252 \log\frac{4079}{2400}\right)$$

$\cong 2$ inches

② Upper Clay Layer: 10'-12'

$\sigma_o' = 2\times110 + 8 + 115 + 1\times110 - 11\times62.4 = 564$ psf

$q = 2{,}600$ psf $\Rightarrow$ $\sigma_f' = 3{,}164$ psf

Using Das, 1998:

$C_c = 0.009(LL-10)$ (Skempton, 1944)

$= 0.009(33-10) = 0.207$

$C_r = C_c/10 = 0.021$

$e_o = \frac{C_c}{0.3} + 0.27$ (Hough, 1957)

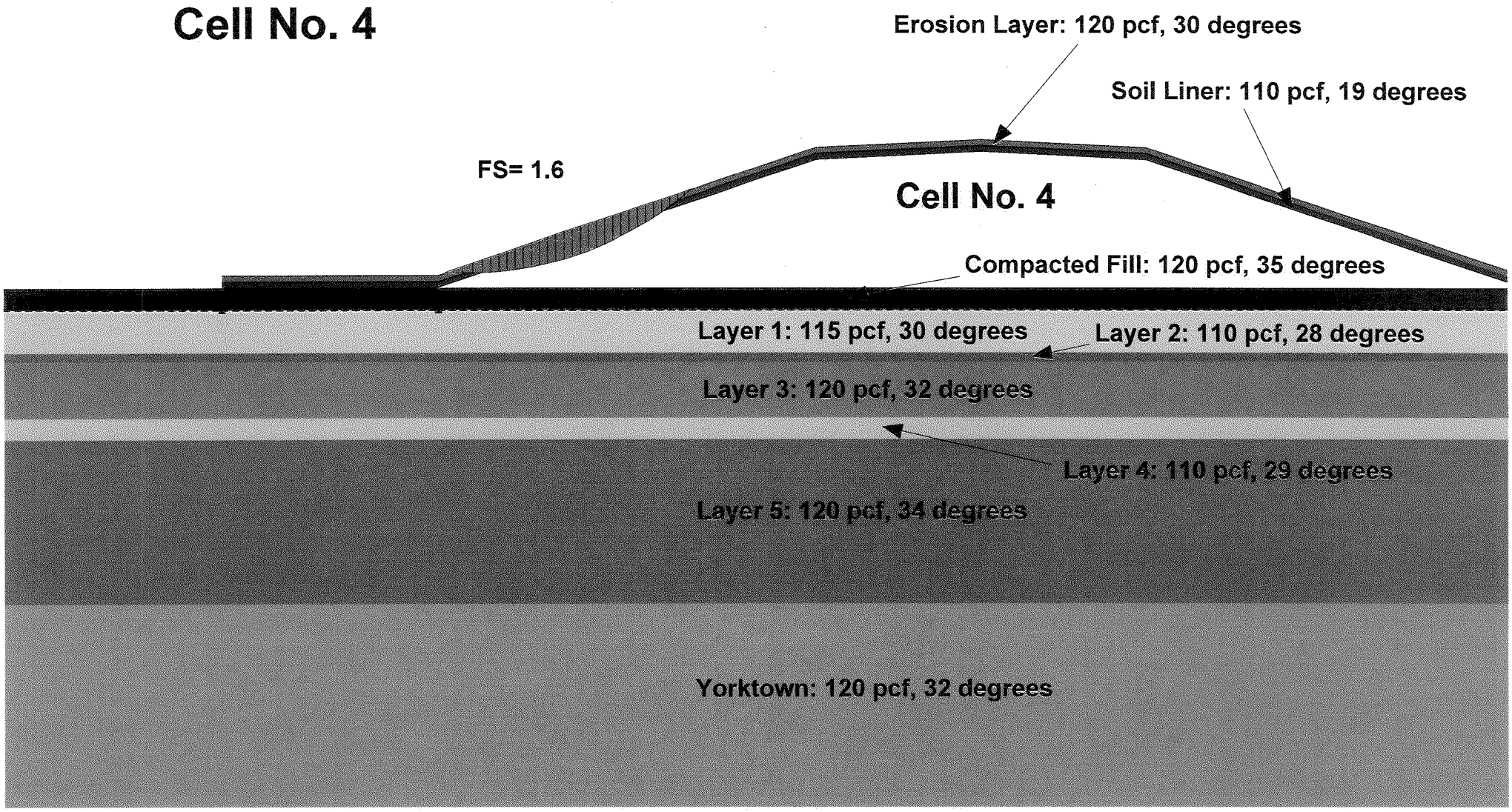
$= 0.96$

Assuming $\sigma_c' = 1{,}500$ psf $\quad \rho = \frac{2}{1+0.96}\left(0.021 \log\frac{1500}{564} + 0.207 \log\frac{3164}{1500}\right) \cong 1$ inch

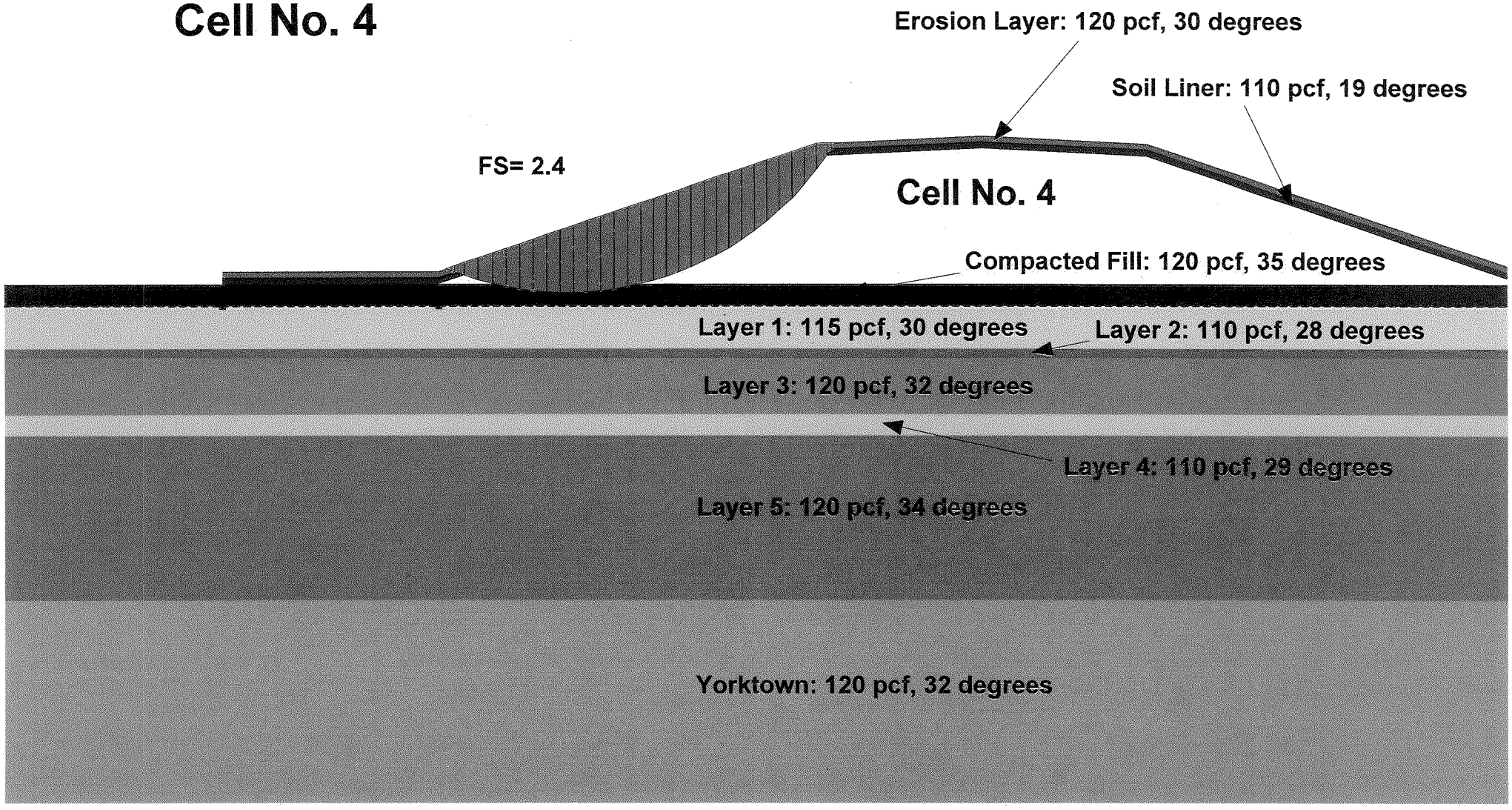
$\Rightarrow \rho_{TOTAL} = 2+1 = 3$ inches

Attachment B-4
Stability Calculations

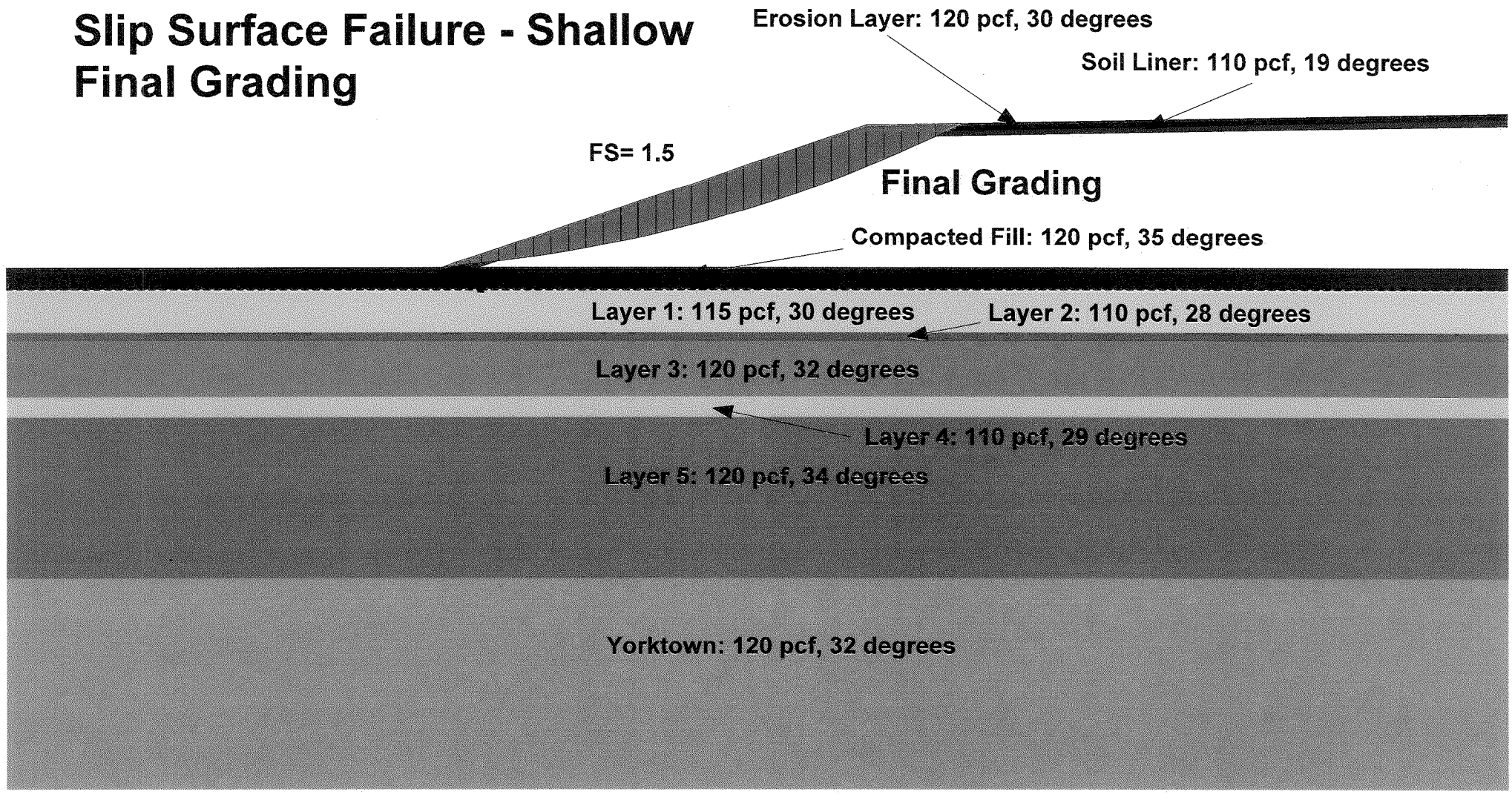
Slip Surface Failure - Shallow
Cell No. 4



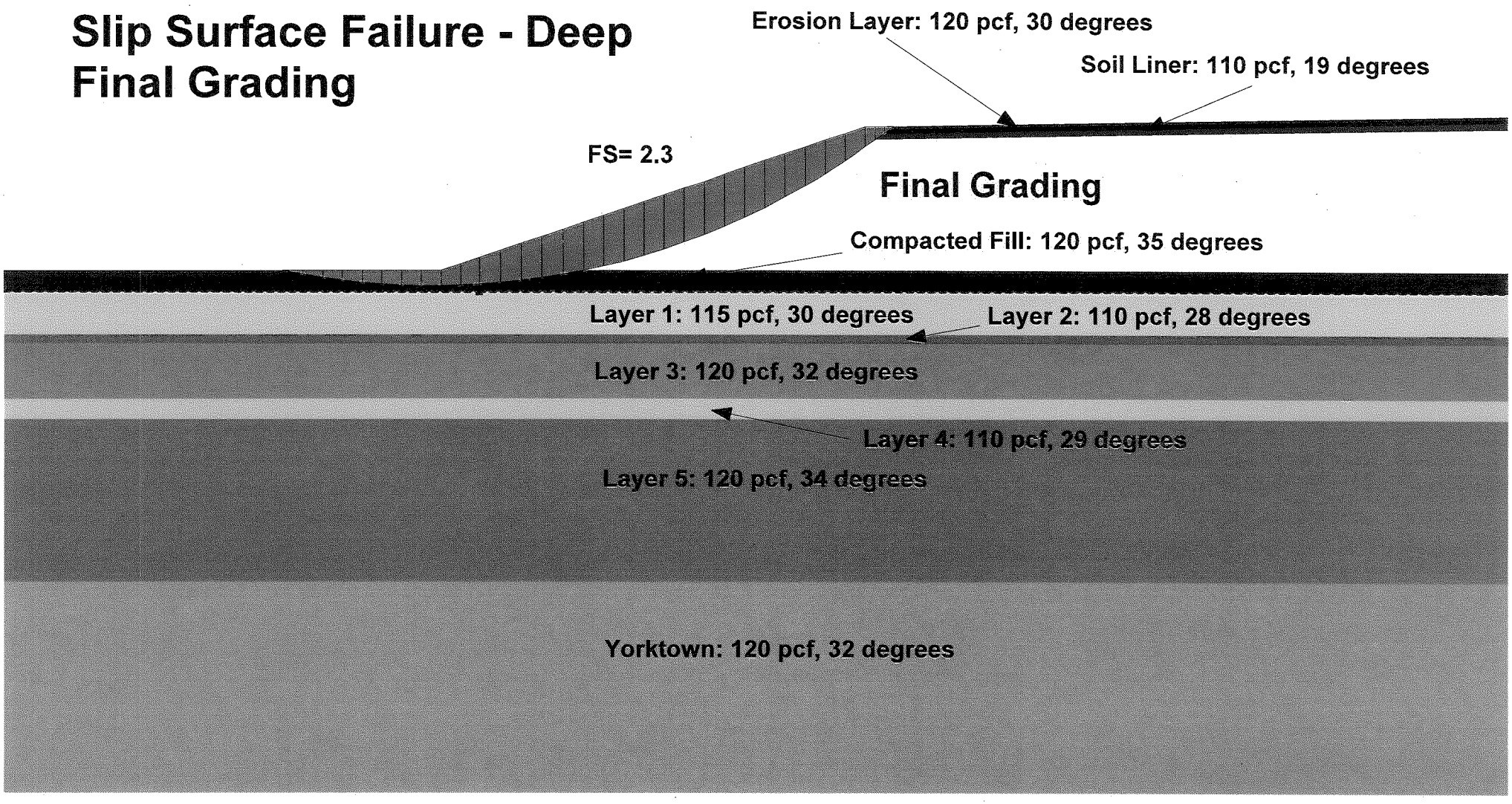
Slip Surface Failure - Deep
Cell No. 4



Slip Surface Failure - Shallow
Final Grading



Slip Surface Failure - Deep
Final Grading



SLOPE-W
INPUT – OUTPUT DATA

SLOPE/W

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File Information

Revision Number: 19
Last Edited By: Akbas, Ibrahim
Date: 7/17/2009
Time: 11:47:16 AM
File Name: Dare-Cell No. 4-revised 071609.gsz
Directory: P:\Dare County - 17952\56960 Cell No. 4\Geotechnical\calculations\
Last Solved Date: 7/17/2009
Last Solved Time: 11:47:23 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W

Kind: SLOPE/W
Method: Spencer
Settings
    Apply Phreatic Correction: No
    PWP Conditions Source: Piezometric Line
    Use Staged Rapid Drawdown: No
SlipSurface
    Direction of movement: Right to Left
    Allow Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 10
    Optimize Critical Slip Surface Location: No
    Tension Crack
        Tension Crack Option: (none)
FOS Distribution
    FOS Calculation Option: Constant
Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1

Materials

C&D Landfill

Model: Mohr-Coulomb
Unit Weight: 65 pcf
Cohesion: 0 psf
Phi: 27.5 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 1

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 2

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 3

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 4

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 29 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Soil Layer 5

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Yorktown

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °

Soil Liner

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 19 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Vegetative Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf

Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (1547.6227, 5.792433) ft
Left-Zone Right Coordinate: (1619.5186, 14.5062) ft
Left-Zone Increment: 4
Right Projection: Range
Right-Zone Left Coordinate: (1625.3512, 16.4504) ft
Right-Zone Right Coordinate: (1760.5953, 37.120235) ft
Right-Zone Increment: 4
Radius Increments: 4

Slip Surface Limits

Left Coordinate: (800, 0) ft
Right Coordinate: (2350, 0) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	800	0
	1000	0
	1250	0
	1300	0
	1550	0
	1600	0
	1850	0
	1900	0
	2150	0
	2350	0

Seismic Loads

Horz Seismic Load: 0
Vert Seismic Load: 0

Regions

	Material	Points	Area (ft^2)
Region 1	Soil Layer 1	15,1,2,3,4,5,6,7,8,9	11500
Region 2	Soil Layer 2	15,23,16,9	2300
Region 3	Soil Layer 3	23,31,24,16	14950
Region 4	Soil Layer 4	31,36,32,24	5750
Region 5	Soil Layer 5	36,11,10,32	43700
Region 6	Yorktown	11,18,17,10	115000
Region 7	Soil Layer 1	1,25,20,15	2000
Region 8	Soil Layer 2	20,21,23,15	400
Region 9	Soil Layer 3	21,22,31,23	2600
Region 10	Soil Layer 4	22,26,36,31	1000
Region 11	Soil Layer 5	26,27,11,36	7600
Region 12	Yorktown	27,19,18,11	20000
Region 13	Soil Layer 1	8,28,29,9	2000
Region 14	Soil Layer 2	9,16,30,29	400
Region 15	Soil Layer 3	16,24,33,30	2600
Region 16	Soil Layer 4	32,34,33,24	1000
Region 17	Soil Layer 5	32,10,14,34	7600
Region 18	Yorktown	10,17,35,14	20000
Region 19	C&D Landfill	1,12,37,38,2	4824.5
Region 20	C&D Landfill	47,39,40,41,48	4824.5
Region 21	C&D Landfill	49,42,43,44,50	4799.2
Region 22	C&D Landfill	7,45,46,13,8	4824.5
Region 23	Compacted Fill	47,3,4,48	1250
Region 24	Compacted Fill	48,49,5,4	250
Region 25	Compacted Fill	49,5,6,50	1250
Region 26	Soil Liner	53,51,49,48	75
Region 27	Vegetative Cover	54,53,51,52	75
Region 28	Soil Liner	49,51,55,42	130.5
Region 29	Vegetative Cover	51,52,56,55	130.5

Region 30	Soil Liner	55,57,59,44,43,42	114
Region 31	Vegetative Cover	56,55,57,59,60,58	114
Region 32	Soil Liner	59,61,50,44	130.5
Region 33	Vegetative Cover	60,59,61,62	130.5

Points

	X (ft)	Y (ft)
Point 1	1000	0
Point 2	1250	0
Point 3	1300	0
Point 4	1550	0
Point 5	1600	0
Point 6	1850	0
Point 7	1900	0
Point 8	2150	0
Point 9	2150	-10
Point 10	2150	-68
Point 11	1000	-68
Point 12	1090	30
Point 13	2060	30
Point 14	2350	-68
Point 15	1000	-10
Point 16	2150	-12
Point 17	2150	-168
Point 18	1000	-168
Point 19	800	-168
Point 20	800	-10
Point 21	800	-12
Point 22	800	-25
Point 23	1000	-12
Point 24	2150	-25
Point 25	800	0
Point 26	800	-30
Point 27	800	-68
Point 28	2350	0

Point 29	2350	-10
Point 30	2350	-12
Point 31	1000	-25
Point 32	2150	-30
Point 33	2350	-25
Point 34	2350	-30
Point 35	2350	-168
Point 36	1000	-30
Point 37	1125	30.7
Point 38	1160	30
Point 39	1390	35
Point 40	1425	35.7
Point 41	1460	35
Point 42	1687	34
Point 43	1725	35.9
Point 44	1763	34
Point 45	1990	30
Point 46	2025	30.7
Point 47	1300	5
Point 48	1550	5
Point 49	1600	5
Point 50	1850	5
Point 51	1600	6.5
Point 52	1600	8
Point 53	1550	6.5
Point 54	1550	8
Point 55	1687	35.5
Point 56	1687	37
Point 57	1725	37.4
Point 58	1725	38.9
Point 59	1763	35.5
Point 60	1763	37
Point 61	1850	6.5
Point 62	1850	8

Critical Slip Surfaces

	Number	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	86	1.1	(1449.98, 637.418)	646.916	(1691.35, 37.2173)	(1601.47, 8.49152)
2	111	1.2	(1500.64, 515.424)	514.831	(1691.35, 37.2173)	(1619.52, 14.5062)
3	77	1.2	(1603.77, 41.403)	32.992	(1625.35, 16.4504)	(1601.47, 8.49152)
4	107	1.6	(1623.24, 67.88)	53.503	(1658.24, 27.4133)	(1619.52, 14.5062)
5	82	1.6	(1606.93, 86.737)	78.436	(1658.24, 27.4133)	(1601.47, 8.49152)
6	87	1.7	(1612.09, 130.231)	122.201	(1691.35, 37.2173)	(1601.47, 8.49152)
7	112	1.7	(1628.39, 111.375)	97.274	(1691.35, 37.2173)	(1619.52, 14.5062)
8	76	1.7	(1558.27, 177.891)	174.822	(1625.35, 16.4504)	(1601.47, 8.49152)
9	81	1.7	(1498.77, 411.229)	415.628	(1658.24, 27.4133)	(1601.47, 8.49152)
10	101	1.7	(1608.96, 55.887)	42.706	(1625.35, 16.4504)	(1619.52, 14.5062)

Slices of Slip Surface: 86

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	86	1602.8915	8.83612	-551.36366	14.323931	8.2699256	0
2	86	1605.7245	9.5320855	-594.81087	42.077336	24.293361	0
3	86	1608.5575	10.241623	-639.07024	68.140116	39.340714	0
4	86	1611.390	10.964775	-	92.521603	53.417373	0

		5		684.20457			
5	86	1614.2235	11.701585	-730.17297	115.23602	66.531549	0
6	86	1617.0565	12.45211	-777.00321	136.28758	78.68567	0
7	86	1619.8895	13.2164	-824.6882	155.6908	89.888128	0
8	86	1622.799	14.015895	-874.58862	175.44052	60.409016	0
9	86	1625.785	14.851425	-926.72178	191.27434	65.861039	0
10	86	1628.771	15.702425	-979.84629	205.46358	70.746784	0
11	86	1631.757	16.56895	-1033.8886	218.00719	75.065896	0
12	86	1634.743	17.45107	-1088.9366	228.91417	78.82147	0
13	86	1637.7295	18.34885	-1144.9807	238.18726	82.01445	0
14	86	1640.716	19.262355	-1201.9786	245.8293	84.645816	0
15	86	1643.702	20.191665	-1259.9534	251.85009	86.718939	0
16	86	1646.688	21.136845	-1318.9264	256.24984	88.233897	0
17	86	1649.674	22.097965	-1378.919	259.03552	89.193083	0

				3			
18	86	1652.66	23.0751	-1439.8895	260.21114	89.597882	0
19	86	1655.646	24.06833	-1501.8574	259.77774	89.44865	0
20	86	1658.632	25.077735	-1564.8437	257.74307	88.748056	0
21	86	1661.618	26.103395	-1628.8368	254.1088	87.496677	0
22	86	1664.604	27.14539	-1693.8567	248.88007	85.696281	0
23	86	1667.59	28.2038	-1759.9221	242.06222	83.348705	0
24	86	1670.5765	29.278715	-1826.9886	233.65457	80.45372	0
25	86	1673.563	30.370225	-1895.107	223.66323	77.013425	0
26	86	1676.549	31.478415	-1964.263	212.09436	73.029945	0
27	86	1679.535	32.603375	-2034.4433	198.94832	68.503401	0
28	86	1682.521	33.745205	-2105.6967	184.22581	63.434032	0
29	86	1685.507	34.904	-2178.0084	167.93715	57.825397	0
30	86	1689.173	36.352485	-2268.3066	76.971931	44.439765	0

Slices of Slip Surface: 111

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	111	1620.7755	14.80781	-924.02071	13.20538	7.6241298	0
2	111	1623.289	15.417715	-962.07344	38.730218	22.360902	0
3	111	1625.803	16.041015	-1000.9686	62.584173	36.132989	0
4	111	1628.3165	16.677765	-1040.6987	84.772839	48.943621	0
5	111	1630.83	17.328015	-1081.2575	105.31599	60.804215	0
6	111	1633.3435	17.991815	-1122.6756	124.21427	71.715141	0
7	111	1635.857	18.66922	-1164.9452	141.48012	81.683585	0
8	111	1638.371	19.360285	-1208.0974	157.12626	90.716891	0
9	111	1640.809	20.04347	-1250.7057	172.65986	59.451558	0
10	111	1643.1715	20.718025	-1292.8093	183.72421	63.261317	0
11	111	1645.534	21.4048	-1335.654	193.49781	66.626639	0
12	111	1647.896	22.103845	-1379.273	201.98116	69.54769	0

				7			
13	111	1650.2585	22.81521	-1423.6602	209.18287	72.027439	0
14	111	1652.621	23.53895	-1468.8462	215.09969	74.064761	0
15	111	1654.9835	24.275115	-1514.7838	219.74077	75.662815	0
16	111	1657.346	25.02377	-1561.4643	223.10722	76.821976	0
17	111	1659.7085	25.78497	-1609.0014	225.20062	77.542791	0
18	111	1662.071	26.558765	-1657.2645	226.02642	77.827138	0
19	111	1664.433	27.345225	-1706.3258	225.58654	77.675675	0
20	111	1666.7955	28.14441	-1756.2163	223.88302	77.089106	0
21	111	1669.158	28.95638	-1806.8865	220.92213	76.069588	0
22	111	1671.5205	29.7812	-1858.3271	216.70234	74.616601	0
23	111	1673.883	30.618935	-1910.6074	211.2303	72.732425	0
24	111	1676.245	31.46965	-1963.7179	204.50902	70.418102	0
25	111	1678.6075	32.333415	-2017.608	196.53373	67.67199	0

				6			
26	111	1680.97	33.210305	-2072.308	187.31574	64.497981	0
27	111	1683.3325	34.100385	-2127.8448	176.85078	60.894608	0
28	111	1685.695	35.00373	-2184.2467	165.1467	56.864568	0
29	111	1686.938	35.48276	-2214.0891	153.75221	88.768882	0
30	111	1688.0865	35.931575	-2242.1229	115.15538	66.484991	0
31	111	1690.2595	36.78684	-2295.4911	38.461818	22.205941	0

Slices of Slip Surface: 77

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	77	1601.848	8.4697595	-528.51381	21.451726	12.38516	0
2	77	1602.594	8.434699	-526.33094	61.804144	35.682639	0
3	77	1603.34	8.4165545	-525.18683	98.139214	56.660702	0
4	77	1604.086	8.4152985	-525.11302	130.70272	75.461248	0
5	77	1604.8325	8.430929	-526.09648	159.7081	92.207515	0

6	77	1605.579	8.463469	-528.11964	185.34833	107.01091	0
7	77	1606.3475	8.5149855	-531.33795	198.50664	68.351317	0
8	77	1607.1385	8.586617	-535.80163	217.30082	74.822673	0
9	77	1607.9295	8.6775255	-541.47777	233.40186	80.366705	0
10	77	1608.7205	8.787873	-548.363	246.89957	85.01434	0
11	77	1609.5115	8.917858	-556.47205	257.86545	88.790195	0
12	77	1610.3025	9.067717	-565.82479	266.35285	91.71264	0
13	77	1611.094	9.2377275	-576.43256	272.43399	93.806546	0
14	77	1611.8855	9.428212	-588.32236	276.17506	95.094701	0
15	77	1612.6765	9.639539	-601.51081	277.59977	95.585268	0
16	77	1613.4675	9.8721275	-616.01534	276.76349	95.297312	0
17	77	1614.2585	10.126452	-631.88868	273.71656	94.248169	0
18	77	1615.0495	10.40305	-649.15604	268.48112	92.445464	0
19	77	1615.840	10.70252	-	261.08825	89.899894	0

		5		667.83725			
20	77	1616.6315	11.02554	-687.99151	251.55545	86.617486	0
21	77	1617.4225	11.372875	-709.66513	239.92278	82.612039	0
22	77	1618.2135	11.745375	-732.91144	226.20794	77.889639	0
23	77	1619.005	12.144005	-757.78479	210.4092	72.449696	0
24	77	1619.7965	12.56985	-784.35593	192.55346	66.301473	0
25	77	1620.5875	13.024135	-812.70356	172.65397	59.449529	0
26	77	1621.3785	13.50825	-842.91326	150.72561	51.898988	0
27	77	1622.221	14.059715	-877.32778	117.41327	67.788586	0
28	77	1623.1155	14.685275	-916.33776	86.510508	49.946865	0
29	77	1624.01	15.35656	-958.21484	53.330002	30.790091	0
30	77	1624.904	16.077225	-1003.2219	17.941412	10.358479	0

Slices of Slip Surface: 107

	Slip Surfac	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength	Cohesive

	e					(psf)	Strength (psf)
1	107	1620.205	14.467225	-902.73659	38.385772	22.162036	0
2	107	1621.5765	14.406925	-899.01982	110.24285	63.64874	0
3	107	1622.948	14.38187	-897.40029	174.29041	100.62662	0
4	107	1624.3165	14.39189	-898.0606	217.07282	74.744166	0
5	107	1625.6815	14.436835	-900.89233	261.23609	89.950798	0
6	107	1627.0465	14.51672	-905.83086	300.10443	103.33424	0
7	107	1628.4115	14.6317	-912.99427	333.87734	114.96319	0
8	107	1629.7225	14.774725	-921.96756	364.51515	189.75457	0
9	107	1630.9795	14.94337	-932.49983	375.06218	195.24501	0
10	107	1632.2365	15.142515	-944.91054	383.23376	199.49887	0
11	107	1633.4935	15.372505	-959.21576	389.09683	202.55099	0
12	107	1634.7505	15.63375	-975.57413	392.72336	204.43884	0
13	107	1636.008	15.92672	-993.8207	394.16794	205.19084	0

				8			
14	107	1637.2655	16.25196	-1014.0843	393.50464	204.84555	0
15	107	1638.5225	16.61008	-1036.4772	390.76014	203.41685	0
16	107	1639.7795	17.001775	-1060.9389	386.00505	200.94151	0
17	107	1641.0365	17.42783	-1087.4645	379.25475	197.42753	0
18	107	1642.2935	17.889125	-1116.2508	370.56226	192.9025	0
19	107	1643.5505	18.386645	-1147.3114	359.95699	187.38175	0
20	107	1644.8075	18.92149	-1180.7048	347.46311	180.87785	0
21	107	1646.0645	19.494905	-1216.4493	333.11342	173.40787	0
22	107	1647.3215	20.10828	-1254.7317	316.92915	164.98287	0
23	107	1648.5785	20.763175	-1295.6132	298.92353	155.60974	0
24	107	1649.8355	21.46135	-1339.1588	279.1306	145.30619	0
25	107	1651.034	22.16805	-1383.2837	259.42378	89.326771	0
26	107	1652.174	22.881095	-1427.751	226.93195	78.138938	0

				3			
27	107	1653.314	23.63499	-1474.7931	191.82396	66.050285	0
28	107	1654.454	24.43187	-1524.5399	154.09267	53.058361	0
29	107	1655.828	25.45896	-1588.6199	97.400436	56.234168	0
30	107	1657.436	26.744935	-1668.8881	32.867474	18.976045	0

Slices of Slip Surface: 82

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	82	1602.468	8.434943	-526.3359	55.116733	31.821661	0
2	82	1604.454	8.347007	-520.83805	158.4958	91.507593	0
3	82	1606.6095	8.3109175	-518.61719	240.47442	82.801983	0
4	82	1608.9345	8.335921	-520.17159	323.7765	111.48519	0
5	82	1611.036	8.414905	-525.08954	390.03947	203.0417	0
6	82	1612.914	8.536028	-532.62282	418.33692	217.77242	0
7	82	1614.7925	8.702539	-543.03719	442.58776	230.39661	0

8	82	1616.671	8.914729	-556.30046	462.9656	241.00464	0
9	82	1618.549	9.172973	-572.41006	479.59548	249.66161	0
10	82	1620.427	9.4777335	-591.40253	492.61166	256.4374	0
11	82	1622.305	9.829563	-613.35248	502.13144	261.39308	0
12	82	1624.1835	10.229115	-638.31688	508.24878	264.57757	0
13	82	1626.062	10.677135	-666.23122	511.06126	266.04165	0
14	82	1627.94	11.17449	-697.26966	510.64884	265.82696	0
15	82	1629.818	11.722165	-731.47965	507.09098	263.97486	0
16	82	1631.696	12.321265	-768.83129	500.44506	260.51521	0
17	82	1633.5745	12.97305	-809.51995	490.78461	255.4863	0
18	82	1635.453	13.678925	-853.55336	478.14859	248.9084	0
19	82	1637.331	14.44048	-901.09855	462.59828	240.81342	0
20	82	1639.209	15.2595	-952.17762	444.17002	231.22028	0

21	82	1641.087	16.13798	-1007.0003	422.90081	220.14823	0
22	82	1642.9655	17.078175	-1065.6605	398.82704	207.61622	0
23	82	1644.844	18.08262	-1128.3646	371.97815	193.63957	0
24	82	1646.722	19.154185	-1195.2215	342.37996	178.23173	0
25	82	1648.6	20.296125	-1266.4583	310.06532	161.40979	0
26	82	1650.478	21.512135	-1342.3375	275.05187	143.18294	0
27	82	1652.3545	22.80528	-1423.0519	232.68715	80.120612	0
28	82	1654.2295	24.180285	-1508.8445	166.82882	57.443769	0
29	82	1655.9355	25.503885	-1591.4328	95.695361	55.249742	0
30	82	1657.472	26.76595	-1670.1858	32.155831	18.565178	0

Slices of Slip Surface: 87

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	87	1603.3255	8.3584295	-521.55852	106.64531	61.571699	0

2	87	1607.184	8.14465	-508.21957	287.15177	98.874283	0
3	87	1610.6885	8.046801	-502.13578	423.01298	220.20662	0
4	87	1613.681	8.0491225	-502.25987	486.99026	253.51108	0
5	87	1616.6735	8.1247775	-506.99112	543.65557	283.00917	0
6	87	1619.666	8.2739025	-516.27724	593.35196	308.87948	0
7	87	1622.6585	8.4967675	-530.21479	636.41088	331.29453	0
8	87	1625.6515	8.7937785	-548.74714	673.082	350.38431	0
9	87	1628.644	9.165482	-571.93143	703.5667	366.25364	0
10	87	1631.6365	9.612569	-599.8362	728.11571	379.03305	0
11	87	1634.629	10.135882	-632.47384	746.863	388.79227	0
12	87	1637.6215	10.73642	-669.963	760.05606	395.66014	0
13	87	1640.6145	11.41536	-712.32852	767.79286	399.68766	0
14	87	1643.607	12.174055	-759.66253	770.21968	400.95099	0
15	87	1646.5995	13.01405	-812.08557	767.46478	399.51687	0

16	87	1649.5925	13.937115	-869.6788	759.60945	395.42765	0
17	87	1652.585	14.94524	-932.5726	746.78321	388.75073	0
18	87	1655.5775	16.04068	-1000.9387	729.0711	379.53039	0
19	87	1658.57	17.225985	-1074.8863	706.54725	367.80522	0
20	87	1661.5625	18.50401	-1154.6388	679.27837	353.60994	0
21	87	1664.5555	19.87798	-1240.3931	647.32693	336.97707	0
22	87	1667.548	21.35153	-1332.3349	610.69566	317.90804	0
23	87	1670.5405	22.92877	-1430.7672	569.51331	296.46987	0
24	87	1673.5335	24.614355	-1535.9318	523.77132	272.65809	0
25	87	1676.526	26.413565	-1648.2089	473.48423	246.48029	0
26	87	1679.5185	28.332425	-1767.9532	418.75435	217.98972	0
27	87	1682.511	30.377845	-1895.5803	359.5584	187.17426	0
28	87	1685.5035	32.55779	-2031.5976	295.96357	154.06888	0
29	87	1687.2175	33.85211	-	255.55317	133.03256	0

				2112.3361			
30	87	1688.435	34.82175	-2172.8816	193.92863	66.774982	0
31	87	1690.3905	36.41953	-2272.5794	62.40477	36.029411	0

Slices of Slip Surface: 112

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	112	1620.443	14.4304	-900.45543	54.968816	31.736261	0
2	112	1622.291	14.2965	-892.08768	159.97209	92.359932	0
3	112	1624.241	14.194555	-885.75891	243.57883	83.870918	0
4	112	1626.293	14.12854	-881.63443	329.93932	113.60722	0
5	112	1628.5125	14.107825	-880.34829	410.47872	213.6817	0
6	112	1630.9	14.14004	-882.31796	457.65795	238.24165	0
7	112	1633.2875	14.23092	-888.01981	499.19214	259.86298	0
8	112	1635.6745	14.38063	-897.34539	535.30775	278.66358	0
9	112	1638.0615	14.589445	-	566.25047	294.77134	0

				910.37737			
10	112	1640.449	14.85775	-927.14098	592.19805	308.27879	0
11	112	1642.8365	15.18604	-947.60049	613.29946	319.26349	0
12	112	1645.2235	15.57493	-971.86637	629.75753	327.83102	0
13	112	1647.6105	16.025165	-999.98645	641.70451	334.05022	0
14	112	1649.9975	16.537625	-1031.9434	649.24297	337.9745	0
15	112	1652.385	17.11332	-1067.8587	652.52842	339.68479	0
16	112	1654.7725	17.753415	-1107.8224	651.60567	339.20444	0
17	112	1657.1595	18.459245	-1151.8524	646.61399	336.60594	0
18	112	1659.5465	19.232325	-1200.0884	637.58417	331.90531	0
19	112	1661.934	20.07436	-1252.6256	624.64169	325.16788	0
20	112	1664.3215	20.987275	-1309.5873	607.80855	316.40511	0
21	112	1666.7085	21.97325	-1371.1162	587.12619	305.63855	0
22	112	1669.0955	23.034735	-	562.73158	292.93952	0

				1437.3605			
23	112	1671.483	24.174485	-1508.4998	534.55451	278.27147	0
24	112	1673.8705	25.395615	-1584.6913	502.70515	261.69174	0
25	112	1676.2575	26.70166	-1666.195	467.20997	243.21412	0
26	112	1678.6445	28.09661	-1753.2351	428.06008	222.83397	0
27	112	1681.032	29.58502	-1846.1095	385.29157	200.5701	0
28	112	1683.4195	31.17211	-1945.1457	338.96789	176.45551	0
29	112	1685.8065	32.863865	-2050.705	289.07609	150.48349	0
30	112	1687.186	33.877645	-2113.9706	256.83795	133.70137	0
31	112	1688.394	34.819685	-2172.7363	195.28215	67.241037	0
32	112	1690.381	36.419055	-2272.5694	62.662114	36.177988	0

Slices of Slip Surface: 76

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	76	1601.8725	8.594008	-536.26117	3.3844087	1.9539893	0

2	76	1602.668	8.800974	-549.18019	9.9034724	5.7177724	0
3	76	1603.464	9.0119445	-562.34387	15.942645	9.2044903	0
4	76	1604.26	9.226935	-575.76239	21.502144	12.414269	0
5	76	1605.056	9.44596	-589.43332	26.585515	15.349155	0
6	76	1605.852	9.6690355	-603.34249	31.192987	18.009279	0
7	76	1606.648	9.896179	-617.52372	35.328466	20.396899	0
8	76	1607.444	10.127405	-631.95039	38.991093	22.511518	0
9	76	1608.24	10.36273	-646.63224	42.184913	24.355471	0
10	76	1609.0355	10.602175	-661.57875	44.909204	25.928341	0
11	76	1609.831	10.845755	-676.77517	47.166923	27.231836	0
12	76	1610.627	11.093485	-692.23092	48.959897	28.26701	0
13	76	1611.423	11.345385	-707.95522	50.28882	29.034264	0
14	76	1612.219	11.60148	-723.93324	51.155654	29.534731	0

15	76	1613.015	11.861785	-740.17407	51.562433	29.769585	0
16	76	1613.811	12.12632	-756.68656	51.50887	29.73866	0
17	76	1614.607	12.39511	-773.45584	50.998343	29.443907	0
18	76	1615.403	12.668165	-790.4906	50.03072	28.88525	0
19	76	1616.1985	12.94551	-807.79943	48.608327	28.064031	0
20	76	1616.994	13.227175	-825.37902	46.732384	26.980955	0
21	76	1617.79	13.513175	-843.2259	44.403006	25.636088	0
22	76	1618.586	13.80353	-861.33667	41.622762	24.030913	0
23	76	1619.382	14.09827	-879.73129	38.393112	22.166273	0
24	76	1620.178	14.397415	-898.39413	34.714421	20.04238	0
25	76	1620.974	14.70099	-917.345	30.587159	17.659504	0
26	76	1621.77	15.00902	-936.56812	26.01422	15.019317	0
27	76	1622.566	15.32153	-956.05954	20.996248	12.122189	0
28	76	1623.3615	15.638545	-975.85021	15.532814	8.9678743	0
29	76	1624.157	15.960095	-	9.6274368	5.5584032	0

				995.91244			
30	76	1624.953	16.286205	-1016.2535	3.2796497	1.8935066	0

Slices of Slip Surface: 81

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	81	1602.421	8.7351735	-545.05898	8.0464012	4.6455919	0
2	81	1604.313	9.2272235	-575.77816	23.544849	13.593625	0
3	81	1606.205	9.728794	-607.07022	37.901684	21.882548	0
4	81	1608.097	10.239922	-638.98057	51.120485	29.514426	0
5	81	1609.989	10.76064	-671.45365	63.204024	36.490861	0
6	81	1611.8815	11.29099	-704.53513	74.16079	42.816752	0
7	81	1613.774	11.83101	-738.2703	83.989229	48.491204	0
8	81	1615.666	12.380735	-772.55226	92.698156	53.519306	0
9	81	1617.558	12.94021	-807.47676	100.29141	57.903272	0
10	81	1619.45	13.50947	-842.9875	106.76797	61.642518	0

				6			
11	81	1621.3425	14.08856	-879.1292	112.13707	64.742369	0
12	81	1623.235	14.67753	-915.89535	116.39798	67.202403	0
13	81	1625.127	15.27642	-953.22919	119.5602	69.028116	0
14	81	1627.019	15.88527	-991.22536	121.61839	70.216413	0
15	81	1628.911	16.50413	-1029.8769	122.58743	70.775883	0
16	81	1630.803	17.133045	-1069.0771	122.46229	70.703639	0
17	81	1632.6955	17.772065	-1108.9687	121.24811	70.00263	0
18	81	1634.588	18.42124	-1149.4948	118.94529	68.673093	0
19	81	1636.48	19.08062	-1190.6472	115.56428	66.721067	0
20	81	1638.372	19.75026	-1232.4194	111.10093	64.144154	0
21	81	1640.264	20.430205	-1274.8529	105.56607	60.948599	0
22	81	1642.156	21.12051	-1317.9394	98.955827	57.132174	0
23	81	1644.0485	21.821235	-1361.6211	91.276494	52.698509	0

24	81	1645.941	22.532435	-1406.0386	82.529644	47.648512	0
25	81	1647.833	23.25417	-1451.0835	72.721909	41.986014	0
26	81	1649.725	23.986495	-1496.7477	61.845416	35.706468	0
27	81	1651.617	24.72947	-1543.1198	49.917092	28.819646	0
28	81	1653.5095	25.483155	-1590.141	36.929491	21.321252	0
29	81	1655.402	26.247615	-1637.8516	22.888705	13.2148	0
30	81	1657.294	27.02292	-1686.2408	7.7970805	4.5016465	0

Slices of Slip Surface: 101

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	101	1619.616	14.531235	-906.73717	0.82674267	0.4773201	0
2	101	1619.81	14.581795	-909.90724	2.4192389	1.3967482	0
3	101	1620.0045	14.63333	-913.14445	3.8943539	2.2484063	0
4	101	1620.199	14.685845	-916.3982	5.2526534	3.0326208	0
5	101	1620.3935	14.73935	-919.7181	6.4942274	3.7494439	0

				9			
6	101	1620.588	14.793845	-923.15246	7.6200167	4.3994187	0
7	101	1620.7825	14.84933	-926.60142	8.6298932	4.9824712	0
8	101	1620.977	14.905815	-930.1141	9.5247356	5.4991087	0
9	101	1621.171	14.9633	-933.68901	10.304934	5.9495563	0
10	101	1621.3655	15.02179	-937.3748	10.970411	6.3337695	0
11	101	1621.56	15.081295	-941.07193	11.522086	6.6522795	0
12	101	1621.7545	15.14181	-944.82911	11.959918	6.9050619	0
13	101	1621.949	15.203345	-948.69427	12.284858	7.0926662	0
14	101	1622.143	15.265905	-952.56826	12.496404	7.2148022	0
15	101	1622.3375	15.32949	-956.54841	12.595547	7.2720427	0
16	101	1622.532	15.39411	-960.58415	12.582794	7.2646795	0
17	101	1622.7265	15.45977	-964.67485	12.458192	7.1927407	0
18	101	1622.921	15.526475	-968.86799	12.221805	7.0562622	0
19	101	1623.115	15.594225	-	11.8742	6.8555725	0

		5		973.06515			
20	101	1623.31	15.663025	-977.36234	11.415964	6.59101	0
21	101	1623.504	15.73289	-981.71027	10.84674	6.2623684	0
22	101	1623.6985	15.80382	-986.15559	10.167632	5.8702853	0
23	101	1623.893	15.87582	-990.64914	9.378807	5.4148568	0
24	101	1624.0875	15.948895	-995.18929	8.4799613	4.8959079	0
25	101	1624.282	16.02305	-999.82331	7.4717875	4.3138386	0
26	101	1624.4765	16.098295	-1004.5493	6.354989	3.6690546	0
27	101	1624.671	16.174635	-1009.3178	5.1288576	2.9611473	0
28	101	1624.865	16.25208	-1014.1288	3.7944857	2.1907473	0
29	101	1625.0595	16.33063	-1019.027	2.351828	1.3578285	0
30	101	1625.254	16.41029	-1024.0115	0.80116052	0.46255024	0

SLOPE/W

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File Information

Revision Number: 6
Last Edited By: Akbas, Ibrahim
Date: 6/26/2009
Time: 10:07:20 AM
File Name: Dare-Final Grading-Revised 062609.gsz
Directory: P:\Dare County - 17952\56960 Cell No. 4\Geotechnical\calculations\
Last Solved Date: 6/26/2009
Last Solved Time: 10:07:28 AM

Project Settings

Length(L) Units: feet
Time(t) Units: Seconds
Force(F) Units: lbf
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D

Analysis Settings

SLOPE/W

Kind: SLOPE/W
Method: Spencer
Settings
- Apply Phreatic Correction: No
- PWP Conditions Source: Piezometric Line
- Use Staged Rapid Drawdown: No

SlipSurface
- Direction of movement: Right to Left
- Allow Passive Mode: No
- Slip Surface Option: Entry and Exit
- Critical slip surfaces saved: 10
- Optimize Critical Slip Surface Location: No
- Tension Crack
  - Tension Crack Option: (none)

FOS Distribution
- FOS Calculation Option: Constant

Advanced

Number of Slices: 30
Optimization Tolerance: 0.01
Minimum Slip Surface Depth: 0.1 ft
Optimization Maximum Iterations: 2000
Optimization Convergence Tolerance: 1e-007
Starting Optimization Points: 8
Ending Optimization Points: 16
Complete Passes per Insertion: 1

Materials

C&D Landfill

Model: Mohr-Coulomb
Unit Weight: 65 pcf
Cohesion: 0 psf
Phi: 27.5 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 1

Model: Mohr-Coulomb
Unit Weight: 115 pcf
Cohesion: 0 psf
Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 2

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 28 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 3

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Soil Layer 4

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 29 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Soil Layer 5

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 34 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Yorktown

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Compacted Fill

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf
Phi: 35 °
Phi-B: 0 °

Soil Liner

Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion: 0 psf
Phi: 119 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1

Vegetative Cover

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion: 0 psf

Phi: 30 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (906.5768, 5) ft
Left-Zone Right Coordinate: (1031.1348, 18.378266) ft
Left-Zone Increment: 8
Right Projection: Range
Right-Zone Left Coordinate: (1049.7319, 24.5773) ft
Right-Zone Right Coordinate: (1177.9847, 39.759694) ft
Right-Zone Increment: 8
Radius Increments: 8

Slip Surface Limits

Left Coordinate: (800, 5) ft
Right Coordinate: (2350, 5) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
	800	0
	1000	0
	1250	0
	1300	0
	1550	0
	1600	0
	1850	0
	1900	0
	2150	0
	2350	0

Seismic Loads

Horz Seismic Load: 0
Vert Seismic Load: 0

Regions

	Material	Points	Area (ft²)
Region 1	C&D Landfill	38,12,14,13,45,44,43,42,41,40,39	36504.5
Region 2	Soil Layer 1	16,1,2,3,4,5,6,7,8,9	11500
Region 3	Soil Layer 2	16,24,17,9	2300
Region 4	Soil Layer 3	24,32,25,17	14950
Region 5	Soil Layer 4	32,37,33,25	5750
Region 6	Soil Layer 5	37,11,10,33	43700
Region 7	Yorktown	11,19,18,10	115000
Region 8	Soil Layer 1	1,26,21,16	2000
Region 9	Soil Layer 2	21,22,24,16	400
Region 10	Soil Layer 3	22,23,32,24	2600
Region 11	Soil Layer 4	23,27,37,32	1000
Region 12	Soil Layer 5	27,28,11,37	7600
Region 13	Yorktown	28,20,19,11	20000
Region 14	Soil Layer 1	8,29,30,9	2000
Region 15	Soil Layer 2	9,17,31,30	400
Region 16	Soil Layer 3	17,25,34,31	2600

Region 17	Soil Layer 4	33,35,34,25	1000
Region 18	Soil Layer 5	33,10,15,35	7600
Region 19	Yorktown	10,18,36,15	20000
Region 20	Compacted Fill	46,26,1,2,3,4,5,6,7,8,29,47,45,44,43,42,41,40,39,38,59,58	7750
Region 21	Soil Liner	59,56,38	3.375
Region 22	Vegetative Cover	58,59,56,57	10.125
Region 23	Soil Liner	38,12,48,56	135
Region 24	Vegetative Cover	57,56,48,49	135
Region 25	Soil Liner	12,14,13,52,50,48	1455
Region 26	Vegetative Cover	49,48,50,52,53,51	1455
Region 27	Soil Liner	52,13,45,54	135
Region 28	Vegetative Cover	53,52,54,55	135

Points

	X (ft)	Y (ft)
Point 1	1000	0
Point 2	1250	0
Point 3	1300	0
Point 4	1550	0
Point 5	1600	0
Point 6	1850	0
Point 7	1900	0
Point 8	2150	0
Point 9	2150	-10
Point 10	2150	-68

Point 11	1000	-68
Point 12	1090	35
Point 13	2060	35
Point 14	1575	44.7
Point 15	2350	-68
Point 16	1000	-10
Point 17	2150	-12
Point 18	2150	-168
Point 19	1000	-168
Point 20	800	-168
Point 21	800	-10
Point 22	800	-12
Point 23	800	-25
Point 24	1000	-12
Point 25	2150	-25
Point 26	800	0
Point 27	800	-30
Point 28	800	-68
Point 29	2350	0
Point 30	2350	-10
Point 31	2350	-12
Point 32	1000	-25
Point 33	2150	-30
Point 34	2350	-25
Point 35	2350	-30
Point 36	2350	-168
Point 37	1000	-30
Point 38	1000	5
Point 39	1250	5
Point 40	1300	5
Point 41	1550	5
Point 42	1600	5
Point 43	1850	5
Point 44	1900	5
Point 45	2150	5
Point 46	800	5

Point 47	2350	5
Point 48	1090	36.5
Point 49	1090	38
Point 50	1575	46.2
Point 51	1575	47.7
Point 52	2060	36.5
Point 53	2060	38
Point 54	2150	6.5
Point 55	2150	8
Point 56	1000	6.5
Point 57	1000	8
Point 58	991	5
Point 59	995.5	5

Critical Slip Surfaces

	Number	FOS	Center (ft)	Radius (ft)	Entry (ft)	Exit (ft)
1	200	1.5	(964.365, 340.711)	336.724	(1112.77, 38.4555)	(991.164, 5.05454)
2	451	1.5	(844.406, 925.49)	931.284	(1129.08, 38.7815)	(995.767, 6.58908)
3	613	1.5	(914.024, 730.972)	724.828	(1129.08, 38.7815)	(1016.11, 13.3689)
4	532	1.5	(872.877, 832.234)	833.79	(1129.08, 38.7815)	(1001.08, 8.35946)
5	281	1.5	(971.085, 317.449)	312.91	(1112.77, 38.4555)	(991.644, 5.21477)
6	362	1.6	(977.516, 294.286)	289.386	(1112.77, 38.4555)	(991.754, 5.25131)
7	406	1.7	(885.601, 446.479)	452.703	(1049.73, 24.5773)	(1007.44, 10.479)
8	415	1.7	(857.677, 556.211)	565.901	(1065.2, 29.7337)	(1007.54, 10.5148)
9	424	1.7	(829.732, 665.949)	679.12	(1080.67, 34.8902)	(1007.62, 10.539)
10	658	1.7	(969.496,	249.43	(1065.2,	(1031.14,

			260.072)		29.7337)	18.3783)

Slices of Slip Surface: 200

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	200	992.69875	5.1841795	-323.49314	46.861004	27.055213	0
2	200	995.7691	5.457617	-340.55905	138.11417	79.740256	0
3	200	998.65215	5.739383	-358.13686	192.80176	-347.82359	0
4	200	1001.986	6.100617	-380.69088	269.54866	-486.27865	0
5	200	1006.02	6.5792375	-410.53228	371.60584	193.44575	0
6	200	1010.1165	7.1155045	-443.99731	422.57013	219.97608	0
7	200	1014.213	7.703029	-480.65897	469.57798	244.44682	0
8	200	1018.3095	8.342082	-520.55398	512.69892	266.89417	0
9	200	1022.4065	9.0329615	-563.66706	551.95706	287.33066	0
10	200	1026.503	9.7759935	-610.02717	587.40336	305.78283	0
11	200	1030.5995	10.57153	-659.6590	619.11547	322.29111	0

				6			
12	200	1034.696	11.41995	-712.60716	647.10202	336.85999	0
13	200	1038.7925	12.32166	-768.86341	671.42231	349.52033	0
14	200	1042.8895	13.277105	-828.48653	692.11454	360.29203	0
15	200	1046.986	14.28676	-891.50574	709.19586	369.184	0
16	200	1051.0825	15.351125	-957.92146	722.71037	376.21921	0
17	200	1055.179	16.47074	-1027.7759	732.68167	381.40994	0
18	200	1059.2755	17.646185	-1101.1279	739.15975	384.78221	0
19	200	1063.372	18.878065	-1177.983	742.17433	386.3515	0
20	200	1067.4685	20.167025	-1258.4328	741.71175	386.1107	0
21	200	1071.5655	21.513765	-1342.4676	737.83191	384.09098	0
22	200	1075.662	22.919025	-1430.1404	730.57511	380.31333	0
23	200	1079.7585	24.383575	-1521.5396	719.91577	374.76443	0
24	200	1083.855	25.908245	-1616.6766	705.87961	367.45767	0

25	200	1087.9515	27.49392	-1715.6193	688.54113	358.43182	0
26	200	1092.0275	29.132775	-1817.8951	632.15655	329.07987	0
27	200	1096.082	30.82515	-1923.4842	537.59231	279.85284	0
28	200	1100.1365	32.580175	-2032.9968	440.77341	229.45212	0
29	200	1104.1915	34.398925	-2146.5033	341.76502	177.91161	0
30	200	1107.8815	36.10762	-2253.1261	363.04144	-654.94409	0
31	200	1111.1585	37.67317	-2350.8108	74.749257	43.156504	0

Slices of Slip Surface: 451

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	451	997.8836	6.9426995	-433.23403	40.995515	23.668772	0
2	451	1002.4715	7.7219715	-481.85267	128.04345	73.925923	0
3	451	1007.397	8.5838665	-535.63362	221.39871	-399.41384	0
4	451	1012.305	9.4699265	-590.92824	305.39409	-550.94552	0

5	451	1016.972	10.337031	-645.0371	351.67089	183.06828	0
6	451	1021.398	11.182705	-697.81169	390.07625	203.06084	0
7	451	1025.824	12.05061	-751.95418	426.91478	222.23777	0
8	451	1030.25	12.94081	-807.50039	462.18787	240.59978	0
9	451	1034.676	13.85336	-864.44183	495.89731	258.1478	0
10	451	1039.102	14.788335	-922.79153	528.06698	274.89427	0
11	451	1043.528	15.745805	-982.54046	558.69905	290.84031	0
12	451	1047.954	16.725835	-1043.701	587.77359	305.97556	0
13	451	1052.38	17.728505	-1106.2635	615.33718	320.32426	0
14	451	1056.806	18.75389	-1170.2398	641.37043	333.87631	0
15	451	1061.2315	19.802065	-1235.6416	665.87622	346.63322	0
16	451	1065.657	20.873105	-1302.4802	688.85766	358.5966	0
17	451	1070.083	21.967095	-1370.7443	710.33983	369.77951	0
18	451	1074.509	23.08412	-1440.444	730.32621	380.18376	0

				6			
19	451	1078.935	24.224265	-1511.5913	748.79858	389.79987	0
20	451	1083.361	25.387615	-1584.194	765.7826	398.64119	0
21	451	1087.787	26.57426	-1658.2408	781.28254	406.70995	0
22	451	1092.064	27.74284	-1731.1441	756.06642	393.58327	0
23	451	1096.192	28.891915	-1802.8567	690.52176	359.46288	0
24	451	1100.3205	30.061495	-1875.8281	624.05715	324.86359	0
25	451	1104.449	31.25166	-1950.0925	556.65756	289.77758	0
26	451	1108.577	32.462495	-2025.6624	488.33222	254.20966	0
27	451	1112.705	33.694085	-2102.5023	419.06692	218.15243	0
28	451	1116.8335	34.946515	-2180.6693	348.91729	181.63484	0
29	451	1121.4695	36.37939	-2270.0026	304.47361	-549.28494	0
30	451	1126.5585	37.98118	-2370.1082	81.030749	46.783125	0

Slices of Slip Surface: 613

	Slip	X (ft)	Y (ft)	PWP (psf)	Base Normal	Frictional	Cohesiv

	Surface				Stress (psf)	Strength (psf)	e Strength (psf)
1	613	1018.1305	13.66255	-852.53566	44.782269	25.855055	0
2	613	1022.1775	14.261605	-889.9133	132.58057	76.545425	0
3	613	1026.364	14.906355	-930.15737	219.57431	-396.12255	0
4	613	1030.6905	15.59854	-973.35318	303.07648	-546.76444	0
5	613	1034.759	16.27313	-1015.4489	353.96031	184.26008	0
6	613	1038.5685	16.92717	-1056.2547	391.75135	203.93284	0
7	613	1042.378	17.602155	-1098.3728	427.98744	222.79616	0
8	613	1046.188	18.298145	-1141.7949	462.74682	240.89075	0
9	613	1049.998	19.015205	-1186.5391	496.03065	258.21721	0
10	613	1053.8075	19.75339	-1232.6222	527.78834	274.74922	0
11	613	1057.617	20.51277	-1279.9841	558.07307	290.51445	0
12	613	1061.427	21.29342	-1328.7186	586.91219	305.52715	0
13	613	1065.237	22.0954	-	614.25604	319.76145	0

				1378.7645			
14	613	1069.0465	22.918785	-1430.1377	640.13247	333.23187	0
15	613	1072.856	23.763655	-1482.8538	664.54389	345.93965	0
16	613	1076.666	24.630085	-1536.9276	687.51834	357.89939	0
17	613	1080.476	25.51815	-1592.323	709.03324	369.09934	0
18	613	1084.2855	26.427935	-1649.1049	729.11689	379.55423	0
19	613	1088.095	27.359525	-1707.2365	747.77276	389.26586	0
20	613	1091.778	28.28057	-1764.707	730.71241	380.38481	0
21	613	1095.334	29.189745	-1821.4499	678.28257	353.09156	0
22	613	1098.8905	30.11814	-1879.3752	624.96295	325.33512	0
23	613	1102.447	31.065835	-1938.4989	570.70738	297.09146	0
24	613	1106.003	32.03291	-1998.8644	515.57881	268.39334	0
25	613	1109.559	33.019445	-2060.4066	459.5319	239.21716	0
26	613	1113.115	34.02552	-2123.1936	402.6024	209.58154	0

27	613	1116.671	35.05122	-2187.1876	344.74575	179.46328	0
28	613	1121.1455	36.37291	-2269.737	303.66241	-547.8215	0
29	613	1126.459	37.97918	-2369.9677	81.451203	47.025874	0

Slices of Slip Surface: 532

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	532	1003.2545	8.704013	-543.11964	44.563721	25.728876	0
2	532	1007.6075	9.4049255	-586.86803	131.94498	76.178471	0
3	532	1012.1125	10.155668	-633.71818	220.07485	-397.02554	0
4	532	1016.7695	10.958025	-683.77648	303.63745	-547.77646	0
5	532	1021.1835	11.74293	-732.74818	352.76011	183.63529	0
6	532	1025.354	12.50776	-780.48298	391.01938	203.5518	0
7	532	1029.5245	13.294545	-829.58872	427.68787	222.64022	0
8	532	1033.6955	14.103345	-880.05724	462.81407	240.92576	0
9	532	1037.866	14.93423	-	496.37589	258.39693	0

		5		931.9034 3			
10	532	1042.037	15.787265	-985.1183 9	528.42202	275.07909	0
11	532	1046.207 5	16.662525	-1039.739 6	558.90724	290.94869	0
12	532	1050.378 5	17.560075	-1095.757 5	587.88058	306.03126	0
13	532	1054.549	18.47999	-1153.162 4	615.32104	320.31586	0
14	532	1058.719 5	19.42235	-1211.943 7	641.23091	333.80368	0
15	532	1062.890 5	20.387225	-1272.161 6	665.65999	346.52066	0
16	532	1067.061	21.3747	-1333.781	688.54076	358.43163	0
17	532	1071.231 5	22.38486	-1396.814 7	709.94675	369.57489	0
18	532	1075.402 5	23.41779	-1461.273 8	729.85774	379.93989	0
19	532	1079.573 5	24.473575	-1527.146 5	748.27739	389.52855	0
20	532	1083.744	25.5523	-1594.467 3	765.20978	398.343	0
21	532	1087.914 5	26.654065	-1663.222 7	780.65855	406.38512	0
22	532	1092.067	27.77388	-1733.092	755.65781	393.37056	0

				9			
23	532	1096.201	28.91164	-1804.0823	690.51802	359.46093	0
24	532	1100.3345	30.072315	-1876.5091	624.33162	325.00647	0
25	532	1104.468	31.256005	-1950.3823	557.0861	290.00067	0
26	532	1108.602	32.462815	-2025.6878	488.81589	254.46145	0
27	532	1112.736	33.692845	-2102.4337	419.48587	218.37052	0
28	532	1116.8695	34.946205	-2180.6505	349.13077	181.74598	0
29	532	1121.501	36.38003	-2270.1782	304.73714	-549.76035	0
30	532	1126.571	37.98143	-2369.9571	81.022337	46.778268	0

Slices of Slip Surface: 281

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	281	994.5498	5.4332725	-339.03546	93.652176	54.070109	0
2	281	998.72765	5.7646125	-359.71015	181.70659	-327.80736	0
3	281	1001.871	6.0624475	-378.2933	253.75647	-457.7888	0

				1			
4	281	1005.796	6.476682	-404.13577	379.57744	197.59551	0
5	281	1009.9035	6.962689	-434.47423	434.42592	226.14782	0
6	281	1014.011	7.50389	-468.25039	484.86596	252.40525	0
7	281	1018.1185	8.1005745	-505.47439	530.96353	276.40212	0
8	281	1022.226	8.753065	-546.20003	572.76426	298.1622	0
9	281	1026.3335	9.461716	-590.40438	610.34173	317.7238	0
10	281	1030.441	10.226914	-638.15506	643.79632	335.13915	0
11	281	1034.5485	11.049085	-689.46676	673.13659	350.41273	0
12	281	1038.656	11.92869	-744.34833	698.42233	363.57565	0
13	281	1042.7635	12.866225	-802.85043	719.74055	374.67322	0
14	281	1046.871	13.86223	-864.99326	737.11031	383.71534	0
15	281	1050.9785	14.91728	-930.83811	750.5787	390.72654	0
16	281	1055.086	16.03199	-1000.390	760.19581	395.73289	0

				9			
17	281	1059.1935	17.20703	-1073.7212	766.016	398.76269	0
18	281	1063.301	18.443115	-1150.8428	768.02728	399.8097	0
19	281	1067.4085	19.741	-1231.83	766.33819	398.93041	0
20	281	1071.516	21.1015	-1316.7251	760.9226	396.11123	0
21	281	1075.6235	22.52548	-1405.5814	751.82794	391.37685	0
22	281	1079.731	24.013865	-1498.4652	739.10706	384.75478	0
23	281	1083.8385	25.56764	-1595.4289	722.77118	376.25086	0
24	281	1087.946	27.187855	-1696.5122	702.81496	365.86231	0
25	281	1092.055	28.87621	-1801.8772	643.20543	334.83155	0
26	281	1096.165	30.63394	-1911.5519	544.81961	283.61514	0
27	281	1100.2755	32.461785	-2025.6111	444.06912	231.16775	0
28	281	1104.386	34.36111	-2144.1368	341.00161	177.5142	0
29	281	1108.0475	36.11095	-2253.3269	318.21023	-574.06646	0
30	281	1111.2135	37.674275	-	74.05125	42.753509	0

				2350.8656			

Slices of Slip Surface: 362

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	362	994.48525	5.411749	-337.69602	94.751887	54.705027	0
2	362	998.6083	5.673901	-354.05073	183.29945	-330.68097	0
3	362	1001.5515	5.904901	-368.47922	254.05538	-458.32803	0
4	362	1005.0775	6.223152	-388.31418	384.38265	200.09694	0
5	362	1009.027	6.628454	-413.61406	441.49871	229.82968	0
6	362	1012.977	7.088649	-442.32512	494.11062	257.21771	0
7	362	1016.927	7.6040015	-474.48829	542.28308	282.2947	0
8	362	1020.877	8.174809	-510.11443	586.10969	305.10939	0
9	362	1024.827	8.801405	-549.20957	625.66282	325.69945	0
10	362	1028.777	9.4841575	-591.79957	660.9936	344.09149	0
11	362	1032.727	10.22347	-	692.15736	360.31431	0

				637.9548 1			
12	362	1036.677	11.01979	- 687.6395 9	719.26204	374.42412	0
13	362	1040.6265	11.873595	- 740.9126	742.32094	386.42782	0
14	362	1044.576	12.78541	- 797.8002 2	761.37538	396.34693	0
15	362	1048.526	13.7558	- 858.3714 2	776.52008	404.23077	0
16	362	1052.476	14.785375	- 922.6139	787.77973	410.09217	0
17	362	1056.426	15.874795	- 990.5811	795.20756	413.95886	0
18	362	1060.376	17.02476	- 1062.341 8	798.81218	415.8353	0
19	362	1064.326	18.23603	- 1137.931 3	798.65546	415.75371	0
20	362	1068.276	19.50942	- 1217.398 5	794.80318	413.74835	0
21	362	1072.2255	20.845795	- 1300.782 3	787.22997	409.80598	0
22	362	1076.175	22.24608	- 1388.156 4	776.01094	403.96573	0
23	362	1080.125	23.71127	- 1479.582 6	761.15546	396.23245	0
24	362	1084.075	25.242425	- 1575.131 6	742.70191	386.62614	0
25	362	1088.025	26.840675	-	720.67114	375.15765	0

				1674.8585			
26	362	1092.087	28.556585	-1781.9296	657.77403	342.41549	0
27	362	1096.261	30.395595	-1896.6817	554.82368	288.82293	0
28	362	1100.4355	32.314015	-2016.3845	449.26865	233.87445	0
29	362	1104.61	34.31361	-2141.1712	341.15398	177.59352	0
30	362	1108.239	36.114775	-2253.5671	335.85983	-605.90717	0
31	362	1111.277	37.675545	-2350.9453	73.392402	42.373123	0

Slices of Slip Surface: 406

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	406	1008.142	10.677185	-666.25834	4.0750232	2.3527157	0
2	406	1009.552	11.076075	-691.13531	11.93097	6.8883486	0
3	406	1010.9615	11.479895	-716.32603	19.21335	11.092833	0
4	406	1012.371	11.888665	-741.86856	25.924884	14.967739	0
5	406	1013.781	12.3024	-	32.066226	18.513444	0

				767.6928 2			
6	406	1015.191	12.721115	-793.7975 1	37.638779	21.730759	0
7	406	1016.601	13.14482	-820.2481 3	42.643941	24.620491	0
8	406	1018.011	13.57353	-846.9753 5	47.082524	27.183108	0
9	406	1019.420 5	14.00726	-874.0439	50.956644	29.419832	0
10	406	1020.83	14.446025	-901.4521 9	54.267192	31.331178	0
11	406	1022.24	14.889845	-929.1304 7	57.015747	32.918057	0
12	406	1023.65	15.33873	-957.1443 3	59.203927	34.181403	0
13	406	1025.06	15.792695	-985.4902 7	60.831283	35.120958	0
14	406	1026.47	16.25176	-1014.099 9	61.900945	35.738527	0
15	406	1027.879 5	16.71594	-1043.105 3	62.413263	36.034314	0
16	406	1029.289	17.185255	-1072.368 6	62.368628	36.008544	0
17	406	1030.699	17.65972	-1101.955 6	61.770251	35.663071	0
18	406	1032.109	18.13935	-1131.864	60.617307	34.997419	0

19	406	1033.519	18.62416	-1162.157	58.911624	34.012642	0
20	406	1034.929	19.11417	-1192.6994	56.655232	32.709913	0
21	406	1036.3385	19.609405	-1223.6214	53.848037	31.089179	0
22	406	1037.748	20.109875	-1254.8542	50.491447	29.15125	0
23	406	1039.158	20.615595	-1286.3953	46.586205	26.896558	0
24	406	1040.568	21.12659	-1318.3071	42.134377	24.326294	0
25	406	1041.978	21.64288	-1350.522	37.136193	21.440591	0
26	406	1043.388	22.164485	-1383.0357	31.592489	18.239932	0
27	406	1044.7975	22.691425	-1415.9128	25.505553	14.725638	0
28	406	1046.207	23.22371	-1449.1495	18.875019	10.897497	0
29	406	1047.617	23.76137	-1482.6766	11.701925	6.7561098	0
30	406	1049.027	24.304425	-1516.6238	3.9882814	2.3026353	0

Slices of Slip Surface: 415

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strengt

							h (psf)
1	415	1008.505	10.78055	-672.71107	6.0651317	3.5017054	0
2	415	1010.427	11.31566	-706.11965	17.755698	10.251257	0
3	415	1012.349	11.85808	-739.95179	28.59205	16.507627	0
4	415	1014.271	12.407835	-774.25465	38.576731	22.272286	0
5	415	1016.193	12.96495	-809.0252	47.711358	27.546166	0
6	415	1018.115	13.52944	-844.2604	55.999613	32.331392	0
7	415	1020.037	14.10133	-879.90645	63.442187	36.628364	0
8	415	1021.959	14.68065	-916.06079	70.041456	40.438454	0
9	415	1023.8805	15.267415	-952.6699	75.794803	43.76015	0
10	415	1025.802	15.86165	-989.77976	80.714597	46.600594	0
11	415	1027.724	16.463385	-1027.3373	84.798376	48.958365	0
12	415	1029.646	17.072645	-1065.3391	88.043774	50.832096	0
13	415	1031.568	17.689455	-1103.8308	90.463324	52.229024	0
14	415	1033.49	18.313835	-1142.759	92.044945	53.142174	0

				9			
15	415	1035.412	18.945815	-1182.2207	92.801258	53.578831	0
16	415	1037.334	19.585425	-1222.111	92.730243	53.537831	0
17	415	1039.256	20.232685	-1262.526	91.834854	53.020878	0
18	415	1041.1775	20.88763	-1303.4111	90.113104	52.026825	0
19	415	1043.099	21.55029	-1344.7141	87.57307	50.560335	0
20	415	1045.021	22.220685	-1386.5779	84.212966	48.620378	0
21	415	1046.943	22.89885	-1428.9007	80.03609	46.208858	0
22	415	1048.865	23.58481	-1471.6764	75.040757	43.324802	0
23	415	1050.787	24.2786	-1515.0003	69.235359	39.973053	0
24	415	1052.709	24.98025	-1558.7688	62.613533	36.14994	0
25	415	1054.631	25.68979	-1603.027	55.183778	31.860369	0
26	415	1056.553	26.407255	-1647.8187	46.943861	27.103051	0
27	415	1058.475	27.13267	-1693.0898	37.896529	21.879571	0
28	415	1060.3965	27.866075	-1738.836	28.043194	16.190746	0

				4			
29	415	1062.318	28.6075	-1785.101	17.385306	10.037411	0
30	415	1064.24	29.356975	-1831.8794	5.9244461	3.4204806	0

Slices of Slip Surface: 424

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	424	1008.8345	10.87193	-678.39552	8.1204649	4.6883526	0
2	424	1011.2695	11.54258	-720.24037	23.770979	13.724181	0
3	424	1013.7045	12.222985	-762.69823	38.276035	22.098679	0
4	424	1016.14	12.91318	-805.7647	51.639231	29.813924	0
5	424	1018.5755	13.613195	-849.4754	63.86351	36.871614	0
6	424	1021.0105	14.32306	-893.74653	74.953031	43.274153	0
7	424	1023.4455	15.04281	-938.653	84.910941	49.023354	0
8	424	1025.8805	15.77248	-984.18959	93.736461	54.118771	0
9	424	1028.3155	16.5121	-1030.3525	101.43692	58.564636	0
10	424	1030.7505	17.261705	-1077.136	108.01564	62.36286	0
11	424	1033.185	18.02133	-	113.47225	65.513236	0

		5		1124.5358			
12	424	1035.6205	18.791005	-1172.5471	117.81432	68.020129	0
13	424	1038.056	19.57077	-1221.2034	121.04156	69.88338	0
14	424	1040.4915	20.360665	-1270.5	123.15398	71.102983	0
15	424	1042.9265	21.160725	-1320.4308	124.15933	71.683422	0
16	424	1045.3615	21.970985	-1370.9912	124.05783	71.624819	0
17	424	1047.7965	22.791485	-1422.1755	122.85359	70.929554	0
18	424	1050.2315	23.622265	-1474.0171	120.55091	69.600098	0
19	424	1052.6665	24.463365	-1526.5094	117.1463	67.634448	0
20	424	1055.1015	25.314825	-1579.6467	112.64818	65.037454	0
21	424	1057.5365	26.17669	-1633.424	107.05345	61.807338	0
22	424	1059.972	27.049	-1687.8728	100.37065	57.949023	0
23	424	1062.4075	27.93179	-1742.9479	92.600737	53.463061	0
24	424	1064.8425	28.82511	-1798.6826	83.74486	48.350117	0

25	424	1067.2775	29.72901	-1855.1077	73.800355	42.608655	0
26	424	1069.7125	30.64353	-1912.1408	62.780176	36.246152	0
27	424	1072.1475	31.568715	-1969.8885	50.67806	29.258992	0
28	424	1074.5825	32.50461	-2028.2691	37.499919	21.650588	0
29	424	1077.0175	33.451265	-2087.35	23.247088	13.421713	0
30	424	1079.453	34.40873	-2147.0879	7.921881	4.5737001	0

Slices of Slip Surface: 658

	Slip Surface	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
1	658	1031.7025	18.52449	-1155.8939	4.8287607	2.7878863	0
2	658	1032.838	18.81978	-1174.3271	14.129914	8.1579099	0
3	658	1033.9735	19.120785	-1193.1083	22.746046	13.132436	0
4	658	1035.109	19.427525	-1212.2355	30.678871	17.712454	0
5	658	1036.245	19.740025	-1231.7888	37.931152	21.899561	0
6	658	1037.380	20.058305	-	44.505852	25.695466	0

		5		1251.5973			
7	658	1038.516	20.38238	-1271.8247	50.405014	29.101348	0
8	658	1039.6515	20.712285	-1292.4685	55.631754	32.119008	0
9	658	1040.787	21.048045	-1313.3566	60.187565	34.749307	0
10	658	1041.9225	21.389675	-1334.7378	64.074831	36.993621	0
11	658	1043.058	21.737205	-1356.4399	67.296923	38.853897	0
12	658	1044.1935	22.09066	-1378.4585	69.854727	40.330645	0
13	658	1045.329	22.450065	-1400.873	71.750907	41.425405	0
14	658	1046.4645	22.815455	-1423.6819	72.988409	42.139877	0
15	658	1047.6	23.18685	-1446.8778	73.567465	42.474196	0
16	658	1048.736	23.56428	-1470.3746	73.492008	42.430631	0
17	658	1049.8715	23.947775	-1494.334	72.763438	42.009991	0
18	658	1051.007	24.33736	-1518.6685	71.382499	41.212705	0
19	658	1052.1425	24.73307	-1543.3714	69.353255	40.04112	0

20	658	1053.278	25.13494	-1568.4411	66.675957	38.495382	0
21	658	1054.4135	25.542995	-1593.8693	63.353178	36.576975	0
22	658	1055.549	25.957265	-1619.7357	59.387003	34.287102	0
23	658	1056.6845	26.37779	-1645.9517	54.777872	31.626019	0
24	658	1057.82	26.8046	-1672.5936	49.528834	28.595486	0
25	658	1058.9555	27.23773	-1699.658	43.64149	25.196426	0
26	658	1060.091	27.67722	-1727.0535	37.116594	21.429276	0
27	658	1061.227	28.1231	-1754.8586	29.956008	17.295109	0
28	658	1062.3625	28.575405	-1783.0668	22.162467	12.795506	0
29	658	1063.498	29.03418	-1811.7541	13.736409	7.9307197	0
30	658	1064.6335	29.49946	-1840.749	4.6792895	2.701589	0

Appendix C
Design Hydrogeologic Investigation

CERTIFICATION OF EFFECTIVENESS

The following statement is based on existing site conditions as ofOctober 20, 2008 and data currently available on subsurface conditions and groundwater flow at theDare County Solid Waste Management C&D landfill site. Additionally, it is our professional opinion that construction of a landfill may alter subsurface conditions.

In accordance with North Carolina Solid Waste Management Rule .0544(h), I hereby state to the best of my knowledge, information and belief and in my professional opinion as a geological professional, that the water quality monitoring system will be effective in providing detection of a release of hazardous constituents from the Dare County Solid Waste Management Construction and Demolition Landfill to the uppermost aquifer, provided the system is operated and maintained properly.

NORTH CAROLINA LICENSED SEAL 1851 GEOLOGIST MATHEW F. COLCHER

1/15/2009

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Appendix C
Design Hydrogeologic Investigation

Rule .0539(d)(3) of the North Carolina Solid Waste Management Rules requires that a Design Hydrogeologic Report be prepared in accordance with the requirements set forth in Rule .0538(b). This document is intended to fulfill all of the specified criteria delineated in this rule.

1 Purpose and Scope

The Design Hydrogeologic Report presented herein is designed to address the applicable Solid Waste Management Rules for the Permit to Construct for Cell 4 of the Dare County C&D Landfill Facility. The report compiles information from all field activities that have been conducted to date, summarizing data from previously submitted documents, as well as subsequent investigation activities, to provide a comprehensive characterization of the geology and hydrogeology at the landfill site. The goal of this investigation is to provide sufficient technical information to design a Water Quality Monitoring Plan for Cell 4 as specified in Rule .0538(b)(2).

1.1 Report Contents

Section 1 of the Design Hydrogeologic Report discusses the purpose and scope of the report, summarizes previous and current investigation activities, and provides a cross-reference between each applicable regulatory requirement set forth in Rule .0538(b) and corresponding sections of this report. Section 2 presents a summary of the methodologies used in this field investigation, as well as data collection and evaluation activities. Section 3 presents the results of this field investigation and data analysis activities. Conclusions derived from this and previous investigations are presented in Section 4, along with a discussion of hydrogeologic factors affecting the landfill design and development of the Water Quality Monitoring Plan.

1.2 Previous Investigations

Borehole drilling was accomplished in several phases by CDM and others utilizing hollow stem auger, mud-rotary and direct push (GeoProbe®) methods.

A geotechnical and hydrogeologic investigation was conducted by Geo-Hydro Engineers, Inc. in 1993 at Cell 1 and Cell 2 of the Dare County C&D landfill. As part of that investigation, a total of 12 borings were advanced (B-1/1a through B-6/6a). Six borings were advanced to 50 feet and 6 borings were advanced to 7 feet. Piezometers were installed at each of the Cells 1 and 2 locations. Geotechnical testing, in-situ hydraulic conductivity testing, and water level data were evaluated. It was determined that the site was suitable for landfill development and Cells 1 and 2 of the Dare County C&D Landfill were constructed.

Following construction of Cell 1, groundwater monitoring wells GW-1 through GW-8 were installed by others. Wells GW-4 and GW-5 has since been abandoned.

Following construction of Cell 2 wells GW-9 through GW-12 were installed by others per the revised groundwater quality monitoring plan.

Drilling for Cell 3 was conducted by CDM in December 2004. An onsite geologist observed all drilling operations and logged the borings. Drilling was accomplished with a GeoProbe® utilizing direct push technology. Boreholes and piezometers installed during the Cell 3 Design Hydrogeologic Investigation were identified as P-1, P-2d, P-2s, P-3, P-4, P-5, P-6, P-7, P-8d, P-8s, P-9, P-10, and P-11. The letter "s" designates the shallow piezometer, and "d" designates the deep piezometer in a nested pair. Soil samples were collected and analyzed for grain-size, USCS classification, and estimated effective porosity. These piezometers were abandoned prior to Cell 3 construction.

Following construction of Cell 3 wells GW-13 through GW-15 were installed per the groundwater quality monitoring plan. Select soil samples were collected and analyzed for USCS classification, hydraulic conductivity, and estimated effective porosity. Following installation, the wells were slug tested in order to determine horizontal hydraulic conductivity.

Drilling for revised facility plan was conducted by CDM in May 2007. An onsite geologist or geotechnical engineer observed all drilling operations and logged the borings. Drilling was accomplished with both mud-rotary and GeoProbe techniques.

Four deep geotechnical boreholes (B-101 through B-104) were extended to depths of 100 feet into the Yorktown Confining Unit with mud-rotary. Following drilling, the boreholes were abandoned according to 15A NCAC 02C rules. The deep geotechnical borings were advanced using a CME 550 all-terrain vehicle drill rig utilizing mud rotary drilling techniques with split spoon sampling and Standard Penetration Testing (SPT). Samples were examined by the field geotechnical engineer and described for color, grain size, texture, and moisture content. The field descriptions were entered into the field log book.

In addition to the deep geotechnical borings, 12 shallow piezometers were installed with a GeoProbe ®. Samples were collected in several borings to verify shallow lithology. GeoProbe drilling was done utilizing a track-mounted probe, creating nominal two-inch diameter boreholes. Lithological information was obtained through continuous four-foot direct push cores. Blow counts were not collected with this type of sampler. The sample was examined by the field geologist and described for color, grain size, texture, and moisture content. The field descriptions were entered into the field log book. Generally, the borings were sampled only to verify existing site lithology data obtained during previous investigations. The main goal of the GeoProbe® borings was to facilitate temporary piezometer installation for water table elevation data and verify lithology obtained from previous investigations.

All GeoProbe® borings were completed with 1-inch piezometers. Piezometers installed during the current investigation were identified as B-401, B-402s, B-402d, B-

403, B-404, B-405, B-501, B-502s, B-502d, B-801, B-802, and B-803. The letter "s" designates the shallow piezometer and "d" the deeper piezometer in a nested pair.

1.3 Current Investigation

The Cell 4 investigation focused on the proposed Cell 4 expansion area adjacent to the existing closed Cell 2 and active Cell 3 of the active C&D landfill. Six boreholes (B-503, -503d, -504, -505, -506, -506d) were drilled at 4 locations during this investigation. The boring locations were selected to complement existing borings and lithologic information in the Cell 4 area. All borings were converted to temporary piezometers for groundwater elevation measurements and lithologic and geotechnical data was collected at each location. Mud rotary drilling was used for installation of all piezometers. Standard penetration tests (blow counts) were collected at each location during the current investigation.

Water level measurements were taken at each of the piezometers at time of boring, and at 24 hours, and at least seven days after boring. Piezometer measuring points were surveyed to state plane coordinates and mean sea level elevation.

Boring locations from this and previous investigations are provided on Sheet 1. Boring logs from this and previous investigations (where available) are provided in Appendix A. Copies of the field notes from this investigation are provided in Appendix B.

2 Methodology

This section presents the methodology and data reduction used during the Cell 4 C&D Landfill hydrogeologic field investigations. As described in Section 1.3, the current investigation included borehole drilling, piezometer installation, water level measurements, and well surveying.

2.1 Drilling Methods

The following section details the drilling methods used to install borings and piezometers and collect geologic and hydrogeologic data for the Cell 4 C&D landfill expansion.

2.1.1 Borehole Drilling

Borehole drilling for this investigation was accomplished with mud-rotary techniques. Boring locations are provided on Sheet 1. Boring logs from the Cell 4 area investigation are provided in Appendix A. Boreholes and piezometers installed in the Cell 4 expansion during this and the previous investigation are identified by 500-series numbers. Only logs for borings from previous investigations relevant to the Cell 4 expansion area are included in Appendix A.

Mud rotary drilling was conducted at all locations during the current investigation to obtain lithologic information and piezometer installation. Mud rotary drilling was

done from an ATV-mounted CME 550 drill rig creating a nominal 4-inch diameter boring. Lithologic information was obtained through split spoon sampling at 5-foot intervals as outlined in ASTM D-1586. Blow counts were noted during the driving of the split spoon sampler, and the sample was examined by the field geologist or geotechnical engineer and described for color, grain size, USCS code, texture, and moisture content. The field descriptions were entered into the field logbook. Borehole logs are provided in Appendix A.

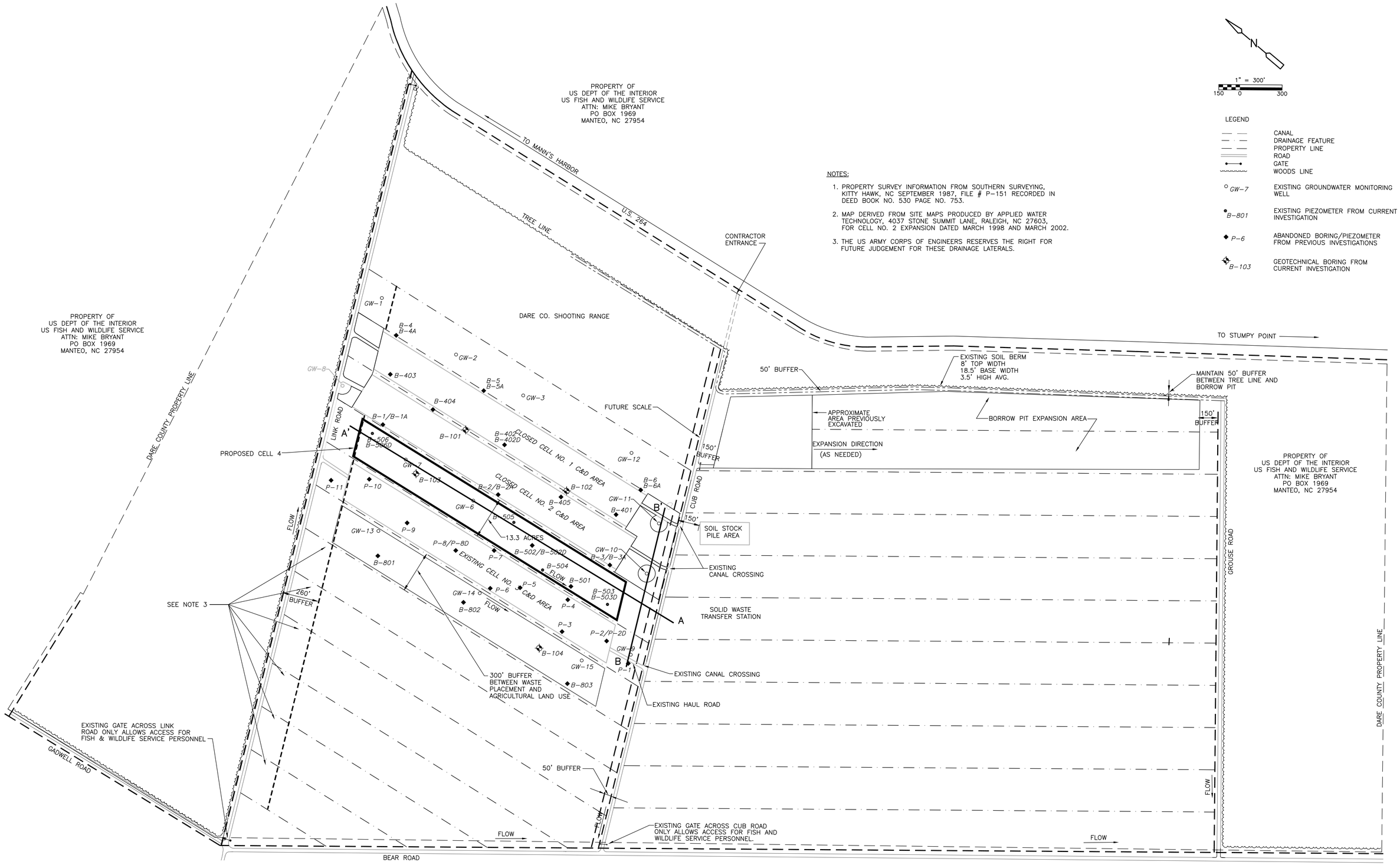
Geotechnical samples collected during mud rotary drilling included jar samples and undisturbed (Shelby tubes) samples. Jar samples were collected by placing split spoon samples in glass jars. Jar samples were analyzed as described in Section 2.6. The laboratory results are discussed in Section 3.2 and the raw data is provided in Appendix C.

Undisturbed Shelby tubes were collected as specified in ASTM D-1587 by attaching an empty 2-foot long, 3-inch diameter galvanized steel tube to the drilling rods, lowering it to the bottom of the auger hole and hydraulically pushing the tube into the undisturbed formation below the borehole bottom. After the tube was retrieved, the ends were sealed with melted paraffin wax and capped. The sample tubes were maintained in an upright position and protected from shock and temperature extremes until delivered to the laboratory. Undisturbed Shelby tubes were analyzed as described in Section 2.6. The laboratory results are discussed in Section 3.2.4 and the data is provided in Appendix B.

2.2 Piezometer Installations

As discussed in Section 1.3, 6 piezometers were installed at 4 locations during the current investigation in the Cell 4 area. The piezometer locations are shown on Sheet 1 along with those installed in and around the Cell 4 area during previous investigations. Table 1 provides a summary of piezometer completion data for the recently installed piezometers and piezometers installed during previous investigations that were relevant to the Cell 4 investigation.

Following completion of each mud rotary boring, a piezometer was installed. The piezometers were constructed of 2-inch diameter PVC casing, with 10 to 20 feet of 0.010-inch slot PVC screen and bottom cap. A filter pack consisting of #2 silica sand was placed around the well screen to a minimum of 2 feet above the top of screen. The piezometer annulus above the filter pack was then sealed with 3/8-inch hydrated bentonite pellets to land surface. Locking steel protective covers with a 3-foot by 3-foot concrete pad were installed over all piezometers.



REV. NO.	DATE	DRWN	CHKD	REMARKS

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APPROVED BY:
DATE: AUGUST 2007

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL EXPANSION
SITE HYDROGEOLOGIC INVESTIGATION

SITE MAP

PROJECT NO. 17952-56960
FILE NAME: SHEET-1.DWG

SHEET NO.
1

000000Table 1
Summary of Monitoring Well and Piezometer Completion Data
Dare County Construction and Demolition Landfill
Cell 4
Design Hydrogeologic Investigation

Well	Completion Date	Drilling Method	Monitoring Interval Lithology	Top of PVC Elevation (feet msl)	Ground Surface Elevation (feet msl)	Borehole Depth (feet bgs)	Screen Interval (feet bgs)	Top of Screen Elevation (feet msl)	Bottom of Screen Elevation (feet msl)	Top of Sand (feet bgs)	Top of Seal (feet bgs)	Borehole Diameter (inches)	Casing Diameter (inches)
B-1	Sep-93	HSA	Surficial	1.96		50	10-20			8	6		2.0
B-1a	Sep-93	HSA	Surficial	1.96		7	2-7			2	1		2.0
B-2	Sep-93	HSA	Surficial	3.17		50	40-50			38	36		2.0
B-2a	Sep-93	HSA	Surficial	1.83		7	2-7			2	1		2.0
B-3	Sep-93	HSA	Surficial	3.92		50	40-50			38	36		2.0
B-3a	Sep-93	HSA	Surficial	2.08		7	2-7			2	1		2.0
B-4	Sep-93	HSA	Surficial	2.68		50	40-50			38	36		2.0
B-4a	Sep-93	HSA	Surficial	1.15		7	2-7			2	1		2.0
B-5	Sep-93	HSA	Surficial	3.07		50	10-20			8	6		2.0
B-5a	Sep-93	HSA	Surficial	2.51		7	2-7			2	1		2.0
B-6	Sep-93	HSA	Surficial	3.32		50	25-30			23	21		2.0
B-6a	Sep-93	HSA	Surficial	1.96		7	2-7			2	1		2.0
GW-1	11/28/1994	HSA	Surficial	1.61	-0.04	10	10-20	-10.04	-20.04	8	7		2.0
GW-2	11/29/1994	HSA	Surficial	1.55	-0.25	20	10-20	-10.25	-20.25	8	7		2.0
GW-3	11/29/1994	HSA	Surficial	1.74	0.10	20	10-20	-9.9	-19.9	8	7		2.0
GW-4	11/29/1994	HSA	Surficial	3.7	2.14	20	10-20	-7.86	-17.86	8	7		2.0
GW-5	11/29/1994	HSA	Surficial	4.04	2.08	20	10-20	-7.92	-17.92	8	7		2.0
GW-6	11/29/1994	HSA	Surficial	3.15	0.31	20	10-20	-9.69	-19.69	8	2		2.0
GW-7	11/29/1994	HSA	Surficial	2.36	0.42	20	10-20	-9.58	-19.58	8	7		2.0
GW-8	11/28/1994	HSA	Surficial	2.90	1.13	20	10-20	-8.87	-18.87	8	7		2.0
GW-9	8/14/2002	HSA	Surficial	3.59	0.90	20	3-20	-1.10	-19.10	1.5	1		2.0
GW-10	8/13/2002	HSA	Surficial	2.87	1.58	20	3-20	-0.42	-18.42	2	1		2.0
GW-11	8/12/2002	HSA	Surficial	3.56	1.64	20	3-20	-0.36	-18.36	2	1		2.0
GW-12	8/13/2002	HSA	Surficial	2.80	0.33	20	3-20	-1.67	-19.67	1.5	1		2.0
GW-13	1/24/2006	HSA	Surficial	2.96	0.65	20	5-20	-4.35	-19.35	3	1	6	2.0
GW-14	1/24/2006	HSA	Surficial	2.96	0.41	20	5-20	-4.59	-19.59	3	1	6	2.0
GW-15	1/24/2006	HSA	Surficial	3.17	0.82	20	5-20	-4.18	-19.18	3	1	6	2.0
P-1	12/8/2004	GeoProbe	Surficial	3.42	0.95	8	3.0-8.0	-2.1	-7.1	2.0	0.0	2.0	1.0
P-2	12/8/2004	GeoProbe	Surficial	3.71	0.73	50	40.0-50.0	-39.27	-49.27	30.0	0.0	2.0	1.0
P-2s	12/8/2004	GeoProbe	Surficial	3.23	0.84	8	3.0-8.0	-2.16	-7.16	2.0	0.0	2.0	1.0
P-3	12/8/2004	GeoProbe	Surficial	3.84	0.57	12	7.0-12.0	-6.43	-11.43	3.0	0.0	2.0	1.0
P-4	12/8/2004	GeoProbe	Surficial	3.63	0.35	12	7.0-12.0	-6.65	-11.65	3.0	0.0	2.0	1.0
P-5	12/9/2004	GeoProbe	Surficial	4.29	0.85	12	7.0-12.0	-6.15	-11.15	3.0	0.0	2.0	1.0
P-6	12/8/2004	GeoProbe	Surficial	3.68	0.26	12	7.0-12.0	-6.74	-11.74	3.0	0.0	2.0	1.0
P-7	12/9/2004	GeoProbe	Surficial	3.34	0.02	12	7.0-12.0	-6.98	-11.98	3.0	0.0	2.0	1.0
P-8	12/9/2004	GeoProbe	Surficial	7.33	3.68	50	42.0-47.0	-38.32	-43.32	14.0	0.0	2.0	1.0
P-8s	12/9/2004	GeoProbe	Surficial	6.94	3.66	10	5.0-10.0	-1.34	-6.34	3.0	0.0	2.0	1.0
P-9	12/9/2004	GeoProbe	Surficial	6.09	2.76	12	7.0-12.0	-4.24	-9.24	3.0	0.0	2.0	1.0
P-10	12/9/2004	GeoProbe	Surficial	3.88	0.50	12	7.0-12.0	-6.50	-11.50	3.0	0.0	2.0	1.0
P-11	12/9/2004	GeoProbe	Surficial	5.15	1.77	12	7.0-12.0	-5.23	-10.23	3.0	0.0	2.0	1.0
B-101	4/30/2007	Mud Rotary	Geotechnical Boring	NA	8.24	100							
B-102	5/1/2007	Mud Rotary	Geotechnical Boring	NA	7.39	99							
B-103	5/1/2007	Mud Rotary	Geotechnical Boring	NA	-0.07	100							
B-104	5/1/2007	Mud Rotary	Geotechnical Boring	NA	0.69	100							
B-401	5/1/2007	GeoProbe	Surficial	2.23	1.93	15	5.0-15.0	-3.07	-13.07	3.0	0.0	2.0	1.0
B-402d	5/1/2007	GeoProbe	Surficial	5.99	5.99	31	26.0-31.0	-20.01	-25.01	24.0	0.0	2.0	1.0
B-402s	5/1/2007	GeoProbe	Surficial	6.26	6.05	15	5.0-15.0	1.05	-8.95	3.0	0.0	2.0	1.0
B-403	5/1/2007	GeoProbe	Surficial	6.15	6.15	15	5.0-15.0	1.15	-8.85	3.0	0.0	2.0	1.0
B-404	5/1/2007	GeoProbe	Surficial	8.72	5.87	15	5.0-15.0	0.87	-9.13	3.0	0.0	2.0	1.0
B-405	5/1/2007	GeoProbe	Surficial	7.55	7.33	15	5.0-15.0	2.33	-7.67	3.0	0.0	2.0	1.0
B-501	5/1/2007	GeoProbe	Surficial	3.14	0.45	15	5.0-15.0	-4.55	-14.55	3.0	0.0	2.0	1.0
B-502d	5/1/2007	GeoProbe	Surficial	0.44	0.44	31	26.0-31.0	-25.56	-30.56	24.0	0.0	2.0	1.0
B-502s	5/1/2007	GeoProbe	Surficial	0.50	0.50	15	5.0-15.0	-4.50	-14.50	3.0	0.0	2.0	1.0
B-503	9/3/2008	Mud Rotary	Surficial	3.56	1.13	20	10.0-20.0	8.87	18.87	8.0	0.0	3.0	2.0

2.3 Water Level Measurements

Water level measurements were taken using an electronic water level meter with an accuracy of 0.01 feet. Water level measurements were taken relative to the north side of the top of each PVC well casing (TOC = top of casing). Water levels were monitored both during and after the piezometer completion. Water levels were collected after piezometer completion, when possible, 24 hours after completion, and at least seven days after completion. Measurement of water levels at precise time periods after completion was not always possible due to conflicts with other drilling operations and the expedited nature of the field investigation. However, adequate measurements were taken for the purposes of the installation and this investigation. Water level measurements are discussed in Section 3.3.

2.4 Piezometer Surveying

All of the newly installed piezometers were surveyed to the TOC measuring point and to ground surface by Quible Associates, Inc. Northing and easting coordinates were reported in the State Plane coordinate system, and elevations were surveyed to mean sea level (msl).

2.5 Slug Tests

Slug testing was performed on five newly installed piezometers within the Cell 4 area (B-503, -503d, -505, -506, -506d). Both slug-in (displacement) and slug-out (recovery) tests were conducted at each piezometer using a stainless steel solid slug and a transducer/data logger. The transducer/data logger was lowered to approximately 10 to 15 feet below the water level in the piezometer, taped into place, and a reference water level was collected. Immediately after starting the data logger, the slug was lowered to approximately 1.5 to 2 feet below the water surface and taped into place. The data logger was then monitored until water levels stabilized. The data logger was then re-started for the slug-out test and the slug was immediately withdrawn from the piezometer. The data logger was monitored until the water level stabilized.

The data was then analyzed using the Bouwer and Rice method (Bouwer, 1989) to estimate horizontal hydraulic conductivity. Slug test results are discussed in Section 3.3.

2.6 Geotechnical Testing

Undisturbed Shelby tube, jar samples and bulk samples collected during this investigation were analyzed for various geotechnical properties by Geotechnics geotechnical laboratory in Raleigh, North Carolina. The testing program consisted of analyses for grain size distribution, soil classification, Atterberg limits, porosity and in-situ hydraulic conductivity. Laboratory geotechnical data from the samples collected during this investigation in the Cell 4 area are presented in Appendix C.

Geotechnical data for samples collected during this and previous investigations in the Cell 4 area is discussed in Section 3.2.

3 Current Investigation Results

This section presents the results of the Cell 4 area investigation which included borehole drilling, geotechnical testing, piezometer installations, water level measurements, and aquifer characterization (slug testing). The regional geology and hydrogeology have been previously discussed (CDM 2005), and, therefore, will not be re-iterated in this report. The site geology is discussed in Section 3.1. Laboratory testing results are discussed in Section 3.2. The site hydrogeology is evaluated in detail in Section 3.3 and includes water level results, potentiometric surface mapping, and slug test analysis.

3.1 Site Geology

Based on this and previous subsurface investigations by CDM and others at the existing C&D landfill, the surficial geology at the site was found to be composed of five layered surficial sediment units. The uppermost unit was found to consist of topsoil and organic silt and extended to depths ranging from eight-inches to two-feet below land surface. Below the topsoil and organic silt, a layer of dark gray to mottled, silty fine sand was encountered. The thickness of the silty fine sand layer generally ranged from 1.5 to 7 feet. Below the silty fine sand, a layer of medium gray fine to medium sand was encountered. This layer was typically found to be about 20 feet thick and extending to depths of about 25 feet below land surface. Some zones of silty sand, coarse sand, and clay were encountered within this layer. The next layer encountered was a dark gray sand and silt or clay layer. The sand and silt/clay layer was found to be about five to seven feet thick and extended to about 32 feet below land surface. Beneath the sand and silt layer, a layer of gray, moderate to well sorted fine to medium sand and shell was encountered. This layer, on average, was found to extend to about 63 feet below land surface. Below the sand and shell, the Yorktown confining unit was encountered. The Yorktown Confining Unit was found to be at least 30 feet thick at the site.

3.2 Testing Program

Table 2 summarizes the results of the geotechnical testing performed on samples in and around the proposed Cell 4 C&D area during this and previous investigations. The following sections discuss Standard Penetration (SPT), particle size, soil classification (USCS), formation descriptions, and saturated hydraulic conductivity, porosity, effective porosity, and dispersive characteristics for each unit of the uppermost aquifer at the expansion site.

Table 2
Summary of Geotechnical Testing Results
Dare County Construction and Demolition Landfill
Cell 4
Design Hydrogeologic Report

Boring No.	Depth (feet)	Surficial Layer	Sample Type	USCS Classification	Natural Moisture Content	Porosity (%)	Estimated Effective Porosity (%)	Undisturbed Hydraulic Conductivity (cm/sec)	Remolded Hydraulic Conductivity (cm/sec)	Atterberg Limits		
										Liquid Limit	Plastic Limit	Plasticity Index
Cells 1-2												
B-1	4	2	SS		21.7	32						
B-1	15	3	SS		27.7	28						
B-1	25	4	UD		35.4	48.6		7.40E-07		25	21	4
B-2	25	4	UD		29.1					32	23	9
B-2	45	5	SS		21.5	20						
B-3	25	4	UD		30.3	46.3		4.80E-06				
B-3	50	5	SS		15.7	23						
B-4	4	2	SS		21.5	31						
B-4	10	3	SS		20.1	25						
B-4	25	4	SS		44.2					32	23	9
B-4	45	5	SS		19.1	17						
B-5	15	3	SS		28.6	26						
B-5	25	4	UD		37.0	50.7						
B-5	45	5	SS		20.6	20						
B-6	8	3	SS		22.6	28						
B-6	25	4	UD		32.5	47.1						
B-7	6	3	SS		23.3							
Bulk 1		1-5	Bulk			35.6			3.40E-05			
Bulk 2		1-5	Bulk			36.5			6.70E-06			
Cell 3												
P-2	8-12	3	Bag	SM	24.7		25			NP	NP	NP
P-2	24-28	4	Bag	ML	38.7		18			NP	NP	NP
P-2	44-48	5	Bag	SP-SM	19.1		38			NP	NP	NP
P-5	2-4	2	Bag	CL	39.0		15			39	19	20
P-8	5-7	3	Bag	CL-ML	25.1		17			28	22	6
P-8	12-16	3	Bag	SM	20.2		32			NP	NP	NP
P-8	24-28	4	Bag	SM	34.1		32			NP	NP	NP
P-8	32-36	5	Bag	SP-SM	22.0		38			NP	NP	NP
Cell 3 Monitoring Wells												
GW-13	2-4	2	SS	SM	23.3		25			NP	NP	NP
GW-13	24-26	4	UD	ML	31.7	43	22	3.6E-06		NP	NP	NP
GW-14	5-7	3	SS	SP-SM	20.7		33			NP	NP	NP
GW-14	13-15	3	SS	SM	21.4		30					
GW-14	8-10	3	UD	SP	25.0	40	35	7.9E-04		NP	NP	NP
GW-15	8-10	3	SS	SM	24.6		21			NP	NP	NP
GW-15	13-15	3	SS	SM	69.7		12			NP	NP	NP
GW-15	18-20	3	SS	SM	24.4		23					
Facility Expansion Investigation - April 2007												
B-101	75-77	YCU	UD	CL-ML	34.7	46.5		1.2E-05		27	20	7
B-101	6-8	3	SS		37.8							
B-101	8-10	2	SS	ML	22.9					NP	NP	NP
B-101	28-30	5	SS	SM	26.1							
B-101	48-50	5	SS	SM	16.0							
B-101	68-70	5	SS	SM	24.3							
B-102	7-8	2	SS	CL	24.7					33	22	11
B-102	8-10	2	UD	SC	18.4					23	14	9
B-102	28-30	5	SS	SP	31.6					NP	NP	NP
B-102	31-33	4	UD	CL	35.4	32.8		5.5E-07		30	17	13
B-102	43-45	5	SS	SP	20.6							
B-102	68-70	5	SS	SM	29.8							
B-103	1-2	1	SS	CL	36.7					43	22	21
B-103	2-4	1	UD	SM	24.6	39.9				NP	NP	NP
B-103	4-6	2	SS		22.0							
B-103	25-27	4	UD	CL	38.1					32	16	16
B-104	1-2	1	SS	CL	21.8					45	23	22
B-104	2-4	1	UD	SC	20.6	40.8	10	1.7E-07		55	27	28
B-104	13-15	3	SS							33	20	13
B-104	25-27	4	UD	CL	37.3	51.5	2	1.6E-06		27	16	11
B-104	27-29	4	UD	SC-SM	43.1	56.1		2.1E-06		22	16	6
B-104	63-65	5	SS	SM	24.0							
B-402s	10-15	3	Bag	SM	25.8		27			19	18	1
B-501	1-4	1	Bag	CL	29.2		8			44	21	23
B-502	4.5-18	3	Bag	SM	25.7		35			NP	NP	NP
B-502	18-25	3-4	Bag	SC	33.0		25			24	13	11
B-801	1.5-5	1	Bag	SC	27.8		17			41	17	24
Cell 4 Investigation - September 2008												
B-503d	28-30	4	SS	CL	41.3		5			30	17	13
B-503d	43-45	4	SS	SP-SM	20.6		35			NP	NP	NP
B-504	13-15	3	SS	SM	29.8		25			NP	NP	NP
B-504	18-20	3-4	SS	SM	24.7		12			19	17	2
B-505	3-5	1	SS	SM	27.6		20			NP	NP	NP
B-505	8-10	2	SS	SP-SM	28.2		40			NP	NP	NP
B-505	2-4	1	UD	ML	24.7	42.0	15	2.3E-04		NP	NP	NP
B-506	23-25	4	UD	SM	34.6	48.1	27	5.7E-07		NP	NP	NP
B-506d	38-40	5	SS	SP-SM	21.8		35			NP	NP	NP
B-506d	48-50	5	SS	SM	25.7		30			NP	NP	NP
Average					**27.9**	**36.8**	**23.8**	**9.51E-05**	**2.04E-05**			
Geometric Mean					**26.9**	**35.0**	**20.6**	**4.06E-06**	**1.51E-05**			

Table includes borings from Cells 1 and 2 (B-1 through B-7) performed and collected by others. All Cells 1 and 2 Data from Geo-Hydro Reports (11/17/93 and 8/11/94).
Boreholes in bold in Proposed Cell 4 footprint.
USCS - Unified Soil Classification System
UD - Undisturbed Sample (Shelby Tube)
YCU - Yorktown Confining Unit
Blank Not Calculated
Estimated Effective Porosity from Johnson, 1967.

3.2.1 Standard Penetration Testing

Standard Penetration Testing (SPT), in accordance with ASTM Standard D1586, was conducted at each boring location during this investigation (B-503 through B-506). SPT's were conducted over 2-foot intervals, typically every 5-feet from ground surface to the termination of the boring. Blow counts were recorded for every 6-inches and recorded. The split spoon sample was placed in a sealed glass jar and labeled by boring number, sample number, depth interval, and blow count. Blow counts are presented on the boring logs in Appendix A.

3.2.2 Particle Size Analysis and Unified Soil Classification

Within the proposed Cell 4 area, 10 split-spoon, 4 Shelby Tube and 3 bulk samples were submitted for laboratory analysis for grain size, USCS classification, natural moisture content, and Atterberg limits. USCS classifications ranged from CL to SM. Natural moisture content values ranged from 20.3% in B-503d (43-45) to 41.3% in B-503d (28-30).

A summary of the geotechnical laboratory results is provided on Table 2. Copies of the laboratory data for the samples collected from the Cell 4 area during this and previous investigations are provided in Appendix C.

3.2.3 Formation Descriptions

Formation descriptions were made in the field during drilling by an on-site geologist or geotechnical engineer. Formation descriptions were made according to moisture content, consistency, color, and grain size. Alterations to the field descriptions, where necessary, were made according to the geotechnical laboratory results. Boring logs are provided in Appendix A. Copies of the field notes for the current investigation are provided in Appendix B.

3.2.4 Geotechnical Laboratory Testing

The following section provides laboratory analysis data for hydraulic conductivity, porosity, and effective porosity.

Porosity and hydraulic conductivity values were obtained from 2 Shelby Tube samples collected from the Cell 4 area during this investigation. Porosity values in the Shelby Tube samples ranged from 42% in B-505 (2-4) to 48.1% in B-506 (23-25) and undisturbed hydraulic conductivity values ranged from 2.3×10^{-4} cm/sec in B-505 sample to 5.7×10^{-7} cm/sec in the B-506 sample.

Porosity values were calculated from the initial void ratio by using the equation:

$$n = e/(1+e)$$

where:
n = porosity
e = void ratio

Values for effective porosity (n_e) for all samples collected during this investigation were estimated based on the grain size analyses applied to the soil classification triangle which illustrates the relationship between grain size and specific yield values (Johnson, 1967). Estimated effective porosity values ranged from 5% in the medium depth clay (B-503d 28-30) to 40% in the shallow fine sands (B-505 8-10).

3.2.5 Dispersive Characteristics

Estimates were made for longitudinal and transverse dispersivity for uppermost aquifer at the site, which in this case is the saturated PWR and shallow fractured bedrock. Using an equation provided by the Solid Waste Section, longitudinal dispersivity (D_l) was estimated by the following calculation:

$$D_l = C \times L \times \frac{Kdh}{n_e dl}$$

where:
C = Constant (0.1)
L = Length to compliance boundary
K = hydraulic conductivity
dh/dl = hydraulic gradient
n_e = effective porosity

For this estimation, an average horizontal hydraulic conductivity value of 1.4×10^{-3} cm/sec (4.1 ft/day) was used. This value represents the average K of the piezometers installed in the Cell 4 area during the current investigation, based on slug test analyses. An average hydraulic gradient of 0.002 ft/ft was used. This value represents measurements collected on October 20, 2008 from piezometers installed in the Cell 4 area during the current investigation. An average effective porosity of 24% was used. This value represents the average estimated effective porosity from all samples collected from the surficial aquifer. A length of 250 feet was used. This value represents the distance from the edge of waste to the compliance boundary.

Using the estimations and calculation described above, an average longitudinal dispersivity of 0.85 ft was determined. Assuming that transverse dispersivity is 10% of longitudinal dispersivity, transverse dispersivity was estimated at 0.08 ft.

Longitudinal dispersivity was also estimated using an EPA calculator. Assuming a plume length of 250 feet, longitudinal dispersivity ranged from 0.41 ft to 1500 ft. And by using the formula from Xu and Eckstein (1995) on the EPA site, assuming a plume length of 250 feet, a longitudinal dispersivity of 12.5 ft was determined. Therefore, transverse dispersivity ranges from 0.041 ft to 150 ft.

3.3 Site Hydrogeology

Results of investigation activities designed to characterize the hydrogeology beneath the area are presented in this section. These activities included water level measurements and aquifer slug testing.

3.3.1 Water Level Measurements

Water level measurements collected from the existing monitoring wells and piezometers installed in and around the Cell 4 area are provided in Table 3. In addition to available historic data, these include measurements at the time of boring, 24 hours after installation, September 4, 2008, October 8, 2008, and October 20, 2008. The water level measurements taken during the October 20, 2008 event were used to construct the potentiometric contour map presented on Sheet 2.

Water levels in most existing monitoring wells and piezometers are within 2 feet of land surface. In the Cell 4 area, depths to groundwater below land surface on October 20, 2008 ranged from 0.08 ft in B-506d to 2.89 ft in B-503d. Since installation of the new piezometers (B-503 through B-506), water table elevations appear to have remained fairly constant.

3.3.1.1 Horizontal and Vertical Gradients

Horizontal Gradients

Sheet 1 presents a potentiometric surface contour map for the proposed Cell 4 area. The map was constructed from water level data collected on October 20, 2008. The potentiometric surface is interpolated from data from piezometers screened at various monitoring interval depths. The contour map shows that the potentiometric surface, like the natural topography is relatively flat. Based on the readings collected October 20, 2008, groundwater flow is generally toward the southern canal along Cub Road.

During the current investigation, the horizontal gradient in the shallow portion of the surficial aquifer from piezometer B-506 towards the Cub Road canal (B-503) was approximately 0.0004 ft/ft. The horizontal gradient in the deeper portion of the surficial aquifer from piezometer B-506d towards the Cub Road canal (B-503d) was approximately 0.0006 ft/ft. These horizontal gradients correlate well with previous investigations at the site.

Vertical Gradients

Vertical gradient data is evaluated by comparing water levels from nested piezometer sets. During the previous investigation in the Cell 4 area, a nested pair was installed at

location B-502s/502. During the current investigation in the Cell 4 area, nested pairs were installed at locations B-503/503d and B-506/506d.

The vertical gradient of the piezometer sets is calculated as the difference in water level elevation, divided by the vertical distance from the saturated midpoint of the screen of the shallow piezometer to the saturated midpoint of the screen of the deeper piezometer. Since the shallow screens were fully saturated, the screen midpoint elevation was used for determining the vertical gradient.

Historical vertical gradients from B-502s/502 were calculated using the groundwater elevation data collected on June 7, 2007. Vertical gradients for the current investigation were calculated using the groundwater elevation data collected on October 20, 2008. The Table below provides groundwater elevation data, saturated screen midpoint separation, and calculated vertical gradient. Negative numbers indicate a downward gradient and positive numbers indicate an upward gradient.

Vertical Gradient Calculations

Well Nest	Shallow Groundwater Elevation (MSL)	Deep Groundwater Elevation (MSL)	Groundwater Elevation Difference (ft)	Shallow Screen Midpoint (MSL)	Deep Screen Midpoint (MSL)	Screen Midpoint Separation (ft)	Calculated Vertical Gradient (ft/ft)
B-502s/502[(1)]	-0.35	-0.71	-0.36	-9.5	-28.06	18.56	-0.019
B-503/503d	-1.53	-1.64	-0.24	-13.87	-43.82	29.95	-0.008
B-506/506d	-0.66	-0.55	+0.11	-15.48	-45.47	29.99	+0.003

[(1)] - Groundwater elevation data from June 7, 2007.

The historic vertical gradient at B-502s/502 was -0.019 ft/ft, the vertical gradient at B-503/503d was -0.008 ft/ft and the vertical gradient at B-506/506d was +0.003 ft/ft. The slight upward vertical gradient at the B-506 location indicates that the groundwater is discharging from the deeper portion to the shallow portion in this area, however it is likely that the entire area serves as both a recharge and discharge area depending on the amount of precipitation.

Graphic presentations of the vertical groundwater flow are provided on the hydrogeologic cross-sections (Figure 1 and 2). The groundwater flow nets indicate that while there is some vertical flow, the dominant flow component at the site is horizontal toward the large canal along Cub Road.

3.3.1.2 Temporal Trends

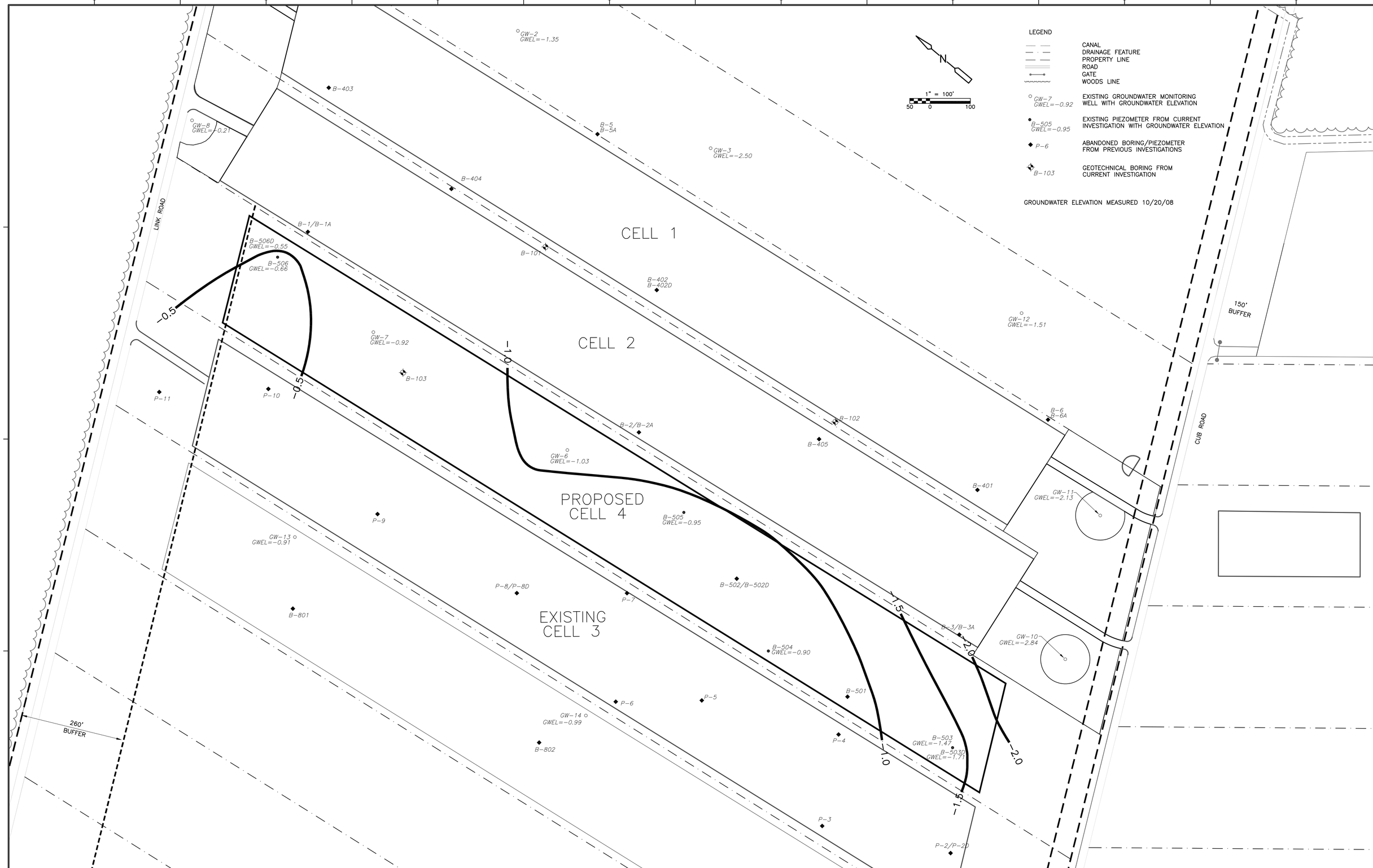
Table 3 summarizes water level measurements collected on a nominal basis from all of the piezometers completed during this and previous investigations. Because most

of the piezometers have been abandoned, the water levels are presented for the discussion of temporal trends only.

Table 3
Water Level Measurements
Dare County Construction and Demolition Landfill
Cell 4
Design Hydrogeologic Investigation

Well	Top of Casing Elevation (MSL)	Ground Elevation (MSL)	Depth to water (BGS) Initial	Water Level (MSL) Initial	Water Level (MSL) 12/8/2004	Water Level (MSL) 12/9/2004	Water Level (MSL) 1/13/2005	Water Level (MSL) 5/2/2007	Water Level (MSL) 6/7/2007	Water Level (MSL) 9/4/2008	Water Level (MSL) 10/8/2008	Water Level (MSL) 10/20/2008
P-1	3.42	0.95	5.73	-2.31		-1.10	-0.73					
P-2	3.71	0.73	5.25	-1.54		-1.08	-0.73					
P-2s	3.23	0.84	5.20	-1.97		-1.07	-0.74					
P-3	3.84	0.57	4.93	-1.09		-1.01	-0.67					
P-4	3.63	0.35	4.75	-1.12		-1.02	-0.65					
P-5	4.29	0.85	5.40	-1.11		-1.03	-0.62					
P-6	3.68	0.26	4.80	-1.12		-1.07	-0.59					
P-7	3.34	0.02	4.42	-1.08		-0.96	-0.48					
P-8	7.33	3.68	9.60	-2.27		-1.72	-0.36					
P-8s	6.49	3.66	10.50	-4.01		-1.54	-0.94					
P-9	6.09	2.76	7.20	-1.11		-0.91	-0.51					
P-10	3.88	0.50	5.10	-1.22		-0.74	-0.36					
P-11	5.15	1.77	5.70	-0.55		-0.55	-0.20					
B-401	2.26	1.93	3.5	-1.57				-1.55	-1.34	--	--	--
B-402s	6.26	6.05	5.5	0.55				1.76	2.58	--	--	--
B-402	5.99	5.99	5.5	0.49				-1.33	-0.96	--	--	--
B-403	6.15	6.15	6.5	-0.35				-0.90	--	--	--	--
B-404	8.72	5.87	6.0	-0.13				-0.91	-0.56	--	--	--
B-405	7.55	7.33	5.5	1.83				1.38	-0.24	--	--	--
B-501	3.14	0.45	3.0	-2.55				-1.65	-0.51	--	--	--
B-502s	0.50	0.50	3.0	-2.50				-1.05	-0.35	--	--	--
B-502	0.44	0.44	3.0	-2.56				-0.96	-0.71	--	--	--
B-503	3.56	1.13	2.0	-0.87						-1.72	-1.53	-1.47
B-503d	3.84	1.18	2.0	-0.82						-1.77	-1.64	-1.71
B-504	3.19	0.36	2.0	-1.64						-1.15	-0.93	-0.90
B-505	3.91	0.95	4.0	-3.05						-1.41	-1.14	-0.95
B-506	2.46	-0.48	2.0	-2.48						-0.65	-0.76	-0.66
B-506d	2.56	-0.47	2.0	-2.47						-0.75	-0.57	-0.55
B-801	0.55	0.32	2.5	-2.18				-1.18	-0.53	--	--	--
B-802	0.44	0.00	4.0	-4.00				-1.70	-0.68	--	--	--
B-803	0.05	-0.20	2.5	-2.70				-1.50	-0.63	--	--	--
GW-1	1.61	-0.04			NM		NM	-1.25	-0.36	-0.74	-0.76	-0.60
GW-2	1.55	-0.25			-0.97		-0.45	-1.90	-0.77	-1.41	-1.52	-1.35
GW-3	1.74	0.10			-2.13		-1.48	-3.35	-1.85	-2.79	-2.67	-2.50
GW-6	3.15	0.31			-0.95		-0.47	-1.71	-0.61	-1.40	-1.26	-1.03
GW-7	2.36	0.42			-0.82		-0.37	-1.52	-0.59	-1.13	-1.15	-0.92
GW-8	2.90	1.13			-0.20		0.08	-0.33	-0.04	-0.22	-0.27	-0.21
GW-9	3.59	0.90			-0.94	-1.01	-0.70	-1.82	-0.60	-3.37	-2.60	-3.01
GW-10	2.87	1.58			-2.08		-1.54	-3.05	-2.24	-2.68	-2.89	-2.84
GW-11	3.56	1.64			-1.86		-1.21	-2.16	-0.85	-1.70	-2.01	-2.13
GW-12	2.80	0.33			-1.36		-0.52	-2.35	-1.14	-1.78	-1.76	-1.51
GW-13	2.96	0.65						-2.10	-0.56	-1.28	-1.14	-0.91
GW-14	2.96	0.41						-1.97	-0.55	-1.52	-1.18	-0.99
GW-15	3.17	0.82						-1.86	-0.25	-1.56	-1.14	-0.88

BTOC - Below Top of Casing
BGS - Below Ground Surface
MSL - Mean Sea Level
NM - Not Measured
Blanks indicate no data collected.
Bold/Italic piezometers abandoned in August 2005



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. COLONE
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consulting • engineering • construction • operations

COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL EXPANSION
SITE HYDROGEOLOGIC INVESTIGATION

GROUNDWATER CONTOUR MAP

PROJECT NO. 17952-56960
FILE NAME: SHEET-2.DWG

SHEET NO.
2

Cross-Section A-A'

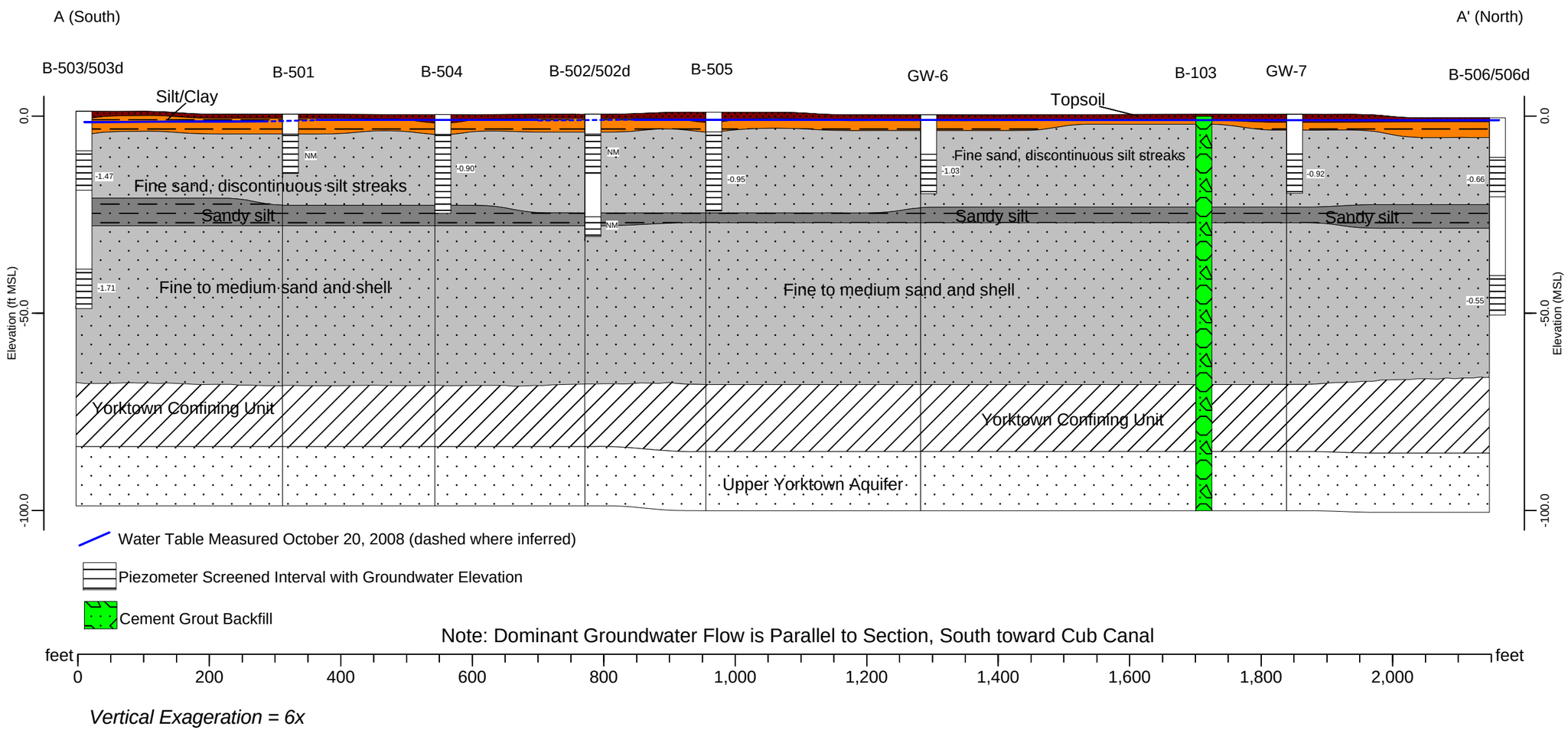

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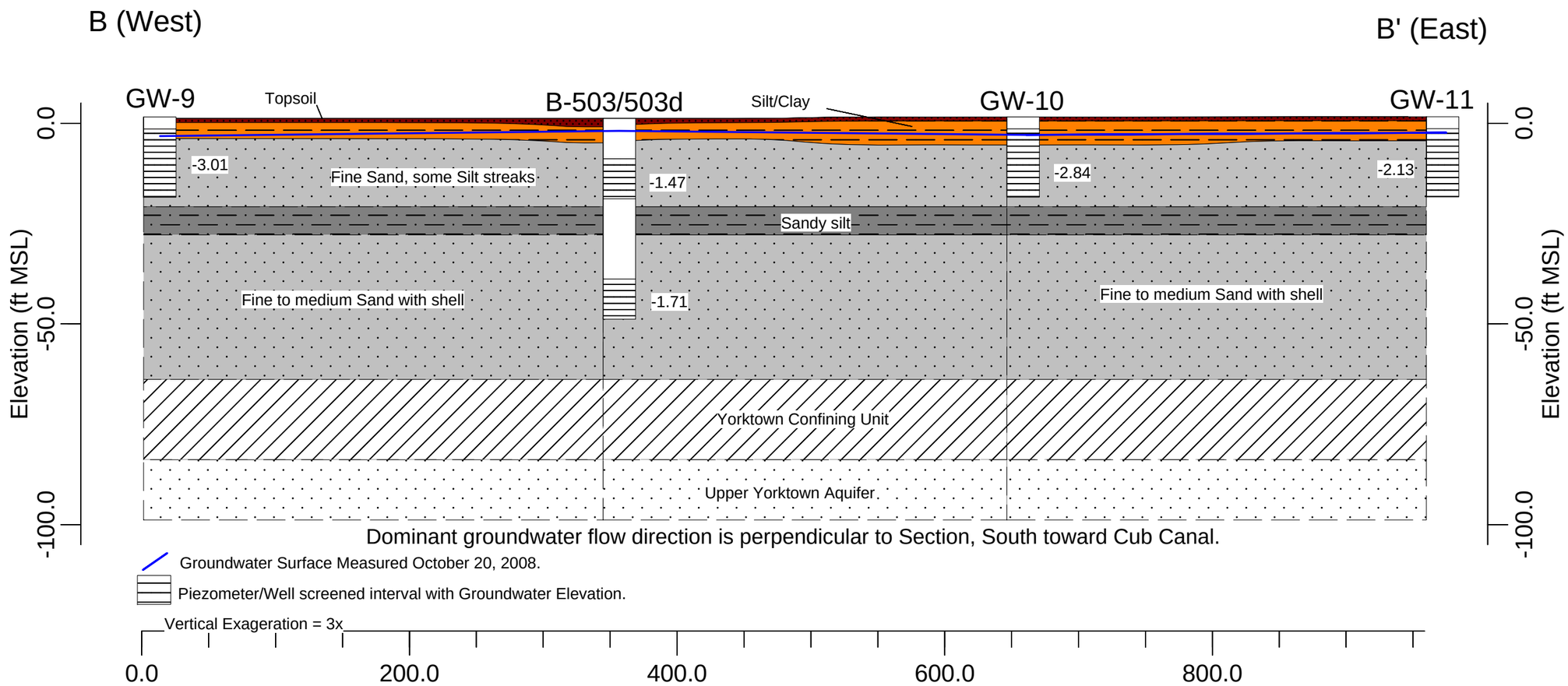
Figure 1
Cross-Section A-A'
Dare County C&D Landfill - Cell 4
Design Hydrogeologic Investigation

Cross-Section B-B'



Notes: Stratigraphic contacts dashed where inferred. Stratigraphy depths inferred from deep borings installed in and around Cell 4 area during this and previous investigations.

CDM

Figure 2
Cross-Section B-B'
Dare County C&D Landfill - Cell 4
Design Hydrogeologic Investigation

Since 1994, the average annual precipitation at the Manteo Airport in Manteo, North Carolina is approximately 50 inches. From January 1994 to May 2007, the average monthly precipitation ranged from a low of 2.86 inches in April to a high of 5.95 inches in August. Long-term monthly precipitation summary statistics are provided in Table 4 and Figure 3.

The precipitation data indicate that peak rainfall for this area would be expected to occur in the summer between June and September. Due to the shallow nature of the groundwater table, response to precipitation events would likely occur rapidly. Precipitation during the summer months generally falls in large amounts over short periods of time, which results in increased runoff and decreased amount of precipitation available for infiltration. Therefore, lower groundwater levels would also occur during this time due to less precipitation infiltration and the increased loss of water by evapotranspiration.

Above normal amounts of rainfall also occur during February and March. Since precipitation in the late winter/early spring months generally occurs as a slow, steady rainfall and evapotranspiration is minimal, more precipitation is available for infiltration. It would be expected that the seasonal high water table would occur in late winter to early spring (January to March) in response to precipitation and decreased evapotranspiration during this period.

Across the site, stabilized groundwater levels are typically within 2 feet of natural ground surface. Due to the shallow nature of the water table, natural land surface will be designated as the seasonal high and long-term seasonal high water table.

3.3.2 Slug Test Results

Several in-situ hydraulic conductivity (slug) tests were performed by others during the siting and design for Cells 1 and 2. Horizontal hydraulic conductivity values ranged from 3.7×10^{-5} cm/sec (0.1 ft/day) to 5.0×10^{-4} cm/sec (1.4 ft/day) in the shallow fine to medium sand layer, and from 2.1×10^{-5} cm/sec (0.06 ft/day) to 3.2×10^{-5} cm/sec (0.09 ft/day) in the deeper medium sand with shell layer. One slug test performed in the sand and silt layer at 25 to 30 feet below land surface had results of 1.9×10^{-6} cm/sec (0.005 ft/day) (Geo-Hydro, 1993). The average hydraulic conductivity for all of the tests was 1.0×10^{-4} cm/sec (0.3 ft/day) and the geometric mean value was 2.9×10^{-5} cm/sec (0.08 ft/day) (Geo-Hydro, 1993, 1994).

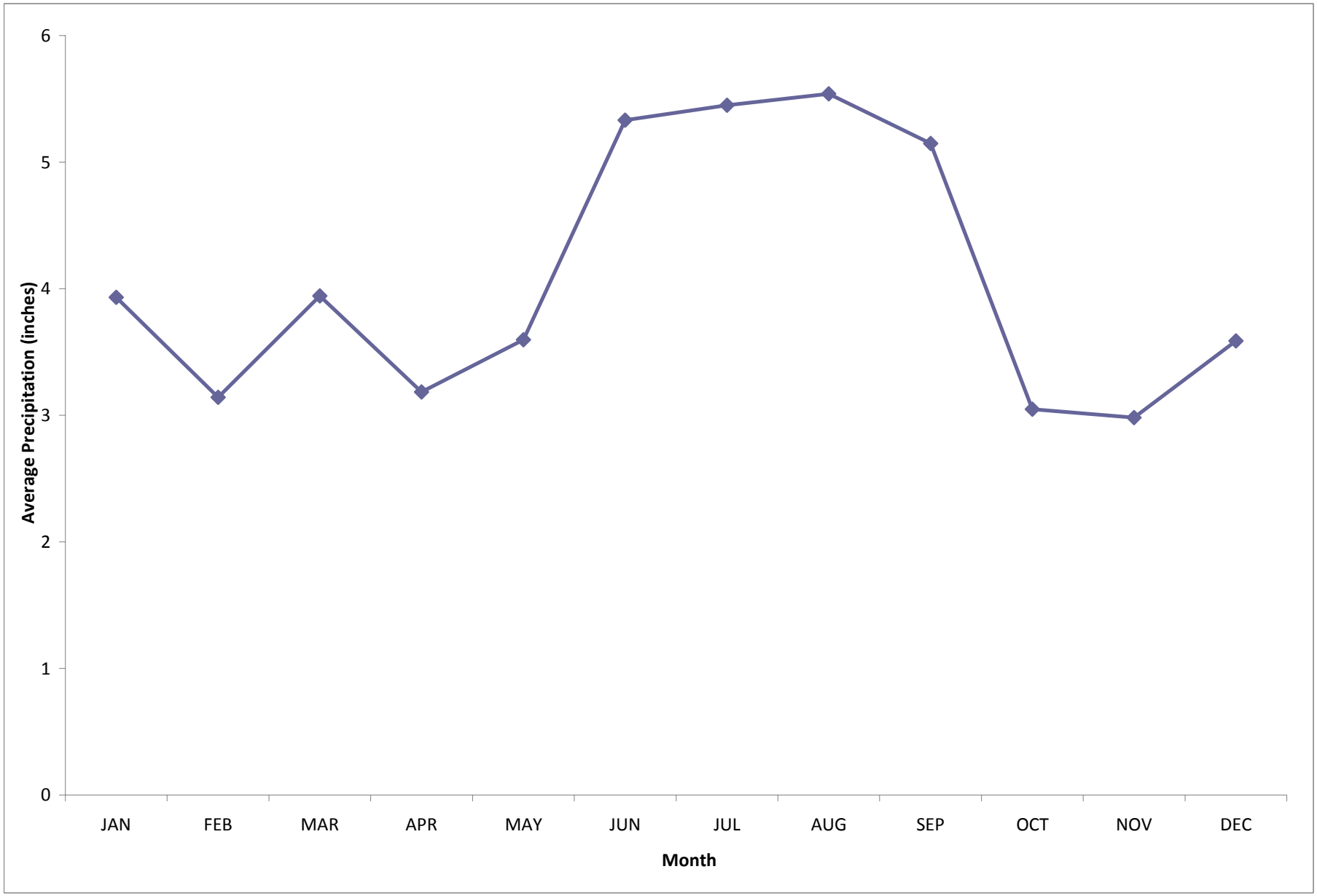
Table 4
Annual Precipitation Data - Manteo Airport Station
Dare County C&D Landfill
Manns Harbor, North Carolina

	MONTHLY PRECIPITATION (inches)												
Year	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**ANNUAL**
1994	6.2	0.9	6.89	0.95	3.37	3.33	7.84	4.53	3.3	5.19	4.8	2.39	49.69
1995	4.17	6.2	2.68	1.82	2.53	6.35	0.51	4.94	2.81	3.84	3.09	3.37	42.31
1996	5.31	2.12	6	2.57	1.4	9.62	9.32	6.74	7.71	3.6	4.16	2.71	61.26
1997	2.85	2	3.18	2.75	2.11	2.73	2.31	3.27	4.56	2.13	3.63	4.65	36.17
1998	7.49	6.25	6.41	0	0	4.03	5.85	4.53	5.41	1.05	1.53	6.55	49.1
1999	3.85	1.95	3.28	2.04	3.99	5.51	2.95	9.6	10.39	5.8	1.92	1.42	52.7
2000	5.23	2.4	1.58	4.07	7.57	9.38	7.59	6.15	5.11	0.4	3.19	3.82	56.49
2001	1.58	2.59	4.33	1.7	1.76	6.43	1.88	4.19	1.25	1.2	0.25	0.73	27.89
2002	3.75	1.79	8.64	1.57	2.4	1.8	7.02	7.59	6.12	4.49	4.23	4.02	53.42
2003	3.11	6.03	4.53	6.91	7.01	4.03	7.29	6.5	9.18	5.19	1.87	5.1	66.75
2004	1.46	3.23	2.47	3.57	5.51	6.37	4.5	11.85	4.23	1.43	2.79	4.2	51.61
2005	2.81	2.95	2.83	4.88	5.64	8.07	9.66	3.06	1.37	6.44	2.37	3.27	53.35
2006	3.84	1.41	1.35	3.15	6.76	4.29	4.18	4.41	7.61	2.47	6.56	4.56	50.59
2007	4.34	2.08	3.05	4.1	2.26	6.98	4.21	2.76	1.6	1.57	1.34	3.44	37.73
2008	2.99	5.22	1.93	7.68	1.63	1.05	6.62	2.98	6.57	0.91	M	M	37.58
Average	3.93	3.14	3.94	3.18	3.60	5.33	5.45	5.54	5.15	3.05	2.98	3.59	48.88

M - Missing Data

Source - Climatological Data - Annual Summary North Carolina

Figure 3
Average Monthly Precipitation Data
Manteo Airport, Dare County, North Carolina



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A summary of the slug test results conducted during the initial hydrogeologic investigation by Geo-Hydro is provided below:

Piezometer	Screen Depth	Lithologic Unit	Hydraulic Conductivity (cm/sec)
B-1	10-20	fine to medium sand	3.7×10^{-5}
B-2	40-50	medium sand with shell	2.1×10^{-5}
B-3	40-50	medium sand with shell	2.6×10^{-5}
B-4	40-50	medium sand with shell	3.2×10^{-5}
B-5	10-20	fine to medium sand	5.0×10^{-4}
B-6	25-30	fine sand and silt	1.9×10^{-6}

From Geo-Hydro (Appendix B, Table 2) (1993)

Following installation of the revised groundwater monitoring network, slug tests were also performed on monitoring wells GW-9 through GW-12. Horizontal hydraulic conductivity values ranged from 3.56×10^{-4} cm/sec (1.0 ft/day) in GW-10 to 8.97×10^{-4} cm/sec (2.5 ft/day) in GW-9 (Tetra Tech, 2002).

In addition, CDM performed slug tests on monitoring wells GW-13, -14, and -15 as part of the Water Quality Monitoring Plan for Cell 3. Slug test rising head (recovery) results indicated that hydraulic conductivity ranged from 1.0×10^{-4} cm/sec (0.28 ft/day) in GW-13 to 3.9×10^{-4} cm/sec (1.12 ft/day) in GW-14.

During the current investigation, CDM performed slug tests on piezometers B-503, B-503d, B-505, B-506, and B-506d. Slug test recovery results indicated that hydraulic conductivity in the shallow piezometers ranged from 6.4×10^{-4} cm/sec (1.80 ft/day) in B-505 to 2.6×10^{-3} cm/sec (7.51 ft/day) in B-503. Recovery results in the deeper piezometers indicated hydraulic conductivity values ranging from 6.0×10^{-4} cm/sec (1.70 ft/day) in B-503d to 1.6×10^{-3} cm/sec (4.55 ft/day) in B-506d. The results of the slug tests completed by CDM during this and previous investigations are presented on Table 5. Slug test curves and sample calculations from the current investigation are provided in Appendix D.

Table 5
Calculated Hydraulic Conductivity Values
Dare County Construction and Demolition Landfill
Cell 4
Design Hydrogeologic Investigation

Well ID	Boring Depth (ft)	Aquifer Monitored Interval	K (in/sec)	K (ft/min)	K (ft/day)	K (cm/sec)
MW-13 Slug In	20	fine to medium sand	2.96E-05	1.48E-04	0.21	7.52E-05
MW-13 Slug Out	20	fine to medium sand	3.94E-05	1.97E-04	0.28	1.00E-04
MW-14 Slug In	20	fine to medium sand	1.72E-04	8.62E-04	1.24	4.38E-04
MW-14 Slug Out	20	fine to medium sand	1.55E-04	7.77E-04	1.12	3.95E-04
MW-15 Slug In	20	fine to medium sand	1.45E-04	7.25E-04	1.04	3.68E-04
MW-15 Slug Out	20	fine to medium sand	1.15E-04	5.73E-04	0.83	2.91E-04
B-503 Slug -In	20	fine to medium sand	6.14E-04	3.07E-03	4.42	1.56E-03
B-503 Slug Out	20	fine to medium sand	1.04E-03	5.22E-03	7.51	2.65E-03
B-503d Slug In	50	medium sand with shell	2.69E-04	1.35E-03	1.94	6.84E-04
B-503d Slug Out	50	medium sand with shell	2.36E-04	1.18E-03	1.70	5.99E-04
B-505 Slug In	25	fine to medium sand	3.65E-04	1.82E-03	2.63	9.26E-04
B-505 Slug Out	25	fine to medium sand	2.51E-04	1.25E-03	1.80	6.36E-04
B-506 Slug In	20	fine to medium sand	9.91E-04	4.95E-03	7.13	2.52E-03
B-506 Slug Out	20	fine to medium sand	NM	NM	NM	NM
B-506d Slug In	50	medium sand with shell	6.82E-04	3.41E-03	4.91	1.73E-03
B-506d Slug Out	50	medium sand with shell	6.32E-04	3.16E-03	4.55	1.61E-03
		Average Cell 4 Area - Shallow	6.53E-04	3.26E-03	4.70	1.66E-03
		Average Cell 4 Area - Deep	4.55E-04	2.27E-03	3.27	1.16E-03
		Average C&D Facility Area	3.83E-04	1.91E-03	2.75	9.72E-04

3.4 Hydrogeologic Conceptual Model

Stratigraphic cross-sections identifying hydrogeologic units and stabilized water table elevations within the proposed Cell 4 area are provided in Figures 1 and 2. Cross-section references for are provided on Sheet 1.

Marine deposited surficial soils were encountered in all borings at the proposed landfill site and extend to an average thickness of about 60 feet. The surficial soils range in color and grain size from dark gray clay and silt to greenish gray medium sand, with mixtures of shell, silt and sand. These surficial soils have been deposited as material from low energy shallow bay environments and floodplain alluvium.

Based on site drilling information and information gathered during the literature search, the surficial soils are underlain by the Yorktown confining unit. The Yorktown confining unit typically consists of a series of discontinuous clay and silt beds with varying amounts of fine sand and shells, and was found to extend from about 63 feet below land surface to 85 feet below land surface.

The potentiometric contour map shows a flat water table surface with the major component of flow towards the south and west in a semi-radial pattern. The major influences to groundwater flow direction are topography and the east-west trending canals, particularly the southern-most canal along Cub road. Water flows in these canals to a larger canal along the western property boundary. The water is then pumped from the canal to the US Fish and Wildlife waterfowl preserve south of the Dare County C&D Landfill site. Flow direction in the canals is provided on Sheet 1.

The pump station is owned by the US Fish and Wildlife Service (USFWS) but is fueled and serviced by the USFWS, the County, and the adjacent landowner. The pump was originally installed for agricultural purposes and has been in place for approximately 20 years. There are no records indicating how much water is pumped, but according to landfill personnel, pump usage depends on water level in the ditch and/or the time of year.

Current and historic vertical gradient data indicate that generally, there is a downward gradient in the interior of the site and an upward gradient near the canals, indicating that the canals act as discharge points and the area to be landfilled is mostly a recharge area. The hydrogeologic cross-sections and flow nets provided on Figures 1 and 2 indicate that although there is a component of downward movement in the surficial aquifer, the major component of groundwater flow is horizontal, with discharge to the canals.

3.4.1 Precipitation and Groundwater Recharge

In the Coastal Plain, infiltration from rainfall provides the bulk of the recharge to the underlying aquifers. The surficial aquifer transmits water laterally to streams, and in this case canals, and also serves as a source bed holding the water that eventually

migrates downward to the underlying Yorktown aquifer. In the case of the Yorktown aquifer, recharge is also from incised streams and rivers and from subcropping aquifers below.

Recharge to the surficial aquifer depends on precipitation rates and infiltration capacities of the surficial soils. Locally, recharge is slow and moves laterally through the surficial aquifers to the canals and surrounding swamps. All of these points serve as both recharge and discharge points depending on season, amount of precipitation, and time.

The most significant recharge to the Yorktown aquifer is downward percolation of water through the surficial aquifer and confining unit. While the downward gradients indicated the potential for downward flow, the cross-sections and flow nets indicated that the dominant flow is lateral toward the canals, indicating that most groundwater migrating downward through the surficial aquifer will flow laterally and ultimately upward to the discharge points. Recharge and discharge to and from the Yorktown aquifer also occurs where the confining unit is incised by streams and rivers, and also by movement to and from the deeper confined aquifers.

3.4.2 Groundwater Flow

Across the site, the water table generally occurs within 1 to 3 feet below land surface. Surficial groundwater moves in a somewhat radial pattern from the recharge areas in the north and central portions of the site and is intercepted by the man-made canals surrounding the area. Based on the groundwater contour map provided on Sheet 2, groundwater flow is south and west towards the larger Cub Road canal.

3.4.2.1 Groundwater Velocity

The average linear velocity of groundwater flow was calculated using the following formula:

$$\mathbf{V_x = \frac{Kdh}{n_e dl}}$$

Where,
V_x = average linear velocity
K = hydraulic conductivity
dh/dl = hydraulic gradient
n_e = effective porosity

Average linear flow velocity estimates are provided in Table 6. Average groundwater flow velocity in the entire surficial aquifer at the site was approximately 0.008 ft/day.

The hydraulic conductivity was obtained from the slug test data presented in Table 5. The hydraulic gradient values were estimated using the potentiometric contour map from October 20, 2008 data. The effective porosity values for the soils were estimated

based on the lithologic descriptions applied to the soil classification triangle which illustrate the relationship between grain size and specific yield values (Johnson, 1967).

The estimated effective porosity values for all geotechnical samples with grain size analysis results are presented on Table 2. The average values were based on the effective porosity results from all samples.

3.4.3 Surface Water Interactions and Groundwater Discharge

No springs were observed at the site. There are no streams on the site, however, there are two man-made canals running east-west that drain off-site to wetlands. These canals intercept shallow groundwater and also collect surface water run-off from the site and smaller north-south drainage ditches during precipitation events or periods of high groundwater.

Across the site and within the Cell 4 area, the water table generally occurs within 1 to 3 feet below natural land surface. Observations from this and previous investigations indicate that similar to topography, surficial groundwater moves in a somewhat radial pattern from the recharge areas in the north and central portions of the site toward the south-west and is intercepted by the man-made canals surrounding the area. During periods of precipitation and seasonal high conditions, the smaller irrigation ditches also intercept the top of the water table.

4 Conclusions

This section presents conclusions based upon site investigation activities to date. These conclusions include considerations regarding the landfill design and considerations for the water quality monitoring plan.

The surficial aquifer is primarily made up of low to average permeability fine sand and silt with layers of silty to clayey sand and fine sand with shell hash. The surficial aquifer is approximately 60 feet thick and is underlain by the Yorktown confining unit. The major groundwater discharge feature for the surficial aquifer is the canal along Cub Road to the south and west. Water from the canal flows and is pumped to the waterfowl refuge to the south of the site.

There are no domestic water wells within 1000-feet of the site; however, there is a well at the existing landfill scale-house that is used for sanitary purposes. This well withdraws water from the underlying Yorktown aquifer.

Across the site, the water table generally occurs within 1 to 3 feet below land surface. Surficial groundwater moves in a somewhat radial pattern from the recharge areas in the north and central portions of the site and is intercepted by the man-made canals surrounding the area. Based on the groundwater contour map provided on Sheet 2, groundwater flow is south and west towards the larger Cub Road canal.

The geology and hydrogeology of the site provide suitable conditions for expansion of the County's C&D landfill for the following reasons:

- Flow within the surficial aquifer is mainly horizontal, with the discharge occurring at the main canal. As expected, the interior of the site serves as a recharge area, as seen by the downward vertical gradients. However, the cross-sections, flow nets, and groundwater contour map indicate that the majority of surficial groundwater flow is toward the Cub Road canal.

- Groundwater flow is controlled by features which allow for effective monitoring. There is an existing monitoring well and surface water monitoring network in place. There are currently three existing surface water monitoring points within the Cub Road canal, which serves as the main groundwater discharge at the site. Due the relative flatness of the water table, the semi-radial flow pattern, and the dominant horizontal flow toward the canals, the site can be effectively monitored with single shallow wells and comprehensive surface water monitoring.

There currently are 3 C&D landfill cells at the site; Cells 1 and 2 are closed and Cell 3 is active. An approved Water Quality Monitoring Network is already in place at the site. A review of historic water quality data from the existing network showed no detected volatile organic compounds above applicable groundwater standards.

4.1 Landfill Construction Considerations

Based on the findings of presented in this report and previous reports, the Cell 4 C&D Landfill area is considered to be suitable for expansion of the Dare County Facility. Similar to previous investigations for adjacent Cell 3, the following issues should be considered in the landfill design.

- The existing ground surface will serve as the Seasonal High Water Table and separation between the base of the landfill will be constructed as such.

- After construction of the landfill, groundwater recharge will decrease due to the placement of the lower permeability separation material, improved run-off control, thus, reduced precipitation available for infiltration and the later placement of the landfill cap. This reduction in groundwater recharge will cause a lowering in the water table surface; however, no change of direction of groundwater flow is anticipated. With the decrease in the water table surface, a decrease in the hydraulic gradient beneath the landfill will occur, which will in turn decrease the groundwater flow velocity.

4.2 Water Quality Monitoring Plan Considerations

The overall C&D Landfill expansion area groundwater system is composed of a shallow, flat water table surface. The Cell 4 area can be easily monitored with one shallow monitoring well completed near the south canal, in addition to the existing monitoring well and surface water network.

The groundwater flow patterns at the proposed C&D Landfill Cell 4 are dictated by and are a direct reflection of surface topography. Groundwater within the Cell 4 area generally flows from north to south, toward the southern canal along Cub Road.

4.3 Piezometer Abandonment

All borings intersecting groundwater at the site during the current investigation have been constructed and maintained as permanent monitoring wells in accordance with NCAC 02C .0108.

Rule .0538(b)(2)(J) requires that all borings at the site not converted to permanent monitoring wells shall be properly abandoned in accordance with the NCAC 02C .0113. All piezometers and the existing monitoring wells (GW-6 and GW-7) within the landfill footprint will be overdrilled to the full depth of the boring and abandoned with cement or bentonite. In addition, all wells installed during previous investigations that have not been converted to permanent monitoring wells will also be overdrilled and abandoned. Well abandonment records will be submitted following abandonment.

5 References

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Appendix A
Borelogs

CAMP DRESSER & McKEE
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Raleigh, NC 27612

BOREHOLE LOG
B-101

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 4-30-07 **End:** 4-30-07
Borehole Coordinates:
N 774,340.20 E 2,943,092.10

Surface Elevation (ft.): 20
Total Depth (ft.): 100
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			20.0					
SS	S-1	24/22	0		3 6 9 16		FILL	Moist, medium dense, gray, fine, SAND, little to some gravel, brick, little woods, silt. -FILL-
SS	S-2	24/23			17 14 12 13			Moist, very stiff, dark gray to black, ORGANIC SILT, some woods, sand, gravel.
SS	S-3	24/19	15.0 / 5		12 15 15 10			Moist to wet, very stiff to hard, dark gray to black, ORGANIC SILT, some woods, sand, gravel.
SS	S-4	24/22			7 7 7 6		ML	Moist to wet, stiff, dark gray, SILT, trace roots.
SS	S-5	24/19		PP= 1.0 (t), 0.8 (m), 0.8 (b)	3 5 9 9		ML/SM	Moist to wet, stiff, greenish gray and brown, SILT and fine SAND.
ST	ST-1	24/0	10.0 / 10					
SS	S-6	24/15	5.0 / 15		2 8 10 12		SP	Wet, medium dense, gray, fine, SAND.
SS	S-7	24/11	0.0		3 3 4 5			Wet, loose, gray, fine, SAND.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: **Date:**

CAMP DRESSER & McKEE
CDM
5400 Glenwood Avenue Suite 300
Raleigh, NC 27612

BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			0.0					
			20				SP	
SS	S-8	24/13	-5.0		1 2 3 2			Wet, loose, gray, fine to medium, SAND, little to some shell fractures (coarse sand to gravel size), trace gravel, silt, clay.
			25					
SS	S-9	24/13	-10.0		3 5 5 12		SM/ML	Wet, loose to medium dense, gray, fine, SAND and SILT.
			30					
SS	S-10	24/24	-15.0	Tor= 2.2 (t), 2.1 (m)	WOH WOH 2 7		ML	Wet, very soft to soft, gray, SILT, some clay.
			35				SP	Wet, very loose, gray, fine, SAND, little shell fractures (fine sand size).
SS	S-11	24/10	-20.0		2 5 6 7			Wet, medium dense, gray, fine, SAND, some shell fractures (fine to coarse sand size), trace silt.
			40					
SS	S-12	24/14	-25.0		4 10 12 12		SM	Wet, medium dense, gray, fine to medium, SAND, little silt, trace shell fractures.
			45					
SS	S-13	24/14	-30.0		7 9 15 16			
			50					
SS	S-14	24/21	-35.0		1 2 2 1		SP	Wet, very loose to loose, gray, fine, SAND and SHELL FRACTURES (sand to gravel size).
			55					
SS	S-15	24/12	-40.0		10 11 17 18			Wet, medium dense, gray, fine, SAND.

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BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-40.0 / 60					
SS	S-16	24/16	-45.0 / 65		2 10 28 32			Wet, dense, gray, fine, SAND.
SS	S-17	24/14	-50.0 / 70		5 8 9 11		SM	Wet, medium dense, gray, fine, SAND, little silt.
SS	S-18	24/24	-55.0 / 75		1 2 2 4		CL/ML	Moist, soft to medium stiff, gray, CLAY and SILT, trace sand. -YORKTOWN-
ST	ST-2	24/24						
SS	S-19	24/15	-60.0 / 80	PP= 1.3 (m)	5 9 12 14			Moist, very stiff, gray, CLAY and SILT, trace to little sand.
SS	S-20	24/24	-65.0 / 85	PP= 1.8 (t), 2.3 (m), 1.8 (b)	2 2 4 6			Moist, medium stiff, gray, CLAY and SILT, trace to little shell fragments (gravel size), trace sand.
SS	S-21	24/24	-70.0 / 90	PP= 1.0 (t), 1.8 (m), 1.3 (b)	2 3 3 5			Moist, medium stiff, gray, CLAY and SILT, little sand.
SS	S-22	24/20	-75.0 / 95		2 11 15 13		SM	Wet, medium dense, light gray to gray, fine, SAND, some silt.
SS	S-23	24/24	-80.0		1 2 5 7		ML	Wet, medium stiff, gray, SILT, little to some sand.

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BOREHOLE LOG
B-101

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-80.0					
			100					Boring terminated at 100 feet below ground surface.
			-85.0 / 105					
			-90.0 / 110					
			-95.0 / 115					
			-100.0 / 120					
			-105.0 / 125					
			-110.0 / 130					
			-115.0 / 135					
			-120.0					

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BOREHOLE LOG
B-102

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 4-30-07 **End:** 5-1-07
Borehole Coordinates:
N 773,613.20 E 2,943,245.90

Surface Elevation (ft.): 20
Total Depth (ft.): 98.9
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			20.0					
SS	S-1	24/24	0		1 2 2 4		FILL	Moist, very loose to loose, light greenish gray and brown, fine, SAND, trace silt. -FILL-
SS	S-2	24/12			2 4 4 7			Moist, very loose to loose, gray to dark gray, fine, ORGANIC SAND, some silt, little to some woods. Moist, medium stiff to stiff, gray to dark gray, ORGANIC SILT, some woods, little sand.
SS	S-3	24/16	15.0 5		4 19 14 9			Moist, dense, gray and dark gray, fine to medium, SAND, some brick, little silt, gravel.
SS	S-4	24/22			7 9 7 10		SP	Wet, medium dense, light gray to gray, fine, SAND, trace silt.
							CL	Moist, very stiff, dark gray and greenish gray, CLAY, some sand, little silt.
ST	ST-1	24/10					SC/CL	Moist, dark gray and greenish gray, fine, SAND and CLAY, little silt.
			10.0					
SS	S-5	24/18	10		3 4 5 5		SM	Wet, loose, light gray to gray, fine, SAND, little to some silt.
SS	S-6	24/13	5.0 15		5 6 5 3		SP	Wet, medium dense, light gray to gray, fine, SAND.
SS	S-7	24/13	0.0		3 2 1 1		SP-SM	Wet, very loose, gray, fine, SAND, trace to little silt.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: **Date:**

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			0.0					
			20				SP-SM	
SS	S-8	24/15	-5.0		14 20 26 14			Wet, dense, gray, fine, SAND, little shell fractures (coarse sand to gravel size), trace to little silt.
			25					
SS	S-9	24/15	-10.0		3 2 3 3		ML	Wet, medium stiff, gray to dark gray, SILT, some fine sand.
			30					
ST	ST-2	24/23					CL	Wet, dark gray, CLAY, some fine sand.
SS	S-10	24/22	-15.0		1 2 1 1		SM	Wet, very loose, gray to dark gray, fine, SAND, some shell fractures (sand to gravel size), little silt.
			35					
SS	S-11	24/18	-20.0		4 5 8 9		SP	Wet, medium dense, gray, fine, SAND, little to some shell fractures (sand to fine gravel size), trace silt.
			40					
SS	S-12	24/16	-25.0		8 10 11 16			Wet, medium dense, gray, fine, SAND.
			45					
SS	S-13	24/21	-30.0		5 4 7 7			Wet, medium dense, gray, fine, SAND, trace to little shell fractures (sand to fine gravel size), trace silt.
			50					
SS	S-14	24/20	-35.0		3 3 3 4		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace to little silt.
			55					
SS	S-15	24/18	-40.0		14 18 28 37		SP	Wet, dense, light gray to gray, fine, SAND, trace shell fractures.

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. / Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-40.0 / 60				SP	
SS	S-16	24/15	-45.0 / 65		11 9 9 12		SM	Wet, medium dense, gray, fine, SAND, little silt.
SS	S-17	24/23	-50.0 / 70		2 3 5 7			Wet, loose, gray, fine, SAND, little silt.
SS	S-18	24/20	-55.0 / 75	PP= 0.5 (t), 0.5 (b)	4 3 2 4		CL/ML	Wet, medium stiff, gray, CLAY and SILT, trace to little sand, trace shell fractures. -YORKTOWN-
SS	S-19	24/24	-60.0 / 80		5 3 7 6			Wet, stiff, gray, CLAY and SILT, some shell fractures (sand to gravel size), little to some fine sand.
SS	S-20	24/24	-65.0 / 85	PP= 1.5 (t), 1.8 (m), 2.0 (b)	2 2 3 7			Wet, medium stiff, gray, CLAY and SILT, trace sand, shell fractures.
SS	S-21	24/24	-70.0 / 90	PP= 1.5 (t), 1.8 (m), 1.8 (b)	2 3 4 6			
SS	S-22	24/24	-75.0 / 95		1 3 3 4		SM	Moist, loose, gray, fine, SAND, some silt.
SS	S-23	11/11	-80.0		25 50/5"		SP	Wet, very dense, light gray to gray, fine, SAND, trace silt.

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BOREHOLE LOG
B-102

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in.	Graphic Log	USCS Classification	Material Description
			-80.0					Boring terminated at 98.9 feet below ground surface.
			100					
			-85.0 / 105					
			-90.0 / 110					
			-95.0 / 115					
			-100.0 / 120					
			-105.0 / 125					
			-110.0 / 130					
			-115.0 / 135					
			-120.0					

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BOREHOLE LOG
B-103

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 5-1-07 **End:** 5-1-07
Borehole Coordinates:
N 774,360.00 E 2,942,685.20

Surface Elevation (ft.): 14
Total Depth (ft.): 100
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			14.0					
SS	S-1	24/23	0	PP= 0.8 (m), 1.0 (b)	WOH 1 1 2		OL	Moist, very soft to soft, dark gray to black, ORGANIC SILT, little sand, woods.
							CL	Moist, very soft to soft, grayish brown, CLAY, trace sand.
ST	ST-1	24/24					SM	Moist, light gray to gray, fine, SAND, little silt.
SS	S-2	24/17	9.0 / 5		3 3 2 1			Wet, loose, gray, fine, SAND, some silt.
SS	S-3	24/16			WOH 1 2 3			Wet, very loose, gray, fine, SAND, little silt.
SS	S-4	24/21	4.0 / 10		4 4 4 6		SP	Wet, loose, light gray to gray, fine, SAND, trace silt.
SS	S-5	24/10	-1.0 / 15		1 2 2 3			Wet, very loose to loose, light gray to gray, fine, SAND.
SS	S-6	24/15	-6.0		3 6 6 7		SP-SM	Wet, medium dense, gray, fine, SAND, trace to little silt.

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: **Date:**

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BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-6.0				SP-SM	
			20					
SS	S-7	24/10			3 3 4 4		SM/ML	Wet, loose, gray, fine, SAND and SILT.
			-11.0					
			25					
ST	ST-2	24/24					CL	Wet, gray, CLAY, some fine sand.
SS	S-8	24/15			1 2 4 2		SP	Wet, loose, gray, fine to medium, SAND, some shell fractures (coarse sand to gravel size), trace silt.
			-16.0					
			30					
SS	S-9	24/16			5 4 5 6		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace to little silt.
			-21.0					
			35					
SS	S-10	24/22			6 6 8 7		SP	Wet, medium dense, gray, fine, SAND, little shell fractures (fine to coarse sand size).
			-26.0					
			40					
SS	S-11	24/12			4 10 16 19			Wet, medium dense, gray, fine, SAND, trace shell fractures.
			-31.0					
			45					
SS	S-12	24/24			4 3 4 4			Wet, loose, gray, fine, SAND, some shell fractures (sand to fine gravel size), trace silt.
			-36.0					
			50					
SS	S-13	24/21			9 13 31 33			Wet, dense, light gray to gray, fine to medium, SAND, trace shell fractures.
			-41.0					
			55					
SS	S-14	24/16			5 8 9 10		SM	Wet, medium dense, gray, fine, SAND, little silt.
			-46.0					

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BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-46.0					
			60				SM	
SS	S-15	24/14	-51.0		6 7 11 15		SP-SM	Wet, medium dense, gray, fine, SAND, trace to little silt, trace shell fractures.
			65					
SS	S-16	24/24	-56.0	PP= 0.8 (t), 0.8 (m), 1.0 (b)	3 3 6 7		CL/ML	Moist, stiff, gray, CLAY and SILT, trace shell fractures. **-YORKTOWN-**
			70					
SS	S-17	24/20	-61.0		9 13 22 37		SM	Moist, dense, gray, fine, SAND, some silt, little shell fractures (sand to fine gravel size).
			75					
SS	S-18	24/24	-66.0	PP= 1.5 (t), 1.5 (m), 1.8 (b)	2 3 3 6		CL/ML	Moist, medium stiff, gray, CLAY and SILT, trace shell fractures.
			80					
SS	S-19	24/23	-71.0		3 4 7 17		SM	Moist, medium dense, gray, fine, SAND, some silt.
			85					
SS	S-20	24/20	-76.0		10 14 13 16			Wet, medium dense, gray, fine, SAND, little silt, clay.
			90					
SS	S-21	24/21	-81.0		23 35 28 28		SP	Wet, very dense, light gray to gray, fine, SAND.
			95					
SS	S-22	24/10	-86.0		15 22 28 32			Wet, dense to very dense, light gray to gray, fine, SAND.

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BOREHOLE LOG
B-103

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-86.0					
			100					Boring terminated at 100 feet below ground surface.
			-91.0 / 105					
			-96.0 / 110					
			-101.0 / 115					
			-106.0 / 120					
			-111.0 / 125					
			-116.0 / 130					
			-121.0 / 135					
			-126.0					

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BOREHOLE LOG
B-104

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Drilling Contractor: Fishburne Drilling Inc.
Drilling Method/Rig: Mud Rotary/CME 550
Drillers: Tim Donahue
Drilling Date: Start: 5-1-07 **End:** 5-1-07
Borehole Coordinates:
N 772,817.30 E 2,942,277.90

Surface Elevation (ft.): 14
Total Depth (ft.): 100
Depth to Initial Water Level (ft. BGS):
Abandonment Method:
Field Screening Instrument:
Logged By: I.S. Akbas

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			14.0					
			0		3		OL	Moist, medium stiff, dark gray, ORGANIC SILT, trace clay, sand.
SS	S-1	24/20		PP= 1.5 (t), 2.5 (m)	2 3 3		CL	Moist, medium stiff, gray and brown, CLAY, little sand.
ST	ST-1	24/23					SC	Moist, brownish gray, fine, SAND, some clay.
SS	S-2	24/21	9.0 / 5		3 2 1 2		SM	Wet, very loose, gray, fine, SAND, some silt.
SS	S-3	24/24			2 2 1 2		SP-SM	Wet, very loose, gray, fine, SAND, trace silt.
SS	S-4	24/24	4.0 / 10		1 2 2 2		SM	Wet, very loose to loose, gray, fine, SAND, little to some silt.
SS	S-5	24/24	-1.0 / 15		WOH WOH WOH WOH		CL	Wet, very soft, gray, CLAY, trace to little sand.
ST	ST-2	24/0						
SS	S-6	24/24	-6.0		5 3 4 5		SP-SM	Wet, loose, gray, fine, SAND, some shell fractures (sand to gravel size), trace to little silt.
							SM	Wet, loose, gray, fine, SAND, some silt, clay, shell fractures (sand

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
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FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

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CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer weight = 140 lb, Hammer drop height = 30 in., Spoon Size = 2 in. OD and 24 in. length.

Reviewed by: **Date:**

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BOREHOLE LOG
B-104

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-6.0 20				SM	to gravel size).
SS	S-7	24/13			2 6 6 7			Wet, medium dense, gray, fine, SAND, some silt.
			-11.0 25				CL/ML	Wet, gray, CLAY and SILT.
ST	ST-3	24/24						
ST	ST-4	24/24						Wet, gray, CLAY and SILT, shell fractures.
SS	S-8	24/18	-16.0 30		WOH WOH WOH 1		SM	Wet, very loose, gray, fine, SAND, some silt, little to some shell fractures (sand to gravel size).
SS	S-9	24/20	-21.0 35		3 5 7 9		SP-SM	Wet, medium dense, gray, fine, SAND, some shell fractures (sand to gravel size), trace to little silt.
SS	S-10	24/17	-26.0 40		8 10 13 14		SP	Wet, medium dense, gray, fine, SAND.
SS	S-11	24/16	-31.0 45		10 11 19 23			Wet, medium dense to dense, gray, fine, SAND, trace shell fractures.
SS	S-12	24/24	-36.0 50		3 4 3 4		SM	Wet, loose, gray, fine to medium, SAND, little silt, shell fractures (sand to fine gravel size).
SS	S-13	24/17	-41.0 55		12 19 20 23		SP	Wet, dense, gray, fine to medium, SAND.
SS	S-14	24/20	-46.0		5 2 6 14		SM	Wet, loose, gray, fine, SAND, little silt.

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BOREHOLE LOG
B-104

Client: Dare County
Project Location: Manns Harbor, NC
Project Name: C&D Landfill Cell No. 4
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-46.0 / 60				SM	
SS	S-15	24/18	-51.0 / 65		1 4 11 14			Wet, medium dense, gray, fine, SAND, little silt.
SS	S-16	24/16	-56.0 / 70		7 14 10 10			Wet, medium dense, gray, fine, SAND, little silt, shell fractures (sand to fine gravel size).
SS	S-17	24/12	-61.0 / 75		25 21 13 13			Wet, dense, gray, fine, SAND, little to some silt.
SS	S-18	24/24	-66.0 / 80	PP= 1.8 (t), 2.3 (m), 2.5 (b)	2 3 4 5		CL/ML	Wet, medium stiff, gray, CLAY and SILT, trace shell fractures. -YORKTOWN-
SS	S-19	24/24	-71.0 / 85	PP= 1.8 (t), 2.0 (m), 2.0 (b)	2 3 4 5			
SS	S-20	24/24	-76.0 / 90		2 3 2 4			Wet, medium stiff, gray, CLAY and SILT, little sand, trace shell fractures.
SS	S-21	24/18	-81.0 / 95		10 8 17 40		SP-SM	Wet, medium dense, gray, fine, SAND, little to some shell fractures (sand to fine gravel size), little silt.
SS	S-22	24/24	-86.0		1 1 2 4		SM/ML	Wet, very loose, gray, fine, SAND and SILT.

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BOREHOLE LOG
B-104

Client: Dare County
Project Name: C&D Landfill Cell No. 4
Project Location: Manns Harbor, NC
Project Number: 17952-56960

Sample Type	Sample Number	Sample Recovery (Inches)	Elev. Depth (ft.)	Pocket Penetrometer / Torvane Reading (tsf)	Blows per 6-in	Graphic Log	USCS Classification	Material Description
			-86.0 / 100					Boring terminated at 100 feet below ground surface.
			-91.0 / 105					
			-96.0 / 110					
			-101.0 / 115					
			-106.0 / 120					
			-111.0 / 125					
			-116.0 / 130					
			-121.0 / 135					
			-126.0					

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-501**

TOTAL DEPTH: **15'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Site Hydrogeologic Study**	DRILLING CO.: **Probe Technology, Inc.**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Adam Burnie**
JOB NO.: **17952-56960**	RIG TYPE: **GeoProbe 6610 DT**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Direct Push Sampler**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Direct Push**
DATE DRILLED: **May 1, 2007**	HAMMER WT./DROP **N/A**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
						Locking, above-grade protective cover
0		SAND: Moist, brown, fine to medium sand, some silt, topsoil.				
		CLAY AND SILT: Moist to wet, mottled, little fine sand. increasing sand content with depth.				Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.				1-inch Schedule 40 PVC riser and screen
-10						#2 Silica sand filter pack
						Screen from 5' to 15' bls
-15						

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-502d**

TOTAL DEPTH: **31'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Site Hydrogeologic Study**	DRILLING CO.: **Probe Technology, Inc.**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Adam Burnie**
JOB NO.: **17952-56960**	RIG TYPE: **GeoProbe 6610 DT**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Direct Push Sampler**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Direct Push**
DATE DRILLED: **May 1, 2007**	HAMMER WT./DROP **N/A**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		SAND: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, mottled, little fine sand. increasing sand content with depth.				
-5		SAND: Wet, gray, fine to medium, trace silt.				Bentonite
-10						
-15						1-inch Schedule 40 PVC riser and screen
-20		SAND: Wet, gray, fine to medium sand with silt and some shell fragments.				
-25		SILTY SAND: Wet, gray fine sand, little shell fragments.				#2 Silica sand filter pack Screen from 26' to 31' bls
-30						

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-502s**

TOTAL DEPTH: **15'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Site Hydrogeologic Study**	DRILLING CO.: **Probe Technology, Inc.**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Adam Burnie**
JOB NO.: **17952-56960**	RIG TYPE: **GeoProbe 6610 DT**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Direct Push Sampler**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Direct Push**
DATE DRILLED: **May 1, 2007**	HAMMER WT./DROP **N/A**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		SAND: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, mottled, little fine sand. increasing sand content with depth.				Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.				1-inch Schedule 40 PVC riser and screen
						#2 Silica sand filter pack
-10						Screen from 5' to 15' bls
-15						

Notes:

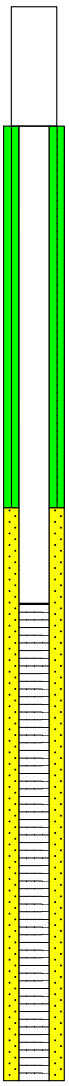
FIELD BOREHOLE LOG

BOREHOLE NO.: **B-503**

TOTAL DEPTH: **20'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 3, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.		3-6-5-3 (16")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.		2-2-2-2 (14")		2-inch Schedule 40 PVC riser and screen
-10		SILT: Wet, gray, trace very fine sand.		1-WOH (20")		#2 Silica sand filter pack
-15		SAND: Wet, gray, fine sand.		6-9-9-9 (14")		Screen from 10' to 20' bls
-20						



Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-503d**

TOTAL DEPTH: **50'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 3, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.		3-6-5-3 (16")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.		2-2-2-2 (14")		
-10		SILT: Wet, gray, trace very fine sand.		1-WOH (20")		2-inch Schedule 40 PVC riser and screen
-15		SAND: Wet, gray, fine sand.		6-9-9-9 (14")		
-20		SANDY SILT: Wet, gray, fine sand, trace clay.		1-2-1-2 (20")		
-25						Bentonite

Notes:

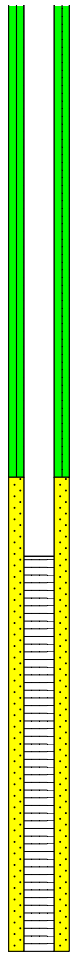
FIELD BOREHOLE LOG

BOREHOLE NO.: **B-503d**

TOTAL DEPTH: **50'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 3, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
-30		SAND: Wet, gray, fine to medium sand with shell fragments.		1-1-1-1 (22")		
-35				3-2-3-4 (22")		
-40				8-11-11-10 (16")		
-45				8-7-8-8 (20")		#2 Silica sand filter pack Screen from 40' to 50' bls
-50				5-4-3-4 (24")		



Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-504**

TOTAL DEPTH: **25'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 3, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.		6-6-3-4 (20")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.				#2 Silica sand filter pack
				1-1-1-1 (12")		
-10						2-inch Schedule 40 PVC riser and screen
		SILT: Wet, gray, trace very fine sand.		1-WOH (12")		
-15		SAND: Wet, gray, fine sand.				
				3-4-3-3 (20")		Screen from 5' to 25' bls
-20		SANDY SILT: Wet, gray, trace clay, some fine sand.		2-2-2-2 (20")		
-25						

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-505**

TOTAL DEPTH: **25'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 3, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.		1-1-1-3 (16")		Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.	Shelby Tube (2-4)	3-5-4-6 (20")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.				#2 Silica sand filter pack
				3-4-5-5 (20")		
-10						2-inch Schedule 40 PVC riser and screen
		SILT: Wet, gray, trace very fine sand.		1-1-1-2 (24")		
-15		SAND: Wet, gray, fine sand.				
				2-5-5-2 (20")		Screen from 5' to 25' bls
-20		SANDY SILT: Wet, gray, trace clay, some fine sand.				
		SAND: Wet, gray, fine sand. Some shell fragments, little silt.		2-3-4-6 (18")		
-25						

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-506**

TOTAL DEPTH: **20'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 2, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.		5-9-5-3 (16")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.		4-4-3-3 (18")		2-inch Schedule 40 PVC riser and screen
-10				2-2-3-2 (16")		#2 Silica sand filter pack
-15				3-6-4-5 (20")		Screen from 10' to 20' bls
-20		SANDY SILT: Wet, gray, fine sand, trace clay.				

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-506d**

TOTAL DEPTH: **50'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 2, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
0		TOPSOIL: Moist, brown, fine to medium sand, some silt, topsoil.				Locking, above-grade protective cover
		CLAY AND SILT: Moist to wet, gray, mottled, little fine sand. increasing sand content with depth.		5-9-5-3 (16")		Bentonite
-5		SAND: Wet, gray, fine to medium, trace silt.		4-4-3-3 (18")		
-10				2-2-3-2 (16")		2-inch Schedule 40 PVC riser and screen
-15				3-6-4-5 (20")		
-20		SANDY SILT: Wet, gray, fine sand, trace clay.	Shelby Tube (23-25)	2-2-2-2 (24")		
-25						

Notes:

FIELD BOREHOLE LOG

BOREHOLE NO.: **B-506d**

TOTAL DEPTH: **50'**

PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: **Cell 4 Expansion**	DRILLING CO.: **Fishburne Drilling**
SITE LOCATION: **Dare County C&D Landfill**	DRILLER: **Tim Donahue**
JOB NO.: **17952-56960**	RIG TYPE: **CME-550**
GEOLOGIST: **Dan Forbes**	METHOD OF DRILLING: **Mud-Rotary**
PROJECT MANAGER: **Mat Colone**	SAMPLING METHODS: **Standard Split Spoon**
DATE DRILLED: **September 2, 2008**	HAMMER WT./DROP **140 lb**

Depth	Soil Symbol	Soil Description	Sample	Blows/6" (recovery)	Boring Completion	Well Description
-25		SAND: Wet, gray, fine to medium sand with shell fragments.				Bentonite
				3-3-6-6 (24")		
-30						
				3-3-2-3 (20")		
-35						
				5-6-6-7 (22")		
-40						
				6-9-13-13 (20")		#2 Silica sand filter pack
-45						Screen from 40' to 50' bls
				3-2-3-4 (23")		
-50						

Notes:

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT – GROUNDWATER SECTION
P.O. BOX 27687 – RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc ___
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. ___

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR McCallum Testing Laboratories, Inc.

DRILLER REGISTRATION NUMBER 777

STATE WELL CONSTRUCTION PERMIT NUMBER: None Needed

1. WELL LOCATION: (Show sketch of the location below)

Nearest Town: Dare County, NC

County: _____

(Road, Community, or Subdivision and Lot No.)

2. OWNER Dare County

ADDRESS _____
(Street or Route No.)

City or Town _____ State _____ Zip Code _____

3. DATE DRILLED 11/29/94 USE OF WELL Monitoring

4. TOTAL DEPTH 20' CUTTINGS COLLECTED ☐ Yes ☒ No

5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No

6. STATIC WATER LEVEL: 4.6 FT. ☐ above ☐ below TOP OF CASING.

TOP OF CASING IS 2 FT. ABOVE LAND SURFACE.

7. YIELD (gpm): None Taken METHOD OF TEST _____

8. WATER ZONES (depth): 4.6 to 20

9. CHLORINATION: Type None Amount _____

10. CASING:

	Depth		Diameter	Wall Thickness or Weight/Ft.	Material
From 0	To 20	Ft.	2"	Sch.40	PVC
From	To	Ft.			
From	To	Ft.			

11. GROUT:

	Depth		Material	Method
From 2	To 8	Ft.	Neat Cement	
From	To	Ft.		

12. SCREEN:

	Depth		Diameter		Slot Size		Material
From 10	To 20	Ft.	2"	in.	#10	in.	PVC
From	To	Ft.		in.		in.	
From	To	Ft.		in.		in.	

13. GRAVEL PACK:

	Depth		Size	Material
From 8	To 20	Ft.	#2	Filter Sand
From	To	Ft.		

14. REMARKS: _____

Depth From	Depth To	DRILLING LOG Formation Description
		See Attached

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

GW-6

See Attached

I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

R. F. Martin

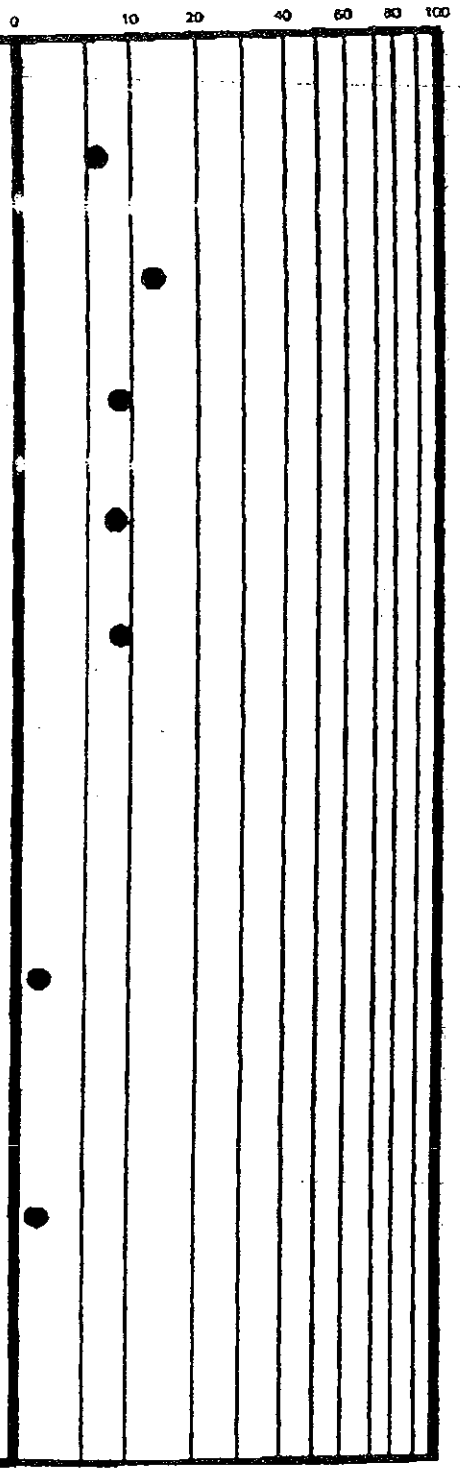
SIGNATURE OF CONTRACTOR OR AGENT DATE

GEOHYDRO

Test Boring Record

DEPTH (FEET)	SOIL DESCRIPTION	ELEV.
	Topsoil and organic silt (OH)	
1.5	Loose tan and gray silty fine sand (SM) with small roots	
	Firm gray silty fine sand (SM)	
	Loose dark gray silty fine sand (SM)	
	Loose dark gray slightly silty fine sand (SP-SM)	
	Loose dark gray silty fine sand (SM)	
	Very loose gray slightly silty fine sand (SP-SM)	
	Very loose dark gray slightly silty fine sand (SP-SM)	
20.0	BORING TERMINATED	

PENETRATION RESISTANCE (BLOWS PER FOOT)



Water Table 24 hr 4.6'

Water Table 1 hr. _____

Boring Number	GW-6
Date Drilled	11-29-94
Job Number	121-94-03160
Page 1 of 1	

NORTH CAROLINA DEPARTMENT OF NATURAL RESOURCES AND COMMUNITY DEVELOPMENT
DIVISION OF ENVIRONMENTAL MANAGEMENT – GROUNDWATER SECTION
P.O. BOX 27687 – RALEIGH, N.C. 27611, PHONE (919) 733-6083

FOR OFFICE USE ONLY
Quad. No. _____ Serial No. _____
Lat. _____ Long. _____ Pc _____
Minor Basin _____
Basin Code _____
Header Ent. _____ GW-1 Ent. _____

WELL CONSTRUCTION RECORD

DRILLING CONTRACTOR McCallum Testing Laboratories, Inc.

DRILLER REGISTRATION NUMBER 777

STATE WELL CONSTRUCTION PERMIT NUMBER: None Needed

1. WELL LOCATION: (Show sketch of the location below)

Nearest Town: Dare County, NC

(Road, Community, or Subdivision and Lot No.)

2. OWNER Dare County

ADDRESS _____
(Street or Route No.)

City or Town State Zip Code

3. DATE DRILLED 11/29/94 USE OF WELL Monitoring

4. TOTAL DEPTH 20 CUTTINGS COLLECTED ☐ Yes ☒ No

5. DOES WELL REPLACE EXISTING WELL? ☐ Yes ☒ No

6. STATIC WATER LEVEL: 4.0 FT. ☐ above ☐ below TOP OF CASING.
TOP OF CASING IS 2 FT. ABOVE LAND SURFACE.

7. YIELD (gpm): None Taken METHOD OF TEST _____

8. WATER ZONES (depth): 4 to 20

9. CHLORINATION: Type None Amount _____

10. CASING:

	Depth From	Depth To	Diameter	Wall Thickness or Weight/Ft.	Material
	0	20	2"	SCH.40	PVC

11. GROUT:

	Depth From	Depth To	Material	Method
	7	8	Neat Cement	

12. SCREEN:

	Depth From	Depth To	Diameter	Slot Size	Material
	10	20	2"	#10	PVC

13. GRAVEL PACK:

	Depth From	Depth To	Size	Material
	8	20	#2	Filter Sand

14. REMARKS: _____

DRILLING LOG

Depth From	Depth To	Formation Description
		See Attached

If additional space is needed use back of form.

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)

GW-7

See Attached

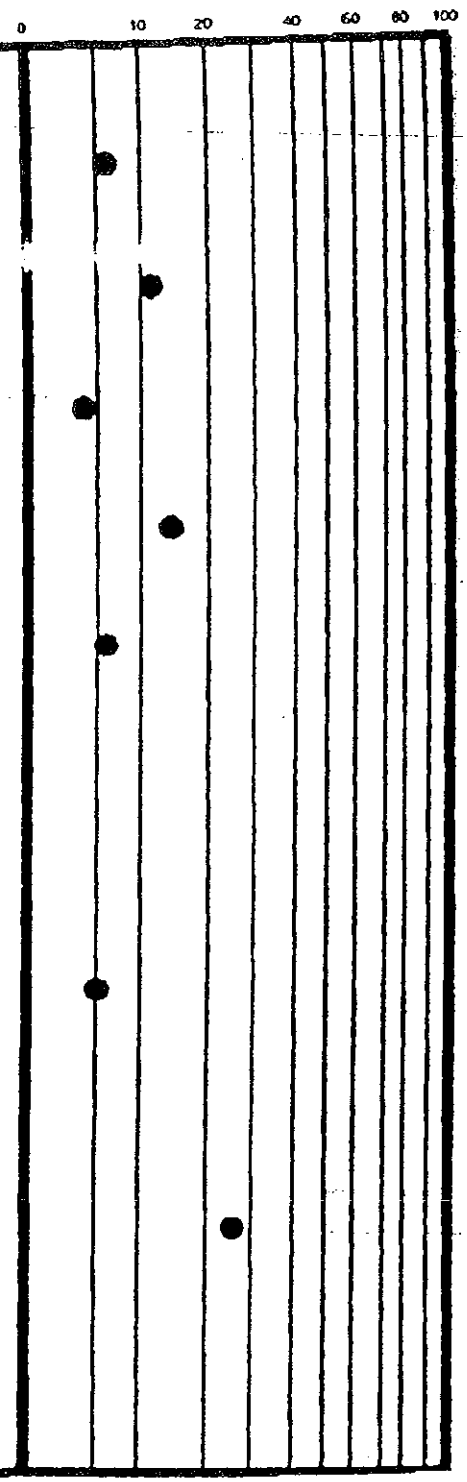
I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15 NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

R. F. Martin
SIGNATURE OF CONTRACTOR OR AGENT DATE

GEOHYDRO

Test Boring Record

DEPTH (FEET)	SOIL DESCRIPTION	ELEV.
	Firm dark brown silt (OH) with small roots	
2.0		
	Loose dark gray silty fine sand (SM)	
	Firm gray slightly silty fine sand (SP-SM)	
	Loose gray slightly silty fine sand (SP-SM)	
	Loose dark gray silty fine sand (SM)	
	Very firm dark gray silty fine sand (SM)	
20.0	BORING TERMINATED	



Water Table 24 hr 4.0'

Water Table 1 hr. _____

Boring Number	GW-7
Date Drilled	11-29-94
Job Number	121-94-03160
Page 1 of 1	

GW-10

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section
1636 Mail Service Center - Raleigh, N.C. 27699-1636-Phone (919) 733-3221

WELL CONSTRUCTION RECORD

WELL CONTRACTOR: Jeffrey C. Garrett
WELL CONTRACTOR CERTIFICATION #: 3138
STATE WELL CONSTRUCTION PERMIT#:

1. WELL USE (Check Applicable Box): Residential ☐ Municipal ☐ Industrial ☐ Agricultural ☐ Monitoring ☒
Recovery ☐ Heat Pump Water Injection ☐ Other ☐ If Other, List Use:

2. WELL LOCATION: (Show sketch of the location below)
Nearest Town: Manns Harbor County: Dare
Dare County Transfer Station US 264
(Road Name and Numbers, Community, or Subdivision and Lot No.)

3. OWNER Terra Tech
Address
(Street or Route No.)
City or Town State Zip Code

4. DATE DRILLED 8-13-02
5. TOTAL DEPTH 20 ft
6. CUTTINGS COLLECTED YES ☒ NO ☐
7. DOES WELL REPLACE EXISTING WELL? YES ☒ NO ☐
8. STATIC WATER LEVEL Below Top of Casing: 4.5 FT.
(Use "+" If Above Top of Casing)
9. TOP OF CASING IS 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118
10. YIELD (gpm): — METHOD OF TEST
11. WATER ZONES (depth): 5.3 20.0 TOB
4.5 24 HR
12. CHLORINATION: Type — Amount

DRILLING LOG From	To	DEPTH Formation Description
0	3.3	Tan Fine Sandy Clay
3.3	7.1	Grey Fine silty sandy clay
7.1	20.0	Grey Fine silty sand

If additional space is needed use back of form

13. CASING:

	Depth From	To	Ft.	Diameter	Wall Thickness or Weight/Ft.	Material
	3.0	+3.0		2"	4	PVC
				2"	4	PVC

14. GROUT:

	Depth From	To	Ft.	Material	Method
	1.0	SURFACE		Portland	Pour

15. SCREEN:

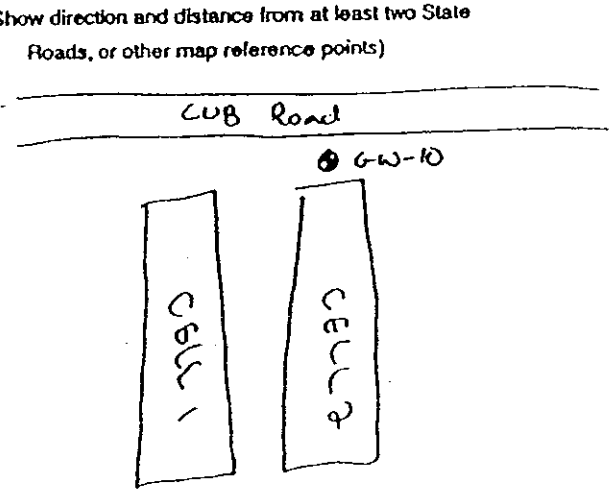
	Depth From	To	Ft.	Diameter	In.	Slot Size	In.	Material
	20	30		2"		010		PVC

16. SAND/GRAVEL PACK:

	Depth From	To	Ft.	Size	Material
	20.0	2.0		A-1	Silica Sand

17. REMARKS: BENT SEAL 2.0 - 1.0

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)



I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

Jeffrey C. Garrett 8-15-02
SIGNATURE OF PERSON CONSTRUCTING THE WELL DATE

Submit original to Division of Water Quality, Groundwater Section within 30 days

FOR OFFICE USE ONLY
Quad No.
Serial No.

GW-1 REV. 12/99

North Carolina - Department of Environment and Natural Resources - Division of Water Quality - Groundwater Section
1636 Mail Service Center - Raleigh, N.C. 27699-1636-Phone (919) 733-3221

WELL CONSTRUCTION RECORD

WELL CONTRACTOR: Jeffrey L. Garrett
WELL CONTRACTOR CERTIFICATION #: 5138
STATE WELL CONSTRUCTION PERMIT#:

1. WELL USE (Check Applicable Box): Residential ☐ Municipal ☐ Industrial ☐ Agricultural ☐ Monitoring ☒
Recovery ☐ Heat Pump Water Injection ☐ Other ☐ If Other, List Use:

2. WELL LOCATION: (Show sketch of the location below)
Nearest Town: Manns Harbor County: Dare
Dare County Transfer Station US264
(Road Name and Numbers, Community, or Subdivision and Lot No.)

3. OWNER Terra Tech
Address
(Street or Route No.)
City or Town State Zip Code

4. DATE DRILLED 8-12-02
5. TOTAL DEPTH 20 ft
6. CUTTINGS COLLECTED YES ☒ NO ☐
7. DOES WELL REPLACE EXISTING WELL? YES ☒ NO ☐
8. STATIC WATER LEVEL Below Top of Casing: 4.3 FT.
(Use "+" if Above Top of Casing)
9. TOP OF CASING IS 3 FT. Above Land Surface*
*Top of casing terminated at/or below land surface requires a variance in accordance with 15A NCAC 2C .0118
10. YIELD (gpm): — METHOD OF TEST
11. WATER ZONES (depth): —
12. CHLORINATION: Type — Amount

DRILLING LOG From	To	DEPTH Formation Description
0	30	Tan Fn sandy clay
3.0	6.4	Grey Fn silty Sand
6.4	20.0	Grey Fine silty Sand

If additional space is needed use back of form

13. CASING:

	Depth From	To	Diameter	Wall Thickness or Weight/FL	Material
	2.0	30	2"	40	PVC
			2"	40	PVC

14. GROUT:

	Depth From	To	Material	Method
	1.0	SURFACE	Portland	Pour

15. SCREEN:

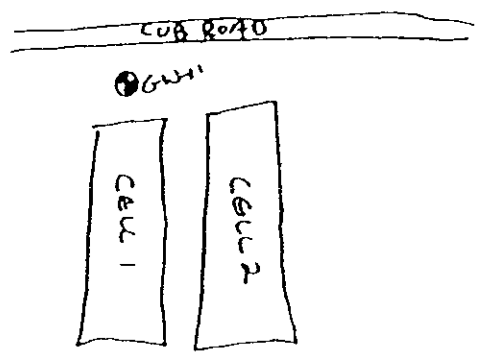
	Depth From	To	Diameter	Slot Size	Material
	20	30	2"	.010	PVC

16. SAND/GRAVEL PACK:

	Depth From	To	Size	Material
	20.0	20	A-1	Silica Sand

17. REMARKS: BENT SEAL 2.0 - 1.0

LOCATION SKETCH
(Show direction and distance from at least two State Roads, or other map reference points)



I DO HEREBY CERTIFY THAT THIS WELL WAS CONSTRUCTED IN ACCORDANCE WITH 15A NCAC 2C, WELL CONSTRUCTION STANDARDS, AND THAT A COPY OF THIS RECORD HAS BEEN PROVIDED TO THE WELL OWNER.

SIGNATURE OF PERSON CONSTRUCTING THE WELL — DATE 8-15-02

Submit original to Division of Water Quality, Groundwater Section within 30 days

FOR OFFICE USE ONLY
Quad No:
Serial No.

GW-1 REV. 12/99

Appendix B
Field Notes

5/1/07 78° Sunny

1015 - Forbes onsite to install additional piezometers and to collect water levels from existing wells. Check in with Sajic of CDM. Fishburne Drilling only has 8 shelby tubes that are intended to be used for the Geotechnical investigation. Informed Sajic of the depths we would like Shelby Tubes to be collected from. Sajic will attempt to collect tubes for us but has already completed drilling in Phase IV.

1100 - Review site. Estimate piezometer locations.

1130 - Probe Technology onsite.

Driller - Adam Burnie

Helper - TR White

Rig - Geoprobe 6610 DT

1200 - Mob to GW-16.

GW-16: Phase IV - Renumbered B-401

Depth		Description
0 - 2.5		Moist, black/gray, fine SAND with some SILT brown
2.5 - 4.0	H_2O(±) 3.5ft	SAA with a trace of SILT/wet
4.0 - 5.0		Moist/wet mottled orange/gray/black CLAY with a little SILT and a trace/little of fine SAND
5.0 - 7.0		Wet, gray/black, fine to med SAND with a little black CLAY and a little SILT
7.0 - 10.0		Wet, gray, fine to med SAND, little SILT

5/1/07 86° Sunny

GW-16 Continued

Depth	Description
10-12	Wet, black, gray, SILTY SAND with some mottled (orange/gray) CLAY
12-15	Wet, gray, Fine to med SAND, trace SILT

Terminate boring at 15ft.

GW-16 15-5 → Screen
3-15 → Sand
0-3 → Bentonite

1240 - Mob to GW-17s

GW-17s Phase IV **Renamed B-402s**

Depth	Description
0-2	Moist, black, gray, brown, Fine to med SAND, (±) 4-inches of wood in bottom of sleeve. Recovery = 2ft
2-5	- Will get from adjacent boring
5-7	H_2O(±) 5.5 ft Wet, gray/black, Fine to med SAND/SILT
7-10	Wet, gray/black, mottled (gray/orange) SILTY/SANDY CLAY grading to a SILTY CLAY grading to a fine SANDY/SILT with a little CLAY
10-15	- ~~[illegible]~~ Wet, gray, SILTY Fine SAND grading to a Fine SAND

Terminate boring at 15ft.

5/1/07 86° Sunny

1300 - Set up on GW-17

GW-17 15-5 → Screen
3-15 → Sand
0-3 → Bentonite

GW-17 Phase IV **Renamed B-402**

Depth	Description
0-2	SA GW-17s
2-5	Moist, black, gray, Fine to med SAND with a little SILT
H_2O(±) 5.5ft	
5-10	SA GW-17s H_2O (±) 6.5 ft
10-15	SA GW-17s
15-20	Wet, gray, fine to med SAND
20-25	SAA
25-30	No Recovery (very wet)

Terminate boring at 31ft.

GW-17 31-26 → Screen
24-31 → Sand
0-24 → Bentonite

5/1/07 89° Sunny

1350 - Mob to GW-18

GW-18 Phase IV **Renamed B-403**

Depth	Description
0-4	Moist, black, gray, brown Fine to med SAND with a little SILT, trace shell Fragments
4-5	SAA with some dark gray SILTY CLAY
5-7 H_2O(±) 6.5Ft	Wet, gray, brown, orange, black, Fine to med SAND with some SILT
7-9	Wet, gray, fine to med SAND with a trace of SILT
9-10	Wet, gray, black, SILTY CLAY/CLAYEY SILT
10-15	(±) 3Ft recovery - Wet, gray, little olive green near 11Ft, Fine to med SAND, trace SILT

Terminate boring at 15Ft

GW-18
15 - 5 → Screen
3 - 15 → Sand
0 - 3 → Bentonite

1450 - Mob to GW-19

5/1/07 93° Sunny

GW-19 Phase IV **Renamed B-404**

Depth		Description
0-2		Moist, brown, Fine to med SAND with a little SILT
2-5		Moist, black, gray, fine to med SAND with some SILT
5-7	H_2O(±) 6Ft	SAA with a trace of CLAY near 7Ft
7-10		Wet, gray/black SILTY/SANDY CLAY grading to a SILTY CLAY with a little Fine SAND grading to a fine to med SAND (± 3 inches) with a trace OF SILT
10-13		Wet, gray/blue gray/olive green, Fine to med SAND with a trace of shell Fragments
13-15		SAA but gray in color

Terminate boring at 15Ft

GW-19
15 - 5 → Screen
3 - 15 → Sand
0 - 3 → Bentonite

1520 - Mob to GW-20

5/1/07 93° Sunny

GW-20 Phase IV **Renamed B-405**

Depth	Description
0-2	Moist, brown, Fine to med SAND with a trace of CLAY and SILT
2-2.5	Moist, gray, Fine to med SAND with shell Fragments
2.5-5 H_2O(±) 5.5 Ft	Wood particles, granular to pebble size rock fragments, little Fine SAND and SILT
5-7	SAA above / mainly wood
7-10	Wet, gray/black, mottled (gray/orange) SILTY/SANDY CLAY grading to a SILTY CLAY/CLAY grading to Fine to med SAND with a trace of SILT (±) [redacted] of CLAYEY material at 7 Ft
10-15	Wet, gray, black, Fine to med SAND

Terminate boring at 15 Ft

GW-20
15-5 → Screen
3-15 → Sand
0-3 → Bentonite

1540 - Mob to GW-21. Complete drilling in Phase IV area. Begin drilling in Phase V

5/1/07 93° Sunny

GW-21 Phase V **Renamed B-501**

Depth	Description
0-1	Brown Topsoil
1-4 H_2O(±) 3 Ft	Moist, mottled (gray/orange) dark brown SILTY CLAY/CLAYEY SILT with a little Fine SAND grading to more SAND with depth
5-15	Wet, gray, Fine to med SAND

Terminate boring at 15 Ft

GW-21
15-5 → Screen
3-15 → Sand
0-3 → Bentonite

- Mob to GW-22

GW-22 Phase V **Renamed B-502**

Depth	Description
0-1	Brown Topsoil
1-4.5 H_2O(±) 3 Ft	Moist, mottled (gray/orange) dark brown, SILTY CLAY/CLAYEY SILT with a [redacted] Fine SAND grading to more SAND with depth
4.5-18	Wet, gray, fine to med SAND
18-25	Wet, gray, Fine to med SAND with [redacted] SILT and some shell Frags.
25-30	Wet, gray, Fine SAND and SILT, little shell Fragments

5/1/07 93° Sunny

GW-22 Continued

GW-22 31 - 26 → Screen
24 - 31 → Sand
0 - 24 → Bentonite

Terminated boring at 31 ft.

Renamed B-502S

GW-22 shallow 15 - 5 → Screen
H_2O(±) 3 ft 3 - 15 → Sand
0 - 3 → Bentonite

1700 - Mob rig to GW-23 location / Phase VIII
1730 - Forbes / Drill Crew offsite

5/2/07 72° Sunny/Windy

0715 - Forbes onsite. Begin collecting water levels.

Access Rd — Phase VIII — N — Scale House

GW-13 5.06 · GW-14 4.93 · GW-15 5.03

Loc	DTW	Rename	Loc	DTW
GW-8	3.23	B-501	~~GW-21~~	4.79
GW-1	2.86	B-502S	~~GW-22S~~	4.55
GW-2	3.45	B-502	~~GW-22~~	4.41
GW-3	5.09	B-405	~~GW-20~~	8.95
GW-11	5.72	B-404	~~GW-19~~	9.63
GW-12	5.15	B-801	~~GW-23~~	4.51
GW-10	5.92	B-802	~~GW-24~~	4.74
GW-9	5.41	B-803	~~GW-25~~	4.40
GW-6	4.86	B-403	~~GW-18~~	10.05
GW-7	3.88	B-402S	~~GW-17S~~	7.29
		B-402	~~GW-17~~	10.32
		B-401	~~GW-16~~	6.48

5/2/07 72° Sunny / Windy

0800 - Drill crew onsite. Set up to install GW-23.

GW-23 Phase VIII **Renamed B-801**

Depth	Description
0 - 1.5	Moist, brown, SILTY SAND, TOPSOIL, little granular rock Frass.
1.5 - 5 H_2O (±) 2.5 ft	Moist, wet dark brown / black, gray, mottled (orange/gray) SANDY SILT with some CLAY
5 - 7	SAA, wet
7 - 15	Wet, gray, Fine to med SAND with traces of SILT from 7 to 9 ft

Terminate boring at 15 ft

GW-23
15 - 5 → Screen
3 - 15 → Sand
0 - 3 → Bentonite

0830 - Mob to GW-24

GW-24 Phase VIII **Renamed B-802**

Depth	Description
0 - 2	Moist, brown, SILTY SAND, TOPSOIL
2 - 4.5	Moist, dark brown / black / gray, mottled (orange/gray) SANDY SILT / SILTY SAND with a little CLAY
4.5 - 15	Wet, gray, Fine to med SAND, little brown SAND at 4.5 to 6 ft, little SILT from 11 to 13 ft

5/2/07 72° Sunny/Windy

GW-24 Continued

Terminate boring at 15 ft

GW-24
15 - 5 → Screen
3 - 15 → Sand
0 - 3 → Bentonite

0855 - Mob to GW-25

GW-25 Phase VIII **Renamed B-803**

Depth	Description
0 - 2.5	Moist, brown, SILTY SAND, TOPSOIL
2.5 - 4 H_2O (±) 2.5 ft	Moist, wet dark brown / black, gray, mottled (orange/gray) SANDY SILT / SILTY SAND with a little CLAY
4 - 15	Wet, gray, Fine to med SAND, some brown SAND at 4 to 5.5 ft, little SILTY Fran, 12 to 13 ft.

Terminate boring at 15 ft

GW-25
15 - 5 → Screen
3 - 15 → Sand
0 - 3 → Bentonite

0930 - Drill crew begins installing 4-inch PVC wells on the 1-inch Piezometers

5/2/07 79° Sunny/Windy

1100 - Drill Crew offsite

1120 - Complete collecting water levels. Mark all the newly installed wells on the outside and inside of the 4-inch protective cover. Gave Dolphin lock keys to the attendant in the guard shack near Cell 3. All existing wells now have Dolphin locks. Ran out of Dolphin locks. GW-18 and GW 17 shallow are not locked.

1130 - Offsite

6/7/07 87° Sunny

1045 - Forbes onsite to collect water levels

Loc	DTW	Comments
GW-1	1.97	
GW-2	2.32	
GW-3	3.59	
B-403 ~~GW-18~~	—	Unable to bend open to insert probe. PVC broken from ground surface. (2) 3-inches in ground
B-402 ~~GW-17~~	6.95	PVC is flush with ground surface
B-402S ~~GW-17S~~	3.68	2.1" stick-up
B-401 ~~GW-16~~	3.60	3.0" stick-up
GW-11	4.41	
GW-12	3.94	
GW-10	5.11	
GW-9	4.19	
B-501 ~~GW-21~~	3.65	Top of casing
B-502 ~~GW-22~~	1.15	PVC is flush with ground surface
B-502S ~~GW-22S~~	0.85	PVC is flush with ground surface. Mud covering GW-22S
GW-6	3.76	
GW-7	2.95	
B-405 ~~GW-20~~	7.79	2.2" stick-up
B-404 ~~GW-19~~	9.28	
GW-8	2.94	
B-801 ~~GW-23~~	1.08	2.3" stick-up
B-802 ~~GW-24~~	1.12	4.4" stick-up
GW-13	3.52	
GW-14	3.51	
GW-15	3.42	
~~GW-25~~ B-803	0.68	2.5" stick-up

- 1300 offsite

9/2/08 78° Sunny

0950 - Forbes onsite to install monitoring wells for CTD landfill expansion. Check well locations while waiting for drill crew. Toby with the landfill said we could use the water at the scale house for drilling

1050 - Drill crew onsite. Unload rig and set up to begin drilling

Drilling Specs

Driller - Tim Donahue
Helper - Tim Foster
Company - Fishburne Contract Drilling Services
Rig - CME 550
Drill Method - Mud Rotary
- 3-inch roller cone / tricone

1200 - Set up on B-506 D

Depth	Blows	Rec	Description
3-5	5-9-5-3	16	- Moist/Wet, gray, fine silty SAND with a trace of clay at (±) 5 ft
H_2O (±) 2 Ft			
8-10	4-4-3-3	18	- Wet, gray, fine SAND,
13-15	2-2-3-2	16	- SAA

9/2/08 88° Sunny

B-506 D Continued

Depth	Blows	Rec	Description
18-20	3-6-4-5	20	- 18-19 Wet, gray, silty fine SAND with a little shell frags - 19-20 SANDY SILT with a trace of CLAY
23-25	2-2-2-2	24	- Wet, gray, silt with some CLAY to a SILTY CLAY trace to a little fine SAND from 23-(±) 24 Ft
28-30	3-3-6-6	24	- Wet, gray, fine SAND shell frags throughout
33-35	3-3-2-3	20	- SAA
38-40	5-6-6-7	22	- SAA
43-45	6-9-13-13	20	- SAA
48-50	3-2-3-4	23	- Wet, gray, SILTY fine SAND, trace CLAY @ (±) 49 ft, shell frags throughout

- Terminate boring @ 50 ft

9/2/08 88° Sunny

B-506D
50-40 → Screen
38-50 → Sand
0-38 → Bentonite

GPS: N3966218 E 1842601l <±13 Ft Accuracy

B-506
20-10 → Screen
8-20 → Sand
0-8 → Bentonite

- Collect shelby tube from 23-25 Ft
  - Wax and seal after collecting the tube

1600 - Install pro covers and pads
1700 - CDM / Drill crew offsite.

Daniel Fabes

9/3/08 72° Sunny

0805 - Forbes onsite. Drill crew onsite at 0750. Began developing B-506 and 506D. Pump tubing is not long enough to reach bottom of 506D. Drill crew will get more tubing to complete development of 506D tonight.

0850 - Set-up on 503D

Depth	Blows	Rec	Description
3-5	3-6-5-3	16	Moist, wet, brown to gray, silty sand, trace CLAY, mottled orange/gray
8-10	2-2-2-2	14	Wet, gray, fine SAND
13-15	1 - Weight of Hammer	20	Wet, gray, CLAYEY SILT, little fine SAND
18-20	6-9-9-9	14	Wet, gray, fine SAND
23-25	1-2-1-2	20	Wet, gray, SILT with some CLAY and fine SAND, shell frags
28-30	1-1-1-1	22	Wet, gray, SILTY CLAY, trace fine SAND, shell frags
33-35	3-2-3-4	22	Wet, gray, fine SAND with shell frags throughout

9/3/08

B-505 84° Sunny

Depth	Blows	Rec	Description
0-2	1-1-1-3	16	Moist, dark brown, organic TOPSOIL dark brown SILT with some CLAY at bottom of spoon.
3-5	3-5-4-6	20	Moist, Wet, brown to gray, SILTY SAND, mottled orange/gray, grading to a fine gray SAND with a little silt at (±) 4.5 Ft.
8-10	3-4-5-5	20	Wet, gray, fine SAND
13-15	1-1-1-2	24	Wet, gray, SILT with some CLAY and fine SAND grading to a fine SAND at (±) 13.75 Ft
18-20	2-5-5-2	20	Wet, gray, fine SAND with some SILT and shell frags to 19.5 Ft. 19.5-20 Ft Wet, gray, SILT with a trace of CLAY and some fine SAND
23-25	2-3-4-6	18	Wet, gray, fine SAND with some silt, shell frags

Terminate boring @ 25 Ft.

GPS: N 3965862 E 1842076 (±) 26 Ft Accuracy

- Install pad and cover

9/3/08 88° Sunny

B-505

25-5 → Screen
3-25 → Sand
0-3 → Bentonite

- Pulled rig up (±) 5 Ft to collect shelby tube from 2-4 Ft. Recovery (±) 1.5 Ft

1425- Mob to B-504. Stop by crew rehabing GW-9. No glue/cement was used. According to them, they removed PVC / No screen

B-504

Depth	Blows	Rec	Description
3-5	6-6-3-4	20	Moist/Wet, brown to gray, Fine SILTY SAND grading to a fine SAND with a little SILT Mottled orange/gray to (±) 4 Ft
8-10	1-1-1-1	12	Wet, gray, Fine SAND, trace SILT
13-15	1 - Weight of Hammer	12	Wet, gray, SILT with a little CLAY and fine SAND
18-20	3-4-3-3	20	Wet, gray, SILTY SAND, trace CLAY, shell frags

9/3/08 92° Sunny

B-504 Continued

Depth	Blows	Rec	Description
23-25	2-2-2-2	2s	Wet, gray SILT with a little fine SAND and CLAY

Terminate boring @ 25 Ft.

B-504

25-5 → Screen
3-25 → Sand
0-3 → Bentonite

GPS: N 3965749 E 1842603 (±) 13 Ft Accuracy

- Install pad and cover
- Way and seal shelby tube from B-505

1630 - Drill Crew / CDM offsite.

Dave Forbes

9/4/08 74° Sunny

0820 - Forbes onsite. Drill crew already onsite developing wells. Set up to slug test B-506

B-506

0855 - Slug In 0917 - Stop Test
- Slug Out - Stop Test

* Cable came off laptop while pulling the slug for the slug out test

B-506 D

0932 - Slug In 0946 - Stop Test
0947 - Slug Out 1005 - Stop Test

B-503

1020 - Slug In 1053 - Stop Test
1054 - Slug Out 1112 - Stop Test

B-503 D

1115 - Slug In 1144 - Stop Test
1145 - Slug Out 1205 - Stop Test

B-505

1215 - Slug In 1240 - Stop Test
1242 - Slug Out 1255 - Stop Test

9/4/08 76° Sunny

Water Levels

Loc	DTW	
B-504	4.34	
B-505	5.32	
B-506	3.11	
B-506D	3.31	
B-503	5.28	
B-503D	5.61	
GW-8	3.12	
GW-9	6.96	TD = 17.98
GW-15	4.73	
GW-14	4.48	
GW-13	4.24	
GW-10	5.55	
GW-11	5.26	- Procover is bent
GW-6	4.55	
GW-7	3.49	
GW-12	4.58	- Lid open / cap on ground
GW-3	4.53	
GW-2	2.96	
GW-1	2.35	

1320 - Offsite

10/8/08 78° Sunny

1115 - Forbes onsite to collect water levels from existing and newly installed wells

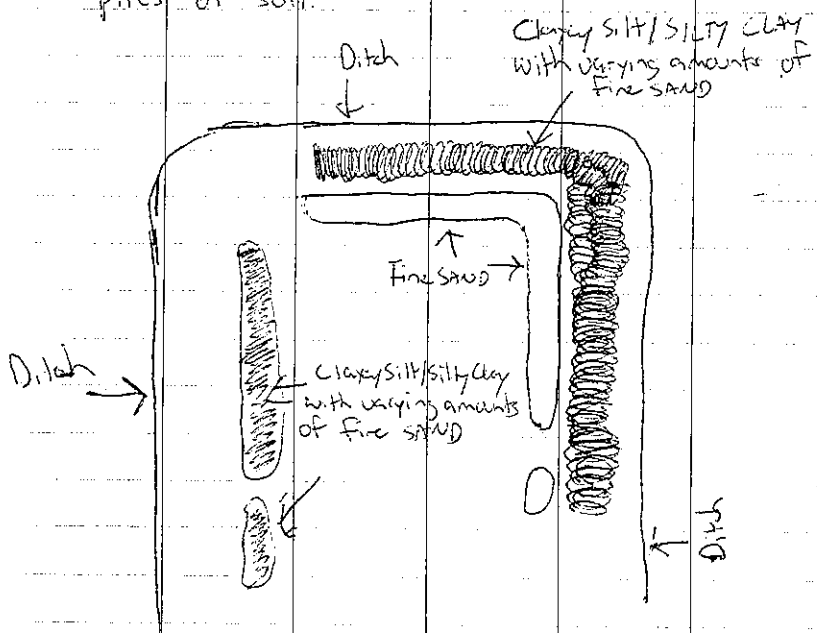
Loc	DTW
GW-8	3.17
506-D	(DF) ~~3.16~~ 3.13
506	3.12
GW-13	4.10
GW-14	4.14
GW-15	4.31
503	5.09
503D	5.48
GW-6	4.41
GW-7	3.51
505	5.05
GW-10	5.76
GW-9	6.19
504	4.12
GW-11	5.57
GW-12	4.56
GW-3	4.41
GW-2	3.07
GW-1	2.37

1315 - Offsite

10/20/08 62° Sunny

1030 - Forbes onsite to collect water levels and to inspect borrow pit.

1035 - Met Glenn with DARE County. Proceed to borrow pit. County has segregated several piles of soil.



- Shaded areas are clayey silt and fine sand removed from the ditch. According to Glenn the pit is excavated to (±) 22 ft below original grade. The silty clay / clayey silt with fine sand is similar to the soil encountered during the well installation for the Phase 4 CD expansion at 23-25 ft. The County will seperate the clayey material from the sand and will stockpile the

10/20/08 62° Sunny

clayey material for the next expansion. Showed Glenn how to determine if the material has enough clay content to stockpile. Glenn is currently the only operator working in the pit and will inspect the excavator buckets for clay content while in the pit. If there is any material that is questionable the County will stockpile it until CDM is onsite again to inspect. Gave Glenn my number and told him to call if he had any questions.

1145 - Proceed to collect water levels

Loc	DTW
GW-1	2.21
GW-2	2.90
GW-3	4.24
GW-6	4.18
GW-7	3.28
GW-8	3.11
GW-9	6.60
GW-10	5.71
GW-11	5.69
GW-12	4.31
GW-13	3.87
GW-14	3.95
GW-15	4.05

Loc	DTW
503	5.03
503D	5.55
504	4.09
505	4.86
506	3.12
506D	3.11

1240 - offsite

Appendix C
Geotechnical Lab Data

Geotechnics

.....GEOTECHNICAL, GEOENVIRONMENTAL, AND GEOSYNTHETIC LABORATORIES

September 18, 2008

Project No. 2008-628-01

Mr. Mat Colone
CDM
5400 Glenwood Ave., Suite 300
Raleigh, NC 27612

Transmittal
Laboratory Test Results
Dare County C & D Landfill Expansion

Please find attached the laboratory test results for the above referenced project. The tests were outlined on the Project Verification Form that was faxed to your firm prior to the testing. The testing was performed in general accordance with the methods listed on the enclosed data sheets. The test results are believed to be representative of the samples that were submitted for testing and are indicative only of the specimens which were evaluated. We have no direct knowledge of the origin of the samples and imply no position with regard to the nature of the test results, i.e. pass/fail and no claims as to the suitability of the material for its intended use.

The test data and all associated project information provided shall be held in strict confidence and disclosed to other parties only with authorization by our Client. The test data submitted herein is considered integral with this report and is not to be reproduced except in whole and only with the authorization of the Client and Geotechnics. The remaining sample materials for this project will be retained for a minimum of 90 days as directed by the Geotechnics' Quality Program.

We are pleased to provide these testing services. Should you have any questions or if we may be of further assistance, please contact our office.

Respectively submitted,
Geotechnics, Inc.

Michael P. Smith
Regional Manager

We understand that you have a choice in your laboratory services and we thank you for choosing Geotechnics.

DCN: Data Transmittal Letter Date: 1 28 05 Rev.: 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

MOISTURE CONTENT

ASTM D 2216 (SOP-S1)

Client	CDM
Client Reference	DARE CO. C&D LF EXPANSION
Project No.	2008-628-01

Lab ID	.001	.002	.003	.004	.005
Boring No.	9/3	9/3	9/3	9/3	9/3
Depth (ft)	28-30	43-45	13-15	18-20	3-5
Sample No.	B-503D	B-503D	B-504	B-504	B-505
Tare Number	P-1	U-1	C-2	M-1	K-1
Wt. of Tare & WS (gm)	32.79	48.57	37.17	42.4	44.97
Wt. of Tare & DS (gm)	27.81	44.01	32.22	38.38	40.01
Wt. of Tare (gm)	15.74	21.87	15.63	22.1	22.01
Wt. of Water (gm)	4.98	4.56	4.95	4.02	4.96
Wt. of DS (gm)	12.07	22.14	16.59	16.28	18
Water Content (%)	**41.3**	**20.6**	**29.8**	**24.7**	**27.6**

Lab ID	.006	.007	.008	.009	.010
Boring No.	9/3/08	9/2	9/2	9/2	9/3/08
Depth (ft)	8-10	38-40	48-50	23-25	2-4
Sample No.	B-505	B-506D	B-506D	B-506	B-505
Tare Number	E-2	F-1	N-1	Z-12	SS-4
Wt. of Tare & WS (gm)	51.45	55.93	53.54	465.19	374.03
Wt. of Tare & DS (gm)	44.95	49.85	47.07	371.05	319.78
Wt. of Tare (gm)	21.9	21.97	21.87	99.3	100.15
Wt. of Water (gm)	6.5	6.08	6.47	94.14	54.25
Wt. of DS (gm)	23.05	27.88	25.2	271.75	219.63
Water Content (%)	**28.2**	**21.8**	**25.7**	**34.6**	**24.7**

Notes : *NA*

Tested By *SD* *Date* *9/15/2008* *Checked By* GLM *Date* 9-18-08

DCN: CT-S1 DATE 6-30-98 REVISION: 2

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INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-05 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	28-30
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-01	Soil Description	**DARK GRAY LEAN CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

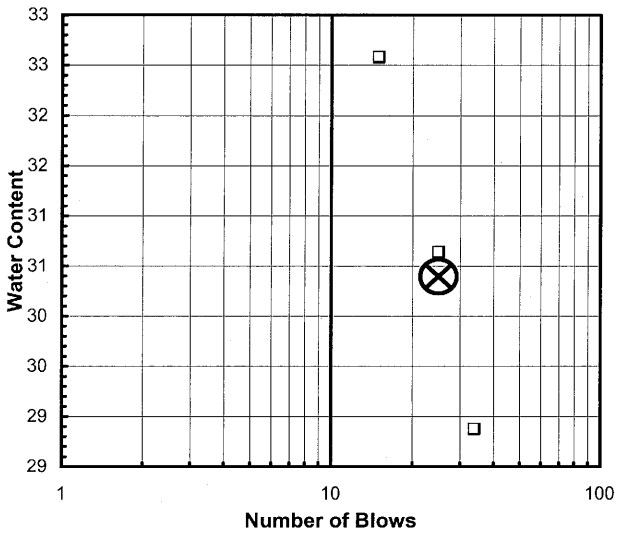
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-H	A-O	A-P	MULTIPOINT
Wt. of Tare & WS (gm)	25.49	27.56	27.81	
Wt. of Tare & DS (gm)	23.05	24.72	25.07	
Wt. of Tare (gm)	15.56	15.45	15.58	
Wt. of Water (gm)	2.4	2.8	2.7	
Wt. of DS (gm)	7.5	9.3	9.5	
Moisture Content (%)	**32.6**	**30.6**	**28.9**	
Number of Blows	**15**	**25**	**34**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	K-A	A-D	
Wt. of Tare & WS (gm)	22.63	21.70	
Wt. of Tare & DS (gm)	21.57	20.77	
Wt. of Tare (gm)	15.50	15.40	
Wt. of Water (gm)	1.1	0.9	
Wt. of DS (gm)	6.1	5.4	
Moisture Content (%)	**17.5**	**17.3**	**0.1**

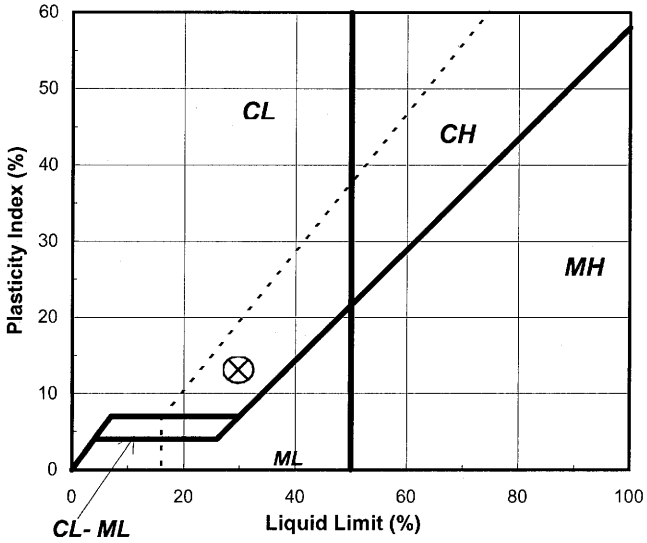
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**30**
Plastic Limit (%)	**17**
Plasticity Index (%)	**13**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



Tested By SD *Date* 9/16/2008 *Checked By* GEM *Date* 9-17-08

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	43-45
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-02	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GEM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	13-15
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-03	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GAN *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMITS

ASTM D 4318-05 / AASHTO T89 (SOP - S4A)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	18-20
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-04	Soil Description	**GRAY SILT**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

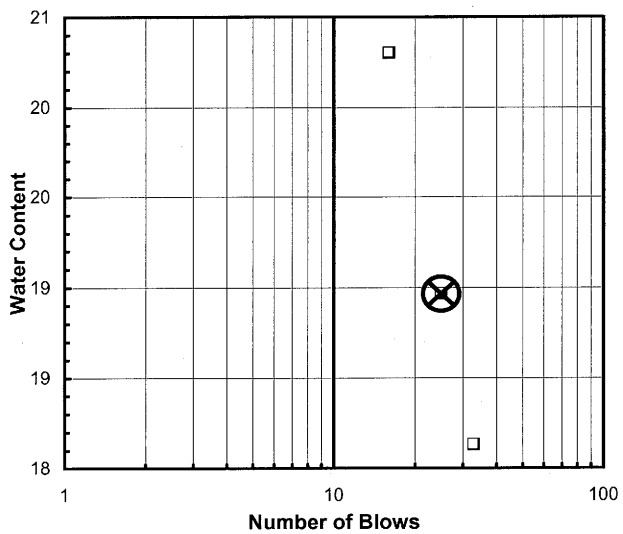
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	A-Q	A-F	A-K	MULTIPOINT
Wt. of Tare & WS (gm)	29.92	29.28	30.34	
Wt. of Tare & DS (gm)	27.49	27.08	28.07	
Wt. of Tare (gm)	15.52	15.48	15.55	
Wt. of Water (gm)	2.4	2.2	2.3	
Wt. of DS (gm)	12.0	11.6	12.5	
Moisture Content (%)	**20.3**	**19.0**	**18.1**	
Number of Blows	**16**	**25**	**33**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-T	B-B	
Wt. of Tare & WS (gm)	21.97	22.14	
Wt. of Tare & DS (gm)	21.04	21.20	
Wt. of Tare (gm)	15.60	15.54	
Wt. of Water (gm)	0.9	0.9	
Wt. of DS (gm)	5.4	5.7	
Moisture Content (%)	**17.1**	**16.6**	**0.5**

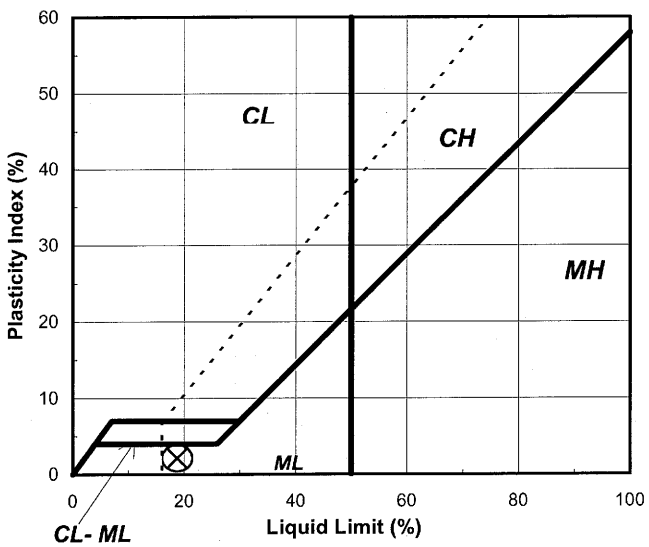
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**19**
Plastic Limit (%)	**17**
Plasticity Index (%)	**2**
USCS Symbol	**ML**

Flow Curve



Plasticity Chart



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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	3-5
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-05	Visual Description	**LIGHT GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GBM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	8-10
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-06	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GEM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	38-40
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-07	Visual Description	**LIGHT GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GJM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	48-50
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-08	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/16/2008 *Checked By* GZM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. D&D LF EXPANSION	Depth (ft)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID	2008-628-01-09	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By SD *Date* 9/15/2008 *Checked By* GEM *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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ATTERBERG LIMIT

ASTM D 4318-00 (SOP - S4)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-10	Visual Description	**GRAY**
			(MInus No. 40 sieve material, Wet Method)

NON - PLASTIC MATERIAL

Tested By *SD* *Date* *9/16/2008* *Checked By* Gem *Date* 9-17-08

DCN: CT-S4C DATE: 7-11-97 REVISION : 2

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	28-30
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-01	Soil Color	**DARK GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay

USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	27.70
Finer Than #200	*Silt & Clay*	72.30

USCS Symbol ***CL, TESTED***

USCS Classification ***LEAN CLAY WITH SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-01 #10 Split Hydro rev 8.xls]Sheet1*

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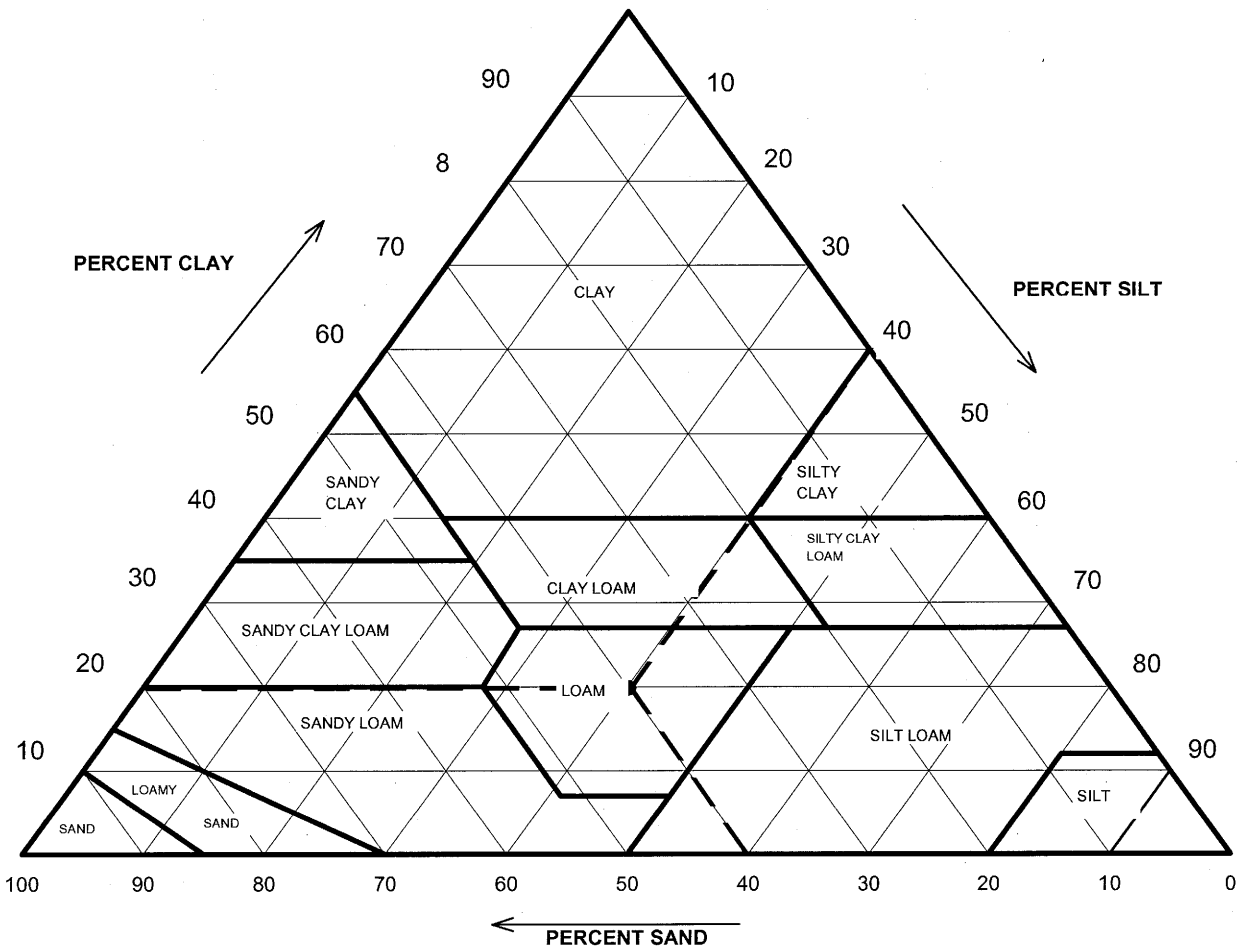
INTEGRITY IN TESTING

USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	28-30
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-01	Soil Color	DARK GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.00	**0.00**
2	100.00	*Sand*	39.98	**39.98**
0.05	60.02	*Silt*	40.20	**40.20**
0.002	19.82	*Clay*	19.82	**19.82**

USDA Classification: ***LOAM***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-01 #10 Split Hydro rev 8.xls]Sheet1

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INTEGRITY IN TESTING

WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	28-30
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-01	Soil Color	**DARK GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	202	Tare No.	F-1
Wgt.Tare + Wet Soil (gm)	234.28	Wgt.Tare + Wet Soil (gm)	37.05
Wgt.Tare + Dry Soil (gm)	232.10	Wgt.Tare + Dry Soil (gm)	35.75
Weight of Tare (gm)	197.33	Weight of Tare (gm)	22.02
Weight of Water (gm)	2.18	Weight of Water (gm)	1.30
Weight of Dry Soil (gm)	34.77	Weight of Dry Soil (gm)	13.73
Moisture Content (%)	**6.3**	**Moisture Content (%)**	**9.5**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	36.95	Weight of the Dry Sample (gm)	126.13
Dry Weight +#10 Material(gm)	34.8	Weight of minus #200 material (gm)	66.05
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	60.08
Dry Weight Hydro. Material (gm)	91.36		
Total Dry Weight Sample (gm)	126.13	**J-FACTOR (%FINER THAN #10)**	**1.0000**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.00	0.00	0.00	100.00	**100.00**
#20	0.85	2.66	2.91	2.91	97.09	**97.09**
#40	0.425	4.01	4.39	7.30	92.70	**92.70**
#60	0.250	4.81	5.26	12.57	87.43	**87.43**
#140	0.106	6.81	7.45	20.02	79.98	**79.98**
#200	0.075	7.02	7.68	27.70	72.30	**72.30**
Pan	-	66.05	72.30	100.00	-	**-**

Notes :

Tested By SD Date 9/17/08 Checked By GOM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-01 #10 Split Hydro rev 8.xls]Sheet1*

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INTEGRITY IN TESTING

HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	28-30
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-01	Soil Color	**DARK GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	42.0	42.0	25.3	3.41	38.6	41.8	0.01263	0.0274	**41.8**
5		38.0	25.3	3.41	34.6	37.5	0.01263	0.0179	**37.5**
15		34.0	25.3	3.41	30.6	33.1	0.01263	0.0107	**33.1**
30		31.0	25.3	3.41	27.6	29.9	0.01263	0.0077	**29.9**
60		29.0	25.3	3.41	25.6	27.7	0.01263	0.0055	**27.7**
250		23.0	25.3	3.41	19.6	21.2	0.01263	0.0028	**21.2**
1440		20.0	24.7	3.59	16.4	17.8	0.01272	0.0012	**17.8**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	91.36	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	100.00
Weight of Dry Material (gm)	91.36		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/08 Checked By GJM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-01 #10 Split Hydro rev 8.xls]Sheet1*

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	43-45
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-02	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay

USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	12.16
#4 To #200	*Sand*	80.09
Finer Than #200	*Silt & Clay*	7.75

		D60 =	0.411		
USCS Symbol	***SP-SM, TESTED (NON PLASTIC FINES)***	D30 =	0.185	CC =	0.77
USCS Classification	***POORLY GRADED SAND WITH SILT***	D10 =	0.109	CU =	3.79

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-02 #10 Split Hydro rev 8.xls]Sheet1*

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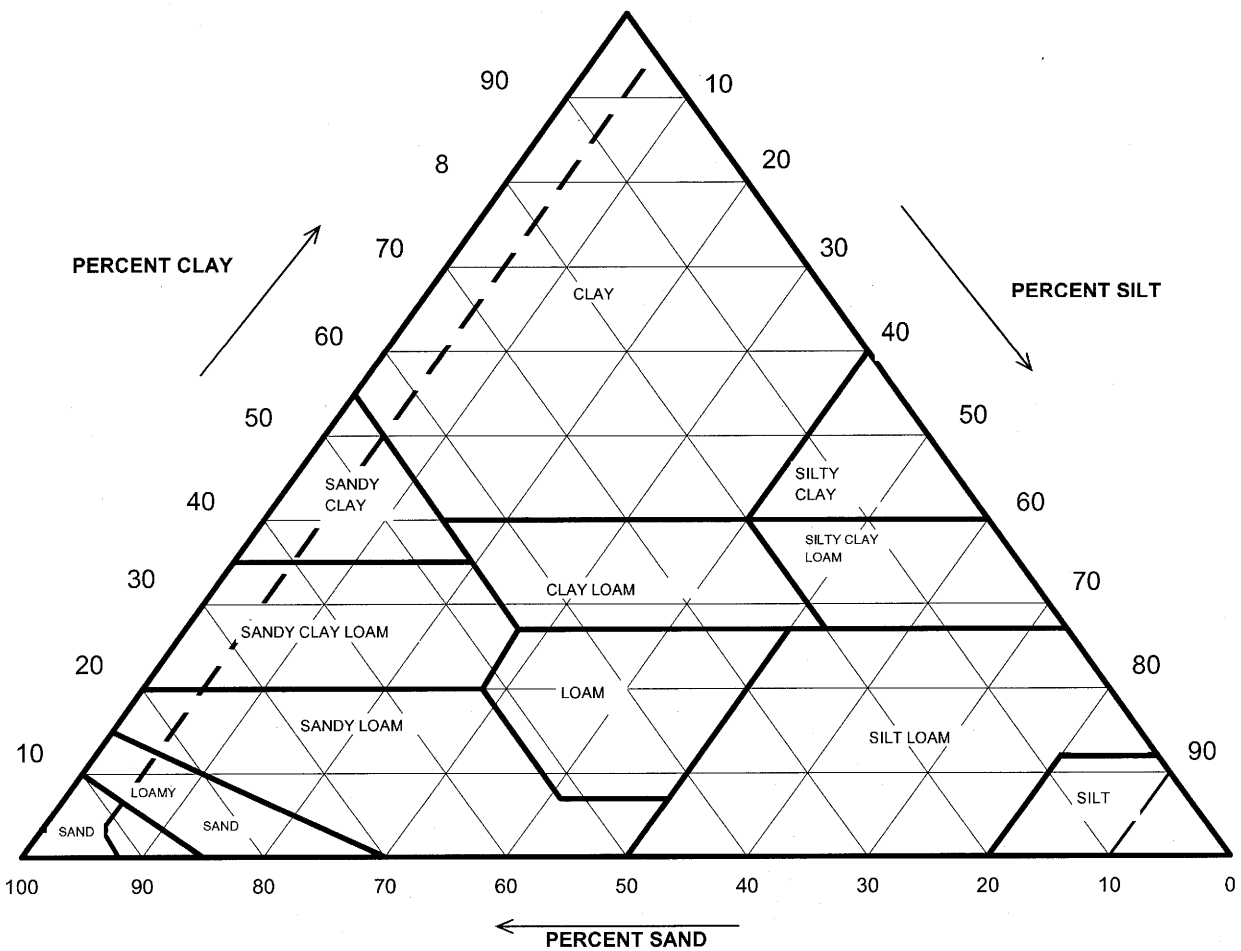
INTEGRITY IN TESTING

USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	43-45
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-02	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	24.11	**0.00**
2	75.89	*Sand*	69.71	**91.86**
0.05	6.18	*Silt*	3.68	**4.84**
0.002	2.50	*Clay*	2.50	**3.30**

USDA Classification: ***SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-02 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	43-45
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-02	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	211	Tare No.	U-1
Wgt.Tare + Wet Soil (gm)	210.97	Wgt.Tare + Wet Soil (gm)	76.66
Wgt.Tare + Dry Soil (gm)	210.45	Wgt.Tare + Dry Soil (gm)	76.15
Weight of Tare (gm)	171.21	Weight of Tare (gm)	22.00
Weight of Water (gm)	0.52	Weight of Water (gm)	0.51
Weight of Dry Soil (gm)	39.24	Weight of Dry Soil (gm)	54.15
Moisture Content (%)	**1.3**	**Moisture Content (%)**	**0.9**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	39.76	Weight of the Dry Sample (gm)	138.31
Dry Weight +#10 Material(gm)	39.2	Weight of minus #200 material (gm)	10.12
Wet Weight Hydro. Material.(gm)	100.00	Weight of plus #200 material (gm)	128.19
Dry Weight Hydro. Material (gm)	99.07		
Total Dry Weight Sample (gm)	138.31	**J-FACTOR (%FINER THAN #10)**	**0.7589**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.96	2.45	2.45	97.55	**97.55**
#4	4.75	3.81	9.71	12.16	87.84	**87.84**
#10	2.00	4.69	11.95	24.11	75.89	**75.89**
#20	0.85	4.70	4.74	4.74	95.26	**72.29**
#40	0.425	14.43	14.57	19.31	80.69	**61.24**
#60	0.250	25.94	26.18	45.49	54.51	**41.37**
#140	0.106	42.09	42.49	87.98	12.02	**9.12**
#200	0.075	1.79	1.81	89.79	10.21	**7.75**
Pan	-	10.12	10.21	100.00	-	-

Notes :

Tested By JP Date 9/18/2008 Checked By GCM Date 9-18-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-02 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	43-45
Project No.	2008-628-01	Sample No.	B-503D
Lab ID	2008-628-01-02	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	10.0	10.0	24.2	3.73	6.3	6.3	0.01279	0.0346	**4.8**
5		9.0	24.2	3.73	5.3	5.3	0.01279	0.0220	**4.0**
15		9.0	24.2	3.73	5.3	5.3	0.01279	0.0127	**4.0**
30		9.0	24.2	3.73	5.3	5.3	0.01279	0.0090	**4.0**
60		8.0	24.0	3.79	4.2	4.2	0.01282	0.0064	**3.2**
250		7.0	24.1	3.76	3.2	3.2	0.01281	0.0032	**2.5**
1440		7.0	24.5	3.65	3.4	3.4	0.01275	0.0013	**2.5**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	99.07	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	75.89
Weight of Dry Material (gm)	99.07		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/16/2008 Checked By GEM Date 9-18-08

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SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	13-15
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-03	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay

USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	75.37
Finer Than #200	*Silt & Clay*	24.63

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-03 #10 Split Hydro rev 8.xls]Sheet1*

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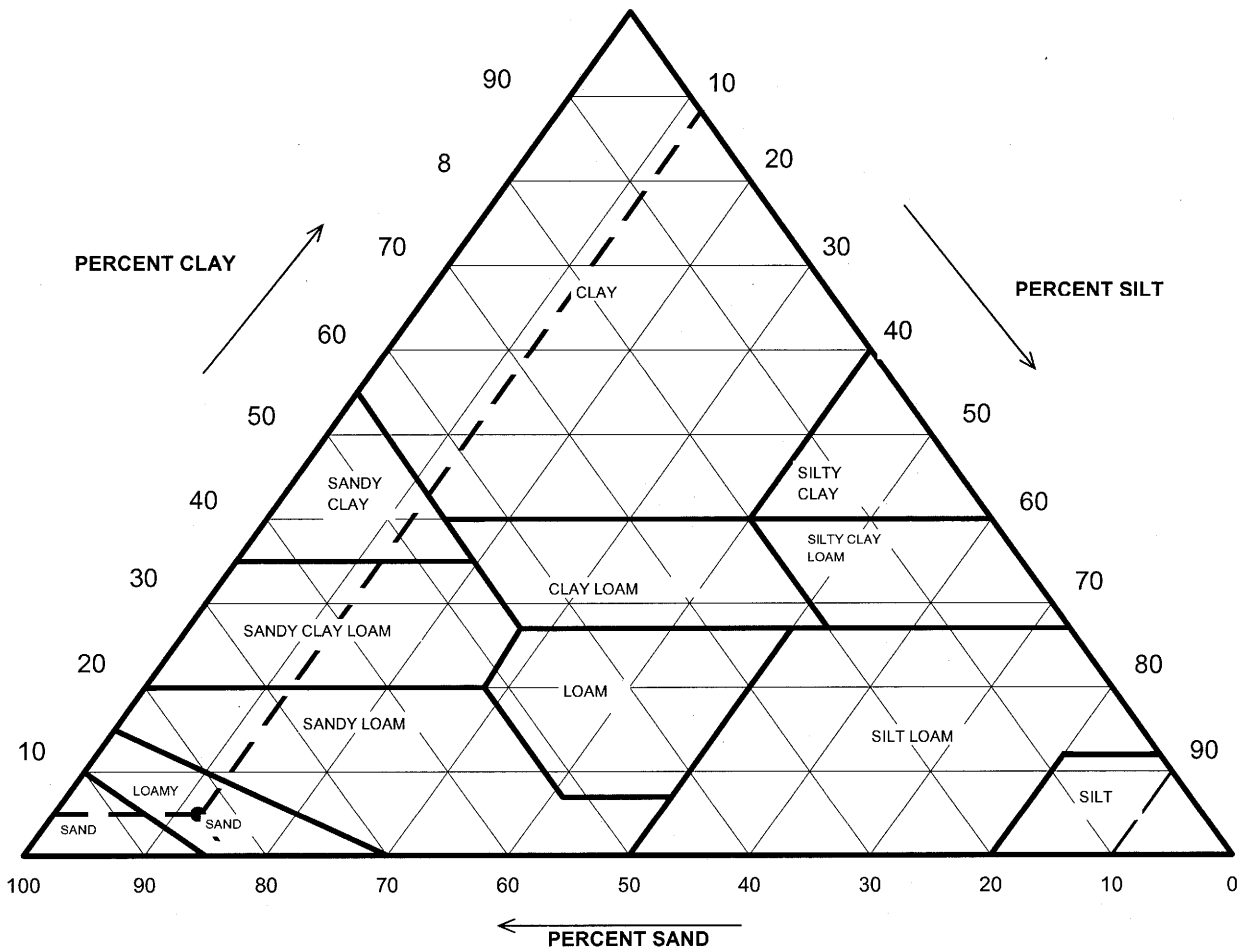
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	13-15
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-03	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.00	**0.00**
2	100.00	*Sand*	83.11	**83.11**
0.05	16.89	*Silt*	11.94	**11.94**
0.002	4.96	*Clay*	4.96	**4.96**

USDA Classification: ***LOAMY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-03 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	13-15
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-03	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	215	Tare No.	P-1
Wgt.Tare + Wet Soil (gm)	209.43	Wgt.Tare + Wet Soil (gm)	46.53
Wgt.Tare + Dry Soil (gm)	205.26	Wgt.Tare + Dry Soil (gm)	45.28
Weight of Tare (gm)	172.31	Weight of Tare (gm)	15.75
Weight of Water (gm)	4.17	Weight of Water (gm)	1.25
Weight of Dry Soil (gm)	32.95	Weight of Dry Soil (gm)	29.53
Moisture Content (%)	**12.7**	**Moisture Content (%)**	**4.2**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	37.12	Weight of the Dry Sample (gm)	128.90
Dry Weight +#10 Material(gm)	33.0	Weight of minus #200 material (gm)	23.63
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	105.27
Dry Weight Hydro. Material (gm)	95.95		
Total Dry Weight Sample (gm)	128.90	**J-FACTOR (%FINER THAN #10)**	**1.0000**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.00	0.00	0.00	100.00	**100.00**
#20	0.85	0.00	0.00	0.00	100.00	**100.00**
#40	0.425	0.03	0.03	0.03	99.97	**99.97**
#60	0.250	0.33	0.34	0.38	99.62	**99.62**
#140	0.106	55.61	57.96	58.33	41.67	**41.67**
#200	0.075	16.35	17.04	75.37	24.63	**24.63**
Pan	-	23.63	24.63	100.00	-	**-**

Notes :

Tested By SD Date 9/18/2008 Checked By GEM Date 9-18-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-03 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	13-15
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-03	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	13.0	13.0	24.2	3.73	9.3	9.6	0.01279	0.0340	**9.6**
5		12.0	24.2	3.73	8.3	8.5	0.01279	0.0217	**8.5**
15		11.0	24.2	3.73	7.3	7.5	0.01279	0.0126	**7.5**
30		11.0	24.2	3.73	7.3	7.5	0.01279	0.0089	**7.5**
60		10.0	23.9	3.82	6.2	6.4	0.01284	0.0063	**6.4**
250		9.0	24.2	3.73	5.3	5.4	0.01279	0.0031	**5.4**
1440		8.0	24.5	3.65	4.4	4.5	0.01275	0.0013	**4.5**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	95.95	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	100.00
Weight of Dry Material (gm)	95.95		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/16/2008 Checked By GEM Date 9-18-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-03 #10 Split Hydro rev 8.xls]Sheet1*

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	18-20
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-04	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay

USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	58.88
Finer Than #200	*Silt & Clay*	41.12

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-04 #10 Split Hydro rev 8.xls]Sheet1*

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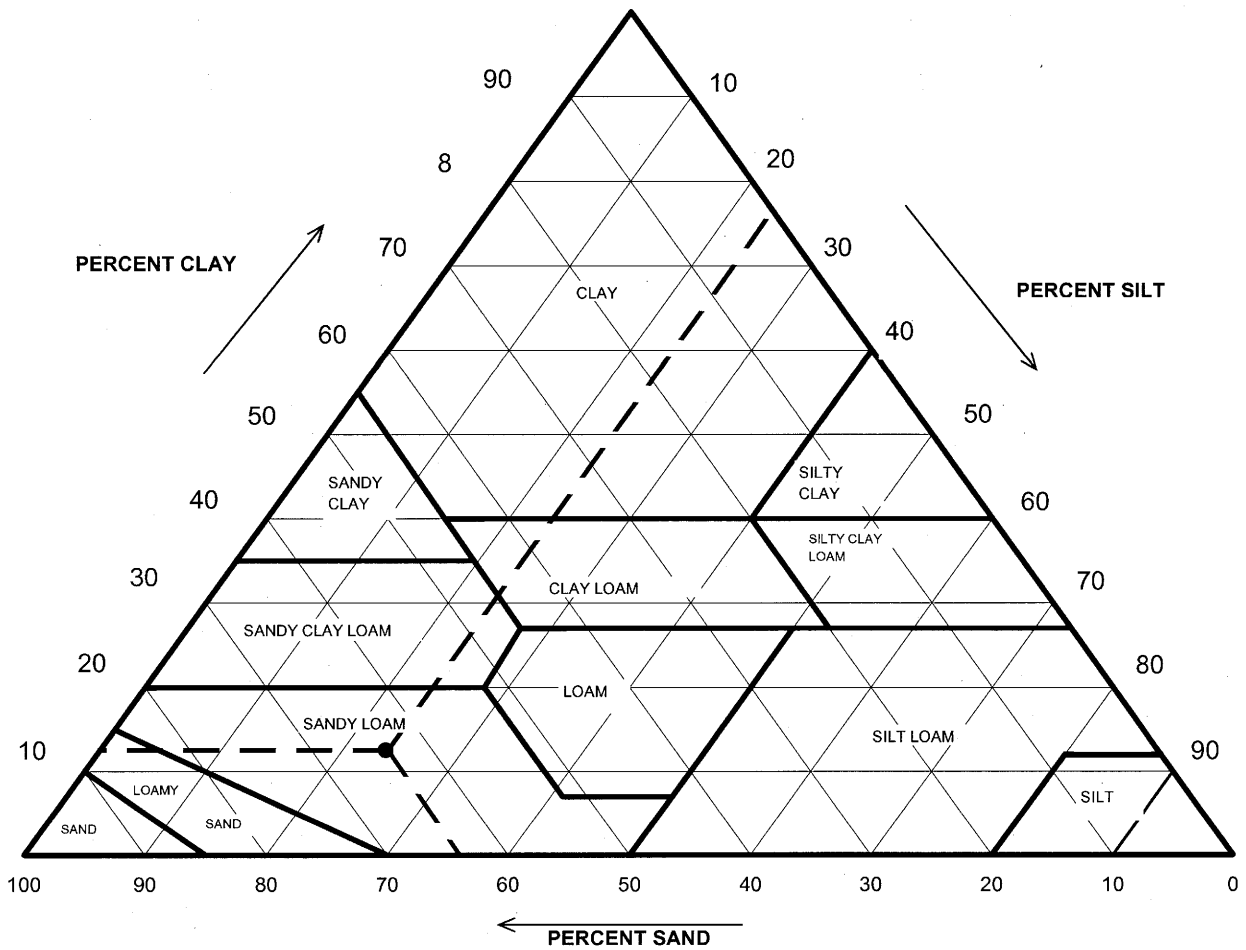
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	18-20
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-04	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	2.31	**0.00**
2	97.69	*Sand*	62.39	**63.86**
0.05	35.30	*Silt*	23.04	**23.59**
0.002	12.26	*Clay*	12.26	**12.55**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-04 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	18-20
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-04	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	216	Tare No.	E-2
Wgt.Tare + Wet Soil (gm)	222.90	Wgt.Tare + Wet Soil (gm)	56.68
Wgt.Tare + Dry Soil (gm)	218.68	Wgt.Tare + Dry Soil (gm)	55.06
Weight of Tare (gm)	170.70	Weight of Tare (gm)	22.83
Weight of Water (gm)	4.22	Weight of Water (gm)	1.62
Weight of Dry Soil (gm)	47.98	Weight of Dry Soil (gm)	32.23
Moisture Content (%)	**8.8**	**Moisture Content (%)**	**5.0**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	52.20	Weight of the Dry Sample (gm)	143.20
Dry Weight +#10 Material(gm)	48.0	Weight of minus #200 material (gm)	40.08
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	103.12
Dry Weight Hydro. Material (gm)	95.22		
Total Dry Weight Sample (gm)	143.20	**J-FACTOR (%FINER THAN #10)**	**0.9769**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	1.11	2.31	2.31	97.69	**97.69**
#20	0.85	0.59	0.62	0.62	99.38	**97.08**
#40	0.425	1.48	1.55	2.17	97.83	**95.56**
#60	0.250	3.09	3.24	5.42	94.58	**92.39**
#140	0.106	40.59	42.63	48.04	51.96	**50.75**
#200	0.075	9.39	9.86	57.91	42.09	**41.12**
Pan	-	40.08	42.09	100.00	-	**-**

Notes :

Tested By SD Date 9/17/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-04 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	18-20
Project No.	2008-628-01	Sample No.	B-504
Lab ID	2008-628-01-04	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	31.0	31.0	25.1	3.47	27.5	28.6	0.01266	0.0300	**28.0**
5		27.0	25.1	3.47	23.5	24.5	0.01266	0.0195	**23.9**
15		23.0	25.1	3.47	19.5	20.3	0.01266	0.0116	**19.8**
30		22.0	25.2	3.44	18.6	19.3	0.01265	0.0082	**18.8**
60		20.0	25.1	3.47	16.5	17.2	0.01266	0.0059	**16.8**
250		16.0	25.3	3.41	12.6	13.1	0.01263	0.0030	**12.8**
1440		15.0	24.8	3.56	11.4	11.9	0.01270	0.0012	**11.6**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	95.22	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	97.69
Weight of Dry Material (gm)	95.22		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-04 #10 Split Hydro rev 8.xls]Sheet1*

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SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	3-5
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-05	Soil Color	**LIGHT GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay

USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	81.17
Finer Than #200	*Silt & Clay*	18.83

USCS Symbol ***SM, TESTED (NON PLASTIC FINES)***

USCS Classification ***SILTY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-05 #10 Split Hydro rev 8.xls]Sheet1*

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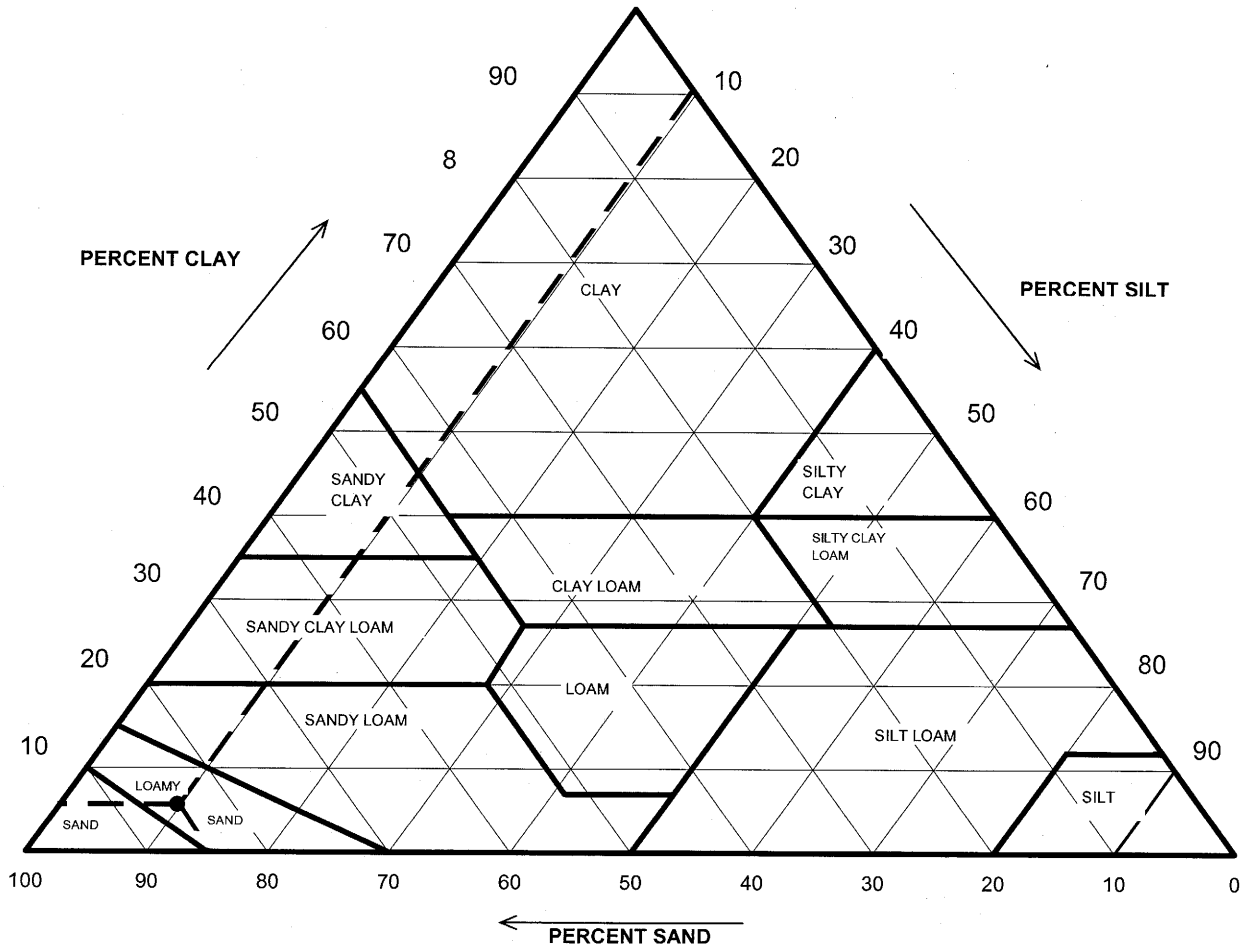
Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	3-5
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-05	Soil Color	LIGHT GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.00	**0.00**
2	100.00	*Sand*	84.64	**84.64**
0.05	15.36	*Silt*	9.67	**9.67**
0.002	5.68	*Clay*	5.68	**5.68**

USDA Classification: ***LOAMY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-05 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	3-5
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-05	Soil Color	**LIGHT GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	209	Tare No.	N-1
Wgt.Tare + Wet Soil (gm)	185.20	Wgt.Tare + Wet Soil (gm)	79.28
Wgt.Tare + Dry Soil (gm)	184.48	Wgt.Tare + Dry Soil (gm)	71.90
Weight of Tare (gm)	171.73	Weight of Tare (gm)	21.90
Weight of Water (gm)	0.72	Weight of Water (gm)	7.38
Weight of Dry Soil (gm)	12.75	Weight of Dry Soil (gm)	50.00
Moisture Content (%)	**5.6**	**Moisture Content (%)**	**14.8**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	13.47	Weight of the Dry Sample (gm)	99.88
Dry Weight +#10 Material(gm)	12.8	Weight of minus #200 material (gm)	16.41
Wet Weight Hydro. Material.(gm)	99.99	Weight of plus #200 material (gm)	83.47
Dry Weight Hydro. Material (gm)	87.13		
Total Dry Weight Sample (gm)	99.88	**J-FACTOR (%FINER THAN #10)**	**1.0000**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.00	0.00	0.00	100.00	**100.00**
#20	0.85	0.04	0.05	0.05	99.95	**99.95**
#40	0.425	0.12	0.14	0.18	99.82	**99.82**
#60	0.250	0.57	0.65	0.84	99.16	**99.16**
#140	0.106	48.44	55.60	56.43	43.57	**43.57**
#200	0.075	21.55	24.73	81.17	18.83	**18.83**
Pan	-	16.41	18.83	100.00	-	**-**

Notes :

Tested By SD Date 9/17/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-05 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	3-5
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-05	Soil Color	**LIGHT GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	14.0	14.0	25.0	3.50	10.5	11.9	0.01268	0.0335	**11.9**
5		13.0	25.1	3.47	9.5	10.8	0.01266	0.0213	**10.8**
15		13.0	25.1	3.47	9.5	10.8	0.01266	0.0123	**10.8**
30		11.0	25.1	3.47	7.5	8.6	0.01266	0.0088	**8.6**
60		11.0	25.1	3.47	7.5	8.6	0.01266	0.0062	**8.6**
250		9.0	25.3	3.41	5.6	6.3	0.01263	0.0031	**6.3**
1440		8.0	24.7	3.59	4.4	5.0	0.01272	0.0013	**5.0**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	87.13	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	100.00
Weight of Dry Material (gm)	87.13		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-05 #10 Split Hydro rev 8.xls]Sheet1*

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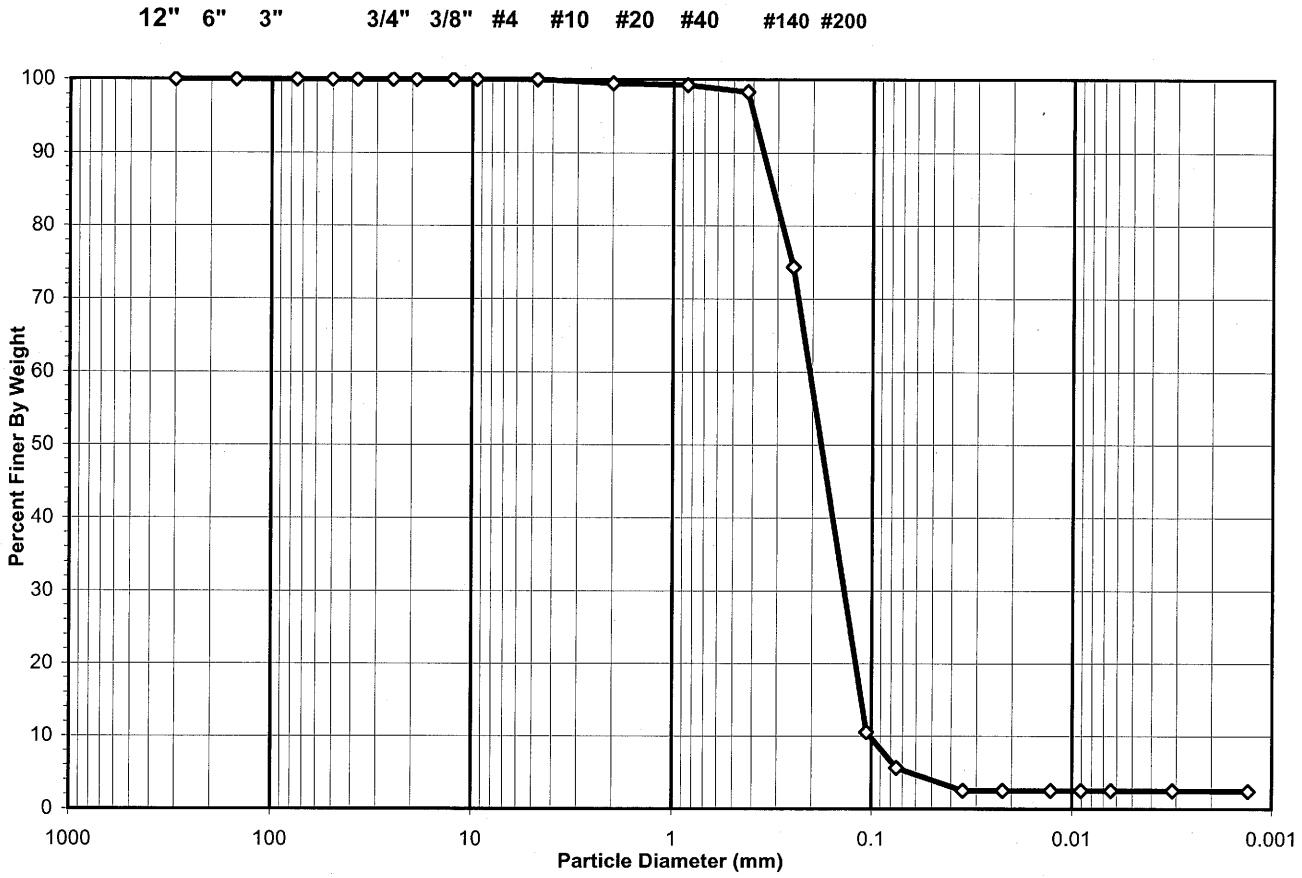
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	8-10
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-06	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary		
Sieve Sizes (mm)		**Percentage**
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	94.36
Finer Than #200	*Silt & Clay*	5.64

		D60 =	0.206		
USCS Symbol	***SP-SM, TESTED (ON PLASTIC FINES)***	D30 =	0.138	CC =	0.90
USCS Classification	***POORLY GRADED SAND WITH SILT***	D10 =	0.102	CU =	2.02

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-06 #10 Split Hydro rev 8.xls]Sheet1*

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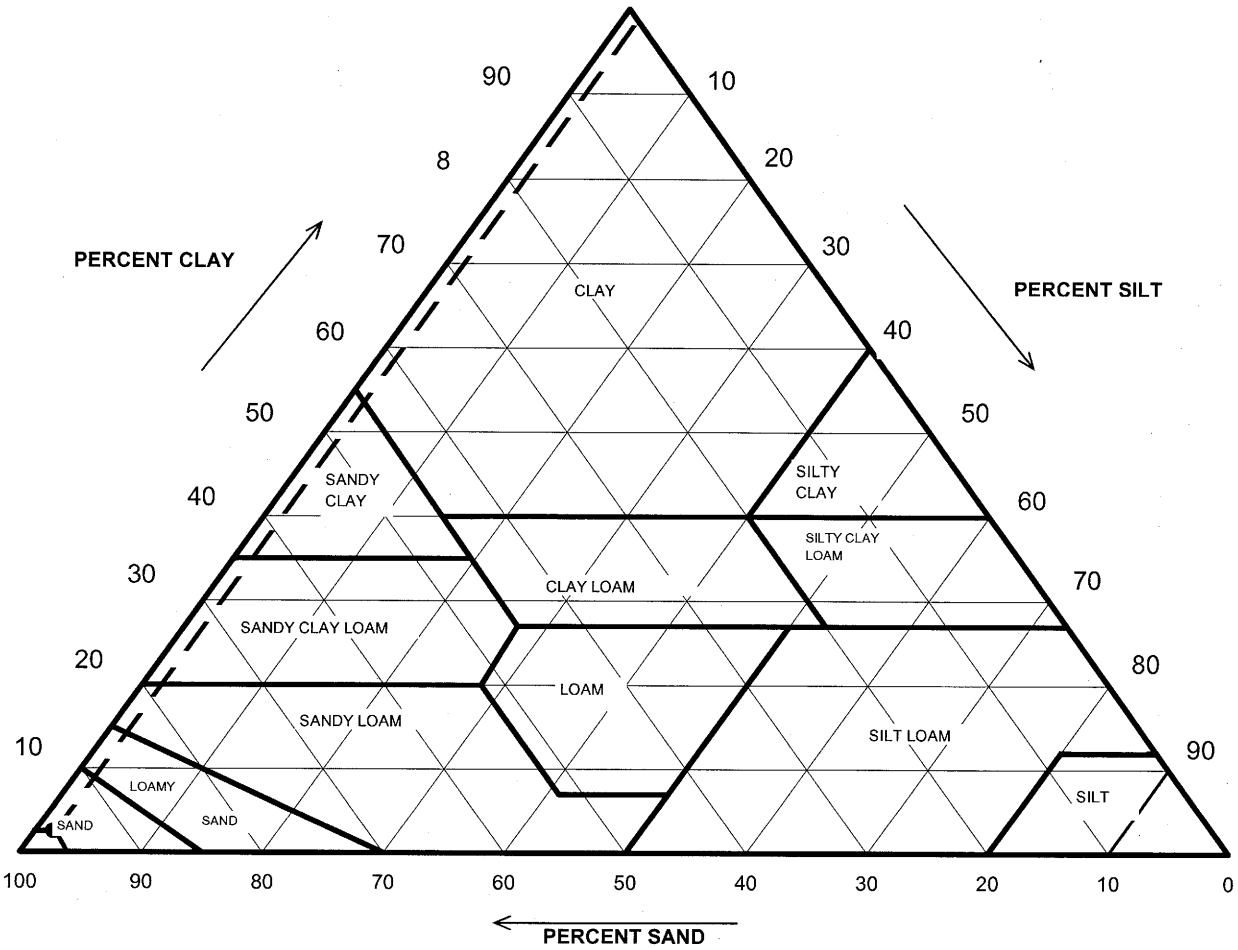
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	8-10
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-06	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.53	**0.00**
2	99.47	*Sand*	95.49	**96.00**
0.05	3.98	*Silt*	1.50	**1.51**
0.002	2.47	*Clay*	2.47	**2.48**

USDA Classification: ***SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-06 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	8-10
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-06	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	208	Tare No.	C-2
Wgt.Tare + Wet Soil (gm)	234.65	Wgt.Tare + Wet Soil (gm)	40.25
Wgt.Tare + Dry Soil (gm)	233.51	Wgt.Tare + Dry Soil (gm)	40.00
Weight of Tare (gm)	169.76	Weight of Tare (gm)	15.72
Weight of Water (gm)	1.14	Weight of Water (gm)	0.25
Weight of Dry Soil (gm)	63.75	Weight of Dry Soil (gm)	24.28
Moisture Content (%)	**1.8**	**Moisture Content (%)**	**1.0**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	64.89	Weight of the Dry Sample (gm)	162.73
Dry Weight +#10 Material(gm)	63.8	Weight of minus #200 material (gm)	5.61
Wet Weight Hydro. Material.(gm)	100.00	Weight of plus #200 material (gm)	157.12
Dry Weight Hydro. Material (gm)	98.98		
Total Dry Weight Sample (gm)	162.73	**J-FACTOR (%FINER THAN #10)**	**0.9947**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.34	0.53	0.53	99.47	**99.47**
#20	0.85	0.20	0.20	0.20	99.80	**99.27**
#40	0.425	0.94	0.95	1.15	98.85	**98.32**
#60	0.250	23.86	24.11	25.26	74.74	**74.34**
#140	0.106	63.49	64.14	89.40	10.60	**10.54**
#200	0.075	4.88	4.93	94.33	5.67	**5.64**
Pan	-	5.61	5.67	100.00	-	-

Notes :

Tested By SD Date 9/17/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-06 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	8-10
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-06	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	6.0	6.0	25.1	3.47	2.5	2.5	0.01266	0.0350	**2.5**
5		6.0	25.1	3.47	2.5	2.5	0.01266	0.0222	**2.5**
15		6.0	25.1	3.47	2.5	2.5	0.01266	0.0128	**2.5**
30		6.0	25.1	3.47	2.5	2.5	0.01266	0.0090	**2.5**
60		6.0	25.1	3.47	2.5	2.5	0.01266	0.0064	**2.5**
250		6.0	25.1	3.47	2.5	2.5	0.01266	0.0031	**2.5**
1440		6.0	24.8	3.56	2.4	2.4	0.01270	0.0013	**2.4**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	98.98	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	99.47
Weight of Dry Material (gm)	98.98		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/2008 Checked By GZM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-06 #10 Split Hydro rev 8.xls]Sheet1*

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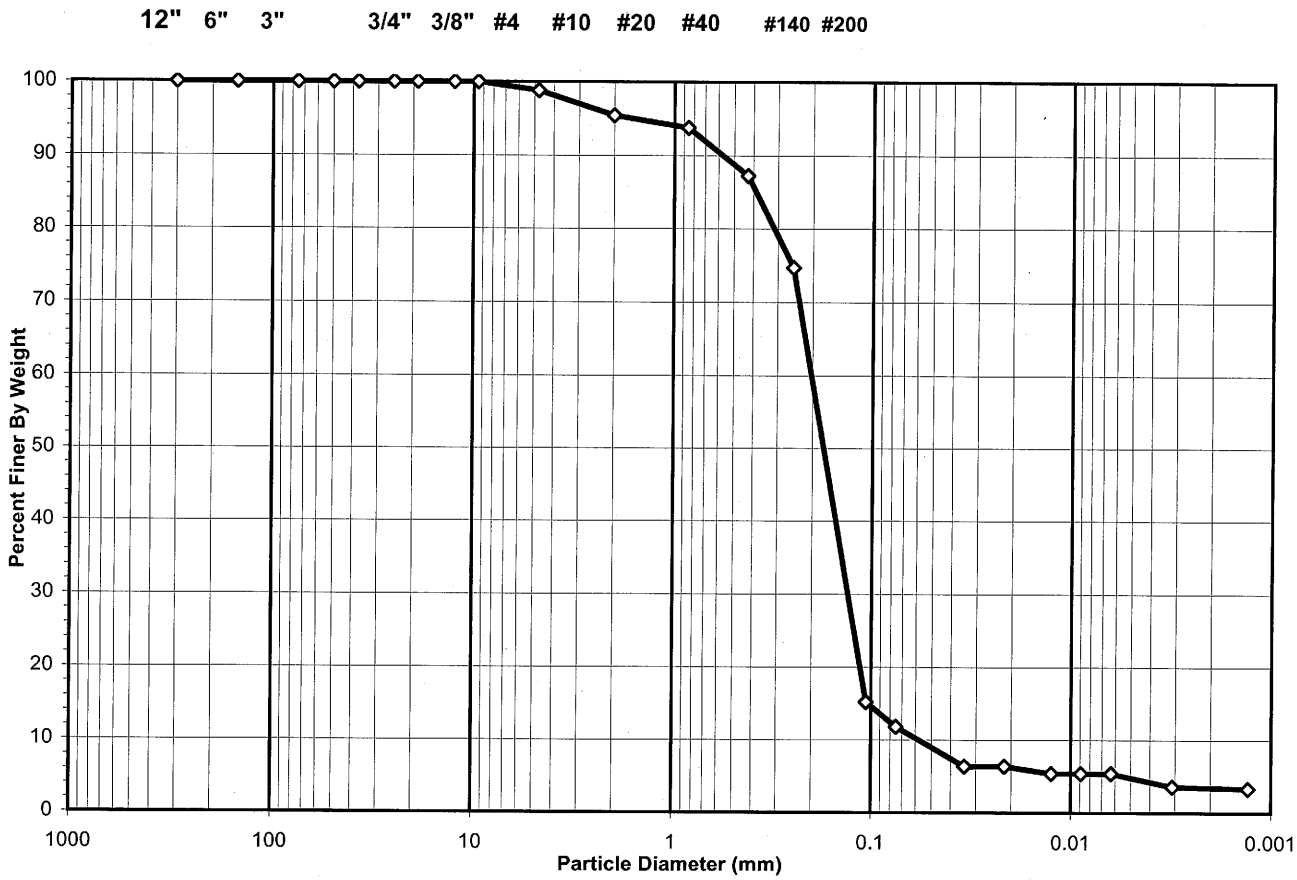
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	38-40
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-07	Soil Color	**LIGHT GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	1.17
#4 To #200	*Sand*	87.02
Finer Than #200	*Silt & Clay*	11.80

		D60 =	0.202			
USCS Symbol	***SP-SM, TESTED (NON PLASTIC FINES)***	D30 =	0.131	CC =	1.47
USCS Classification	***POORLY GRADED SAND WITH SILT***	D10 =	0.058	CU =	3.50

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-07 #10 Split Hydro rev 8.xls]Sheet1*

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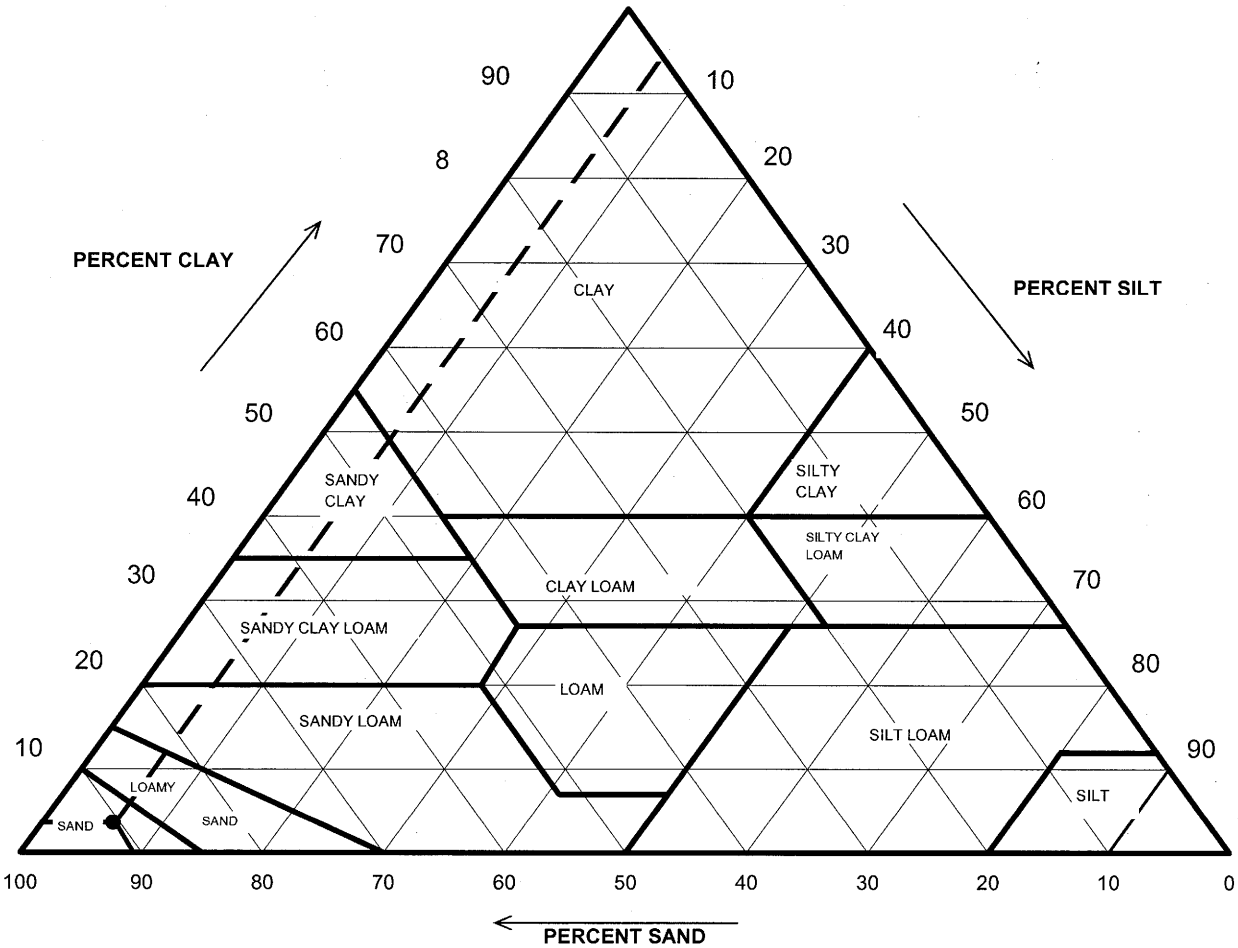
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	38-40
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-07	Soil Color	LIGHT GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	4.56	**0.00**
2	95.44	*Sand*	86.43	**90.56**
0.05	9.00	*Silt*	5.55	**5.82**
0.002	3.45	*Clay*	3.45	**3.62**

USDA Classification: ***SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-07 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	38-40
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-07	Soil Color	**LIGHT GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	213	Tare No.	M-1
Wgt.Tare + Wet Soil (gm)	222.43	Wgt.Tare + Wet Soil (gm)	59.38
Wgt.Tare + Dry Soil (gm)	220.10	Wgt.Tare + Dry Soil (gm)	58.26
Weight of Tare (gm)	173.22	Weight of Tare (gm)	22.09
Weight of Water (gm)	2.33	Weight of Water (gm)	1.12
Weight of Dry Soil (gm)	46.88	Weight of Dry Soil (gm)	36.17
Moisture Content (%)	**5.0**	**Moisture Content (%)**	**3.1**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	49.21	Weight of the Dry Sample (gm)	143.87
Dry Weight +#10 Material(gm)	46.9	Weight of minus #200 material (gm)	12.00
Wet Weight Hydro. Material.(gm)	99.99	Weight of plus #200 material (gm)	131.87
Dry Weight Hydro. Material (gm)	96.99		
Total Dry Weight Sample (gm)	143.87	**J-FACTOR (%FINER THAN #10)**	**0.9544**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.55	1.17	1.17	98.83	**98.83**
#10	2.00	1.59	3.39	4.56	95.44	**95.44**
#20	0.85	1.68	1.73	1.73	98.27	**93.78**
#40	0.425	6.65	6.86	8.59	91.41	**87.24**
#60	0.250	12.73	13.13	21.71	78.29	**74.71**
#140	0.106	60.50	62.38	84.09	15.91	**15.18**
#200	0.075	3.43	3.54	87.63	12.37	**11.80**
Pan	-	12.00	12.37	100.00	-	**-**

Notes :

Tested By SD Date 9/17/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-07 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	38-40
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-07	Soil Color	**LIGHT GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	10.0	10.0	25.2	3.44	6.6	6.7	0.01265	0.0342	**6.4**
5		10.0	25.2	3.44	6.6	6.7	0.01265	0.0217	**6.4**
15		9.0	25.2	3.44	5.6	5.7	0.01265	0.0126	**5.4**
30		9.0	25.2	3.44	5.6	5.7	0.01265	0.0089	**5.4**
60		9.0	25.2	3.44	5.6	5.7	0.01265	0.0063	**5.4**
250		7.0	25.6	3.32	3.7	3.8	0.01259	0.0031	**3.6**
1440		7.0	24.7	3.59	3.4	3.5	0.01272	0.0013	**3.3**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	96.99	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	95.44
Weight of Dry Material (gm)	96.99		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-07 #10 Split Hydro rev 8.xls]Sheet1*

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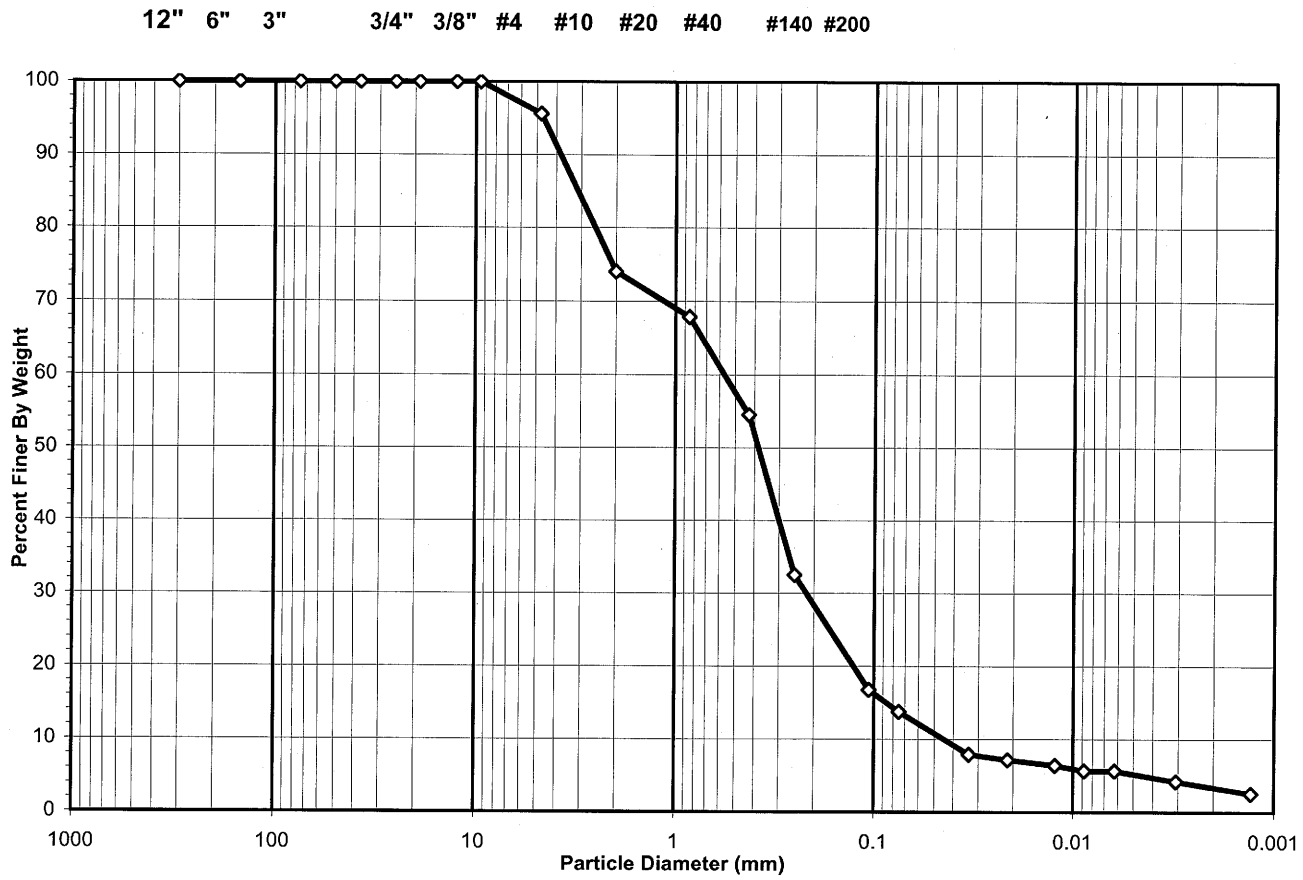
SIEVE AND HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	48-50
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-08	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	4.38
#4 To #200	*Sand*	81.88
Finer Than #200	*Silt & Clay*	13.74

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-08 #10 Split Hydro rev 8.xls]Sheet1*

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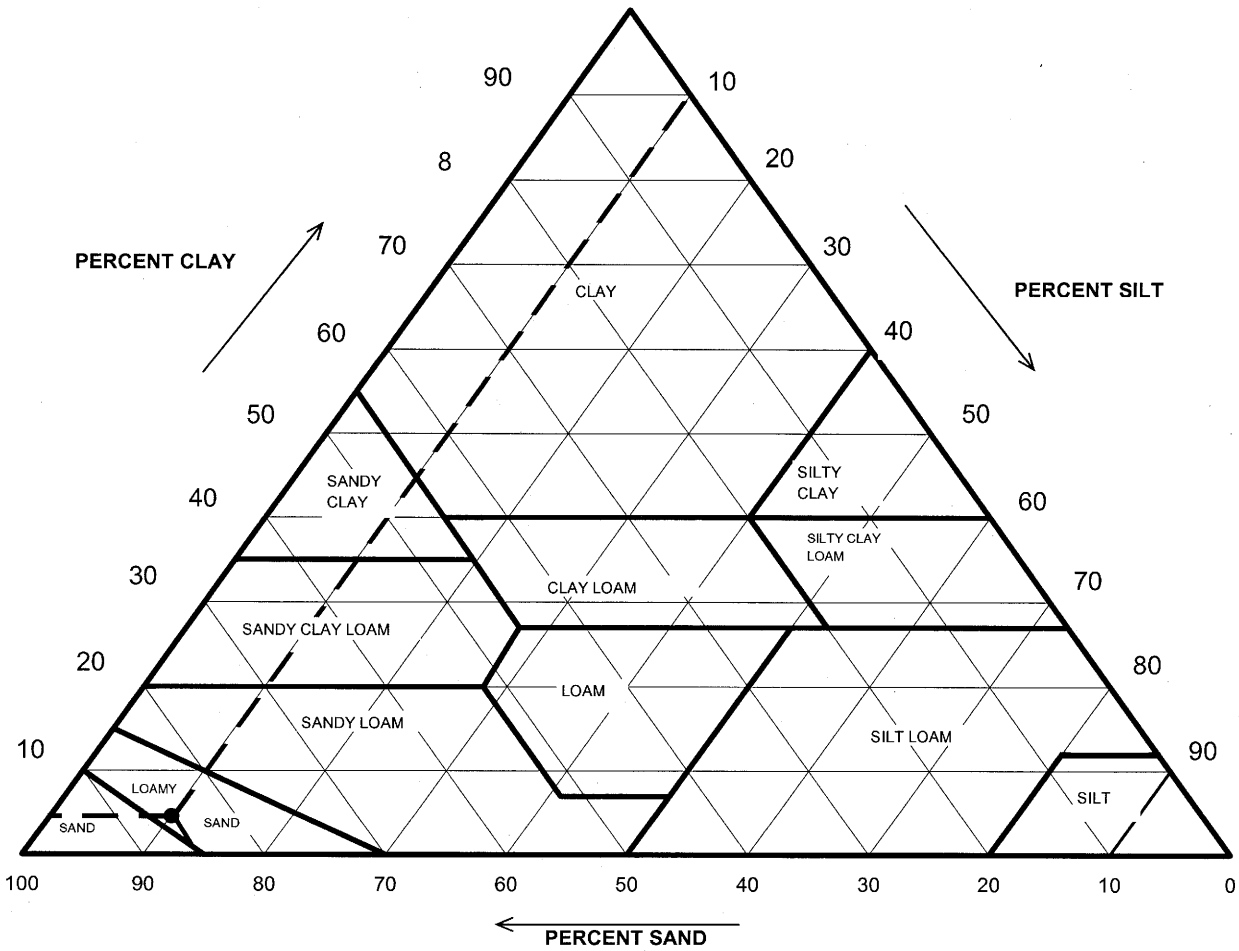
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	48-50
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-08	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	26.01	**0.00**
2	73.99	*Sand*	63.17	**85.38**
0.05	10.81	*Silt*	7.43	**10.05**
0.002	3.38	*Clay*	3.38	**4.57**

USDA Classification: ***LOAMY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-08 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	48-50
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-08	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	214	Tare No.	K-1
Wgt.Tare + Wet Soil (gm)	198.90	Wgt.Tare + Wet Soil (gm)	58.95
Wgt.Tare + Dry Soil (gm)	198.02	Wgt.Tare + Dry Soil (gm)	58.11
Weight of Tare (gm)	171.30	Weight of Tare (gm)	22.02
Weight of Water (gm)	0.88	Weight of Water (gm)	0.84
Weight of Dry Soil (gm)	26.72	Weight of Dry Soil (gm)	36.09
Moisture Content (%)	**3.3**	**Moisture Content (%)**	**2.3**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	27.60	Weight of the Dry Sample (gm)	124.46
Dry Weight +#10 Material(gm)	26.7	Weight of minus #200 material (gm)	18.16
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	106.30
Dry Weight Hydro. Material (gm)	97.74		
Total Dry Weight Sample (gm)	124.46	**J-FACTOR (%FINER THAN #10)**	**0.7399**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	1.17	4.38	4.38	95.62	**95.62**
#10	2.00	5.78	21.63	26.01	73.99	**73.99**
#20	0.85	8.08	8.27	8.27	91.73	**67.87**
#40	0.425	17.73	18.14	26.41	73.59	**54.45**
#60	0.250	29.02	29.69	56.10	43.90	**32.48**
#140	0.106	20.80	21.28	77.38	22.62	**16.73**
#200	0.075	3.95	4.04	81.42	18.58	**13.74**
Pan	-	18.16	18.58	100.00	-	**-**

Notes :

Tested By SD Date 9/17/2008 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-08 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. C&D EXPANSION	Depth (ft)	48-50
Project No.	2008-628-01	Sample No.	B-506D
Lab ID	2008-628-01-08	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	14.0	14.0	25.2	3.44	10.6	10.7	0.01265	0.0335	**7.9**
5		13.0	25.2	3.44	9.6	9.7	0.01265	0.0213	**7.2**
15		12.0	25.2	3.44	8.6	8.7	0.01265	0.0124	**6.4**
30		11.0	25.2	3.44	7.6	7.7	0.01265	0.0088	**5.7**
60		11.0	25.2	3.44	7.6	7.7	0.01265	0.0062	**5.7**
250		9.0	25.4	3.38	5.6	5.7	0.01262	0.0031	**4.2**
1440		7.0	24.7	3.59	3.4	3.5	0.01272	0.0013	**2.6**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	97.74	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	73.99
Weight of Dry Material (gm)	97.74		
		Specific Gravity	2.7 Assumed

Note:

Tested By JBD Date 9/15/2008 Checked By GDM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-08 #10 Split Hydro rev 8.xls]Sheet1*

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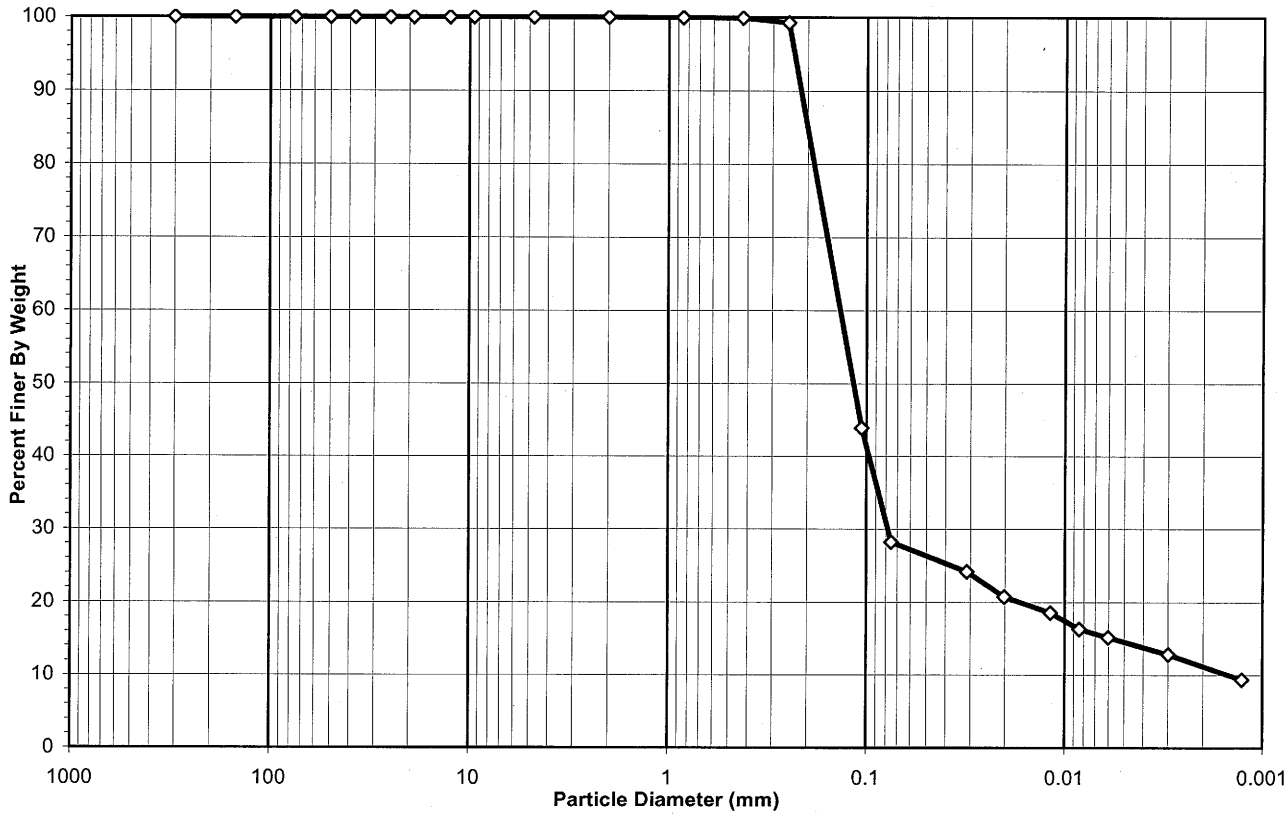
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. D&D LF EXPANSION	Depth (ft)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID	2008-628-01-09	Soil Color	**GRAY**

	SIEVE ANALYSIS					HYDROMETER
USCS	cobbles	gravel	sand			silt and clay fraction
USDA	cobbles	gravel		sand	silt	clay

12" 6" 3" 3/4" 3/8" #4 #10 #20 #40 #140 #200



USCS Summary

Sieve Sizes (mm)		Percentage
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	71.82
Finer Than #200	*Silt & Clay*	28.18

USCS Symbol ***SM, TESTED***

USCS Classification ***SILTY SAND***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 #10 Split Hydro rev 8.xls]Sheet1*

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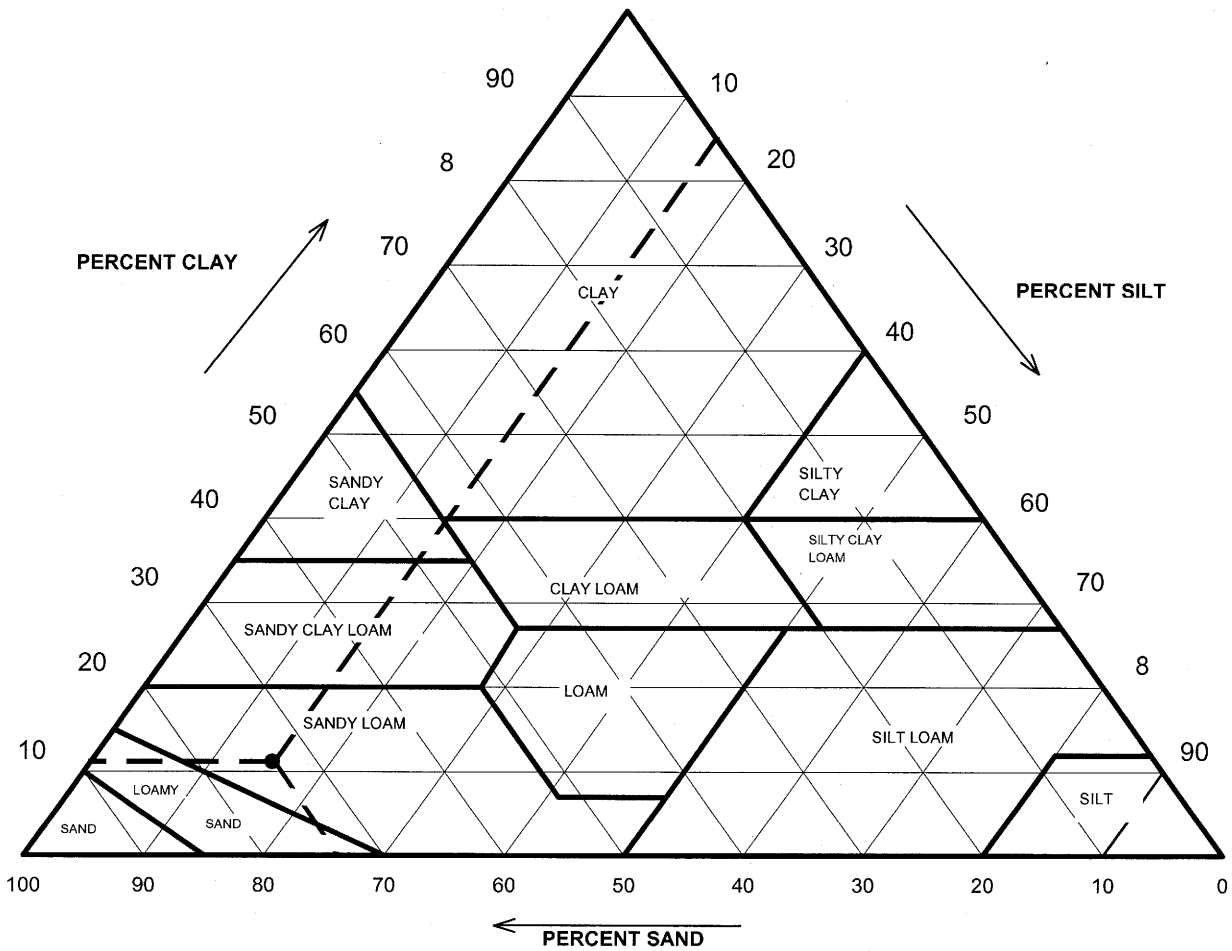
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. D&D LF EXPANSION	Depth (ft)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID	2008-628-01-09	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.00	**0.00**
2	100.00	*Sand*	73.68	**73.68**
0.05	26.32	*Silt*	15.12	**15.12**
0.002	11.20	*Clay*	11.20	**11.20**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. D&D LF EXPANSION	Depth (ft)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID	2008-628-01-09	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	211	Tare No.	Z-1
Wgt.Tare + Wet Soil (gm)	406.15	Wgt.Tare + Wet Soil (gm)	47.90
Wgt.Tare + Dry Soil (gm)	353.42	Wgt.Tare + Dry Soil (gm)	44.18
Weight of Tare (gm)	171.13	Weight of Tare (gm)	15.63
Weight of Water (gm)	52.73	Weight of Water (gm)	3.72
Weight of Dry Soil (gm)	182.29	Weight of Dry Soil (gm)	28.55
Moisture Content (%)	**28.9**	**Moisture Content (%)**	**13.0**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	235.02	Weight of the Dry Sample (gm)	270.77
Dry Weight +#10 Material(gm)	182.3	Weight of minus #200 material (gm)	24.93
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	245.84
Dry Weight Hydro. Material (gm)	88.48		
Total Dry Weight Sample (gm)	270.77	**J-FACTOR (%FINER THAN #10)**	**1.0000**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.00	0.00	0.00	100.00	**100.00**
#20	0.85	0.03	0.03	0.03	99.97	**99.97**
#40	0.425	0.06	0.07	0.10	99.90	**99.90**
#60	0.250	0.59	0.67	0.77	99.23	**99.23**
#140	0.106	48.99	55.37	56.14	43.86	**43.86**
#200	0.075	13.88	15.69	71.82	28.18	**28.18**
Pan	-	24.93	28.18	100.00	-	-

Notes :

Tested By SD Date 9/15/08 Checked By GEM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/2/08
Client Reference	DARE CO. D&D LF EXPANSION	Depth (ft)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID	2008-628-01-09	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	25.0	25.0	25.3	3.41	21.6	24.2	0.01263	0.0312	**24.2**
5		22.0	25.1	3.47	18.5	20.7	0.01266	0.0202	**20.7**
15		20.0	25.2	3.44	16.6	18.5	0.01265	0.0118	**18.5**
30		18.0	25.2	3.44	14.6	16.3	0.01265	0.0084	**16.3**
60		17.0	25.1	3.47	13.5	15.1	0.01266	0.0060	**15.1**
250		15.0	24.9	3.53	11.5	12.8	0.01269	0.0030	**12.8**
1440		12.0	24.5	3.65	8.4	9.3	0.01275	0.0013	**9.3**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	88.48	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	100.00
Weight of Dry Material (gm)	88.48		
		Specific Gravity	2.7 Assumed

Note:

Tested By TMS Date 9/11/08 Checked By GZM Date 9-17-08

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 #10 Split Hydro rev 8.xls]Sheet1*

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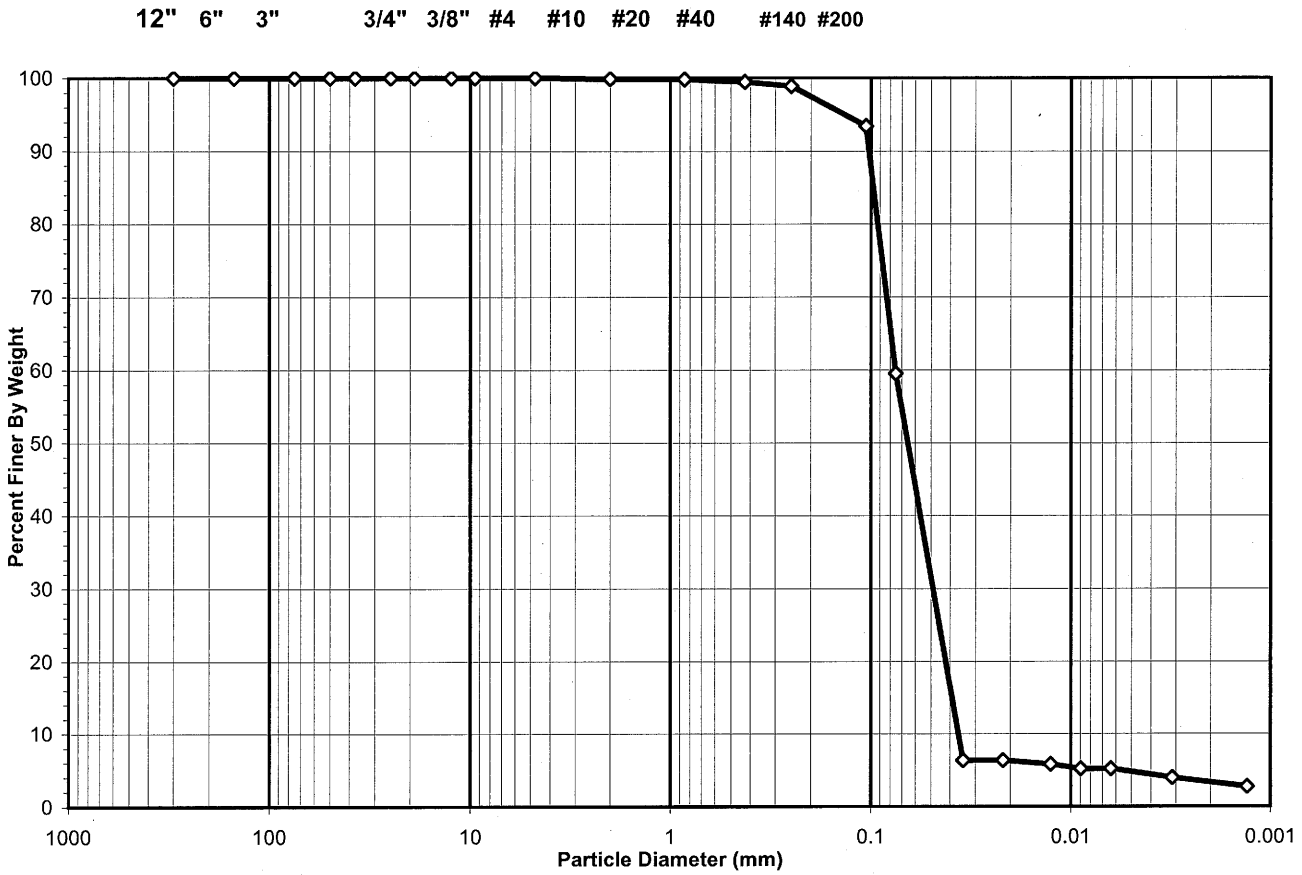
SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-10	Soil Color	**GRAY**

	SIEVE ANALYSIS			HYDROMETER	
USCS	cobbles	gravel	sand	silt and clay fraction	
USDA	cobbles	gravel	sand	silt	clay



USCS Summary		
Sieve Sizes (mm)		**Percentage**
Greater Than #4	*Gravel*	0.00
#4 To #200	*Sand*	40.48
Finer Than #200	*Silt & Clay*	59.52

USCS Symbol ***ML, TESTED (NON PLASTIC FINES)***

USCS Classification ***SANDY SILT***

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 #10 Split Hydro rev 8.xls]Sheet1*

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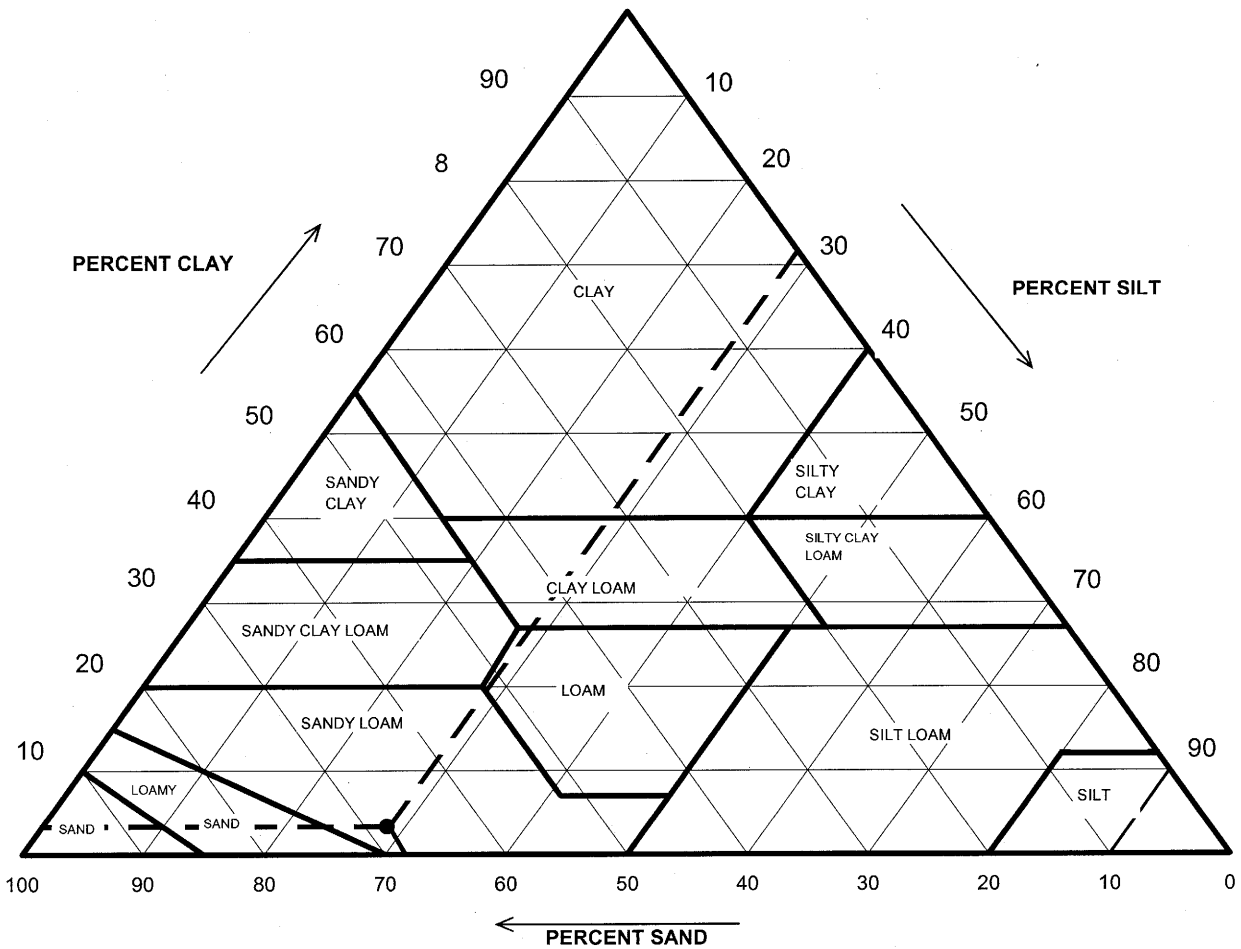
USDA CLASSIFICATION CHART

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-10	Soil Color	GRAY



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	0.15	**0.00**
2	99.85	*Sand*	68.07	**68.17**
0.05	31.78	*Silt*	28.45	**28.49**
0.002	3.33	*Clay*	3.33	**3.33**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3P DATE:02/15/05 REVISION:8 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 #10 Split Hydro rev 8.xls]Sheet1

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WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-10	Soil Color	**GRAY**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	212	Tare No.	R-1
Wgt.Tare + Wet Soil (gm)	509.82	Wgt.Tare + Wet Soil (gm)	45.14
Wgt.Tare + Dry Soil (gm)	427.16	Wgt.Tare + Dry Soil (gm)	41.13
Weight of Tare (gm)	171.48	Weight of Tare (gm)	15.62
Weight of Water (gm)	82.66	Weight of Water (gm)	4.01
Weight of Dry Soil (gm)	255.68	Weight of Dry Soil (gm)	25.51
Moisture Content (%)	**32.3**	**Moisture Content (%)**	**15.7**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	338.34	Weight of the Dry Sample (gm)	342.10
Dry Weight +#10 Material(gm)	255.7	Weight of minus #200 material (gm)	51.51
Wet Weight Hydro. Material.(gm)	100.01	Weight of plus #200 material (gm)	290.59
Dry Weight Hydro. Material (gm)	86.42		
Total Dry Weight Sample (gm)	342.10	**J-FACTOR (%FINER THAN #10)**	**0.9985**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	0.00	0.00	0.00	100.00	**100.00**
#4	4.75	0.00	0.00	0.00	100.00	**100.00**
#10	2.00	0.38	0.15	0.15	99.85	**99.85**
#20	0.85	0.04	0.05	0.05	99.95	**99.81**
#40	0.425	0.27	0.31	0.36	99.64	**99.49**
#60	0.250	0.53	0.61	0.97	99.03	**98.88**
#140	0.106	4.75	5.50	6.47	93.53	**93.39**
#200	0.075	29.32	33.93	40.39	59.61	**59.52**
Pan	-	51.51	59.61	100.00	-	**-**

Notes :

Tested By SD Date 9/15/2008 Checked By Date

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 #10 Split Hydro rev 8.xls]Sheet1*

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HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	CDM	Boring No.	9/3/08
Client Reference	DARE CO. C&D LF EXPANSION	Depth (ft)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID	2008-628-01-10	Soil Color	**GRAY**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	9.0	9.0	25.1	3.47	5.5	6.3	0.01266	0.0345	**6.3**
5		9.0	25.1	3.47	5.5	6.3	0.01266	0.0218	**6.3**
15		8.5	25.2	3.44	5.1	5.8	0.01265	0.0126	**5.8**
30		8.0	25.1	3.47	4.5	5.2	0.01266	0.0089	**5.2**
60		8.0	25.1	3.47	4.5	5.2	0.01266	0.0063	**5.2**
250		7.0	24.9	3.53	3.5	4.0	0.01269	0.0031	**4.0**
1440		6.0	24.6	3.62	2.4	2.7	0.01273	0.0013	**2.7**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	86.42	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	99.85
Weight of Dry Material (gm)	86.42		
		Specific Gravity	2.7 Assumed

Note:

Tested By TMS Date 9/11/2008 Checked By Date

DCN: CT-S3P DATE:02/15/05 REVISION:8 *\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 #10 Split Hydro rev 8.xls]Sheet1*

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FLEXIBLE WALL PERMEABILITY TEST

geotechnics
INTEGRITY IN TESTING

PERMOMETER METHOD

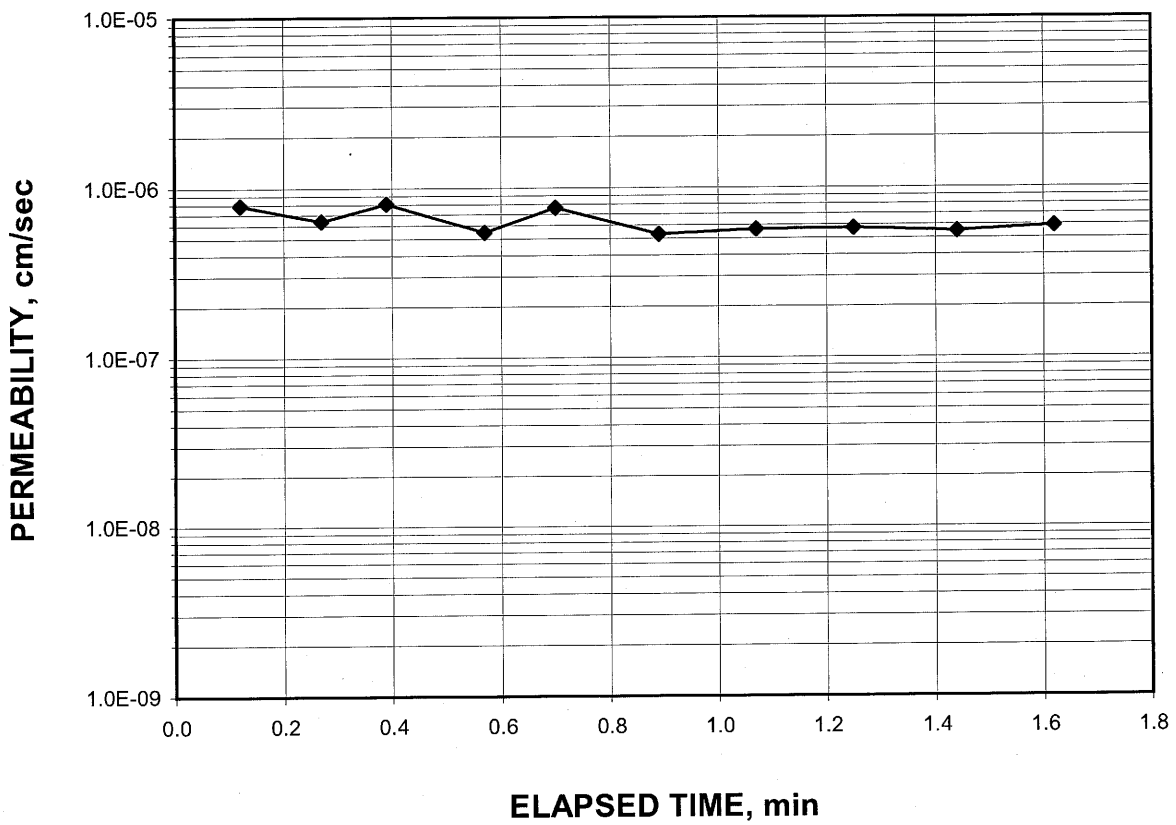
ASTM D 5084-03
(SOP-S22C)

Client	CDM	Boring No.	9/2/08
Client Project	DARE CO. C&D LF. EXPANSION	Depth (ft.)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID No.	2008-628-01-09		

Visual Description: GRAY SILTY SAND

AVERAGE PERMEABILITY = 5.7E-07 cm/sec @ 20°C
AVERAGE PERMEABILITY = 5.7E-09 m/sec @ 20°C

PERMEABILITY vs. TIME



Tested By: TMS Date: 9/11/2008 Checked By: Gem Date: 9-18-08

DCN: CT-22C DATE:12-21-98 REVISION: 4 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 PERMOM.xls]Sheet1

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FLEXIBLE WALL PERMEABILITY TEST

geotechnics
INTEGRITY IN TESTING

PERMOMETER METHOD

ASTM D 5084-03
(SOP-S22C)

Client	CDM	Boring No.	9/2/08
Client Project	DARE CO. C&D LF. EXPANSION	Depth (ft.)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID No.	2008-628-01-09		

Specific Gravity	2.70	Assumed
Sample Condition		Undisturbed

Visual Description: GRAY SILTY SAND

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	Z-12	SS-4
Wt. of Tare & WS (gm.)	465.19	475.6
Wt. of Tare & DS (gm.)	371.05	380.64
Wt. of Tare (gm.)	99.30	101.3
Wt. of Water (gm.)	94.14	94.96
Wt. of DS (gm.)	271.75	279.34
Moisture Content (%)	**34.6**	**34.0**

SPECIMEN:	BEFORE TEST	AFTER TEST
Wt. of Tube & WS (gm.)	734.97	NA
Wt. of Tube (gm.)	0.00	NA
Wt. of WS (calc.) (gm.)	734.97	731.43
Length 1 (in.)	3.761	3.737
Length 2 (in.)	3.732	3.732
Length 3 (in.)	3.768	3.742
Top Diameter (in.)	2.847	2.854
Middle Diameter (in.)	2.849	2.853
Bottom Diameter (in.)	2.825	2.821
Average Length (in.)	3.75	3.74
Average Area (in.^{2})	6.34	6.35
Sample Volume (cm^3)	389.75	388.66
Unit Wet Wt. (gm./ cm^3)	1.886	1.882
Unit Wet Wt. (pcf)	117.7	117.5
Unit Dry Wt. (pcf)	87.4	87.7
Unit Dry Wt. (gm./ cm^3)	1.401	1.405
Void Ratio, e	0.928	0.922
Porosity, n	0.481	0.480
Pore Volume (cm^3)	187.6	186.5
Total Wt. Of Sample After Test		731.93

Tested By: TMS Date: 9/11/2008 Checked By: GBM Date: 9-18-08

DCN: CT-22C DATE:12-21-98 REVISION: 4\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 PERMOM.xls]Sheet1

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FLEXIBLE WALL PERMEABILITY TEST

Geotechnics
INTEGRITY IN TESTING

PERMOMETER METHOD

ASTM D 5084-03
(SOP-S22C)

Client	CDM	Boring No.	9/2/08
Client Project	DARE CO. C&D LF. EXPANSION	Depth (ft.)	23-25
Project No.	2008-628-01	Sample No.	B-506
Lab ID No.	2008-628-01-09		

Test Pressures

Cell Pressure(psi)	45.0
Back Pressure(psi)	40.0
Eff. Cons. Pressure(psi)	5.0
Response (%)	100

Final Sample Dimensions

Sample Length (cm), L	9.49
Sample Area (cm^2), A	40.95
Pipette Area (cm^2), a_p	0.03142
Annulus Area (cm^2), a_a	0.76712
Equilibrium Level (cm), R_{eq}	1.75

AVERAGE PERMEABILITY = 5.7E-07 cm/sec @ 20°C
AVERAGE PERMEABILITY = 5.7E-09 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	(min)	ELAPSED TIME t (min)	PIPETTE READING R_p (cm)	INCREMENT GRADIENT i (cm/cm)	FLOW CONDITION (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
9/11/2008	13	51.73	0	10.5	12.0	0	25.1	NA
9/11/2008	13	51.85	0	10.4	11.9	0	25.1	7.9E-07
9/11/2008	13	52.00	0	10.3	11.8	0	25.1	6.4E-07
9/11/2008	13	52.12	0	10.2	11.6	0	25.1	8.1E-07
9/11/2008	13	52.30	1	10.1	11.5	0	25.1	5.5E-07
9/11/2008	13	52.43	1	10.0	11.4	0	25.1	7.6E-07
9/11/2008	13	52.62	1	9.9	11.2	0	25.1	5.3E-07
9/11/2008	13	52.80	1	9.8	11.1	0	25.1	5.7E-07
9/11/2008	13	52.98	1	9.7	10.9	0	25.1	5.7E-07
9/11/2008	13	53.17	1	9.6	10.8	0	25.1	5.5E-07
9/11/2008	13	53.35	2	9.5	10.7	1	25.1	5.9E-07

Tested By: TMS Date: 9/11/2008 Checked By: GZM Date: 9-18-08

DCN: CT-22C DATE:12-21-98 REVISION: 4\\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-09 PERMOM.xls]Sheet1

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PERMEABILITY TEST

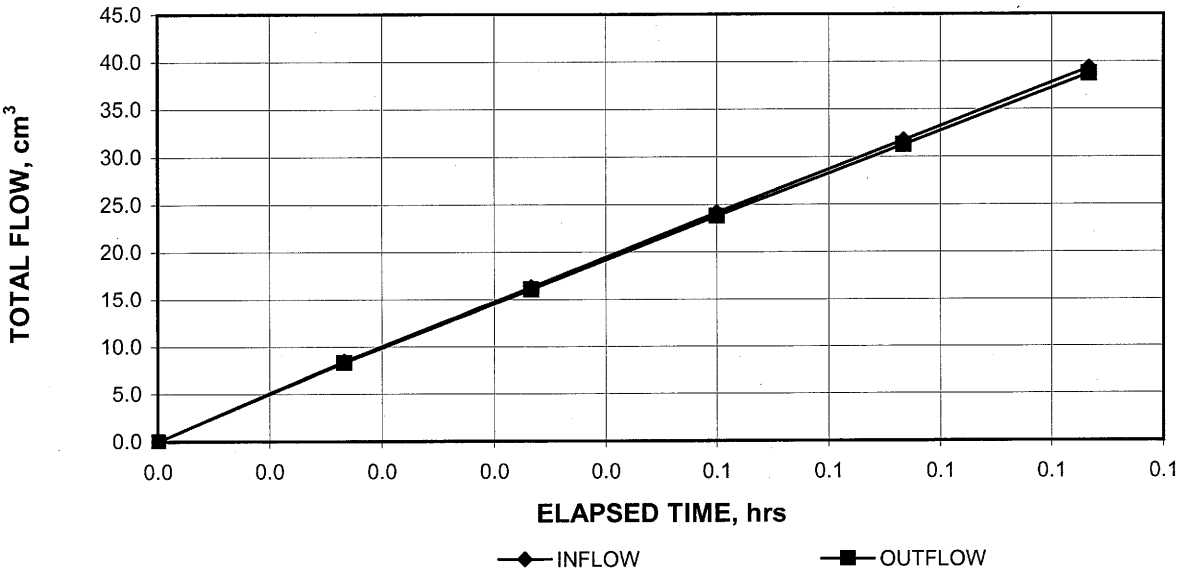
ASTM D 5084-90(Reapproved 2003)
(SOP-S22A & S22B)

geotechnics
INTEGRITY IN TESTING

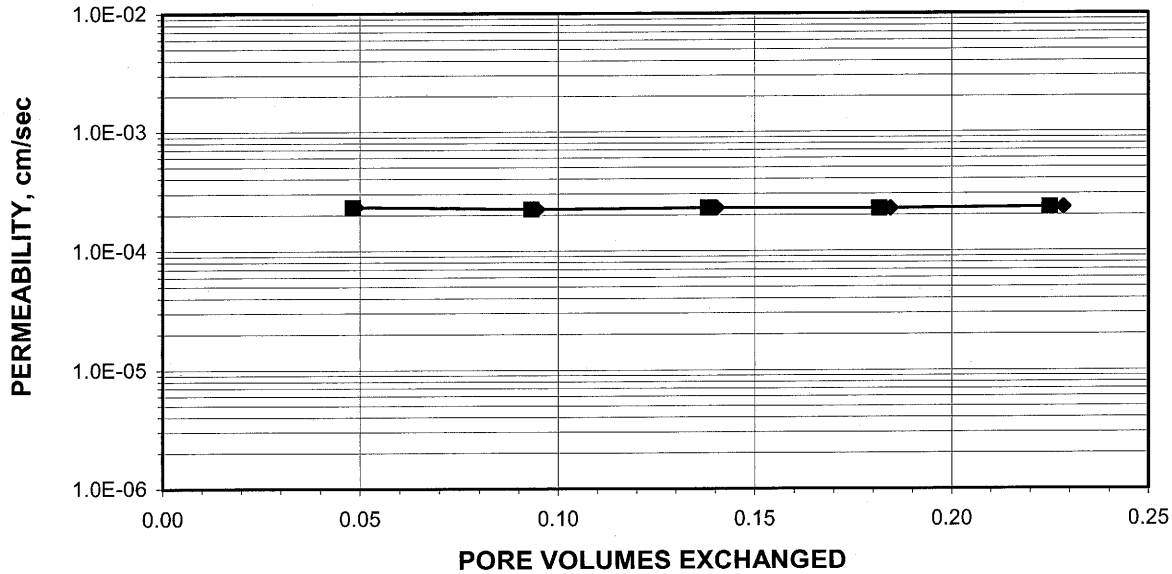
Client	CDM	Boring No.	9/3/08
Client Project	DARE CO. C&D LF EXPANSION	Depth (ft.)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID No.	2008-628-01-10		

AVERAGE PERMEABILITY = 2.3E-04 cm/sec @ 20°C
AVERAGE PERMEABILITY = 2.3E-06 m/sec @ 20°C

TOTAL FLOW vs. ELAPSED TIME



PORE VOLUMES EXCHANGED vs. PERMEABILITY



Tested By: TMS Date: 9/11/2008 Checked By: GEM Date: 9-18-08

DCN: CT-22 DATE: 01-08-99 REVISION:2Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 PERM.xls]Sheet1
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PERMEABILITY TEST

ASTM D 5084-90(Reapproved 2003)
(SOP-S22A & S22B)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	9/3/08
Client Project	DARE CO. C&D LF EXPANSION	Depth (ft.)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID No.	2008-628-01-10		
		Specific Gravity	2.70 Assumed
		Sample Condition	Undisturbed

Visual Description: GRAY SANDY SILT

MOISTURE CONTENT:	BEFORE TEST	AFTER TEST
Tare Number	SS-4	Z-12
Wt. of Tare & WS (gm.)	374.03	480.27
Wt. of Tare & DS (gm.)	319.78	399.58
Wt. of Tare (gm.)	100.15	99.36
Wt. of Water (gm.)	54.25	80.69
Wt. of DS (gm.)	219.63	300.22
Moisture Content (%)	**24.7**	**26.9**

SPECIMEN:	BEFORE TEST	AFTER TEST
Wt. of Tube & WS (gm.)	833.13	NA
Wt. of Tube (gm.)	0.00	NA
Wt. of WS (gm.)	833.13	847.67
Length 1 (in.)	4.123	3.865
Length 2 (in.)	4.114	4.063
Length 3 (in.)	4.133	4.014
Top Diameter (in.)	2.815	2.823
Middle Diameter (in.)	2.864	2.771
Bottom Diameter (in.)	2.835	2.991
Average Length (in.)	4.12	3.98
Average Area (in.^{2})	6.33	6.43
Sample Volume (cm^3)	427.43	419.55
Unit Wet Wt. (gm./ cm^3)	1.95	2.02
Unit Wet Wt. (pcf)	121.7	126.1
Unit Dry Wt. (pcf)	97.6	99.4
Unit Dry Wt. (gm./ cm^3)	1.56	1.59
Void Ratio, e	0.73	0.70
Porosity, n	0.42	0.41
Pore Volume (cm^3)	180.0	172.1
Total Wgt. Of Sample After Test		832.7

Tested By: TMS Date: 9/11/2008 Checked By: GJM Date: 9-18-08

DCN: CT-22 DATE: 01-08-99 REVISION:2 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 PERM.xls]Sheet1

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PERMEABILITY TEST

ASTM D 5084-90(Reapproved 2003)
(SOP-S22A & S22B)

geotechnics
INTEGRITY IN TESTING

Client	CDM	Boring No.	9/3/08
Client Project	DARE CO. C&D LF EXPANSION	Depth (ft.)	2-4
Project No.	2008-628-01	Sample No.	B-505
Lab ID No.	2008-628-01-10		

Pressure Heads (Constant)		Final Sample Dimensions	
Top Cap (psi)	38.5	Sample Length (cm), L	10.11
Bottom Cap (psi)	40.0	Sample Diameter (cm)	7.27
Cell (psi)	45.0	Sample Area (cm^2), A	41.49
Total Pressure Head (cm)	105.5	Inflow Burette Area (cm^2), a-in	4.993
Hydraulic Gradient	10.43	Outflow Burette Area (cm^2), a-out	4.935
		B Parameter (%)	100

AVERAGE PERMEABILITY = 2.3E-04 cm/sec @ 20°C
AVERAGE PERMEABILITY = 2.3E-06 m/sec @ 20°C

DATE (mm/dd/yy)	TIME (hr)	TIME (min)	ELAPSED TIME t (hr)	TOTAL INFLOW (cm^3)	TOTAL OUTFLOW (cm^3)	TOTAL HEAD h (cm)	FLOW (0 flow) (1 stop)	TEMP. (°C)	INCREMENTAL PERMEABILITY @ 20°C (cm/sec)
9/11/2008	14	8	0.0	0.0	0.0	131.4	0	25.1	NA
9/11/2008	14	9	0.0	8.4	8.3	128.1	0	25.1	2.3E-04
9/11/2008	14	10	0.0	16.3	16.0	124.9	0	25.1	2.2E-04
9/11/2008	14	11	0.1	24.2	23.8	121.8	0	25.1	2.3E-04
9/11/2008	14	12	0.1	31.7	31.2	118.7	0	25.1	2.3E-04
9/11/2008	14	13	0.1	39.3	38.7	115.7	1	25.1	2.3E-04

Tested By: TMS Date: 9/11/2008 Checked By: GEM Date: 9-18-08

DCN: CT-22 DATE: 01-08-99 REVISION:2 \\Server\c\2008 PROJECTS\2008-628 CDM\[2008-628-01-10 PERM.xls]Sheet1

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Appendix D
Slug Tests

Slug Test Calculations
Dare County Construction and Demolition Landfill

Well ID	Boring Depth (ft)	Boring Depth (inches)	Lw	r_w	A	B	C	H	Le	1.1/ln(Lw/rw)	A+B	ln((H-lw)/rw) or C	$\ln(R_e/r_w)$	r_c	t	y_o	y_t	K (in/sec)	K (ft/min)	K (ft/day)	K (cm/sec)
B-503 Slug In	20	240	177	3	2.8	0.4	2.3	837	120	0.269770668	3.2	5.393627546	2.4715	1.5	118	2.28	0.1	6.1E-04	3.07E-03	4.42	1.6E-03
B-503 Slug Out	20	240	177	3	2.8	0.4	2.3	837	120	0.269770668	3.2	5.393627546	2.4715	1.5	122	2.43	0.01	1.0E-03	5.22E-03	7.51	2.6E-03
B-503D Slug In	50	600	533	3	2.8	0.4	2.3	833	120	0.212358937	3.2	4.605170186	3.0535	1.5	358	2.9	0.1	2.7E-04	1.35E-03	1.94	6.8E-04
B-503D Slug Out	50	600	533	3	2.8	0.4	2.3	833	120	0.212358937	3.2	4.605170186	3.0535	1.5	400	2.7	0.1	2.4E-04	1.18E-03	1.70	6.0E-04
B-505 Slug In	25	300	236	3	3.9	0.6	3.5	836	240	0.251991909	3.2	5.298317367	3.1425	1.5	123	2.1	0.1	3.6E-04	1.82E-03	2.63	9.3E-04
B-505 Slug Out	25	300	236	3	3.9	0.6	3.5	836	240	0.251991909	3.2	5.298317367	3.1425	1.5	182	2.21	0.1	2.5E-04	1.25E-03	1.80	6.4E-04
B-506 Slug In	20	240	203	3	2.8	0.4	2.3	863	120	0.260997876	3.2	5.393627546	2.5263	1.5	130	2.3	0.01	9.9E-04	4.95E-03	7.13	2.5E-03
B-506D Slug In	50	600	560	3	2.8	0.4	2.3	860	120	0.210352217	3.2	4.605170186	3.0724	1.5	225	2.06	0.01	6.8E-04	3.41E-03	4.91	1.7E-03
B-506D Slug Out	50	600	560	3	2.8	0.4	2.3	860	120	0.210352217	3.2	4.605170186	3.0724	1.5	220	1.25	0.01	6.3E-04	3.16E-03	4.55	1.6E-03
																		5.6E-04	2.8E-03	4.1	1.4E-03

Notes:

Equation used for partially penetrating piezometers:

$$\ln R_e/r_w = [1.1/\ln (Lw/r_w) + (A+B \ln[(H-Lw)/r_w]/(L_e/r_w]^{-1}$$

$$K = (r_c^2 \ln(R_e/r_w)/2Le)\ (1/t)\ (\ln y_o/y_t)$$

Equation used for fully penetrating deep piezometers (screened at top of bedrock):

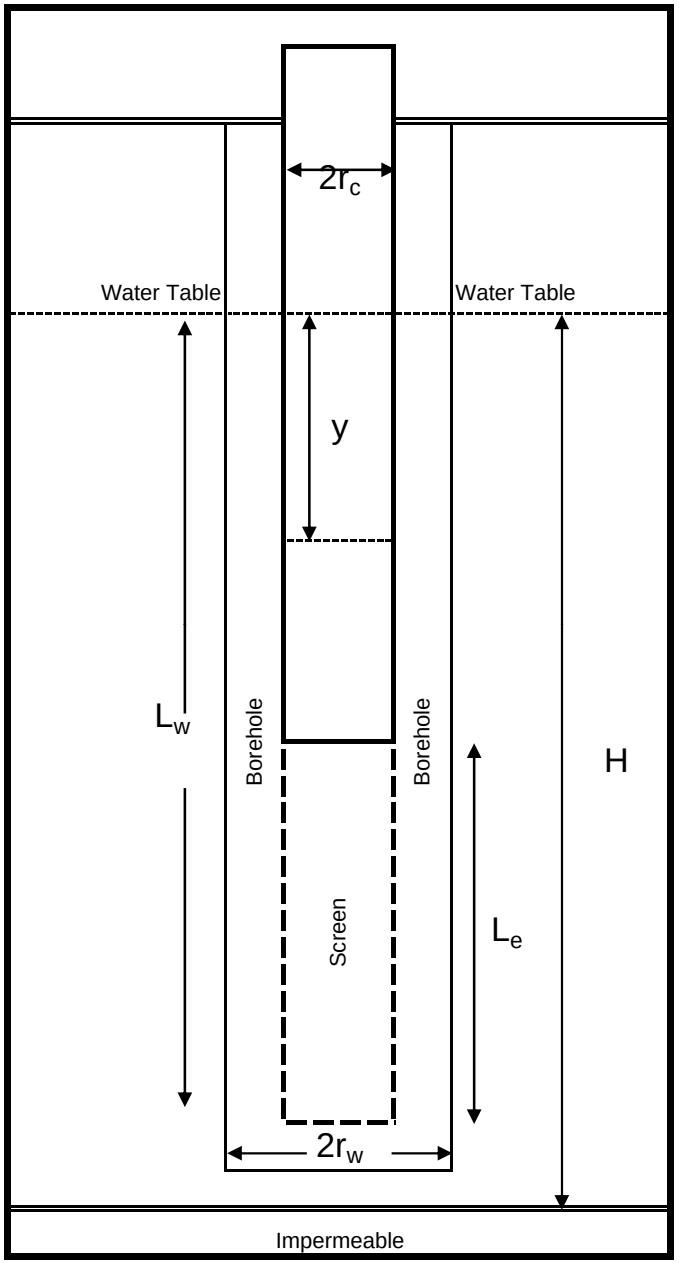
$$\ln Re/rw = [1.1/\ln (Lw/rw) + C/(Le/rw]-1$$

$$K = (rc2 \ln(Re/rw)/2Le)\ (1/t)\ (\ln yo/yt)$$

Where:

r_c = radius of the unscreened part of the well where the head is rising
r_w = horizontal distance from well center to undisturbed aquifer
R_e = radial distance over which the difference in head, ho, is dissipated in the flow system of the aquifer
L_e = length of the saturated gravel pack or open section of the well
y_o = displacement in the well at time to = 0
y_t = dispacement in the well at time t > to
Lw = head in the well before slug test
A = dimensionless parameter which is a function of d/rw
B = dimensionless parameter which is a function of d/rw
C = dimensionless parameter which is a function of d/rw
H = saturated thickness of the aquifer
t = time (seconds)
K = hydraulic conductivity (units given above)

All measurements of length (e.g., radius, distance, head, thickness) are in inches unless specified otherwise.



Input Data

Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	14.7
L_e	Feet	10
H*	Feet	70
y_0	Feet	2.28
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	118

Solutions

Hydraulic Conductivity in Feet/Second
5.21E-05
Hydraulic Conductivity in Feet/Minute
3.12E-03
Hydraulic Conductivity in Feet/Day
4.50E+00

***** - Assumed value

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.516
A	None	2.780	
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ = 2.516
C	None	2.336	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

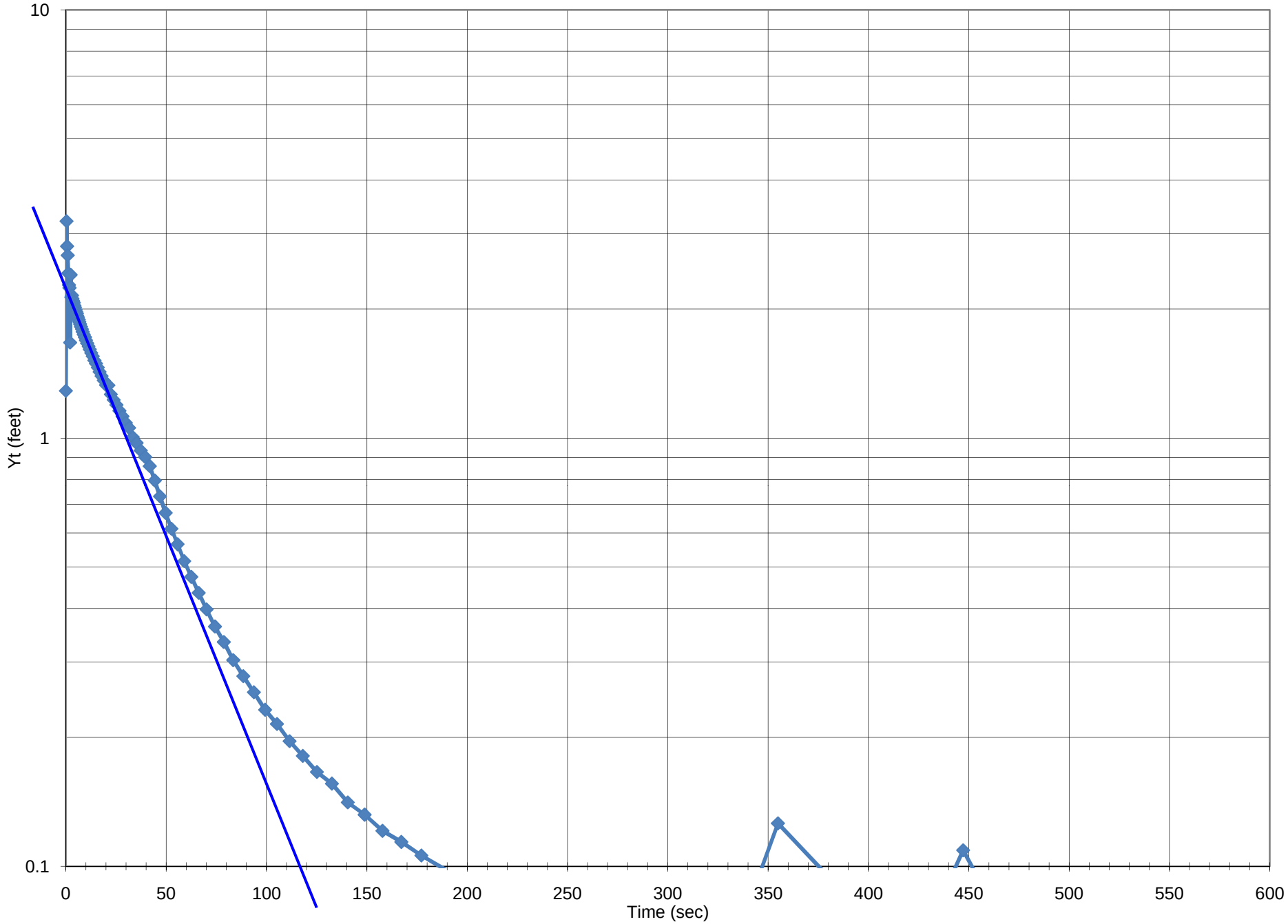
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-503 Slug In
Dare County C&D Landfill



CDM

B-503 Slug In
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:47:45
Report from fi ...\SN08812 2008-09-04 102017 B-503 In.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-503 In

Test defined c 9/4/2008 10:19:26
Test started o 9/4/2008 10:20:17
Test stopped 9/4/2008 10:53:05

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 121

TOTAL DATA 121

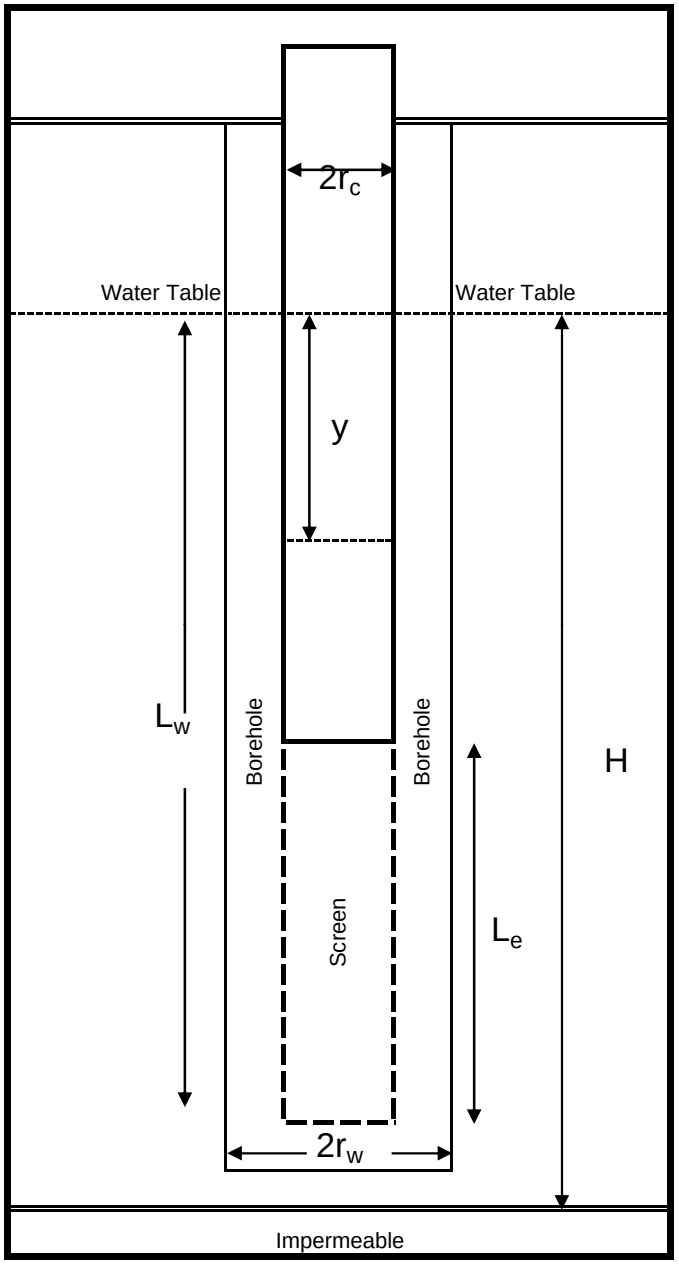
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	10:20:17	0	67.86	6.809	1.289
9/4/2008	10:20:17	0.3	67.88	8.729	3.209
9/4/2008	10:20:17	0.6	67.9	8.325	2.805
9/4/2008	10:20:18	0.9	67.9	8.191	2.671
9/4/2008	10:20:18	1.2	67.9	7.945	2.425
9/4/2008	10:20:18	1.5	67.9	7.798	2.278
9/4/2008	10:20:19	1.8	67.93	7.763	2.243
9/4/2008	10:20:19	2.1	67.93	7.191	1.671
9/4/2008	10:20:19	2.4	67.93	7.925	2.405
9/4/2008	10:20:19	2.7	67.93	7.653	2.133
9/4/2008	10:20:20	3	67.93	7.673	2.153
9/4/2008	10:20:20	3.3	67.93	7.636	2.116
9/4/2008	10:20:20	3.6	67.93	7.61	2.09
9/4/2008	10:20:21	3.9	67.93	7.591	2.071
9/4/2008	10:20:21	4.2	67.93	7.559	2.039
9/4/2008	10:20:21	4.5	67.93	7.54	2.02
9/4/2008	10:20:22	4.8	67.93	7.516	1.996
9/4/2008	10:20:22	5.1	67.93	7.495	1.975
9/4/2008	10:20:22	5.4	67.93	7.475	1.955
9/4/2008	10:20:22	5.7	67.93	7.45	1.93
9/4/2008	10:20:23	6	67.93	7.434	1.914
9/4/2008	10:20:23	6.4	67.93	7.41	1.89
9/4/2008	10:20:23	6.7	67.9	7.389	1.869
9/4/2008	10:20:24	7.1	67.93	7.365	1.845

9/4/2008	10:20:24	7.5	67.93	7.34	1.82
9/4/2008	10:20:25	8	67.93	7.316	1.796
9/4/2008	10:20:25	8.4	67.93	7.291	1.771
9/4/2008	10:20:26	8.9	67.9	7.265	1.745
9/4/2008	10:20:26	9.5	67.9	7.24	1.72
9/4/2008	10:20:27	10	67.9	7.212	1.692
9/4/2008	10:20:27	10.6	67.9	7.185	1.665
9/4/2008	10:20:28	11.3	67.9	7.158	1.638
9/4/2008	10:20:29	11.9	67.88	7.13	1.61
9/4/2008	10:20:29	12.6	67.88	7.101	1.581
9/4/2008	10:20:30	13.4	67.88	7.073	1.553
9/4/2008	10:20:31	14.2	67.88	7.038	1.518
9/4/2008	10:20:32	15	67.88	7.013	1.493
9/4/2008	10:20:33	15.9	67.88	6.981	1.461
9/4/2008	10:20:34	16.8	67.86	6.948	1.428
9/4/2008	10:20:35	17.8	67.86	6.916	1.396
9/4/2008	10:20:36	18.9	67.86	6.883	1.363
9/4/2008	10:20:37	20	67.86	6.85	1.33
9/4/2008	10:20:38	21.2	67.86	6.848	1.328
9/4/2008	10:20:39	22.4	67.86	6.785	1.265
9/4/2008	10:20:41	23.8	67.86	6.748	1.228
9/4/2008	10:20:42	25.2	67.86	6.715	1.195
9/4/2008	10:20:43	26.7	67.86	6.678	1.158
9/4/2008	10:20:45	28.2	67.88	6.644	1.124
9/4/2008	10:20:47	29.8	67.88	6.605	1.085
9/4/2008	10:20:48	31.5	67.88	6.576	1.056
9/4/2008	10:20:50	33.3	67.88	6.525	1.005
9/4/2008	10:20:52	35.2	67.88	6.494	0.974
9/4/2008	10:20:54	37.3	67.88	6.455	0.935
9/4/2008	10:20:56	39.5	67.9	6.423	0.903
9/4/2008	10:20:59	41.8	67.9	6.38	0.86
9/4/2008	10:21:01	44.3	67.9	6.316	0.796
9/4/2008	10:21:04	46.9	67.93	6.251	0.731
9/4/2008	10:21:06	49.7	67.93	6.189	0.669
9/4/2008	10:21:09	52.6	67.95	6.134	0.614
9/4/2008	10:21:12	55.7	67.95	6.085	0.565
9/4/2008	10:21:16	59	67.97	6.036	0.516
9/4/2008	10:21:19	62.5	68	5.994	0.474
9/4/2008	10:21:23	66.2	68.02	5.955	0.435
9/4/2008	10:21:27	70.1	68.04	5.918	0.398
9/4/2008	10:21:31	74.3	68.06	5.883	0.363
9/4/2008	10:21:35	78.7	68.11	5.854	0.334
9/4/2008	10:21:40	83.4	68.15	5.823	0.303
9/4/2008	10:21:45	88.4	68.2	5.798	0.278
9/4/2008	10:21:50	93.7	68.27	5.775	0.255
9/4/2008	10:21:56	99.3	68.31	5.752	0.232
9/4/2008	10:22:02	105.2	68.38	5.735	0.215
9/4/2008	10:22:08	111.5	68.45	5.716	0.196
9/4/2008	10:22:15	118.1	68.52	5.701	0.181
9/4/2008	10:22:22	125.1	68.58	5.686	0.166
9/4/2008	10:22:29	132.6	68.65	5.676	0.156
9/4/2008	10:22:37	140.5	68.72	5.661	0.141
9/4/2008	10:22:46	148.9	68.76	5.652	0.132
9/4/2008	10:22:55	157.8	68.83	5.641	0.121
9/4/2008	10:23:04	167.2	68.9	5.634	0.114
9/4/2008	10:23:14	177.2	68.95	5.626	0.106
9/4/2008	10:23:25	187.8	69.01	5.619	0.099
9/4/2008	10:23:36	199	69.06	5.612	0.092
9/4/2008	10:23:48	210.9	69.08	5.606	0.086
9/4/2008	10:24:00	223.5	69.13	5.599	0.079
9/4/2008	10:24:14	236.8	69.15	5.593	0.073
9/4/2008	10:24:28	250.9	69.17	5.587	0.067
9/4/2008	10:24:43	265.8	69.19	5.585	0.065

9/4/2008	10:24:58	281.6	69.22	5.586	0.066
9/4/2008	10:25:15	298.4	69.22	5.582	0.062
9/4/2008	10:25:33	316.2	69.22	5.58	0.06
9/4/2008	10:25:52	335	69.22	5.59	0.07
9/4/2008	10:26:12	354.9	69.22	5.646	0.126
9/4/2008	10:26:33	376	69.24	5.619	0.099
9/4/2008	10:26:55	398.4	69.24	5.598	0.078
9/4/2008	10:27:19	422.1	69.24	5.58	0.06
9/4/2008	10:27:44	447.2	69.26	5.629	0.109
9/4/2008	10:28:11	473.8	69.29	5.584	0.064
9/4/2008	10:28:39	502	69.29	5.565	0.045
9/4/2008	10:29:09	531.9	69.29	5.557	0.037
9/4/2008	10:29:40	563.5	69.29	5.549	0.029
9/4/2008	10:30:14	597	69.26	5.545	0.025
9/4/2008	10:30:49	632.5	69.24	5.541	0.021
9/4/2008	10:31:27	670.1	69.22	5.539	0.019
9/4/2008	10:32:07	709.9	69.17	5.536	0.016
9/4/2008	10:32:49	752.1	69.13	5.534	0.014
9/4/2008	10:33:34	796.8	69.06	5.533	0.013
9/4/2008	10:34:21	844.2	69.01	5.531	0.011
9/4/2008	10:35:11	894.4	68.95	5.53	0.01
9/4/2008	10:36:04	947.5	68.9	5.528	0.008
9/4/2008	10:37:01	1003.8	68.83	5.527	0.007
9/4/2008	10:38:00	1063.4	68.76	5.525	0.005
9/4/2008	10:39:03	1126.6	68.7	5.526	0.006
9/4/2008	10:40:10	1193.5	68.65	5.524	0.004
9/4/2008	10:41:21	1264.4	68.58	5.525	0.005
9/4/2008	10:42:36	1339.5	68.52	5.523	0.003
9/4/2008	10:43:56	1419	68.45	5.524	0.004
9/4/2008	10:45:20	1503.3	68.38	5.525	0.005
9/4/2008	10:46:49	1592.6	68.31	5.523	0.003
9/4/2008	10:48:24	1687.1	68.24	5.524	0.004
9/4/2008	10:50:04	1787.2	68.18	5.525	0.005
9/4/2008	10:51:50	1893.3	68.11	5.525	0.005



Input Data

Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	14.7
L_e	Feet	10
H*	Feet	70
y_0	Feet	2.43
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	122

Solutions

Hydraulic Conductivity in Feet/Second
8.85E-05
Hydraulic Conductivity in Feet/Minute
5.31E-03
Hydraulic Conductivity in Feet/Day
7.65E+00

***** - Assumed value

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{partial\ penetration}$ = 2.516
A	None	2.780	
B	None	0.430	$\ln(R_e/r_W)_{full\ penetration}$ = 2.516
C	None	2.336	3.045

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

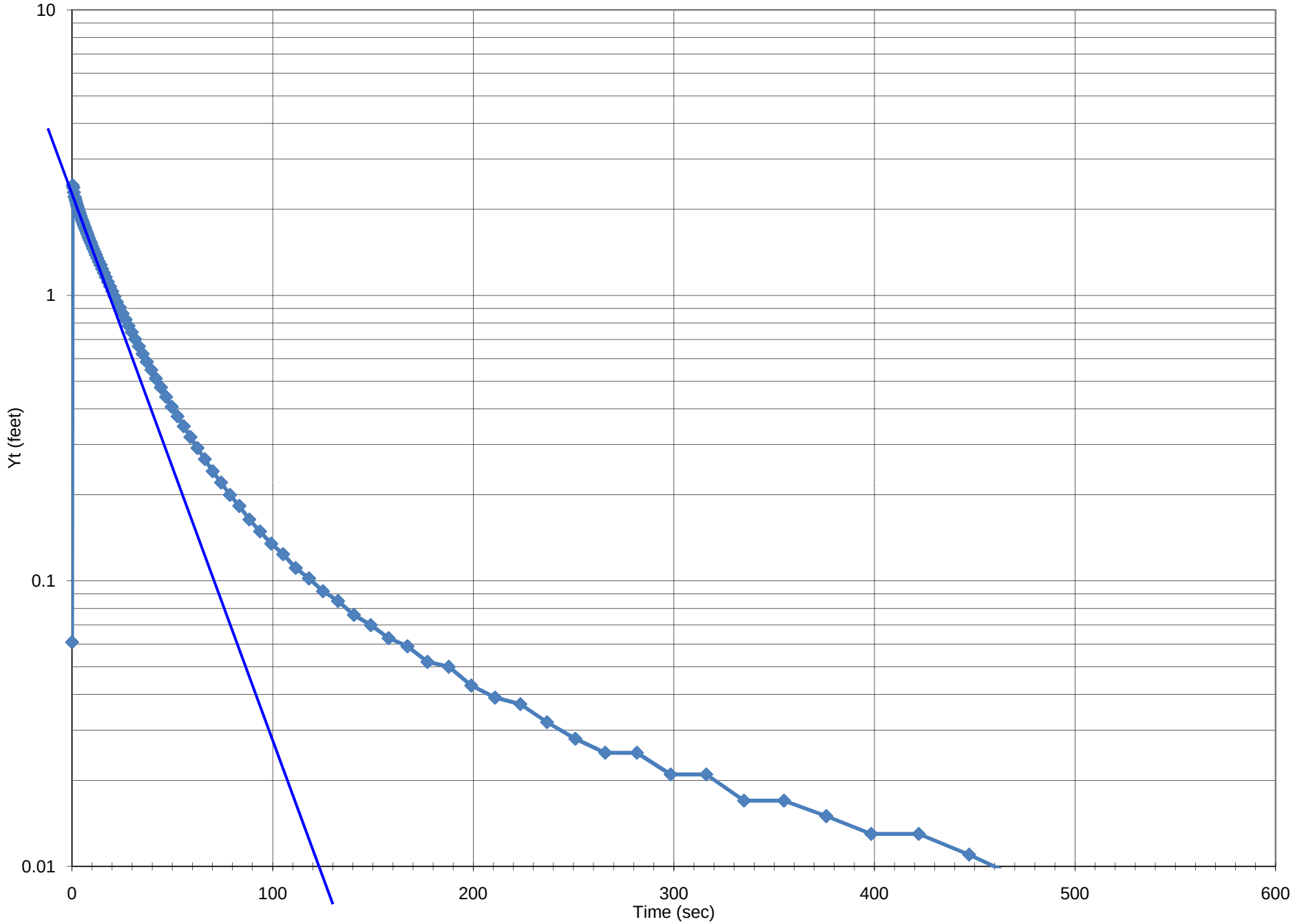
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-503 Slug Out
Dare County C&D Landfill



CDM

B-503 Slug Out
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:48:25
Report from fi ...\SN08812 2008-09-04 105424 B-503 Out.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-503 Out

Test defined c 9/4/2008 10:54:01
Test started o 9/4/2008 10:54:24
Test stopped 9/4/2008 11:12:07

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 110

TOTAL DATA 110

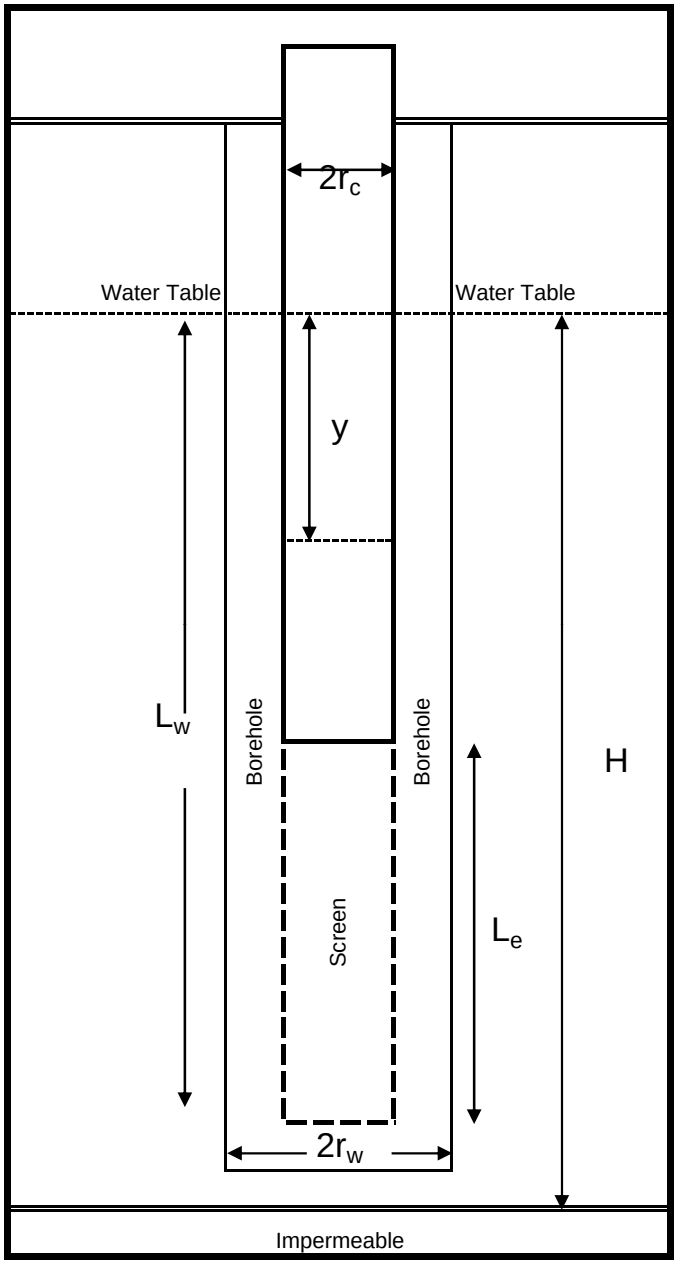
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	10:54:24	0	68.02	5.379	0.061
9/4/2008	10:54:24	0.3	68.04	3.011	2.429
9/4/2008	10:54:24	0.6	68.04	3.055	2.385
9/4/2008	10:54:25	0.9	68.06	3.144	2.296
9/4/2008	10:54:25	1.2	68.06	3.226	2.214
9/4/2008	10:54:25	1.5	68.06	3.236	2.204
9/4/2008	10:54:26	1.8	68.06	3.283	2.157
9/4/2008	10:54:26	2.1	68.09	3.326	2.114
9/4/2008	10:54:26	2.4	68.09	3.364	2.076
9/4/2008	10:54:27	2.7	68.09	3.393	2.047
9/4/2008	10:54:27	3	68.09	3.428	2.012
9/4/2008	10:54:27	3.3	68.09	3.458	1.982
9/4/2008	10:54:27	3.6	68.09	3.485	1.955
9/4/2008	10:54:28	3.9	68.09	3.512	1.928
9/4/2008	10:54:28	4.2	68.09	3.54	1.9
9/4/2008	10:54:28	4.5	68.09	3.565	1.875
9/4/2008	10:54:29	4.8	68.09	3.591	1.849
9/4/2008	10:54:29	5.1	68.09	3.616	1.824
9/4/2008	10:54:29	5.4	68.09	3.638	1.802
9/4/2008	10:54:30	5.7	68.09	3.663	1.777
9/4/2008	10:54:30	6	68.09	3.685	1.755
9/4/2008	10:54:30	6.4	68.09	3.712	1.728
9/4/2008	10:54:31	6.7	68.11	3.738	1.702
9/4/2008	10:54:31	7.1	68.09	3.765	1.675

9/4/2008	10:54:31	7.5	68.11	3.794	1.646
9/4/2008	10:54:32	8	68.11	3.822	1.618
9/4/2008	10:54:32	8.4	68.11	3.853	1.587
9/4/2008	10:54:33	8.9	68.11	3.884	1.556
9/4/2008	10:54:33	9.5	68.11	3.914	1.526
9/4/2008	10:54:34	10	68.11	3.949	1.491
9/4/2008	10:54:34	10.6	68.09	3.984	1.456
9/4/2008	10:54:35	11.3	68.09	4.019	1.421
9/4/2008	10:54:36	11.9	68.09	4.053	1.387
9/4/2008	10:54:36	12.6	68.09	4.088	1.352
9/4/2008	10:54:37	13.4	68.06	4.127	1.313
9/4/2008	10:54:38	14.2	68.06	4.162	1.278
9/4/2008	10:54:39	15	68.06	4.203	1.237
9/4/2008	10:54:40	15.9	68.06	4.242	1.198
9/4/2008	10:54:41	16.8	68.04	4.281	1.159
9/4/2008	10:54:42	17.8	68.04	4.324	1.116
9/4/2008	10:54:43	18.9	68.02	4.365	1.075
9/4/2008	10:54:44	20	68.02	4.406	1.034
9/4/2008	10:54:45	21.2	68.02	4.449	0.991
9/4/2008	10:54:46	22.4	68	4.492	0.948
9/4/2008	10:54:48	23.8	67.97	4.533	0.907
9/4/2008	10:54:49	25.2	67.95	4.576	0.864
9/4/2008	10:54:51	26.7	67.95	4.617	0.823
9/4/2008	10:54:52	28.2	67.93	4.658	0.782
9/4/2008	10:54:54	29.8	67.9	4.697	0.743
9/4/2008	10:54:55	31.5	67.88	4.738	0.702
9/4/2008	10:54:57	33.3	67.86	4.777	0.663
9/4/2008	10:54:59	35.2	67.84	4.816	0.624
9/4/2008	10:55:01	37.3	67.84	4.855	0.585
9/4/2008	10:55:03	39.5	67.79	4.892	0.548
9/4/2008	10:55:06	41.8	67.77	4.929	0.511
9/4/2008	10:55:08	44.3	67.75	4.964	0.476
9/4/2008	10:55:11	46.9	67.72	4.999	0.441
9/4/2008	10:55:14	49.7	67.68	5.033	0.407
9/4/2008	10:55:16	52.6	67.66	5.063	0.377
9/4/2008	10:55:20	55.7	67.61	5.092	0.348
9/4/2008	10:55:23	59	67.59	5.121	0.319
9/4/2008	10:55:26	62.5	67.54	5.148	0.292
9/4/2008	10:55:30	66.2	67.5	5.173	0.267
9/4/2008	10:55:34	70.1	67.45	5.198	0.242
9/4/2008	10:55:38	74.3	67.41	5.219	0.221
9/4/2008	10:55:43	78.7	67.36	5.24	0.2
9/4/2008	10:55:47	83.4	67.32	5.257	0.183
9/4/2008	10:55:52	88.4	67.27	5.276	0.164
9/4/2008	10:55:58	93.7	67.2	5.291	0.149
9/4/2008	10:56:03	99.3	67.16	5.305	0.135
9/4/2008	10:56:09	105.2	67.09	5.316	0.124
9/4/2008	10:56:15	111.5	67.05	5.329	0.111
9/4/2008	10:56:22	118.1	66.98	5.338	0.102
9/4/2008	10:56:29	125.1	66.93	5.348	0.092
9/4/2008	10:56:36	132.6	66.89	5.355	0.085
9/4/2008	10:56:44	140.5	66.82	5.364	0.076
9/4/2008	10:56:53	148.9	66.77	5.37	0.07
9/4/2008	10:57:02	157.8	66.73	5.377	0.063
9/4/2008	10:57:11	167.2	66.68	5.381	0.059
9/4/2008	10:57:21	177.2	66.64	5.388	0.052
9/4/2008	10:57:32	187.8	66.59	5.39	0.05
9/4/2008	10:57:43	199	66.57	5.397	0.043
9/4/2008	10:57:55	210.9	66.52	5.401	0.039
9/4/2008	10:58:07	223.5	66.5	5.403	0.037
9/4/2008	10:58:21	236.8	66.48	5.408	0.032
9/4/2008	10:58:35	250.9	66.43	5.412	0.028
9/4/2008	10:58:50	265.8	66.41	5.415	0.025

9/4/2008	10:59:05	281.6	66.41	5.415	0.025
9/4/2008	10:59:22	298.4	66.39	5.419	0.021
9/4/2008	10:59:40	316.2	66.37	5.419	0.021
9/4/2008	10:59:59	335	66.37	5.423	0.017
9/4/2008	11:00:19	354.9	66.37	5.423	0.017
9/4/2008	11:00:40	376	66.37	5.425	0.015
9/4/2008	11:01:02	398.4	66.34	5.427	0.013
9/4/2008	11:01:26	422.1	66.34	5.427	0.013
9/4/2008	11:01:51	447.2	66.37	5.429	0.011
9/4/2008	11:02:18	473.8	66.37	5.431	0.009
9/4/2008	11:02:46	502	66.37	5.431	0.009
9/4/2008	11:03:16	531.9	66.39	5.433	0.007
9/4/2008	11:03:47	563.5	66.39	5.433	0.007
9/4/2008	11:04:21	597	66.39	5.433	0.007
9/4/2008	11:04:56	632.5	66.41	5.435	0.005
9/4/2008	11:05:34	670.1	66.43	5.435	0.005
9/4/2008	11:06:14	709.9	66.43	5.435	0.005
9/4/2008	11:06:56	752.1	66.46	5.437	0.003
9/4/2008	11:07:41	796.8	66.46	5.437	0.003
9/4/2008	11:08:28	844.2	66.48	5.438	0.002
9/4/2008	11:09:18	894.4	66.48	5.436	0.004
9/4/2008	11:10:11	947.5	66.5	5.436	0.004
9/4/2008	11:11:08	1003.8	66.52	5.436	0.004



Input Data		
Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	44.4
L_e	Feet	10
H*	Feet	69
y_0	Feet	2.9
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	358

Solutions
Hydraulic Conductivity in Feet/Second
2.22E-05
Hydraulic Conductivity in Feet/Minute
1.33E-03
Hydraulic Conductivity in Feet/Day
1.92E+00

***** - Assumed value

Calculations			
Term	Units		3.020
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
A	None	2.780	3.020
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.693

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

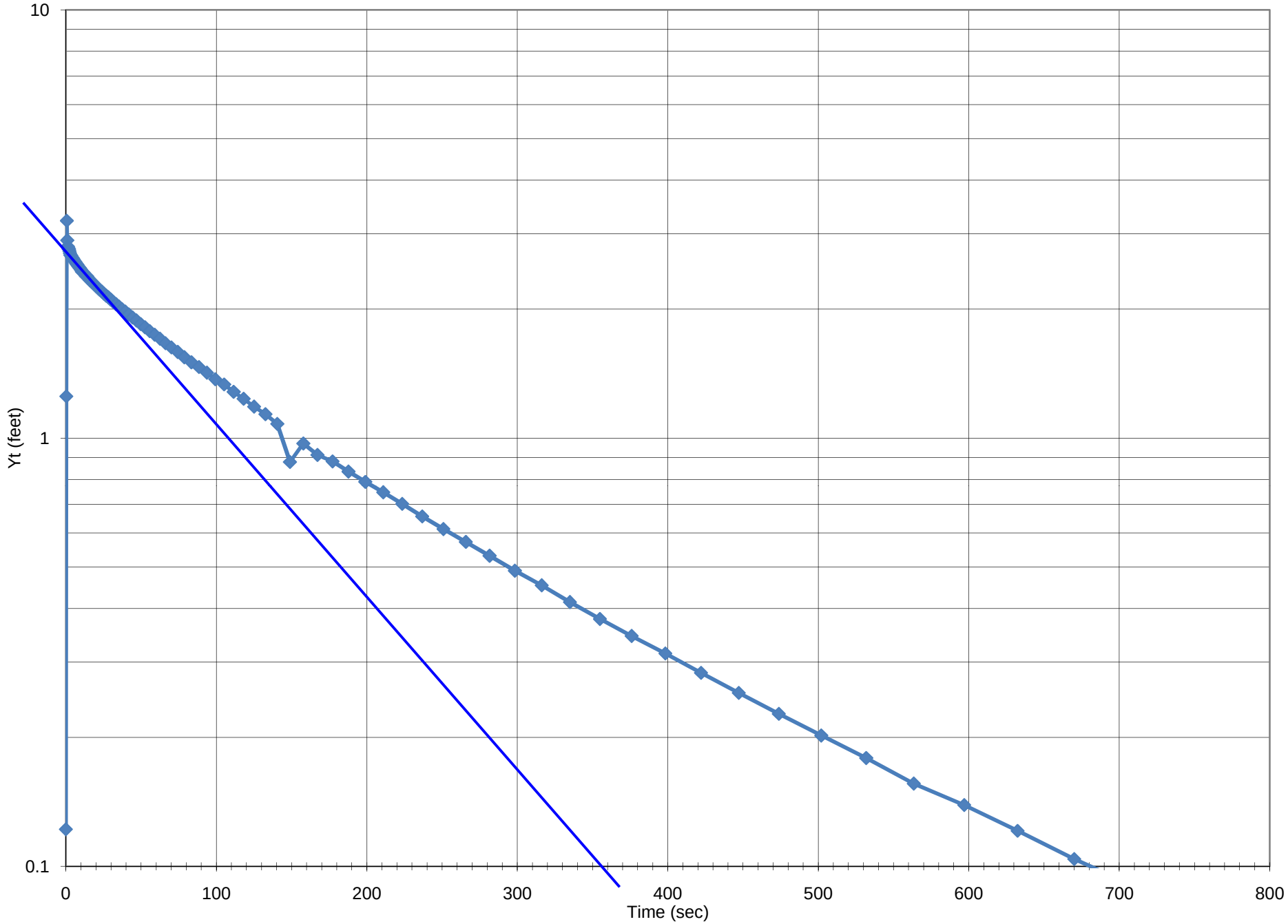
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-503D Slug In
Dare County C&D Landfill



CDM

B-503D Slug In
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:49:04
Report from fi ...\SN08812 2008-09-04 111535 B-503D In.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-503D In

Test defined c 9/4/2008 11:14:52
Test started o 9/4/2008 11:15:35
Test stopped 9/4/2008 11:44:04

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 119

TOTAL DATA 119

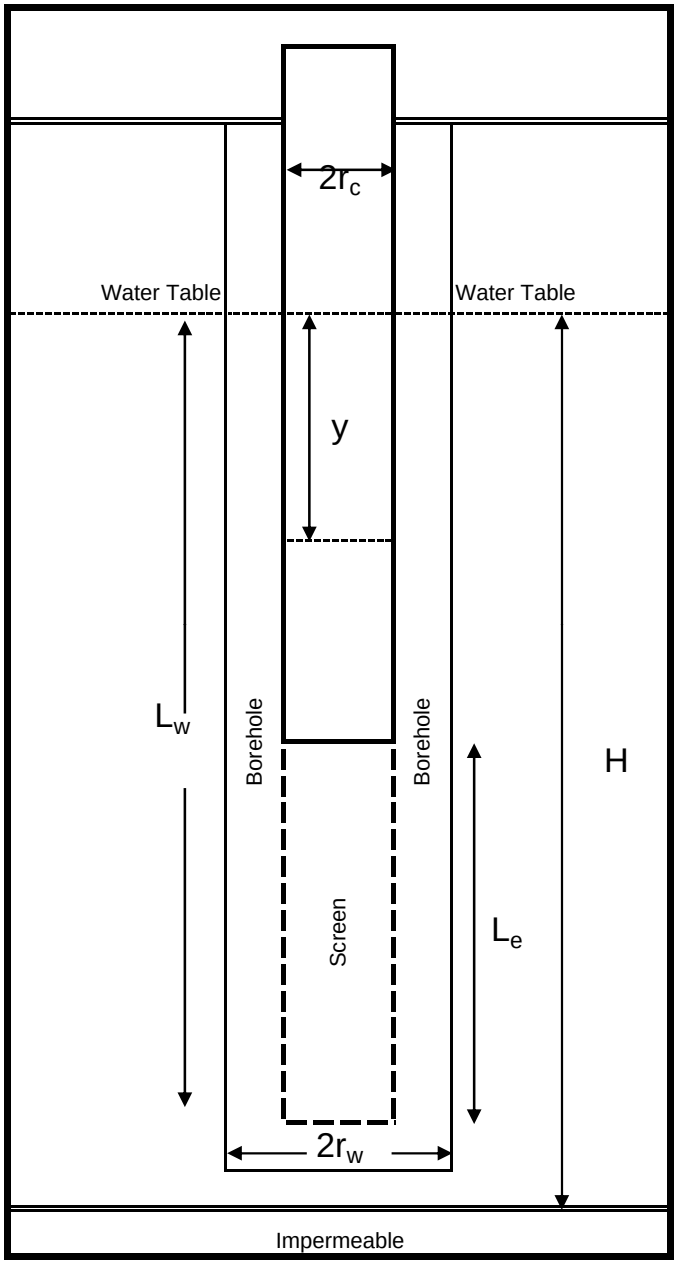
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	11:15:35	0	63.74	12.502	0.122
9/4/2008	11:15:35	0.3	63.76	13.631	1.251
9/4/2008	11:15:36	0.6	63.76	15.596	3.216
9/4/2008	11:15:36	0.9	63.79	15.276	2.896
9/4/2008	11:15:36	1.2	63.79	15.182	2.802
9/4/2008	11:15:37	1.5	63.81	15.167	2.787
9/4/2008	11:15:37	1.8	63.81	15.144	2.764
9/4/2008	11:15:37	2.1	63.81	15.14	2.76
9/4/2008	11:15:37	2.4	63.81	15.111	2.731
9/4/2008	11:15:38	2.7	63.81	15.083	2.703
9/4/2008	11:15:38	3	63.81	15.055	2.675
9/4/2008	11:15:38	3.3	63.81	15.053	2.673
9/4/2008	11:15:39	3.6	63.81	15.043	2.663
9/4/2008	11:15:39	3.9	63.81	15.03	2.65
9/4/2008	11:15:39	4.2	63.81	15.02	2.64
9/4/2008	11:15:40	4.5	63.81	15.012	2.632
9/4/2008	11:15:40	4.8	63.81	15.002	2.622
9/4/2008	11:15:40	5.1	63.81	14.992	2.612
9/4/2008	11:15:40	5.4	63.81	14.981	2.601
9/4/2008	11:15:41	5.7	63.81	14.973	2.593
9/4/2008	11:15:41	6	63.81	14.963	2.583
9/4/2008	11:15:41	6.4	63.81	14.955	2.575
9/4/2008	11:15:42	6.7	63.81	14.943	2.563
9/4/2008	11:15:42	7.1	63.81	14.93	2.55

9/4/2008	11:15:43	7.5	63.81	14.92	2.54
9/4/2008	11:15:43	8	63.81	14.906	2.526
9/4/2008	11:15:44	8.4	63.81	14.894	2.514
9/4/2008	11:15:44	8.9	63.81	14.881	2.501
9/4/2008	11:15:45	9.5	63.81	14.869	2.489
9/4/2008	11:15:45	10	63.79	14.851	2.471
9/4/2008	11:15:46	10.6	63.79	14.828	2.448
9/4/2008	11:15:46	11.3	63.76	14.82	2.44
9/4/2008	11:15:47	11.9	63.76	14.806	2.426
9/4/2008	11:15:48	12.6	63.76	14.792	2.412
9/4/2008	11:15:48	13.4	63.76	14.767	2.387
9/4/2008	11:15:49	14.2	63.76	14.765	2.385
9/4/2008	11:15:50	15	63.74	14.739	2.359
9/4/2008	11:15:51	15.9	63.74	14.718	2.338
9/4/2008	11:15:52	16.8	63.74	14.704	2.324
9/4/2008	11:15:53	17.8	63.74	14.684	2.304
9/4/2008	11:15:54	18.9	63.74	14.665	2.285
9/4/2008	11:15:55	20	63.72	14.643	2.263
9/4/2008	11:15:56	21.2	63.72	14.623	2.243
9/4/2008	11:15:58	22.4	63.72	14.6	2.22
9/4/2008	11:15:59	23.8	63.72	14.578	2.198
9/4/2008	11:16:00	25.2	63.72	14.555	2.175
9/4/2008	11:16:02	26.7	63.69	14.531	2.151
9/4/2008	11:16:03	28.2	63.69	14.511	2.131
9/4/2008	11:16:05	29.8	63.69	14.486	2.106
9/4/2008	11:16:07	31.5	63.69	14.459	2.079
9/4/2008	11:16:08	33.3	63.69	14.435	2.055
9/4/2008	11:16:10	35.2	63.69	14.408	2.028
9/4/2008	11:16:12	37.3	63.67	14.38	2
9/4/2008	11:16:15	39.5	63.67	14.353	1.973
9/4/2008	11:16:17	41.8	63.67	14.323	1.943
9/4/2008	11:16:19	44.3	63.67	14.292	1.912
9/4/2008	11:16:22	46.9	63.67	14.262	1.882
9/4/2008	11:16:25	49.7	63.67	14.225	1.845
9/4/2008	11:16:28	52.6	63.67	14.194	1.814
9/4/2008	11:16:31	55.7	63.67	14.157	1.777
9/4/2008	11:16:34	59	63.67	14.123	1.743
9/4/2008	11:16:38	62.5	63.67	14.086	1.706
9/4/2008	11:16:41	66.2	63.67	14.045	1.665
9/4/2008	11:16:45	70.1	63.67	14.008	1.628
9/4/2008	11:16:49	74.3	63.67	13.969	1.589
9/4/2008	11:16:54	78.7	63.69	13.924	1.544
9/4/2008	11:16:58	83.4	63.69	13.883	1.503
9/4/2008	11:17:03	88.4	63.69	13.845	1.465
9/4/2008	11:17:09	93.7	63.72	13.801	1.421
9/4/2008	11:17:14	99.3	63.72	13.752	1.372
9/4/2008	11:17:20	105.2	63.72	13.714	1.334
9/4/2008	11:17:27	111.5	63.74	13.662	1.282
9/4/2008	11:17:33	118.1	63.76	13.615	1.235
9/4/2008	11:17:40	125.1	63.76	13.564	1.184
9/4/2008	11:17:48	132.6	63.79	13.517	1.137
9/4/2008	11:17:56	140.5	63.81	13.459	1.079
9/4/2008	11:18:04	148.9	63.81	13.259	0.879
9/4/2008	11:18:13	157.8	63.83	13.351	0.971
9/4/2008	11:18:22	167.2	63.88	13.293	0.913
9/4/2008	11:18:32	177.2	63.9	13.262	0.882
9/4/2008	11:18:43	187.8	63.94	13.215	0.835
9/4/2008	11:18:54	199	63.97	13.17	0.79
9/4/2008	11:19:06	210.9	63.97	13.127	0.747
9/4/2008	11:19:19	223.5	63.99	13.082	0.702
9/4/2008	11:19:32	236.8	64.01	13.036	0.656
9/4/2008	11:19:46	250.9	64.03	12.993	0.613
9/4/2008	11:20:01	265.8	64.06	12.952	0.572

9/4/2008	11:20:17	281.6	64.08	12.911	0.531
9/4/2008	11:20:33	298.4	64.12	12.87	0.49
9/4/2008	11:20:51	316.2	64.15	12.833	0.453
9/4/2008	11:21:10	335	64.19	12.794	0.414
9/4/2008	11:21:30	354.9	64.24	12.758	0.378
9/4/2008	11:21:51	376	64.31	12.725	0.345
9/4/2008	11:22:13	398.4	64.35	12.694	0.314
9/4/2008	11:22:37	422.1	64.4	12.663	0.283
9/4/2008	11:23:02	447.2	64.46	12.634	0.254
9/4/2008	11:23:29	473.8	64.51	12.607	0.227
9/4/2008	11:23:57	502	64.56	12.582	0.202
9/4/2008	11:24:27	531.9	64.6	12.559	0.179
9/4/2008	11:24:59	563.5	64.62	12.536	0.156
9/4/2008	11:25:32	597	64.65	12.519	0.139
9/4/2008	11:26:08	632.5	64.65	12.501	0.121
9/4/2008	11:26:45	670.1	64.67	12.484	0.104
9/4/2008	11:27:25	709.9	64.65	12.47	0.09
9/4/2008	11:28:07	752.1	64.65	12.458	0.078
9/4/2008	11:28:52	796.8	64.62	12.446	0.066
9/4/2008	11:29:39	844.2	64.6	12.436	0.056
9/4/2008	11:30:29	894.4	64.58	12.428	0.048
9/4/2008	11:31:23	947.5	64.56	12.42	0.04
9/4/2008	11:32:19	1003.8	64.53	12.414	0.034
9/4/2008	11:33:18	1063.4	64.49	12.409	0.029
9/4/2008	11:34:22	1126.6	64.46	12.405	0.025
9/4/2008	11:35:29	1193.5	64.42	12.401	0.021
9/4/2008	11:36:39	1264.4	64.37	12.397	0.017
9/4/2008	11:37:55	1339.5	64.35	12.396	0.016
9/4/2008	11:39:14	1419	64.31	12.394	0.014
9/4/2008	11:40:38	1503.3	64.26	12.392	0.012
9/4/2008	11:42:08	1592.6	64.22	12.389	0.009
9/4/2008	11:43:42	1687.1	64.19	12.387	0.007



Input Data

Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	44.4
L_e	Feet	10
H*	Feet	69
y_0	Feet	2.7
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	400

Solutions

Hydraulic Conductivity in Feet/Second
1.94E-05
Hydraulic Conductivity in Feet/Minute
1.17E-03
Hydraulic Conductivity in Feet/Day
1.68E+00

***** - Assumed value

Calculations

Term	Units		
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 3.020
A	None	2.780	
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ = 3.020
C	None	2.336	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

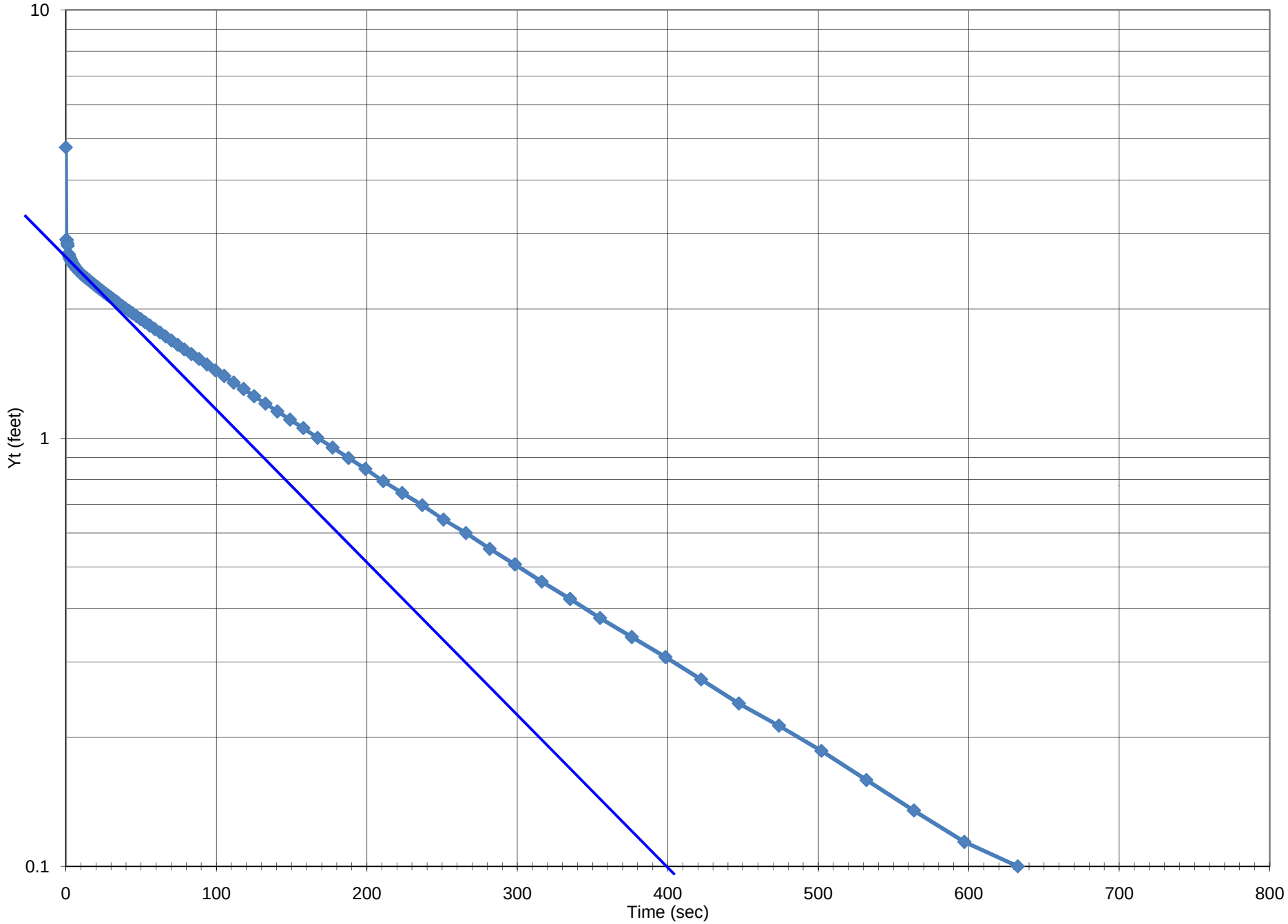
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-503D Slug Out
Dare County C&D Landfill



CDM

B-503D Slug Out
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:49:48
Report from fi ...\SN08812 2008-09-04 114505 B-503D Out.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-503D Out

Test defined c 9/4/2008 11:44:36
Test started o 9/4/2008 11:45:05
Test stopped 9/4/2008 12:05:48

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 113

TOTAL DATA 113

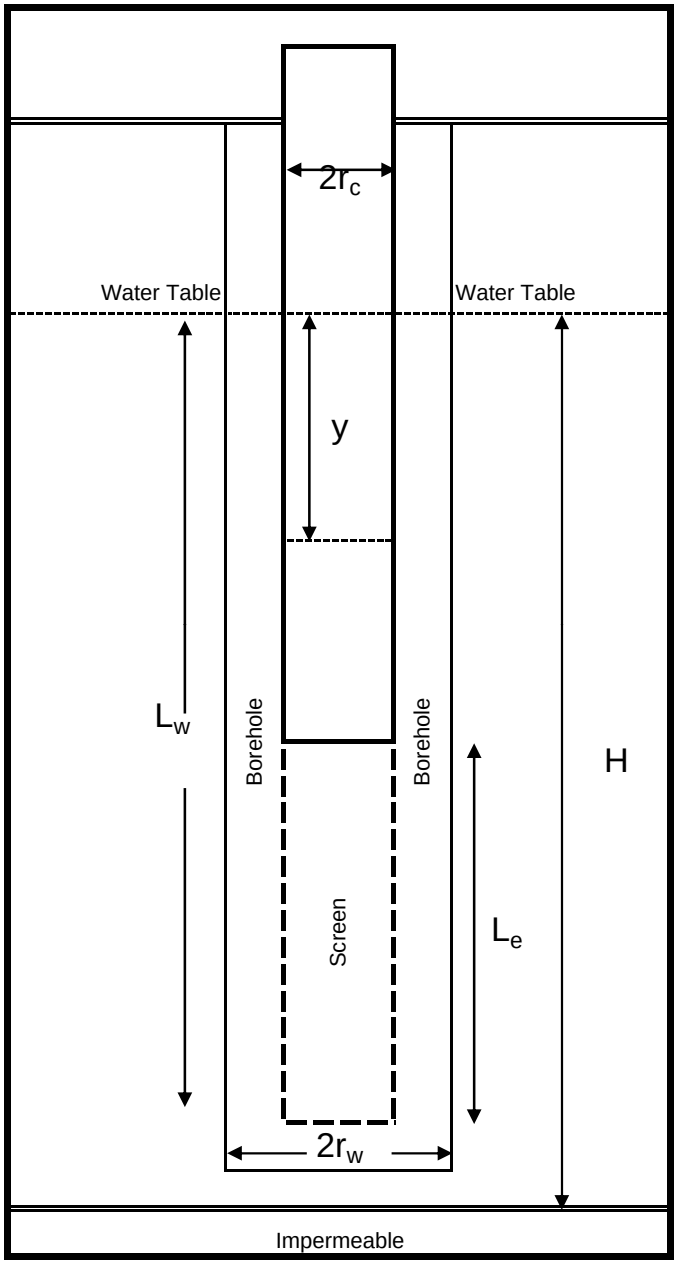
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	11:45:05	0	64.15	7.579	4.771
9/4/2008	11:45:05	0.3	64.17	9.441	2.909
9/4/2008	11:45:05	0.6	64.17	9.452	2.898
9/4/2008	11:45:06	0.9	64.19	9.499	2.851
9/4/2008	11:45:06	1.2	64.19	9.536	2.814
9/4/2008	11:45:06	1.5	64.19	9.653	2.697
9/4/2008	11:45:07	1.8	64.19	9.665	2.685
9/4/2008	11:45:07	2.1	64.22	9.685	2.665
9/4/2008	11:45:07	2.4	64.22	9.704	2.646
9/4/2008	11:45:08	2.7	64.22	9.72	2.63
9/4/2008	11:45:08	3	64.22	9.734	2.616
9/4/2008	11:45:08	3.3	64.22	9.749	2.601
9/4/2008	11:45:08	3.6	64.22	9.761	2.589
9/4/2008	11:45:09	3.9	64.22	9.775	2.575
9/4/2008	11:45:09	4.2	64.22	9.783	2.567
9/4/2008	11:45:09	4.5	64.22	9.794	2.556
9/4/2008	11:45:10	4.8	64.22	9.804	2.546
9/4/2008	11:45:10	5.1	64.22	9.814	2.536
9/4/2008	11:45:10	5.4	64.24	9.824	2.526
9/4/2008	11:45:11	5.7	64.22	9.832	2.518
9/4/2008	11:45:11	6	64.24	9.84	2.51
9/4/2008	11:45:11	6.4	64.24	9.849	2.501
9/4/2008	11:45:12	6.7	64.24	9.857	2.493
9/4/2008	11:45:12	7.1	64.24	9.867	2.483

9/4/2008	11:45:12	7.5	64.24	9.877	2.473
9/4/2008	11:45:13	8	64.24	9.887	2.463
9/4/2008	11:45:13	8.4	64.24	9.898	2.452
9/4/2008	11:45:14	8.9	64.24	9.906	2.444
9/4/2008	11:45:14	9.5	64.24	9.918	2.432
9/4/2008	11:45:15	10	64.22	9.928	2.422
9/4/2008	11:45:15	10.6	64.22	9.939	2.411
9/4/2008	11:45:16	11.3	64.22	9.949	2.401
9/4/2008	11:45:17	11.9	64.22	9.961	2.389
9/4/2008	11:45:17	12.6	64.22	9.973	2.377
9/4/2008	11:45:18	13.4	64.22	9.984	2.366
9/4/2008	11:45:19	14.2	64.19	9.996	2.354
9/4/2008	11:45:20	15	64.19	10.008	2.342
9/4/2008	11:45:21	15.9	64.19	10.025	2.325
9/4/2008	11:45:22	16.8	64.19	10.039	2.311
9/4/2008	11:45:23	17.8	64.19	10.053	2.297
9/4/2008	11:45:24	18.9	64.19	10.07	2.28
9/4/2008	11:45:25	20	64.19	10.086	2.264
9/4/2008	11:45:26	21.2	64.19	10.102	2.248
9/4/2008	11:45:27	22.4	64.17	10.121	2.229
9/4/2008	11:45:29	23.8	64.17	10.139	2.211
9/4/2008	11:45:30	25.2	64.17	10.16	2.19
9/4/2008	11:45:32	26.7	64.17	10.18	2.17
9/4/2008	11:45:33	28.2	64.17	10.199	2.151
9/4/2008	11:45:35	29.8	64.17	10.219	2.131
9/4/2008	11:45:36	31.5	64.17	10.242	2.108
9/4/2008	11:45:38	33.3	64.15	10.264	2.086
9/4/2008	11:45:40	35.2	64.15	10.289	2.061
9/4/2008	11:45:42	37.3	64.12	10.314	2.036
9/4/2008	11:45:44	39.5	64.12	10.34	2.01
9/4/2008	11:45:47	41.8	64.12	10.367	1.983
9/4/2008	11:45:49	44.3	64.1	10.396	1.954
9/4/2008	11:45:52	46.9	64.1	10.424	1.926
9/4/2008	11:45:55	49.7	64.08	10.455	1.895
9/4/2008	11:45:57	52.6	64.08	10.486	1.864
9/4/2008	11:46:01	55.7	64.06	10.519	1.831
9/4/2008	11:46:04	59	64.06	10.553	1.797
9/4/2008	11:46:07	62.5	64.03	10.586	1.764
9/4/2008	11:46:11	66.2	64.01	10.623	1.727
9/4/2008	11:46:15	70.1	64.01	10.66	1.69
9/4/2008	11:46:19	74.3	63.99	10.699	1.651
9/4/2008	11:46:24	78.7	63.97	10.74	1.61
9/4/2008	11:46:28	83.4	63.94	10.779	1.571
9/4/2008	11:46:33	88.4	63.92	10.82	1.53
9/4/2008	11:46:39	93.7	63.9	10.865	1.485
9/4/2008	11:46:44	99.3	63.88	10.911	1.439
9/4/2008	11:46:50	105.2	63.83	10.954	1.396
9/4/2008	11:46:56	111.5	63.81	11.003	1.347
9/4/2008	11:47:03	118.1	63.79	11.048	1.302
9/4/2008	11:47:10	125.1	63.76	11.098	1.252
9/4/2008	11:47:17	132.6	63.72	11.147	1.203
9/4/2008	11:47:25	140.5	63.69	11.196	1.154
9/4/2008	11:47:34	148.9	63.65	11.246	1.104
9/4/2008	11:47:43	157.8	63.63	11.295	1.055
9/4/2008	11:47:52	167.2	63.58	11.349	1.001
9/4/2008	11:48:02	177.2	63.56	11.4	0.95
9/4/2008	11:48:13	187.8	63.51	11.452	0.898
9/4/2008	11:48:24	199	63.49	11.503	0.847
9/4/2008	11:48:36	210.9	63.45	11.557	0.793
9/4/2008	11:48:48	223.5	63.42	11.606	0.744
9/4/2008	11:49:02	236.8	63.38	11.653	0.697
9/4/2008	11:49:16	250.9	63.35	11.705	0.645
9/4/2008	11:49:31	265.8	63.31	11.75	0.6

9/4/2008	11:49:46	281.6	63.29	11.799	0.551
9/4/2008	11:50:03	298.4	63.24	11.843	0.507
9/4/2008	11:50:21	316.2	63.22	11.888	0.462
9/4/2008	11:50:40	335	63.17	11.929	0.421
9/4/2008	11:51:00	354.9	63.15	11.97	0.38
9/4/2008	11:51:21	376	63.11	12.007	0.343
9/4/2008	11:51:43	398.4	63.08	12.042	0.308
9/4/2008	11:52:07	422.1	63.06	12.077	0.273
9/4/2008	11:52:32	447.2	63.04	12.11	0.24
9/4/2008	11:52:59	473.8	63.02	12.137	0.213
9/4/2008	11:53:27	502	62.99	12.164	0.186
9/4/2008	11:53:57	531.9	62.97	12.191	0.159
9/4/2008	11:54:28	563.5	62.95	12.215	0.135
9/4/2008	11:55:02	597	62.95	12.236	0.114
9/4/2008	11:55:37	632.5	62.92	12.25	0.1
9/4/2008	11:56:15	670.1	62.92	12.269	0.081
9/4/2008	11:56:55	709.9	62.92	12.285	0.065
9/4/2008	11:57:37	752.1	62.9	12.295	0.055
9/4/2008	11:58:22	796.8	62.9	12.306	0.044
9/4/2008	11:59:09	844.2	62.9	12.316	0.034
9/4/2008	11:59:59	894.4	62.9	12.324	0.026
9/4/2008	12:00:52	947.5	62.9	12.33	0.02
9/4/2008	12:01:49	1003.8	62.92	12.336	0.014
9/4/2008	12:02:48	1063.4	62.92	12.34	0.01
9/4/2008	12:03:51	1126.6	62.92	12.342	0.008
9/4/2008	12:04:58	1193.5	62.95	12.344	0.006



Input Data

Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	19.7
L_e	Feet	20
H*	Feet	70
y_0	Feet	2.1
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	123

Solutions

Hydraulic Conductivity in Feet/Second
2.83E-05
Hydraulic Conductivity in Feet/Minute
1.70E-03
Hydraulic Conductivity in Feet/Day
2.45E+00

***** - Assumed value

Calculations

Term	Units		
L_e/r_W	Feet/Foot	80.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.929
A	None	3.852	
B	None	0.624	$\ln(R_e/r_W)_{\text{full penetration}}$ = 3.387
C	None	3.465	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

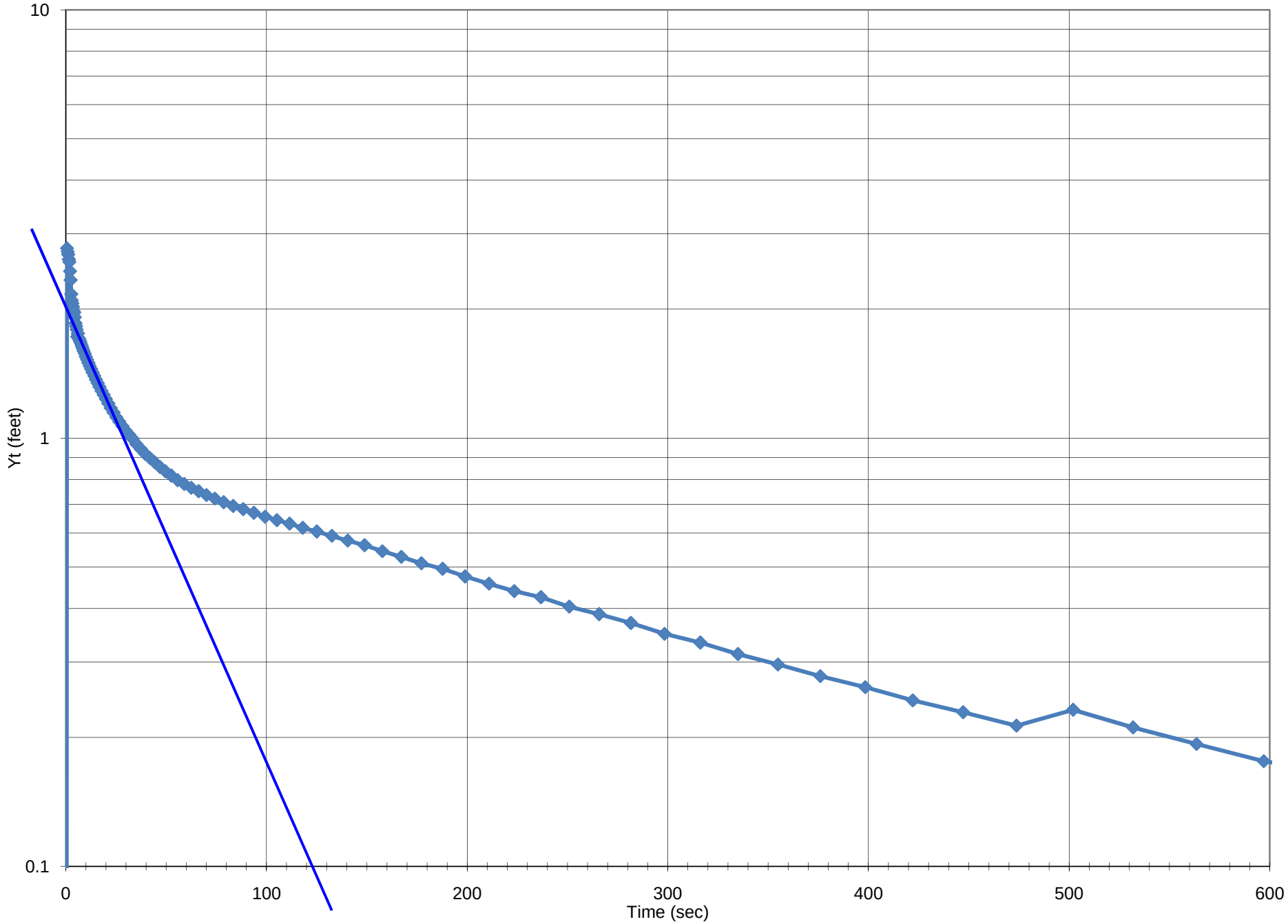
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-505 Slug In
Dare County C&D Landfill



CDM

B-505 Slug In
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:50:38
Report from fi ...\SN08812 2008-09-04 121511 B-505 In.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-505 In

Test defined c 9/4/2008 12:14:25
Test started o 9/4/2008 12:15:11
Test stopped 9/4/2008 12:40:33

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 117

TOTAL DATA 117

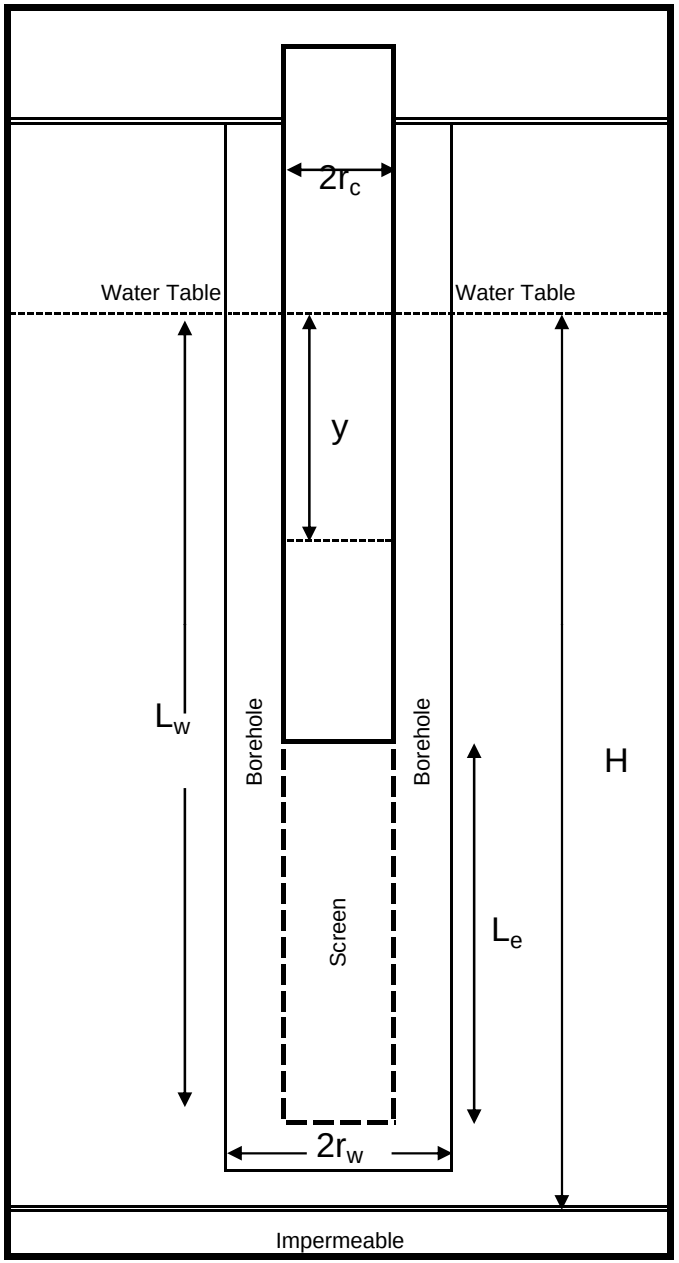
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	12:15:11	0	65.26	13.018	0.008
9/4/2008	12:15:11	0.3	65.28	13.022	0.012
9/4/2008	12:15:11	0.6	65.3	15.782	2.772
9/4/2008	12:15:11	0.9	65.3	15.733	2.723
9/4/2008	12:15:12	1.2	65.3	15.691	2.681
9/4/2008	12:15:12	1.5	65.3	15.624	2.614
9/4/2008	12:15:12	1.8	65.3	15.587	2.577
9/4/2008	12:15:13	2.1	65.32	15.461	2.451
9/4/2008	12:15:13	2.4	65.32	15.348	2.338
9/4/2008	12:15:13	2.7	65.3	15.177	2.167
9/4/2008	12:15:14	3	65.3	15.106	2.096
9/4/2008	12:15:14	3.3	65.32	15.072	2.062
9/4/2008	12:15:14	3.6	65.3	15.033	2.023
9/4/2008	12:15:14	3.9	65.3	14.988	1.978
9/4/2008	12:15:15	4.2	65.3	14.973	1.963
9/4/2008	12:15:15	4.5	65.3	14.923	1.913
9/4/2008	12:15:15	4.8	65.3	14.864	1.854
9/4/2008	12:15:16	5.1	65.3	14.834	1.824
9/4/2008	12:15:16	5.4	65.3	14.801	1.791
9/4/2008	12:15:16	5.7	65.3	14.734	1.724
9/4/2008	12:15:17	6	65.3	14.764	1.754
9/4/2008	12:15:17	6.4	65.3	14.721	1.711
9/4/2008	12:15:17	6.7	65.3	14.711	1.701
9/4/2008	12:15:18	7.1	65.3	14.691	1.681

9/4/2008	12:15:18	7.5	65.3	14.672	1.662
9/4/2008	12:15:19	8	65.3	14.65	1.64
9/4/2008	12:15:19	8.4	65.3	14.629	1.619
9/4/2008	12:15:20	8.9	65.3	14.607	1.597
9/4/2008	12:15:20	9.5	65.3	14.584	1.574
9/4/2008	12:15:21	10	65.26	14.558	1.548
9/4/2008	12:15:21	10.6	65.26	14.534	1.524
9/4/2008	12:15:22	11.3	65.26	14.507	1.497
9/4/2008	12:15:22	11.9	65.23	14.483	1.473
9/4/2008	12:15:23	12.6	65.23	14.459	1.449
9/4/2008	12:15:24	13.4	65.23	14.432	1.422
9/4/2008	12:15:25	14.2	65.21	14.406	1.396
9/4/2008	12:15:26	15	65.21	14.379	1.369
9/4/2008	12:15:26	15.9	65.21	14.353	1.343
9/4/2008	12:15:27	16.8	65.21	14.326	1.316
9/4/2008	12:15:28	17.8	65.19	14.298	1.288
9/4/2008	12:15:29	18.9	65.19	14.271	1.261
9/4/2008	12:15:31	20	65.17	14.243	1.233
9/4/2008	12:15:32	21.2	65.17	14.214	1.204
9/4/2008	12:15:33	22.4	65.17	14.185	1.175
9/4/2008	12:15:34	23.8	65.17	14.157	1.147
9/4/2008	12:15:36	25.2	65.14	14.128	1.118
9/4/2008	12:15:37	26.7	65.14	14.102	1.092
9/4/2008	12:15:39	28.2	65.12	14.076	1.066
9/4/2008	12:15:40	29.8	65.12	14.051	1.041
9/4/2008	12:15:42	31.5	65.12	14.029	1.019
9/4/2008	12:15:44	33.3	65.1	14.006	0.996
9/4/2008	12:15:46	35.2	65.1	13.978	0.968
9/4/2008	12:15:48	37.3	65.08	13.953	0.943
9/4/2008	12:15:50	39.5	65.08	13.929	0.919
9/4/2008	12:15:52	41.8	65.05	13.909	0.899
9/4/2008	12:15:55	44.3	65.05	13.888	0.878
9/4/2008	12:15:57	46.9	65.03	13.866	0.856
9/4/2008	12:16:00	49.7	65.03	13.846	0.836
9/4/2008	12:16:03	52.6	65.01	13.827	0.817
9/4/2008	12:16:06	55.7	65.01	13.807	0.797
9/4/2008	12:16:10	59	64.99	13.791	0.781
9/4/2008	12:16:13	62.5	64.99	13.775	0.765
9/4/2008	12:16:17	66.2	64.96	13.761	0.751
9/4/2008	12:16:21	70.1	64.94	13.746	0.736
9/4/2008	12:16:25	74.3	64.94	13.732	0.722
9/4/2008	12:16:29	78.7	64.92	13.718	0.708
9/4/2008	12:16:34	83.4	64.92	13.704	0.694
9/4/2008	12:16:39	88.4	64.89	13.692	0.682
9/4/2008	12:16:44	93.7	64.89	13.679	0.669
9/4/2008	12:16:50	99.3	64.87	13.665	0.655
9/4/2008	12:16:56	105.2	64.85	13.653	0.643
9/4/2008	12:17:02	111.5	64.85	13.641	0.631
9/4/2008	12:17:09	118.1	64.83	13.627	0.617
9/4/2008	12:17:16	125.1	64.83	13.615	0.605
9/4/2008	12:17:23	132.6	64.8	13.601	0.591
9/4/2008	12:17:31	140.5	64.8	13.586	0.576
9/4/2008	12:17:39	148.9	64.78	13.572	0.562
9/4/2008	12:17:48	157.8	64.76	13.554	0.544
9/4/2008	12:17:58	167.2	64.76	13.538	0.528
9/4/2008	12:18:08	177.2	64.74	13.52	0.51
9/4/2008	12:18:18	187.8	64.74	13.505	0.495
9/4/2008	12:18:30	199	64.71	13.485	0.475
9/4/2008	12:18:41	210.9	64.69	13.467	0.457
9/4/2008	12:18:54	223.5	64.69	13.449	0.439
9/4/2008	12:19:07	236.8	64.67	13.435	0.425
9/4/2008	12:19:21	250.9	64.67	13.414	0.404
9/4/2008	12:19:36	265.8	64.65	13.398	0.388

9/4/2008	12:19:52	281.6	64.65	13.38	0.37
9/4/2008	12:20:09	298.4	64.65	13.359	0.349
9/4/2008	12:20:27	316.2	64.62	13.343	0.333
9/4/2008	12:20:46	335	64.62	13.323	0.313
9/4/2008	12:21:05	354.9	64.62	13.306	0.296
9/4/2008	12:21:27	376	64.6	13.288	0.278
9/4/2008	12:21:49	398.4	64.6	13.272	0.262
9/4/2008	12:22:13	422.1	64.58	13.254	0.244
9/4/2008	12:22:38	447.2	64.58	13.239	0.229
9/4/2008	12:23:04	473.8	64.58	13.223	0.213
9/4/2008	12:23:33	502	64.56	13.242	0.232
9/4/2008	12:24:02	531.9	64.56	13.221	0.211
9/4/2008	12:24:34	563.5	64.56	13.203	0.193
9/4/2008	12:25:08	597	64.56	13.186	0.176
9/4/2008	12:25:43	632.5	64.56	13.176	0.166
9/4/2008	12:26:21	670.1	64.56	13.164	0.154
9/4/2008	12:27:00	709.9	64.53	13.154	0.144
9/4/2008	12:27:43	752.1	64.53	13.146	0.136
9/4/2008	12:28:27	796.8	64.53	13.138	0.128
9/4/2008	12:29:15	844.2	64.51	13.132	0.122
9/4/2008	12:30:05	894.4	64.51	13.128	0.118
9/4/2008	12:30:58	947.5	64.49	13.124	0.114
9/4/2008	12:31:54	1003.8	64.49	13.12	0.11
9/4/2008	12:32:54	1063.4	64.46	13.116	0.106
9/4/2008	12:33:57	1126.6	64.46	13.112	0.102
9/4/2008	12:35:04	1193.5	64.44	13.11	0.1
9/4/2008	12:36:15	1264.4	64.44	13.108	0.098
9/4/2008	12:37:30	1339.5	64.44	13.106	0.096
9/4/2008	12:38:50	1419	64.42	13.104	0.094
9/4/2008	12:40:14	1503.3	64.42	13.102	0.092



Input Data

Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	19.7
L_e	Feet	20
H*	Feet	70
y_0	Feet	2.21
t_0	Seconds	0
y_t	Feet	0.1
t	Seconds	182

Solutions

Hydraulic Conductivity in Feet/Second
1.95E-05
Hydraulic Conductivity in Feet/Minute
1.17E-03
Hydraulic Conductivity in Feet/Day
1.68E+00

***** - Assumed value

Calculations

Term	Units		
L_e/r_W	Feet/Foot	80.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ = 2.929
A	None	3.852	
B	None	0.624	$\ln(R_e/r_W)_{\text{full penetration}}$ = 3.387
C	None	3.465	

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

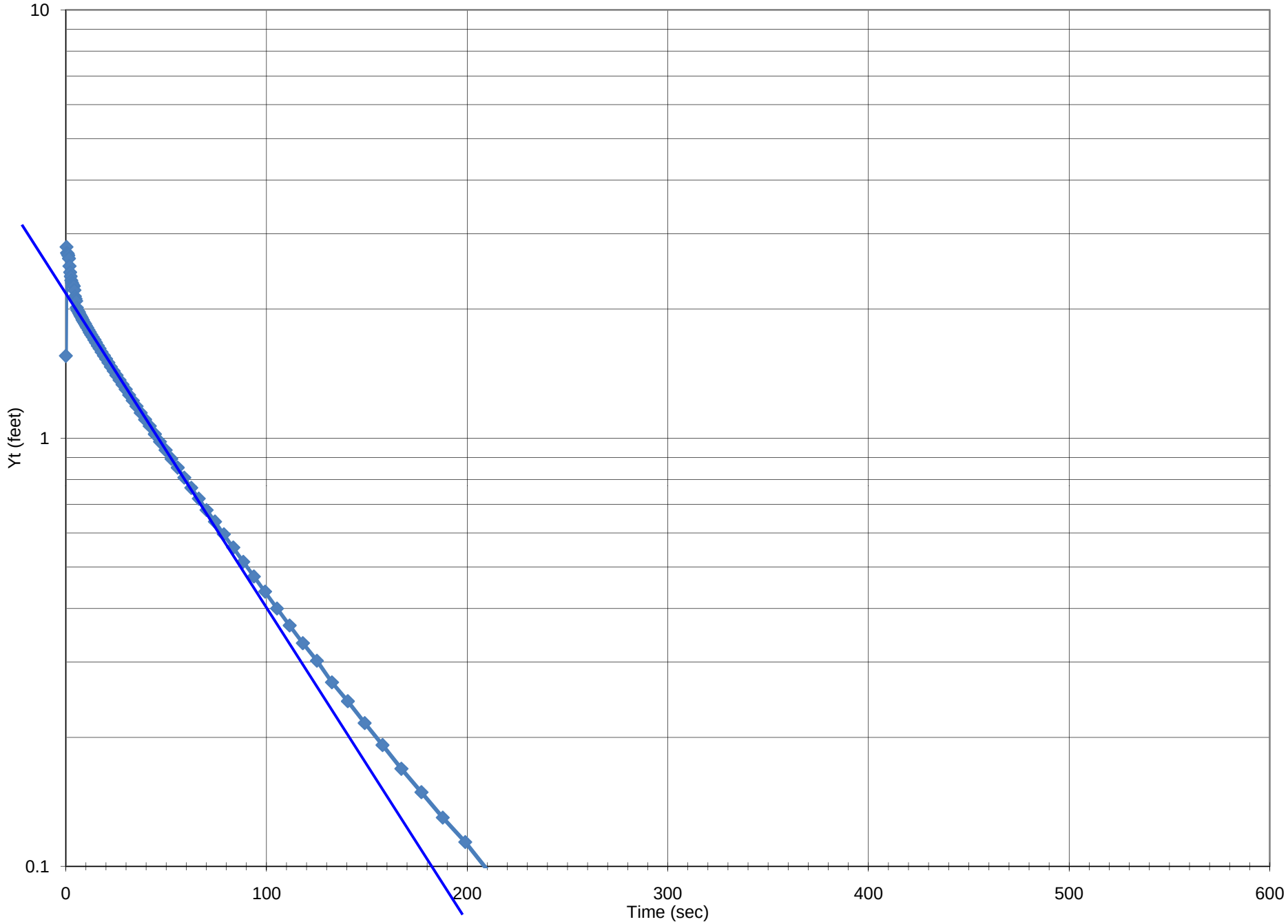
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-505 Slug Out
Dare County C&D Landfill



CDM

B-505 Slug Out
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:51:15
Report from fi ...\SN08812 2008-09-04 124218 B505 OUT.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B505 OUT

Test defined c 9/4/2008 12:41:28
Test started o 9/4/2008 12:42:18
Test stopped 9/4/2008 12:55:58

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 106

TOTAL DATA 106

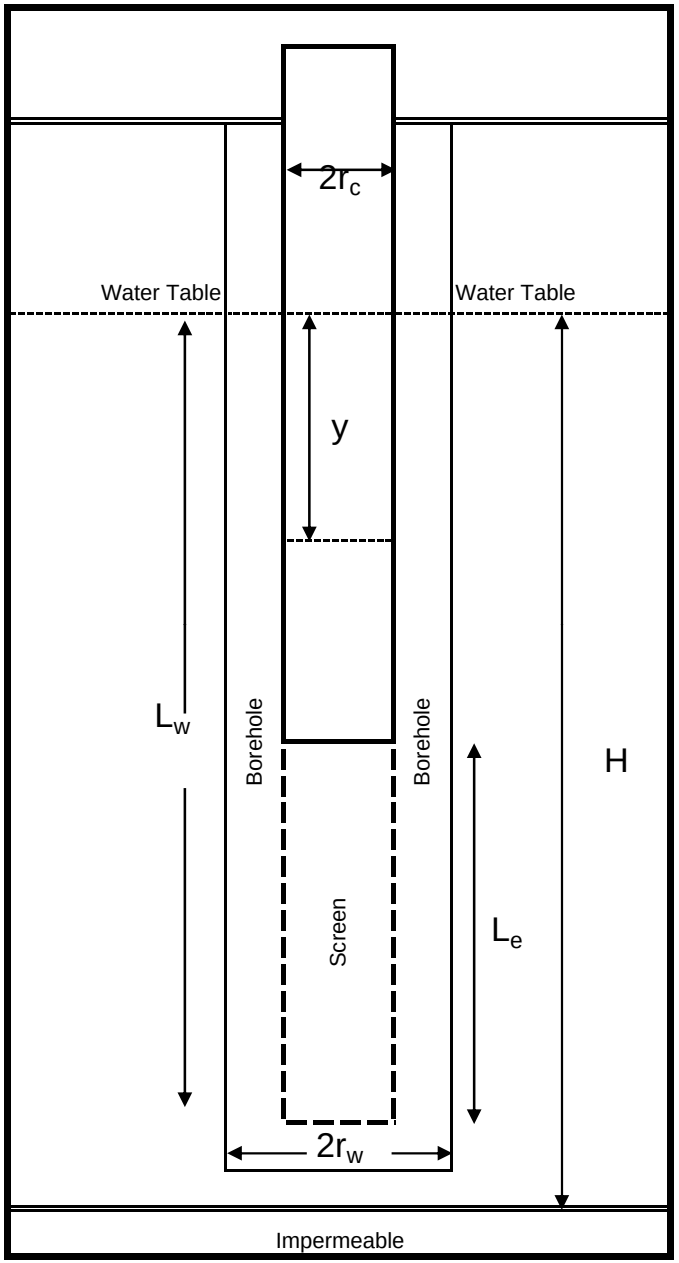
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	12:42:18	0	64.4	11.515	1.555
9/4/2008	12:42:18	0.3	64.44	10.278	2.792
9/4/2008	12:42:18	0.6	64.44	10.366	2.704
9/4/2008	12:42:19	0.9	64.44	10.382	2.688
9/4/2008	12:42:19	1.2	64.46	10.404	2.666
9/4/2008	12:42:19	1.5	64.46	10.446	2.624
9/4/2008	12:42:20	1.8	64.46	10.551	2.519
9/4/2008	12:42:20	2.1	64.46	10.633	2.437
9/4/2008	12:42:20	2.4	64.46	10.686	2.384
9/4/2008	12:42:20	2.7	64.46	10.737	2.333
9/4/2008	12:42:21	3	64.49	10.766	2.304
9/4/2008	12:42:21	3.3	64.49	10.784	2.286
9/4/2008	12:42:21	3.6	64.49	10.798	2.272
9/4/2008	12:42:22	3.9	64.49	10.809	2.261
9/4/2008	12:42:22	4.2	64.49	10.856	2.214
9/4/2008	12:42:22	4.5	64.49	10.929	2.141
9/4/2008	12:42:23	4.8	64.49	10.956	2.114
9/4/2008	12:42:23	5.1	64.49	10.98	2.09
9/4/2008	12:42:23	5.4	64.49	11.054	2.016
9/4/2008	12:42:23	5.7	64.49	11.082	1.988
9/4/2008	12:42:24	6	64.49	11.087	1.983
9/4/2008	12:42:24	6.4	64.49	11.101	1.969
9/4/2008	12:42:24	6.7	64.49	11.117	1.953
9/4/2008	12:42:25	7.1	64.49	11.134	1.936

9/4/2008	12:42:25	7.5	64.49	11.15	1.92
9/4/2008	12:42:26	8	64.49	11.166	1.904
9/4/2008	12:42:26	8.4	64.51	11.184	1.886
9/4/2008	12:42:27	8.9	64.51	11.203	1.867
9/4/2008	12:42:27	9.5	64.51	11.221	1.849
9/4/2008	12:42:28	10	64.49	11.24	1.83
9/4/2008	12:42:28	10.6	64.49	11.26	1.81
9/4/2008	12:42:29	11.3	64.49	11.283	1.787
9/4/2008	12:42:30	11.9	64.49	11.305	1.765
9/4/2008	12:42:30	12.6	64.46	11.328	1.742
9/4/2008	12:42:31	13.4	64.46	11.35	1.72
9/4/2008	12:42:32	14.2	64.46	11.375	1.695
9/4/2008	12:42:33	15	64.46	11.399	1.671
9/4/2008	12:42:34	15.9	64.46	11.428	1.642
9/4/2008	12:42:35	16.8	64.46	11.453	1.617
9/4/2008	12:42:36	17.8	64.46	11.483	1.587
9/4/2008	12:42:37	18.9	64.46	11.512	1.558
9/4/2008	12:42:38	20	64.46	11.54	1.53
9/4/2008	12:42:39	21.2	64.46	11.571	1.499
9/4/2008	12:42:40	22.4	64.46	11.604	1.466
9/4/2008	12:42:42	23.8	64.46	11.636	1.434
9/4/2008	12:42:43	25.2	64.46	11.669	1.401
9/4/2008	12:42:44	26.7	64.46	11.704	1.366
9/4/2008	12:42:46	28.2	64.46	11.737	1.333
9/4/2008	12:42:48	29.8	64.46	11.771	1.299
9/4/2008	12:42:49	31.5	64.46	11.81	1.26
9/4/2008	12:42:51	33.3	64.46	11.847	1.223
9/4/2008	12:42:53	35.2	64.44	11.884	1.186
9/4/2008	12:42:55	37.3	64.44	11.925	1.145
9/4/2008	12:42:57	39.5	64.44	11.966	1.104
9/4/2008	12:43:00	41.8	64.44	12.004	1.066
9/4/2008	12:43:02	44.3	64.44	12.049	1.021
9/4/2008	12:43:05	46.9	64.44	12.09	0.98
9/4/2008	12:43:07	49.7	64.44	12.133	0.937
9/4/2008	12:43:10	52.6	64.44	12.176	0.894
9/4/2008	12:43:13	55.7	64.44	12.217	0.853
9/4/2008	12:43:17	59	64.44	12.262	0.808
9/4/2008	12:43:20	62.5	64.42	12.305	0.765
9/4/2008	12:43:24	66.2	64.44	12.348	0.722
9/4/2008	12:43:28	70.1	64.44	12.391	0.679
9/4/2008	12:43:32	74.3	64.44	12.432	0.638
9/4/2008	12:43:36	78.7	64.44	12.474	0.596
9/4/2008	12:43:41	83.4	64.44	12.515	0.555
9/4/2008	12:43:46	88.4	64.46	12.556	0.514
9/4/2008	12:43:51	93.7	64.46	12.595	0.475
9/4/2008	12:43:57	99.3	64.46	12.632	0.438
9/4/2008	12:44:03	105.2	64.46	12.67	0.4
9/4/2008	12:44:09	111.5	64.46	12.705	0.365
9/4/2008	12:44:16	118.1	64.46	12.738	0.332
9/4/2008	12:44:23	125.1	64.46	12.768	0.302
9/4/2008	12:44:30	132.6	64.46	12.801	0.269
9/4/2008	12:44:38	140.5	64.49	12.827	0.243
9/4/2008	12:44:47	148.9	64.49	12.854	0.216
9/4/2008	12:44:56	157.8	64.51	12.878	0.192
9/4/2008	12:45:05	167.2	64.51	12.901	0.169
9/4/2008	12:45:15	177.2	64.51	12.921	0.149
9/4/2008	12:45:26	187.8	64.51	12.94	0.13
9/4/2008	12:45:37	199	64.51	12.956	0.114
9/4/2008	12:45:49	210.9	64.49	12.973	0.097
9/4/2008	12:46:01	223.5	64.49	12.985	0.085
9/4/2008	12:46:15	236.8	64.46	12.997	0.073
9/4/2008	12:46:29	250.9	64.46	13.005	0.065
9/4/2008	12:46:44	265.8	64.44	13.014	0.056

9/4/2008	12:46:59	281.6	64.42	13.02	0.05
9/4/2008	12:47:16	298.4	64.4	13.029	0.041
9/4/2008	12:47:34	316.2	64.4	13.035	0.035
9/4/2008	12:47:53	335	64.37	13.037	0.033
9/4/2008	12:48:13	354.9	64.37	13.041	0.029
9/4/2008	12:48:34	376	64.37	13.045	0.025
9/4/2008	12:48:56	398.4	64.4	13.047	0.023
9/4/2008	12:49:20	422.1	64.37	13.051	0.019
9/4/2008	12:49:45	447.2	64.35	13.051	0.019
9/4/2008	12:50:12	473.8	64.33	13.054	0.016
9/4/2008	12:50:40	502	64.31	13.056	0.014
9/4/2008	12:51:10	531.9	64.26	13.056	0.014
9/4/2008	12:51:41	563.5	64.22	13.059	0.011
9/4/2008	12:52:15	597	64.17	13.059	0.011
9/4/2008	12:52:50	632.5	64.19	13.059	0.011
9/4/2008	12:53:28	670.1	64.19	13.059	0.011
9/4/2008	12:54:08	709.9	64.19	13.061	0.009
9/4/2008	12:54:50	752.1	64.22	13.061	0.009
9/4/2008	12:55:35	796.8	64.26	13.063	0.007



Input Data		
Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	16.9
L_e	Feet	10
H*	Feet	72
y_0	Feet	2.3
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	130

Solutions
Hydraulic Conductivity in Feet/Second
8.41E-05
Hydraulic Conductivity in Feet/Minute
5.05E-03
Hydraulic Conductivity in Feet/Day
7.27E+00

***** - Assumed value

Calculations			
Term	Units		2.574
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
A	None	2.780	2.574
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.130

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

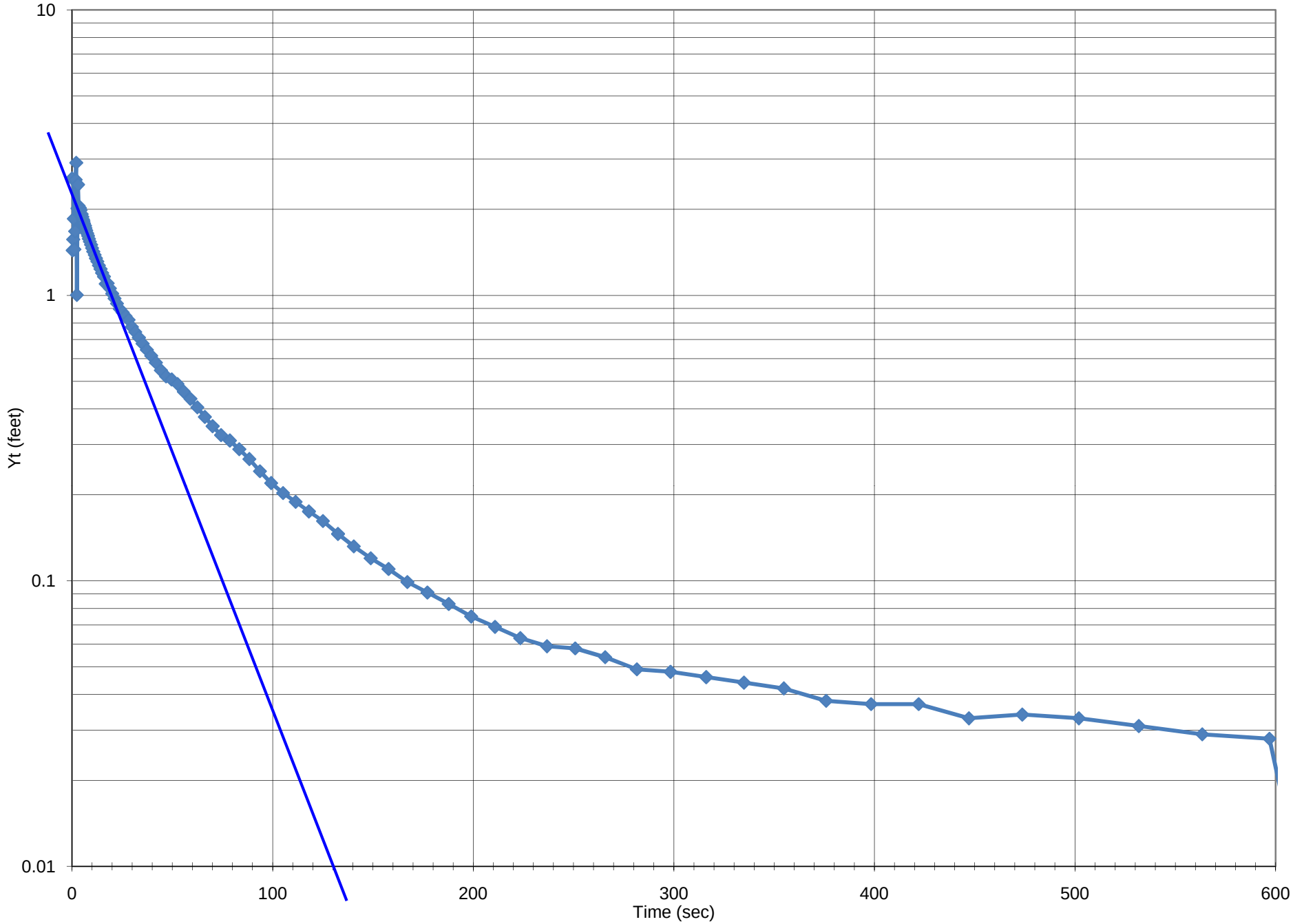
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-506 Slug In
Dare County C&D Landfill



CDM

B-506 Slug In
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:45:16
Report from fi ...\SN08812 2008-09-04 085501 B-506 In.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-506 In

Test defined c 9/4/2008 8:53:52
Test started o 9/4/2008 8:55:01
Test stopped 9/4/2008 9:17:57

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 115

TOTAL DATA 115

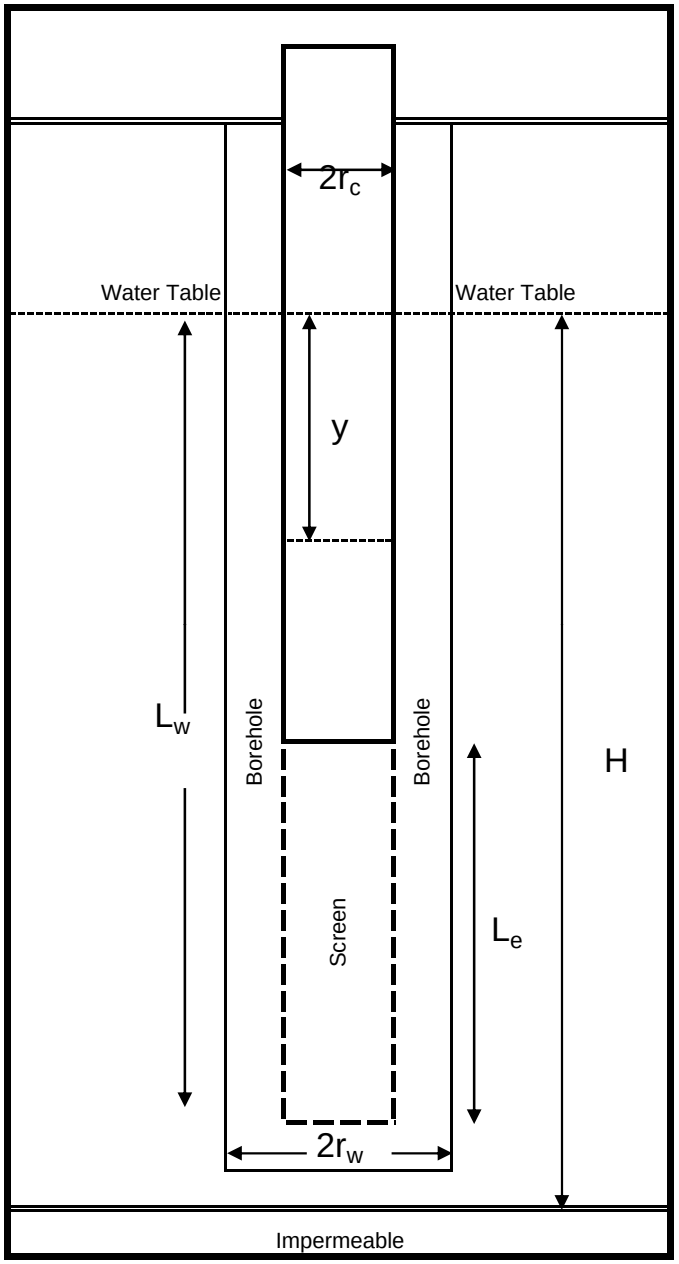
Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	8:55:01	0	66.3	16.876	2.566
9/4/2008	8:55:02	0.3	66.34	15.747	1.437
9/4/2008	8:55:02	0.6	66.34	15.879	1.569
9/4/2008	8:55:02	0.9	66.34	16.163	1.853
9/4/2008	8:55:03	1.2	66.37	15.759	1.449
9/4/2008	8:55:03	1.5	66.37	15.985	1.675
9/4/2008	8:55:03	1.8	66.37	16.849	2.539
9/4/2008	8:55:04	2.1	66.37	17.221	2.911
9/4/2008	8:55:04	2.4	66.39	15.313	1.003
9/4/2008	8:55:04	2.7	66.39	16.326	2.016
9/4/2008	8:55:04	3	66.39	16.751	2.441
9/4/2008	8:55:05	3.3	66.39	16.367	2.057
9/4/2008	8:55:05	3.6	66.39	16.232	1.922
9/4/2008	8:55:05	3.9	66.39	16.334	2.024
9/4/2008	8:55:06	4.2	66.39	16.298	1.988
9/4/2008	8:55:06	4.5	66.39	16.234	1.924
9/4/2008	8:55:06	4.8	66.39	16.234	1.924
9/4/2008	8:55:07	5.1	66.39	16.195	1.885
9/4/2008	8:55:07	5.4	66.39	16.155	1.845
9/4/2008	8:55:07	5.7	66.39	16.13	1.82
9/4/2008	8:55:07	6	66.39	16.095	1.785
9/4/2008	8:55:08	6.4	66.39	16.063	1.753
9/4/2008	8:55:08	6.7	66.41	16.032	1.722
9/4/2008	8:55:09	7.1	66.39	15.997	1.687

9/4/2008	8:55:09	7.5	66.41	15.96	1.65
9/4/2008	8:55:09	8	66.39	15.926	1.616
9/4/2008	8:55:10	8.4	66.41	15.887	1.577
9/4/2008	8:55:10	8.9	66.41	15.852	1.542
9/4/2008	8:55:11	9.5	66.41	15.813	1.503
9/4/2008	8:55:11	10	66.39	15.773	1.463
9/4/2008	8:55:12	10.6	66.39	15.732	1.422
9/4/2008	8:55:13	11.3	66.37	15.695	1.385
9/4/2008	8:55:13	11.9	66.37	15.658	1.348
9/4/2008	8:55:14	12.6	66.37	15.624	1.314
9/4/2008	8:55:15	13.4	66.37	15.583	1.273
9/4/2008	8:55:16	14.2	66.37	15.546	1.236
9/4/2008	8:55:16	15	66.37	15.507	1.197
9/4/2008	8:55:17	15.9	66.37	15.473	1.163
9/4/2008	8:55:18	16.8	66.37	15.407	1.097
9/4/2008	8:55:19	17.8	66.34	15.412	1.102
9/4/2008	8:55:20	18.9	66.34	15.367	1.057
9/4/2008	8:55:21	20	66.34	15.324	1.014
9/4/2008	8:55:23	21.2	66.34	15.285	0.975
9/4/2008	8:55:24	22.4	66.34	15.246	0.936
9/4/2008	8:55:25	23.8	66.34	15.205	0.895
9/4/2008	8:55:27	25.2	66.34	15.181	0.871
9/4/2008	8:55:28	26.7	66.34	15.156	0.846
9/4/2008	8:55:30	28.2	66.34	15.13	0.82
9/4/2008	8:55:31	29.8	66.34	15.085	0.775
9/4/2008	8:55:33	31.5	66.34	15.054	0.744
9/4/2008	8:55:35	33.3	66.34	15.021	0.711
9/4/2008	8:55:37	35.2	66.34	14.987	0.677
9/4/2008	8:55:39	37.3	66.32	14.954	0.644
9/4/2008	8:55:41	39.5	66.32	14.924	0.614
9/4/2008	8:55:43	41.8	66.34	14.891	0.581
9/4/2008	8:55:46	44.3	66.32	14.856	0.546
9/4/2008	8:55:48	46.9	66.32	14.83	0.52
9/4/2008	8:55:51	49.7	66.32	14.817	0.507
9/4/2008	8:55:54	52.6	66.32	14.799	0.489
9/4/2008	8:55:57	55.7	66.32	14.77	0.46
9/4/2008	8:56:00	59	66.32	14.744	0.434
9/4/2008	8:56:04	62.5	66.32	14.715	0.405
9/4/2008	8:56:08	66.2	66.32	14.685	0.375
9/4/2008	8:56:12	70.1	66.3	14.658	0.348
9/4/2008	8:56:16	74.3	66.3	14.634	0.324
9/4/2008	8:56:20	78.7	66.3	14.62	0.31
9/4/2008	8:56:25	83.4	66.3	14.599	0.289
9/4/2008	8:56:30	88.4	66.3	14.577	0.267
9/4/2008	8:56:35	93.7	66.28	14.552	0.242
9/4/2008	8:56:41	99.3	66.28	14.53	0.22
9/4/2008	8:56:47	105.2	66.3	14.513	0.203
9/4/2008	8:56:53	111.5	66.28	14.499	0.189
9/4/2008	8:57:00	118.1	66.3	14.485	0.175
9/4/2008	8:57:07	125.1	66.3	14.472	0.162
9/4/2008	8:57:14	132.6	66.3	14.456	0.146
9/4/2008	8:57:22	140.5	66.3	14.442	0.132
9/4/2008	8:57:30	148.9	66.28	14.43	0.12
9/4/2008	8:57:39	157.8	66.28	14.42	0.11
9/4/2008	8:57:49	167.2	66.28	14.409	0.099
9/4/2008	8:57:59	177.2	66.25	14.401	0.091
9/4/2008	8:58:09	187.8	66.23	14.393	0.083
9/4/2008	8:58:20	199	66.23	14.385	0.075
9/4/2008	8:58:32	210.9	66.21	14.379	0.069
9/4/2008	8:58:45	223.5	66.21	14.373	0.063
9/4/2008	8:58:58	236.8	66.19	14.369	0.059
9/4/2008	8:59:12	250.9	66.16	14.368	0.058
9/4/2008	8:59:27	265.8	66.16	14.364	0.054

9/4/2008	8:59:43	281.6	66.16	14.359	0.049
9/4/2008	9:00:00	298.4	66.14	14.358	0.048
9/4/2008	9:00:18	316.2	66.14	14.356	0.046
9/4/2008	9:00:36	335	66.12	14.354	0.044
9/4/2008	9:00:56	354.9	66.12	14.352	0.042
9/4/2008	9:01:17	376	66.12	14.348	0.038
9/4/2008	9:01:40	398.4	66.14	14.347	0.037
9/4/2008	9:02:04	422.1	66.16	14.347	0.037
9/4/2008	9:02:29	447.2	66.16	14.343	0.033
9/4/2008	9:02:55	473.8	66.12	14.344	0.034
9/4/2008	9:03:23	502	66.14	14.343	0.033
9/4/2008	9:03:53	531.9	66.14	14.341	0.031
9/4/2008	9:04:25	563.5	66.12	14.339	0.029
9/4/2008	9:04:58	597	66.07	14.338	0.028
9/4/2008	9:05:34	632.5	66.05	14.312	0.002
9/4/2008	9:06:12	670.1	66.05	14.316	0.006
9/4/2008	9:06:51	709.9	66.03	14.32	0.01
9/4/2008	9:07:34	752.1	65.98	14.322	0.012
9/4/2008	9:08:18	796.8	65.94	14.327	0.017
9/4/2008	9:09:06	844.2	65.94	14.327	0.017
9/4/2008	9:09:56	894.4	65.94	14.329	0.019
9/4/2008	9:10:49	947.5	65.94	14.335	0.025
9/4/2008	9:11:45	1003.8	65.89	14.331	0.021
9/4/2008	9:12:45	1063.4	65.87	14.34	0.03
9/4/2008	9:13:48	1126.6	65.87	14.36	0.05
9/4/2008	9:14:55	1193.5	65.82	14.363	0.053
9/4/2008	9:16:06	1264.4	65.82	14.348	0.038
9/4/2008	9:17:21	1339.5	65.82	14.353	0.043



Input Data		
Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	46.7
L_e	Feet	10
H*	Feet	72
y_0	Feet	2.06
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	225

Solutions
Hydraulic Conductivity in Feet/Second
5.62E-05
Hydraulic Conductivity in Feet/Minute
3.37E-03
Hydraulic Conductivity in Feet/Day
4.85E+00

***** - Assumed value

Calculations			
Term	Units		3.036
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
A	None	2.780	3.036
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.721

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

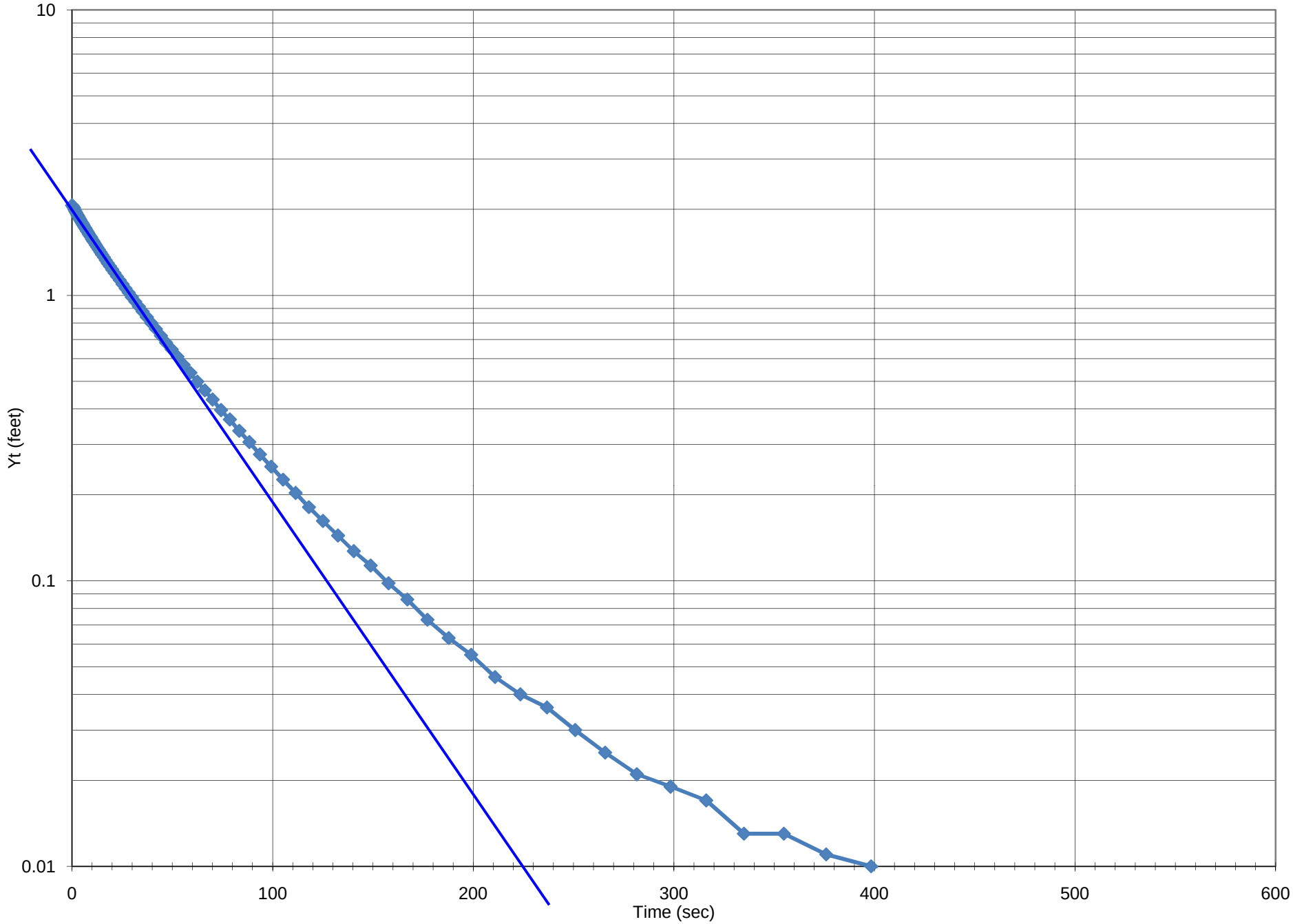
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-506D Slug In
Dare County C&D Landfill



CDM

B-506D Slug In
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:46:07
Report from fi ...\SN08812 2008-09-04 093210 B-506D In.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-506D In

Test defined c 9/4/2008 9:31:32
Test started o 9/4/2008 9:32:10
Test stopped 9/4/2008 9:46:27

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 107

TOTAL DATA 107

Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	9:32:10	0	65.82	16.154	2.064
9/4/2008	9:32:10	0.3	65.85	16.142	2.052
9/4/2008	9:32:10	0.6	65.87	16.129	2.039
9/4/2008	9:32:11	0.9	65.87	16.113	2.023
9/4/2008	9:32:11	1.2	65.89	16.086	1.996
9/4/2008	9:32:11	1.5	65.89	16.068	1.978
9/4/2008	9:32:12	1.8	65.89	16.051	1.961
9/4/2008	9:32:12	2.1	65.89	16.033	1.943
9/4/2008	9:32:12	2.4	65.89	16.015	1.925
9/4/2008	9:32:13	2.7	65.89	16	1.91
9/4/2008	9:32:13	3	65.89	15.984	1.894
9/4/2008	9:32:13	3.3	65.91	15.967	1.877
9/4/2008	9:32:13	3.6	65.91	15.951	1.861
9/4/2008	9:32:14	3.9	65.91	15.935	1.845
9/4/2008	9:32:14	4.2	65.91	15.92	1.83
9/4/2008	9:32:14	4.5	65.91	15.904	1.814
9/4/2008	9:32:15	4.8	65.91	15.89	1.8
9/4/2008	9:32:15	5.1	65.91	15.877	1.787
9/4/2008	9:32:15	5.4	65.91	15.861	1.771
9/4/2008	9:32:16	5.7	65.91	15.847	1.757
9/4/2008	9:32:16	6	65.91	15.835	1.745
9/4/2008	9:32:16	6.4	65.91	15.816	1.726
9/4/2008	9:32:17	6.7	65.91	15.802	1.712
9/4/2008	9:32:17	7.1	65.91	15.784	1.694

9/4/2008	9:32:17	7.5	65.91	15.765	1.675
9/4/2008	9:32:18	8	65.94	15.747	1.657
9/4/2008	9:32:18	8.4	65.91	15.726	1.636
9/4/2008	9:32:19	8.9	65.91	15.706	1.616
9/4/2008	9:32:19	9.5	65.94	15.685	1.595
9/4/2008	9:32:20	10	65.91	15.659	1.569
9/4/2008	9:32:20	10.6	65.89	15.637	1.547
9/4/2008	9:32:21	11.3	65.89	15.61	1.52
9/4/2008	9:32:22	11.9	65.89	15.586	1.496
9/4/2008	9:32:22	12.6	65.89	15.561	1.471
9/4/2008	9:32:23	13.4	65.89	15.533	1.443
9/4/2008	9:32:24	14.2	65.89	15.504	1.414
9/4/2008	9:32:25	15	65.89	15.477	1.387
9/4/2008	9:32:26	15.9	65.89	15.447	1.357
9/4/2008	9:32:27	16.8	65.89	15.416	1.326
9/4/2008	9:32:28	17.8	65.89	15.385	1.295
9/4/2008	9:32:29	18.9	65.89	15.353	1.263
9/4/2008	9:32:30	20	65.89	15.32	1.23
9/4/2008	9:32:31	21.2	65.89	15.287	1.197
9/4/2008	9:32:32	22.4	65.89	15.253	1.163
9/4/2008	9:32:34	23.8	65.89	15.218	1.128
9/4/2008	9:32:35	25.2	65.89	15.183	1.093
9/4/2008	9:32:37	26.7	65.89	15.146	1.056
9/4/2008	9:32:38	28.2	65.89	15.112	1.022
9/4/2008	9:32:40	29.8	65.89	15.075	0.985
9/4/2008	9:32:41	31.5	65.89	15.04	0.95
9/4/2008	9:32:43	33.3	65.89	15.003	0.913
9/4/2008	9:32:45	35.2	65.89	14.967	0.877
9/4/2008	9:32:47	37.3	65.89	14.928	0.838
9/4/2008	9:32:49	39.5	65.89	14.889	0.799
9/4/2008	9:32:52	41.8	65.89	14.852	0.762
9/4/2008	9:32:54	44.3	65.89	14.811	0.721
9/4/2008	9:32:57	46.9	65.91	14.772	0.682
9/4/2008	9:33:00	49.7	65.91	14.736	0.646
9/4/2008	9:33:02	52.6	65.91	14.699	0.609
9/4/2008	9:33:06	55.7	65.91	14.66	0.57
9/4/2008	9:33:09	59	65.91	14.625	0.535
9/4/2008	9:33:12	62.5	65.94	14.588	0.498
9/4/2008	9:33:16	66.2	65.94	14.554	0.464
9/4/2008	9:33:20	70.1	65.94	14.521	0.431
9/4/2008	9:33:24	74.3	65.94	14.486	0.396
9/4/2008	9:33:29	78.7	65.96	14.457	0.367
9/4/2008	9:33:33	83.4	65.96	14.425	0.335
9/4/2008	9:33:38	88.4	65.98	14.396	0.306
9/4/2008	9:33:44	93.7	65.98	14.367	0.277
9/4/2008	9:33:49	99.3	66	14.341	0.251
9/4/2008	9:33:55	105.2	66.03	14.316	0.226
9/4/2008	9:34:01	111.5	66.03	14.293	0.203
9/4/2008	9:34:08	118.1	66.05	14.271	0.181
9/4/2008	9:34:15	125.1	66.05	14.252	0.162
9/4/2008	9:34:22	132.6	66.07	14.234	0.144
9/4/2008	9:34:30	140.5	66.09	14.217	0.127
9/4/2008	9:34:39	148.9	66.09	14.203	0.113
9/4/2008	9:34:48	157.8	66.12	14.188	0.098
9/4/2008	9:34:57	167.2	66.14	14.176	0.086
9/4/2008	9:35:07	177.2	66.16	14.163	0.073
9/4/2008	9:35:18	187.8	66.16	14.153	0.063
9/4/2008	9:35:29	199	66.19	14.145	0.055
9/4/2008	9:35:41	210.9	66.21	14.136	0.046
9/4/2008	9:35:53	223.5	66.21	14.13	0.04
9/4/2008	9:36:07	236.8	66.23	14.126	0.036
9/4/2008	9:36:21	250.9	66.23	14.12	0.03
9/4/2008	9:36:36	265.8	66.25	14.115	0.025

9/4/2008	9:36:51	281.6	66.28	14.111	0.021
9/4/2008	9:37:08	298.4	66.28	14.109	0.019
9/4/2008	9:37:26	316.2	66.3	14.107	0.017
9/4/2008	9:37:45	335	66.3	14.103	0.013
9/4/2008	9:38:05	354.9	66.3	14.103	0.013
9/4/2008	9:38:26	376	66.3	14.101	0.011
9/4/2008	9:38:48	398.4	66.32	14.1	0.01
9/4/2008	9:39:12	422.1	66.32	14.098	0.008
9/4/2008	9:39:37	447.2	66.34	14.098	0.008
9/4/2008	9:40:04	473.8	66.34	14.098	0.008
9/4/2008	9:40:32	502	66.34	14.098	0.008
9/4/2008	9:41:02	531.9	66.34	14.098	0.008
9/4/2008	9:41:33	563.5	66.37	14.098	0.008
9/4/2008	9:42:07	597	66.37	14.096	0.006
9/4/2008	9:42:42	632.5	66.37	14.096	0.006
9/4/2008	9:43:20	670.1	66.37	14.096	0.006
9/4/2008	9:44:00	709.9	66.37	14.096	0.006
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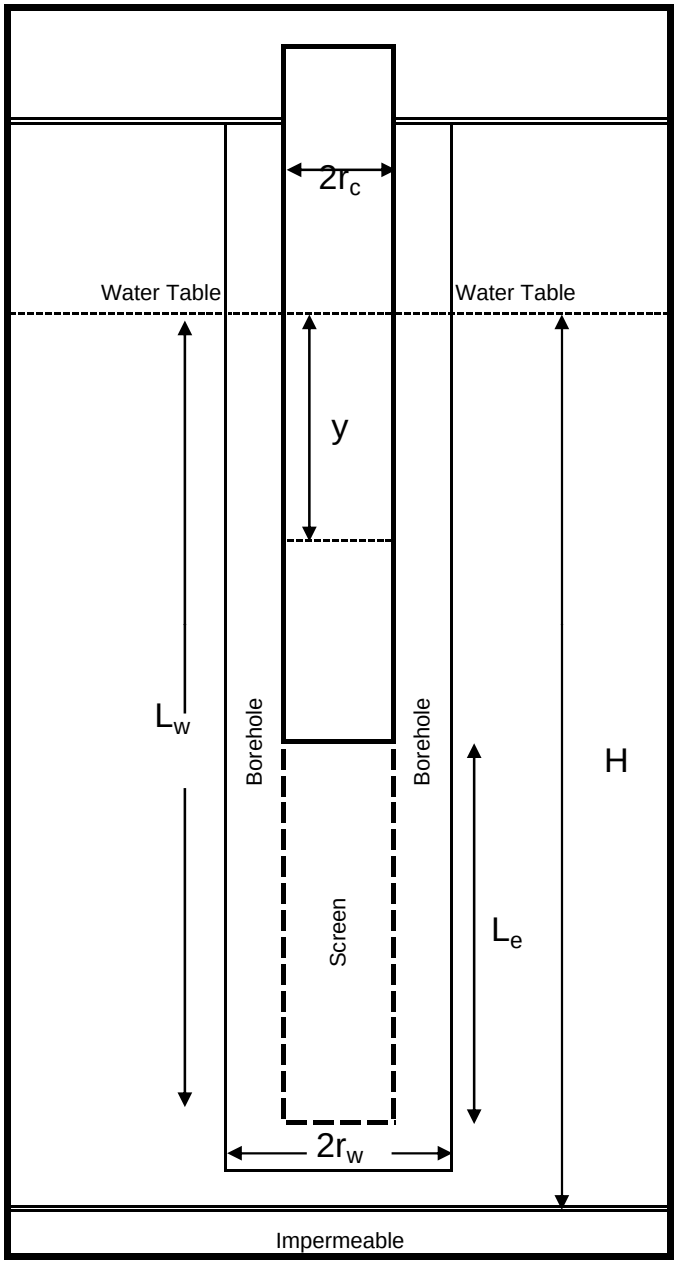


Input Data		
Term	Units	
$2r_c$	Inches	3
$2r_W$	Inches	6
L_w	Feet	46.7
L_e	Feet	10
H*	Feet	72
y_0	Feet	1.25
t_0	Seconds	0
y_t	Feet	0.01
t	Seconds	220

Solutions
Hydraulic Conductivity in Feet/Second
5.20E-05
Hydraulic Conductivity in Feet/Minute
3.12E-03
Hydraulic Conductivity in Feet/Day
4.50E+00

***** - Assumed value

Calculations			
Term	Units		3.036
L_e/r_W	Feet/Foot	40.00	$\ln(R_e/r_W)_{\text{partial penetration}}$ =
A	None	2.780	3.036
B	None	0.430	$\ln(R_e/r_W)_{\text{full penetration}}$ =
C	None	2.336	3.721

General Equations

$$K = \frac{r_c^2 \ln(R_e/r_W)}{2L_e} \quad \frac{1}{t} \ln \frac{y_0}{y_t}$$

Where

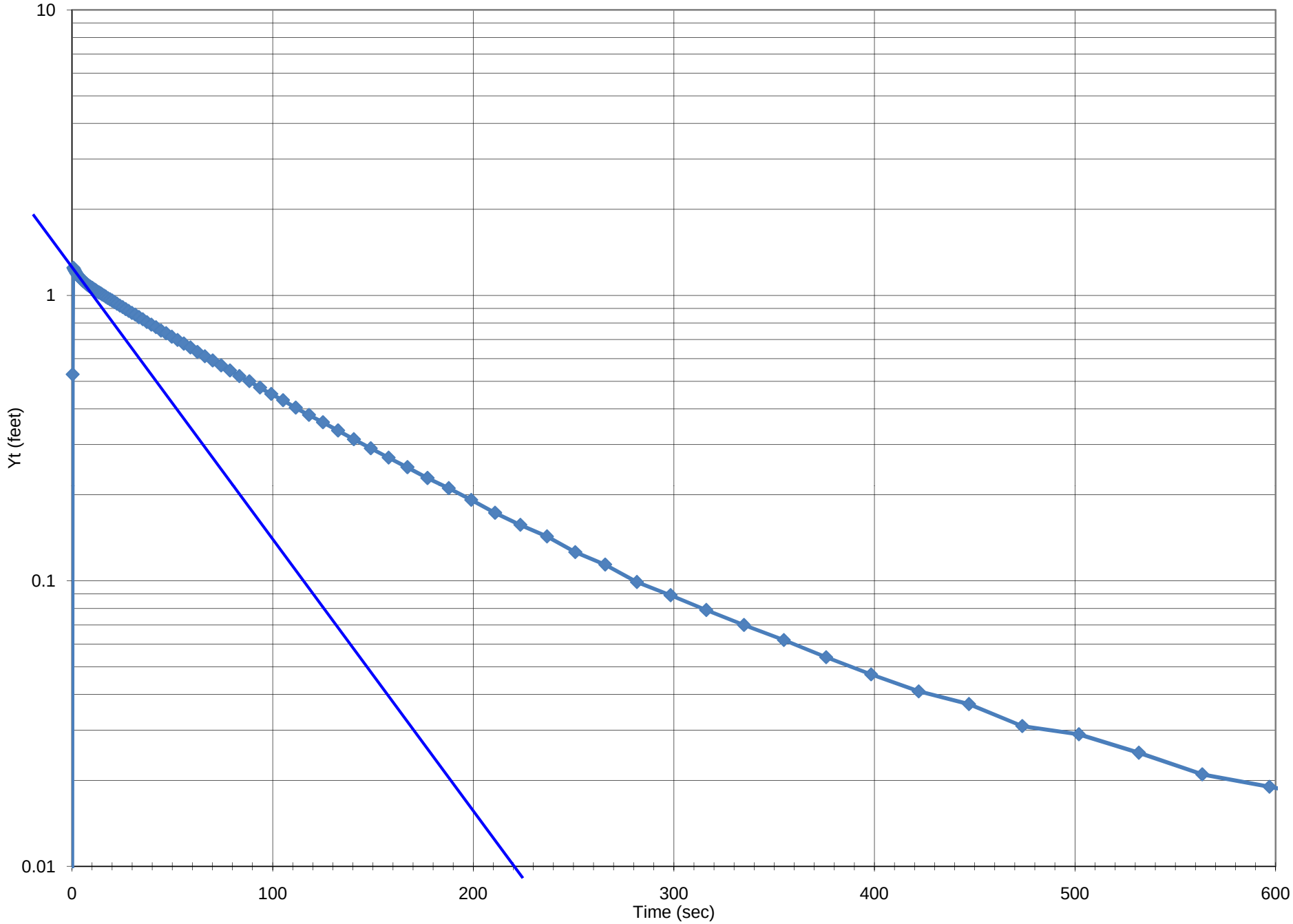
$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{A + B \ln[(H - L_W)/r_W]}{L_e/r_W} \right\}^{-1}$$

For partial penetration or the equation below for full penetration

$$\ln(Re/r_W) = \left\{ \frac{1.1}{\ln(L_W/r_W)} + \frac{C}{L_e/r_W} \right\}^{-1}$$

CDM

B-506D Slug Out
Dare County C&D Landfill



CDM

B-506D Slug Out
Dare County C&D Landfill

In-Situ Inc. MiniTroll Pro

Report genera 9/5/2008 8:47:02
Report from fi ...\SN08812 2008-09-04 094730 B-506D Out.bin
Win-Situ Ver 4.57.5.0

Serial number 8812
Firmware Ver 3.09
Unit name:

Test name: B-506D Out

Test defined c 9/4/2008 9:47:10
Test started o 9/4/2008 9:47:30
Test stopped 9/4/2008 10:05:13

Data gathered using Logarithmic testing
Maximum ti Seconds.
Number of c 110

TOTAL DATA 110

Channel number [1]
Measuremer Temperature
Channel name:

Channel number [2]
Measuremer Pressure
Channel name:
Sensor Rang 30 PSIG.
Sensor Offse 0.000 psi
Specific grav 1

Date	Time	ET (sec)	Chan[1] Temperatu Fahrenheit	Chan[2] Pressure Feet H2O	yt (ft)
9/4/2008	9:47:30	0	66.39	14.098	0.002
9/4/2008	9:47:31	0.3	66.43	13.572	0.528
9/4/2008	9:47:31	0.6	66.43	12.852	1.248
9/4/2008	9:47:31	0.9	66.43	12.863	1.237
9/4/2008	9:47:31	1.2	66.46	12.875	1.225
9/4/2008	9:47:32	1.5	66.46	12.886	1.214
9/4/2008	9:47:32	1.8	66.46	12.896	1.204
9/4/2008	9:47:32	2.1	66.46	12.906	1.194
9/4/2008	9:47:33	2.4	66.46	12.914	1.186
9/4/2008	9:47:33	2.7	66.46	12.922	1.178
9/4/2008	9:47:33	3	66.48	12.928	1.172
9/4/2008	9:47:34	3.3	66.48	12.937	1.163
9/4/2008	9:47:34	3.6	66.48	12.943	1.157
9/4/2008	9:47:34	3.9	66.48	12.949	1.151
9/4/2008	9:47:34	4.2	66.48	12.955	1.145
9/4/2008	9:47:35	4.5	66.48	12.961	1.139
9/4/2008	9:47:35	4.8	66.48	12.965	1.135
9/4/2008	9:47:35	5.1	66.48	12.971	1.129
9/4/2008	9:47:36	5.4	66.48	12.975	1.125
9/4/2008	9:47:36	5.7	66.48	12.982	1.118
9/4/2008	9:47:36	6	66.48	12.986	1.114
9/4/2008	9:47:37	6.4	66.48	12.992	1.108
9/4/2008	9:47:37	6.7	66.5	12.998	1.102
9/4/2008	9:47:37	7.1	66.5	13.004	1.096

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9/4/2008	9:47:39	8.4	66.5	13.022	1.078
9/4/2008	9:47:39	8.9	66.5	13.028	1.072
9/4/2008	9:47:40	9.5	66.5	13.034	1.066
9/4/2008	9:47:40	10	66.48	13.039	1.061
9/4/2008	9:47:41	10.6	66.48	13.047	1.053
9/4/2008	9:47:42	11.3	66.48	13.053	1.047
9/4/2008	9:47:42	11.9	66.48	13.061	1.039
9/4/2008	9:47:43	12.6	66.46	13.07	1.03
9/4/2008	9:47:44	13.4	66.46	13.078	1.022
9/4/2008	9:47:44	14.2	66.46	13.084	1.016
9/4/2008	9:47:45	15	66.46	13.094	1.006
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9/4/2008	9:48:45	74.3	66.37	13.532	0.568
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9/4/2008	9:48:54	83.4	66.34	13.579	0.521
9/4/2008	9:48:59	88.4	66.34	13.6	0.5
9/4/2008	9:49:04	93.7	66.32	13.625	0.475
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9/4/2008	9:49:28	118.1	66.28	13.719	0.381
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9/4/2008	9:54:09	398.4	66	14.053	0.047
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9/4/2008	9:58:40	670.1	66.05	14.085	0.015
9/4/2008	9:59:20	709.9	66.05	14.085	0.015
9/4/2008	10:00:02	752.1	66.07	14.087	0.013
9/4/2008	10:00:47	796.8	66.09	14.086	0.014
9/4/2008	10:01:34	844.2	66.09	14.088	0.012
9/4/2008	10:02:25	894.4	66.12	14.086	0.014
9/4/2008	10:03:18	947.5	66.09	14.088	0.012
9/4/2008	10:04:14	1003.8	66.09	14.088	0.012

Attachment No. 2

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Section 1
Introduction

1.1 Purpose

The Construction Quality Assurance (CQA) Plan is intended to fulfill Rule .0541, which requires that a CQA Plan be developed to ensure that the design materials meet the design specifications and the construction and certification requirements set forth in Rule.0540 for C&D landfills. This plan describes the observations and tests that will be used before, during, and upon completion of base pad and closure construction to ensure that the construction materials and workmanship meet the design specifications and the requirements set forth in Rule .0543.

1.2 Quality Assurance and Quality Control

In the context of this CQA Plan, quality assurance and quality control are defined as follows:

- *Quality Assurance:* A program of tests and observations, executed by a party independent of the contractor, performed in order to confirm that completed work meets contractual and regulatory requirements and will perform satisfactorily in service.

- *Quality Control:* Those actions performed by the contractor or an agent of the contractor which provide a means to monitor the quality of the work being performed.

1.3 Units

In this CQA Plan, all properties and dimensions are expressed in U.S. units, with "equivalent" SI units in parentheses. It should be noted that the conversion is typically only accurate within ten percent. In cases of conflict or clarification, the U.S. units shall be deemed to govern.

1.4 References

The CQA Manual includes references to test procedures of the American Society for Testing Materials (ASTM).

1.5 Overview of Manual

Per .0541(b)(1) through (5) this CQA Plan addresses:

1. Responsibilities and authorities. The plan establishes responsibilities and authorities for the construction management organization. This includes a pre-construction meeting conducted prior to beginning construction of the closure cap. The meeting shall include a discussion of the construction management organization, respective duties during construction, and periodic reporting requirements for test results and construction activities. This information is presented in subsequent sections.

2. Inspection activities: A description of all field observations, tests, and equipment that will be used to ensure that the construction meets or exceeds all design criteria established in accordance with Rule .0543(c) is presented in Sections 3 through 6 of the CQA Plan.

3. Sampling strategies. A description of all sampling protocols, sample size, methods for determining sample locations and frequency of sampling is presented in Sections 3 and 5.

4. Documentation. Reporting requirements for CQA activities are described in detail in Sections 2 through 6

5. Progress and troubleshooting meetings. A plan will be prepared for holding periodic troubleshooting meetings. The proceedings of the meetings will be documented. Meeting information is included in Section 2 of the Plan.

Section 2
Definitions, Responsibilities, Qualifications, and Communication Between Involved Parties

The parties discussed in this section are associated with the ownership, design, construction, and quality assurance of the landfill closure cap and base pad. The definitions, responsibilities, and qualifications of these parties are summarized in Table 2-1 and outlined in the following subsections.

2.1 Contractor

2.1.1 Definition

The Contractor is the company with which the Owner has entered into agreement to construct the project.

2.1.2 Responsibilities

The Contractor is ultimately responsible for meeting the requirements of the Contract Documents and the successful completion of the landfill base pad and closure cap construction. Some of the Contractor's specific responsibilities include: providing qualified personnel to perform quality control, providing submittals for the various materials as required by the specifications, scheduling and coordinating the work with suppliers and subcontractors, providing a representative at all times during construction activity, provide surveying services, furnish progress and record drawings, attending progress meetings, and notifying the Engineer of design discrepancies.

2.1.3 Qualifications

The Contractor shall be experienced in all aspects of the work required to successfully construct the project. The Contractor shall be registered in the State of North Carolina and shall provide references from previous projects.

2.2 Contractor's Representative

2.2.1 Definition

The Contractor's Representative (CR) is a qualified individual assigned by the Contractor to represent him/her onsite during construction activities.

2.2.2 Responsibilities

The CR is responsible for: communication with the Engineer and Owner, coordinating and supervising his crew, subcontractors, and quality control personnel, ensuring that construction activities are conducted in accordance with the plans and specifications, immediately notifying the Engineer's Field Representative (EFR) of any discrepancies between the plans and specifications and the field conditions, attending all meetings held on the project, and keeping a daily log of all construction activities onsite.

Table 2-1
Project Personnel Responsibilities

PARTY	DEFINITION	RESPONSIBILITIES	QUALIFICATIONS	REPORT TO
Owner	The Owner is the party who owns the facility and who is financially responsible for the facility and project.	Page 2-4	Proof of Financial Responsibility	Not Applicable
Contractor	Company contracted by Owner to construct project in accordance with plans and specifications	Page 2-1	Licensed in North Carolina and similar project experience	Owner, Engineer, and EFR
Contractor's Representative (CR)	Person assigned by the Contractor to act as the CR onsite	Pages 2-1 and 2-3	Similar project experience	Contractor and EFR
Engineer	Company contracted by Owner for design of the project and to provide services during construction	Page 2-3	Registered professional engineer in North Carolina	Owner
Engineer's Field Representative (EFR)	Person assigned by the Engineer to perform QA inspection and document construction activities	Pages 2-3 and 2-4	Similar project experience	Engineer and Owner
Quality Assurance Laboratory (QAL)	Lab assigned by Owner or Engineer to conduct materials testing	Page 2-4	Experience in testing in accordance with ASTM.	EFR and Owner

2.2.3 Qualifications

The CR shall be an individual who demonstrates the capability to direct all tasks required for landfill closure cap construction. The CR shall demonstrate experience similar to the nature of the project and be knowledgeable of all aspects of the work.

2.3 Engineer

2.3.1 Definition

The Engineer is the party with which the Owner has entered into agreement with to provide project design and construction oversight.

2.3.2 Responsibilities

The Engineer is responsible for performing the engineering design and preparing the associated construction drawings and specifications. The Engineer is responsible for approving all design and specification changes, clarifying the design, reviewing and approving shop drawings, and other tasks as required during construction. The Engineer conducts the pre-construction meeting and progress meetings outlined in this plan. The Engineer will certify that the construction was completed in accordance with this CQA plan and the conditions of the closure plan in accordance with the requirements of Rule .0543 (c)(7), and acceptable engineering practices.

2.3.3 Qualifications

The Engineer shall be a professional engineer registered by the State of North Carolina. The Engineer shall have a working knowledge of landfill closure cap design and construction and all applicable regulatory requirements.

2.4 Engineer's Field Representative

2.4.1 Definition

The EFR is a qualified individual assigned by the Engineer to observe and document activities requiring quality assurance.

2.4.2 Responsibilities

The EFR is responsible for observing and documenting activities related to the quality assurance of the construction of the landfill closure cap. The EFR is responsible for implementation of this CQA Plan and coordination of the Quality Assurance Laboratory (QAL).

The specific duties of the EFR are as follows:

a. Review all construction drawings and specifications.

b. Review other site-specific documentation, including permits.

c. Review all changes to design drawings and specifications as issued by the Engineer.

d. Act as the Owner's representative.

e. Attend all quality assurance related meetings, e.g., resolution, pre-construction, progress, trouble-shooting, etc.

f. Review Contractor's Daily Reports, logs, and photographs.

g. Report to the Engineer, and log any relevant observations.

h. Review the results of laboratory testing.

i. Report any unapproved deviations from the CQA Manual.

j. Prepare the final certification report.

2.4.3 Qualifications

The EFR shall be experienced with the implementation and preparation of quality assurance documentation including: quality assurance forms, reports, certifications, and manuals; and shall have prior experience with soil liner installation.

2.5 Owner

2.5.1 Definition

The Owner is the party who owns the facility and is financially responsible for the facility and project.

2.5.2 Responsibilities

The Owner shall be responsible for providing necessary communications with the Contractor. All communications with the Contractor will be issued through the Engineer. The Owner shall promptly furnish all data required of the Owner under the Contract Documents. The Owner shall make payments to the Contractor when they are due as provided in the Contract Documents.

2.5.3 Qualifications

The Owner shall be financially responsible in accordance with Rule .0546.

2.5.4 Submittals

The Owner will not be responsible for delivering any submittals.

2.6 Quality Assurance Laboratory

2.6.1 Definition

The QAL is a firm, independent from the Contractor and Owner, responsible for conducting tests on samples of materials for the closure cap construction.

2.6.2 Responsibilities

The QAL shall be responsible for conducting the appropriate laboratory tests as directed by the Engineer and in accordance with the project plans and specifications.

The test procedures shall be done in accordance with the test methods outlined in this CQA Plan.

2.6.3 Qualifications

The QAL shall have experience in soil testing and be familiar with American Society for Testing and Materials (ASTM).

2.6.4 Submittals

The QAL shall deliver all test results to the Engineer in written form. Written test results shall be in an easily readable format and include references to the standard test methods used.

2.7 Lines of Communication

All communication between parties shall go through the Engineer's Field Representative (EFR), who, in turn, will direct the communication through the proper channels.

2.8 Pre-Construction Meeting

A pre-construction meeting shall be held before construction activity begins. The meeting shall be conducted by the Engineer and attended by the Owner, EFR, Contractor, CR, and a Solid Waste Section representative.

Per Rule .0541(b)(1), the meeting will include a discussion of the construction management organization, the responsibilities and duties of each party during construction, and periodic reporting requirements for testing results and construction activities.

2.9 Progress and Troubleshooting Meetings

Per Rule .0541(b)(5) progress and troubleshooting meetings shall be conducted by the Engineer and attended by the Owner, EFR, and CR. Progress meetings shall be held as deemed necessary, but at a minimum frequency of one per month. These meetings shall discuss current progress, planned activities to be accomplished prior to the next progress meeting, issues requiring resolution, and any new business or revisions to the work. The EFR shall log any problems, decisions, or questions arising at this meeting. If any matter remains unresolved at the end of this meeting, the EFR will be responsible for obtaining a resolution of the matter and for forwarding communication of the decision to the appropriate parties.

Section 3
Intermediate Cover (Cover Cap)

The materials, construction and certification requirements in this Section are intended to comply with Rule .0543 (c)(1)(A) and (B). This section applies to requirements for construction of the C&D landfills closure cap.

3.1 Materials

A. Intermediate soil liner materials installed as part of construction shall conform to the following properties:

■ Passing the 1-inch Sieve	ASTM D422	100 percent
■ Organic Content	ASTM D2974	5% maximum

B. The Contractor shall use adequate construction quality control (CQC) to verify the conformance of materials according to this section. The Contractor shall submit to the Engineer, within 30 days of the effective date of the Agreement, representative samples from the soil source(s). In the case that the submitted samples fail to conform to the required criteria, the Contractor may locate another source, and upon approval of that source by the Engineer, submit samples from the new source for conformance testing at the cost of the Contractor.

3.2 Conformance Testing

A. Initial conformance testing shall be performed by the quality assurance laboratory (QAL) on samples from the soil source to assure compliance with the Specifications. The samples will be obtained from multiple test pits to be dug by the Contractor under the direction of the QAL. The following tests shall be performed on the samples:

1. Sieve Analysis (ASTM D422) (including hydrometer analysis)
2. Moisture-Density Curves (ASTM D698)
3. Natural Moisture (ASTM D2216)

B. For each delivery of material from the borrow source, the quality control laboratory (QCL) personnel of the Contractor shall note, on an approved form, the color of the material, date, time, and approximate quantity of material brought onsite and submit copies of completed forms to the Engineer . The soil source shall be conformance tested by the QCL during the excavation and stockpiling operation at the following frequency.

Test	Method	Frequency
Grain Size w/hydrometer	(ASTM D422)	Every 2,000 cy
Moisture/Density	(ASTM D698)	Every 5,000 cy
Natural Moisture	(ASTM D2216)	Every 2,000 cy

Results of the tests will be submitted to the Engineer within 24 hours of test completion. The Engineer reserves the right to reject material based on the results of the conformance tests.

3.3 Construction

A. The QCL shall supervise additional intermediate soil liner installation. Work shall not be performed by the Contractor without the QCL onsite. The QCL shall perform field tests (i.e. moisture content, densities, etc.) as required to ensure proper installation.

B. Water for Compaction

1. The Contractor shall provide water as required to guarantee constructability and proper condition of the inplace and stockpiled material.

2. Prior to installing the soil liner, the Contractor shall inspect the existing soil surface to ensure that it has been sufficiently wetted to prevent excessive absorption of moisture from the installed material.

3. Should the material be stockpiled for any length of time the Contractor shall slope and compact the stockpile to prevent erosion and oversaturation.

4. Should the material become oversaturated, the Contractor shall spread and dry the material as needed to adjust the moisture to the proper level.

C. The materials shall be uniformly compacted to no less than 92 percent of standard proctor.

D. During construction, the Contractor shall make all necessary provisions to deal with inclement weather conditions. The Contractor shall be fully responsible for control of stormwater during installation of the cap system and for moisture control and protection of the low permeability soil liner.

E. After final grading is completed, the compacted intermediate cover thickness shall not be less than 12-inches. Soil liner will be tested by the QAL at a frequency as specified in Section 3.4.1. Each test shall penetrate to disposed waste. The thickness shall be measured from top of waste to top of intermediate cover. Areas

not meeting the thickness requirements shall be augmented with additional material.

3.4 Certification

3.4.1 Field Quality Control

A. The QAL shall conduct the following tests during installation of the intermediate cover at the specified frequencies.

Test	Method	Frequency
Liner thickness	(Hand Auger or push tube)	4/acre

B. All holes made as a result of testing, grade stakes or other means shall be completely filled by the Contractor, as instructed by the Engineer.

3.4.2 Corrective Action

If soil has been desiccated to a depth greater than or equal to three inches, the desiccated material shall be moistened, and recompacted. Also, it should be recognized that if the soil is wetted, time must be allowed for water to be absorbed into the clods and hydration to take place uniformly.

For this reason it may be necessary to remove the desiccated soil from the construction area, process the lift in a separate processing area, and replace the soil accordingly.

Section 4
Low Permeability Soil Liner (Closure Cap)

The materials, construction and certification requirements in this Section are intended to comply with Rule .0543 (c)(1)(A) and (B). This section applies to requirements for construction of the C&D landfill closure cap.

4.1 Materials

A. Low permeability soil liner materials shall conform to the following properties:

■ Passing the 1-inch Sieve	ASTM D422	100 percent
■ Passing the 200 Sieve	ASTM D1140	45 percent minimum*
■ Liquid Limit	ASTM D4318	30 minimum*
■ Plasticity Index	ASTM D4318	7 minimum*
■ Soil Classification	ASTM D2487	SC, SM, ML, CL, MH, CH
■ Hydraulic Conductivity	ASTM D5084	1.0×10^{-5} cm/s maximum
■ Internal Friction Angle	ASTM D4767	19° minimum
■ Organic Content	ASTM D2974	5% maximum

* The Engineer may modify these conformance test properties based on the results of initial conformance testing, provided modification of these results does not compromise the hydraulic conductivity or internal friction angle test results.

B. A soil-bentonite mixture can be used for the low permeability soil liner provided it achieves the specified hydraulic conductivity and internal friction angles as presented in Paragraph 4.1 A. Both onsite and offsite soils may by used for soil-bentonite mix. Soil to be used for the soil-bentonite mix shall conform to the following properties:

■ Passing the 1-inch Sieve	ASTM D422	100 percent
■ Soil Classification	ASTM D2487	SC, SM, ML, CL, MH, CH

■ Soils with organic materials of any kind, particularly leaves and roots, shall not be used in the mixture.

C. The soil-bentonite mixture shall consist of an acceptable soil described in Paragraph 4.1 B containing a sealant consisting of free flowing, high swelling sodium-based Wyoming type bentonite. The bentonite sealant shall conform to all items of this specification with all supporting test data certified, submitted to, and approved by the Engineer, prior to bid, as follows:

- The bentonite shall be covered by the Manufacturer's warranty against defects in material and workmanship and shall have a useful life of 30 years under normal weathering and normal use conditions.

D. The low permeability soil liner or soil-bentonite mixture material used for cap construction shall be uniform in character, and after compaction, shall have an in-place saturated hydraulic conductivity of 1.0×10^{-5} cm/s or less.

E. The Contractor shall use adequate construction quality control (CQC) to verify the conformance of materials according to this section. The Contractor shall submit to the Engineer, within 30 days of the effective date of the Agreement, representative samples from the soil source(s). In the case that the submitted samples fail to conform to the required criteria, the Contractor may locate another source, and upon approval of that source by the Engineer, submit samples from the new source for conformance testing at the cost of the Contractor.

F. If the Contractor plans to use any blending of soils as low permeability soil liner material, the Contractor shall submit the blended soil for the Engineer's approval in accordance with the requirements.

4.2 Conformance Testing

A. Initial conformance testing shall be performed by the quality assurance laboratory (QAL) on samples from the soil source to assure compliance with the Specifications. The samples will be obtained from multiple test pits to be dug by the Contractor under the direction of the QAL. The following tests shall be performed on the samples. If soil-bentonite mix is used, test 8 will be performed on the mix, not on the untreated soil.

1. Soil Classification (ASTM D2487)
2. Sieve Analysis (ASTM D422) (including hydrometer analysis)
3. Atterberg Limits (ASTM 4318)
4. Moisture-Density Curves (ASTM D698 and D1557)
5. Specific Gravity (ASTM D854)
6. Laboratory Hydraulic Conductivity (ASTM D5084 except as modified in Paragraph 4.3.1.E)
7. Natural Moisture (ASTM D2216)
8. Shear Tests (ASTM D4767 or as approved by the Engineer)
9. Organic Content (ASTM D2974)

B. For natural low permeability soil sources, the QAL shall determine an acceptable zone of moisture contents, dry unit weights and compaction for which hydraulic conductivities are less than or equal to 1.0×10^{-5} cm/s by performing the following testing and analysis procedures:

1. Using the samples extracted from the proposed source, perform Modified and Standard Proctor compaction tests to develop at least two moisture-density curves. For each of the compaction tests use up to five specimens at incremental moisture contents to develop a compaction curve showing dry density for each molding water content.

2. Permeate each compacted specimen to determine its hydraulic conductivity in accordance with ASTM D5084.

3. On the graph of dry density vs. moisture content, identify the samples which have hydraulic conductivities less than or equal to 1×10^{-5} cm/s.

4. Draw an "acceptable zone" of water content and dry density around the passing samples.

5. Perform Internal Shear Tests on one specimen from the high and low ends of the acceptable zone and plot the friction angles as a function of molding water content.

6. Based on the shear test results and other pertinent factors such as constructibility, shrink/swell potential, dessication cracks, and consolidation, the QAL shall modify the acceptable zone as required.

C. For soil-bentonite mixes, prior to constructing the test pad, the QAL shall determine an acceptable zone of moisture contents and dry unit weights in which the hydraulic conductivity is less than or equal to 1.0×10^{-5} cm/sec by following the procedures described above in Paragraph 4.2.B (with the exception that samples will be extracted from the pug mill operation). The samples will be taken from a soil-bentonite mix once the bentonite percentage for production has been firmly established. The Contractor shall be responsible for performing preliminary hydraulic conductivity tests on initial mix ratios (based on manufacturer's recommendation and adjusted based on Contractor's experience) in order to establish the percentage of bentonite to be used in production.

D. For each delivery of material from the borrow source, the quality control laboratory (QCL) personnel of the Contractor shall note, on an approved form, the color of the material, date, time, and approximate quantity of material brought onsite and submit copies of completed forms to the Engineer . The soil source shall be conformance tested by the QCL during the excavation and stockpiling operation at the following frequency.

Test	Method	Frequency
Grain Size w/hydrometer	(ASTM D422)	Every 2,000 cy
Atterberg Limits	(ASTM D4318)	Every 2,000 cy
Moisture/Density	(ASTM D698)	Every 5,000 cy
Natural Moisture	(ASTM D2216)	Every 2,000 cy

Results of the tests will be submitted to the Engineer within 24 hours of test completion. The Engineer reserves the right to reject material based on the results of the conformance tests.

4.3 Construction

4.3.1 Test Pad

A. A test pad of a dimension of no less than 40-ft by 60-ft and 18-inch thickness shall be constructed onsite using the same equipment, processing and installation procedures that will be used during full-scale liner construction. The low permeability soil or the soil-bentonite mixture to be used for the test pad shall be the same material that the Contractor proposes to use for construction of the base liner. If approved by the Engineer, the test pad may be installed within the cap limits and incorporated in the work, provided the pad passes all testing requirements.

B. The construction of the pad shall be directed by the QCL. The QCL shall use the acceptable zone established by the QAL to set moisture contents and percent compaction. The QCL may perform tests as needed to assist in the construction of the test pad. However, only the results of the QAL's test will be recognized for determining the performance of the pad.

C. For each lift, the QAL shall perform testing of moisture content and density in accordance with 4.4.1.A at a minimum of three test locations. The QAL shall record moisture content, compaction procedures, and density throughout the construction of the test pad. Two Shelby Tube Samples shall be obtained per lift by the QAL. One tube will be used to perform a hydraulic conductivity test in accordance with 4.4.1.A the second tube will be kept as a backup in case of damage to the first sample or dispute of test results. Holes within the soil liner as a result of in-place testing shall be replaced in accordance with 4.4.1.B.

D. For soil-bentonite mixtures, the bentonite content used for the test pad shall be set by the Contractor and written notification of the mix ratio will be submitted to the Engineer prior to constructing the test pad.

E. One triaxial type hydraulic conductivity test (ASTM D5084) will be performed on each test pad per lift.

F. The cap thickness shall be determined from four locations selected by the QAL per test pad using a method that is approved by the Engineer, which will be determined prior to test pad construction.

4.3.2 Soil Liner Installation

A. The QCL shall supervise the soil liner installation. Work shall not be performed by the Contractor without the QCL onsite. The QCL shall perform field tests (ie. moisture content, densities, etc.) as required to ensure proper installation. The QAL shall perform tests as described in Section 4.4 to determine acceptance of the soil liner.

B. The placement moisture content shall be within the acceptable zone of moisture content as determined by the QAL during the conformance testing of the low permeability soil described in Paragraph 4.2. The acceptable zone may be modified by the Engineer based on results and observations of the test pad.

C. Water for Compaction

1. The Contractor shall provide water as required to guarantee constructability and proper condition of the inplace and stockpiled material.

2. The water shall be of potable quality.

3. Prior to installing the soil liner, the Contractor shall inspect the subgrade to ensure that it has been sufficiently wetted to prevent excessive absorption of moisture from the installed material.

4. Should the material be stockpiled for any length of time the Contractor shall slope and compact the stockpile to prevent erosion and oversaturation.

5. Should the material become oversaturated, the Contractor shall spread and dry the material as needed to adjust the moisture to the proper level.

D. The materials shall be uniformly compacted to no less than the minimum dry density of the acceptable zone that corresponds to the placement moisture content. The acceptable zone shall be as specified by the QAL in accordance with the procedures outlined in Section 4.3.1. This minimum density shall be uniformly obtained throughout the entire thickness of the liner. The cap shall be constructed in lifts with a maximum compacted thickness of 6 inches per lift to assure achievement of the specified compaction in the lower part of the cap. However, the initial lift may be placed at 8 inches to prevent mixing with the existing operational cover during compaction.

E. Soil liner material which has been contaminated with clusters of rock or gravel, sand lenses, organic debris or other deleterious material shall be removed and replaced with uncontaminated low permeability soil materials.

F. The Contractor shall use a pugmill to produce the soil-bentonite mix at the required moisture content to achieve an in-place compacted minimum 18-inch thick layer of material with a hydraulic conductivity less than or equal 1×10^{-5} cm/sec. Based on the soil material to be used, the Engineer may direct the Contractor to screen the soils prior to placement in the pugmill. The pugmill must be approved by the Engineer prior to its arrival on site.

G. No low permeability soil liner material shall be placed, spread, or compacted while the existing operational cover or soil liner material is frozen/thawing, saturated, desiccated, nor during unfavorable weather conditions or periods of precipitation. The cap surface must be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the soil liner material. Any regrading due to the above conditions or final preparation should be retested at those locations for liner thickness prior to placement of the next lift or erosion control layer. Thickness measurements should be performed as indicated in Section 4.4.1.

H. Work shall be limited to an area where a lift can be completed in one working day and shall continue in that area until three lifts have been placed. Completion of an area shall be defined as the construction of a cap of a minimum 18-inches that is homogenously installed at a moisture content and density within the acceptable zone, free rocks larger than 1-inch diameter, and possessing a smooth rolled surface.

I. If a lift is not to receive a subsequent lift within 16 hours of its completion, the lift shall be sealed with a smooth wheel compactor at the end of each day's work to protect the material from desiccation. Should desiccation cracks develop, soil liner material shall be scarified, disked, rewetted, rehomogenized and recompacted in accordance with the Specifications to the depth of any such cracks or as instructed by the Engineer. If desiccation extends below half of the lift thickness, the lift shall be removed and replaced.

J. During construction, the Contractor shall make all necessary provisions to deal with inclement weather conditions. The Contractor shall be fully responsible for control of stormwater during installation of the cap system and for moisture control and protection of the low permeability soil liner.

M. After final grading and smooth rolling is completed, the compacted soil liner thickness shall not be less than 18 inches. Soil liner will be tested by the QAL on the final lift at a frequency as specified in Section 4.4.1 using a method of hand augering or push tube sampling (minimum 3/4" sample). Each test shall

penetrate all underlying lifts to disposed waste. The thickness shall be measured from top of waste to top of low permeability soil liner. Areas not meeting the thickness requirements shall be augmented with additional low permeability soil material at the expense of the Contractor. Any additional testing or CQA services associated with corrective action for achieving the 18-inch cap thickness requirement will be at the cost of the Contractor. The added material shall be worked into the in-place liner to ensure homogeneity and proper bonding. This shall be done by scarification of the surface prior to addition of the new material. As a minimum, the top 4-in of the soil liner shall be wetted, kneaded, compacted and reworked with the additional material to obtain the required thickness.

4.4 Certification

4.4.1 Field Quality Control

A. The QAL shall conduct the following tests during installation of the low permeability soil or soil-bentonite liner at the specified frequencies.

Test	Method	Frequency
Atterberg Limits	(ASTM D4318)	2/acre/lift
Moisture of Undisturbed Hydraulic Conductivity Sample	(ASTM D2216)	1/two acres/lift
Undisturbed Hydraulic Conductivity	(ASTM D5084)	1/two acres/lift
Density	(ASTM D2937 or ASTM D2992)	4/acre/lift
Moisture	(ASTM D2216 or ASTM D3017)	4/acre/lift
Liner thickness	(Topographic Survey)	2 - existing and post liner installation
Grain Size	(Sieve Only)	2/acre/lift
Shear Test of Undisturbed Hydraulic Conductivity Sample	(ASTM D4767)	1/two acres/lift

B. All holes made as a result of depth measurements, hydraulic conductivity samples, density tests, grade stakes or other means shall be completely filled by the Contractor with bentonite or soil-bentonite mix, as instructed by the Engineer.

C. The Engineer shall have the authority to request additional hydraulic conductivity tests in areas that, in the Engineer's judgement, may be suspect or deficient. Hydraulic conductivity tests shall be conducted in accordance with ASTM D5084 except as modified in Paragraph 4.3.1.E. For each sample tested, one back-up sample will be extracted in the proximity of the sample location. These samples will be held in a controlled environment at the QAL laboratory as a precautionary measure. If adequate demonstration is presented that a sample was not representative of the low permeability soil liner or that an error in testing occurred, the backup samples will be tested and the original test will be disregarded.

D. Any sample or area tested shall be rejected, removed and replaced if it does not meet the requirements of the technical specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent liner areas.

E. Grade stakes for soil liner construction shall be numbered by the Contractor and located on an inventory map. The inventory map shall be submitted to the Engineer. Upon completion of an area, the removed stakes will be compared to the inventory map to ensure that none were left inplace.

F. The Contractor shall submit a survey plan with final elevation of top of low permeability soil liner for Engineer's approval.

4.4.2 Corrective Action

If soil has been desiccated to a depth less than or equal to the thickness of a single lift, the desiccated lift may be disked, moistened, and recompacted. However, disking may produce large, hard clods that will require pulverization. Also, it should be recognized that if the soil is wetted, time must be allowed for water to be absorbed into the clods and hydration to take place uniformly. For this reason it may be necessary to remove the desiccated soil from the construction area, process the lift in a separate processing area, and replace the soil accordingly.

Section 5
Erosion Layer Materials (Closure Cap)

The materials, construction and certification requirements in this Section are intended to comply with Rule .0543 (c)(1)(C). This section applies to requirements for construction of the C&D landfill closure cap.

5.1 Materials

A. Erosion Layer Material

1. Erosion layer material shall be capable of sustaining native plant growth. Erosion layer soil shall not be compacted except by tracking during spreading operations.

B. Erosion Control Blanket

1. If needed, erosion control blankets shall consist of wood excelsior with 80% 6-inch fibers or greater fiber length with the top of the blanket covered with photo-degradable or biodegradable netting. Blanket shall be of consistent thickness with fibers evenly distributed throughout the entire area of the blanket. Blanket shall be recommended by manufacturer for use on slopes up to 1.5:1, stormwater channel velocities up to 5 fps, and flow shear stresses up to 2 lbs/sf.

5.2 Conformance Testing

A. Erosion layer material shall be tested for nutrient fertilizer requirements and pH requirements at a frequency of once per 5,000 cubic yards.

1. The pH value shall be between pH 6.0 and 7.0.

2. Fertilizer and lime shall be spread and incorporated as per soil test recommendations after the erosion layer material is spread but prior to fine grading.

5.3 Construction

A. The Contractor shall place a minimum of 18 inches of erosion layer material over the low permeability soil liner.

B. The Contractor shall be responsible for identifying earthen material to be used for erosion layer material and adding amendments to create suitable erosion layer material. Stockpiled material may be used in areas disturbed by Contractor's activities as approved by the Engineer.

C. Commercial fertilizer, lime, peat, humus, sand or other additives shall be used to counter act soil deficiencies as recommended by the soil analysis and as directed by the Engineer.

5.4 Certification

A. Erosion layer material thickness will be tested by the QAL on the final lift at a frequency four per acre using a method approved by the Engineer prior to construction of the erosion layer construction survey. Each test shall penetrate to the low permeability soil liner material. The thickness shall be measured from top of erosion layer to top of low permeability soil liner. Areas not meeting the thickness requirements shall be augmented with additional erosion layer material.

Section 6
Compacted Fill (Base Pad)

The materials, construction and certification requirements in this Section are intended to comply with Rule .0543 (c)(1)(A) and (B). This section applies to requirements for construction of the C&D landfills base pad.

6.1 Materials

A. Compacted fill materials shall conform to the following properties:

■ Internal Friction Angle	ASTM D4767	35° minimum
■ Soil Classification	ASTM D2487	SC, ML, CL, MH, CH (Upper two feet of base pad only)
■ As-Built Thickness	Topographic Survey	5-ft, total base pad thickness (including upper 2-ft and bottom 3-ft layers)

* The Engineer may modify these conformance test properties based on the results of initial conformance testing, provided modification of these results does not compromise the hydraulic conductivity or internal friction angle test results.

B. Compacted fill shall be a mineral soil free of organic material, loam, wood, trash, snow, ice, frozen soil, and other objectionable material.

C. The Contractor shall use adequate construction quality control (CQC) to verify the conformance of materials according to this section. The Contractor shall submit to the Engineer, within 30 days of the effective date of the Agreement, representative samples from the soil source(s). In the case that the submitted samples fail to conform to the required criteria, the Contractor may locate another source, and upon approval of that source by the Engineer, submit samples from the new source for conformance testing at the cost of the Contractor.

D. If the Contractor plans to use any blending of soils as compacted fill material, the Contractor shall submit the blended soil for the Engineer's approval in accordance with the requirements.

6.2 Conformance Testing

A. Initial conformance testing shall be performed by the quality assurance laboratory (QAL) on samples from the soil source to assure compliance with the Specifications. The samples will be obtained from multiple test pits to be dug by the Contractor under the direction of the QAL. The following tests shall be performed on the samples.

1. Soil Classification (ASTM D2487)

2. Sieve Analysis (ASTM D422)

3. Atterberg Limits (ASTM 4318)

4. Moisture-Density Curves (ASTM D698 and D1557)

5. Natural Moisture (ASTM D2216)

6. Shear Tests (ASTM D4767 or as approved by the Engineer)

D. For each delivery of material from the borrow source, the quality control laboratory (QCL) personnel of the Contractor shall note, on an approved form, the color of the material, date, time, and approximate quantity of material brought onsite and submit copies of completed forms to the Engineer . The soil source shall be conformance tested by the QCL during the excavation and stockpiling operation at the following frequency.

Test	Method	Frequency
Grain Size	(ASTM D422)	Every 2,000 cy
Atterberg Limits	(ASTM D4318)	Every 2,000 cy
Moisture/Density	(ASTM D698)	Every 5,000 cy
Natural Moisture	(ASTM D2216)	Every 2,000 cy
Soil Classification	(ASTM D2487)	Every 5,000 cy (Upper 2-feet of Base Pad)

Results of the tests will be submitted to the Engineer within 24 hours of test completion. The Engineer reserves the right to reject material based on the results of the conformance tests.

6.3 Construction

6.3.1 Subgrade Preparation

A. Subgrade shall be roughly leveled and proof rolled with a 25 ton roller, (or the equivalent) making at least four passes (two passes being perpendicular to the others).

6.3.2 Compacted Fill Installation

A. Compacted Fill shall be placed in maximum 8-inch-thick loose lifts and compacted to 95% of the maximum dry density determined by standard Proctor test performed in accordance with ASTM D698, or as otherwise shown in the

Drawings. The soils shall be wetted or dried as necessary so that the moisture content during compaction is within two percent of the optimum moisture content determined by the standard Proctor test.

B. Water for Compaction

1. The Contractor shall provide water as required to guarantee constructability and proper condition of the inplace and stockpiled material.

2. The water shall be of potable quality.

3. Prior to installing the compacted fill, the Contractor shall inspect the subgrade to ensure that it has been sufficiently wetted to prevent excessive absorption of moisture from the installed material.

4. Should the material be stockpiled for any length of time, the Contractor shall slope and compact the stockpile to prevent erosion and oversaturation.

5. Should the material become oversaturated, the Contractor shall spread and dry the material as needed to adjust the moisture to the proper level.

C. No compacted fill material shall be placed, spread, or compacted while the existing operational fill material is frozen/thawing, saturated, desiccated, nor during unfavorable weather conditions or periods of precipitation. The fill surface must be made smooth and free from ruts or indentations at the end of any working day when significant precipitation is forecast and/or at the completion of the compaction operations in that area in order to prevent saturation of the fill material. Any regrading due to the above conditions or final preparation should be retested at those locations for compacted fill thickness prior to placement of the next lift. Thickness measurements should be performed as indicated in Section 6.4.1.

D. If a lift is not to receive a subsequent lift within 16 hours of its completion, the lift shall be sealed with a smooth wheel compactor at the end of each day's work to protect the material from desiccation. Should desiccation cracks develop, compacted fill material shall be scarified, disked, rewetted, rehomogenized and recompacted in accordance with the Specifications to the depth of any such cracks or as instructed by the Engineer. If desiccation extends below half of the lift thickness, the lift shall be removed and replaced.

E. After final grading and smooth rolling is completed, the compacted fill thickness shall not be less than 5 feet. Compacted fill shall be tested by the QAL on the final lift at a frequency as specified in Section 6.4.1. The thickness shall be measured from top of subgrade to top of compacted fill. Areas not meeting the thickness requirements shall be augmented with additional fill material at the expense of the Contractor. The added material shall be worked into the in-place fill to ensure

homogeneity and proper bonding. This shall be done by scarification of the surface prior to addition of the new material. As a minimum, the top 4-inch of the fill shall be wetted, kneaded, compacted and reworked with the additional material to obtain the required thickness.

6.4 Certification

6.4.1 Field Quality Control

A. The QAL shall conduct the following tests during installation of the low permeability soil or soil-bentonite liner at the specified frequencies.

Test	Method	Frequency
Density	(ASTM D2937 or ASTM D2992)	4/acre/lift
Moisture	(ASTM D2216 or ASTM D3017)	4/acre/lift
Base pad as-built thickness	(Topographic Survey)	3 surveys*

* Three topographic surveys shall be conducted to verify the base pad thickness. The first survey shall be performed prior to the start of any construction activities, then after the initial three feet of compacted fill is installed and a final survey after the upper two feet of compacted fill is installed. These topographic surveys shall be compared to determine the as-built thickness of the base pad.

B. All holes made as a result of depth measurements, density tests, grade stakes, or other means shall be completely filled by the Contractor with sand or as instructed by the Engineer.

C. Any sample or area tested shall be rejected, removed and replaced if it does not meet the requirements of the technical specifications. Reconstructed areas shall have feathered, overlapping edges that tie into adjacent fill areas.

D. Grade stakes for compacted fill construction shall be numbered by the Contractor and located on an inventory map. The inventory map shall be submitted to the Engineer. Upon completion of an area, the removed stakes will be compared to the inventory map to ensure that none were left inplace.

F. The Contractor shall submit a survey plan with final elevation of top of compacted fill for Engineer's approval.

6.4.2 Corrective Action

If soil has been desiccated to a depth less than or equal to the thickness of a single lift, the desiccated lift may be disked, moistened, and recompacted. However, disking may produce large, hard clods that will require pulverization. Also, it should be recognized that if the soil is wetted, time must be allowed for water to be absorbed into the clods and hydration to take place uniformly. For this reason it may be necessary to remove the desiccated soil from the construction area, process the lift in a separate processing area, and replace the soil accordingly.

Section 7
Documentation

This Section is intended to comply with Rules .0540(8) and .0541(b)(4) and .0543(c)(7).

Upon completion of construction activities, a Construction Quality Assurance Certification Report will be submitted to the Solid Waste Section in accordance with Rules .0541 and .0543. The report will summarize all quality assurance services performed during construction of the C&D landfill base pad and cap and will include, at a minimum the following:

- Field observation inspection reports;
- Final acceptance zones for low permeability soil liner;
- The results of all construction quality assurance and construction quality control testing required by this Plan;
- Documentation of any failed test results, descriptions of procedures used to correct the improperly installed material and results of all retesting performed;
- Record drawings documenting the completed project and noting any deviation from the approved engineering plans; and
- A comprehensive narrative including, but not limited to, daily reports from the project engineer and a series of color photographs of major project features.

The CQA Certification report shall bear the seal of a North Carolina Professional Engineer who was involved during the construction and a certification that construction was completed in accordance with:

1. This CQA Plan;
2. The conditions of the Permit to Construct;
3. The requirements of Rules .0541 and .0543; and
4. Good engineering practices.

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Section 1
Introduction

The purpose of this Operations Plan is to provide the Dare County C&D Landfill staff with a manual that will serve as a guide for safe and efficient operation of the C&D Landfill, including Cell No. 4 that is proposed for construction. This Operations Plan has been prepared in accordance with the North Carolina Solid Waste Rule 15A NCAC 13B .0542, Operation Plan and Requirements for C&D Landfill Facilities, and therefore addresses the following issues.

- Waste Acceptance and Disposal Requirements
- Cover Material Requirements
- Spreading and Compacting Requirements
- Disease Vector Control
- Air Criteria and Fire Control
- Access and Safety Requirements
- Erosion and Sedimentation Control Requirements
- Drainage Control and Water Protection Requirements
- Survey for Compliance
- Operating Record and Recordkeeping Requirements

Additionally, Table 1 is provided to summarize all required documents or documentation (record keeping) to be included in the operating record which must be maintained by the County and retained at the facility. The operating record may be inserted into a 3-ring binder located at the scale house or main administration building. It is the intent that Table 1 is clearly and visually posted to ensure direction on record keeping.

Table -1
Dare County C&D Landfill
Operating Record Requirements

Required Record Keeping	Rule	Reference in Ops Plan	Action
INCOMING WASTE			
Attempted disposal of any prohibited wastes	.0542	2.5	Report to NCDENR within 24 hrs and keep report on file
Attempted disposal of any waste from outside the permitted service area	.0542	2.5	Report to NCDENR within 24 hrs and keep report on file
Records of random waste inspections	.0544	11.1	Note date and result and include in Operating Record
Amounts by weight of solid waste received at the C&D landfill, include county of generation	--	11.1	Include in Operating Record monthly totals
DISPOSAL OPERATIONS			
Placement of cover material	.0542	3.1	Note date and time and include in Operating Record
Open burning requests	.0542	6.2	Note date of approval and approving DWM personnel and include in Operating Record
Fire and explosion notification	.0542	6.4	Report to NCDENR verbally within 24 hrs and written by 15 days and keep notification on file
GROUNDWATER AND SURFACE WATER MONITORING			
Groundwater and surface water monitoring reports	.0544	App. A	Semi-annual, include current reports in Operating Record
METHANE (LFG) MONITORING			
Methane (LFG) monitoring reports	.0544	App. B	Quarterly, include forms in Operating Record.
Exceedance in methane levels – required action within 7 days following detection	.0544	App. B	Include in Operating Record detected levels and description of steps to protect human health
Exceedance in methane levels – required action within 60 days following detection	.0544	App. B	Include in Operating Record a remediation plan for gas releases

Table -1 (Continued)
Dare County C&D Landfill
Operating Record Requirements

Required Record Keeping	Rule	Reference in Ops Plan	Action
TRAINING			
Certifications of training	.0544	11.1	Include in Operating Record
Training procedures	.0544	11.1	Include in Operating Record
MISCELLANOUS			
Audit records, compliance records and inspection reports	.0542	11.1	Include in Operating Record
CLOSURE/POST-CLOSURE			
Any closure or post-closure monitoring, testing, or analytical data	.0543	11.1	Note date and result and include in Operating Record
REQUIRED APPROVED DOCUMENTS TO BE INCLUDED IN THE OPERATING RECORD			
Current Operations Plan and Monitoring Plan in accordance with Rules .0542 & .0544			
Current Engineering Plan required by Rule .0539			
Current Permit to Construct and Permit to Operate			
Current cost estimates and financial assurance documentation			

Section 2
Waste Acceptance and Disposal Requirements

2.1 Waste Definitions

Agricultural Waste - waste material produced from raising of plants and animals, including animal manures, bedding plant stalks, hulls, and vegetative matter.

Asbestos Waste - any waste material that is determined to contain asbestos.

Asphalt - in accordance with G.S. 130-294 (m).

Blood Product - all bulk blood and blood products.

Commercial Solid Waste - all types of solid waste generated by retail stores, offices, restaurants, warehouses, and other non-manufacturing activities, excluding residential waste.

Construction or Demolition Debris - solid waste resulting solely from construction, remodeling, repairs or demolition operations on pavement, buildings, or other structures, but does not include inert debris, land-clearing debris or yard debris.

Hazardous Waste - any solid waste that is defined as hazardous in 15A NCAC 13A 261.3 and that is not excluded from regulation as a hazardous waste from conditionally exempt small quantity generators as defined within 15A NCAC 13A 261.5.

Hot Load - when a waste hauling vehicle is transporting solid waste that is burning or smoldering, it is referred to as a hot load.

Household Waste - any solid waste derived from households including hotels and motels, bunkhouses, ranger stations, crew quarters, campgrounds, picnic grounds, and day-use recreation areas.

Industrial Solid Waste - solid waste generated by manufacturing processes that is not a hazardous waste regulated under Subtitle C of RCRA. Such waste may include, but is not limited to, waste resulting from the following manufacturing processes: electric power generation; fertilizer/agricultural chemicals; food and related products/by-products; inorganic chemicals; iron and steel manufacturing; leather and leather products; nonferrous metals manufacturing/foundries; organic chemicals; plastics and resins manufacturing; pulp and paper industry; rubber and miscellaneous plastic products; stone, glass, clay, and concrete products; textile manufacturing; transportation equipment; and water treatment. This term does not include mining waste or oil and gas waste.

Inert Debris - any solid waste which consists solely of material such as concrete, brick, concrete block, uncontaminated soil, rock, and gravel.

Infectious Waste - any solid waste capable of producing an infectious disease. These types of waste include microbiological waste, pathological waste, blood products, and sharps.

Land-Clearing Debris - solid waste which is generated solely from land clearing activities such as stumps and trees trunks.

Liquid Hydrocarbons - as defined under Article 21A of Chapter 143 of the North Carolina General Statutes: except that any such oils or other liquid hydrocarbons that meet the criteria for hazardous waste under the Federal Resource Conservation and Recovery Act (P.L. 94-580) as amended.

Liquid Waste - any waste material that is determined to contain free liquid by Method 9095 (Paint Filter Test).

Microbiological Waste - includes cultures and stocks of etiologic agents. The term includes cultures of specimens from medical, pathological, pharmaceutical, research, commercial, and industrial laboratories.

Oils - As defined under Article 21A of Chapter 143 of the North Carolina General Statutes: except that any such oils that meet the criteria for hazardous waste under the Federal Resource Conservation and Recovery Act (P.L. 94-580) as amended.

Pathological Waste - includes: human tissue, organs, body parts, secretions, and excretions, blood, and body fluids that are removed during surgery and autopsies; the carcasses and body parts of all animals that were exposed to pathogens in research, were used in the production of biological or in the in-vitro testing of pharmaceuticals, or that died of known or suspected infectious disease.

Polychlorinated Biphenyls (PCB) - defined as any of several compounds that are produced by replacing hydrogen atoms in biphenyl with chlorine. PCB's were most frequently used as an additive to oil or other liquid in situations where heat is involved. PCB's have been used in paints and lubricants, however the most common application was in electric transformers.

Radioactive Waste - any waste that contains radioactivity as defined by the North Carolina Radiation Protection Act, G.S. 104E-1 through 104E-23. Radioactivity is defined as the property possessed by some elements of spontaneously emitting alpha or beta rays and sometimes gamma rays by the disintegration of the nuclei of atoms.

Sharps - includes needles, syringes with attached needles, capillary tubes, slides and cover slips, and scalpel blades.

Spoiled Food - any food which has been removed from sale by the United States Department of Agriculture, North Carolina Department of Agriculture, Food and Drug Administration, or any other regulatory agency having jurisdiction in determining that food is unfit for consumption.

Treatment or Processing Waste - any waste that is a residual solid from a wastewater treatment or pretreatment facility.

Tires - rubber tires from vehicles.

White Goods - any inoperative and discarded refrigerators, freezers, ranges, washers, dryers, water heaters, and other large domestic commercial appliances.

Yard Trash - solid waste resulting from landscaping and yard maintenance such as brush, grass, tree limbs, and similar vegetative material.

2.2 Acceptable Waste

In accordance with Rule .0542(c)(1), a C&D landfill shall only accept those solid wastes which it is permitted to dispose of. In accordance with the current Permit to Operate (dated November 30, 2006), the Dare County C&D Landfill is permitted to dispose of the following using normal operating procedures (as defined previously):

- Construction or Demolition Debris;
- Inert Debris;
- Land-Clearing Debris;
- Asphalt; and
- Scrap Tires.
- Asbestos (Non-Friable Asbestos Only)

2.3 Prohibited Wastes

The following wastes will be prohibited from disposal at the Dare County C&D Landfill:

- Wastewater treatment sludge;
- Containers such as tubes, drums, barrels, tanks, cans, and bottles unless they are empty and perforated to ensure that no liquid, hazardous or municipal solid waste is contained within;
- Garbage as defined in G.S. 130A-290(a)(7);
- Hazardous waste as defined in G.S. 130A-290(a)(8);
- Industrial solid waste;
- Liquid waste;

- Medical waste as defined in G.S. 130A-290(a)(18);
- Municipal solid waste as defined in G.S. 130A-290(a)(18a);
- Polychlorinated biphenyls (PCB) wastes as defined in 40CFR 761;
- Radioactive waste as defined in G.S. 104E-5(14);
- Septage as defined in G.S. 130A-290(a)(32);
- Sludge as defined in G.S. 130A-290(a)(34);
- Special wastes as defined in G.S. 130A-290(a)(40);
- White goods as defined in G.S. 130A-290(a)(44); and
- Yard trash as defined in G.S. 130A-290(a)(45).

The following wastes cannot be received if separate from C&D landfill waste:

- Lamps or bulbs including but not limited to halogen, incandescent, neon or fluorescent;
- Lighting ballast or fixtures;
- Thermostats and light switches;
- Batteries including but not limited to those from exit and emergency lights and smoke detectors;
- Lead pipes;
- Lead roof flashing;
- Transformers;
- Capacitors; and
- Copper chrome arsenate (CCA) and creosote treated woods.

Waste accepted for disposal in the C&D landfill shall be readily identifiable as C&D waste and shall not have been shredded, pulverized, or processed to such an extent that the composition of the original waste cannot be readily ascertained.

The County shall not knowingly dispose any type or form of C&D waste that is generated within the boundaries of a unit of local government that by ordinance:

- Prohibits generators or collectors of C&D waste from disposing that type or form of C&D waste.
- Requires generators or collectors of C&D waste to recycle that type or form of C&D waste.

2.4 Receiving Prohibited Waste

The Dare County C&D Landfill shall only accept those solid wastes that it is permitted to receive. The County will notify the North Carolina Department of Environment and Nature Resources Division of Waste Management (NCDENR

DWM) within 24 hours of attempted disposal of any waste the C&D landfill is not permitted to receive.

A report shall be prepared of any attempted delivery of waste of which the landfill is not permitted to receive, including waste from outside the permitted landfill service area. The report will be forwarded to:

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646

2.5 Waste Screening Program

Dare County has adopted a waste screening program at their C&D landfill facility for detecting and preventing the disposal of MSW, hazardous waste, and liquid waste. This program includes:

- Random inspection of incoming loads or other comparable procedures.
- Records of inspection.
- Training of facility personnel to recognize hazardous and liquid waste.
- Development of a contingency plan to properly manage any identified hazardous and liquid waste addressing identification, removal, storage, and final disposition of the waste.

Since Cell No. 4 will be located within the same property as the Dare County C&D Landfill, the existing waste screening program can be effectively used.

Section 3
Cover Material Requirements

3.1 Daily Cover

In accordance with Rule .0542(f), the County shall cover disposed C&D waste with six inches of earthen material (or alternative cover material (ACM) approved by the Solid Waste Section (SWS)) when the waste disposal area exceeds one-half acre and at least once weekly. Cover shall be placed at more frequent intervals if necessary, to control disease vectors, fires, odors, blowing litter, and scavenging. A notation of the date and time of the cover placement must be recorded in the operating record.

In accordance with Rule .0542(f)(2), areas which will not have additional wastes placed on them for three months or more, but where final termination of disposal operations has not occurred, shall be covered and stabilized with vegetative ground cover or other stabilizing material.

3.2 Alternative Cover

Dare County does not intend to utilize any alternative daily cover materials at this time. If, in the future, the County chooses to utilize an alternative daily cover, an application will be submitted for review by the North Carolina Solid Waste Section.

Section 4
Spreading and Compacting of Waste

The primary goals of Cell No. 4 waste placement are to (1) maximize the mass of waste landfilled through compaction, (2) minimize erosion and sedimentation impact to the surrounding and disposal areas, and (3) comply with all operating rules and regulations of the North Carolina Solid Waste Section for C&D landfills.

4.1 Working Area

In accordance with Rule .0542(g)(1), the County shall restrict solid waste into the smallest area feasible (working face). The working face is defined as where waste is unloaded, inspected, spread, compacted, and ultimately covered with cover material. The working face shall be wide enough to prevent a backlog of vehicles waiting to unload and to allow adequate working space for landfill equipment. At a maximum, the width of the working face shall not exceed 100 feet.

4.2 Compaction

Per Rule .0542(g)(2), solid waste shall be compacted as densely as practical into cells. Proper waste spreading and compaction is necessary both to conserve the capacity of the disposal areas and to minimize future settlement. C&D waste will be unloaded, inspected for unacceptable items, and spread on the working face. Each layer shall be compacted with a dozer.

4.3 Controlling Wind Blown Material

In accordance with Rule .0542(g)(3), appropriate methods such as fencing and diking shall be provided as needed within the landfill area to confine solid waste which is subject to be blown by the wind. At the conclusion of each day of operation, all windblown material at the landfill site shall be collected and returned to the working face.

4.4 Filling Sequence

Yearly operational grades are provided per rule .0542(b1)(B) on Sheets OP-1to OP-3.

Section 5
Disease Vector Control

In accordance with Rule .0542(h), the County shall prevent or control on-site populations of disease vectors using techniques appropriate for the protection of human health and the environment. Disease vectors are defined as any rodent, flies, mosquitoes, or other animals or insects, capable of transmitting disease to humans.

Effective vector control measures shall be applied when necessary. Control of vectors will be maintained by application of well-compacted cover material over the compacted solid waste that promotes drainage. This will protect against migration of vectors into and from the landfill. Stagnant ponding water should be prevented to control mosquito breeding. Filling in low spots should be performed regularly, and if necessary, County mosquito control or a licensed exterminator shall be employed to control vectors.

Section 6
Air Criteria and Fire Control

6.1 State Implementation Plan

In accordance with Rule .0542(i)(1), the County shall ensure that units do not violate any applicable requirements developed under a State Implementation Plan (SIP) approved or promulgated by the U.S. EPA Administrator pursuant to Section 110 of

6.2 Open Burning of Waste

Per Rule .0542(i)(2), open burning of solid waste, except for the approved burning of land clearing debris generated on-site or debris from emergency clean-up operations, is prohibited at the C&D landfill. Prior to any burning, a request shall be sent to the NCDENR DWM for review. The DWM will determine if the burning to be approved is one of the two types of burning as described above. A notation of the date of approval and the name of the Division personnel who approved the burning shall be included in the operating record.

6.3 Fire Protection Equipment

In accordance with Rule .0542(i)(3), equipment shall be provided to control accidental fires and arrangements shall be made with the local fire protection agency to immediately provide fire-fighting services when needed. Fires that break out close to the surface of the fill area should be dug out and smothered with cover material. Deep fires should be smothered out by placing moist soil on the surface and by constructing soil barriers around the fire. Where the smothering technique fails, the burning material shall be excavated and smothered or quenched with water once the burning material is brought to the surface. Water is usually not effective unless it can be directly applied to the burning material.

6.4 Fire and Explosion Notification

Per Rule .0542(i)(4), fires and explosions that occur at a C&D landfill require verbal notice to the DWM within 24 hours and written notification within 15 days. Written notification shall include the suspected cause of fire or explosion, the response taken to manage the incident, and the action(s) to be taken to prevent the future occurrence of fire or explosion. Verbal and written notification shall be submitted to:

Department of Environment and Natural Resources
Division of Waste Management
Solid Waste Section
1646 Mail Service Center
Raleigh, North Carolina 27699-1646
(919) 733-4810

Section 7
Access and Safety Requirements

7.1 Landfill Access and Safety

In accordance with 15A NCAC 13B . 0542(j)(1), the Dare County C&D Landfill must be adequately secured by means of gates, chains, berms, fences and other security measures approved by the Division of Solid Waste Management to prevent unauthorized entry.

The property is located in a relatively remote area of mainland Dare County and is bounded to the east by US Hwy 264 and by the Alligator River National Wildlife Refuge, which is under the administration of the US Fish and Wildlife Service (USFWS) on the remaining sides. Access to the C&D disposal area from US Hwy 264 is provided by a constructed canal crossing that connects Cub Road with US Hwy 264. Secondary access to the site is provided by Link Road, however this access remains closed to the public. Primary access to the C&D disposal area is provided by way of Cub Road.

The eastern ends of Link Road and Cub Road cross a drainage canal before they connect to US Hwy 264. Because of the canal and adjacent forested wetlands, there are no other access points to the site from US Hwy 264 and additional fencing is not required.

An access gate is currently located at the entrance of Cub and Link Road and is locked when the site is closed. All vehicles disposing of waste at the facility will enter and leave through the access control gate at Cub Road. A gate attendant house is located immediately inside the gate on the southern edge of Cub Road. All vehicles carrying waste to the landfill must first be weighed at the scale house before disposing at the landfill.

Access from the western side of the site is limited because all adjacent properties are in the wildlife refuge and the nearest public access (other than Link Road and Cub Road) is approximately five miles away. An access gate is at the western end of Link Road. This gate belongs to the USFWS and is locked at all times when not in use to prevent unauthorized access to the wildlife refuge.

7.2 Attendant

In accordance with 15A NCAC 13B .0542(j)(2), an attendant shall be on duty at the site at all times while the facility is open for public use to ensure compliance with operational requirements.

A full-time attendant will be located in the scale house during operating hours. The attendant will verify compliance with operation requirements. In addition, a Facility Supervisor will be present on-site at all times during operation.

7.3 Access Road

In accordance with 15A NCAC 13B .0542(j)(3), the access road to the site shall be of all weather construction and maintained in good condition. The all weather access roads at the site include Link Road, Cub Road and the access roads from Link and Cub Road to each of the disposal cells, which are paved with compacted crushed stone. Potholes, ruts, and debris on the roads will receive immediate attention in order to avoid damage to vehicles and maintain all weather access. Access roads will be regraded as necessary to maintain positive slope for adequate drainage.

7.4 Dust Control

Per Rule .0542(j)(4), dust control measures shall be implemented when necessary. Minimum dust control will include a water truck for wetting of dusty roads. Sprinklers are also used along some portions of the landfill perimeter access road. Petroleum products shall not be used for dust control.

7.5 Signs

In accordance with Rule .0542(j)(5), a sign providing information on disposal procedures, the hours during which the site is open for public use, the permit number and other pertinent information specified in the permit conditions is posted at the site entrance at Cub Road.

In accordance with Rule .0542(j)(6), signs shall be clearly posted stating that no liquid, hazardous and municipal solid waste can be disposed in the C&D landfill.

In accordance with Rule .0542(j)(7), traffic signs or markers are provided to promote an orderly traffic pattern to and from the discharge area and to maintain efficient operating conditions.

7.6 Waste Removal Scavenging Policy

Per Rule .0542(j)(8), the removal of solid waste from the C&D landfill is prohibited.

7.7 Managing Recyclables

The only recyclables accepted at the Dare County C&D LF are white goods and scrap metal. Upon arrival of these materials at the scale house they are inspected, and if they are deemed acceptable recyclable materials they are directed to a stockpile area near the working face of the active C&D landfill phase. Periodically a local recycling collection company collects the recyclables for processing and recycling. Recyclables are not stockpiled under a covered structure, however the stockpile area is always

adjacent to the working are in each active phase thus proper drainage is established to prevent standing water from developing.

Section 8
Erosion and Sediment Control Requirements

8.1 Control of Sediment

In accordance with Rule .0542(k)(1), adequate sediment control measures shall be utilized to capture and control sediment in order to prevent sediment from impacting wetlands and off-site properties.

Erosion control measures for Cell No. 4 are shown on the Grading Plan, Sheet C-3 and Detail Sheet D-1 of the Engineering Plan. Measures include maintaining a 250-foot buffer to protect the canals adjacent to Link Road and Cub Road. In addition, gravel and riprap filter basins will be constructed on the south end of the drainage ditches bordering the east and west sides of Cell No. 4. Calculations for the filter basins are included in the Engineering Plan. Temporary and permanent vegetation will be established at the site in accordance with the Engineering Plan.

The filter basins have been designed in such a manner that releases will not overload downstream drainage features or damage adjacent property. Sediment accumulated in the filter basins shall be removed as the filter basins becomes filled with sediment (approximately two feet above the bottom of the basins). Silt gages shall be installed in both basins. Ditches require frequent inspection for sediment buildup. At a minimum, the sediment buildup should be assessed after all significant rain events. All sediment removed will be transported to the borrow area, dewatered, and stockpiled.

8.2 On-Site Erosion Control

1) Per Rule .0542(k)(2), adequate erosion control measures consisting of vegetative cover, materials, structures or devices shall be utilized to prevent excessive on-site erosion of the C&D landfill.

2) Erosion control measures shall include:

   A. Disturbing as little area as practical at any one time for landfilling operations.

   B. Seeding/Mulching of all disturbed areas commencing as soon as practically possible.

   C. Employing erosion netting or sod on steep slopes and other erosion prone areas.

   D. Use of earthen berms, hay bales, silt fences, riprap or equivalent devices down-gradient of disturbed areas, stockpiles, drainage pipes inlets and outlets and at intervals along grassed waterways, until such time as permanent vegetation is established.

E. Placement of riprap at the inlets and outlets of stormwater piping.

8.3 Vegetative Cover

In accordance with Rule .0542(k)(3), vegetative ground cover sufficient to restrain erosion shall be accomplished as directed by appropriate state or local agency upon completion of any phase of C&D landfill development consistent with Rule .0543(c)(5).

Riprap, hay bales, or other acceptable temporary methods of erosion control may be required until permanent cover is established. Mulching, until a vegetative cover is established, can stabilize areas where final grade has been reached. Soil mulching can be achieved using wood chips, straw, hay, asphalt emulsion, jute matting, and synthetic fibers. Mulches allow for greater water retention; reduce the amount of runoff; retain seeds, fertilizer, and lime in place; and, improve soil moisture and temperature conditions.

Temporary seeding shall be applied in accordance with the NC Erosion and Sediment Control Planning and Design Manual, June 2006.

Section 9
Drainage Control and Water Protection Requirements

9.1 Surface Water Diverted From Operational Area

In accordance with Rule .0542(l)(1), surface water shall be diverted from the operational area. Excessive surface water at the working face creates difficulties for maneuvering equipment and prevents the operator from achieving maximum compaction of the waste. To divert surface runoff away from the working face, temporary diversion berms shall be installed on the current lift, up-gradient from the working face and in other locations as dictated by the direction of grade. The area between the temporary berm and the working face should be limited to one acre to prevent excessive ponding. The soil cover in the areas beyond the diversion berms shall be uniformly graded and compacted to prevent the formation of erosion channels. In the event that channels do form, the cover shall be promptly repaired. During the formation of the initial lift of each phase area additional measures shall be employed to divert surface water.

9.2 Surface Water Shall Not Be Impounded Over Waste

Per Rule .0542(l)(2), surface water shall not be impounded over or in waste. Completed areas shall be adequately sloped at a minimum of 5% to allow surface water runoff in a controlled manner.

9.3 Waste Shall Not Be Disposed Of In Water

In accordance with Rule .0542(l)(3), solid waste shall not be disposed of in water. The minimum four-foot separation between waste and the seasonal high groundwater table along with the drainage controls will prevent waste from being disposed of in water.

9.4 Discharge of Pollutants

In accordance with Rule .0542(l)(5)(A), discharge of pollutants into waters of the United States, including wetlands, that violates any requirements of the Clean Water Act, including, but not limited to, the National Pollutant Discharge Elimination System (NPDES) requirements, pursuant to Section 402 is strictly prohibited.

9.5 Discharge of Nonpoint Source Pollution

In accordance with Rule .0542(l)(5)(B), discharge of nonpoint source of pollution to waters of the United States, including wetlands, that violates any requirement of an area-wide or State-wide water quality management plan that has been approved under Section 208 or 319 of the Clean Water Act, as amended is strictly prohibited.

Section 10
Survey for Compliance

In accordance with Rule .0542(m), within 60 days of the County's receipt of the DWM's written request, the County shall conduct a survey of the active or closed portions of the C&D landfill in order to determine whether operations are being conducted in accordance with the approved design and operational plans. The County shall report the results of such survey, including a map produced by the survey, to the DWM within 90 days of receipt of the DWM's request. The survey shall be performed by a land surveyor registered in North Carolina.

Section 11
Operating Record and Record Keeping Requirements

11.1 Regulatory Requirements

In accordance with Rule .0542(n)(1), the county shall record and retain at the facility or alternative location near the facility the following information as it becomes available:

- Records of random waste inspections, monitoring results, certifications of training, and training procedures required by Rule .0544;
- Amounts by weight of solid waste received at the C&D landfill, include county of generation;
- Any demonstration, certification, finding, monitoring, testing, or analytical data required by Rules .0544 through .0545;
- Any closure or post-closure monitoring, testing, or analytical data as required by Rule .0543;
- Any cost estimates and financial assurance documentation required by Rule .0546;
- Notation of date and time of placement of cover material; and
- All audit records, compliance records and inspection reports.

11.2 Operating Record

Per Rule .0542(n)(2), all information contained in the operating record must be furnished to the Division according to the permit or upon request, or be made available for inspection by the Division.

The operating record must also include:

(A) A copy of the approved operation plan required by this Rule and the engineering plan required by Rule .0539;

(B) A copy of the current Permit to Construct and Permit to Operate; and

(C) The Monitoring Plan, in accordance with Rule .0544 of this Section, included as appendices to the Operation Plan.

Section 12
Contingency Plan

The purpose of this contingency plan is to provide a general operations overview in the event of unforeseen conditions at the landfill. This is for general purposes and should be evaluated with each event to determine the most appropriate means and methods for dealing with the situation.

12.1 Equipment Breakdown

In the event of equipment malfunction, the County will either Transfer all waste off-site via the transfer station until equipment is properly restored or provide rental equipment necessary to perform the daily landfill operations, until the repairs are made.

12.2 Unusual Traffic Patterns

Landfill traffic is controlled at the gate. Should a period of unusual traffic volume occur, traffic will be controlled at the gate to ensure the landfill working surface is not impacted. All traffic patterns inside the landfill gate will be properly marked to direct traffic accordingly once through the gate.

12.3 Natural Disasters

In the event of a natural disaster temporary staffing and rental equipment will be provided at the facility to maintain normal operating conditions. In addition, if waste volume cannot be handled at the C&DLF, waste will be diverted through the transfer station as necessary.

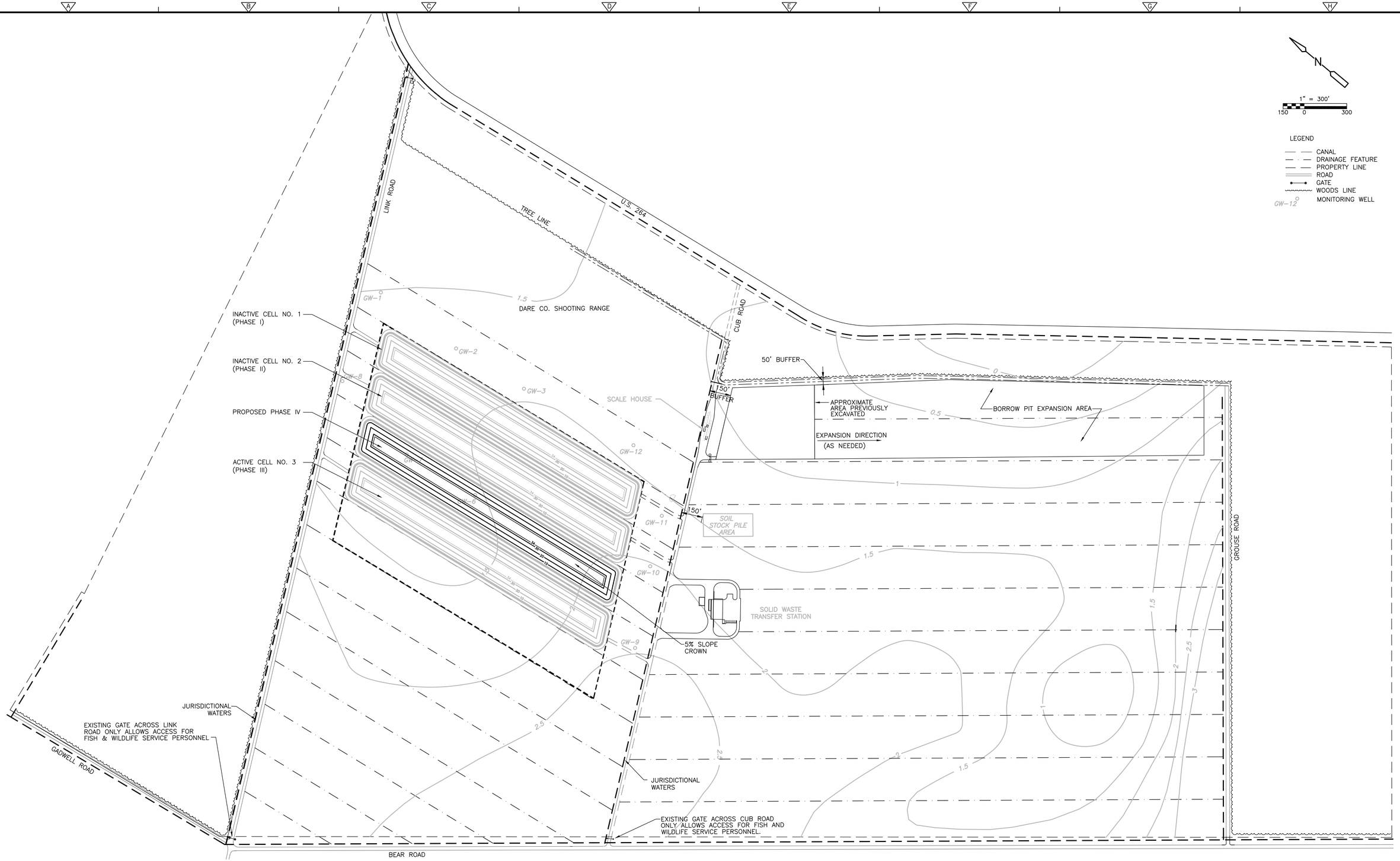
12.4 Power Outages

In the event a power outage occurs the landfill will have a contract with a local equipment rental company to provide the necessary generator(s) to maintain landfill scale house operations. Power outages are not expected to impact other filling operations.

12.5 Accidental Spills

In the event an accidental spill occurs the spill will be contained and all landfill operations will be shifted to another area within the landfill or C&D waste will be transferred until operations can return to the C&DLF.

Operations Plan Drawings



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: M. BRINCHEK
DRAWN BY: J. KILLINGSWORTH
SHEET CHK'D BY: P. STOUT
CROSS CHK'D BY: K. YANG
APPROVED BY:
DATE: JULY 2009

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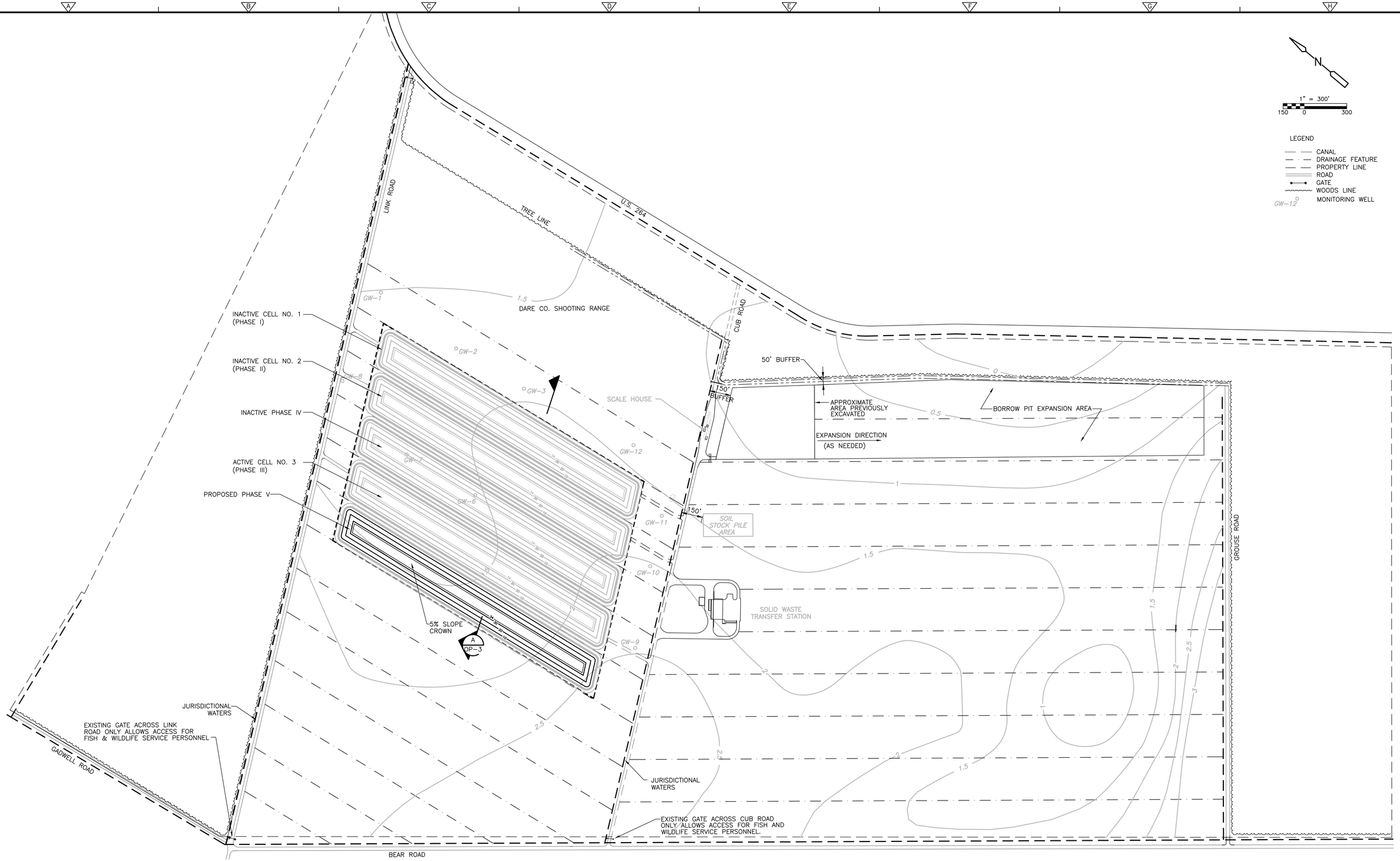
DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV PERMIT DRAWINGS

PROPOSED OPERATION PLAN (PHASE IV)

PROJECT NO.
FILE NAME: OP-1
SHEET NO.
OP-1

NOT FOR CONSTRUCTION



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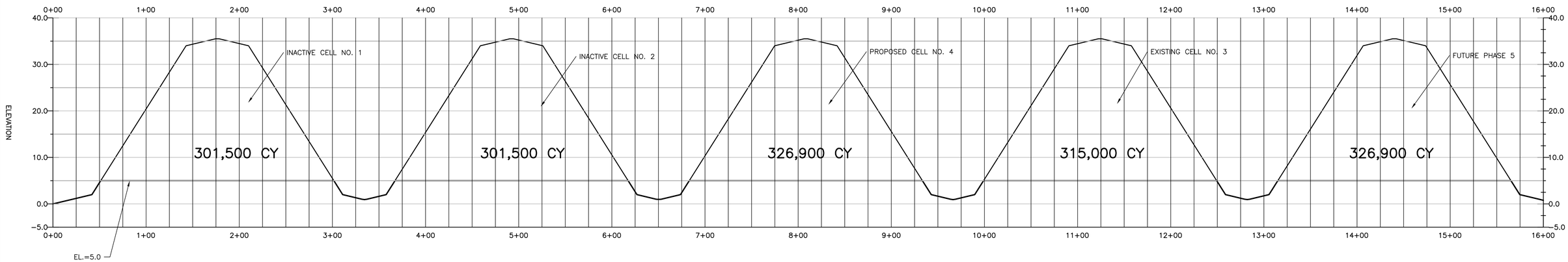
PROPOSED OPERATION PLAN (PHASE V)

PROJECT NO. 17952-56960
FILE NAME: OP-2
SHEET NO.
OP-2

NOT FOR CONSTRUCTION



SECTION A
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OP−2

REV. NO.	DATE	DRWN	CHKD	REMARKS

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CROSS SECTIONS

PROJECT NO. 17952−56960
FILE NAME: OP−3
SHEET NO.
OP-3

NOT FOR CONSTRUCTION

Appendix A
Water Quality Management Plan

CERTIFICATION OF EFFECTIVENESS

The following statement is based on existing site conditions as ofOctober 20, 2008 and data currently available on subsurface conditions and groundwater flow at theDare County Solid Waste Management C&D landfill site. Additionally, it is our professional opinion that construction of a landfill may alter subsurface conditions.

In accordance with North Carolina Solid Waste Management Rule .0544(h), I hereby state to the best of my knowledge, information and belief and in my professional opinion as a geological professional, that the water quality monitoring system will be effective in providing detection of a release of hazardous constituents from the Dare County Solid Waste Management Construction and Demolition Landfill to the uppermost aquifer, provided the system is operated and maintained properly.

NORTH CAROLINA LICENSED SEAL 1851 GEOLOGIST MATHEW F. COUGHLIN

1/15/2009

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Appendix A
Water Quality Monitoring Plan

1 Purpose

The purpose of this Water Quality Monitoring Plan is to address the requirements in Rule .0544(b) and (c) to present a plan for groundwater and surface water monitoring for the proposed Dare County C&D Landfill Cell 4 expansion. This Water Quality Monitoring Plan is an addendum to the Revised Plan for Cell 3 which was submitted to the Solid Waste Section by CDM in May 2005 with the Cell 3 Permit to Construct Application. This Water Quality Monitoring Plan includes information on the expansion of the existing groundwater monitoring network, surface water monitoring plan, sampling and analysis requirements, and detection monitoring requirements. The groundwater monitoring network was designed based on information obtained from recent and previous subsurface investigations and a review of literature pertaining to regional geology and groundwater resources.

1.1 Scope

The Water Quality Monitoring Plan includes the following elements, in accordance with Rule .0544:

- Design and installation of a groundwater monitoring system, based on site-specific information, to yield groundwater samples from the aquifer that represents the quality of the background groundwater that has not been affected by landfill activities or other man-made activities.
- Design and installation of groundwater monitoring system, based on site-specific information, to yield groundwater samples from the aquifer that represent the quality of groundwater passing the relevant point of compliance.
- Monitor wells designed and constructed in accordance with the applicable North Carolina Well Construction Standards as found in 15A NCAC 2C.
- A Sampling and Analysis Plan that includes procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain-of-custody procedures, and quality assurance and quality control.

2 Geologic Setting

The Dare County Construction and Demolition Landfill property is located approximately 2.5 south of the intersection of US-64 and US-264 near Manns Harbor, North Carolina and encompasses an area of approximately 836 acres. With the exception of the landfill cells, the site is flat with natural ground elevations generally ranging from 0 feet msl to 4 feet msl. The C&D landfill property is surrounded by cultivated farmland with some wooded areas. There are several irrigation ditches trending from north to south across the property that discharge to larger east-west trending canals on either side of the property.

The Dare County C&D Landfill is located in the Coastal Plain Physiographic Province. The Coastal Plain of North Carolina is approximately 90 to 150 miles wide from the Atlantic Ocean westward to its boundary with the Piedmont province. The western boundary is generally known as the Fall Line and is recognized as zones of rapids in streams, indicating a change of gradient as the streams pass from crystalline basement rocks to Coastal Plain sediments (Winner and Coble, 1989). The Coastal Plain consists of two subdivisions: The Tidewater region and the Inner Coastal Plain. The proposed landfill site is located within the Tidewater region. Land surface altitudes in the area range from mean sea level (msl) to 10 feet above msl. The Tidewater region is generally of low relief and contains swampy areas.

The site is located within the Pasquotank (Albermarle Sound) River Basin. Most of the proposed Cell 4 area is currently used as farmland that was converted from wetlands.

2.1 Geology

Sediments of the Coastal Plain range from clay to gravel with lesser amounts of marine limestone overlying the crystalline basement rocks. In Dare County, depth to the basement rock is approximately 6,000 feet below land surface. The numbers of individual sedimentary beds of the Coastal Plain increase towards the east, have an easterly dip, and tend to thicken towards the east (Winner and Coble, 1989).

The proposed Cell 4 site is directly underlain by post-Miocene aged surficial deposits and the Yorktown Formation of Pliocene age. The surficial deposits consist of undifferentiated marine and non-marine clastic sediments including very fine to medium grained quartz sand with common shell beds and minor amounts of interbedded silt and clay. Thickness of the surficial deposits in this area range from 70 feet to greater than 100 feet, with the thickness increasing towards the east (CDM, 1998). In the proposed landfill area, the surficial sediments were found to be approximately 65 feet thick.

Typically, the Yorktown formation underlies the surficial deposits. West of the Tidewater Region, the Yorktown formation is thin, but thickens eastward at an approximate rate of 7 feet per mile, and in Dare County, North Carolina, thickness can exceed 500 feet (Winner and Coble, 1989). The Yorktown formation is composed largely of fine sand, silty and clayey sand, and clay and is characterized by shells and indurated shell beds throughout. Coarser sand and shell beds are not uncommon to the east, but fine sand is the dominant material (Winner and Coble, 1989). At the proposed landfill site, sediments of the Yorktown confining unit formation were encountered at depths of about 65 feet below land surface and typically extended to depths of 85 to 90 feet.

Based on the previous Cell 1&2 investigation by others and subsequent subsurface investigations completed by CDM in 2004, 2007 and 2008, the geology at the site was found to be composed of 5 layered surficial sediment units. The uppermost unit was found to consist of topsoil and organic silt and extended to depths ranging from 8-

inches to 2-feet below land surface. Below the topsoil and organic silt, a layer of mottled silty fine sand was encountered. At the Cell 4 site, the thickness of the silty fine sand layer ranged from 1.5 to 2 feet. Below the silty fine sand, a layer of medium gray fine to medium sand was encountered. This layer was generally found to be about 19 feet thick and extended to a depth of about 24 feet below land surface. Some zones of silty sand and coarse sand were encountered within this layer. The next layer encountered was a dark gray sand and silt layer. The sand and silt layer was found to be about 5 to 7 feet thick and extended to about 32 feet below land surface. Beneath the sand and silt layer, a layer of gray, moderate to well sorted fine to medium sand and shell was encountered. This layer was found to extend to approximately 65 feet below land surface. This layer extended to the top of the Yorktown Confining Unit clays (CDM, 2005).

2.2 Hydrogeology

The hydrogeology of the region consists of a series of younger aquifers and confining units overlying Cambrian age basement rocks. For the purposes of this report, only the surficial aquifer and the Yorktown aquifer will be discussed. The Yorktown aquifer and confining unit are comprised of the upper part of the Pungo River, Yorktown and Chowan River formations. The surficial aquifer is primarily made up of Quaternary age surficial deposits.

Surficial Aquifer

Generally, the surficial aquifer within the Coastal Plain consists of Quaternary age deposits near land surface that were deposited in a marginal marine environment, and is mostly made up of shelly, silty sands and thin clay beds. The thickness of the aquifer is variable and ranges from 10 feet in the western portions of the Coastal Plain to more than 100 feet in Camden, Currituck, and Dare Counties (Lautier, 1998). The surficial aquifer at the proposed landfill site was found to be approximately 60 feet thick.

This unit is of major importance to the hydrology of the area because it extends over a large part of the Coastal Plain and infiltration from rainfall provides the bulk of recharge to the underlying aquifers. The surficial aquifer transmits water laterally to canals and swamps and serves as a source bed holding the water that migrates downward to the underlying aquifers. The recharge to the surficial aquifer depends on how quickly rainfall can infiltrate into the aquifer. Recharge rates depend on the capacity of the soils to allow water to migrate downward through the unsaturated zone (Winner and Coble, 1989).

Yorktown Confining Unit

The Yorktown confining unit consists of a series of discontinuous clay and silt beds that vary considerably in stratigraphic position between the Chowan River and the upper part of the Yorktown formation (Lautier, 1998). The Yorktown aquifer and its confining unit are entirely overlain by the surficial aquifer in this area and receive

some recharge from it. The Yorktown is a leaky aquifer that is in direct contact with streams that have channeled into it or with their alluvial deposits (Lautier, 1998).

The Yorktown confining unit overlies the Yorktown aquifer and serves as the hydrogeologic boundary between the Yorktown aquifer and the surficial aquifer. The average thickness of the Yorktown confining unit is about 22 feet. Westward toward the Fall Line, the confining unit averages about 13 feet thick and eastward near the coast about 40 feet and reaches thicknesses up to 70 feet in some areas (Winner and Coble, 1989). Geophysical logs from test wells installed by CDM in Manns Harbor showed confining unit thicknesses around 60 feet (CDM, 1998).

Yorktown Aquifer
The Yorktown aquifer is the uppermost confined aquifer in the area, and is principally comprised of the Chowan River and Yorktown formations. The Yorktown aquifer is separated into subaquifers due to its complex, discontinuous nature of deposition (Lautier, 1998). The Yorktown aquifer is described as fine to medium grained shelly, clayey sands that were deposited in a shallow marine shelf setting. The Yorktown aquifer is confined regionally by a series of confining beds which do not comprise a single unit, since these beds vary significantly in stratigraphic position (Lautier, 1998). Thickness of the Yorktown aquifer varies from less than 20 feet thick in areas to the west where erosion by stream channels has occurred to greater than 300 feet thick in eastern Dare County.

Winner and Coble (1989) estimated the average hydraulic conductivity for the Yorktown aquifer to be about 22 feet/day. Lautier (1998) reported hydraulic conductivity values ranging from 0.226 to 98 ft/day.

Individual private wells are the only source of water supply currently existing in the area surrounding the site. The nearest water supply is greater than 500 feet in any direction from the landfill. Supply wells in the area are generally completed in the upper Yorktown aquifer at depths ranging from 130 to 200 feet below land surface.

Based on data from the new and existing piezometers and monitoring wells in and around the expansion area, the major groundwater recharge feature at the site is precipitation. Surface drainage at the site is predominately governed by the canals to the north and south of the site. These canals trend in an east/west direction toward the canal along US-264. There are also two smaller ditches on the east and west of the Cell 4 site that discharge surface water to the southern canal along Cub Road. All of the drainage features at the site are man-made. The topography of the expansion area is flat with no discernable topographic features.

3 Proposed Groundwater Monitoring Network

This section presents the proposed groundwater monitoring network for the Area. Section 3.1 presents proposed monitoring well locations, Section 3.2 discusses

monitoring well installation and construction specifications, and Section 3.3 discusses hydraulic conductivity testing of the monitoring wells.

3.1 Monitoring Well Locations

3.1.1 Existing Monitoring Well Network

The current monitoring system consists of the background well (GW-1) and compliance wells GW-2, GW-3, GW-6, GW-7, GW-8, GW-9, GW-10, GW-11, GW-12, GW-13, GW-14, and GW-15. GW-1 serves as the background well for the entire facility. Monitoring wells GW-2, -3, -11, and -12 monitor Cell 1. Monitoring wells GW-6, -7, -8, and -10 monitor Cell 2. Monitoring wells GW-9, GW-13, -14, and -15 monitor Cell 3.

Monitoring wells GW-1 through GW-8 were installed in November 1994. Two monitoring wells (GW-4 and GW-5) were abandoned during Cell 1 construction. Monitoring wells GW-9, -10, -11, and -12 were installed in August 2002. Wells GW-13, -14, and -15 were installed in January 2006.

3.1.2 Proposed Monitoring Well Network Expansion

The SWS regulations require that upgradient monitoring well(s) be located so that groundwater samples collected from the uppermost aquifer provide an indication of background groundwater quality. Upgradient well MW-1 has already been installed to monitor background water quality for the entire site. Existing and proposed well locations are shown on Sheet 1.

The downgradient monitoring wells must represent groundwater quality at the relevant point of compliance. The wells must be located in similar geologic units so that upgradient and downgradient groundwater quality data can be compared.

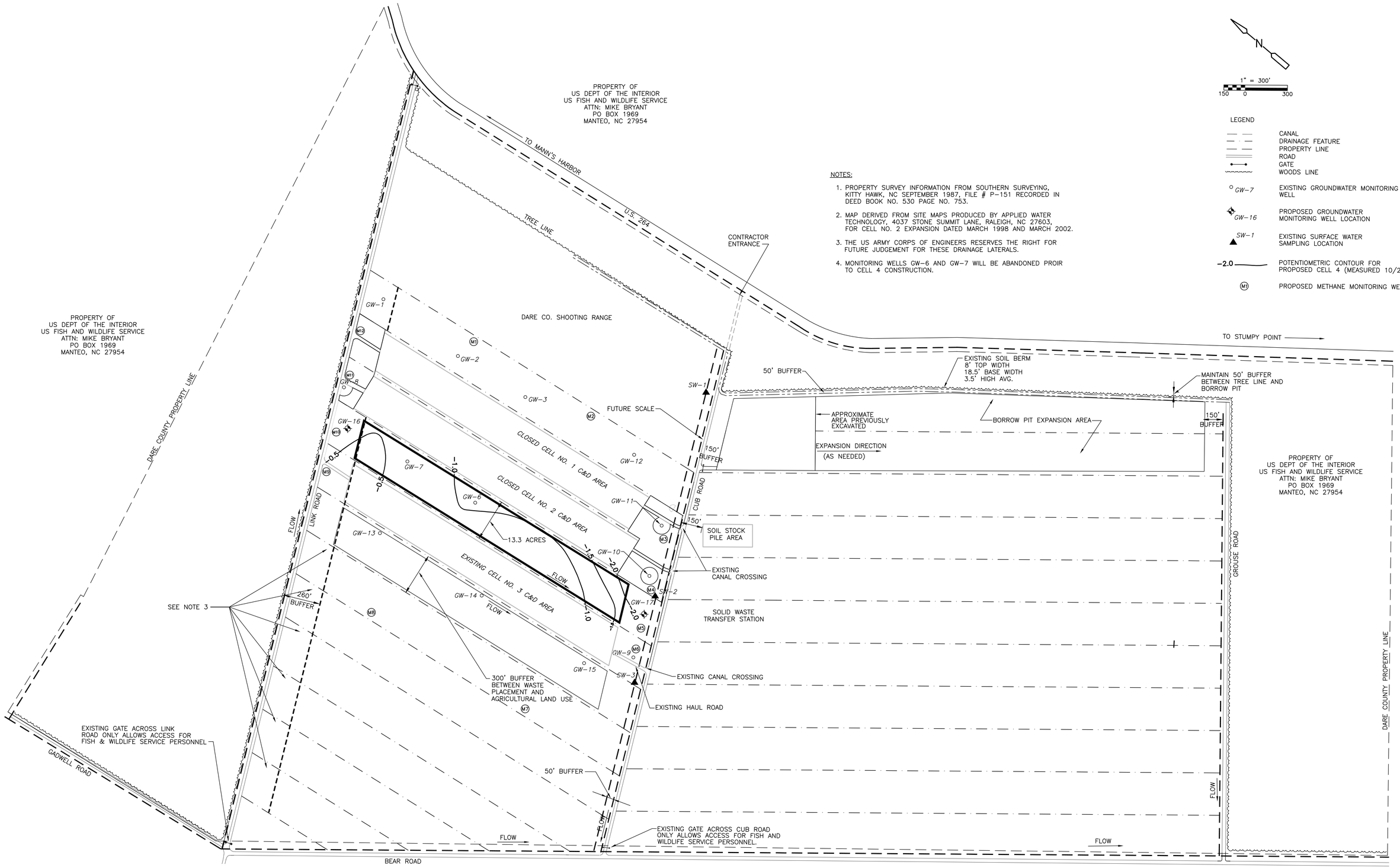
This Plan for the Cell 4 Expansion is provided as an addendum to the May 2005 Revised Water Quality Monitoring Plan.

Existing monitoring wells GW-6 and GW-7 are located within the proposed Cell 4 footprint and will be abandoned prior to construction of the new Cell.

For clarification, the following nomenclature will be used for the proposed monitoring wells for the proposed Cell 4:

GW-16
Proposed monitoring well GW-16 will be located 125′ north of the proposed Cell 4 area. The well will be screened from 5 to 20 feet below land surface.

GW-17
Proposed monitoring well GW-17 will be located 125′ south of the proposed Cell 4 area. The well will be screened from 5 to 20 feet below land surface.



REV. NO.	DATE	DRWN	CHKD	REMARKS

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COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL EXPANSION

LANDFILL GAS MONITORING PLAN

PROJECT NO. 17952-56960
FILE NAME: WQMP-SHEET.DWG

SHEET NO.
1

The current groundwater and surface water monitoring system along with the proposed C&D Expansion Monitoring Well locations is shown on Sheet 1. This sheet shows the existing Cells 1 - 3 and the proposed Cell 4 and the relationship of the existing and proposed monitor wells to the cells. The location of the current background well (MW-1) is also shown on Sheet 1. Table 1 lists the existing and proposed monitoring well network, in addition to the approximate depth of completion for the proposed wells, and the rationale for each location.

3.2 Monitoring Well Installation and Construction

The new monitoring wells will be constructed in accordance with standard industry procedures and will meet the requirements of 15A NCAC 2C. An example of a typical monitoring well is shown on Figure 1. All monitoring wells will be installed in the shallow surficial sands, above the fine sand and silt layer. The monitoring wells will be installed by advancing the borehole through the water table using hollow-stem auger or mud rotary techniques. Soil samples will be collected at five-foot intervals with a split spoon sampler in accordance with ASTM D-1586. Soil lithology will be described in the field by an onsite geologist to develop a borehole log.

The monitoring wells will be constructed using 2-inch ID PVC well casing with threaded flush joints. The monitoring wells will be constructed with 15 feet of 0.010-inch slot screen at the end of the casing string placed so that a sufficient bentonite seal and grout seal can be placed. The PVC casing string will extend approximately three feet above ground surface. A sand pack will be placed around the screen interval to a maximum of two feet above the top of the screen. A two foot thick bentonite seal consisting of hydrated bentonite pellets will be placed on top of the sand to hydraulically seal the completion interval. The remainder of the annulus will be sealed with a bentonite-Portland cement grout to ground surface. A protective outer casing with a lockable cap will be placed over the PVC casing and into the grout, extending 2.5 to 3 feet below ground surface.

Following completion, the monitor wells will be developed to remove the residual effects of drilling. The wells will be developed using a combination of surging and overpumping. All drilling and downhole equipment will be decontaminated by steam cleaning between borings. Well development equipment will be decontaminated by washing in a non-phosphate detergent solution followed by a potable water rinse, then a distilled water rinse, and allowed to air dry.

The horizontal location of all new monitor wells will be surveyed to State Plane Coordinates by a Registered Land Surveyor to the nearest 0.1 foot. The vertical control or elevation of the top of PVC casing (the well measuring point) will be surveyed to the nearest 0.01 foot accuracy to mean sea level (msl). The height of the well measuring point above ground surface will be measured.

Table 1
Groundwater and Surface Water Monitoring System Details
Dare County Construction and Demolition Landfill Cell 4 Expansion

EXISTING GROUNDWATER MONITORING WELLS FOR CELLS 1 - 3

Well	Drilling Method	Screen Interval Depth (feet)	Rationale
GW-1	HSA	*10-20*	Background Well
GW-2	HSA	*10-20*	Upgradient of existing Cell 1
GW-3	HSA	*10-20*	Upgradient of existing Cell 1
GW-6	HSA	*10-20*	Downgradient of existing Cell 2 in proposed Cell 4 area - will be abandoned.
GW-7	HSA	*10-20*	Downgradient of existing Cell 2 in proposed Cell 4 area - will be abandoned.
GW-8	HSA	*5-20*	Upgradient of existing Cell 2
GW-9	HSA	*5-20*	Downgradient of existing Cell 3
GW-10	HSA	*2-20*	Downgradient of existing Cell 2
GW-11	HSA	*2-20*	Downgradient of existing Cell 1
GW-12	HSA	*2-20*	Downgradient of existing Cell 1
GW-13	HSA	*5-20*	Downgradient of existing Cell 3
GW-14	HSA	*5-20*	Downgradient of existing Cell 3
GW-15	HSA	*5-20*	Downgradient of existing Cell 3

PROPOSED GROUNDWATER MONITORING WELLS FOR C&D EXPANSION (CELL 4)

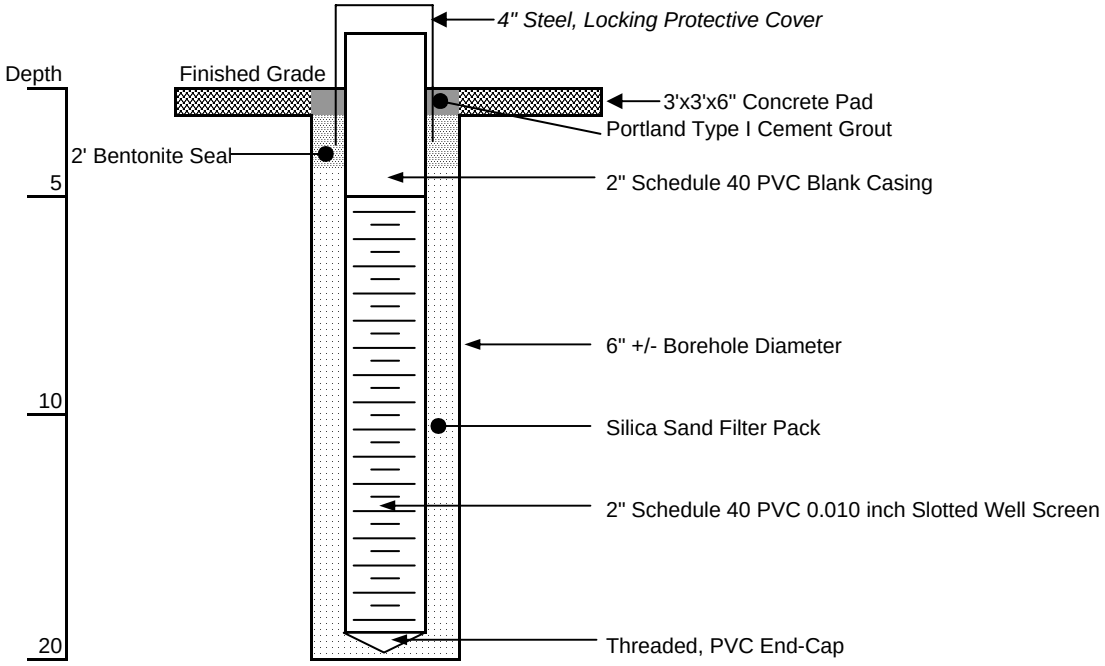
Well	Drilling Method	Anticipated Screen Interval Depth (feet)	Rationale
GW-16	HSA	*5-20*	Upgradient of proposed Cell 4.
GW-17	HSA	*5-20*	Downgradient of proposed Cell 4 along preferred flow path.

EXISTING SURFACE WATER SAMPLING LOCATIONS

Location	Rationale
SW-1	Up-gradient location, within Cub Road canal.
SW-2	Downgradient of existing Cell 2, within Cub Road canal.
SW-3	Downgradient of existing Cell 3, within Cub Road canal.

Notes:
All proposed monitoring wells will be installed using hollow stem augers
** The screen interval depths are actual. Anticipated depths will depend on subsurface conditions.

Dare County C&D Landfill Cell 4 Expansion
Water Quality Monitoring Plan



Notes:
Stick-up will extend between 2.5 and 3 feet above finished grade.
Silica sand filter pack will extend at least 2 feet above top of screen elevation.
Anticipated screen length of 15 feet for all wells.

CDM

Figure 1
Typical Type II Groundwater Monitoring Well

3.3 Hydraulic Conductivity Testing

Following installation and development of the new monitor wells, the hydraulic conductivity of the aquifer material surrounding each well will be determined by conducting slug falling head and/or recovery tests on each well. During drilling operations, samples will be collected for laboratory testing of grain size in order to estimate effective porosity. Hydraulic conductivity and estimated effective porosity, along with horizontal gradient, will be used to calculate groundwater flow velocities.

4 Surface Water Quality Monitoring Plan

There are currently three surface water sampling locations at the site (SW-1, SW-2, and SW-3). No additional surface water sampling locations are proposed at this time. The existing surface water sampling locations are shown on Sheet 1.

5 Sampling and Analysis Plan

Rule .0544 states that the owner/operator must provide, as part of the groundwater monitoring program, a groundwater and surface water sampling and analysis (S&A) plan. The S&A plan should be designed to provide accurate results of groundwater quality at the upgradient and downgradient sampling locations. The S&A plan will address the following subjects:

- Groundwater sample collection
- Sample preservation and shipment
- Analytical procedures
- Chain-of-custody
- Quality assurance/quality control (QA/QC)

5.1 Groundwater and Surface Water Sample Collection

Upon completion of well construction, development, and a well stabilization period, the sampling plan will be instituted. Groundwater samples will be collected from the newly installed monitoring wells. The proposed frequency of sampling will include one sample to be collected from each newly installed monitoring well prior to the Cell 4 receiving waste and one additional sample within six months of issuance of the Permit To Operate, during the normal semi-annual sampling for the existing wells and surface water locations. Groundwater samples from each of the monitoring wells and surface water samples will be collected as part of the required semi-annual events thereafter.

The following sampling procedures will be performed for all monitoring wells (new and existing) during each sampling event.

Static Water Level Measurements
Static water level elevations will be measured prior to any purging or sampling activities. Static water level data will be used to monitor changes in site hydrogeologic conditions. The following measurements will be recorded in a dedicated field book prior to sample collection:

- Height of the well measuring point above ground surface
- Depth of water in the well from the TOC measuring point (to the nearest 0.01 foot)
- Total depth of the well
- Height of the water column in the well casing

An electronic water level indicator will be used to accurately measure water elevations to within 0.01 foot within the same day in as short a period of time as possible. Each well will have a permanent, easily identified reference point from which all water level measurements will be taken. The reference point will be marked and the elevation surveyed by a North Carolina Registered Land Surveyor.

Detection of Immiscible Layers
USEPA's Technical Manual for Solid Waste Disposal Facility Criteria outlines specifications for groundwater sampling and analysis. One of these specifications outlines the establishment of provisions for detecting immiscible fluids, if applicable. Typically, immiscible fluids are categorized as either, (1) light, non-aqueous phase liquids (L-NAPLs), or (2) dense, non-aqueous phase liquids (D-NAPLs). L-NAPLs are more commonly referred to as "floaters" due to their relatively lighter specific gravity, while D-NAPLs are typically referred to as "sinkers" due to their relatively denser specific gravity.

In most instances, the probability of immiscible fluids being present and subsequently detected in groundwater monitoring wells surrounding C&D landfills is somewhat remote because chemical products (such as industrial solvents) are not accepted for storage or disposal at C&D waste management facilities. However, for those rare instances where a separate immiscible phase is believed to be present, EPA suggests that provisions for detecting these types of fluids should be developed.

The following procedure is proposed to address these concerns in the event that the SWS ever requires this test to be performed. In those instances where the monitoring well's screened interval encompasses the water table surface, the ability to detect and sample light nonaqueous phase liquids (LNAPLs) prior to implementation of routine groundwater sampling activities may exist. To accomplish this objective, a transparent teflon bailer will be lowered into the well to just below the water table surface. The bailer will then be removed from the well and the contents examined to identify if any immiscible fluids are present. If any immiscible fluids are determined to be potentially present, an interface probe is proposed to be used. The depth of the

light phase immiscible layer as determined by the interface probe will then be recorded in a field logbook. The interface probe will continue to be lowered until it intersects the groundwater table surface. The depth of the organic/water interface zone also will be recorded. From these two measurements, the thickness of the light phase immiscible layer can be readily determined.

The potential presence of dense phase immiscible layer will be determined by the examination of laboratory analytical results. Analytical results above a percentage of a given chemicals solubility limit can indicate the potential presence of DNAPLs.

As mentioned above, monitoring for immiscible phase fluids is not envisioned to be performed during typical sampling events, but is provided here to document how the test will be performed if the SWS requires it at a future date.

Monitoring Well Evacuation
Following measurement of the static water level in all of the wells, individual wells will be purged of all stagnant water. The stagnant water, which is not representative of true aquifer conditions, will be removed to ensure that fresh formation water can be sampled. A minimum of three well casing volumes will be removed prior to sampling. The volume for 2-inch diameter wells will be calculated using the following equation: one well volume in gallons equals the height of the water column (in feet) times 0.1632 (slightly less than 0.5 gallons per foot water for 3 casing volumes). During the well purging process, field measurements (pH, temperature, specific conductance, turbidity, dissolved oxygen, and oxidation/reduction potential) will be collected at regular intervals, and reported in a tabular format. The well will be purged until field measurements stabilize within approximately 10 percent between subsequent readings or until the well goes dry. Stabilization of these measurements will indicate that fresh formation water is present. Field measurements of pH, temperature, conductivity, dissolved oxygen, and oxidation/reduction potential will be obtained by using a YSI 556 Multi-parameter meter or equivalent. Turbidity measurements will be collected with a Lamont meter or equivalent.

If a well is purged to dryness, the samples will be collected after a sufficient volume of water has entered to allow collection of the sample. Wells will be purged using laboratory decontaminated Teflon bailers with new nylon rope or an acceptable pumping device approved by the SWS. Field measurements collected during purging activities will be recorded in the field logbook.

Sample Collection
After purging activities are complete, groundwater samples will be collected for laboratory analysis. Each well will be sampled using a new, laboratory decontaminated Teflon bailer equipped with new nylon rope. Bailers will be used for one well only. Field decontamination of bailers will not be permitted. Both groundwater and surface water samples will be analyzed for North Carolina SWS

Appendix I Volatile Organic Compounds (VOC) and metals, mercury, manganese, iron, alkalinity, chloride, sulfate, and Total Dissolved Solids.

The bailers will be lowered slowly into the well to minimize sample agitation. Sample water will be placed directly into sample bottles provided by the analytical laboratory, using the following method:

1. Retrieve bailer and slowly transfer sample water to the appropriate sample container. The bailer should not be allowed to touch the sample container.

2. The sample container for the volatile organic compounds should be filled first, leaving no headspace or air bubbles. The container should then be tightly sealed. The sample container will come pre-preserved from the laboratory.

3. The sample bottles for the wet chemistry parameters (alkalinity, chloride, sulfate, and Total Dissolved Solids) should then be filled. These containers should be filled to the bottle shoulder. Preservative, where applicable, will be added by the laboratory prior to shipping.

4. The sample container for the metals (including iron, manganese and mercury) should then be filled last. This container should be filled to the bottle shoulder. The sample bottle will come pre-preserved from the laboratory.

Surface water samples will be obtained from areas of minimal turbulence and aeration. The following procedure will be implemented regarding sampling of surface waters:

1. Hold the bottle near the bottom with one hand, and with the other, remove the cap.

2. Push the sample container slowly into the water and tilt up towards the current to fill. A depth of about six inches is satisfactory. Avoid breaching the surface while filling the container.

3. The container should be moved slowly, in a lateral direction, if there is little current movement.

4. If the canal depths are too shallow to allow submersion of the sample container, a pool may be scooped out of the channel bottom and allowed to clear prior to sampling.

5. Lift the container from the water and place the uncontaminated cap on the container.

The wells and surface water stations will be sampled in the order of potential for increasing contamination levels beginning with the upgradient (background)

sampling locations. The individual water samples will be collected and bottled in the order of parameter volatility. The collection order for the samples will be as follows:

- Volatile organic compounds (VOCs),
- Wet chemistry parameters (alkalinity, chloride, sulfate, Total Dissolved Solids).
- Total metals (including iron, manganese, and mercury).

The samples will be transferred from the sampling equipment directly into a pre-preserved sample container provided by the laboratory. Field filtering of samples is not permitted. There will be a specific size and type of container provided for each constituent to be analyzed. For VOC analysis, the containers provided will be pre-preserved 40-ml glass vials. For metals analysis, the samples will be collected in pre-preserved 500-ml HDPE bottles. Chloride, sulfate, alkalinity and TDS will be collected in unpreserved 500-ml HDPE bottles. Extra containers will be provided in case of accidental breakage.

All field personnel will wear protective latex disposable gloves in order to prevent extrinsic contamination from clothing, body oils, dirt, and other various contaminants. Sample documentation requirements to ensure sample integrity, will include sample locations, date and time of sample collection, proper analysis, and preservative (if applicable).

5.2 Sample Preservation and Shipment

In order to ensure sample integrity, preservation and shipment procedures will be carefully monitored. Generally, ice and chemical additives will be used as sample preservatives, as recommended by the commercial laboratory. For VOC analysis, hydrochloric acid will be used as the preservation method as well as maintaining the samples at a temperature of 4°C. Nitric acid will be used as the preservative for samples needing metals analysis.

If the analytical laboratory is located some distance from the site, samples shall be shipped via a 24-hour delivery service to ensure holding times are not exceeded. Shipment of samples will be coordinated with the laboratory. Proper storage and transport conditions must be maintained in order to preserve the integrity of the sample. Once taken, samples will be placed on ice and cooled to a temperature of 4°C. Samples are to be packed in coolers to maintain temperature and inhibit breakage or accidental spills.

Custody seals will be placed on the outside of the cooler, to detect tampering of the samples. The laboratory shall immediately notify the owner/operator of any samples that arrive with custody seals broken.

5.3 Analytical Procedures

The samples taken from each well and from the surface water sampling locations will be analyzed for the constituents listed in 40 CFR Part 258, Appendix I. The analytical procedures for the indicated parameters will be conducted using the following methods:

Analysis	EPA Method Number
Volatile organic compounds	8260
Total metals	6010
Mercury	7470
Chloride	300.0
Sulfate	300.0
Alkalinity	SM 2320B
Total Dissolved Solids	SM 2540C

5.4 Chain of Custody

It is imperative that an accurate record of sample collection, transport, analysis, and disposal be maintained and documented. Therefore, chain-of-custody procedures will be instituted and followed throughout the sampling program. It is necessary to establish documentation to trace sample possession from the time of collection until disposal. The chain-of-custody program shall include the following requirements:

- Samples shall be accompanied by a chain-of-custody record that notes the date and time of collection as well as sampling personnel.
- All samples shall be properly labeled to prevent misidentification of samples.
- Field notes shall be included to provide pertinent information about each sample.
- A sample analysis sheet shall accompany all samples to the laboratory.
- Sample custody seals shall be used to indicate any tampering of samples.
- All records pertaining to the shipment of a sample shall be retained (freight bills, post office receipts, and bills of lading).

The laboratory shall not accept samples for analysis without a correctly prepared chain-of-custody form. The laboratory shall be responsible for maintaining chain-of-

custody of the sample(s) from time of receipt to disposal. The chain-of-custody form shall be signed by each individual who possesses the samples.

To prevent sample misidentification, a label will be affixed to each sample container in a manner as to prevent the label from becoming dislodged during transport. The sample labels will contain the following information:

- Sample identification number
- Name and signature of sample collector
- Date and time of collection
- Place of collection
- Parameters requested
- Sample preservative.

In addition the container itself should be labeled with the sample identification number, at a minimum, to allow for identification should the label fall off.

5.5 Quality Assurance/Quality Control

The reliability and validity of the field and analytical laboratory data will be monitored as part of the QA/QC program used in the laboratory. Field duplicates and sample blanks will be collected to check sampling protocol and to account for any changes that occur after sampling. The QA/QC program will stipulate the use of standards, laboratory blanks, and duplicates for identification of matrix interferences.

Field Duplicates
Field duplicates provide a measure of field and laboratory precision. Field duplicates will be collected from identical locations using proper sampling procedures. The duplicate samples will be collected at a frequency of one per day per sampling event.

Equipment Rinsate Blanks
To evaluate the effectiveness of the decontamination procedures, equipment rinsate blanks will be collected. The sample will be collected by passing distilled water through the sampling equipment after decontamination has been completed. Equipment blanks will be collected at a minimum of one per day of groundwater sampling activities.

Trip Blanks
A trip blank shall be prepared to account for any sample contamination that may occur during transport to and from the site. The sample will be prepared in the laboratory with deionized or distilled water and shall accompany the sample

shipping container to the field. The trip blank shall remain unopened until receipt by the lab for analysis. One trip blank per sampling event will be collected.

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Appendix B
Gas Control Plan

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Gas Control Plan – C&D Landfill

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Section 1
Introduction

Landfill gas (LFG) is a natural by-product of the anaerobic decomposition of landfilled bio-degradable waste. LFG can present a danger to human health and the environment and therefore must be monitored. For these reasons, LFG is regulated by Federal and North Carolina state legislation. This Plan describes the systems and programs needed to fulfill federal and state regulations concerning LFG. In addition, this Plan describes the characteristics of LFG and its migration patterns; and provides alternative methods to control and destroy its harmful components. This additional background information is presented in the Plan to insure it is readily available should a situation occur that requires information and action beyond that described in this Plan. Since this plan is for the C&D landfill, it is noted that LFG generation is expected to be minimal based on the lack of organic matter in the waste stream.

1.1 Purpose

This Plan fulfills the requirements set forth in Rule .0544(d) for monitoring and controlling LFG. This Plan:

- describes the necessary LFG monitoring systems,
- sets forth the monitoring procedures and programs, and
- identifies the actions needed if levels of methane exceed regulatory limits.

1.2 General Characteristics of LFG and Methane Generation

LFG can be an energy resource as well as a source of environmental pollution. The methane content is what makes LFG valuable as an energy resource. LFG is composed of approximately 50 percent methane in contrast to natural gas which consists of approximately 95 percent methane. LFG programs which focus on recovering gas as an energy resource include collection and extraction systems used to maximize its recovery. What makes LFG a source of environmental pollution is its odor, its potentially explosive properties, and its contribution to global warming. LFG programs which focus on the environmental hazards of landfill gas include collection systems to monitor the migration of gas and control or neutralize its environmental impacts.

LFG is composed of 50 to 55 percent methane (CH_4); 45 to 50 percent carbon dioxide (CO_2); and, less than one percent non-methane organic compounds. These individual gases remain co-mingled and do not naturally separate.

1.2.1 Decomposition Rate and Volume

The decomposition of bio-degradable waste begins with aerobic decomposition that typically lasts three to 18 months until the oxygen in the municipal solid waste (MSW)

landfill is depleted. Following this, the anaerobic phase begins which results in LFG production. This anaerobic phase continues until all of the carbon-based materials are broken down or oxygen is reintroduced.

A reintroduction of oxygen does not stop the production of LFG, it only inhibits it. The volume of LFG generated over the life of a landfill is a function of the total volume of organic waste in the landfill as influenced by age, moisture, compaction, and pH.

1.2.2 LFG Migration

The production of LFG creates a positive pressure within the landfill that forces the gas to migrate. LFG is lighter than air and moves upward unless there is a barrier. LFG will move laterally along the path of least resistance or lowest pressure. LFG migration is a function of soil conditions, hydrogeologic conditions, and weather conditions. LFG moves through porous soils, along underground pipes, and through trenches. In some cases the LFG migration path can be observed at the surface through observations of stressed vegetation. In these instances LFG replaces the oxygen in root structures and eventually destroys the plants.

If tightly capped, LFG will move downward or laterally. Unless LFG is collected, it may migrate laterally, off the landfill site. If the MSW landfill does not have an impermeable cover cap, LFG may migrate upward, through the MSW landfill surface and cause odor and air quality problems. The lining and capping of an MSW landfill does not effect the production of gas, it improves the potential to collect and control it.

Section 2
Regulatory Background

Because of the real and potential dangers from LFG and the methane in landfill gas, to the public health and safety and to the environment, existing state regulations require owners of C&D landfills to monitor and control it.

2.1 C&D Landfills and North Carolina Regulations

Methane gas is explosive when present within the range of 5 to 15 percent by volume in air. When present in concentrations greater than 15 percent, the mixture will not explode. The 5 percentage mixture is referred to as the Lower Explosive Limit (LEL) while the 15 percentage concentration is referred to as the Upper Explosive Limit (UEL). The State of North Carolina, through its 15A NCAC 13B .0544(d)(1), requires owners or operators of all C&D landfills to ensure that the facility:

A) Does not exceed 25 percent of the LEL for methane in facility structures;

B) Does not exceed the LEL at the facility property boundary; and

C) Does not release methane gas or other explosive gases in any concentration that can be detected in offsite structures.

The LEL means the lowest percent by volume of a mixture of explosive gases in air that will propagate a flame at 25 C and atmospheric pressure.

Rule .0544(d)(2) requires that a routine methane monitoring program be implemented to insure that these standards are met. The type of monitoring will be determined based on soil conditions, hydrogeologic conditions under and surrounding the facility, hydraulic conditions on and surrounding the facility, the location of facility structures and property boundaries, and the location of all off-site structures adjacent to property boundaries. Additionally, frequency of monitoring shall be quarterly.

Rule .0544(d)(3) requires that if methane or explosive gas levels exceed the specified limits, the owner or operator must:

A) Immediately take all necessary steps to ensure the protection of human health and notify the Division;

B) Within seven days of detection, place in the operating record the methane or explosive gas levels detected and a description of the steps taken to protect human health;

C) Within 60 days of detection, implement a remediation plan for the methane or explosive gas releases, place a copy of the plan in the operating record, and notify the Division that the plan has been implemented. The plan must describe the nature and extend of the problem and the proposed remedy.

Section 3
LFG Monitoring Program

The LFG monitoring program includes a schedule for reading or monitoring LFG emission levels at designated locations on a regular basis and a system for reporting the concentration levels.

The requirements for regularly reading the emission levels, and the plan for actions if readings exceed safe levels should, at a minimum, be based on compliance with state regulations. The plan that is recommended in this report exceeds the regulatory criteria to further protect the health and safety of nearby residents.

3.1 Frequency of Routine Monitoring

Rule .0544(d)(2) states that a quarterly methane monitoring program be implemented.

3.2 Staffing

Monitoring should consist of having a trained technician use calibrated equipment designed to monitor methane at on-site structures on the landfill property and in locations near the C&D landfill.

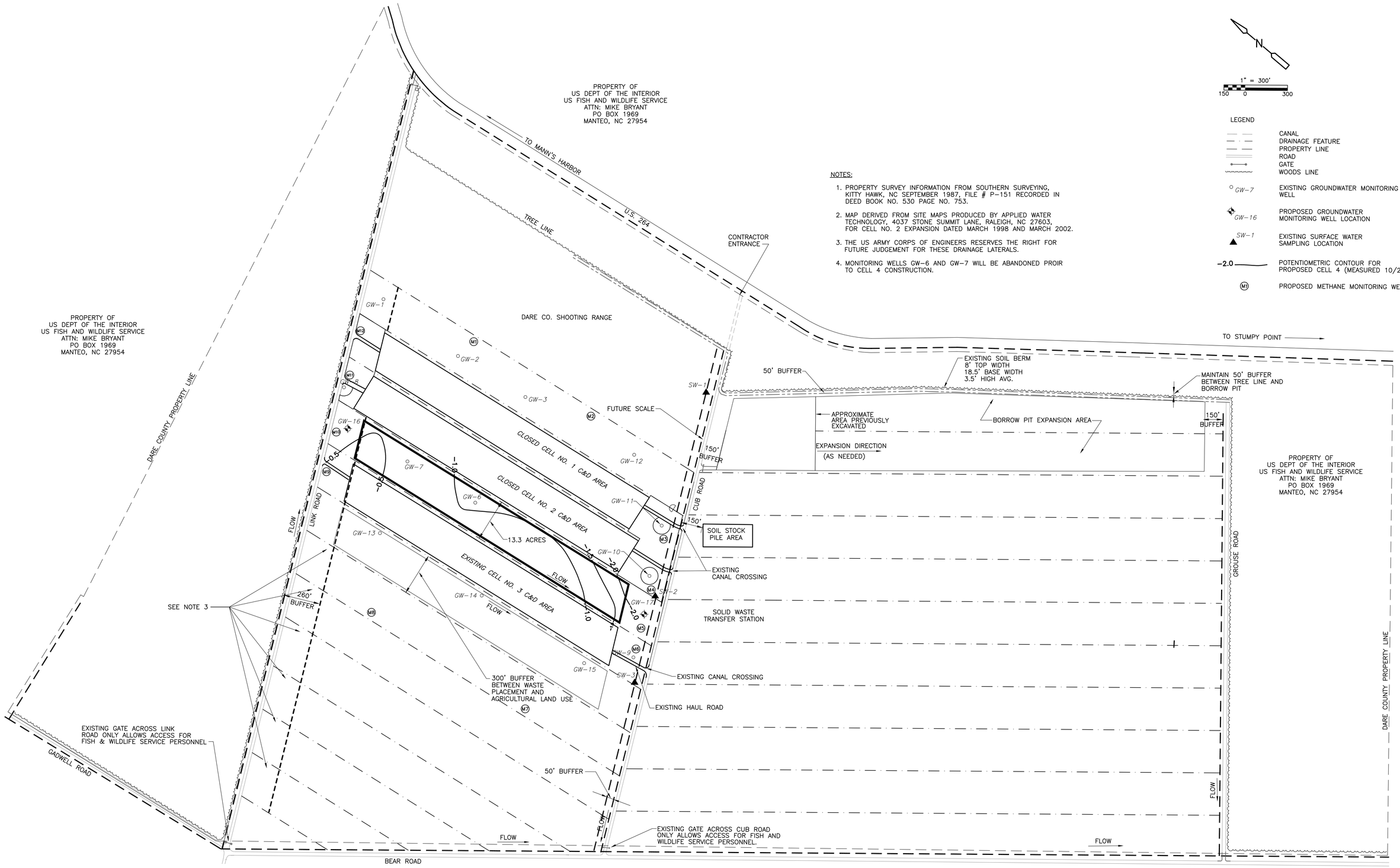
The job of monitoring the methane levels will require a trained staff person. Available options include training an existing staff person, hiring a special contractor, or hiring part-time staff to perform this task.

3.3 Monitoring Procedures

Each regular quarterly monitoring procedure shall begin by checking methane levels in the scale-house and any occupied structure on the landfill site. Next, the non-occupied buildings at the landfill shall be checked. Finally, monitoring wells around the C&D landfill shall be checked. Currently there are no methane monitoring wells at the facility. Planned well locations for the facility are provided on Sheet 1.

Proposed wells M-1 through M-12 will be used to monitor for LFG migration. The methane monitoring wells will be constructed with 2-inch diameter schedule 40 PVC with 5 feet of 0.010-inch slotted screen with a #2 sand filter pack extending 1 foot above the top of the screen. A 1 to 2-foot thick bentonite seal will be placed on top of the sand filter pack and hydrated. The remainder of the borehole annulus will be completed with a Portland cement/bentonite grout. Given the shallow depth to the groundwater table at the Dare County C&D Landfill site, the bottom of the screened interval shall extend 2 –feet into the groundwater table.

All methane monitoring wells will be constructed in accordance with the North Carolina Well Construction Standards described in 15A NCAC 2C and will be completed with locking above grade protective covers and 2-foot by 2-foot concrete pads. Following installation, the wells will be surveyed to State Plane coordinates. Figure 1includes a typical detail of a methane monitoring well detail.



NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. THE US ARMY CORPS OF ENGINEERS RESERVES THE RIGHT FOR FUTURE JUDGEMENT FOR THESE DRAINAGE LATERALS.
4. MONITORING WELLS GW-6 AND GW-7 WILL BE ABANDONED PROIR TO CELL 4 CONSTRUCTION.

REV. NO.	DATE	DRWN	CHKD	REMARKS

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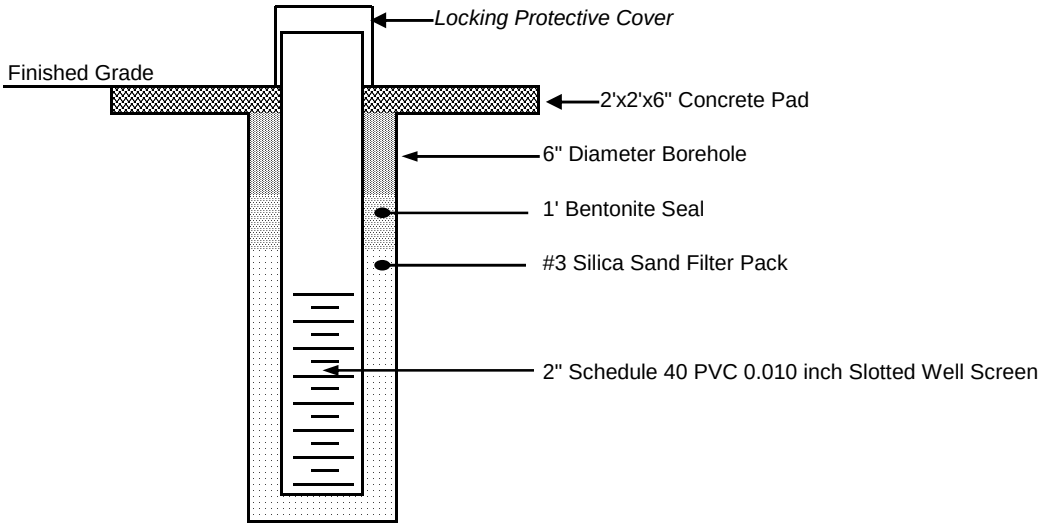
COUNTY OF DARE
NORTH CAROLINA

CONSTRUCTION AND DEMOLITION LANDFILL EXPANSION

LANDFILL GAS MONITORING PLAN

PROJECT NO. 17952-56960
FILE NAME: LFGMP-SHEET1.DWG

SHEET NO.
1



Notes:
Stick-up will extend between 2.5 and 3 feet above finished grade.
Silica sand filter pack will extend at least 1 feet above top of screen elevation.
Well depth will vary upon depth to groundwater.
Anticipated construction depth to 7-feet below land surface with 5 feet of screen.

CDM

Figure 1
Typical Methane Monitoring Well Detail

If the methane levels detected within on-site buildings are greater than 25 percent of the LEL, the technician shall immediately follow the actions presented in Section 4.1 of this report. If methane levels detected at the monitoring wells exceeds the LEL, the technician shall immediately follow the action plan presented in Section 4.2.

3.4 Record Keeping

All readings will be recorded on a standard methane monitoring log form. A sample methane monitoring log is provided at the end of this section. These forms will be reviewed and initialed by the landfill supervisor or the County's environmental consultant and then placed in the landfill operating records. These quarterly methane monitoring logs will remain on file at the landfill with other landfill records. These readings should be available for review by EPA and the State upon request.

METHANE MONITORING LOG FORM
(this report must be completed quarterly)

Dare County C&D Landfill
Dare County, North Carolina

Technician Name: _____

Date: (mo/day/year)_____

General weather conditions: _____

Temperature: _____

Barometric condition pressure: _____

MONITORING INSTRUCTIONS

1. Measure methane levels within structures on the landfill property. The landfill gas reading must not exceed 25% of the methane lower explosive limit (L.E.L). If methane measurements exceed 25% of the L.E.L., contact the landfill supervisor and follow the outlined plan in Appendix B of the operations manual.

2. Measure methane levels at all two groundwater monitoring wells located around the C&D landfill boundaries. The landfill gas reading must not exceed 100% of the methane L.E.L. If methane measurements exceed 100% of the L.E.L., contact the landfill supervisor and follow the outlined plan in Appendix B of the operations manual.

3. Complete the entire data sheet located on the next page.

4. If methane levels exceed the above-mentioned levels at any monitoring location, report the measurements to the County for further action as described in the Gas Control Plan – C&D Landfill.

5. File this methane monitoring log sheet in the landfill office in the appropriate record keeping section with other landfill records.

METHANE MONITORING DATA SHEET

Monitoring Locations	*% L.E.L. Reading*	*Within Compliance*		*Landfill Supervisor Contacted*		*Monitoring Point within Structure*
		Yes	*No*	*Yes*	*No*	
Scale house						
Transfer Station						
M-1						
M-2						
M-3						
M-4						
M-5						
M-6						
M-7						
M-8						
M-9						
M-10						
M-11						
M-12						
Comments and Observations:						
Landfill Supervisor Actions Taken:						

Section 4
Contingency Plan

The North Carolina Solid Waste Management Rules, .0544(d)(3), require a contingency plan for action if methane levels exceed the regulatory concentration limits. The plan for action includes the specific step by step actions needed should regulatory limits be detected.

4.1 Actions if Regulatory Limits Detected in Structures

If any structures on the landfill property measures a methane level equal to or more than 25 percent of the LEL the following actions should be taken:

- the building should be immediately evacuated;
- the landfill supervisor should be immediately contacted;
- all individuals in and around the structure should be ordered to immediately stop smoking;
- all space heaters and similar appliances should be immediately disconnected from their power source;
- all doors and windows in the structure which gave the reading should be opened to permit the methane to escape;
- as a precautionary measure, the landfill operator will open doors and windows in all structures on the landfill property; and
- equipment used to take the readings should be tested immediately to verify it was giving accurate readings.

The technician will then proceed to take readings at all groundwater monitoring wells used for the C&D landfill LFG monitoring. All levels should be verified and recorded in the methane monitoring log book. This information, including the verification that the equipment is providing accurate readings, the current readings, and the levels at all monitoring locations for the previous three quarters should be provided to the County's landfill supervisor. The Dare County landfill supervisor will make the decision to return to business as usual; temporarily evacuate the site; or follow the plan proposed in Section 4.3.

4.2 Actions if Regulatory Limits Detected at Monitoring Wells

If any of the methane monitoring wells measure a level equal to or more than the LEL as defined by in the Rules, the technician should:

- immediately contact the landfill supervisor; and

- recheck the methane levels inside the facility structures. If levels are close to or exceed 25 percent of the LEL the actions in Section 4.1 should be followed.

Once it is verified that levels inside the buildings are safe, the technician should check and record readings at all remaining monitoring wells for the C&D landfill. The equipment used to take the readings should be tested to verify it is giving accurate readings.

This information, the current readings, and the levels for the previous three quarters should be provided to the Dare County landfill supervisor who will make the decision to: return to business as usual; temporarily evacuate the site; or, follow the plan proposed in Section 4.3.

4.3 C&D Compliance Action Plan

If upon verification as described in Sections 4.1 and 4.2, the methane monitoring levels are equal to or exceed the regulatory limits as defined by state regulations, the following actions are proposed to comply with state regulations as well as protect the health and safety of the individuals at or near the C&D landfill.

4.3.1 Immediate Action

If methane levels exceed the specified limits, the landfill operator or the landfill supervisor will take immediate action to ensure the protection of human health and safety. This will include:

- evacuate all buildings on the site;
- open all doors and windows in buildings on the landfill site;
- notify the Dare County Manager Office's about the concentration levels;
- if warranted by the degree of intensity of the methane concentration, check the methane levels in structures near the landfill yet outside the facility boundary;
- if warranted by the degree of intensity of the methane concentration, evacuate the landfill area or evacuate the area adjacent to the landfill;
- notify the Division about the reading;
- begin to identify or narrow down the source of the methane causing the readings exceeding the regulatory limits (i.e. the path that the methane is taking to the monitoring location);
- begin to identify the extent of the methane problem; and
- as appropriate, begin to take corrective action to control the methane levels in building at the landfill site, at the boundaries to the landfill, and at the landfill site.

4.3.2 Actions Within Seven Days

If methane levels exceed the regulatory limits, the County must, within seven days, place in the operating record the gas levels detected and a description of the steps taken to protect human health.

It is also suggested that at this time, the operator begin to develop a plan which:

- describes the nature and extent of the problem and
- proposes a remedy for the problem.

4.3.3 Actions Within Sixty Days

If methane levels exceed the specified limits, the County must take the following actions within 60 days:

- implement a remediation plan for the methane gas release;
- place a copy of the plan in the operating record of the landfill; and
- notify the Division that the plan has been implemented.

4.4 Public Relations and Information

As with any potentially dangerous situation, it is important to keep the public, public service agencies, and the media informed. False information, inaccurate information, or the lack of information concerning potential explosions at a public facility could create panic.

If the County Manager determines that a potentially dangerous situation exists, it is recommended that a one page explanation of the situation be written and distributed to all homes and businesses within a one-half mile radius of the landfill. This should be done within the first two to four hours of making the determination that a potential danger to human health and safety exists.

It is recommended that the County Manager appoint one individual to provide information to: the media; the police authorities with jurisdiction in the area; and area medical facilities. Area hospitals and police departments may receive calls once the local media releases the story. Centralizing the flow of information will avoid conflicting information and inaccurate information. Providing detailed and honest facts about the situation being under control is critical.

Section 5
Options for Controlling LFG

This section presents several options which may be implemented by Dare County should methane readings exceed regulatory levels. It is presented in this Plan to insure that the information is readily available to the County if needed.

If regular LFG monitoring demonstrates levels that exceed the regulatory limits, the state requires actions by the owner to eliminate the problem. Remedial options to eliminate the problem include controlling the migration path or controlling the release of the LFG into the environment.

5.1 Migration Control Techniques

Four techniques which can be used for controlling the migration of LFG include:

- impermeable physical barriers
- passive removal system
- active removal system
- air injection or air dikes

5.1.1 Impermeable Physical Barriers

An impermeable physical barrier, such as a landfill liner or a vertical impermeable barrier, can be installed to impede and ultimately stop the migration of LFG. This type of a barrier also helps to contain the gas thereby facilitating its collection.

5.1.2 Passive Removal System

A passive removal system generally provides a safe path of least resistance for migrating LFG to exit the landfill. Passive removal systems include open air ditches or passive venting wells installed in porous gravel trenches. These systems are designed to rely on the difference between the internal landfill pressure and the atmospheric pressure to control the migration path that the LFG takes.

5.1.3 Active Removal System

An active removal system requires the installation of a connected system of collection pipes, wells, trenches, well heads, collection headers, storage tanks, blowers, or compressors. Active removal systems include the use of a mechanized device (usually a gas compressor) to induce a vacuum in the well or trench to draw-out the LFG. Active systems include both positive and negative pressure extraction. Active systems are similar to a gas removal system for recovery projects. Installation of an active removal system may enable the gas control system to be integrated into a recovery system at a future date.

5.1.4 Air Injection

Air injection, or the creation of "air dikes" was first tried in Monterey Park, California in 1980. In this control technique, air is injected into the ground and distributed through a perforated screen. This technique is used to stop the migration of the methane through very saturated soils when use of a vacuum extraction system would pull in water.

The injection of air into a landfill as a technique for controlling LFG migration is potentially dangerous and not recommended. The introduction of air or oxygen into a landfill may create a number of problems such as subsurface landfill fires. Additionally, it could affect the percentage of methane content in the LFG, making it more explosive. The introduction of air will ultimately result in only temporarily slowing the production of methane by interrupting the anaerobic condition and not provide a long term solution. It could also cause the methane to migrate to a more potentially dangerous location.

5.2 Environmental Control Techniques

In addition to controlling the migration of LFG, it is possible and may be necessary to control its negative environmental effects by controlling its release into the environment. Two methods for accomplishing this control are through its recovery and use as an energy source or by burning the LFG through flares.

5.2.1 Control through LFG Recovery Systems

Recovering LFG for use as an energy source virtually eliminates its release into the atmosphere. A LFG recovery system requires the installation of a collection system and a system to pipe the gas to a user or to a generator which can turn the gas into an energy source.

There are two common types of LFG collection system designs, vertical and horizontal. The appropriate system is based on the way the landfill was constructed to be filled, vertically with lifts, or horizontally. A horizontal collection system is best used for landfills filled in a horizontal pattern. A vertical collection system is best used in landfills designed to be filled vertically or vertically with lifts. Both systems involve installing perforated pipes surrounded by rocks or gravel. Horizontal systems install the pipes in trenches. Vertical systems install the pipes in wells or manholes. A horizontal system does not lend itself to a high vacuum recovery operation. This system is best installed as the horizontal layers are completed, before the landfill is completed. Vertical systems can be installed either when the landfill is operating or after it is closed.

While LFG recovery systems are expensive to install and operate, some income may be generated from the sell of the gas or the energy produced from the system.

5.2.2 Control through Flaring LFG

A second method of controlling the release of LFG into the environment is by destroying it by flaring it as it is released from the MSWLF. Like recovering LFG for use as an energy source, flaring LFG also requires a collection system. However, the collection system need not be as elaborate a system as is needed for gas recovery.

In order for the flares used to destroy the harmful components in LFG, they must burn the LFG for:

- an adequate period of time (.25 to five seconds);
- at an adequate temperature (300 to 500 degrees above its auto ignition temperature) to insure complete destruction of trace elements; and,
- with sufficient turbulence, (i.e. with a uniform mix of gas and air).

Four types of flares are typically used throughout the United States: open flares, enclosed flares, invisible flares, and emission control enclosed flares.

- Open Flares, also called pipe flares, function like candles. They are often used with a passive recovery system and are ignited manually. One problem typically associated with them is that they may blow out with a strong wind.
- Enclosed flares are designed to hide the flame and protect it from blowing out in a strong wind.
- Invisible flares extend 20 to 30 feet above the landfill surface and are designed to create a "flame envelope." This design may not permit an adequate gas and air mix.
- Emission control enclosed flares rise 35 to 50 feet above the landfill surface. They are designed with an air damper to control both LFG and air flow. These are the most effective in the destruction of NMOC.

Section 6
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Appendix C
Waste Acceptability Plan

Appendix C – Contents
Waste Acceptability Plan – C&D Landfill

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Section 1
Introduction

The Waste Acceptability Plan sets forth the procedures and programs implemented by the solid waste management staff of Dare County (County) to identify and prevent the disposal of unauthorized wastes in the C&D landfill in accordance with the Operating Plan. This plan also presents the procedures and policies established by the County that comply with state regulations requiring random waste screening by owners of C&D landfills.

The County manages the storage, collection, and disposal of solid wastes in accordance with state regulations and in a manner that protects the public health, safety, and welfare of the residents of Dare County. Some of the standard operating procedures at the landfill are designed to insure that unauthorized wastes, as defined by state and county regulations, are not landfilled.

Current County programs and procedures fulfill some state and federal regulations for waste screening to detect or prevent landfilling of prohibited or unauthorized solid wastes. Some of these programs and facilities include:

- Hazardous waste awareness certification training for all landfill staff; and
- County owned and operated drop-off facilities for lead acid batteries, yard wastes, white goods, and whole scrap tires.

Section 2
Overview of Waste Acceptability Plan

The Waste Acceptability Plan presents the standard operating procedures at the County C&D landfill. It presents the procedures and contingency plan that the County will implement to comply with applicable State and Federal regulations.

The Waste Acceptability Plan:

- identifies the state regulatory authority for prohibiting the disposal of industrial, hazardous, liquid, municipal solid waste, and excluded waste in the C&D landfill;
- identifies and defines the wastes to which waste acceptability applies;
- describes the required training for facility personnel;
- presents the procedures, decisions, and actions which will be taken if a waste load is suspected of containing a waste covered by this plan or is found to contain such a waste;
- explains how records of inspections will be kept and how notification of the proper authorities will take place if prohibited waste is discovered; and
- clarifies the financial and legal responsibility of the County and the waste hauler who brings the prohibited waste to the C&D landfill.

Section 3
Regulatory Background

State and county regulations each prohibit certain categories of waste from being landfilled. This section presents the regulatory authority prohibiting certain categories of waste from being landfilled and the requirement for waste screening.

3.1 State Regulations

North Carolina State Solid Waste Management Rules 15A NCAC 13B .0544 (e) require that owners and operators of all C&D landfill units to implement a program at the facility for detecting and preventing the disposal of industrial, hazardous, liquid, municipal solid waste, and excluded waste. This program must include:

- random inspections of incoming loads;
- records of any inspections;
- training of facility personnel to recognize industrial, hazardous, liquid, municipal solid waste, and excluded waste; and
- a contingency plan to properly manage any identified industrial, hazardous, liquid, municipal solid waste, or excluded waste. The plan will address identification, removal, storage and final disposition of the waste.

3.2 Materials Prohibited From C&D Landfilling

By North Carolina regulations, a C&D landfill shall only accept for landfilling those wastes which it is permitted to receive. According to Rule .0542 (e) the following wastes are prohibited from disposal at a C&D landfill unit:

(1) Containers such as tubes, drums, barrels, tanks, cans, and bottles unless they are empty and perforated to ensure that no liquid, hazardous or municipal solid waste is contained therein,

(2) Garbage as defined in G.S. 130A-290(a)(7),

(3) Hazardous waste as defined in G.S. 130A-290(a)(8), to also include hazardous waste from conditionally exempt small quantity generators,

(4) Industrial solid waste unless a demonstration has been made and approved by the Division that the landfill meets the requirements of Rule .0503(2)(d)(ii)(A),

(5) Liquid wastes,

(6) Medical waste as defined in G.S. 130A-290(a)(18),

(7) Municipal solid waste as defined in G.S. 130A-290(a)(18a),

(8) Polychlorinated biphenyls (PCB) wastes as defined in 40 CFR 761,

(9) Radioactive waste as defined in G.S. 104E-5(14),

(10) Septage as defined in G.S. 130A-290(a)(32),

(11) Sludge as defined in G.S. 130A-290(a)(34),

(12) Special wastes as defined in G.S. 130A-290(a)(40),

(13) White goods as defined in G.S. 130A-290(a)(44), and

(14) Yard trash as defined in G.S. 130A-290(a)(45).

(15) The following wastes cannot be received if separate from C&D landfill waste: lamps or bulbs including but not limited to halogen, incandescent, neon or fluorescent; lighting ballast or fixtures; thermostats and light switches; batteries including but not limited to those from exit and emergency lights and smoke detectors; lead pipes; lead roof flashing; transformers; capacitors; and copper chrome arsenate (CCA) and creosote treated woods

3.3 County Regulations

The County only accepts, for disposal, materials it is permitted to receive by the state solid waste operating permit.

The County reserves the right to turn away any waste hauling vehicle containing materials it is not permitted to accept based on federal or state regulations and which in its judgement require special handling and cannot safely be managed by the operating staff of the Dare County C&D landfill.

Section 4
Applicability

The Waste Acceptability Plan and related programs apply to all wastes as included in the current NCDENR Permit to Operate as permitted to be disposed of in the C&D landfill. Asbestos is included as an acceptable waste per NCDENR Permit to Operate dated December 18, 2006 (see Attachment 1).

This plan prohibits the disposal of wastes as outlined in Section 3.2. Scrap tires are not included in this waste acceptability plan primarily because of recycling efforts to achieve waste reduction.

Section 5
Training

A responsible individual certified in landfill operations shall be on-site at all times during operating hours of the facility and while open for public use. The Solid Waste Inspector has been instructed in the procedures, as described in this plan, to follow if industrial, hazardous, liquid, municipal or excluded waste, as outlined in Section 3.2, is identified or suspected in a waste load received at the landfill.

Section 6
General Waste Acceptance Procedures

As part of the standard operating procedures at the Dare County C&D Landfill, all drivers of incoming loads are questioned about the content and source of their waste load. Scale house operators and landfill staff, trained per Section 5 to recognize wastes prohibited from being disposed in the C&D landfill, have the authority to:

- detain a waste load from entering the facility;
- request additional information from the driver about the waste load;
- temporarily prohibit the waste load from being deposited at the working face; and/or
- contact the landfill supervisor who has the authority to reject the waste load.

The general waste acceptance procedure begins with a visual observation by landfill staff and questioning of the driver as to the contents of the waste load. Depending on the satisfactory answering of these questions and the judgement of the landfill staff, the load is either:

- determined to contain permitted C&D waste as stated in the current operating permit and is directed to the C&D landfill; or

- determined to contain waste prohibited, as summarized in Section 3.2, from disposal in the C&D landfill and then is diverted to the Dare County Transfer Station; or

- the landfill supervisor is contacted for a further screening.

If the load is dumped or unloaded onto the C&D landfill working face and is found to contain industrial, hazardous, liquid, municipal or excluded waste as summarized in Section 3.2, the party who brought the waste to the landfill will be required to cover all costs associated with removal, treatment, and safe disposal of that waste load as well as any contaminated soil and surrounding natural features which occurred because of the unloading of the prohibited waste. Verification of proper disposal of the waste and any additional and reasonable testing of the soil and water in the disposal area necessary to insure that no contamination remains, are the legal and financial responsibility of the party who brought the waste to the landfill.

Section 7
Random Inspections of Incoming Loads

While all loads entering the C&D landfill are visually screened by landfill staff, they are generally not inspected in detail. Therefore random inspections are used to provide a reasonable means to adequately control the receipt of prohibited wastes.

7.1 Selecting Loads for Sampling

Waste loads will be selected for screening based on some of the general principals of statistical random sampling. In selecting a statistically random sample, it is necessary to first identify or define the entire population from which the sample could be selected. Then it is necessary to give each individual member of that population an equal chance of being selected as a sample. It is also important to have approximately 80 to 100 usable samples as the basis for any conclusions made about the entire population. While there is no legal requirement that the waste loads selected for screening be "a random" sample, it is important to the overall validity of the program that the time and money spent by the County for this mandated screening program be cost effective.

It is typical that waste is collected from most commercial, industrial, manufacturing, and institutions on a weekly basis, therefore it is probable that if all waste loads for any one week were sampled, each load would have an equal chance of being selected. However, the composition of waste loads vary throughout the year and therefore sampling should occur throughout the year.

The following annual schedule provides a basic format for selecting waste loads for random screening. This schedule is only recommended and may be varied:

- 50 waste loads will be screened over a 12 month period;
- 2 to 4 waste loads per day will be randomly selected over a three day period in each of four seasons;
- during the 12 month period each of the six days that the C&D landfill is open for operation will be a sampling day at least twice except for Saturday which only needs to be a sampling day at least once during the year;
- of the 50 load total, a minimum of 10 will be industrial waste loads, a minimum of 10 manufacturing waste loads, and a minimum of 20 will be business or commercial loads;
- the exact days and loads to be sampled will remain random to reduce any attempts to avoid being sampled.

If after compiling a full year of random sampling, the County determines that less than 5 percent of the loads selected in the random screening contain any prohibited materials, the frequency of the random screenings can be reduced to 40 random screenings per year phased as described above.

7.2 Screening the Waste Loads

Waste loads selected for random screening will be directed to an area adjacent to the working face of the C&D landfill where the driver will be questioned about the loads contents before it is deposited onto the screening area. The random inspection form will be completed for all loads selected for screening. Upon answering the necessary questions for the waste screening form and unloading the waste load, the driver and truck may be released. Because this load has been randomly selected for waste screening, this release of the driver and vehicle is not intended to imply the County accepts the waste load.

The waste will be spread over the area for easy visual observation using a front end loader or similar piece of equipment. Only trained waste screening personnel, wearing protective safety equipment should come in physical contact with the waste contained in the load selected for screening.

Upon verification that the C&D waste passes the screening and is acceptable, the County will officially accept it for disposal. It is then transferred by landfill staff to the working face of the C&D landfill for disposal.

7.3 Procedures

If a waste load is suspected of containing prohibited materials, the County Solid Waste Inspector and waste hauler are to be immediately contacted by telephone and requested to send an authorized representative to the site of the waste load. The driver and truck are released as soon as they have adequately completed their sections on the random inspection form and the waste hauler has been reached. Based on the discretion of the landfill manager the Dare County Emergency Management can be contacted to come to the site and determine if the materials are prohibited wastes. The following will be completed based on the determination:

- The wastes are determined to be permitted for disposal in the C&D landfill under current operating permit; the County absorbs the cost for the testing.
- If the wastes are found to be either industrial, liquid, or municipal solid waste, the hauler will be billed for the testing and be required to immediately remove the wastes and transport to the working face of the Subtitle D landfill. The hauler will also be required to cover all costs associated with site clean-up and verification that the C&D landfill screening area is safe.
- If the wastes are found to be hazardous, the hauler will be billed for the testing and demonstrate to the County and the State that it was disposed of properly. The hauler will also be required to cover all costs associated with site clean-up and verification that the C&D landfill screening area is safe.

If the wastes are not removed within 24 hours, as required by the County, the County shall have the wastes removed and disposed of properly and bill the waste hauler for all the costs associated with their removal and site cleanup and repair.

Within one business day the County will confirm in writing via certified mail to the NCDENR and the waste hauler, the attempted illegal disposal of prohibited waste, the actions taken by the County, and the disposition of the waste. If a hauler is found to have attempted to dispose of prohibited materials in the C&D landfill, future additional waste screening for that hauler may be required. This additional screening could include screening every load of the hauler who has been previously found to be in violation. The County also reserves the right to refuse all future waste loads from a hauler found to be in violation.

Section 8
Records of Inspections

Figure 8-1 presents a sample random inspection form. It will be completed for every waste load screened through the random inspection program and for every incident where landfill staff suspect a waste load contains prohibited or hazardous waste and the driver cannot verify that these suspicions are false. The form will be completed by landfill staff, waste screening staff, and if appropriate, signed by the waste driver. One copy will be kept on file at the landfill where the waste load was received. One will be kept on file as open public record at the Dare County Manager's Office. This copy, or a permanent record of it, will remain on file for a minimum of 30 years.

Dare County Public Works Department
1018 Driftwood Drive
Manteo, NC 27954
252-475-5880

RECORD OF INSPECTION

Day: _____ **Time Crossed Scales:** _____
Truck Owner: _____ **Driver Name:** _____
Truck Type: _____
Vehicle ID# or Tag #: _____
Weight: _____
Tare: _____
Waste Generating Company/Source: _____

Reason Load Inspected: _____ **random inspection** _____ **staff initials**
_____ **detained by scale house** _____ **staff initials**
_____ **detained by LF operating staff** _____ **staff initials**

Approved County "Special Waste Determination" letter present _____ **Yes** _____ **No** _____ **N/A**
Description of waste load: _____
_____
_____

Disposition: Load Accepted (signature) _____ **Date:** _____
Load Not Accepted (signature) _____ **Date:** _____

Reason Load Not Accepted: (complete this section only if waste NOT ACCEPTED)

Description of Suspicious Contents:
color _____ **Haz. Waste markings** _____
texture _____ **smell** _____
drums present _____ **approx Cu. Yds. present in load** _____
approx tons present in load _____

Wake County Emergency Management Contacted: _____**Yes** _____ **No**
Hazardous or dangerous materials present: _____
(Dare County Emergency Management test results or verification attached)

Hauler notified (if waste not accepted)
Phone: _____ **Time person contacted:** _____
Other observations: _____
_____
_____

Final Disposition: _____
Signed by: _____ **Date:** _____
(Waste Screening Inspector or Landfill Supervisor)

cc: Landfill
Dare County Public Works

Figure 8-1

Section 9
Contingency Plan

If during a random screening or during regular operation of the C&D landfill, hazardous materials or materials defined by this waste screening plan as dangerous are discovered at the C&D landfill, the landfill supervisor on duty has the authority to contact appropriate emergency personnel (911) and request their immediate action to remove and safely dispose of the prohibited waste. All telephone and written notification will take place within the first business day of the discovery of such materials. A completed inspection form, letters of notification, and test results will be filed as required in Section 8.

Section 10
Responsible Party

Legal responsibility for all waste entering the landfill remains with the waste hauler until such a time that it is determined to be permitted C&D waste and is accepted by the County. The County does not accept the legal responsibility for waste which is prohibited from being landfilled in a C&D landfill. The hauler is defined as the responsible party who attempted to, either knowingly or unknowingly, illegally deposited the prohibited waste in the landfill. The hauler shall be billed by the County for all costs associated with illegal disposal of prohibited C&D waste. This includes, but is not limited to, costs in testing the waste, removing the prohibited waste from the C&D landfill, for the cost of transporting the prohibited waste to an appropriate waste management facility, for the disposal fee, and for all necessary and related site clean-up and testing.

If, after testing at the landfill by Dare County Emergency Management or the County's authorized contractor, the waste load is found to be materials which can legally be disposed in the C&D landfill, the County will accept legal responsibility for it. The County or their contractor (as per contract agreement) will absorb all costs for testing and removal or disposal of the C&D waste.

If Dare County Emergency Management or the County's authorized contractor, finds that the waste load contains hazardous or regulated materials that should not be landfilled, the County will not absorb the costs for any further testing either at the landfill or at another laboratory. If further testing by other laboratories indicate the materials could legally be landfilled, the County will be assumed to have "acted in good faith" to protect the public health and safety by refusing to landfill the waste. The County will not reimburse any cost associated with removal of the materials from the landfill site or its subsequent testing or disposal.

Section 11
Fines and Penalties

Dare County reserves the right to institute fines and penalties to any person found to have attempted to landfill waste prohibited from being disposed in the C&D landfill by state regulations.

NCDENR

NORTH CAROLINA DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES

Dexter R. Matthews, Director | Division of Waste Management | Michael F. Easley, Governor
William G. Ross Jr., Secretary

STATE OF NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT
AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT

CONSTRUCTION AND DEMOLITION LANDFILL FACILITY PERMIT No. 28-03

COUNTY OF DARE
is hereby issued a

PERMIT TO OPERATE

DARE COUNTY C&D LANDFILL
(CELL 3 EXPANSION)

located west of US Highway 264 approximately 2.4 miles south of the intersection of US Highway 64/264 in Dare County, North Carolina, in accordance with Article 9, Chapter 130A, of the General Statutes of North Carolina and all rules promulgated thereunder and subject to the conditions set forth in this permit. The facility is located and described by the legal description of the site or the property map contained within the approved application.

Edward F. Mussler III
CN = Edward F. Mussler III, C = US, O = Division of Waste Management, OU = Solid Waste Section
I have reviewed this document and I am approving this document
2006.12.18 16:28:07 -05'00'

Edward F. Mussler, III, P.E.,
Permitting Branch Supervisor
Permitting Branch
Solid Waste Section

ATTACHMENT 3

PART I: PERMIT HISTORY

Issuance	Date
Original Issue (PTC & PTO)	November 15, 1995
Version 1: Modification (PTO) Cell 2a	December 28, 1998
Version 2: Amendment (PTO) Cell 1 and 2	March 14, 2000
Version 3: Amendment (PTC) Cell 1	October 30, 2001
Version 4: Modification (PTC) Cells 1 and 2	June 24, 2002
Version 5: Modification (PTO) 180' of Cell 2	December 20, 2002
Version 6: Modification (PTO) Cells 1 and 2	June 27, 2003
Version 7: Amendment (PTO) Cells 1 and 2	May 5, 2005
Version 8: Amendment (PTC) Cell 3a	July 22, 2005
Version 9: Modification (PTO) Cell 3 (a & b)	March 17, 2006

PART II: LIST OF DOCUMENTS FOR THE APPROVED PLAN

1. – 24. See *Facility Permit No. 28-03, Part 2- Permit to Operate.* May 5, 2005. Amendment to Permit (Cells 1 and 2).

25. *Certification Letter, Cell No. 3a.* Prepared by: W. Michael Brinchek, P.E., Camp Dresser & McKee. Raleigh, NC. March 14, 2006.

26. Drawing: *Asbuilt Survey of a Portion of Cell #3 of County of Dare Landfill.* Prepared by: McKim & Creed, Virginia Beach, VA. Prepared for: Camp Dresser & McKee. Raleigh, NC. Project No. 03160-0010. Sheet 1 of 1. March 14, 2006. The surveyor of record is Timothy J. Cawood, P.L.S., NC Registration No. L-3358.

27. *Certification Letter, Cell No. 3 Expansion.* Prepared by: W. Michael Brinchek, P.E., Camp Dresser & McKee. Raleigh, NC. July 10, 2006.

28. Drawing: *Asbuilt Survey of Cell #3 of County of Dare Landfill.* Prepared by: McKim & Creed, Virginia Beach, VA. Prepared for: Camp Dresser & McKee. Raleigh, NC. Project No. 03160-0010. Sheets 1 and 2. April 28, 2006. The surveyor of record is Timothy J. Cawood, P.L.S., NC Registration No. L-3358.

- End of Section -

ATTACHMENT 4

Conditions of Permit to Operate

Site Specific Conditions

1. This permit approves the operation of the County of Dare Construction and Demolition Debris Landfill Cell 3 for five (5) years from the issuance date of this Permit to Operate, and is subject to review on or before November 30, 2011, as required under 15A NCAC 13B .0201(e).

    a. Modifications to the facility and engineering plans may be required in accordance with the rules in effect at the time of the review.

    b. The owner or operator shall submit a permit amendment or modification by July 30, 2011, prepared in accordance with the rules applicable to Construction and Demolition Debris landfills effective at the time of submittal.

2. The service area for this facility is Dare County per the resolution passed by the Dare County Commissioners on August 2, 2004.

3. The total design gross capacity for the construction of Cell 3 shall be consistent with the final grades as shown on Sheet Nos. 1 and 2 submitted with the letter of certification dated July 10, 2006. Gross capacity is defined as bottom of waste through the top of final cover.

    a. This permit approves the operation of Cell 3 that has a capacity of 315,000 cubic yards of airspace with a projected life of 5.3 years at 85 tons per day assuming an in-place density of 1,000 lbs/cy and 310 operating days.

    b. The total facility capacity, existing cells plus capacity of Cell 3, is 918,000 cubic yards.

4. Operation of future cells shall require written approval of the Section and shall be in accordance with the terms and conditions of the Permit to Construct issued July 22, 2005.

General Conditions

5. The documents submitted in support of the application for permitting the facility are identified in Attachment 1 and 3, "List of Documents for Approved Plan" and constitute the approved plan for the construction, operation and closure of the facility. Where discrepancies exist, the most recent submittal and the Conditions of Permit shall govern. Some components of the approved plan are reiterated in the Conditions of Permit.

6. This permit is not transferable.

7. All sedimentation/erosion control activities shall be conducted in accordance with the Sedimentation Control Act codified at 15 NCAC 4. Native vegetation shall be established on the completed C&D landfill unit in accordance with 15A NCAC 13B .0505 (3)(b)(c).

Operations

8. Operation of the C&D landfill shall be in accordance with Section .0505 and .0542 of the Solid Waste Management Rules, 15A NCAC 13B, the requirements contained in this permit, and shall conform to the operating procedures described in the approved plan. Should the approved plan and the rules be in conflict, the Solid Waste Management Rules shall take precedence unless specifically addressed by permit condition.

9. The facility operator shall have completed an approved operator training course in compliance with G.S. 130A-309.25.

   a. A responsible individual certified in landfill operations shall be on-site at all times during operating hours of the facility and while open for public use to ensure compliance with operational requirements.

   b. All pertinent landfill-operating personnel shall receive training and supervision necessary to properly operate the C&D landfill unit in accordance with G.S. 130A-309.25 and addressed by memorandum dated November 29, 2000.

10. The C&D landfill units are permitted to receive the following waste types:

   a. Unless otherwise specifically approved by permit condition, only "construction" or "demolition" types of solid wastes as defined in G.S. 130A-290 (a)(4) are permitted for acceptance and disposal in the C&D landfill units.

   b. "Construction or demolition debris" as defined in G.S. 130A-290 (4) means solid waste resulting solely from construction, remodeling, repair or demolition operations on pavement, buildings, or other structures, but does not include inert debris, land-clearing debris or yard debris.

   c. "Inert debris" as defined in G.S. 130A-290 (14) means solid waste that consists solely of material that is virtually inert, such as brick, concrete, rock and clean soil.

   d. "Land-clearing debris" as defined in G.S. 130A-290 (15) means solid waste that is generated solely from land-clearing activities such as stumps and tree trunks.

   e. "Asphalt" in accordance with G.S. 130-294(m).

   f. "Scrap tires" in accordance with G.S. 130A-309.53(6).

11. The C&D landfill units shall not receive the following waste types:

    a. "Yard trash" as defined in G.S. 130A-290 (45) shall not be disposed in the landfill area.

    b. Municipal solid wastes, hazardous wastes, or liquid wastes are not permitted for acceptance or disposal in the C&D landfill units.

12. The Permittee shall actively employ a screening program for the C&D unit that detects and prevents the disposal of MSW, hazardous, liquid or non-permitted wastes. At a minimum, the program shall include:

    a. Random inspections of incoming loads or other comparable procedures.

    b. Records of any inspections.

    c. Training of personnel to recognize hazardous and liquid wastes.

    d. Development of a contingency plan to properly manage any identified hazardous, liquid or MSW wastes.

    e. The plan must address identification, removal, storage, and final disposition of waste.

Cover Material Requirements

13. Solid waste shall be covered with a minimum of 6 inches of soil or an approved material of equivalent performance and thickness at least once per week or when the active area reaches 1/2 acre in size, or more often when necessary to prevent the site from becoming a visual nuisance or to mitigate conditions associated with fire, windblown materials, vectors, or excessive water infiltration.

14. Areas that will not receive additional waste for 12 months or more, but where final termination of operations has not occurred, shall be covered with a minimum of one foot of soil cover in accordance with Rule .0505(3)(b), and stabilized with vegetative cover.

15. After final termination of disposal operations at the C&D unit or major part thereof, or upon revocation of a permit, the fill areas shall be covered with at least two feet of suitable compacted earth in accordance with Rule .0505(3)(c), or other protective barrier as specified by the rules or the permit in effect at the time of closure.

Access and Safety

16. The C&D unit shall be adequately secured by means of gates, chains, berms, fences, or other security measures approved by the DWM to prevent unauthorized entry.

17. The access road to the C&D unit shall be of all-weather construction and maintained in good condition.

18. Signs shall be posted at the entrance of landfill in accordance with the Access and Safety Requirements under Operation Condition .0505(8).

    a. Signs shall provide information on dumping procedures, the hours of operation, the permit number, and other pertinent information shall be posted at the entrance to the landfill.

    b. Signs shall be posted stating that NO MSW, hazardous waste or liquid waste can be received in the C&D unit.

    c. Traffic signs or markers shall be provided as necessary to promote orderly traffic patterns to and from the discharge area and to maintain safe operating conditions.

19. Dust control measures shall be implemented when necessary.

20. Barrels and drums shall not be disposed unless they are empty and perforated sufficiently to ensure that no liquid or hazardous waste is contained therein.

21. Asbestos waste shall be managed in accordance with 40 CFR 61.

22. Open burning of solid waste is prohibited. Fires shall be reported to the Solid Waste Section by phone within 24 hours of an incident and written notification shall be submitted within 14 working days addressing the events at the site and future actions to be taken in the future to avoid and or mitigate potential fire hazards.

23. The concentration of explosive gases generated by the C&D unit shall not exceed:

    a. 25% of the lower explosive limit for gases in site structures excluding gas control or recovery system components if necessary; and
    b. 100% of the lower explosive limit for gases at the property boundary. Installation of permanent gas monitoring wells may be required in the future to demonstrate compliance.

24. The removal of solid waste from the facility is prohibited unless the owner/operator approves and the removal is not performed on the working face. If C&D recycling is to take place in the future, an amendment to the operations plan shall be submitted to the Solid Waste Section for review and approval.

Erosion and Sedimentation Control

25. Adequate sedimentation and erosion control measures shall be practiced to prevent silt from leaving the site of the C&D unit.

26. Adequate sedimentation and erosion control measures shall be practiced to prevent excessive on-site erosion.

27. Provisions for a vegetative ground cover sufficient to restrain erosion must be accomplished within 30 working days or 120 calendar days upon completion of any phase of C&D landfill unit development or as addressed in the approved Sedimentation and Erosion Control permit.

Drainage Control and Water Protection Requirements

28. Surface water shall be diverted from the operational area.

29. Surface water shall not be impounded over or in waste.

30. A separation distance of at least four feet shall be maintained between the C&D waste and the groundwater table as addressed in the site suitability application, hydrologic assessment section.

31. Solid waste (C&D) shall not be disposed in standing water.

32. Leachate shall be contained on site or properly treated prior to discharge. An NPDES permit may be required prior to discharge of leachate to surface waters and or for land disturbing activities greater than one acre.

33. Ground water quality for the C&D landfill unit is subject to the classification and remedial action provisions referenced in Rule .0503 (2)(d) of 15A NCAC 13B.

34. A closure and post-closure plan must be submitted for approval at least 90 days prior to closure or partial closure of any landfill unit. The plan must include all steps and measures necessary to close and maintain the C&D unit in accordance with all rules in effect at that time. At a minimum, the plan shall address the following:

    a. Design of a final cover system as required by the solid waste management rules in effect at the time of closure;

    b. Construction and maintenance/operation of the final cover system and erosion control structures;

    c. Surface water, ground water, and explosive gas monitoring.

Monitoring and Reporting Requirements

35. The following are requirements relating to groundwater monitoring for the C&D landfill facility:

    a. Groundwater and surface water monitoring locations shall conform to the specifications outlined in "North Carolina Water Quality Monitoring Guidance Document for Solid Waste Facilities" and in the North Carolina Well Construction Standards, 15A NCAC 2C .0108.

    b. A total of eight locations as illustrated in the approved plan shall be established to monitor this facility.

    c. A licensed geologist shall be present to supervise the installation of groundwater monitoring wells. The exact locations, screened intervals, and nesting of the wells shall be established after consultation with the SWS Hydrogeologist at the time of well installation.

    d. All well construction records and soil boring logs for new wells shall be submitted to the Solid Waste Section Hydrogeologist for review within 30 days of completion.

    e. Prior to the acceptance of any waste at the facility, a baseline sampling event shall be completed.

    f. The owner or operator shall sample the monitoring wells semi-annually or as otherwise directed in writing by the SWS Hydrogeologist.

    g. A readily accessible, unobstructed, path shall be maintained so that monitoring wells may be accessed using four-wheel drive vehicles.

    h. Each monitoring well shall be surveyed and hydraulic conductivity and effective porosity values shall be established for each screened interval in order to develop groundwater flow characteristics.

    i. The owner or operator shall maintain a record of all monitoring events and analytical data. Reports of the analytical data for each water quality monitoring sampling event shall be submitted to DWM in a timely manner.

36. The owner or operator shall maintain a record of the amount of solid waste received at the C&D unit, compiled on a monthly basis. Scales shall be used to weigh the amount of waste received.

37. On or before August 1 annually, the Permittee shall report the tons of waste received and disposed in the C&D landfill unit to the Solid Waste Section and to all counties from which waste was accepted on forms prescribed by the Section. The following is information regarding the annual reports:

    a. The reporting period shall be for the previous year beginning July 1 and ending June 30.

    b. The annual report shall list the amount of waste received and landfilled in tons and be compiled:
        i) On a monthly basis.
        ii) By county, city or transfer station of origin.
        iii) By specific waste type.
        iv) By disposal location within the facility.
        v) By diversion to alternative management facilities.

    c. A copy of the completed report shall be forwarded to each county manager for each county from which waste was received at the facility.

    d. A copy of the report and documentation that a copy of the report has been forwarded to all counties from which waste was accepted must be sent to the regional Waste Management Specialist by the date due on the prescribed annual report form.

38. All records required to be maintained by the owner or operator by regulation or permit shall be maintained on-site and made available to the SWS upon request.

- End of Permit Conditions -

Closure Plan
Contents

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Closure Plan

Section 1

The North Carolina Solid Waste Regulation Section Rule 15A NCAC 13B .0543(a) requires construction and demolition landfill (C&DLF) owners/operators to prepare a closure plan that describes the steps necessary to close a C&DLF at any point during its active life. This closure plan establishes: design criteria for the closure cap system and the gas collection system, a closure sequence and construction schedule, construction cost estimates, and other important information relating to closure.

1.1 Construction of Cap System

1.1.1 Final Cover System

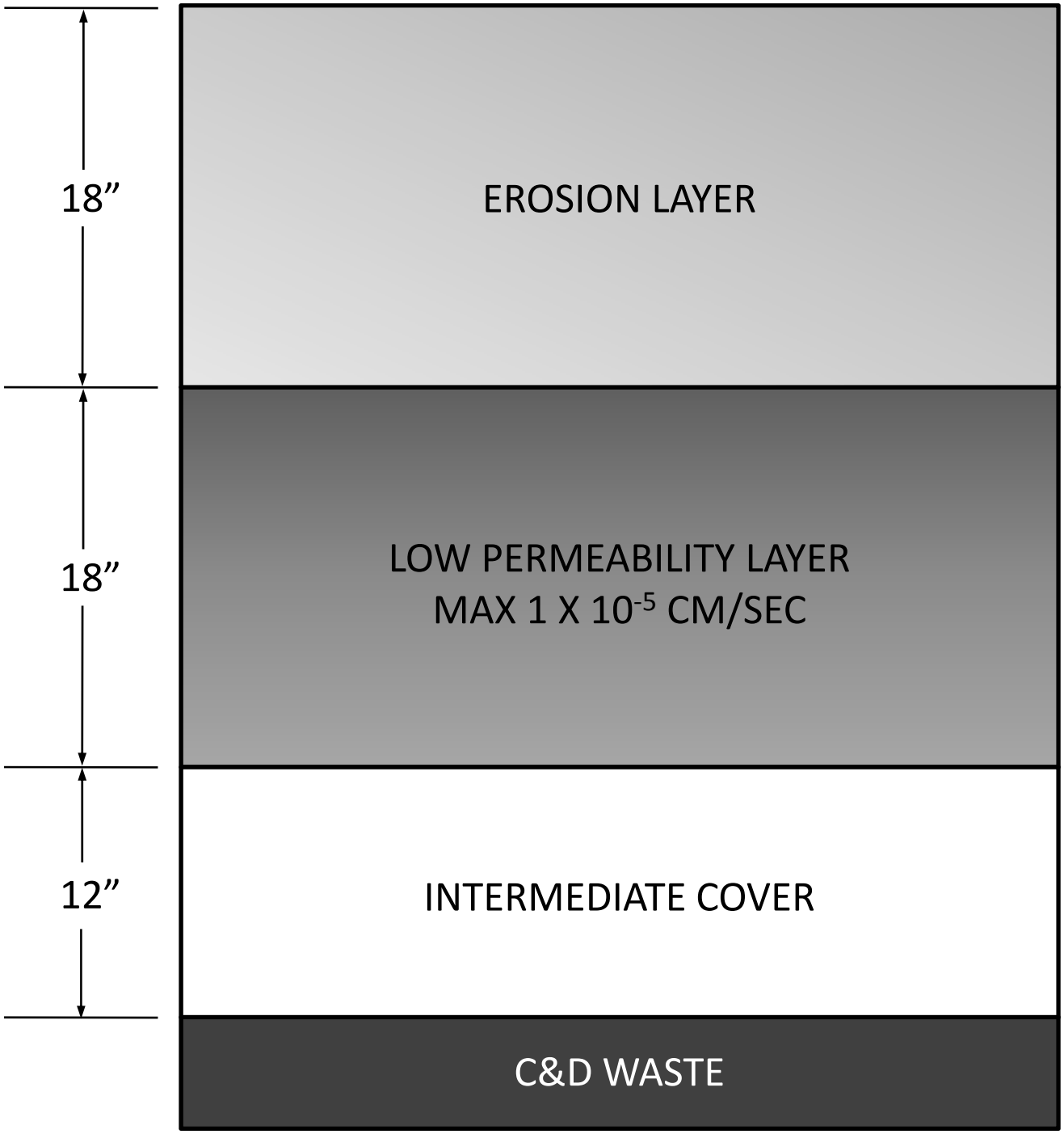
The final cover system has been designed to minimize the amount of storm water infiltration into the landfill and to resist erosive forces. The final cover system consists of the following layers (listed from top to bottom), which meet the requirements of Rule 0.543(c)(1):

- An 18-inch erosion layer consisting of earthen material that is capable of sustaining native plant growth; and
- An 18-inch low permeability barrier of earthen material with a permeability no greater than 1.0×10^{-5} cm per second.

Material for the low permeability layer will originate from the on-site borrow area. As the borrow area is mined for intermediate and daily cover, material that is most suitable for the cap will be stockpiled. It is currently anticipated that bentonite will be added to the stockpiled soil at a rate of 2 percent to achieve the required permeability.

The post-settlement grades of the top surface slopes will not be less than 5 percent (to prevent ponding). Figure No. 1-1 provides a section detail of the proposed final cover system.

Closure side slopes will be 3:1; however, post-settlement slopes are expected to be less than 3:1. Rule 0.543(c)(3)(C) allows for alternative side slopes (those greater than 25%) to be approved by the North Carolina Department of Environment and Natural Resources Solid Waste Section (NCDENR SWS) if the design is certified (by a licensed professional engineer in the State of North Carolina) to be stable, encourage runoff, and be safe to construct, operate and maintain. A slope stability analysis was prepared as part of the Permit Application. The slope stability analysis demonstrates these requirements (see Section 2 - Engineering Plan - Appendix B).



	DATE 6-18-2008	FINAL COVER SYSTEM	FIGURE NO.
CDM Camp Dresser & McKee			1-1

1.1.2 Gas Collection System

The placement of a low-permeability final cover system will prevent the release of landfill gas generated during the post-closure period. To minimize pressures exerted on the barrier, passively vented gas wells will be used. The exact location of the vertical gas wells will be determined at the time of closure. Generally, one vertical well per acre is anticipated to be installed. A bentonite seal and synthetic boot will be installed around the vertical gas well to prevent storm water infiltration. The depth of the vertical gas wells will extend from final grade to less than 10 feet into waste. Figure No. 1-2 provides a section detail of the proposed vertical gas well design.

1.2 Estimate of Largest Closure

The approved C&DLF site plan includes five individual disposal cells separated by drainage laterals. Each cell represents one phase of C&DLF development. Currently, Cells No. 1 and 2 are inactive and at finished grades, while Cell No. 3 is in operation. Cells 4 and 5 are proposed to be developed as Phases IV and V, but are not yet permitted. Cells 1 through 4 cover 45.2 acres. This represents the largest closure area, as currently permitted.

1.3 Estimate of Maximum Inventory of Waste On-Site

The maximum amount of waste that is expected to be disposed at the C&DLF, based on the approved permit, was calculated using the Earthworks Module of Softdesk. The total gross airspace available between the proposed top of final cover and the base grades is approximately 1,244,900 cubic yards (CY). The final cover material required to construct the 3-foot thick cover system for the C&D Landfill (45.2 acres total surface area) is 218,768 CY. It is anticipated that a 4:1 waste to cover ratio will be achieved; therefore, (1,244,900 CY – 218,768 CY) x 20% cover = 205,226 CY daily and intermediate cover will be required. Deducting the volume of the final cover system (218,768 CY) and daily/intermediate cover materials (205,226 CY) from the total gross airspace, the maximum available net airspace in Cells 1 through 4 for waste to be disposed is projected to be 820,906 CY.

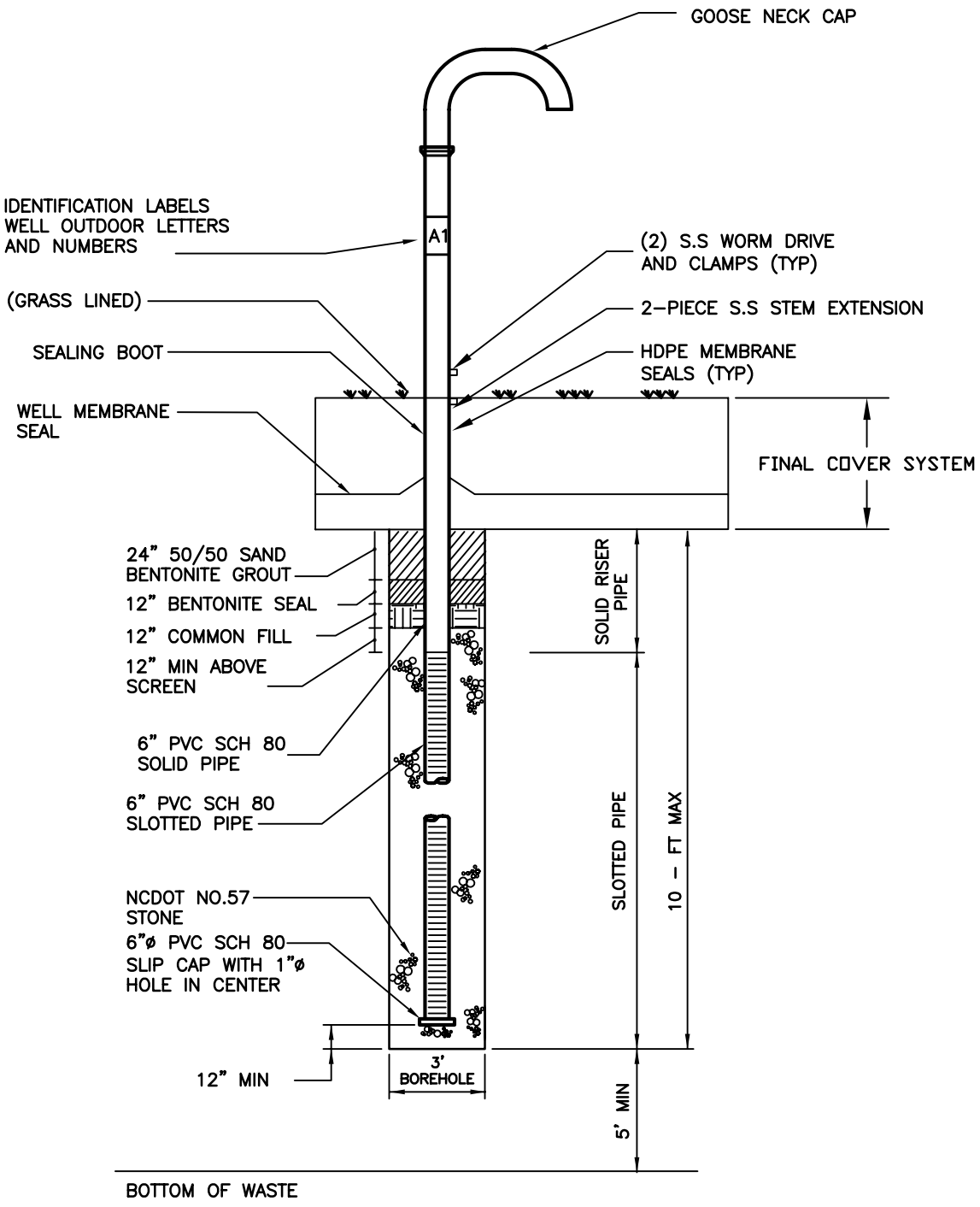
1.4 Landfill Closure Sequence

The landfill closure sequence is summarized in the table on Page 1-5 and described in the following sections.

1.4.1 Determination of Closure Area

The County will determine the location and acreage of areas to be closed. Closure procedures will not be instituted until an adequate area (approximately 10 acres or more) of the landfill is within 15 feet of final grade. An estimate of landfill area that is within 15 feet of final grade should be determined periodically by the surveyor for the site during the active life of the facility.

When an area has reached final grades, the County must initiate the closure process no later than 30 days after the final receipt of waste. However, if the area has not



DATE 5-21-2008

VERTICAL GAS WELL

FIGURE NO.

1-2

CDM Camp Dresser & McKee

CLOSURE SEQUENCE	
Activity	***Process Date***
Determination of Closure Area and Initiate Closure Process	No later than 30 days after the final receipt of waste
Notification of Intent to Close	Once an area has been determined to be closed
Develop Closure Schedule for Closure Activities	
Prepare Construction Contract Documents	
Develop Final Closure Schedule	Once the SWS has commented on the closure schedule
Select a General Contractor	After receiving sealed bids
Closure Construction	Closure activities must be completed within 180 days of beginning closure activities or as otherwise approved
Certification of Closure Construction	At completion of construction
Record Notation to Deed	After final closure of property

reached final grades and there is reasonable likelihood that additional waste will be received in the near future, then closure activities must begin no later than one year after the most recent receipt of wastes.

1.4.2 Notification of Intent to Close

Once the County has determined that an area will be closed, a Notice of Intent to Close must be placed in the operating record and the SWS must be notified of the action per Rule .0543(c)(4). The final cover design, area to be closed, and scheduling of closure activities presented in this Permit Modification Application shall be reviewed and updated as necessary.

1.4.3 Develop Closure Schedule

The County will prepare a schedule for bidding and construction of the closure activities. Closure activities must be completed within 180 days of beginning closure activities unless the County gains approval from the SWS by demonstrating that the construction period, by necessity, will require an extended schedule and that measures to protect human health and the environment have been implemented in the interim.

1.4.4 Prepare Construction Contract Documents

For the purpose of bidding, construction documents will be prepared for the area to be closed. The bidding documents will allow contractors to estimate the quantity of materials needed to properly implement the closure plan, as well as estimating the construction costs.

1.4.5 Develop Final Closure Schedule

Once the SWS has reviewed and commented on the closure schedule, the County will prepare a final schedule for bidding and construction of the closure activities.

1.4.6 Selecting a General Contractor

After receiving sealed bids, a contractor will be awarded the job of constructing the final cover according to the approved closure plan. The contractor will be required to complete all closure activities within 180 days of beginning such activities, or as otherwise approved by the SWS.

1.4.7 Securing Borrow Material for Landfill Cover

The material to be used for construction of the closure cap system will be obtained primarily from on-site sources. Off-site sources, as needed, will be selected based on proximity to the site, ability to provide material according to project specifications, and price.

1.4.8 Certification of Closure Construction

Following completion of the closure construction, a Construction Quality Assurance certification will be prepared in accordance with the approved CQA Plan and submitted to the SWS for review and approval. This will verify that the closure construction was performed in accordance with the closure plan and signed by a registered professional engineer licensed in the State of North Carolina and will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

1.4.9 Record Notation to Deed

After final closure of the property, a notation will be placed on the deed to the property stating that the property was used as a landfill facility, and its use is restricted under the closure plan approved by the SWS.

1.5 Financial Assurance

A detailed cost estimate based on current costs has been prepared for closure of the largest active area of the landfill facility at any time during the life of the facility and is provided in Table 1-1. A copy of the cost estimate has been placed in the operating record. The cost estimate will be annually adjusted to account for inflation and any changes in conditions at the facility or in the design. If conditions call for a reduction in the amount to be financially assured, approval of the SWS must be obtained prior to officially reducing the amount.

Per Rule .0546(c)(1)(B), the County will annually adjust the closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. It is expected that Dare County will use the local financial government test, and therefore will be required to update the closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 1-1

Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
Revised December 2008

	Quantity	Unit	Cost	Total
Final Cover System				
Grade Intermediate Cover/Strip Existing Vegetation	33.9	ac	$1,500.00	$50,850
Cap System Components:				
a. 18″ Erosion Layer[1]	82,038	cy	$13.30	$1,091,105
b. 18″ Low-Permeability Layer, augmented with 2% bentonite[1]	82,038	cy	$20.00	$1,640,760
Seeding, Fertilizing & Mulching	33.9	ac	$1,850.00	$62,715
Temporary Erosion Control	33.9	ac	$3,000.00	$101,700
Permanent Erosion and Stormwater Control	33.9	ac	$33,300.00	$1,128,870
Landfill Gas Management				
Vertical Gas Vents (34 @ Avg. Depth of 10′)	340	vf	$108.50	$36,890
Surveys	33.9	ac	$333.33	$11,300
Final Landscaping				
Seeding, Fertilizing & Mulching	33.9	ac	$1,850.00	$62,715
Indemnification	1	ls	$5,000.00	$5,000
Subtotal				$4,191,905
Bonds and Mobilization/Demobilization (5% of Subtotal)				$209,595
Engineering Services, CQA/CQC (12% of Subtotal)[2]				$503,029
Contingency (15% of Subtotal)				$628,786
			TOTAL	**$5,533,315**
			COST PER ACRE	**$163,225**

1. The material quantity is as measured in-place and compacted.
2. Engineering services include construction document preparation; construction contract administration; construction observation; preparation of the CQA report; closure certification; and record notation to deed.

Post-Closure Plan
Contents

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Post-Closure Plan
Section 1

The North Carolina Solid Waste Regulation Section Rule 15A NCAC 13B .0543(a) requires owners/operators of C&DLFs to prepare a post-closure plan. The purpose of the plan is to provide the necessary information for preserving the integrity of the landfill facility in its post-closure life. This post-closure plan specifically addresses maintenance activities for the closure cap, landfill gas monitoring system, groundwater monitoring wells, and erosion and sedimentation control system to be installed at the C&DLF. This plan also addresses certification and financial assurance requirements.

Post-closure care will begin immediately following final closure of the landfill. Post-closure care may be decreased from the minimum time period of 30 years specified in the regulations if the County can demonstrate that the reduced period will pose no threat to human health or the environment. However, the SWS reserves the right to increase the post-closure care period if it is deemed necessary to protect human health and the environment.

1.1 Maintenance and Monitoring Activities

Post-closure maintenance and monitoring activities for the C&DLF are described in the following sections. Post-Closure Inspection form is provided as Figure 1-1.

1.1.1 Final Cover System

Inspection of the final cover system will take place quarterly and encompass the entire landfill. Items of concern to be noted by the inspector include but are not limited to: signs of erosion (ruts, sediment deposits, etc.), patches of stressed or dead vegetation, animal burrows, recessed areas or ponding, upheaving, leachate seepage stains and/or flowing leachate, cracks in the cap, damaged gas vents and tree saplings (especially species with tap roots). Following each inspection, a summary report of the condition of the cover and the items of concern should be recorded in the post-closure log book of the facility. Areas that require further attention should be photographed and delineated on a map of the facility. These items should also be entered in the log book. Since post-closure inspection personnel will most likely change during the post-closure period, the post-closure log book should be kept in a standardized format that allows for new inspection personnel to easily review the results of past post-closure inspections of the site.

Action should be taken immediately to address any items of concern identified during the inspection. Obvious repair items should be performed under the supervision of the post-closure maintenance manager. If an item of concern requires further study to determine a course of action, the engineering firm responsible for closure design should be contacted for consultation.

Dare County
Construction and Demolition Debris Landfill
Post-Closure Inspection Form (Figure 1-1)

Inspector: _____ **Weather:** _____
Date/Time: _____

Inspection List	Last Date of Inspection	Frequency of Inspection	Condition GC/MC/NR[1]	Photographs	Map ID's	Corrective Action/Comments
1. Site Maintenance						
1.1 Final Cover System						
1.1.1 Signs of erosion (ruts, sediment deposits, etc.)		Quarterly				
1.1.2 Patches of stressed or dead vegetation		Quarterly				
1.1.3 Animal burrows		Quarterly				
1.1.4 Recessed areas or ponding		Quarterly				
1.1.5 Leachate seepage stains and/or flowing leachate		Quarterly				
1.1.6 Upheaval or Cracks in the cap		Quarterly				
1.1.7 Tree saplings (especially species with tap roots)		Quarterly				
1.1.8 Semi-Annually mowed (Y/N)		Quarterly				
1.2 Site Security and Access						
1.2.1 Access Road		Quarterly				
1.2.2 Security Fencing and Gates		Quarterly				
1.2.3 Signage		Quarterly				
2. Erosion and Sedimentation Control System						
2.1 Drainage Ditches						
2.1.1 Obstructions		Semi-annually[2]				
2.1.2 Erosion of side slopes		Semi-annually[2]				
2.1.3 Loss of vegetative cover		Semi-annually[2]				
2.1.4 Excessive build-up of sediment		Semi-annually[2]				
2.2 Drainage Pipes						
2.2.1 Obstructions		Semi-annually[2]				

Dare County
Construction and Demolition Debris Landfill
Post-Closure Inspection Form (Figure 1-1)

Inspection List	Last Date of Inspection	Frequency of Inspection	Condition GC/MC/NR[1]	Photographs	Map ID's	Corrective Action/Comments
2.2.2 Undercutting and rutting of inlets & outlets		Semi-annually[2]				
2.3 Sedimentation Devices						
2.3.1 Sediment Level		Semi-annually[2]				
2.3.2 Outlet Control Device		Semi-annually[2]				
2.3.3 Berm Stability		Semi-annually[2]				
3. Monitoring						
3.1 Groundwater and Gas Monitoring Wells						
3.1.1 Casing Condition (cracks, corrosion, etc...)		Semi-annually				
3.1.2 Condition of locking system and cover		Semi-annually				
3.1.3 Presence of surface seal damage		Semi-annually				
3.1.4 Debri near cap		Semi-annually				
3.1.5 Sampling performed		Semi-annually				
3.2 Landfill Gas Monitoring System						
3.2.1 Gas vent blockages		Quarterly				
3.2.2 Gas vent condition		Quarterly				
3.2.3 Gas vent air pump test		Annually				

1 Description of Condition
GC = Good condition
MC= Monitor condition to determine course of action
NR = Needs repair

2 Inspection should be conducted after major storm events.

As part of general maintenance, the vegetative cover should be mowed at least twice a year to suppress weed and brush growth. If vegetative cover is not adequate in any particular area, soil amendments should be applied as necessary and the area re-seeded in order to re-establish vegetation. Insecticides may be used to eliminate insect populations that are detrimental to the vegetation. Animal burrows and eroded or depressed areas should be filled in with compacted soil and reseeded.

1.1.2 Site Access and Security

In addition to the final cover cap, quarterly inspection shall be performed on all site access roads and all security features; including but not limited to fencing, gates, signage, etc.

1.1.3 Groundwater Monitoring Wells

Inspection of the groundwater monitoring wells will take place semi-annually during sampling events. The inspection will consist of verifying the condition of the monitoring wells to ensure that they are providing representative samples of the ground water being collected. The inspector should note the following:

1) The total depth of the well should be recorded every time a water sample is collected or a water level reading is taken to check if sediment has accumulated at the bottom. If sediment build-up has occurred, the sediment should be removed by pumping or bailing.
2) If turbid samples are collected from a well, redevelopment of the well will be necessary.
3) The above-ground protective casing should be inspected for damage. The protective casing should be of good structural integrity and free of any cracks or corrosion. The lockable cover and lock should also be checked at this time.
4) The surface seals should be inspected for settling and cracking. If the seal is damaged in any way, the seal should be replaced.
5) The well casing and cap should be inspected. The casing and cap should be of good structural integrity and free of any cracks or corrosion. Any debris should be removed from around the cap to prevent it from entering the well.

The condition of the groundwater monitoring system should be recorded in the post-closure log book following each sampling event. Monitoring of the groundwater wells shall be conducted as described in the groundwater monitoring plan.

1.1.4 Landfill Gas Monitoring System

Inspection of the landfill gas monitoring system should take place at least quarterly. The inspection should consist of verifying the condition and operation of the passive gas vents and gas monitoring wells. The full depth of all vents and monitoring wells

should be checked for blockage that may be caused by settlement or cracks in the casing. At least once a year, all vents and wells should be tested with an air pump to ensure they are free-flowing. The summary of each inspection of the landfill gas monitoring system should be recorded in the post-closure log book along with photographs of any items of concern.

Testing of the gas monitoring wells shall be conducted quarterly, or as otherwise approved by the SWS.

If any vents or wells are not properly working, they should be flushed and pressure cleaned. If all attempts to repair a vent or well are unsuccessful, a replacement will be installed.

1.2 Erosion and Sedimentation Control System

Inspection of the erosion and sedimentation control system should occur semi-annually and after major storm events. During each inspection, the elements of the system including drainage ditches, drainage pipes, sedimentation devices, and inlet/outlet structures should be checked for obstructions and damage. The drainage ditches should be inspected for obstructions, erosion of side slopes, loss of vegetative cover, shifting of riprap, excessive buildup of sediment, or any other item that may prevent the proper functioning of the ditch. Drainage piping should be checked for blockages and the inlets/outlets should be inspected for undercutting and rutting. The sediment level in the sedimentation devices should be measured to determine if removal is required. The condition of the outfall structure should be checked to ensure proper functioning. The berms should be inspected for stability. Following each inspection, a summary report should be entered in the post-closure log book along with photographs of any items of concern.

Maintenance and/or repairs should be performed immediately as prescribed by the inspectors review.

1.3 Certification of Post-Closure

Following completion of the post-closure care period, a certification verifying that post-closure care was performed in accordance with the post-closure plan and signed by a registered professional engineer licensed in the State of North Carolina will be made part of the operating record. The County will notify the SWS that the certification has been placed in the operating record.

1.4 Name of Individual Responsible for Post-Closure Maintenance of the Site

Mr. Edward Mann of Dare County is currently responsible for operations and maintenance of the site. Mr. Mann can be reached at the following address:

Mr. Edward Mann
Public Works Director, Dare County
P.O. Box 100
Manteo, North Carolina 27954

Mr. Mann most likely will not be employed with Dare County throughout the entire 30 year post-closure period. A new individual will be appointed at the time Mr. Mann's employment with the County ends.

1.5 Planned Use of Landfill after Closure

There are no current planned uses for the landfill site after closure. The property will remain County property, maintained by the County, with public access prohibited.

1.6 Financial Assurance

Dare County will submit a financial assurance package to SWS in accordance with the criteria set forth under Rule .0546. A detailed cost estimate for post-closure care has been prepared and is provided herein (Table 1-1) and a copy has been placed in the operating record. The cost estimate is based on 30 years of post-closure care.

Per Rule .0546(c)(3)(B), the County will annually adjust the post-closure cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument. Dare County anticipates using the local financial government test, and therefore will be required to update the post-closure cost estimate for inflation within 30 days after the close of the fiscal year and before submission of updated information to the SWS.

Table 1-1

Post-Closure Cost Estimate
Dare County C&DLF
Dare County, North Carolina
Revised December 2008

	Quantity	Unit	Cost	Total
Administration[1]	30	yr	$5,000	$150,000
Engineering[2]	30	yr	$10,000	$300,000
Monitoring				
15 Groundwater Monitoring Well and QA/QC Samples Analyzed Semi-Annually for 30 years	60	events	$2,475	$148,500
3 Surface Water Sample Analyzed Semi-Annually for 30 years	60	events	$325	$19,500
Maintenance				
Fencing, Gates, Signs, etc.	30	yr	$1,000	$30,000
Access Roads	30	yr	$3,000	$90,000
Mowing	30	yr	$12,000	$360,000
Stormwater Structures	30	yr	$9,000	$270,000
Final Cover System Inspection & Repair	30	yr	$25,000	$750,000
Groundwater Monitoring Wells	30	yr	$8,000	$240,000
Surface Water Monitoring Points	30	yr	$2,500	$75,000
Landfill Gas Wells	30	yr	$5,000	$150,000
Subtotal				$2,583,000
Contingency (15%)				$387,450
			TOTAL	**$2,970,450**
			ANNUAL COST	**$99,015**

1. Administration costs include contract selection and procurement of firms to perform inspection, monitoring and repairs.
2. Engineering costs include general site inspection activities.

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919-325-3500
fax: 919-781-5730

Permit No.	Date	Document ID No.
28-03	**February 23, 2010**	**9841**

RECEIVED
February 22, 2010 via hand delivery
Solid Waste Section
Raleigh Central Office

February 22, 2010

Mr. Ming-Tai Chao, P.E.
Environmental Engineer II
North Carolina Department of Environment and Natural Resources
Division of Waste Management
Permitting Branch, Solid Waste Section
1646 Mail Service Center
Raleigh, NC 27699-1646

Subject: Dare County
Dare County Construction and Demolition Landfill (C&DLF)
NCDENR LQS – Erosion and Sedimentation Control Plan and Permit

Dear Mr. Chao:

On behalf of Dare County, CDM is pleased to submit a CD with an electronic copy of the approved NCDENR Land Quality Section (LQS) Erosion and Sedimentation Control Plan and Permit along with the NCDENR LQS approval letter.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

W. Michael Brinchek, P.E.
Project Manager
Camp Dresser & McKee

cc: Ed Mussler, NCDENR DWM
Edward Mann, Dare County
Kevin Irby, CDM

NCDENR
North Carolina Department of Environment and Natural Resources
Division of Land Resources
Land Quality Section

James D. Simons, PG, PE
Director and State Geologist

Beverly Eaves Perdue, Governor
Dee Freeman, Secretary

February 18, 2010

LETTER OF APPROVAL WITH MODIFICATIONS

Dare County
ATTN: Mr. Edward L Mann, Public Works Director
Post Office Box 1000
Manteo, North Carolina 27954

RE: Erosion and Sedimentation Control Plan No. DARE-2010-006
Project Name: C&D Landfill Cell #4
Location: US 264 County: Dare
River Basin: Pasquotank
Date Received by LQS: January 20, 2010
Acres Approved: 18 Project Type: New
Project Description: New Landfill cell, including access roads, as shown on the submitted plan dated January 11, 2010

Dear Sir:

This office has reviewed the subject erosion and sedimentation control plan. We find the plan to be acceptable and hereby issue this Letter of Approval with Modifications. The modifications required for approval are listed on the attached pages. This plan approval shall expire three (3) years following the date of approval, if no land-disturbing activity has been undertaken, as required by 15A NCAC 4B.0129, unless modified by other legislation.

Please be advised that 15A NCAC 4B.0118(a) requires that a copy of the approved erosion and sedimentation control plan be on file at the job site. Also, you should consider this letter as giving the Notice required by G.S. 113A-61.1(a) of our right of periodic inspection to ensure compliance with the approved plan.

North Carolina's Sedimentation Pollution Control Program is performance oriented, requiring protection of existing natural resources and adjoining properties. If, following the commencement of this project, it is determined that the erosion and sedimentation control plan is inadequate to meet the requirements of the Sedimentation Pollution Control Act of 1973 (G.S. 113A-51 through 66), this office may require revisions to the plan and implementation of the revisions to ensure compliance with the Act.

Acceptance and approval of this plan is conditioned upon your compliance with Federal and State water quality laws, regulations and rules. In addition, local city or county ordinances or rules may also apply to this land-disturbing activity. This approval does not supersede any other permit or approval.

Please be aware that your project will be covered by the enclosed NPDES General Stormwater Permit NCG010000 (Construction Activities). You should first become familiar with all of the requirements for compliance with the enclosed permit.

Please note that this approval is based in part on the accuracy of the information provided in the Financial Responsibility/Ownership Form, which you have submitted. You are required to file an amended form if there is any change in the information included on the form. In addition, 15A NCAC 4B.0127(c) requires that you notify this office of the proposed starting date for this project (using the enclosed Project Information Sheet). Please notify us if you plan to have a preconstruction conference.

Sincerely,

Robert James Belvin, PE
Assistant Regional Engineer

Enclosures

cc w/o enc: W. Michael Brinchek, PE, CDM
Alton Hodge, Division of Water Quality
1993 C&D Landfill file
DARE-2002-009

1. **AS THE DECLARED RESPONSIBLE PARTY, YOUR LEGAL RESPONSIBILITY** is to understand the Act and comply with the following minimum requirements of the Act:

   A. In the event of a conflict between the requirements of the Sedimentation Pollution Control Act, the submitted plan and/or the contract specifications, the more restrictive requirement shall prevail;

   B. The land-disturbing activity shall be conducted in accordance with the approved erosion and sedimentation contorl plan;

   C. The **LATEST APPROVED** erosion and sediment control plan will be used during periodic unannounced inspections to determine compliance and a copy of the plan must be on file at the job site. If it is determined that the implemented plan is inadequate, this office may require the installation of additional measures and/or that the plan be revised to comply with state law;

   D. All revisions, including those required by other local, state or federal agencies, which affect site layout, drainage patterns, limits of disturbance and/or disturbed acreage must be submitted to this office for approval a minimum of 15 days prior to the start of construction;

   E. Revisions exceeding the approved scope of this project without prior approval of the plan showing the changes can be considered a violation. Failure to comply with any part of the approved plan or with any requirements of this program could result in appropriate legal action (civil or criminal) against the financially responsible party. Legal actions include Stop Work Orders and the assessing of a civil penalty of up to $5000 for the initial violation plus an additional penalty of up to $5000 per day for each day the site is out of compliance;

   F. The **CERTIFICATE OF PLAN APPROVAL must be posted** at the primary entrance to the job site and remain until the site is permanently stabilized;

   G. In cases of natural disaster related changes to the proposed land disturbing activity, all appropriate actions and adequate measure installations may be performed to prevent sediment damage, prior to submitting and receiving approval of the revised plan. A revised plan must be submitted for approval as soon as possible, but no later than 15 days after all emergency actions have been performed;

H. Erosion and sediment control measures or devices are to be installed to safely withstand the runoff resulting from a 10 year storm event - 6.5 - 7 inches in 24 hours or at the rate of 6.5 - 7 inches in 1 hour;

I. Unless the off-site borrow and/or disposal sites are identified in the erosion control plan, no earthen material is to be brought on or removed from the project site;

J. Buffer zone, sufficient to restrain visible sedimentation within the 25% of the width closest to the land disturbance, must be provided and maintained between the land-disturbing activity and any adjacent property or watercourse;

K. In order to comply with the intent of the Act, the scheduling of the land-disturbing activities is to be such that both the area of exposure and the time between the land disturbance and the providing of a ground cover is minimized;

L. Unless a temporary, manufactured, lining material has been specified, a clean straw mulch must be applied, at the minimum rate of 2 tons/acre, to all seeded areas. The mulch must cover at least 75% of the seeded area after it is either tacked, with an acceptable tacking material, or crimped in place;

M. New or affected cut or filled slopes must be at an angle that can be retained by vegetative cover, AND **must be provided with a ground cover** sufficient to restrain erosion **within 21 calendar days of completion of any phase (rough or final) of grading** (**ANNUAL RYE GRASS IS NOT** in the **APPROVED** seeding specifications **NOR** is it an **ACCEPTABLE** substitute for the providing of a temporary ground cover);

N. A **permanent ground cover**, sufficient restrain erosion, **must be provided** within the shorter of 15 working or 90 calendar days (if in a High Quality Zone, the shorter of 15 working or 60 calendar days) after completion of construction or development on any portion of the tract (**ANNUAL RYE GRASS IS NOT** in the **APPROVED** seeding specifications **NOR** is it an **ACCEPTABLE** substitute for the providing of a nurse cover for the permanent grass cover);

2. Adequate and appropriate measures must be properly installed downstream, within the limits of disturbance, of any land disturbing activity to prevent sediment from leaving the limits of disturbance, entering existing drainage systems, impacting an on-site natural watercourse or adjoining property.

3. Provide an overal site plan identifying the limits of disturbance associated with all existing SESC & mining permits and proposed permits.

PROJECT INFORMATION SHEET

APPROVAL DATE: February 18, 2010

RESPONSIBLE PARTY: Dare County

PROJECT NAME: C&D Landfill Cell #4

COUNTY: Dare NO.: DARE-2010-006

START-UP DATE: _____

CONTRACTOR: _____

ON-SITE CONTACT: _____

ON-SITE PHONE NO.: _____

OFFICE PHONE NO.: _____

ADDITIONAL INFORMATION REQUIRED

ADDITIONAL INFORMATION ENCLOSED (PLEASE CIRCLE) YES NO

COMPLETE & RETURN THIS FORM
PRIOR TO THE START OF CONSTRUCTION TO:

N.C.D.E.N.R.
LAND QUALITY SECTION
ATTN: *Robert Belvin, PE*
943 WASHINGTON SQUARE MALL
WASHINGTON, NORTH CAROLINA 27889

CDM

5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
tel: 919-325-3500
fax: 919-781-5730

January 15, 2010

Mr. Pat McClain, P.E.
North Carolina Department of Environment and Natural Resources
Land Quality Section
943 Washington Square Mall
Washington, N.C. 27889

Subject: Dare County
Dare County Construction and Demolition Debris Landfill Cell No. 4
Erosion and Sedimentation Control Permit Application

Dear Mr. McClain:

Please find enclosed two (2) sets of the Erosion and Sedimentation Control Permit Application for the above referenced project located off U.S. Highway 264 in Dare County. Also included with the application are project drawings and a completed Financial Responsibility and Ownership Form. A check is attached for the normal review permitting fee.

The proposed Phase No. 4 Construction and Demolition Debris (C&D) Landfill will include construction of a 11.3-acre C&D landfill, including access roads, stormwater controls, and a canal crossing.

If you have any questions or need additional information, please do not hesitate to call me at (919) 787-5620.

Very truly yours,

W. Michael Brinchek, P.E.
Project Manager
Camp Dresser & McKee

cc: Edward L. Mann, Dare County

CDM

Dare County, North Carolina

Dare County Construction and Demolition Debris Landfill

Phase No. 4 Expansion

Erosion and Sedimentation Control Permit Application

December 2009

Permit Application

Dare County

Dare County Construction and Demolition Landfill Phase No. 4

EROSION AND SEDIMENTATION CONTROL PLAN

NORTH CAROLINA PROFESSIONAL SEAL 026420 ENGINEER W. MICHAEL BRINCHEK

12/31/2009

CDM PN: 17952-56960

Prepared by

CDM
5400 Glenwood Avenue, Suite 300
Raleigh, North Carolina 27612
Firm Licensure: F-0412

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Appendix E Calculations

Appendix F NPDES Form

Section 1
Narrative

1.1 Site Description

The Dare County Construction and Demolition Debris Landfill is located in Dare County, North Carolina, west of US Highway 264 between Link Road and Cub Road. The intent of this permit is to obtain a sedimentation and erosion control plan and permit for the proposed Cell 4 Construction and Demolition Debris Landfill (C&D) expansion. This expansion will consist of an 11.3 acre soil lined cell that will receive construction and demolition debris. The proposed expansion is identical to the previously approved cell number 3 expansion that is currently in operation.

The approximate site location is shown on the USGS map provided in **Appendix A**. A site map of the facility is also included on **Sheet C-1** (See **Appendix C**). Topography within the site boundaries is characterized by flat areas at or near mean sea level.

1.2 Soils

The Dare County Soil Survey was used to evaluate the upper subsurface soils within the proposed site boundaries. The information for the Dare County Soil Survey, North Carolina was obtained from the National Resource Conservation Service (NRCS) and is attached in **Appendix B**.

1.3 Project Description

The area of disturbance is 18 acres and includes access roads; canal crossings; filter basins for stormwater management; and silt fence around the perimeter of the proposed cell for added erosion and sedimentation control.

The proposed Erosion and Sedimentation Control Measures are identified on **C-3** and details are presented on **Sheets D-1 and D-2** (See **Appendix C**). Supporting calculations are provided in the attached **Appendix E**.

The Financial Responsibility/Ownership Form for the project, including a copy of the Property Deed is provided in **Appendix D**.

Section 2
Planned Erosion and Sedimentation Control Practices

The location of the erosion and sedimentation control features described below are shown on the design drawings and details contained in **Appendix C.** In addition, the North Carolina Erosion and Sediment Control Planning and Design Manual is referred to in the project specifications. Calculations supporting the design are in **Appendix D**. The contractor shall be responsible for installing all erosion control devices prior to beginning any land disturbing activities and shall maintain all control devices until construction is completed and all disturbed areas are stabilized.

2.1 Surface Roughening - Practice 6.03

Any disturbed areas will be lightly roughened by disking just prior to vegetating. All construction slopes 3:1 or steeper will also be roughened. Surface stabilization will be accomplished with vegetation and mulch as specified in the vegetation plan.

2.2 Gravel Construction Entrance - Not Applicable

A temporary gravel construction entrance/exit will be not be required, because all construction and landfill operation traffic will enter/exit by the proposed entrance road located off Link Road (Gravel Road) or the haul road located off Cub Road (Gravel Road).

2.3 Temporary Seeding - Practice 6.10

Temporary seeding will be provided as described in Section 5.1 of the Vegetative Plan.

2.4 Permanent Seeding - Practice 6.11

Permanent seeding will be provided as described in Section 5.2 of the Vegetative

2.5 Mulching - Practice 6.14

Mulching will accompany both permanent and temporary seeding at a minimum and will be completed immediately following seeding.

2.6 Silt Fence - Practice 6.62

Silt fence will be installed as shown on **Sheet C-3**, until permanent vegetation is established. A silt fence detail has been provided on **Sheet D-1**.

2.7 Filter Basin

Filter basins will be installed at the low points of each existing drainage channel located on the east and west sides of the proposed Cell no. 4. These filter basins will be the primary treatment device used to capture and treat sediment laiden runoff.

Section 3
Construction Schedule

Erosion and sedimentation control will be completed to address the Dare County Construction and Demolition Debris Landfill Cell No. 4 Expansion construction.

1. Obtain erosion and sediment control permit approval and other applicable permits.

2. Hold preconstruction conference with NCDENR Land Quality Section at least one week prior to starting construction.

3. Notify permitting agency at (252)-946-6481 that approved the erosion and sediment control plan of the date that construction will begin.

4. Flag the limits of construction.

5. Clear the minimum amount of area necessary to install all silt fence as shown on the construction drawings.

6. Install erosion and sedimentation control measures as shown on the construction drawings.

8. Inspect all erosion and sediment control practices weekly and after each significant (1/2 inch or greater) rainfall event. Clean out sediment from silt fence when the depth of sediment reaches half of the allotted depth. Needed repairs will be made immediately.

9. Permanent ground cover shall be established within 15 working days or 90 calendar days after final grade is reached, whichever is shorter.

10. After site is stabilized, remove all temporary erosion control measures.

Section 4
Inspection and Maintenance Plan

Maintenance of the erosion and sedimentation control structures shall be performed throughout the final construction and during site stabilization. The maintenance activities will consist of the following:

1. All erosion and sediment control practices will be checked for stability and operation following every runoff-producing rainfall but at a minimum once per week and fill out NPDES form NCG010000 (**Appendix F**). Any needed repairs will be made immediately to maintain all practices as designed.

2. Sediment will be removed from behind the sediment fence when it reaches a height of 0.5 feet up the fence. The sediment fence will be repaired as necessary to provide adequate storage volume for the next rain event.

3. Sediment will be removed from filter basins and channels when it reaches ½ the design depth and upon completion of the work. Following cleaning activities all disturbed areas will be stabilized.

4. All seeded areas will be fertilized, re-seeded as necessary, and mulched according to specifications in the vegetative plan to maintain a vigorous, dense vegetative cover.

Section 5
Vegetative Plan

5.1 Temporary Seeding

Ground cover shall be established on exposed slopes within 21 calendar days following completion of any phase of grading. Temporary seeding shall be performed in accordance with the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual and as shown on the drawings.

5.2 Permanent Seeding

Areas to be stabilized with permanent vegetation must be seeded or planted within 15 working days or 90 calendar days after final grade is reached, unless temporary stabilization is applied. Permanent seeding shall be performed in accordance with the requirements of the North Carolina Erosion and Sediment Control Planning and Design Manual and as shown on the drawings.

Apply temporary erosion control matting over mulched areas on sloped surfaces greater than 4:1.

Section 6
Construction Specifications and Details

The erosion and sedimentation control measures will be constructed in accordance with the erosion and sedimentation control details in the Project Plans and Specifications and the *North Carolina Erosion and Sedimentation Control Planning and Design Manual.* These Specifications and Details are attached as follows:

Details

6.03 – Surface Roughening

6.10 – Temporary Seeding

6.11 – Permanent Seeding

6.14 – Mulching

6.62 – Sediment Fence

6.03

SURFACE ROUGHENING

Definition

Roughening a bare soil surface with horizontal grooves running across the slope, stair stepping, or tracking with construction equipment.

Purpose

To aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies

All construction slopes require surface roughening to facilitate stabilization with vegetation, particularly slopes steeper than 3:1.

Planning Considerations

Rough slope surfaces are preferred because they aid the establishment of vegetation, improve water infiltration, and decrease runoff velocity. Graded areas with smooth, hard surfaces may be initially attractive, but such surfaces increase the potential for erosion. A rough, loose soil surface gives a mulching effect that protects lime, fertilizer, and seed. Nicks in the surface are cooler and provide more favorable moisture conditions than hard, smooth surfaces; this aids seed germination.

There are different methods for achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving (Figure 6.03a), and tracking. Factors to be considered in choosing a method are slope steepness, mowing requirements, and whether the slope is formed by cutting or filling.

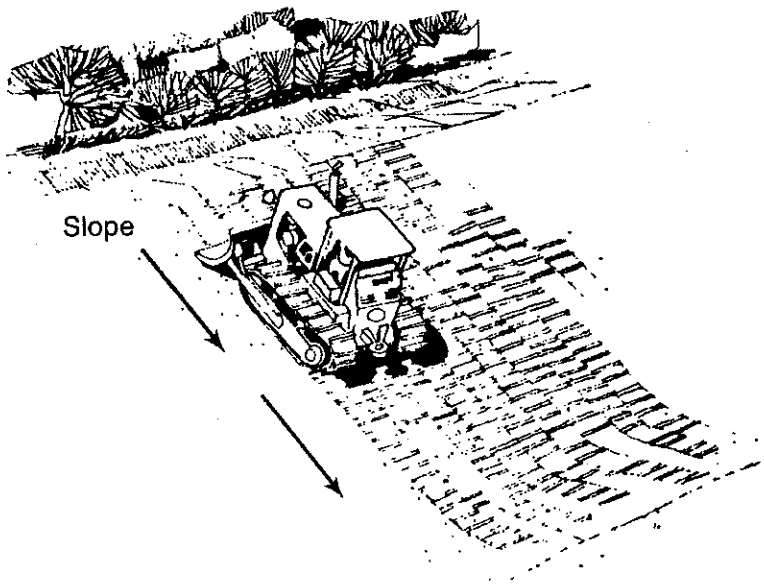


Figure 6.03a Bulldozer treads create grooves perpendicular to the slope. The slope face should not be back-bladed during the final grading operation (source: Va SWCC).

Design Criteria

No formal design is required.

Construction Specifications

CUT SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED
Stair-step grade or groove cut slopes with a gradient steeper than 3:1 (Figures 6.03b and 6.03c).

Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.

Do not make individual vertical cuts more than 2 feet in soft materials or more than 3 feet in rocky materials.

Grooving uses machinery to create a series of ridges and depressions that run across the slope (on the contour).

Groove using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. Do not make such grooves less than 3 inches deep nor more than 15 inches apart.

FILL SLOPE ROUGHENING FOR AREAS NOT TO BE MOWED
Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed 9 inches, and make sure each lift is properly compacted. Ensure that the face of the slope consists of loose, uncompacted fill 4 to 6 inches deep. Use grooving, as described above, to roughen the face of the slopes, if necessary.

Do not blade or scrape the final slope face.

CUTS, FILLS, AND GRADED AREAS THAT WILL BE MOWED
Make mowed slopes **no steeper than 3:1**.

Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use of cultipacker-seeder. Make the final pass of any such tillage implement on the contour.

Make grooves, formed by such implements, close together (less than 10 inches) and not less than 1 inch deep.

Excessive roughness is undesirable where mowing is planned.

ROUGHENING WITH TRACKED MACHINERY
Limit roughening with tracked machinery to sandy soils to avoid undue compaction of the soil surface. Tracking is generally not as effective as the other roughening methods described.

Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.

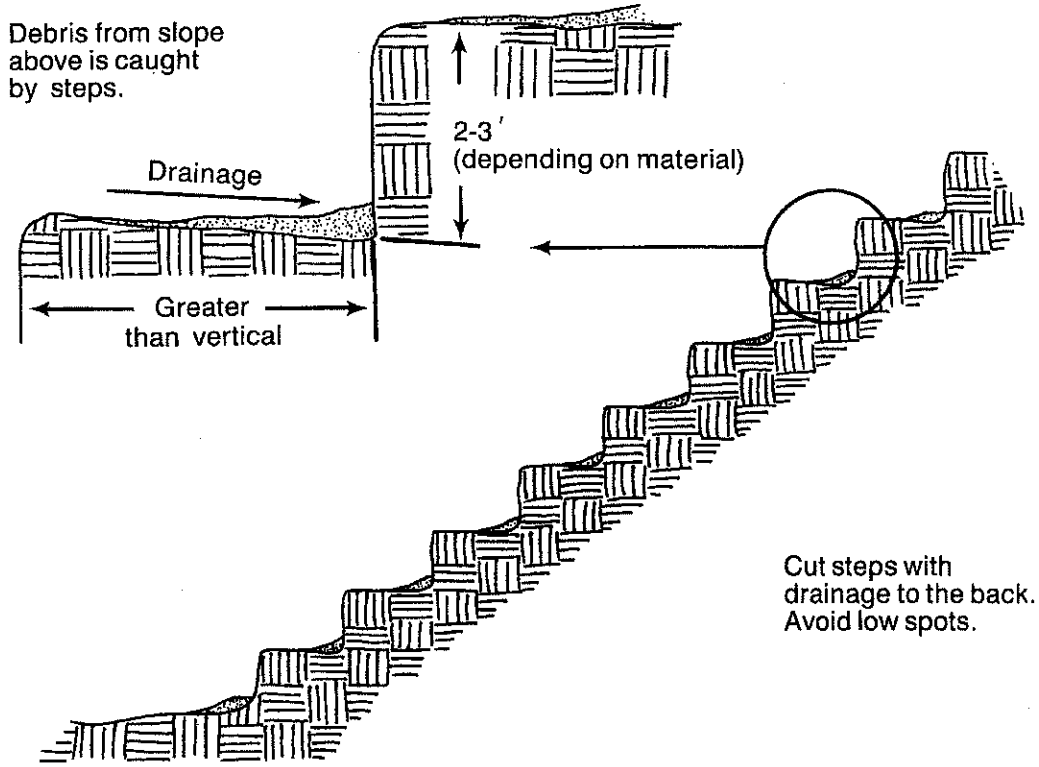


Figure 6.03b Stair stepping cut slopes (modified from Va SWCC).

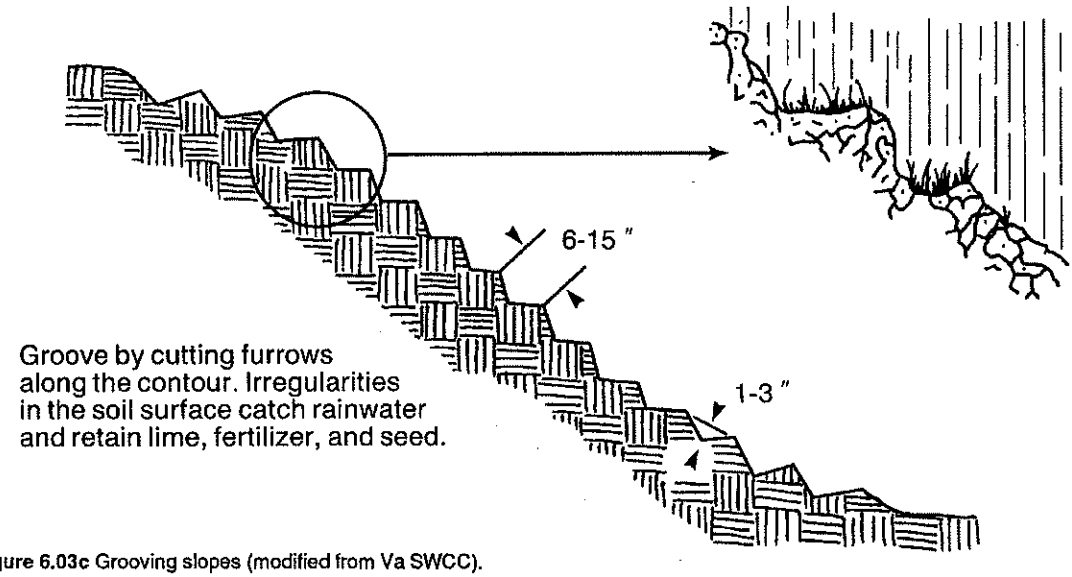


Figure 6.03c Grooving slopes (modified from Va SWCC).

Seeding—Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.

Maintenance

Periodically check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.

References

Surface Stabilization
6.10, Temporary Seeding
6.11, Permanent Seeding
6.14, Mulching

Chapter 3, Vegetative Considerations

6.10

TEMPORARY SEEDING

TS

Definition

Planting rapid-growing annual grasses, small grains, or legumes to provide initial, temporary cover for erosion control on disturbed areas.

Purpose

To temporarily stabilize denuded areas that will not be brought to final grade for a period of more than 21 calendar days.

Temporary seeding controls runoff and erosion until permanent vegetation or other erosion control measures can be established. In addition, it provides residue for soil protection and seedbed preparation, and reduces problems of mud and dust production from bare soil surfaces during construction.

Conditions Where Practice Applies

On any cleared, unvegetated, or sparsely vegetated soil surface where vegetative cover is needed for less than 1 year. Applications of this practice include diversions, dams, temporary sediment basins, temporary road banks, and topsoil stockpiles.

Planning Considerations

Annual plants, which sprout and grow rapidly and survive for only one season, are suitable for establishing initial or temporary vegetative cover. Temporary seeding preserves the integrity of earthen sediment control structures such as dikes, diversions, and the banks of dams and sediment basins. It can also reduce the amount of maintenance associated with these devices. For example, the frequency of sediment basin cleanouts will be reduced if watershed areas, outside the active construction zone, are stabilized.

Proper seedbed preparation, selection of appropriate species, and use of quality seed are as important in this Practice as in Practice 6.11, *Permanent Seeding*. Failure to follow established guidelines and recommendations carefully may result in an inadequate or short-lived stand of vegetation that will not control erosion.

Temporary seeding provides protection for no more than 1 year, during which time permanent stabilization should be initiated.

Specifications

Complete grading before preparing seedbeds, and install all necessary erosion control practices such as, dikes, waterways, and basins. Minimize steep slopes because they make seedbed preparation difficult and increase the erosion hazard. If soils become compacted during grading, loosen them to a depth of 6-8 inches using a ripper, harrow, or chisel plow.

SEEDBED PREPARATION

Good seedbed preparation is essential to successful plant establishment. A good seedbed is well-pulverized, loose, and uniform. Where hydroseeding methods are used, the surface may be left with a more irregular surface of large clods and stones.

Liming—Apply lime according to soil test recommendations. If the pH (acidity) of the soil is not known, an application of ground agricultural limestone at the

rate of 1 to 1 1/2 tons/acre on coarse-textured soils and 2-3 tons/acre on fine-textured soils is usually sufficient. Apply limestone uniformly and incorporate into the top 4-6 inches of soil. Soils with a pH of 6 or higher need not be limed.

Fertilizer—Base application rates on soil tests. When these are not possible, apply a 10-10-10 grade fertilizer at 700-1,000 lb/acre. Both fertilizer and lime should be incorporated into the top 4-6 inches of soil. If a hydraulic seeder is used, do not mix seed and fertilizer more than 30 minutes before application.

Surface roughening—If recent tillage operations have resulted in a loose surface, additional roughening may not be required, except to break up large clods. If rainfall causes the surface to become sealed or crusted, loosen it just prior to seeding by disking, raking, harrowing, or other suitable methods. Groove or furrow slopes steeper than 3:1 on the contour before seeding (Practice 6.03, *Surface Roughening*).

PLANT SELECTION

Select an appropriate species or species mixture from Table 6.10a for seeding in late winter and early spring, Table 6.10b for summer, and Table 6.10c for fall.

In the Mountains, December and January seedings have poor chances of success. When it is necessary to plant at these times, use recommendations for fall and a securely tacked mulch.

SEEDING

Evenly apply seed using a cyclone seeder (broadcast), drill, cultipacker seeder, or hydroseeder. Use seeding rates given in Tables 6.10a-6.10c. Broadcast seeding and hydroseeding are appropriate for steep slopes where equipment cannot be driven. Hand broadcasting is not recommended because of the difficulty in achieving a uniform distribution.

Small grains should be planted no more than 1 inch deep, and grasses and legumes no more than 1/2 inch. Broadcast seed must be covered by raking or chain dragging, and then lightly firmed with a roller or cultipacker. Hydroseeded mixtures should include a wood fiber (cellulose) mulch.

MULCHING

The use of an appropriate mulch will help ensure establishment under normal conditions, and is essential to seeding success under harsh site conditions (Practice 6.14, *Mulching*). Harsh site conditions include:

- seeding in fall for winter cover (wood fiber mulches are not considered adequate for this use),
- slopes steeper than 3:1,
- excessively hot or dry weather,
- adverse soils (shallow, rocky, or high in clay or sand), and
- areas receiving concentrated flow.

If the area to be mulched is subject to concentrated waterflow, as in channels, anchor mulch with netting (Practice 6.14, *Mulching*).

Maintenance

Reseed and mulch areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.

References

Site Preparation
6.03, Surface Roughening
6.04, Topsoiling

Surface Stabilization
6.11, Permanent Seeding
6.14, Mulching

Appendix
8.02, Vegetation Tables

Table 6.10a Temporary Seeding Recommendations for Late Winter and Early Spring

Seeding mixture

Species	Rate (lb/acre)
Rye (grain)	120
Annual lespedeza (Kobe in Piedmont and Coastal Plain, Korean in Mountains)	50

Omit annual lespedeza when duration of temporary cover is not to extend beyond June.

Seeding dates

Mountains—Above 2500 feet: Feb. 15 - May 15
Below 2500 feet: Feb. 1- May 1
Piedmont—Jan. 1 - May 1
Coastal Plain—Dec. 1 - Apr. 15

Soil amendments

Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer.

Mulch

Apply 4,000 lb/acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

Maintenance

Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

Table 6.10b Temporary Seeding Recommendations for Summer

Seeding mixture

Species	Rate (lb/acre)
German millet	40

In the Piedmont and Mountains, a small-stemmed Sudangrass may be substituted at a rate of 50 lb/acre.

Seeding dates
Mountains—May 15 - Aug. 15
Piedmont—May 1 - Aug. 15
Coastal Plain—Apr. 15 - Aug. 15

Soil amendments
Follow recommendations of soil tests or apply 2,000 lb/acre ground agricultural limestone and 750 lb/acre 10-10-10 fertilizer.

Mulch
Apply 4,000 lb/acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

Maintenance
Refertilize if growth is not fully adequate. Reseed, refertilize and mulch immediately following erosion or other damage.

Table 6.10c
Temporary Seeding Recommendations for Fall

Seeding mixture

Species	Rate (lb/acre)
Rye (grain)	120

Seeding dates
Mountains—Aug. 15 - Dec. 15
Coastal Plain and Piedmont—Aug. 15 - Dec. 30

Soil amendments
Follow soil tests or apply 2,000 lb/acre ground agricultural limestone and 1,000 lb/acre 10-10-10 fertilizer.

Mulch
Apply 4,000 lb/acre straw. Anchor straw by tacking with asphalt, netting, or a mulch anchoring tool. A disk with blades set nearly straight can be used as a mulch anchoring tool.

Maintenance
Repair and refertilize damaged areas immediately. Topdress with 50 lb/acre of nitrogen in March. If it is necessary to extent temporary cover beyond June 15, overseed with 50 lb/acre Kobe (Piedmont and Coastal Plain) or Korean (Mountains) lespedeza in late February or early March.

6.11

PERMANENT SEEDING

PS

Definition

Controlling runoff and erosion on disturbed areas by establishing perennial vegetative cover with seed.

Purpose

To reduce erosion and decrease sediment yield from disturbed areas, to permanently stabilize such areas in a manner that is economical, adapts to site conditions, and allows selection of the most appropriate plant materials.

Conditions Where Practice Applies

Fine-graded areas on which permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. Permanent seeding may also be used on rough-graded areas that will not be brought to final grade for a year or more.

Areas to be stabilized with permanent vegetation must be seeded or planted within 15 working days or 90 calendar days after final grade is reached, unless temporary stabilization is applied.

Introduction

During the initial phase of all land disturbing projects, the protective layer, either natural or man-made, is removed from the earth's surface. As the protective layer is removed, the resulting bare areas are exposed to the natural forces of rainfall, freezing, thawing, and wind. The result is soil erosion that leads to sediment pollution of North Carolina streams, rivers, lakes, and estuaries.

This design manual presents many alternative strategies for preventing erosion and reducing sediment loss during the construction process. Establishment of protective vegetative cover during the construction project, however, is the crucial step in achieving soil stabilization, controlling soil erosion, and preventing sedimentation of waterways. Without a sufficient amount of root mat and leaf cover to protect and hold the soil in place, large volumes of soil will be lost and waterways will be degraded long after projects are considered complete.

Sections of this practice standard address many of these various situations and set forth selection criteria for the appropriate cover based on purpose and adaptability. Some sediment and erosion control practices recommended in earlier editions of the manual may no longer be applicable. For example, many popular and commonly used seed and plant varieties have been identified as invasive. Invasive plants are defined as species that aggressively compete with, and displace, locally adapted native plant communities. In select cases where no practical alternative is available, these plants may be considered on a limited basis for soil stabilization, understanding that the goal is to eliminate the use of all invasive plants in favor of non-invasive native and/or introduced species that will provide an equally acceptable vegetative cover. Where there is no alternative to the use of invasive species, measures need to be incorporated in the installation and maintenance of these plants to limit their impacts.

It is imperative that disturbed soils be totally protected from erosion and sediment loss during construction and before a project is considered complete and acceptable. Installing appropriate vegetation in an immediate and timely fashion is the optimal means of achieving this stabilization. Vegetative specifications for most exposed soil conditions across North Carolina are provided in this section of the manual. It should be noted however, that no two sites in the State are exactly alike; therefore the protective vegetative cover for individual sites should be carefully selected. Each requires its own investigation, analysis, design and vegetative prescription as set forth in this section of the manual.

This practice standard describes three stages of vegetative cover; immediate, primary and long term. Effective and acceptable stabilization can be provided only when the optimum combination of immediate, primary, and long term vegetative practices are applied.

The vegetative measures presented in this chapter include application of seed, sod and sprigs. Use of field and container grown plants are not addressed in this manual. Planting of these types of vegetation is typically at spacing and intervals that will not provide the required protective cover. However, the design professional is encouraged to utilize these larger plants to compliment the required protective cover, particularly where these types of plants will provide seed for continued long term cover and wildlife habitat.

PLANNING CONSIDERATIONS

SOILS

Test and analyze the type(s) and quality of the existing soils on a site, their pH ranges, and their nutrient levels. Taking soil samples from the different areas of the project site and having them tested at a state or independent lab will provide a baseline for determining the pH modifiers and additional nutrients required for the selected plant varieties.

Disturbed conditions on a site may produce a variety of soil communities. Nutrient and pH levels in deeply cut soils will be quite different from those soils found on the original surface. When sites are highly disturbed through mechanical means such as grading, the soils become mixed together in many different ratios. These areas should be identified and tested.

Results from soil tests will usually include recommended application rates of soil modifiers such as lime and fertilizer for the selected plant species in the particular soils. Application rates will be itemized in the report.

The texture of the soil on a site, which is the proportion of sand, silt, and clay in the soil, is an important physical indicator of the site's ability to support vegetation. In heavy clay soils amendments may be necessary to provide an adequately drained planting medium. Conversely, in extremely sandy soils, amendments may be required to provide for moisture and nutrient retention.

Soil tests will indicate the texture of the given soil but will not provide recommendations for amendments that will improve the soil texture. Generally, the addition of organic materials will improve the porosity of heavy clay soils and improve the water holding capacity of extremely sandy soils. On sites where these different soil conditions exist, it is recommended that a design professional with experience in soil modification be employed to recommend the proper amendments.

For more information visit the NCDA Agronomic Services Soil Testing web page http://www.agr.state.nc.us/agronomic/sthome.htm

SOIL PREPARATION

Proper soil preparation is necessary for successful seed germination and root establishment. It is also necessary for establishment of rooted sprigs, sod and woody plants. Heavily compacted soils prevent air, nutrients and moisture from reaching roots thereby retarding or preventing plant growth. The success of site stabilization and reduction of future maintenance are dependent on an adequately prepared soil bed. Following are the requirements for preparation of areas to be vegetated by grassing, sprigging, sodding, and/or planting of woody plants:

General Requirements:

- Preparation for primary/permanent stabilization shall not begin until all construction and utility work within the preparation area is complete. However, it may be necessary to prepare for nurse crops prior to completion of construction and installation of utilities.

- A North Carolina Department of Agriculture Soils Test (or equal) shall be obtained for all areas to be seeded, sprigged, sodded or planted. Recommended fertilizer and pH adjusting products shall be incorporated into the prepared areas and backfill material per the test.

- All areas to be seeded or planted shall be tilled or ripped to a depth specified on the approved plans, construction sequence and/or construction bid list. Ripping consists of creating fissures in a criss-cross pattern over the entire surface area, utilizing an implement that will not glaze the side walls of the fissures. Site preparation that does not comply with these documents shall not be acceptable. The depth of soil preparation may be established as a range based on the approval of the reviewing state or local agency. Once tilled or ripped according to the approved plan, all areas are to be returned to the approved final grade. pH modifiers and/or other soil amendments specified in the soil tests can be added during the soil preparation procedure or as described below.

- All stones larger than three (3) inches on any side, sticks, roots, and other extraneous materials that surface during the bed preparation shall be removed.

Areas to be Seeded:

- Till or disc the prepared areas to be seeded to a minimum depth of four (4) inches. Remove stones larger than three (3) inches on any side, sticks, roots and other extraneous materials that surface. If not incorporated during the soil preparation process, add pH modifier and fertilizers at the rate specified in the soil test report.

- Re-compact the area utilizing a cultipacker roller. The finished grade shall be a smooth even soil surface with a loose, uniformly fine texture. All ridges and depressions shall be removed and filled to provide the approved surface drainage. Seeding of graded areas is to be done immediately after finished grades are obtained and seedbed preparation is completed.

Areas to be Sprigged, Sodded, and/or Planted:

- At the time of planting till or disc the prepared areas to a depth of four (4) to six (6) inches below the approved finished grade. Remove all stones larger than three (3) inches on any side, sticks, roots and other extraneous materials that surface. If not incorporated in the ripping process, add pH modifier, fertilizer, and other recommended soil amendments.

- Re-compact the area utilizing a cultipacker roller and prepare final grades as described above. Install sprigs, sod and plants as directed immediately after fine grading is complete. Mulch, mat and/or tack as specified.

VEGETATION

Availability of seed and plant materials is an important consideration of any construction stabilization effort. Throughout North Carolina, climate, economics, construction schedule delays and accelerations, and other factors present difficult challenges in specifying the different vegetation needed for site stabilization. To help resolve this issue, vegetative stabilization requires consideration in three categories:

- Immediate Stabilization – nurse crop varieties (Note: temporary mulching may be utilized for immediate stabilization if outlined on the approved plans and construction sequence.)

- Primary Stabilization – plant varieties providing cover up to 3 years with a specified maintenance program

- Long Term Stabilization – plant varieties providing protective cover with maintenance levels selected by the owner

An adequate job in one of these areas does not guarantee success in the later phases. Horticultural maintenance must be included in the plans.

Immediate vegetative cover will always require additional fertilization, soil amendments, soil tests, overseeding and/or other horticultural maintenance until primary vegetative cover is established.

Where provisions are made for regular maintenance, primary vegetative cover may be the end result. An example of primary vegetative cover being acceptable as an end use would be lawns in residential and commercial developments that are established, monitored and complimented with regular and approved horticultural maintenance practices. (See Example 6.11.a.)

In projects where continual maintenance will not be provided or scheduled following the primary stabilization of a project, long-term stabilization will be necessary. Maintenance of initial and long-term stabilization can cease only after the long-term cover has established and hardened to local climatic conditions. Maintenance of long-term vegetation must be included in the project construction sequence and on the approved plans. Examples of areas suitable for long term vegetation include roadsides, reforestation areas, restored flood plains, restored riparian areas, phased closing of landfills, and mining reclamations.

Complete stabilization requires using at least two, and most times, all three vegetative phases. The design professional must clearly communicate this point in their specifications, construction sequence, and in direct communications to owners and installers. The charts in tables 6.11.a through 6.11.d provide information to assist the design professional in this task. The tables are not inclusive and are presented only as alternatives. The professional is expected and required to provide design and specifications that combine the information in the manual with knowledge of the particular sites and their constraints.

pH AND NUTRIENT AMENDMENTS

Determining the nutrients that enable seed and container plants to grow, flourish, and become established after planting are critical elements of the design and stabilization process. The soils tests previously described will provide a recipe for amendments based on particular plants and particular soils. The test results will recommend the amounts of base elements (nitrogen, phosphorous, potassium), pH modifiers and other trace elements that should to be added to the soil for selected species of seeds and plants.

The acid/base characteristic of the soil is a primary component of soil fertility. If the soil acidity is not in the proper range, other nutrients will be ineffective, resulting in less productive plant growth. Most plants grow best in a pH range of 6.5 – 7.0 (slightly acidic to neutral). The soil tests will recommend the specific amendments and application rates required to achieve this range. These amendments must be incorporated into the soil (not applied on the surface) to be effective. (See the General Requirements for soil preparation specifications and timing for incorporation of soil amendments.)

The base elements are easily found in bulk quantities. Lime can also be obtained in large quantities. They all must be thoroughly incorporated into the soil through appropriate mechanical means. Ground surface applications without proper soil mixing will result in poor results.

In addition to the base fertilizers, other trace elements are needed to produce healthy and vigorous growth. These include but may not be limited to sulfur, manganese, zinc, boron, chlorine and molybdenum. If not already included with bulk mixes of the base elements, they can be obtained from commercial suppliers.

Provisions for soils test during and/or after initial grading is complete shall be included on the approved plan, in the approved construction sequence, and on the bid item list utilized for the project. *If you did not obtain a soil test:* Follow these recommendations for all grasses except centipedegrass.

1. Apply 75 pounds of ground limestone per 1,000 sq. ft.
2. Apply a starter type fertilizer (one that is high in phosphorus) based on the type of grass and planting method. Fertilizer bags have a three-number system indicating the primary nutrients, such as 8-8-8 or 5-10-10. These numbers denote the N-P-K ratio—the percentage of each nutrient in a fertilizer. The percentages are always noted in the following order:
N Nitrogen for green color and growth.
P_2O_5 Phosphorus for good establishment and rooting.
K_2O Potassium to enhance pest and environmental stress tolerance.

Some common examples of starter type fertilizers required for a 1,000 sq. ft. area include 40 pounds of 5-10-10, 20 pounds of 10-20-20, or 16 pounds of 18-24-6. For sandy soils, typical to coastal plain and sandhills of North Carolina, fertilizer rates should be increased by 20 percent.

Where available, it is recommended that the design professional specify organic compounds that meet the fertilization requirements, pH and other element requirements. Initial studies have indicated that these compounds have a more positive effect on the environment than some of the synthetic compounds used to manufacture inorganic fertilizers. These materials are readily available in the commercial trade as well as found in recycled yard waste debris, sewerage sludge, lime-stabilized sludge and animal manures. Materials proposed for use must be industry certified and/or privately tested and certified to be acceptable for proposed areas of use and application prior to approval.

MULCHES AND TACKING AGENTS

Mulches and tacking agents may be required or necessary to protect a seedbed's disturbed surface until the seed can germinate and provide the required protection from erosion. Selection of the materials used in this application should be based on their ability to hold moisture in the soil, as well as protect exposed soil from rainfall, storm water runoff, and wind. The availability of the selected material and the means to apply it are critical factors to consider when planning for the stabilization of any disturbed area. The mulch must cover a minimum of eighty (80) percent of the soil surface and must be secured by a tacking agent, crimping, or protective biodegradable netting. Netting that incorporates plastic mesh and/or plastic twine should not be used in wetlands, riparian buffers or floodplains due to the potential of small animal mortality. See Section 6.14 for detailed specifications and product applications.

SOIL BLANKETS

Soil blankets can be an acceptable and effective method of temporary sediment and erosion control in lieu of nurse crops. See Section 6.17 of the manual for descriptions of this product and how it can be used in conjunction with this section. In absence of mulches and tracking agents other means of protection may be necessary and required.

PROTECTIVE MATTING

Protective matting consists of an impervious cover secured to the soil surface in lieu of vegetative cover. It is used to protect and stabilize the surface where the process of seeding or planting forms of vegetation may cause more erosion and off-site sedimentation than application of the mat. It is also used where a disturbed area is intended to lay fallow for a period of time before additional construction or land disturbance takes place. If a pervious matting is selected, a combination of vegetation and matting is required. Seeds can be applied prior to installation of the matting only after proper seedbed preparation has been provided. Also, live stakes, dormant sprigs, and other vegetation forms can be inserted in the pervious matting once it has been installed. Pre-seeded pervious matting may be used for quicker root establishment and stabilization only if certified dating and germination guarantees are provided. The reviewing agency must approve all pre-seeded matting on site prior to installation. Matting that incorporates plastic mesh and/or plastic twine should not be used in wetlands, riparian buffers or floodplains due to the potential of small animal mortality. See Section 6.17 for detailed specifications and recommended product applications.

STABILIZATION IN WETLANDS, RIPARIAN BUFFERS, AND FLOODPLAINS

Land disturbing activity involving streams, wetlands or other waterbodies may also require permitting by the U.S. Army Corps of Engineers or the N.C. Division of Water Quality. Approval of an erosion and sedimentation control plan is conditioned upon the applicant's compliance with federal and State water quality laws, regulations, and rules. Additionally, a draft plan should be disapproved if implementation of the plan would result in a violation of rules adopted by the Environmental Management Commission to protect riparian buffers along surface waters. Care should be taken in selecting vegetative stabilization of wetlands and riparian buffers to comply with permitting requirements of other agencies, as well as provide adequate ground cover.

Planning Considerations for Land Disturbing Activities Within Wetland, Riparian, and Floodplain Areas

Wetlands, riparian areas, floodplains, and/or terrestrial areas between streams and uplands, serve to buffer surface water and provide habitat for aquatic and terrestrial flora and fauna. When cleared and disturbed, these sensitive areas are difficult to protect. Because of their proximity to water courses, relatively high ground water tables, and flooding potential, detailed analysis and design is necessary to determine the appropriate erosion control measures during construction. Determining the appropriate and most expeditious means of permanent vegetative stabilization in these areas requires equally detailed analysis and design. The following considerations for erosion control and stabilization should be taken into account during the design phase of the land disturbing project where sensitive areas are involved:

- Obtain soil tests to determine the soil type, pH, texture and available nutrients.
- Based on the soil tests provide a schedule of nutrients and other soil amendments that will be required.

- Select a seeding mix of non-invasive species that will provide immediate stabilization (a short-term environment that will support and compliment permanent vegetative stabilization) and include a selective native species mix that will eventually provide a permanent cover (a long-term environment that, with minimal maintenance, will provide adequate root and leaf cover).

- Invasive species are to be avoided. If native species and introduced non-invasive seed sources are not available, protective matting that will hold and foster the development of native cover from adjacent seed sources should be used. Continuous maintenance must be employed until the selected species have matured and are no longer susceptible to competition from invasive plants. If no alternative to the use of invasive seeds and plants is available, invasives approved on the plans may be utilized only with strict containment measures outlined in detail on the plans, in the construction sequence and in the maintenance specifications.

- A quickly germinating nurse crop of non-invasive, non-competitive annual grass species can be used along with native seeding and/or matting. These temporary systems should be planted at minimal density so that they do not inhibit the growth and establishment of the permanent, native species. (See the plant chart in Table 6.11.a for recommended native and nurse crop species.)

- Seed bed preparation is key to successful establishment of seeds. Particular care should be taken, however, when working in wetlands, riparian areas, or floodplains due to their sensitive nature. Careful consideration should be given to the types and placement of large equipment working in these areas. This process must be outlined in detail on the plan's construction sequence.

- Installation techniques vary and should be planned for accordingly.

- A maintenance plan must be established for optimal plant establishment, submitted with the plans and included in the bid list for the project.

Like all construction sites, wetlands, riparian areas, and floodplains will vary widely in physical makeup across North Carolina. Different conditions will dictate specific treatment, design and plant selection within the Mountains, Piedmont, and Coastal Plain regions. Soil tests, seedbed preparation, mulching, matting, and maintenance will be critical for successful vegetative establishment and long-term protection of these environmentally sensitive areas. Unavoidable impacts to these areas during land disturbing activities need to be addressed in detail on the plan sheets and construction sequence.

Native Seed and Plant Selection for Stabilization of Wetlands, Riparian Areas, and Floodplains

Upon the completion of the land disturbing activity, vegetative cover must be established on all areas not stabilized by other means. If work in these areas stops for more than 15 working days, temporary vegetative cover and/ or matting must be applied to all disturbed areas. The goal is to protect these areas from erosion and to prevent sedimentation of adjacent streams, wetlands, lakes, and other water bodies.

Planning considerations for wetlands, riparian areas and floodplains will require additional research, detail and specifications. Native grasses are usually required as a condition of a 401 Water Quality Certification or a trout buffer variance.

Native vegetative species are plant species that naturally occur in the region in which they evolved. These plants are adapted to local soil types and climatic variations. Because most native species do not germinate and establish as readily as some introduced species, it is necessary to provide a non-native nurse crop or matting to stabilize the soil until the native crop can become established as the dominant cover. Once established, the native plants will produce an extensive root structure that, if properly maintained, will stabilize soils and reduce erosive forces of rainfall and overland stormwater flow. Many of these plants also possess characteristics that, when established, allow them not only to survive, but also to thrive under local conditions.

Seeding a mixture of perennial native grasses, rushes, and sedges is a way to establish permanent ground cover within wetlands, riparian areas and floodplains. The use of propagated plants is another method of reestablishing natives in these environments. Selecting a seed mixture and/or propagated plants of different species with complimentary characteristics will provide vegetation to fill select niches on sites with varying physical conditions. The design professional should note that because most native species do not germinate and establish as readily as some introduced species, it is necessary to provide a non-native nurse crop or matting to stabilize the soil until the native crop can become established as the dominant cover. For additional information about acceptable nurse crop varieties, consult the planting list in Appendix 8.02, local seed and plant suppliers, the North Carolina Cooperative Extension Service or a qualified design professional to assure the proper selection and plant mix.

Permanent native seed species within the seed mixture should be selected based on natural occurrence of each species in the project site area. Climate, soils, topography, and aspect are major factors affecting the suitability of plants for a particular site and these factors vary widely across North Carolina, with the most significant contrasts occurring among the three major physiographic regions of the state – Mountains, Piedmont, and Coastal Plain. Sub-regions of the state should also be considered. For example, the Triassic Basin in the Piedmont region may have characteristics that call for special soil treatment, limited plant selection, and special maintenance. Even within the riparian area, there may be need for different species depending on site conditions (i.e., dry sandy alluvial floodplains with wet pockets). Therefore, thoughtful planning is required when selecting species for individual sites in order to maximize successful vegetation establishment.

Native seed and plant species are included on the plant list in Appendix 8.02 of this manual.

The design professional should note that regardless of the benefits and advantages of native seeds and plants, there are potential issues if proper planning, installation and maintenance do not occur. These may include:

- Potential for erosion or washout during the establishment stage;
- Seasonal limitation on suitable seeding dates and availability of seed and plants;
- Adaptability of species at specific sites;
- Availability of water and appropriate temperatures during germination and early growth; and
- Lack of maintenance to control invasive plants and undesirable competition.

PLANTING

- **Seed** – Prepare the seed bed as described above in soil preparation. Apply seed at rates specified on the plans, and/or as recommended in Tables 6.11a-c of this manual, with a cyclone seeder, prop type spreader, drill, or hydroseeder on and/or into the prepared bed. Incorporate the seed into the seed bed as specified. Provide finished grades as specified on the approved plan and carefully culti-pack the seedbed as terrain allows. If terrain does not allow for the use of a cultipacker, the approved plans and construction sequence must provide an alternative method of lightly compacting the soil. Mulch immediately.
- **Sprigs and Sod** – Install onto the prepared seed bed per the most current guidance in Carolina Lawns, NCSU Extension Bulletin AG-69, or Practice 6.12 *Sodding*.

- **Woody plants (liners, container, B&B)** – These materials are typically used to complement an herbaceous protective cover. They eventually are major components of long-term, permanent stabilization and should be chosen and planned in conjunction with immediate and long-term maintenance. The plants should be selected and specified by the design professional for each individual project. See Practice 6.13 *Trees, Shrubs, Vines, and Ground Covers.*

MAINTENANCE

The absence of or an incomplete landscape management specification and/ or complete maintenance schedule shall constitute grounds for disapproval of the plans. Proper maintenance is critical for the continued stabilization once vegetative cover is established. Although maintenance strategies for different sites may be similar, no two construction sites in North Carolina have been or will be able to be controlled or protected in identical ways. Variations in climate, topography, soils, available moisture, size and many other conditions will dictate the maintenance methodology to be used. A detailed schedule of maintenance will be required on the plans. This schedule will illustrate how the initial planting will be maintained to assure immediate, short term and permanent protection. The schedule will address topics such as appropriate irrigation of plants during the early establishment phase, drought conditions, excessive rainfall, mulch replacement, supplemental seeding, supplemental soils tests, application of nutrients and amendments, control of competitive and invasive species, disease and insect control, and corrective maintenance, measures to address failure of vegetation to become established. Contractual responsibility for maintenance after initial establishment of vegetative cover will be provided on the plans, in the construction sequence and on the bid list for the project. Maintenance bonds and/or warranty guarantee may be required of the responsible party, especially for areas in or adjacent to environmentally sensitive sites such as wetlands, riparian buffers, floodplains, and waters of the State. See Example 6.11a for a sample maintenance specification and a minimum maintenance check list that shall be provided on all plans.

RECOMMENDED BID LIST

(These items should be itemized on documents utilized to obtain pricing for planting pertaining to vegetative stabilization of land disturbing projects in North Carolina.)

- Soil test prior to grading (price per each test).
- Soil test during grading operations (price per each test).
- Soil test at completion of grading and/or prior to seeding, sprigging, sodding and application of fertilizer, lime, and other soil amendments (price per each test).
- Ripping/subsoiling to a depth of six (6) inches. (Provide an alternate for ripping to a depth greater than six (6) inches.) (price per acre)
- Tilling/discing ripped area to a depth of four (4) inches and re-compacting with a cultipacker roller (include in seeding price).

- Seeding (price per square foot).
- Mulching (price per square foot).
- Repair seeding (price per square foot).
- Repair mulching (price per square foot).
- Matting (price per square yard).
- Watering (price per thousand gallons).
- Mowing (price per square foot).

SEEDING RECOMMENDATIONS

The following tables list herbaceous plants recommended for use as nurse crops for immediate stabilization and primary crops for initial and long-term stabilization. Nurse crops are expected to develop in two to five weeks and, with adequate maintenance, be an effective method of soil stabilization for a period of six months to one year. Nurse crops are not effective as primary long-term cover, however if properly maintained they can be an adequate cover and protection for the development of primary crops.

The goal for a primary crop is for it to develop over a three-week to one-year period and be effective up to three years with a well-defined maintenance program. The long-term goal for a primary crop is the initial step toward a sustainable protective cover without the need of maintenance. Where the primary crop is intended for a managed lawn and landscape aesthetics, the effective period can be extended by a more intense maintenance program. Where native species are utilized and become established during the planned maintenance program, a permanent cover that will support future succession species should exist and require little or no additional maintenance or management.

In uses of both nurse and primary crops, the development periods listed on the tables are optimal based on normal climatic conditions for the planting dates listed. The sediment and erosion control maintenance program must recognize that optimum temperatures and rainfall are the exception rather than the rule. The design professional needs to provide flexibility in the stabilization plan to address the potential ranges of temperature and moisture conditions we experience in North Carolina.

Information is provided for seeding rates, optimum planting dates in the state's three regions, sun and shade tolerance, invasive characteristics, compatibility in wetlands and riparian buffers, and installation maintenance considerations. By going through the lists the design professional can select the nurse and primary seed varieties and maintenance characteristics they feel are best suited for their site conditions, vegetation management expertise and maintenance capabilities.

To use the information in the seeding charts the plan preparer must:

- Determine what nurse crop best fits their site, soil conditions, and permanent seed mix.
- Obtain soil tests for all areas to be seeded.
- Know the site's region: mountains, piedmont, or coastal plain.
- Know if the areas to be seeded are sunny, part shade, or full shade.
- Know if the areas are well or poorly drained.
- Know if wetlands or riparian buffers are included in the areas to be seeded.
- Know if a chosen crop is invasive and if so, what potential impacts it will have on the site and adjacent properties.

With this knowledge the plan preparation may proceed utilizing the charts provided to provide the several seed mixes that will be applicable to the different areas requiring stabilization.

HERBACEOUS PLANTS-Seeding recommendations for immediate stabilization/nurse crops

(2 to 5 weeks for development; effectiveness goal: 6 months to 1 year stabilization)

Table 6.11.a

NURSE CROP SPECIES

					Optimal Planting Dates								
Common Name	Botanical Name	Native / Introduced	Seeding Rates lbs/acre	Fertilization/ limestone lbs/acre	Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
Rye Grain	*Secale cereale*	I	40 lbs	By soil test	11/1 - 4/30	8/15 - 4/15	8/15 - 4/15	Sun	Yes	Yes	No	Must be mown to reduce competitiveness with permanent or long term vegetation	
Wheat	*Triticum aestivum*	I	30 lbs	By soil test	11/1 - 4/30	8/15 - 5/15	8/15 - 4/15	Sun	Yes	Yes	No	Must be mown to reduce competitiveness with permanent or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
German Millet	*Setaria italica*	I	10 lbs	By soil test	5/11 - 9/30	5/15 - 8/15	4/15 - 8/15	Sun	Yes	Yes	No	Crop should be cut / disc prior to planting primary or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
Browntop Millet	*Urochloa ramosa*	I	10 lbs	By soil test	5/11 - 9/30	5/15 - 8/15	4/15 - 8/15	Sun	Yes	Yes	No	Crop should be cut / disc prior to planting primary or long term vegetation	Not water tolerant. May be used in wetlands that are not continuously saturated.
Sudangrass (hybrids)	*Sorghum saccharatum* *S. bicolor ssp.Drummondi*	I	15 lbs	By soil test	NR	NR	4/15 - 8/15	Sun	No	No	Yes	Crop should be cut / disc prior to planting primary or long term vegetation	Use only where plants and seed can be contained and controlled.
Kobe Lespedeza	*Kummerowia striata v. kobe*	I	10 lbs	By soil test	5/1 - 9/1	5/1 - 9/1	5/1 - 9/1	Sun	No	No	No	Consult qualified horticulturalist or extension agent for over-seeding with primary cover	Use in Coastal Plain
Korean Lespedeza	*Kummerowia stipulacea*	I	10 lbs	By soil test	5/1 - 9/1	5/1 - 9/1	5/1 - 9/1	Sun	No	No	No	Consult qualified horticulturalist or extension agent for over-seeding with primary cover	Use in Piedmont and Mountains. May become invasive

NOTES:

1. Seeding rates are for hulled seed unless otherwise noted.
2. Fertilizer & Limestone - rates to be applied in absense of soils tests. Recommended application rate assumes significantly disturbed site soils with little or no residual value.
3. NR means Species not recommended for this region or application area.
4. Invasive designation as determined by the N.C. Exotic Pest Pant Council and N.C. Native Plant Society .
5. Sprigging is not recommended for immediate stabilization unless terrain is flat heavy mulch is applied and no other immediate stabilization method is practical.

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization

Successful development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

Table 6.11.b

NON-NATIVE SPECIES

					Optimal Planting Dates								
Common Name	Botanical Name / Cultivar	Native / Introduced	Broadcast Seeding Rates lbs/acre	Fertilization/ limestone lbs/acre	Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
Sericea Lespedeza	*Lespedeza cuneata Dumont'*	I	15 lbs	By soil test	9/1 - 6/1	9/1 - 5/1	10/1 - 4/1	Sun	NR	NR	Yes	Responds well to controlled burns	Severe Threat Invasive species
Crown Vetch	*Securigera varia (Coronilla varia)*	I	15 lbs	By soil test	3/15-4/30	NR	NR	Sun	NR	NR	Yes	Highly competitive, not recommended unless an acceptable alternative is not available.	Prefers neutral soils
Centipede Grass	*Eremochloa ophiuroi*	I	5 lbs 10 lbs. for road shoulders	By soil test	NR	Eastern only	9/1 - 5/1	Sun	NR	NR	No	Significant maintenance may be required to obtain desired cover	Does not tolerate high traffic. Acceptable for sodding
KY 31 Tall Fescue	*Schedonorus phoeni (Festuca arundinacea)*	I	100 lbs	By soil test	8/15-5/1	9/1-4/15	9/30 - 3/15	Sun / mod. Shade	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Acceptable for sodding
KY Blue Grass	*Poa pratensis*	I	15 lbs	By soil test	8/15-5/1	NR	NR	Sun	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Prefers neutral soils, highly competitive, not recommended unless an acceptable alternative is not available. Acceptable for sodding
Hard Fescue	*Festuca brevipila (Festuca longifolia)*	I	15 lbs	By soil test	8/1 - 6/1	NR	NR	Shade	NR	NR	No	Not recommended for slopes greater than 5%	Low growing, bunch grass
Bermuda Grass	*Cynodon dactylon*	I	25 lbs	By soil test	NR	4/15-6/30	4/15-6/30	Sun	NR	NR	Yes	If utilized, it is imperative that maintenance includes a containment plan	Extremely aggressive, not recommended and should be avoided unless an acceptable alternative is not available. May be sodded or sprigged

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization

Successfull development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

Table 6.11.c

NATIVE SPECIES

					Optimal Planting Dates								
Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11.d for variety seedling rates	Fertilization/ limestone lbs/acre	Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
Switchgrass	*Panicum virgatum / Cave-in-Rock*	N	A	By soil test	12/1-4/15	NR	NR	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Switchgrass	*Panicum virgatum / Blackwell*	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Switchgrass	*Panicum virgatum / Shelter*	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained only	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Switchgrass	*Panicum virgatum / Carthage*	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	Yes	Yes	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Switchgrass	*Panicum virgatum / Kanlow*	N	A	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	No	Poorly drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Switchgrass	*Panicum virgatum / Alamo*	N	A	By soil test	NR	12/1 - 5/1	1/1 - 5/1	Sun	No	Poorly drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Indiangrass	*Sorghastrum nutans / Rumsey*	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only
Indiangrass	*Sorghastrum nutans / Osage*	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization

Successfull development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

Table 6.11.c (con't)

NATIVE SPECIES

					Optimal Planting Dates								
Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11d for variety seedling rates	Fertilization/ limestone lbs/acre	Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
Indiangrass	*Sorghastrum nutans / Cheyenne*	N	B	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Western coastal plain only
Indiangrass	*Sorghastrum nutans / Lomenta*	N	B	By soil test	NR	12/1 - 5/1	1/1 -5/1	Sun	NR	Well drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Only Indiangrass adaptable to Eastern coastal plain (Zone 8)
Deertongue	*Dichanthelium clandestinum / Tioga*	N	C	By soil test	5/1-4/15	5/1 - 4/1	NR	Sun & Shade	Yes	Poorly drained to drought	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	
Big Bluestem	*Andropogon gerardii / Rountree*	N	D	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Welll drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass
Big Bluestem	*Andropogon gerardii / Kaw*	N	D	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Welll drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass
Big Bluestem	*Andropogon gerardii / Earl*	N	D	By soil test	12/1-4/15	12/1 - 4/1	12/1-5/1	Sun	NR	Welll drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass
Little Bluestem	*Schizachyrium scoparium / Aldous*	N	E	By soil test	12/1-4/15	NR	NR	Sun	NR	Welll drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass
Little Bluestem	*Schizachyrium scoparium / Cimmaron*	N	E	By soil test	12/1-4/15	12/1 - 4/1	NR	Sun	NR	Welll drained	No	Responds well to controlled burns. Mix with 3 to 5 other seed varieties that have similar soil drainage adaptations.	Warm season grass

HERBACEOUS PLANTS-Seeding recommendations for primary stabilization

Successfull development depends on planting date (effectiveness goal: 6 mo. - 3 yrs. without an ongoing maintenance program)

Table 6.11.c (con't)

NATIVE SPECIES

					Optimal Planting Dates								
Common Name	Botanical Name / Cultivar	Native / Introduced	See Table 6.11.d for variety seedling rates	Fertilization/ limestone lbs/acre	Mountains	Piedmont	Coastal Plains	Sun/Shade tolerant	Wetlands	Riparian Buffers	Invasive Yes or No	Installation / Maintenance Considerations	Other information, commentary
Little Bluestem	Schizachyrium	N	E	By soil test	NR	NR	12/1-4/1	Sun	NR	Well	No	Responds well to	Warm season grass
	scoparium / Common									drained		controlled burns. Mix with	
												3 to 5 other seed varieties	
												that have similar soil	
												drainage adaptations.	
Sweet Woodreed	Cinna arundinacea	N	F	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun &	Yes	Poorly to	No	Mix with 3 to 5 other seed	Warm season grass
								mod. Shade		well drained		varieties that have similar	
												soil drainage adaptations	
Rice Cutgrass	Leersia oryzoides	N	G	By soil test	12/1-4/15	12/1 - 4/1	12/1-4/1	Sun	Yes	Poorly	No	Mix with 3 to 5 other seed	Warm season grass
										drained		varieties that have similar	
												soil drainage adaptations	
Indian Woodoats	Chasmanthium latifolium	N	H	By soil test	3/1 - 5/15	2/15 - 4/1	2/15-3/20	Sun &	NR	Well	No	Mix with 3 to 5 other seed	Cool season grass
					7/15-8/15	8/15 - 10/15	9/1 - 11/1	mod. Shade		drained		varieties that have similar	
												soil drainage adaptations	
Virginia Wild Rye	Elymus virginicus	N	I	By soil test	3/1 - 5/15	2/15 - 4/1	2/15-3/20	Sun &	NR	Well	No	Mix with 3 to 5 other seed	Cool season grass
					7/15-8/15	8/15 - 10/15	9/1 - 11/1	mod. Shade		drained		varieties that have similar	
												soil drainage adaptations	
Eastern Bottlebrush	Elymus hystrix	N	J	By soil test	3/1 - 5/15	2/15 - 4/1	NR	Sun &	NR	Well	No	Mix with 3 to 5 other seed	Cool season grass
Grass					7/15-8/15	8/15 - 10/15		mod. Shade		drained		varieties that have similar	
												soil drainage adaptations	
Soft Rush	Juncus effusus	N	K	By soil test	12/1 - 5/15	12/1 - 5/1	12/1-4/15	Sun	Yes	Poorly	No	Mix with 3 to 5 other seed	
					8/15-10/15	9/1 - 11/1				drained		varieties that have similar	
												soil drainage adaptations	
Shallow Sedge	Carex lurida	N	L	By soil test	12/1 - 5/15	12/1 - 5/1	12/1-4/15	Sun	Yes	Poorly	No	Mix with 3 to 5 other seed	
					8/15-10/15	9/1 - 11/1				drained		varieties that have similar	
												soil drainage adaptations	
Fox Sedge	Carex vulpinoidea	N	L	By soil test	12/1 - 5/15	12/1 - 5/1	12/1-4/15	Sun	Yes	Poorly	No	Mix with 3 to 5 other seed	
					8/15-10/15	9/1 - 11/1				drained		varieties that have similar	
												soil drainage adaptations	

NOTE:

1. Seeding rates are for hulled seed unless otherwise noted.
2. Fertilizer & Limestone - rates to be applied in absense of soils tests. Recommended application rate assumes significantly disturbed site soils with little or no residual value.
3. NR means Species not recommended for this region or application area.
4. Native, warm season grasses require six or more months to germinate under optimum conditions. If they are planted in the summer, then a whole year will have to pass before they germinate.
5. Invasive designation as determined by the N.C. Exotic Pest Pant Council and N.C. Native Plant Society .
6. Sprigging is not recommended for immediate stabilization unless terrain is flat, heavymulch is applied and no other immediate stabilization method is practical.
7. Sodding for immediate stabilization - see primary stabilization charts (other information column) and Section 6.12.
8. Long term stabilization can only be accomplished with an adequate, immediate, and primary stabilization program. To achieve long term protective cover with the species listed in

Table 6.11.d

Seed Mixes for Native Species (lbs/ac)
When Mixed with 3, 4, or 5 Other Native Species
(See Table 6.11.a for nurse crop species to be added to these mixes)

	3 Other (total 4 species)	4 Other (total 5 species)	5 Other (total 6 species)
Switch Grasses (A)	3.5 lbs.	3.0 lbs.	2.5 lbs.
Indian Grasses (B)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Deertongue (C)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Big Bluestem (D)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Little Bluestem (E)	7.0 lbs.	6.0 lbs.	5.0 lbs.
Sweet Woodreed (F)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Rice Cutgrass (G)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Indian Woodoats (H)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Virginia Wild Rye (I)	6.0 lbs.	5.0 lbs.	4.0 lbs.
Eastern Bottlebrush Grass (J)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Soft Rush (K)	2.5 lbs.	2.0 lbs.	1.5 lbs.
Sedges (L)	2.5 lbs.	2.0 lbs.	1.5 lbs.

NOTE:
With the native varieties, the seed mix should be in the range of 15 pounds per acre. Depending on availability of native seeds adaptable to North Carolina, the percentage of a particular variety used may be reduced or increased accordingly. Although diversity is desirable, it is imperative that the primary crop develop and become an effective protective cover. In addition to the native species mix, additional nurse crop species must be included to provide immediate stabilization and an adequate ground cover.

Example 6.11.a GUIDELINES FOR WRITING MINIMUM LANDSCAPE MANAGEMENT SPECIFICATIONS

Following is an outline that demonstrates what should be included in specifications that will insure the long term stabilization of disturbed sites in North Carolina. As noted before in this manual, each construction site in the state is unique and has features that will require special provisions for revegetation and stabilization. The outline provided below cannot address these individual sites. It is the responsibility of the design professional and the financially responsible party to see that the specifications are edited to fit their site and to assure that permanent stabilization is achieved.

General Provisions

A. Intent:

1. These specifications are prepared with the intent of promoting outstanding performance in long-term stabilization. They are to be used as guidelines in establishing sediment control and vegetative standards for the sites. Final technical decisions such as herbicides, fertilizer ratios, times of application and schedules are to be determined by the Contractor, who has the responsibility to obtain soil test and to manage the vegetation to achieve the desired results. The maintenance specifications must address maintenance for sediment and erosion control vegetation during construction and for permanent/long-term stabilization.

B. Description of Work:

1. Perform all work necessary and required for the (insert period of contract) maintenance of the project as indicated on the drawings, in the project manual, and specified herein.

2. Licensing:

a) Contractor shall provide verification of current, applicable pesticide applicator licensing for each applicator that will handle pesticides on the contracted sites.

3. Contract Administration

a) Staffing: The Contractor shall provide adequate staffing, with the appropriate expertise, to perform all required work.

b) Monthly Site Review meetings will be held. Attendees will include the Contractor's Project Manager and Site Foreman and the property manager or other representative designated by the financially responsible party. Result of site reviews will be documented and circulated to the attendees and the owner by the contractor.

c) The Contractor will communicate with the proper person on a monthly basis to summarize work performed and immediately notify the project manager of any failure of the site to remain stabilized.

II. Materials

A. Soil Additives: Additives are to be applied per soils test taken prior to, during and after construction. **(Use this section to provide the types and quantities of fertilizers, lime, and other soil amendments called for in the soils report. Include all soils test reports in the specifications document. This narrative or list should include quantities, rates, mixes, organic information, manufacturer, sources, and other information suggested in the soils test.)**

A. Pesticides:

1. Establish an Integrated Pest Management (IPM) program for the site that relies on targeted insect and disease control coupled with sound stabilization management and water management practices.

2. These specifications do not include pesticide treatments for infestations of Southern Pine Beetle, Gypsy Moth, or Fire Ants. The contractor shall notify the Owner if these pests are observed on site.

3. All pesticides shall be applied by a North Carolina licensed applicator in accordance with all State and Federal regulations and per manufacturer's recommendations.

B. Mulches: Mulch for areas not subject to erosion and over wash by storm water should be called out in this section addressing its maintenance, replacement, removal and conversion to other uses. Those subject to erosion and over wash by storm water must be addressed on the plans and in the calculations.

III. Execution

A. General:

1. Good long term stabilization is based on the proper maintenance, management and balance of nutrients, soil moisture and general cultural practices. It is recognized that fewer fungicide and pesticide treatments as well as lower fertility rates are required with a well managed, balanced landscape. The following section is meant to promote this balance and therefore do not highlight specific quantitative standards. **(Quantitative standards should be addressed as site specific by the design professional in conjunction with the owner and contractor.)** Calendar references are general and are to be used only as a guide. Weather and soil conditions that are most appropriate for a given process, procedure and/or area of the state shall be the determining factor in scheduling work.

B. Soil Tests:

1. After the soil test prior to stabilization, tests shall be made yearly in the fall to determine the required soil additives for all stabilized areas. If known nitrogen requirements are not specified by previous test, they need to be determined by the subsequent soils test and the proper applications made. Fertilizer ratios may be determined through analysis of the soil tests coupled with the contractor's experience and knowledge of the site.

C. Mowing

1. Mowing for maintained turf/lawns

a. Mow areas intended for "groomed appearance" on a schedule during the growing season and as required throughout the year to provide the desired appearance. **(Establish a mowing frequency here that addresses the specific plant species used and their growing habits.)** This frequency will be a minimum standard. Particular properties and their peculiar characteristics as well as individual plant species may require mowing more often than the stated minimum may be required. This should be noted in this section.

b. The range of turf species suggested for lawns in the three growing regions of North Carolina vary as to optimum maintained height. The selected species should be maintained at a height recommended by the seed producer. Do not cut too short and do not allow the turf to attain a height that will cause the crop to decline or die. Consult individual seed producers and/or packaging for recommended mowing heights.

c. Mow with a mulching mower to limit the amount of clippings removed, or mow and blow in such a manner that clippings are not evident and not to adversely effect the growing capacity

and/or health of the existing vegetation turf. It is important clippings are allowed to remain spread throughout the lawn area, to the extent possible, so that they might aid in building a more productive soil profile and root zone.

2. Mowing other stabilized areas to promote continued growth. Include mowing specification here for other stabilized areas which require maintenance but not a "groomed" appearance. Also include specifications for mowing areas where it is desirable for woody native volunteer vegetation to become established. This should include attention to mowing stakes or other way of protecting the desired woody natives from the mowing operation.

D. Watering

1. Irrigation System Maintenance and Monitoring: If stabilized areas are to be irrigated the design professional should include specifications for the system, its maintenance and its operation in this section.

2. In the absence of an automatic or manual irrigation system, provisions for providing adequate water to stabilized areas should be addressed in this section.

3. **(Provisions should be made in this section for adjustments to application rates of water during times of regulated droughts and/or periods of excessive rainfall.)**

E. CONTROL OF INVASIVES: Competition from invasive species can be detrimental to the establishment of the permanent vegetative cover. Left unchecked, these invasives can undermine a revegetation process in a short period of time and eventually lead to unprotected soil and sediment damage. Make site observations monthly to check for the presence of such species and, if found, treat them immediately with the appropriate cultural practices and/or by the use of seasonally-appropriate and site appropriate herbicides.

F. Maintenance items including fertilization, mowing, continued soils testing, repair, mulching, matting and soil preparation are to be addressed in the approved construction sequence and on the project bid list.

6.14

MULCHING

M

Definition

Application of a protective blanket of straw or other plant residue, gravel, or synthetic material to the soil surface.

Purpose

To protect the soil surface from the forces of raindrop impact and overland flow. Mulch fosters the growth of vegetation, reduces evaporation, insulates the soil, and suppresses weed growth. Mulch is frequently used to accent landscape plantings.

Conditions Where Practice Applies

Mulch temporary or permanent seedings immediately. Areas that cannot be seeded because of the season should be mulched to provide temporary protection of the soil surface. Use an organic mulch in this case (but not wood fiber), and seed the area as soon as possible. Mulch around plantings of trees, shrubs, or ground covers to stabilize the soil between plants.

Planning Considerations

A surface mulch is the most effective, practical means of controlling runoff and erosion on disturbed land prior to vegetation establishment. Mulch reduces soil moisture loss by evaporation, prevents crusting and sealing of the soil surface, moderates soil temperatures, provides a suitable microclimate for seed germination, and may increase the infiltration rate of the soil.

Organic mulches such as straw, wood chips, and shredded bark have been found to be the most effective. Do not use materials which may be sources of competing weed and grass seeds. Decomposition of some wood products can tie up significant amounts of soil nitrogen, making it necessary to modify fertilization rates, or add fertilizer with the mulch (Table 6.14a).

A variety of mats and fabrics have been developed in recent years for use as mulch, particularly in critical areas such as waterways and channels. Various types of netting materials are also available to anchor organic mulches.

Chemical soil stabilizers or soil binders, when used alone, are less effective than other types of mulches. These products are primarily useful for tacking wood fiber mulches.

The choice of materials for mulching should be based on soil conditions, season, type of vegetation, and size of the area. A properly applied and tacked mulch is always beneficial. It is especially important when conditions for germination are not optimum, such as midsummer and early winter, and on difficult areas such as cut slopes and slopes with southern exposures.

ORGANIC MULCHES

Straw is the mulch most commonly used in conjunction with seeding. The straw should come from wheat or oats ("small grains"), and may be spread by hand or with a mulch blower. Straw may be lost to wind, and must be tacked down.

Wood chips are suitable for areas that will not be closely mowed, and around ornamental plantings. Chips do not require tacking. Because they decompose slowly, they must be treated with 12 pounds of nitrogen per ton to prevent

Table 6.14a
Mulching Materials and Application Rates

Material	Rate Per Acre	Quality	Notes
Organic Mulches			
Straw	1-2 tons	Dry, unchopped, unweathered; avoid weeds.	Should come from wheat or oats; spread by hand or machine; must be tacked down.
Wood chips	5-6 tons	Air dry	Treat with 12 lbs nitrogen/ton. Apply with mulch blower, chip handler, or by hand. Not for use in fine turf.
Wood fiber	0.5-1 tons		Also referred to as wood cellulose. May be hydroseeded. Do not use in hot, dry weather.
Bark	35 cubic yards	Air dry, shredded or hammer-milled, or chips.	Apply with mulch blower, chip handler, or by hand. Do not use asphalt tack.
Corn stalks	4-6 tons	Cut or shredded in 4-6 in. lengths.	Apply with mulch blower or by hand. Not for use in fine turf.
Sericea lespedeza seed-bearing stems	1-3 tons	Green or dry; should contain mature seed.	
Nets and Mats[1]			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn.	Withstands waterflow. Best when used with organic mulch.
Fiberglass net	Cover area		Withstands waterflow. Best when used with organic mulch.
Excelsior (wood fiber) mat	Cover area		Withstands waterflow.
Fiberglass roving	0.5-1 tons	Continuous fibers of drawn glass bound together with a non-toxic agent.	Apply with a compressed air ejector. Tack with emulsified asphalt at a rate of 25-35 gal/1,000 sq ft.
Chemical Stabilizers[2]			
Aquatain Aerospray Curasol AK Petroset SB Terra Tack Crust 500 Genaqua 743 M-145	follow manufacturer's specifications		Not beneficial to plant growth.

[1]Refer to Practice No. 6.30, *Grass Lined Channels.*

[2]Use of trade names does not imply endorsement of product.

nutrient deficiency in plants. This can be an inexpensive mulch if chips are obtained from trees cleared on the site.

Bark chips and shredded bark are by-products of timber processing often used in landscape plantings. Bark is also a suitable mulch for areas planted to grasses and not closely mowed. It may be applied by hand or with a mulch blower. Unlike wood chips, the use of bark does not require additional nitrogen fertilizer.

Wood fiber refers to short cellulose fibers applied as a slurry in hydroseeding operations. Wood fiber does not require tacking, although tacking agents or soil binders can easily be added to the slurry. Wood fiber hydroseeder slurries may be used to tack straw mulch on steep slopes, critical areas, and where harsh climatic conditions exist. **Wood fiber mulch does not provide sufficient erosion protection to be used alone.**

There are other organic materials that make excellent mulches, but may only be available locally or seasonally, for example: dried sewage sludge, corn stalks, animal manure, pine boughs, cotton burs, peanut hulls, and hay. Creative use of these materials can reduce costs.

CHEMICAL MULCHES AND SOIL BINDERS

A wide range of synthetic mulching compounds is available to stabilize and protect the soil surface. These include emulsions or dispersions of vinyl compounds, asphalt, or rubber mixed with water. They may be used alone, or may be used to tack wood fiber hydromulches.

When used alone, chemical mulches do not insulate the soil or retain moisture, and therefore do little to aid seedling establishment. They are easily damaged by traffic, are usually more expensive than organic mulches, and they decompose in 60-90 days.

Check labels on chemical mulches and binders for environmental concerns. Take precautions to avoid damage to fish, wildlife, and water resources.

NETS, MATS, AND ROVING

Netting is very effective in holding mulch in place on waterways and slopes before grasses become established.

Mats promote seedling growth in the same way as organic mulches. They are very useful in establishing grass in channels and waterways. A wide variety of synthetic and organic materials are available. "Excelsior" is a wood fiber mat, and should not be confused with wood fiber slurry.

When installing nets and mats, it is critical to obtain a firm, continuous contact between the material and the soil. Without such contact, the material is useless, and erosion will occur underneath.

Fiberglass roving consists of continuous strands of fiberglass which, when blown onto the soil surface from a special compressed air ejector, form a mat of glass fibers. This mat must then be tacked down with asphalt.

Select a material based on site and practice requirements, availability of material, labor, and equipment. Table 6.14a lists commonly used mulches and some alternatives.

Before mulching, complete the required grading, install sediment control practices, and prepare the seedbed. Apply seed before mulching **except** in the following cases:

- Seed is applied as part of a hydroseeder slurry containing wood fiber mulch.
- A hydroseeder slurry is applied over straw.

APPLICATION OF ORGANIC MULCH

Organic mulches are effective where they can be tacked securely to the surface. Material and specifications are given in Table 6.14a.

Spread mulch uniformly by hand, or with a mulch blower. When spreading straw mulch by hand, divide the area to be mulched into sections of approximately 1,000 ft^2, and place 70-90 lb of straw (1 1/2 to 2 bales) in each section to facilitate uniform distribution. After spreading mulch, no more than 25% of the ground surface should be visible. In hydroseeding operations a green dye, added to the slurry, assures a uniform application.

ANCHORING ORGANIC MULCH

Straw mulch must be anchored immediately after spreading. The following methods of anchoring mulch may be used:

Mulch anchoring tool—A tractor-drawn implement designed to punch mulch into the soil, a mulch anchoring tool provides maximum erosion control with straw. A regular farm disk, weighted and set nearly straight, may substitute, but will not do a job comparable to the mulch anchoring tool. The disk should not be sharp enough to cut the straw. These methods are limited to slopes no steeper than 3:1, where equipment can operate safely. Operate machinery on the contour.

Liquid mulch binders—Application of liquid mulch binders and tackifiers should be heaviest at the edges of areas and at crests of ridges and banks, to resist wind. Binder should be applied uniformly to the rest of the area. Binders may be applied after mulch is spread, or may be sprayed into the mulch as it is being blown onto the soil. Applying straw and binder together is the most effective method. Liquid binders include asphalt and an array of commercially available synthetic binders.

Emulsified asphalt is the most commonly used mulch binder. Any type thin enough to be blown from spray equipment is satisfactory. Asphalt is classified according to the time it takes to cure. Rapid setting (RS or CRS designation) is formulated for curing in less than 24 hours, even during periods of high humidity; it is best used in spring and fall. Medium setting (MS or CMS) is formulated for curing within 24 to 48 hours, and slow setting (SS or CSS) is formulated for use during hot, dry weather, requiring 48 hours or more curing time.

Apply asphalt at 0.10 gallons per square yard (10 gal/1,000 ft^2). Heavier applications cause straw to "perch" over rills.

In traffic areas, uncured asphalt can be picked up on shoes and cause damage to rugs, clothing etc. Use types RS or CRS to minimize such problems.

Synthetic binders such as Petroset, Terratack, and Aerospray may be used, as recommended by the manufacturer, to anchor mulch. These are expensive, and therefore usually used in small areas or in residential areas where asphalt may be a problem (Use of trade names does not constitute an endorsement).

Mulch nettings—Lightweight plastic, cotton, jute, wire, or paper nets may be stapled over the mulch according to the manufacturer's recommendations (see "Nets and Mats" below).

Peg and twine—Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8-10 inch wooden pegs to within 3 inches of the soil surface, every 4 feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross-within-a-square pattern. Turn twine two or more times around each peg. Twine may be tightened over the mulch by driving pegs further into the ground.

Vegetation—Rye (grain) may be used to anchor mulch in fall plantings, and German millet in spring. Broadcast at 15 lb/acre before applying mulch.

CHEMICAL MULCHES

Chemical mulches may be effective for soil stabilization if used between May 1 and June 15, or Sept. 15 and Oct. 15, provided that they are used on slopes **no steeper** than 4:1, and that proper seedbed preparation has been accomplished, including surface roughening where required.

Chemical mulches may be used to bind other mulches, or with wood fiber in a hydroseeded slurry at any time. Follow the manufacturer's recommendations for application.

FIBERGLASS ROVING

Fiberglass roving ("roving") is wound into a cylindrical package so that it can be continuously withdrawn from the center using a compressed air ejector. Roving expands into a mat of glass fibers as it contacts the soil surface. It is often used over a straw mulch, but must still be tacked with asphalt.

Spread roving uniformly over the area at a rate of 0.25 to 0.35 lb/yd^2. Anchor with asphalt immediately after application, at a rate of 0.25 to 0.35 gal/yd^2.

As a channel lining, and at other sites of concentrated flow, the roving mat must be further anchored to prevent undermining. It may be secured with stakes placed at intervals no greater than 10 feet along the drainageway, and randomly throughout its width, but not more than 10 feet apart. As an option to staking, the roving can be buried to a depth of 5 inches at the upgrade end and at intervals of 50 feet along the length of the channel.

NETS AND MATS

Nets alone generally provide little moisture conservation benefits and only

limited erosion protection. Therefore, they are usually used in conjunction with an organic mulch such as straw.

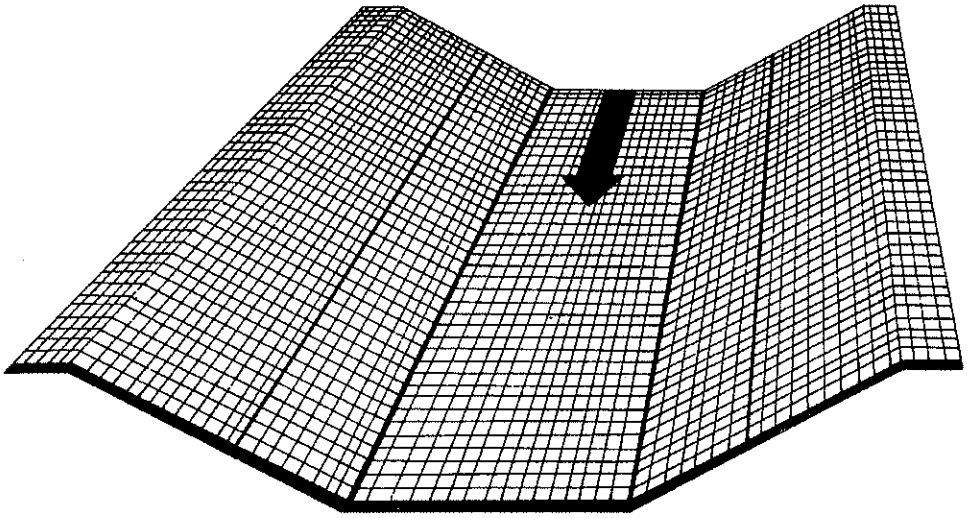
Except when wood fiber slurry is used, netting should always be installed **over** the mulch. Wood fiber may be sprayed on top of an installed net.

Mats, including "excelsior" (wood fiber) blankets, are considered protective mulches and may be used alone, on erodible soils, and during all times of the year. Place the matting in firm contact with the soil, and staple securely.

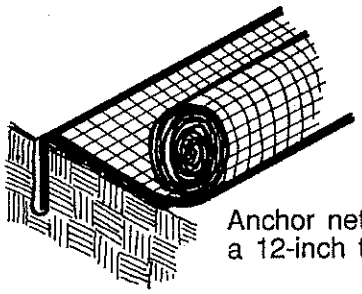
INSTALLATION OF NETTING AND MATTING

Products designed to control erosion should be installed in accordance with manufacturer's instructions. Any mat or blanket-type product used as a protective mulch should provide cover of at least 30% of the surface where it is applied. Installation is illustrated in Figure 6.14a.

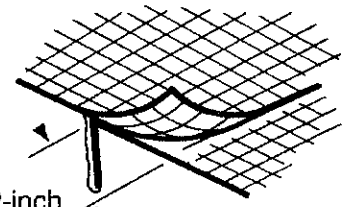
1. Apply lime, fertilizer, and seed **before** laying the net or mat.



In channels, roll out strips of netting parallel to the direction of flow and over the protective mulch.



Anchor netting in a 12-inch trench



12-inch overlap

Join strips by anchoring and overlapping.

Figure 6.14a Installation of netting and matting (modified from Va. Div. of Forestry).

2. Start laying the net from the top of the channel or slope, and unroll it down the grade. **Allow netting to lay loosely on the soil or mulch cover but without wrinkles—do not stretch.**

3. To secure the net, bury the upslope end in a slot or trench no less than 6 inches deep, cover with soil, and tamp firmly as shown in Figure 6.14a. Staple the net every 12 inches across the top end and every 3 ft around the edges and bottom. Where 2 strips of net are laid side by side, the adjacent edges should be overlapped 3 inches and stapled together. Each strip of netting should also be stapled down the center, every 3 ft. **Do not stretch the net when applying staples.**

4. To join two strips, cut a trench to anchor the end of the new net. Overlap the end of the previous roll 18 inches, as shown in Figure 6.14a, and staple every 12 inches just below the anchor slot.

Maintenance

Inspect all mulches periodically, and after rainstorms to check for rill erosion, dislocation or failure. Where erosion is observed, apply additional mulch. If washout occurs, repair the slope grade, reseed and reinstall mulch. Continue inspections until vegetation is firmly established.

References

Surface Stabilization
6.11, Permanent Seeding

Appendix
8.02, Vegetation Tables

6.62

SEDIMENT FENCE

Definition

A temporary sediment control measure consisting of fabric buried at the bottom, stretched, and supported by posts.

Purpose

To retain sediment from small disturbed areas by reducing the velocity of sheet flows to allow sediment deposition.

Conditions Where Practice Applies

Below small-disturbed areas that are less then ¼ acre per 100 feet of fence.

Where runoff can be stored behind the sediment fence without damaging the fence or the submerged area behind the fence.

Do not install sediment fences across streams, ditches, or waterways, or other areas of concentrated flow.

Sediment fence should be placed along topographic elevation contours, where it can intercept stormwater runoff that is in dispersed sheet flow. Sediment fence should not be used alone below graded slopes greater than 10 feet in height.

Planning Considerations

A sediment fence is a system to retain sediment on the construction site. The fence retains sediment primarily by retarding flow and promoting deposition. In operation, generally the fence becomes clogged with fine particles, which reduce the flow rate. This causes a pond to develop behind the fence. The designer should anticipate ponding and provide sufficient storage areas and overflow outlets to prevent flows from overtopping the fence. Since sediment fences are not designed to withstand high water levels, locate them so that only shallow pools can form. Tie the ends of a sediment fence into higher ground to prevent flow around the end of the fence before the pool reaches design level. Curling each end of the fence uphill in a "J" pattern may be appropriate to prevent end flow. Provide stabilized outlets to protect the fence system and release storm flows that exceed the design storm.

Deposition occurs as the storage pool forms behind the fence. The designer can direct flows to specified deposition areas through appropriate positioning of the fence or by providing an excavated area behind the fence. Plan deposition areas at accessible points to promote routine cleanout and maintenance. Show deposition areas in the erosion and sedimentation control plan. A sediment fence acts as a diversion if placed slightly off the contour. A maximum slope of 2 percent is recommended. This technique may be used to control shallow, uniform flows from small disturbed areas and to deliver sediment-laden water to deposition areas. The anchoring of the toe of the fence should be reinforced with 12 inches of NC DOT #5 or #57 washed stone when flow will run parallel to the toe of the fence.

Sediment fences serve no function along ridges or near drainage divides where there is little movement of water. Confining or diverting runoff unnecessarily with a sediment fence may create erosion and sedimentation problems that would not otherwise occur.

Straw barriers have only a 0-20% trapping efficiency and are inadequate. Straw bales may not be used in place of sediment fence. Prefabricated sediment fence with the fabric already stapled to thin wooden posts does not meet minimum standards specified later in this section.

Anchoring of sediment fence is critical. The toe of the fabric must be anchored in a trench backfilled with compacted earth. Mechanical compaction must be provided in order for the fence to effectively pond runoff.

Design Criteria

Ensure that drainage area is no greater than ¼ acre per 100 feet of fence. This is the maximum drainage area when the slope is less than 2 percent. Where all runoff is to be stored behind the fence, ensure that the maximum slope length behind a sediment fence does not exceed the specifications shown in Table 6.62a. The shorter slope length allowed for steeper slopes will greatly reduce the maximum drainage area. For example, a 10–20 % slope may have a maximum slope length of 25 feet. For a 100-foot length of sediment fence, the drainage area would be 25ft X 100ft = 2500sq.ft., or 0.06 acres.

Table 6.62a Maximum Slope Length and Slope for which Sediment Fence is Applicable

Slope	Slope Length (ft)	Maximum Area (ft^2)
<2%	100	10,000
2 to 5%	75	7,500
5 to 10%	50	5,000
10 to 20%	25	2,500
>20%	15	1,500

Make the fence stable for the 10-year peak storm runoff.

Ensure that the depth of impounded water does not exceed 1.5 feet at any point along the fence.

If non-erosive outlets are provided, slope length may be increased beyond that shown in Table 6.62a, but runoff from the area should be determined and bypass capacity and erosion potential along the fence must be checked. The velocity of the flow at the outlet or along the fence should be in keeping with Table 8.05d, Appendix 8.05.

Provide a riprap splash pad or other outlet protection device for any point where flow may overtop the sediment fence, such as natural depressions or swales. Ensure that the maximum height of the fence at a protected, reinforced outlet does not exceed 2 feet and that support post spacing does not exceed 4 feet.

The design life of a synthetic sediment fence should be 6 months.

Construction Specifications

MATERIALS

1. Use a synthetic filter fabric of at least 95% by weight of polyolefins or polyester, which is certified by the manufacturer or supplier as conforming to the requirements in ASTM D 6461, which is shown in part in Table 6.62b.

Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120° F.

2. Ensure that posts for sediment fences are 1.33 lb/linear ft steel with a minimum length of 5 feet. Make sure that steel posts have projections to facilitate fastening the fabric.

3. For reinforcement of standard strength filter fabric, use wire fence with a minimum 14 gauge and a maximum mesh spacing of 6 inches.

Table 6.62b Specifications For Sediment Fence Fabric

Temporary Silt Fence Material Property Requirements					
	Test Material	Units	Supported[1] Silt Fence	Un-Supported[1] Silt Fence	Type of Value
Grab Strength	ASTM D 4632	N (lbs)			
Machine Direction			400	550	MARV
			(90)	(90)	
X-Machine Direction			400	450	MARV
			(90)	(90)	
Permittivity[2]	ASTM D 4491	sec-1	0.05	0.05	MARV
Apparent Opening Size[2]	ASTM D 4751	mm	0.60	0.60	Max. ARV[3]
		(US Sieve #)	(30)	(30)	
Ultraviolet Stability	ASTM D 4355	% Retained Strength	70% after 500h of exposure	70% after 500h of exposure	Typical

[1] Silt Fence support shall consist of 14 gage steel wire with a mesh spacing of 150 mm (6 inches), or prefabricated poylmer mesh of equivalent strength.
[2] These default values are based on empirical evidence with a variety of sediment. For environmentally sensitive areas, a review of previous experience and/or site or regionally specific geotextile tests in accordance with Test Method D 5141 should be performed by the agency to confirm suitability of these requirements.
[3] As measured in accordance with Test Method D 4632.

CONSTRUCTION

1. Construct the sediment barrier of standard strength or extra strength synthetic filter fabrics.

2. Ensure that the height of the sediment fence does not exceed 24 inches above the ground surface. (Higher fences may impound volumes of water sufficient to cause failure of the structure.)

3. Construct the filter fabric from a continuous roll cut to the length of the barrier to avoid joints. When joints are necessary, securely fasten the filter cloth only at a support post with 4 feet minimum overlap to the next post.

4. Support standard strength filter fabric by wire mesh fastened securely to the **upslope** side of the posts. Extend the wire mesh support to the bottom of the trench. Fasten the wire reinforcement, then fabric on the upslope side of the fence post. Wire or plastic zip ties should have minimum 50 pound tensile strength.

5. When a wire mesh support fence is used, space posts a maximum of 8 feet apart. Support posts should be driven securely into the ground a minimum of 24 inches.

6. Extra strength filter fabric with 6 feet post spacing does not require wire mesh support fence. Securely fasten the filter fabric directly to posts. Wire or plastic zip ties should have minimum 50 pound tensile strength.

7. Excavate a trench approximately 4 inches wide and 8 inches deep along the proposed line of posts and upslope from the barrier (Figure 6.62a).

8. Place 12 inches of the fabric along the bottom and side of the trench.

9. Backfill the trench with soil placed over the filter fabric and compact. Thorough compaction of the backfill is critical to silt fence performance.

10. Do not attach filter fabric to existing trees.

SEDIMENT FENCE INSTALLATION USING THE SLICING METHOD

Instead of excavating a trench, placing fabric and then backfilling trench, sediment fence may be installed using specially designed equipment that inserts the fabric into a cut sliced in the ground with a disc (Figure 6.62b).

Installation Specifications

1. The base of both end posts should be at least one foot higher than the middle of the fence. Check with a level if necessary.

2. Install posts 4 feet apart in critical areas and 6 feet apart on standard applications.

3. Install posts 2 feet deep on the downstream side of the silt fence, and as close as possible to the fabric, enabling posts to support the fabric from upstream water pressure.

4. Install posts with the nipples facing away from the silt fabric.

5. Attach the fabric to each post with three ties, all spaced within the top 8 inches of the fabric. Attach each tie diagonally 45 degrees through the fabric, with each puncture at least 1 inch vertically apart. Also, each tie should be positioned to hang on a post nipple when tightened to prevent sagging.

6. Wrap approximately 6 inches of fabric around the end posts and secure with 3 ties.

7. No more than 24 inches of a 36 inch fabric is allowed above ground level.

8. The installation should be checked and corrected for any deviations before compaction.

9. Compaction is vitally important for effective results. Compact the soil immediately next to the silt fence fabric with the front wheel of the tractor, skid steer, or roller exerting at least 60 pounds per square inch. Compact the upstream side first, and then each side twice for a total of 4 trips.

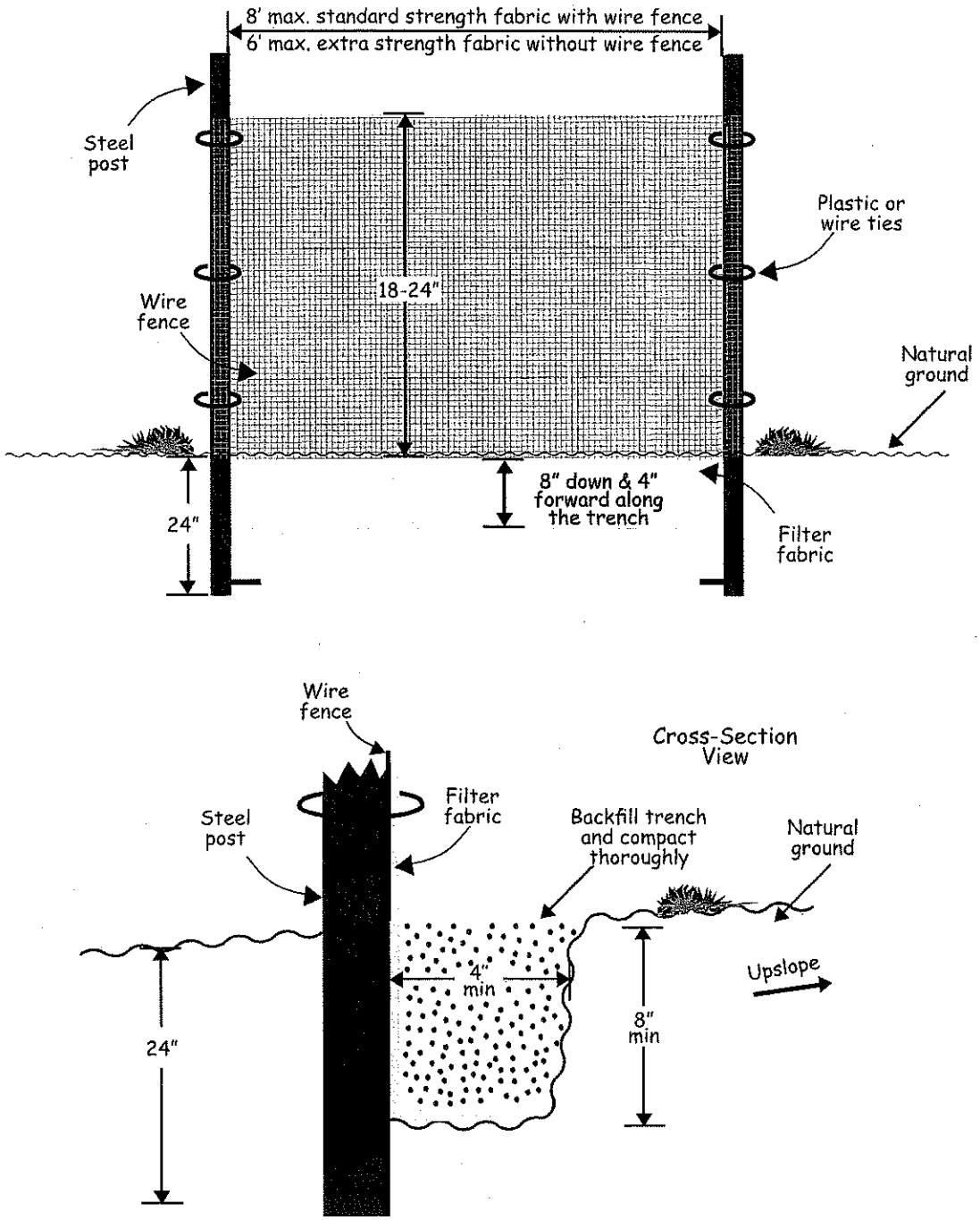
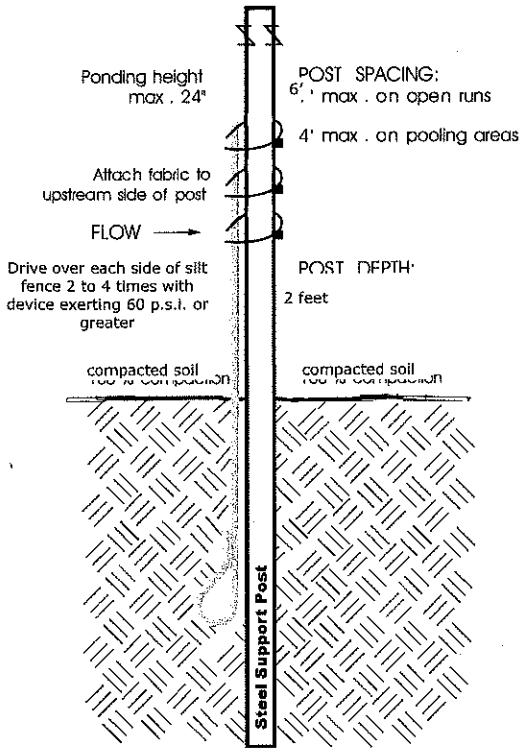
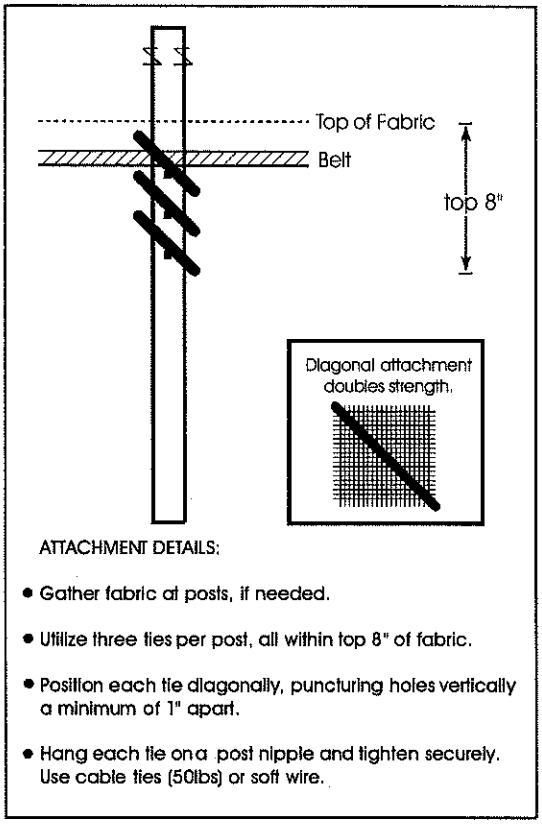


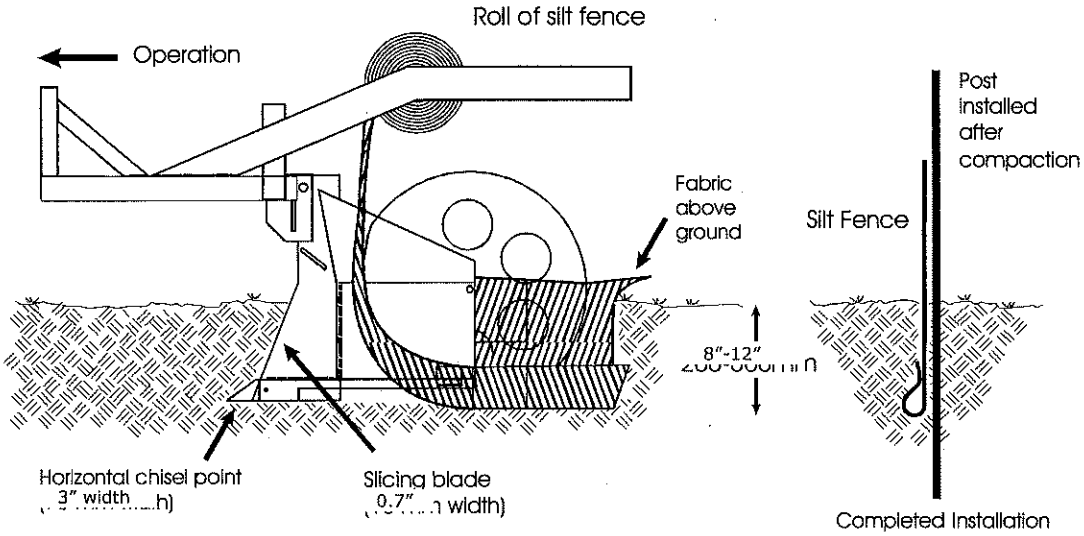
Figure 6.62a Installation detail of a sediment fence.

The Slicing Method



No more than 24" of a 36" fabric is allowed above ground.





Vibratory plow is not acceptable because of horizontal compaction

Figure 6.62b Schematics for using the slicing method to install a sediment fence. Adapted from *Silt Fence that Works*

Maintenance

Inspect sediment fences at least once a week and after each rainfall. Make any required repairs immediately.

Should the fabric of a sediment fence collapse, tear, decompose or become ineffective, replace it promptly.

Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.

Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized.

References

ASTM D 6461 – 99. "Standard Specification for Silt Fence Materials" ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

ASTM D 6462 – 03. "Standard Practice for Silt Fence Installation" ASTM International. For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

C. Joel Sprague, PE, Silt Fence Performance Limits and Installation Requirements. Sprague and Sprague Consulting Engineers and TRI/ Environmental, Inc.

Carpenter Erosion Control. http://www.tommy-sfm.com/

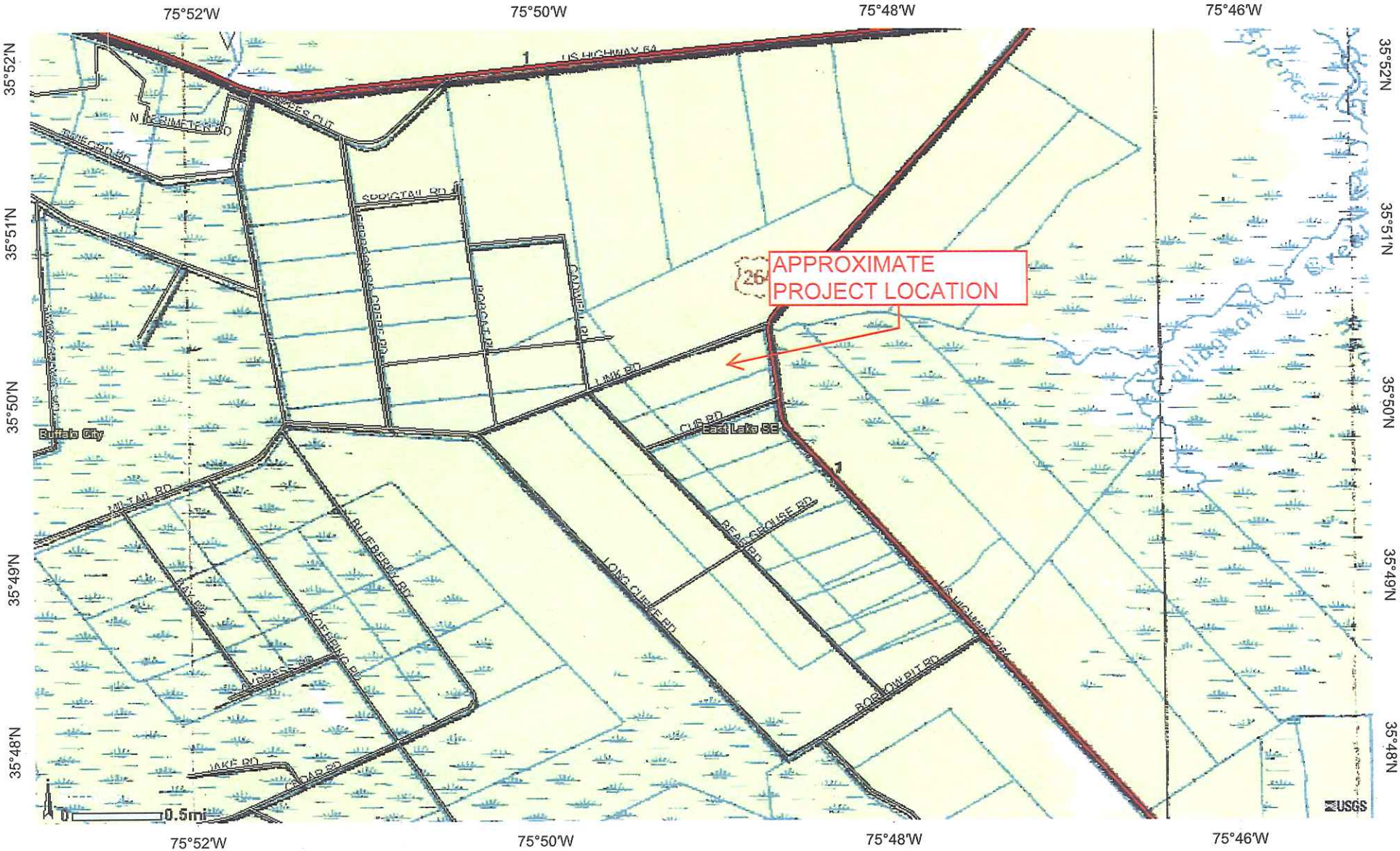
Kentucky Erosion Prevention and Sediment Control Field Manual, 2004.

Runoff Control Measures
6.20, Temporary Diversions

Outlet Protection
6.41, Outlet Stabilization Structure

Appendix
8.03, Estimating Runoff

Appendix A



35°52'11"N

75°52'56"W Map Extent 75°45'14"W

35°47'36"N

USGS
science for a changing world

The National Map
http://nationalmap.gov/

Geographic Coordinate System (WGS84)

TOPOGRAPHIC MAPS

1:100,000 Index

Quad Index - 100K

1:250,000 Index

Quad Index - 250 K

7.5 Minute Index

Quad Index - 7.5min

USGS Raster Graphics (Topo Maps)

No legend available

BOUNDARIES

TRANSPORTATION

Roads

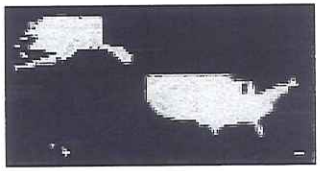
No legend available

US Interstate Labels (BTS)

No legend available

ELEVATION

1/3 ArcSecond NED CONUS



B

Appendix B

Soil Map—Dare County, North Carolina
(Dare County C&D NRCS Soil Survey)

Map Scale: 1:5,560 if printed on A size (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1,200

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features

- Gully
- Short Steep Slope
- Other

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:5,560 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 18N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dare County, North Carolina
Survey Area Data: Version 11, Mar 27, 2009

Date(s) aerial images were photographed: 8/26/2006

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Dare County, North Carolina (NC055)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
HyA	Hyde loam, 0 to 2 percent slopes, rarely flooded	96.4	89.2%
PoA	Ponzer muck, 0 to 2 percent slopes, rarely flooded	3.8	3.5%
RpA	Roper muck, 0 to 2 percent slopes, rarely flooded	7.8	7.2%
Totals for Area of Interest		**108.0**	**100.0%**

Appendix C

C&D LANDFILL BUFFER REQUIREMENTS:

1. MINIMUM 200-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ALL PROPERTY LINES FOR MONITORING PURPOSES.
2. MINIMUM 500-FOOT BUFFER BETWEEN THE C&D LANDFILL AND EXISTING RESIDENTIAL STRUCTURES AND WELLS.
3. MINIMUM 50-FOOT BUFFER BETWEEN THE C&D LANDFILL AND ANY STREAM, RIVER, LAKE, POND OR OTHER WATERS OF THE STATE AS DEFINED IN G.S. 143-212.

NOTES:

1. PROPERTY SURVEY INFORMATION FROM SOUTHERN SURVEYING, KITTY HAWK, NC SEPTEMBER 1987, FILE # P-151 RECORDED IN DEED BOOK NO. 530 PAGE NO. 753.
2. MAP DERIVED FROM SITE MAPS PRODUCED BY APPLIED WATER TECHNOLOGY, 4037 STONE SUMMIT LANE, RALEIGH, NC 27603, FOR CELL NO. 2 EXPANSION DATED MARCH 1998 AND MARCH 2002.
3. PHASE NO 3 IS ACTIVE, CONTRACTOR SHALL COORDINATE HIS CONSTRUCTION ACTIVITIES WITH ENGINEER SUCH THAT LANDFILL OPERATIONS ARE NOT ADVERSELY AFFECTED.

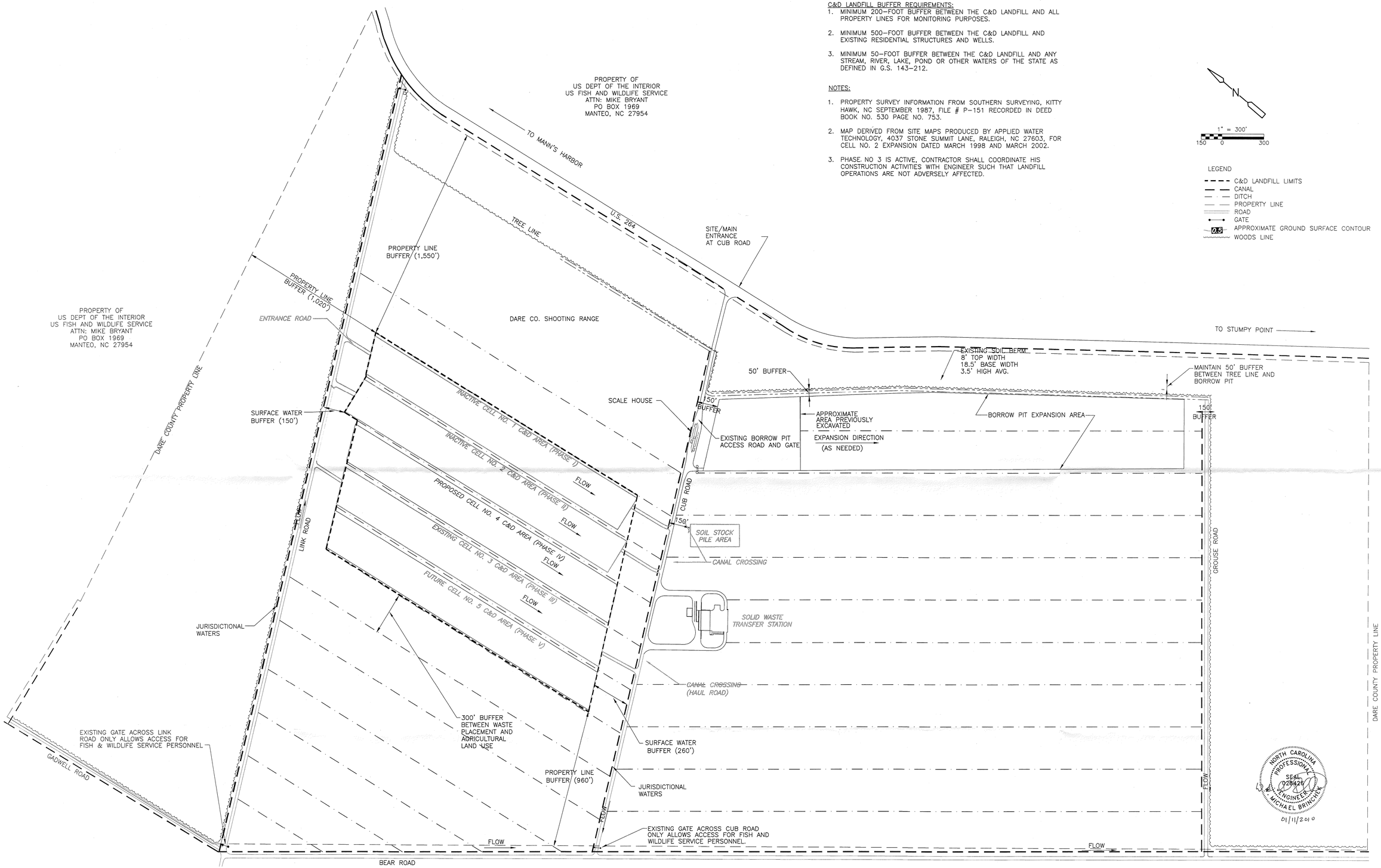
N

1" = 300'

150 0 300

LEGEND

- C&D LANDFILL LIMITS
- CANAL
- DITCH
- PROPERTY LINE
- ROAD
- GATE
- 0.5 APPROXIMATE GROUND SURFACE CONTOUR
- WOODS LINE



REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: JANUARY 2010

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North Carolina Firm Licensure: F-0412
consulting • engineering • construction • operations

DARE COUNTY
NORTH CAROLINA

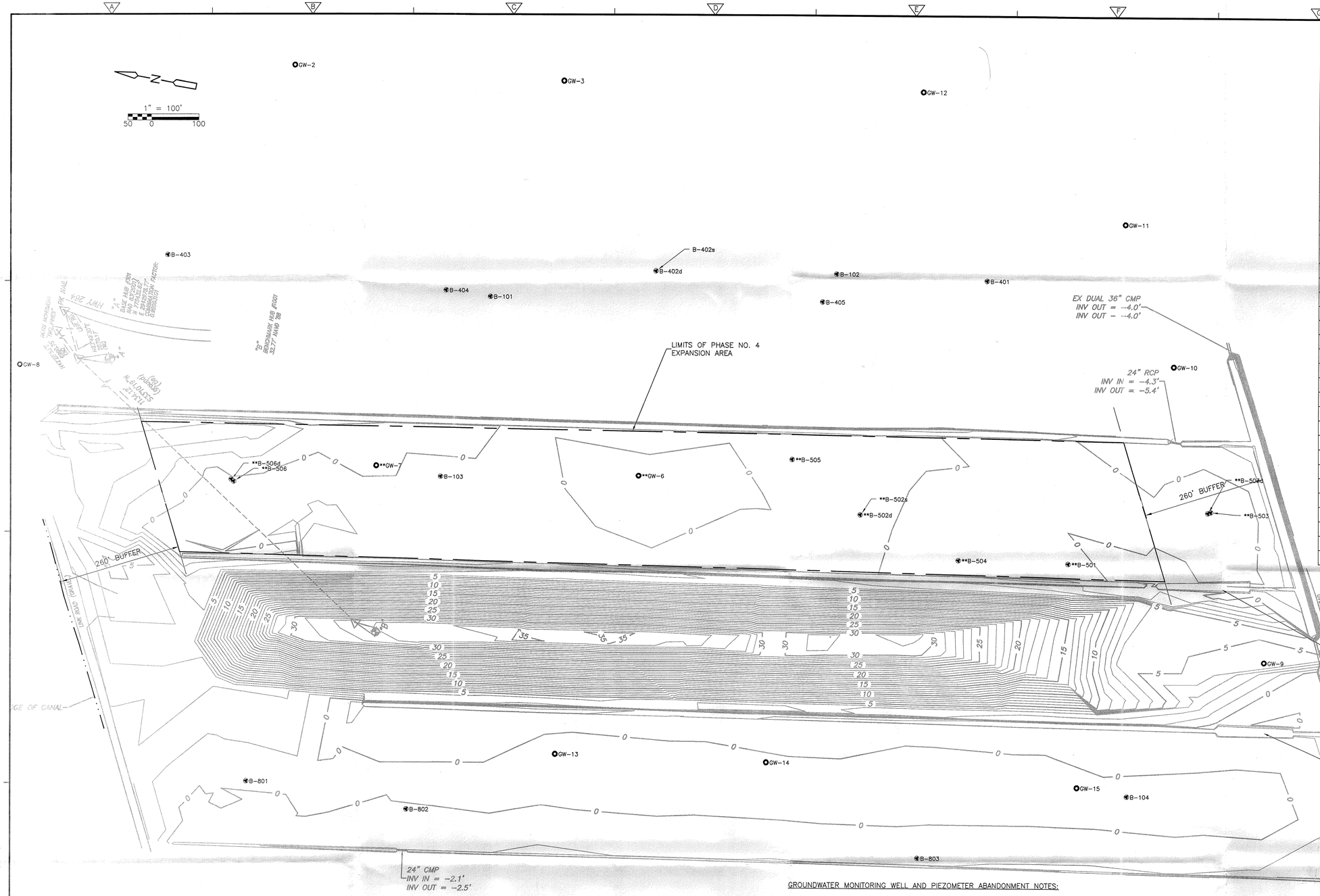
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL PHASE IV CONSTRUCTION DRAWINGS

SITE DEVELOPMENT PLAN

PROJECT NO. 17952 56960
FILE NAME: C001LFPL.DWG
SHEET NO.
C-1

PERMIT SET

01/11/10 2:10:41 PM L:\17952-56960\CONFORMED DRAWINGS\100%\C001LFPL.DWG



PIEZOMETER AND MONITORING WELL SCHEDULE				
POINT #	PIEZOMETER/GW WELL	BOREHOLE DEPTH (FEET BGS)	NORTHING	EASTING
1	GW-1	10	775459.46	2943423.17
2	GW-2	20	774812.63	2943476.21
3	GW-3	20	774246.50	2943544.29
4	**GW-6	20	773947.90	2942765.94
5	**GW-7	20	774497.80	2942689.46
6	GW-8	20	775276.96	2942765.21
7	GW-9	20	772578.01	2942615.36
8	GW-10	20	772873.78	2943188.48
9	GW-11	20	773027.15	2943464.85
10	GW-12	20	773495.49	2943656.65
11	GW-13	20	774019.56	2942163.28
12	GW-14	20	773577.80	2942224.90
13	GW-15	20	772922.37	2942289.76
14	B-401	15	773293.90	2943295.50
15	B-402d	31	773986.50	2943192.70
16	B-403	15	775008.80	2943046.40
17	B-404	15	774415.90	2943075.50
18	B-405	15	773628.50	2943191.10
19	**B-501	15	773021.90	2942745.50
20	**B-502d	31	773472.30	2942768.70
21	B-801	15	774653.40	2941992.70
22	B-802	15	774309.30	2941994.10
23	B-803	15	773228.10	2942083.90
24	B-101	100	774321.40	2943078.80
25	B-102	99	773609.40	2943254.10
26	B-103	100	774359.70	2942690.90
27	B-104	100	772815.20	2942290.30
28	**B-503	20	772744.09	2942905.36
29	**B-503d	50	772749.74	2942902.33
30	**B-504	25	773251.27	2942711.61
31	**B-505	25	773633.82	2942856.46
32	**B-506	20	774789.35	2942603.78
33	**B-506d	50	774795.08	2942607.09
34	B-402s	15	773986.50	2943192.70
35	**B-502s	15	773472.30	2942768.70

LEGEND

- GW-1 EXISTING MONITORING WELL
- B-101 EXISTING PIEZOMETER
- EXISTING INTERMEDIATE CONTOUR
- 2 EXISTING INDEX CONTOUR

NOTES:

1. TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY QUIBLE & ASSOCIATES, P.C.
2. REFERENCE DB 530, PG 733 & PL C, SL 32B.
3. DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
4. HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180456, 000177169, 000147860, 000242228 AND 000237065.
5. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGED SINCE DATE OF SURVEY.

GROUNDWATER MONITORING WELL AND PIEZOMETER ABANDONMENT NOTES:

PIEZOMETERS AND GROUNDWATER MONITRORING WELLS WITH DUAL ASTRICS (**) REPRESENT WELLS TO BE ABANDONED.

CONTRACTOR SHALL ADHERE TO THE FOLLOWING CONDITIONS WHEN ABANDONING GROUNDWATER MONITORING WELLS, PIEZOMETERS AND LOCATED IN THE PROPOSED PHASE NO. 4 EXPANSION AREA:

PRIOR TO CONSTRUCTION OF THE PHASE OR CELL(S) WITHIN THE PHASE, ALL PIEZOMETERS, GROUNDWATER MONITORING WELLS AND LOCATED WITHIN THE FOOTPRINT MUST BE PROPERLY ABANDONED BY OVERDRILLING FIRST (EXCEPTION OF NON-CASED BORINGS) AND SEALED WITH GROUT IN ACCORDANCE WITH 15A NCAC 2C.0113(b)(1) ENTITLED "ABANDONMENT OF WELLS",

a. IN AREAS WHERE SOIL IS TO BE UNDERCUT, ABANDONED PIEZOMETERS, MONITORING WELLS AND BORINGS MUST NOT BE GROUTED TO PRE-GRADE LAND SURFACE, BUT TO THE PROPOSED BASE GRADE SURFACE TO PREVENT HAVING TO CUT EXCESS GROUT AND POTENTIALLY DAMAGING THE WELLS.

b. WELL ABANDONMENT RECORDS (GW-30 FORM) FOR EACH DECOMMISSIONED PIEZOMETER, BORING AND GROUNDWATER MONITORING WELL MUST BE CERTIFIED BY A LICENSED GEOLOGIST IN ACCORDANCE WITH RULE .1623(b)(2)(1) AND SUBMITTED TO THE SOLID WASTE SECTION IN ACCORDANCE WITH 15A NCAC 02C.0114(b).

NORTH CAROLINA PROFESSIONAL SEAL 028426 ENGINEER MICHAEL BRINCHEK

01/11/2010

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: JANUARY 2010

CDM
Camp Dresser & McKee
5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612
Tel: (919) 787-5620 Fax: (919) 781-5730
North Carolina Firm Licensure: F-0412
consulting • engineering • construction • operations

DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV CONSTRUCTION DRAWINGS

EXISTING CONDITIONS

PROJECT NO. 17952 56960
FILE NAME: C002LFPL.DWG
SHEET NO.
C-2

PERMIT SET

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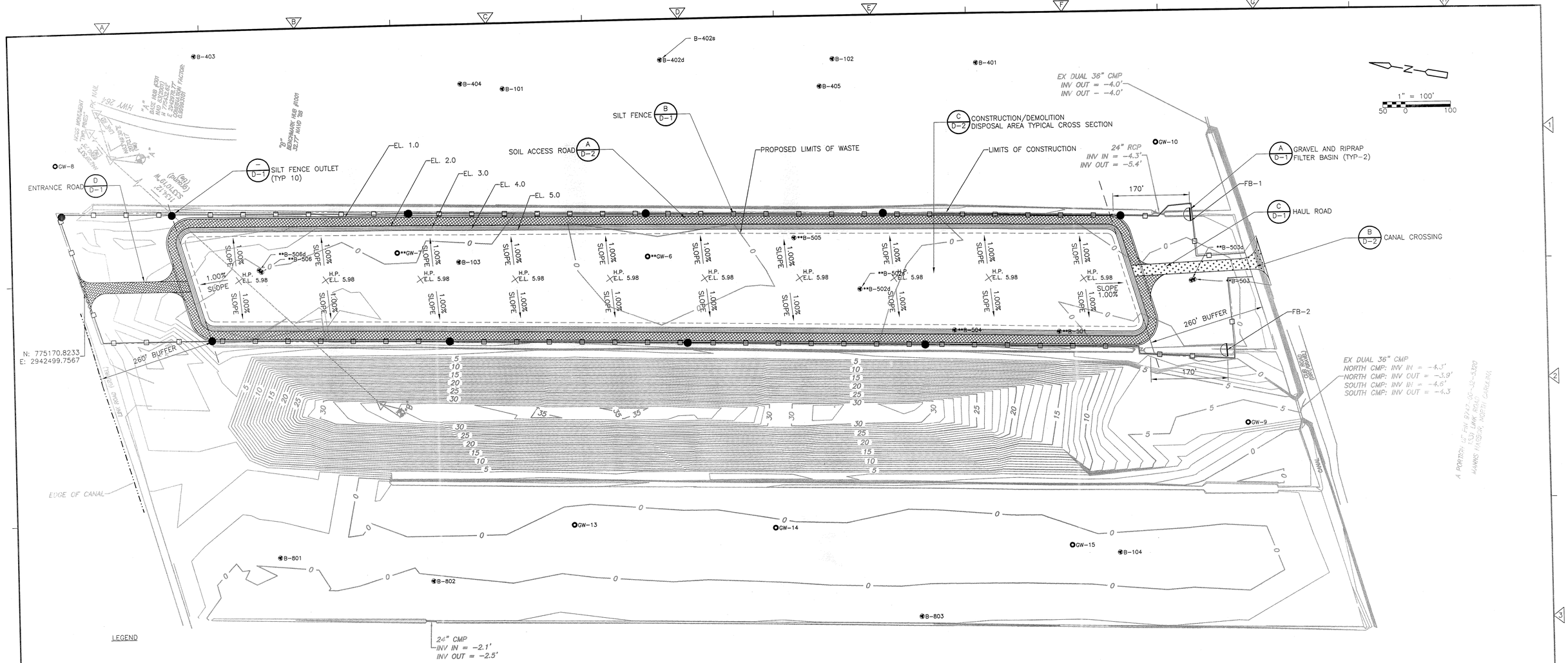

LEGEND

- GW-9 EXISTING MONITORING WELL
- P-1 EXISTING PIEZOMETER
- 4 EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- 4 PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- H.P. E.L. 0.00 HIGH POINT
- FB-1 FILTER BASIN
- SILT FENCE
- HAUL ROAD
- PROPOSED SOIL ACCESS ROAD
- ENTRANCE ROAD
- LIMITS OF CONSTRUCTION
- SILT FENCE OUTLET

GENERAL CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND/OR RELOCATE ALL EXISTING UTILITIES, DRAINAGE STRUCTURES, MONITORING WELLS, ETC. IN COORDINATION WITH THE APPROPRIATE UTILITIES, AGENCY, OR COMPANY WITHIN 72 HOURS PRIOR TO CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR LOCATING, PROTECTING, MAINTAINING, AND RESTORING ALL SITE UTILITIES AND BUILDING SERVICES.
2. NO HAUL ROUTE SHALL BE USED FOR MATERIAL TRANSPORT UNTIL NO THE ROUTE HAS BEEN COORDINATED WITH THE OWNER.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING OR REPLACING, AT NO ADDITIONAL COST TO THE OWNER, ANY EXISTING MONITORING WELLS, DRAINAGE STRUCTURES, ETC. DAMAGED DURING CONSTRUCTION.
4. CONTRACTOR'S TRAILER SHALL BE LOCATED WITHIN STAGING AREAS AS DESIGNATED BY THE OWNER ON THIS SHEET. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY UTILITY CONNECTIONS, A POTABLE WATER SUPPLY, AND TEMPORARY SANITARY SERVICE FOR TRAILER.
5. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF THESE PLANS BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, OR PRESERVATION AREAS AND OTHER FEATURES AFFECTING HIS WORK.
6. THE CONTRACTOR SHALL REPLACE ALL PAVING (ASPHALT, STONE, OR CONCRETE), STABILIZED EARTH, CURBS, DRIVEWAYS, SIDEWALKS, MAILBOXES, DRAINAGE CULVERTS, FENCES, ETC. WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION.
7. STORM DRAINAGE PIPE LENGTHS SHOWN ARE APPROXIMATE AND MAY BE ADJUSTED AS REQUIRED IN THE FIELD, UPON APPROVAL BY ENGINEER.
8. EXISTING DRAINAGE DITCHES SHALL HAVE SEDIMENT AND DEBRIS REMOVED AND SHALL BE REPAIRED AND ALL NEW EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO ANY CLEARING AND GRUBBING. THEY SHALL BE INSTALLED TO THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS, REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS.
9. THE LIMITS OF DISTURBANCE SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR. ALL INGRESS AND EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF DISTURBANCE.
10. CONTRACTOR SHALL VERIFY THE EXISTANCE AND ACCURACY OF BENCHMARK AND CONTROL DATA PRIOR TO INITIATING CONSTRUCTION. CONTRACTOR SHALL NOTIFY ENGINEER IF DISCREPANCES ARE FOUND.
11. CONTRACTOR SHALL STAKE OUT LIMITS OF WORK (INCLUDING CUT/FILL SLOPES) PRIOR TO INITIATING EXCAVATION AND BACKFILL ACTIVITIES. SURVEY DATA SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. CONTRACTOR SHALL SEED AND MULCH ALL DISTURBED AREAS PER SPECIFICATIONS EXCEPT FOR ROAD SURFACES AND AREA WITHIN PROPOSED EDGE OF WASTE.
12. CONTROL POINTS PROVIDED ARE BASED ON A LOCAL COORDINATE SYSTEM. COORDINATE WITH QUIBLE & ASSOC., PC (PHONE NO. 252-261-3300) PRIOR TO LAYING OUT WORK.

SURVEY NOTES:

1. TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY MCKIM AND CREED, PA.
2. REFERENCE DB 530, PG 733 & PL C, SL 32B.
3. DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
4. HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180456, 000177169, 000147860, 000242228 AND 000237065.
5. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGE SINCE DATE OF SURVEY.

NORTH CAROLINA PROFESSIONAL SEAL 025426 ENGINEER W. MICHAEL BRINCHEK
01/11/2010

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: JANUARY 2010

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DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV CONSTRUCTION DRAWINGS

GRADING PLAN

PROJECT NO. 17952 56960
FILE NAME: C003LFPL.DWG
SHEET NO.
C-3

PERMIT SET

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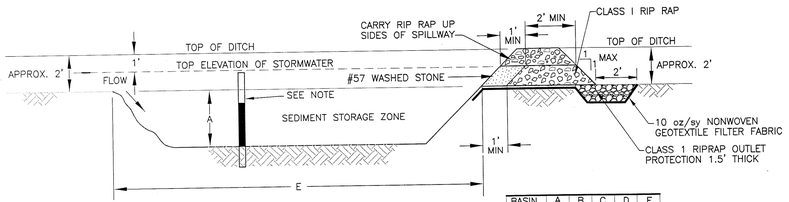
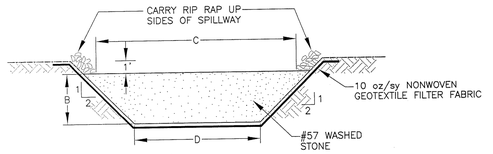


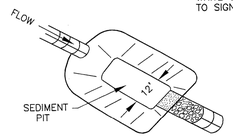
SECTION THRU BASIN & FILTER

BASIN	A	B	C	D	E
1	3'	1'	25'	19'	170'
2	3'	1'	25'	19'	170'

NOTE:
PROVIDE TREATED 6x6 POST PLACED 50' FROM FILTER BERM. MARK POST WITH WHITE STRIPE 2' FROM BOTTOM OF BASIN TO SIGNIFY CLEANOUT DEPTH.



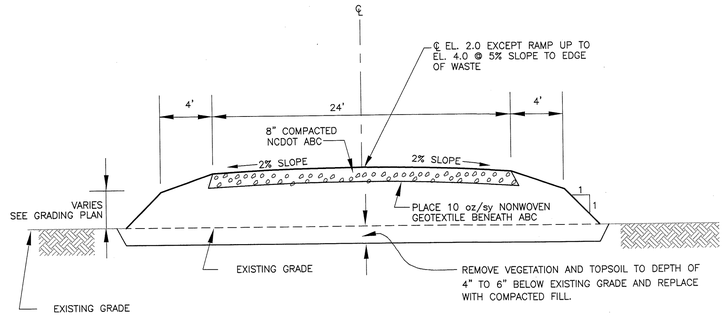
SECTION THRU FILTER



PERSPECTIVE VIEW

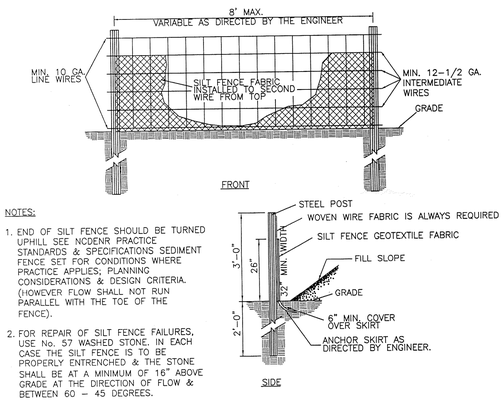
GRAVEL & RIPRAP FILTER BASIN

DETAIL A
NOT TO SCALE C-3



ENTRANCE ROAD

DETAIL D
NOT TO SCALE C-3

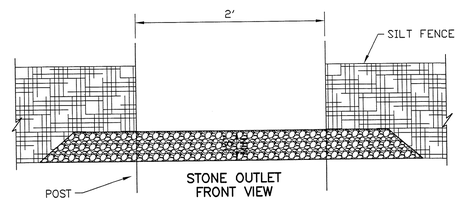


NOTES:

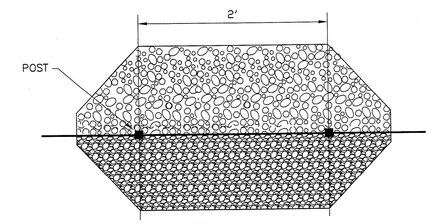
1. END OF SILT FENCE SHOULD BE TURNED UPHILL SEE NCDENR PRACTICE STANDARDS & SPECIFICATIONS SEDIMENT FENCE SET FOR CONDITIONS WHERE PRACTICE APPLIES; PLANNING CONSIDERATIONS & DESIGN CRITERIA. (HOWEVER FLOW SHALL NOT RUN PARALLEL WITH THE TOE OF THE FENCE).
2. FOR REPAIR OF SILT FENCE FAILURES, USE No. 57 WASHED STONE. IN EACH CASE THE SILT FENCE IS TO BE PROPERLY ENTRENCHED & THE STONE SHALL BE AT A MINIMUM OF 16" ABOVE GRADE AT THE DIRECTION OF FLOW & BETWEEN 60 – 45 DEGREES.

SILT FENCE

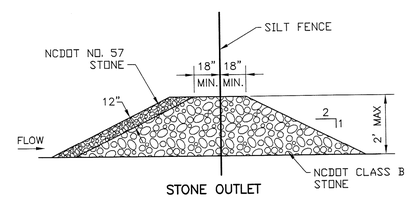
DETAIL B
NOT TO SCALE C-3



STONE OUTLET
FRONT VIEW



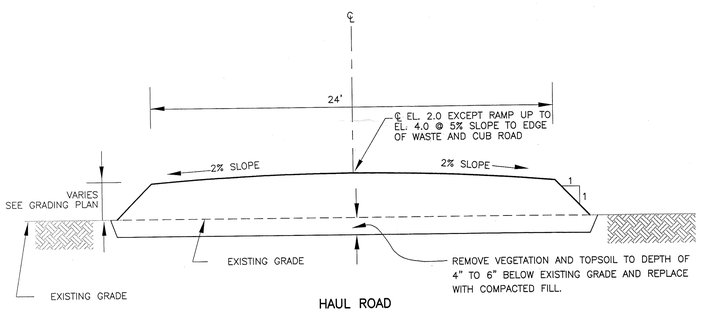
STONE OUTLET
PLAN VIEW



STONE OUTLET
CROSS SECTION

SILT FENCE OUTLET

DETAIL E
NTS C-3



HAUL ROAD

DETAIL C
NOT TO SCALE C-3

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: JANUARY 2010

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DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV CONSTRUCTION DRAWINGS

DETAILS

PROJECT NO. 17952 56960
FILE NAME: CD001LFD
SHEET NO.
D-1

PERMIT SET

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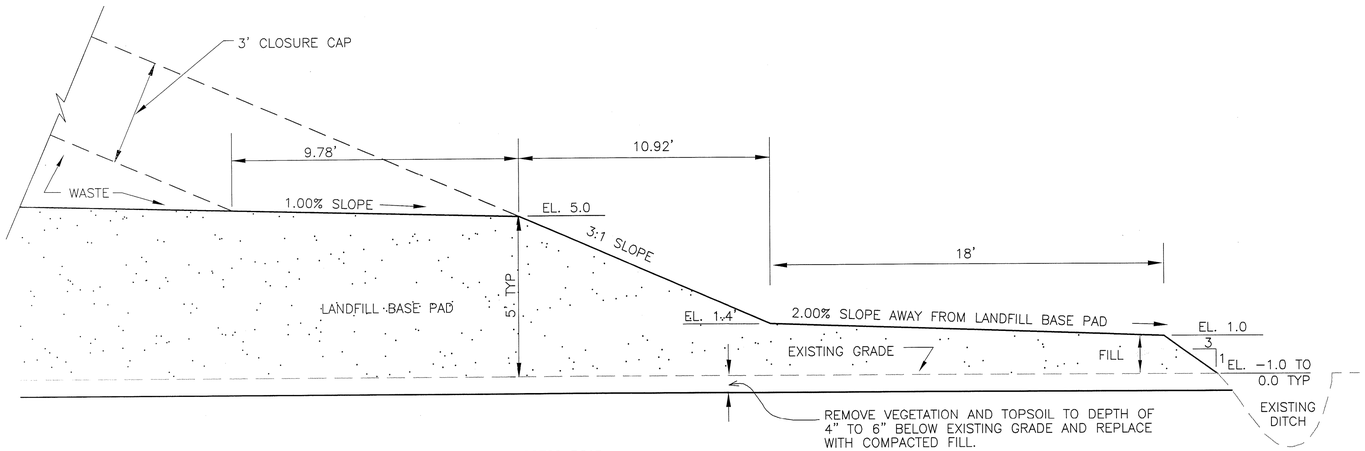
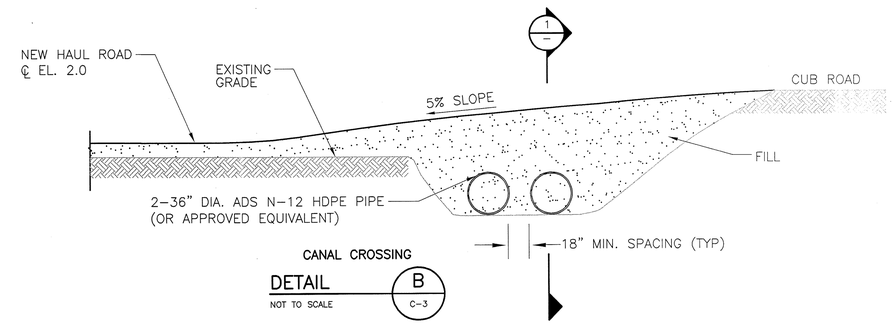


SOIL ACCESS ROAD

DETAIL A / C-3

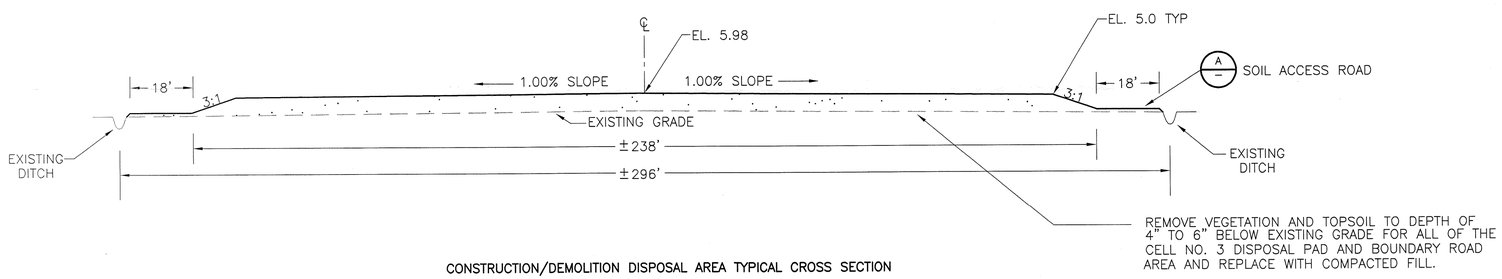
NOT TO SCALE



CANAL CROSSING

DETAIL B / C-3

NOT TO SCALE



CONSTRUCTION/DEMOLITION DISPOSAL AREA TYPICAL CROSS SECTION

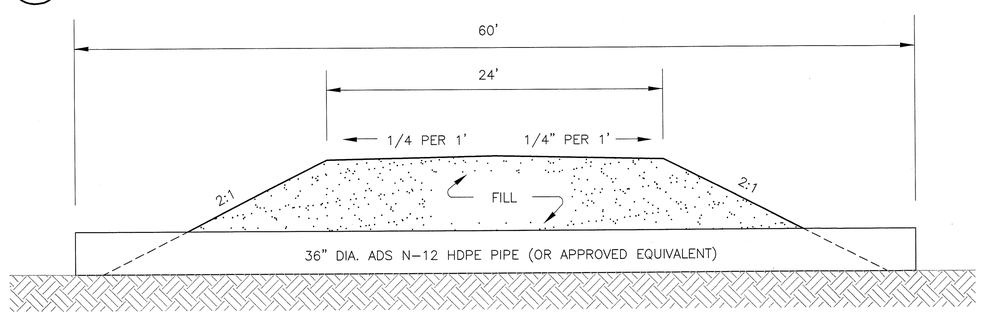
DETAIL C / C-3

NOT TO SCALE

CANAL CROSSING

DETAIL B / C-3

NOT TO SCALE



CANAL CROSSING

SECTION 1 / -

NOT TO SCALE

CANAL CROSSING

SECTION 1 / -

NOT TO SCALE

NORTH CAROLINA PROFESSIONAL SEAL 028426 ENGINEER MICHAEL BRINCHEK

01/11/2010

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
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DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV CONSTRUCTION DRAWINGS

DETAILS

PROJECT NO. 17952 56960
FILE NAME: D-2
SHEET NO.
D-2

PERMIT SET

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Appendix D

FINANCIAL RESPONSIBILITY/OWNERSHIP FORM
SEDIMENTATION POLLUTION CONTROL ACT

No person may initiate any land-disturbing activity on one or more acres as covered by the Act before this form and an acceptable erosion and sedimentation control plan have been completed and approved by the Land Quality Section, N.C. Department of Environment and Natural Resources. (Please type or print and, if the question is not applicable or the e-mail and/or fax information unavailable, place N/A in the blank.)

Part A.

1. Project Name Dare County Construction and Demolition Debris Landfill Cell No. 4 Expansion

2. Location of land-disturbing activity: County Dare City or Township Manns Harbor

   Highway/Street 1531 Link Road Latitude 35.8402 Longitude 75.8136

3. Approximate date land-disturbing activity will commence: March 2010

4. Purpose of development (residential, commercial, industrial, institutional, etc.): Municipal

5. Total acreage disturbed or uncovered (including off-site borrow and waste areas): 18 Acres

6. Amount of fee enclosed: $ 1,170.00. The application fee of $65.00 per acre (rounded up to the next acre) is assessed without a ceiling amount (Example: a 9-acre application fee is $585).

7. Has an erosion and sediment control plan been filed? Yes____ No____ Enclosed X

8. Person to contact should erosion and sediment control issues arise during land-disturbing activity:

   Name W. Michael Brinchek E-mail Address brinchekwm@cdm.com

   Telephone 919-787-5620 Cell # 919-280-7705 Fax # 919-781-5730

9. Landowner(s) of Record (attach accompanied page to list additional owners):

   Dare County (Name) 252-475-5880 (Telephone) (252)473-5218 (Fax Number)

   P.O. Box 1000 (Current Mailing Address) 1018 Driftwood Drive (Current Street Address)

   Manteo NC 27954 (City State Zip) Manteo NC 27954 (City State Zip)

10. Deed Book No. 530 Page No. 733 Provide a copy of the most current deed.

Part B.

1. Person(s) or firm(s) who are financially responsible for the land-disturbing activity (Provide a comprehensive list of all responsible parties on an attached sheet):

   Dare County (Name) edwardlee@co.dare.nc.us (E-mail Address)

   P.O. Box 1000 (Current Mailing Address) 1018 Driftwood Drive (Current Street Address)

   Manteo NC 27954 (City State Zip) Manteo NC 27954 (City State Zip)

   Telephone 252-475-5888 Fax Number ____

2. (a) If the Financially Responsible Party is not a resident of North Carolina, give name and street address of the designated North Carolina Agent:

Name	E-mail Address
Current Mailing Address	Current Street Address
City State Zip	City State Zip
Telephone	Fax Number

(b) If the Financially Responsible Party is a Partnership or other person engaging in business under an assumed name, **attach a copy of the Certificate of Assumed Name.** If the Financially Responsible Party is a Corporation, give name and street address of the Registered Agent:

Name of Registered Agent	E-mail Address
Current Mailing Address	Current Street Address
City State Zip	City State Zip
Telephone	Fax Number

The above information is true and correct to the best of my knowledge and belief and was provided by me under oath (This form must be signed by the Financially Responsible Person if an individual or his attorney-in-fact, or if not an individual, by an officer, director, partner, or registered agent with the authority to execute instruments for the Financially Responsible Person). I agree to provide corrected information should there be any change in the information provided herein.

Edward L Mann	Dare County Public Works Director
Type or print name	Title or Authority
Edward L. Mann	01/04/10
Signature	Date

I, Shanna T. Fullmer, a Notary Public of the County of Dare

State of North Carolina, hereby certify that Edward L Mann appeared personally before me this day and being duly sworn acknowledged that the above form was executed by him.

Witness my hand and notarial seal, this 4th day of January, 2010

Shanna Fullmer
Notary

Seal

My commission expires January 5, 2013

STATE OF NORTH CAROLINA
DARE COUNTY
SEP 21 '87

Real Estate Excise Tax
500.00

BK 530 PG 0733

FILED
'87 SEP 21 PM 4 48
DORRIS A. FRY
REGISTER OF DEEDS
DARE COUNTY, N.C.

APPROVED
DARE COUNTY TAX COLLECTOR
NO. 5057-87
Transfer Tax $5,000.00
Excise Tax $500.00

Recording Time, Book and Page

Tax Lot No. DARE Parcel Identifier No.
Verified by COUNTY REAL ESTATE TRANSFER TAX
by 5057-87 $5000.00 County on the day of , 19

Mail after recording to GRANTEE c/o Dwight R. Wheless, Attorney at Law, P. O. Box 500, Manteo, NC 27954

This instrument was prepared by Ralph S. Wheatly, Regional Counsel, The Prudential Insurance Co. Of America, Suite 300, 855 Ridge Lake Blvd., Memphis, TN 38119.

Brief description for the Index

NORTH CAROLINA SPECIAL WARRANTY DEED

THIS DEED made this 15th day of September, 1987, by and between

GRANTOR	GRANTEE
THE PRUDENTIAL INSURANCE COMPANY OF AMERICA Suite 300, 855 Ridge Lake Boulevard Memphis, Tennessee 38119	COUNTY OF DARE, a body politic and corporate under the laws of the state of North Carolina P. O. Box 1000 Manteo, North Carolina 27954

Enter in appropriate block for each party: name, address, and, if appropriate, character of entity, e.g. corporation or partnership.

The designation Grantor and Grantee as used herein shall include said parties, their heirs, successors, and assigns, and shall include singular, plural, masculine, feminine or neuter as required by context.

WITNESSETH, that the Grantor, for a valuable consideration paid by the Grantee, the receipt of which is hereby acknowledged, has and by these presents does grant, bargain, sell and convey unto the Grantee in fee simple, all that certain lot or parcel of land situated in the City of , Croatan Township, Dare County, North Carolina and more particularly described as follows:

SEE EXHIBIT "A" ANNEXED HERETO AND BY REFERENCE INCORPORATE HEREIN WHICH EXHIBIT IS SIGNED AT THE BOTTOM FOR IDENTIFICATION BY ABNER M. BECK, VICE PRESIDENT OF GRANTOR.

N.C. Bar Assoc. Form No. 6 © 1977 – Stevens Publishing Co., Inc., Box 727, Indianapolis, N.C. 27056
Printed by Agreement with the N.C. Bar Assoc. – 1981

BK 530 PG 0734

The property hereinabove described was acquired by Grantor by instrument recorded in _____

A map showing the above described property is recorded in Plat Book _____ page _____

TO HAVE AND TO HOLD the aforesaid lot or parcel of land and all privileges and appurtenances thereto belonging to the Grantee in fee simple.

And the Grantor covenants with the Grantee, that Grantor has done nothing to impair such title as Grantor received, and Grantor will warrant and defend the title against the lawful claims of all persons claiming by, under or through Grantor, except for the exceptions hereinafter stated.
Title to the property hereinabove described is subject to the following exceptions:

All matters of public record without reimposing the same.

IN WITNESS WHEREOF, the Grantor has hereunto set his hand and seal, or if corporate, has caused this instrument to be signed in its corporate name by its duly authorized officers and its seal to be hereunto affixed by authority of its Board of Directors, the day and year first above written.

THE PRUDENTIAL INSURANCE COMPANY OF AMERICA
(Corporate Name)

By: Abner M. Beck
Abner M. Beck
Vice President

ATTEST: Ralph S. Wheatly
Ralph S. Wheatly
Assistant Secretary (Corporate Seal)

SEAL - STAMP

USE BLACK INK ONLY

_____ (SEAL)
_____ (SEAL)
_____ (SEAL)
_____ (SEAL)

USE BLACK INK ONLY

NORTH CAROLINA, _____ County.

I, a Notary Public of the County and State aforesaid, certify that _____ Grantor, personally appeared before me this day and acknowledged the execution of the foregoing instrument. Witness my hand and official stamp or seal, this _____ day of _____, 19____

My commission expires: _____ _____ Notary Public

SEAL - STAMP

TENNESSEE
NORTH CAROLINA, Shelby County.

I, a Notary Public of the County and State aforesaid, certify that Ralph S. Wheatly personally came before me this day and acknowledged that he is Assistant Secretary of THE PRUDENTIAL INSURANCE COMPANY OF AMERICA, a New Jersey corporation, and that by authority duly given and as the act of the corporation, the foregoing instrument was signed in its name by its Vice President, sealed with its corporate seal and attested by Ralph S. Wheatly as its Assistant Secretary.

Witness my hand and official stamp or seal, this 15th day of September, 87

My commission expires: July 3, 1990 Marilyn R. McVay Notary Public

The foregoing Certificate(s) of Marilyn R. McVay a Notary Public of Shelby Co. Tenn

is/are certified to be correct. This instrument and this certificate are duly registered at the date and time and in the Book and Page shown on the first page hereof.

Dorris A. Fry REGISTER OF DEEDS FOR Dare COUNTY
By Mary B. Scarborough Deputy/Assistant-Register of Deeds.

N. C. Bar Assoc. Form No. 5 © 1977 – Allen Printing & Co., Inc., Box 123, Tarboro, N. C. 27886
Printed by Agreement with the N. C. Bar Assoc. 1987

All that certain piece or parcel of land lying and being in Croatan Township, Dare County, North Carolina, and described as follows:

BEGINNING at a stake or other marker lying in and on the West line of the right of way of U. S. Highway 264 and at a point thereon which lies North 34 deg. 40 min. 27 sec. East 102.95 feet from another concrete marker, said point of beginning also lying and being North 24 deg. 45 min. 56 sec. East 577.39 feet from a concrete marker identified as "Bridge 1974" (said marker lying at the following grid coordinates based on the North Carolina Grid System: North 776227.158, East 2944678.124), said point of beginning also lying South 76 deg. 38 min. 10 sec. West 60.55 feet from an existing concrete monument which itself lies on the same course and 44.14 feet from an existing P. K. nail in the centerline of the pavement of U. S. Highway 264 which said nail lies North 32 deg. 4 min. 29 sec. East 647.29 feet from the concrete marker identified as "Bridge 1974"; proceeding thence from the point of beginning South 76 deg. 38 min. 10 sec. West along the South line of lands belonging to the United States Department of the Interior (U. S. Fish and Wildlife Service) 4,686.48 feet to an existing concrete monument, then cornering and running North 9 deg. 0 min. 23 sec. West 23.87 feet to a concrete monument, thence South 81 deg. 24 min. 20 sec. West 975.64 feet to a concrete monument, thence South 8 deg. 38 min. 54 sec. East 1,731.72 feet to a concrete monument, thence South 39 deg. 44 min. 25 sec. East 8,291.60 feet to a concrete monument, thence North 50 deg. 10 min. 9 sec. East 3,468.62 feet to a concrete monument which concrete monument lies on the same course 40 feet to another existing concrete monument and 30 feet beyond that to an existing P. K. nail on the centerline of the pavement of U. S. Highway 264, thence from the concrete monument on the edge of the right of way in a general Northwesterly, Northerly and Northeasterly direction following the curvature of the right of way U. S. Highway 264 to the point or place of beginning.

The aforesaid tract is identified on a plat prepared by Southern Surveying recorded in Plat Cabinet C at Slide 32B in the office of the Register of Deeds of Dare County, North Carolina.

All courses in this description are coordinated with the North Carolina Grid System as further shown on the aforesaid plat.

There is also conveyed hereby a right of access over and upon portions of the road shown on the aforesaid plat as "Bear Road".

Portions of the described properties are subject to existing land leases which terminate no later than December 31, 1987.

MARKED FOR IDENTIFICATION THIS 15th DAY OF September, 1987.

THE PRUDENTIAL INSURANCE COMPANY OF AMERICA

By: Abner M. Beck
Abner M. Beck, Vice President

Appendix E

CDM	CLIENT	Dare County	COMPUTED BY / DATE	WPS 01/21/09
	PROJECT	Dare County Cell 4 C&D LF	CHECKED BY / DATE	WMB -
	DETAIL	Filter Basin #'s 1 &2	REVISION NO. / DATE	- -
	PROJECT NO.	17952-56960	REVIEWED BY / DATE	- -

Calculation Brief Title: Filter Basin #'s 1 & 2

1.0 Objective

Design Gravel & Riprap Filter Basins for Dare County Cell No. 4 epansion.

2.0 Procedure

1. Determine total area draining to each filter basin.
2. Determine Disturbed area draining to each filter basin.
3. Determine required pond volume.
4. Determine required surface area for pond behind berm.
5. Determine time of concentration.
6. Determine dimensions of pond.
7. Determine length of spillway.

3.0 References / Data Sources

1. Dare County C&D Landfill Cell # 4 Expansion
2. North Carolina Erosion and Sediment Control Planning and Design Manual

4.0 Assumptions / Limitations

1. Assume base design on 25-yr Storm

5.0 Calculations

Filter berms will be placed in the existing drainage ditches located east and west of Cell No. 4, downstream of cell construction, as shown in Sheet C-3, Grading Plan, of the permit application. FB-1 and FB-2 will serve same total and disturbed areas, so design will be the same.

1.) Total Area Draining to Each Filter Basin:

= 2,500 ft X 300 ft = 750,000 ft^2 = **17.22 AC**

2.) Disturbed Area Draining to Each Filter Basin (including cell & roads):

= 1/2*(2,300 ft X 300 ft) = 345,000 ft^2 = **7.9 AC**

3.) Determine reqd. pond volume behind berm:

V = 3,600 ft^3 / disturbed acre
V = 3,600*(7.9) = **14,220 ft^3**

4.) Determine reqd. surface area for pond behind berm:

Use Area (A) = 0.01 acres per cfs based on 25 yr storm (disturbed area only)

$Q_{25D} = C_D I_{25} A_D$ where:

Q_{25D} = 25yr peak runoff from disturbed area (cfs)
I_{25} = $_{25}$yr rainfall intensity (in/hr)
A_D = Disturbed Area (AC)
C_D = Runoff Coeificient for disturbed area, dimensionless

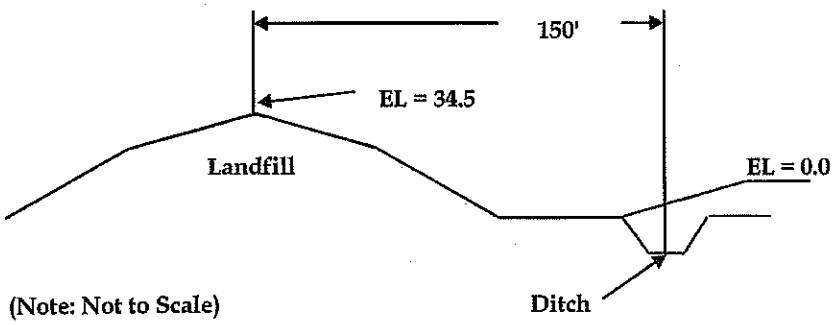
From Attachment A, use C_D = **0.45** for bare packed smooth soil

5.) Determine Time of Concentration:

Assume two components

1.) Overland flow from top of landfill to ditch.
2.) Ditch flow to filter basin.

1.) Use Attachment B for Overland Flow:



(Note: Not to Scale)

Conclusion:

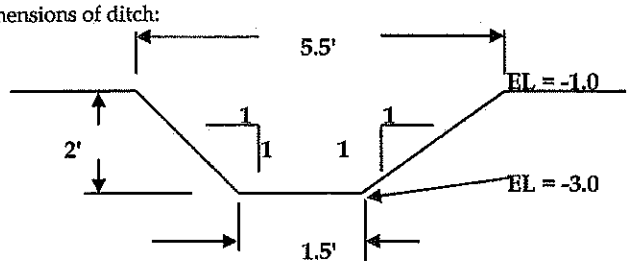
H = 34.5 ft
L = 150 ft

From Attachment B, T_{C1} = 0.5 min

CLIENT	Dare County	COMPUTED BY / DATE	WPS	01/21/09
PROJECT	Dare County Cell 4 C&D LF	CHECKED BY / DATE	WMB	-
DETAIL	Filter Basin #'s 1 &2	REVISION NO. / DATE	-	-
PROJECT NO.	17952-56960	REVIEWED BY / DATE	-	-

1.) Length of flow in ditch = **2100 ft**

Typical Dimensions of ditch:



(Note: Not to Scale)

Avg. Slope along ditch:

Slope (S) = 1'/2100' = 0.0005 = 0.05%

Determine Velocity in ditch using Manning's Eqn.

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n_{Total}}$$

Where: r = hydraulic radius
s = Slope
n = Manning's Coeff.

	n = 0.02	for channels in earth (basic)
	0.010	
+	0.005	Low vegetative effect
n_{Total} =	0.035	

V = 0.94 ft/s

Conclusion:

T_{C2} = 2100'/0.94 ft/s =2,234 sec = **37.2 min**

$T_{CTotal} = T_{C1} + T_{C2}$ = 0.5 min + 37.2 min = **37.7 min**

From Attachment C, for T_C = 37.7 min.

25yr intensity = **5.31 in/hr** (Hatteras)

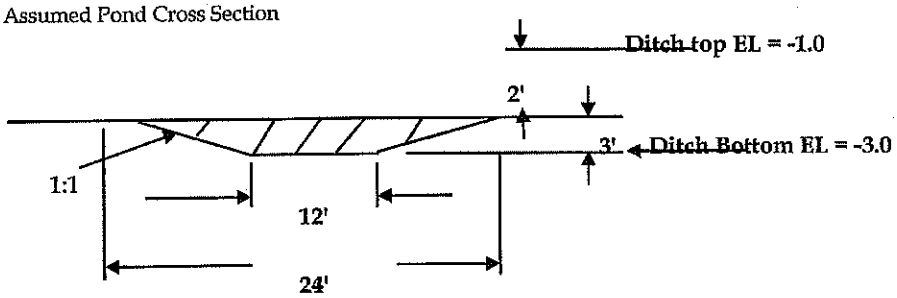
Conclusion:

$Q_{25D} = C_D I_{25} A_D = 0.45*(5.31)*(7.9) =$ **18.9 cfs**

Reqd. Surface Area of Pond = 0.01*(18.9 cfs) = **0.19 AC**

6.) Determine Dimensions of Pond:

Assumed Pond Cross Section



(Note: Not to Scale)

Sediment Storage Volume per foot of cross-section

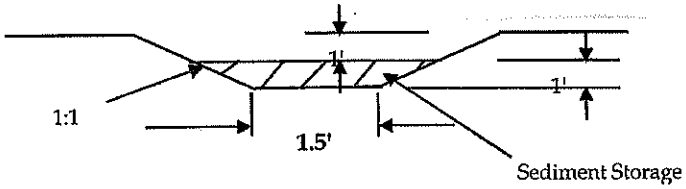
$V = (12' + 6')*(3') = 54\ ft^3/ft$

Reqd. Volume = 14,220 ft^3

$$\text{Reqd. Length of Pond} = \frac{14{,}220\ ft^3}{54ft^2} = \textbf{263 ft (Too Long)}$$

Account for sediment storage capacity of existing ditch or 1.0' between spillway and ditch bottom:

Typcial Dimensions of ditch



Sediment storage volume per ft of ditch

$= (1.5' + 1')*(1') = 2.5\ ft^3/ft$

Length of ditch =2,100 ft

Conclusion:

Sediment storage capacity per ditch

$V = 2.5ft^3/ft\ (2{,}100ft) = \mathbf{5{,}250\ ft^3}$

Reqd. length of pond after accounting for sediment storage within ditch:

$$\frac{14{,}220\ ft^3 - 5{,}250\ ft^3}{54} = 166' \quad \textbf{(Use 170')}$$

Check surface Area Requirement:

Reqd. Surface Area = **0.19 AC**

Surface Area of Pond at ditch bottom elev.

$A_1 = 24'(170') = \mathbf{4{,}080\ ft^2}$

Surface area of ditch w/ 1' of ponded water:

$A_2 = 2.5'(2{,}100') = \mathbf{5{,}250\ ft^2}$

Total Surface Area = $A_1 + A_2$ = 9,350 ft2 = **0.21 AC**

0.21 AC > 0.19AC OK!

7.) Determine Length of Spillway:

Total Area draining to each basin = 17.22 AC of which 7.9 AC is disturbed:

Undisturbed area = 17.22 AC - 7.9 AC = **9.32 AC**

Use C = 0.30 (Pasture heavy soil) (See Attachment A)

Disturbed Area = **7.9 AC**

Use C = 0.45 (Base Packed Soil, Smooth)

$$\text{Composite } C_C = \frac{9.32*(0.30)+7.9*(0.45)}{17.22} = \mathbf{0.37}$$

Flow through spillway: $Q_{25} = C_C I_{25} A_T$

$Q_{25} = CLH^{1.5}$

Where:
- Q = discharge (cfs)
- C = Coefficient = 2.6
- L = Length of weir (ft)
- H = Depth of flow over weir = 0.5

Try L = 10' :

$Q = 2.6*(10)*(0.5)^{1.5} = 9.19$ cfs < 23 cfs (No Good!)

Solve for L:

$$L_{reqd} = \frac{Q}{CH^{1.5}} = \frac{23}{2.6(0.5)^{1.5}} = \mathbf{25'}$$

6.0 Conclusion

Based on the above calculations filter basin # 1 & 2 need to be built at a minimum to the above highlighted dimensions to treat the 25-yr storm and meet the requirements of the NC Erosion and Sediment Control Planning and Design Manual.

ATTACHMENT A

Table 8.03a
Value of Runoff Coefficient (C) for Rational Formula

Land Use	C
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.50-0.70
Residential:	
Single-family areas	0.30-0.50
Multi units, detached	0.40-0.60
Multi units, attached	0.60-0.75
Suburban	0.25-0.40
Industrial:	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard areas	0.20-0.40
Unimproved areas	0.10-0.30
Streets:	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.85
Roofs	0.75-0.85

Land Use	C	
Lawns:		
Sandy soil, flat, 2%	0.05-0.10	
Sandy soil, ave., 2-7%	0.10-0.15	
Sandy soil, steep, 7%	0.15-0.20	
Heavy soil, flat, 2%	0.13-0.17	
Heavy soil, ave., 2-7%	0.18-0.22	
Heavy soil, steep, 7%	0.25-0.35	
Agricultural land:		
Bare packed soil		
Smooth	0.30-0.60	Avg. = 0.45
Rough	0.20-0.50	
Cultivated rows		
Heavy soil no crop	0.30-0.60	
Heavy soil with crop	0.20-0.50	
Sandy soil no crop	0.20-0.40	
Sandy soil with crop	0.10-0.25	
Pasture		
Heavy soil	0.15-0.45	Avg. = 0.30
Sandy soil	0.05-0.25	
Woodlands	0.05-0.25	

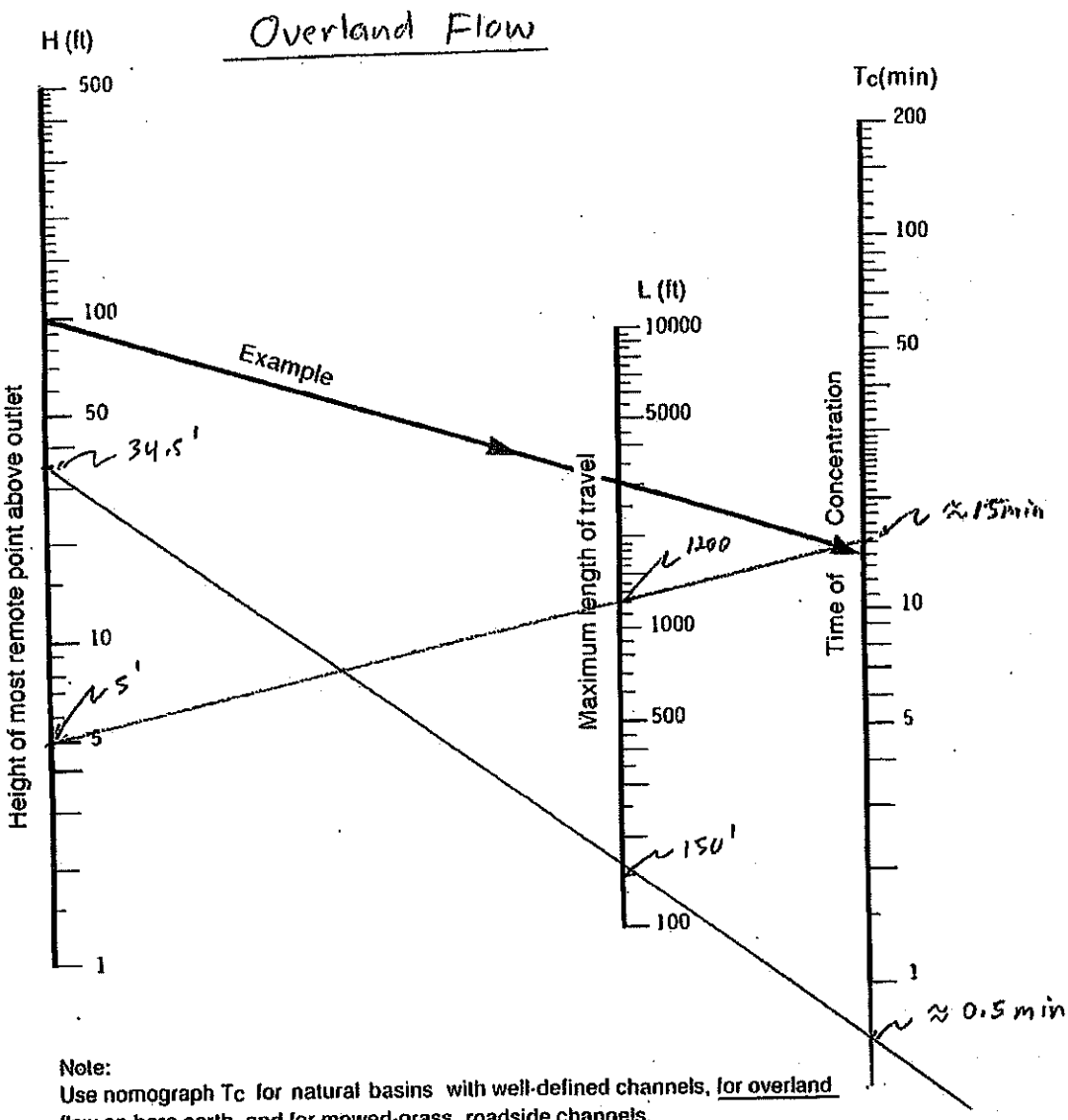
NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

Source: American Society of Civil Engineers

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

Step 4. Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration, T_C. Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor, i, in inches per hour.

Step 5. Determine peak discharge, Q (ft^3/sec), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

ATTACHMENT C

Raleigh, North Carolina 35.8706N, 78.7864W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	6.86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

Fayetteville, North Carolina 35.0583N, 78.8583W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.11	4.88	4.09	2.83	1.77	1.04	0.74	0.44	0.26	0.15
10	7.96	6.36	5.36	3.88	2.53	1.54	1.10	0.66	0.39	0.23
25	8.94	7.13	6.02	4.46	2.97	1.83	1.32	0.80	0.47	0.28
100	10.44	8.29	6.99	5.35	3.69	2.29	1.69	1.03	0.62	0.36

Wilmington, North Carolina 34.2683N, 77.9061W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.39	5.92	4.96	3.42	2.15	1.28	0.91	0.56	0.33	0.19
10	9.70	7.75	6.54	4.74	3.08	1.94	1.39	0.87	0.51	0.30
25	10.98	8.75	7.40	5.48	3.65	2.38	1.73	1.08	0.64	0.38
100	12.92	10.27	8.65	6.63	4.56	3.18	2.37	1.49	0.89	0.53

Washington, North Carolina 35.5333N, 77.0167W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.41	5.12	4.29	2.96	1.86	1.10	0.78	0.47	0.27	0.16
10	8.38	6.70	5.65	4.09	2.66	1.64	1.19	0.72	0.42	0.25
25	9.48	7.55	6.38	4.73	3.15	1.99	1.46	0.88	0.52	0.31
100	11.16	8.87	7.47	5.72	3.94	2.58	1.93	1.18	0.70	0.42

Manteo Airport, North Carolina 35.9167N, 75.7000W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.46	5.16	4.32	2.99	1.87	1.08	0.79	0.48	0.29	0.17
10	8.47	6.77	5.71	4.14	2.69	1.62	1.20	0.74	0.44	0.27
25	9.56	7.62	6.44	4.77	3.17	1.96	1.47	0.91	0.54	0.33
100	11.26	8.95	7.54	5.77	3.98	2.54	1.95	1.21	0.73	0.44

Cape Hatteras, North Carolina, 35.2322N, 75.6225W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.20	5.75	4.82	3.33	2.09	1.29	0.94	0.58	0.34	0.20
10	9.41	7.52	6.35	4.60	2.99	1.93	1.43	0.89	0.53	0.31
25	10.66	8.49	7.18	5.31	3.54	2.33	1.75	1.09	0.65	0.38
100	12.53	9.95	8.39	6.42	4.42	3.03	2.32	1.45	0.88	0.51

CLIENT	Dare County	COMPUTED BY / DATE	WPS 01/22/09
PROJECT	Dare County Cell 4 C&D LF	CHECKED BY / DATE	WMB -
DETAIL	Cell # 4 Canal Crossing	REVISION NO. / DATE	- -
PROJECT NO.	17952-56960	REVIEWED BY / DATE	- -

Calculation Brief Title: Cell # 4 Canal Crossing

1.0 Objective

Design a Canal Crossing for Cell # 4

2.0 Procedure

1. Estimate flow passing through culvert.
2. Estimate time of concentration.
3. Determine flow capacity of single 36" dia. CMP pipe.

3.0 References / Data Sources

1. Dare County C&D Landfill Cell # 4 Expansion
2. North Carolina Erosion and Sediment Control Planning and Design Manual

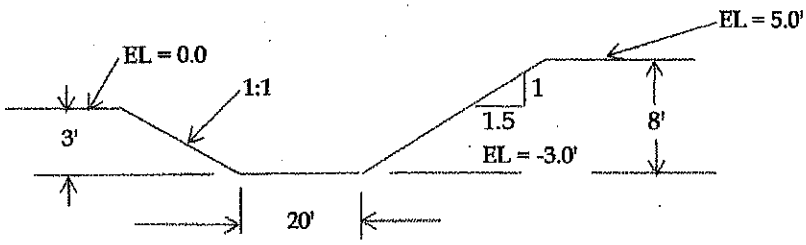
4.0 Assumptions / Limitations

1. Assume base design on 25-yr Storm

5.0 Calculations

Canal crossing will occur on the south side of Cell # 4 at Cub Road. The crossing will be designed in accordance with the North Carolina Erosion and Sedimentation Control Planning and Design Manual for stream crossings.

Cross - Section of Canal @ proposed crossing @ Cub Rd.



1.) Estimate flow passing through culvert:

A = 2,700' X 2,700' = 7,290,00 ft^2 = 167 AC

Assume maximum disturbed area for any given time
= 15 AC c = 0.45 (Bare packed soil, smooth) - See Attachment A

Undisturbed Area = 167 AC - 15 AC = 152 AC
C = 0.30 (Pasture, Heavy Soil)

$$\text{Composite } C_c = \frac{15*(0.45) + 152*(0.30)}{167} = 0.31$$

2.) Estimate Time of Concentration:

Assume two components:

1.) Overland flow from most remote point.
2.) Ditch/canal flow.

Use Attachment B, Assume H = 5' , L = 1,200'

T_{c1} = **15 min**

Length of flow in ditches/canal = **4,100'**

Assume V = **1 ft/s** in ditches/canal (see filter basin calcs.)

T_{c2} = **68 min**

T_{CT} = 15 min + 68 min = **83 min**

From Attachment C, for T_C = 37.7 min.

25yr intensity = **3.54 in/hr** (Hatteras - 60 min)

$Q_{p25} = C_c I_{10} A_T$ = 0.31(3.54)(167) = **184 cfs**

2.) Determine flow capacity of 36" Dia. CMP pipe.

1.) Use chart on Attachment D.
2.) Assume submerged outlet.

Length of culvert, L = 60'

Use Ke = 0.9 for cmp projecting from fill (no headwall)

Assume H = 1'

From Attachment D, Q = **24 cfs** per 36" pipe.

6.0 Conclusion

Upstream existing canal crossing, has three 36" CMP culverts, which will limit flow entering new canal crossing. Thus three culverts were choosen on the basis that the flow will not overflow the crossing because sufficient head will be generated to drive the flow through the three 36" CMP culverts.

ATTACHMENT A

Table 8.03a
Value of Runoff Coefficient (C) for Rational Formula

Land Use	C
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.50-0.70
Residential:	
Single-family areas	0.30-0.50
Multi units, detached	0.40-0.60
Multi units, attached	0.60-0.75
Suburban	0.25-0.40
Industrial:	
Light areas	0.50-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.20-0.35
Railroad yard areas	0.20-0.40
Unimproved areas	0.10-0.30
Streets:	
Asphalt	0.70-0.95
Concrete	0.80-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.85
Roofs	0.75-0.85

Land Use	C	
Lawns:		
Sandy soil, flat, 2%	0.05-0.10	
Sandy soil, ave., 2-7%	0.10-0.15	
Sandy soil, steep, 7%	0.15-0.20	
Heavy soil, flat, 2%	0.13-0.17	
Heavy soil, ave., 2-7%	0.18-0.22	
Heavy soil, steep, 7%	0.25-0.35	
Agricultural land:		
Bare packed soil		
Smooth	0.30-0.60	Avg. = 0.45
Rough	0.20-0.50	
Cultivated rows		
Heavy soil no crop	0.30-0.60	
Heavy soil with crop	0.20-0.50	
Sandy soil no crop	0.20-0.40	
Sandy soil with crop	0.10-0.25	
Pasture		
Heavy soil	0.15-0.45	Avg. = 0.30
Sandy soil	0.05-0.25	
Woodlands	0.05-0.25	

NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C values.

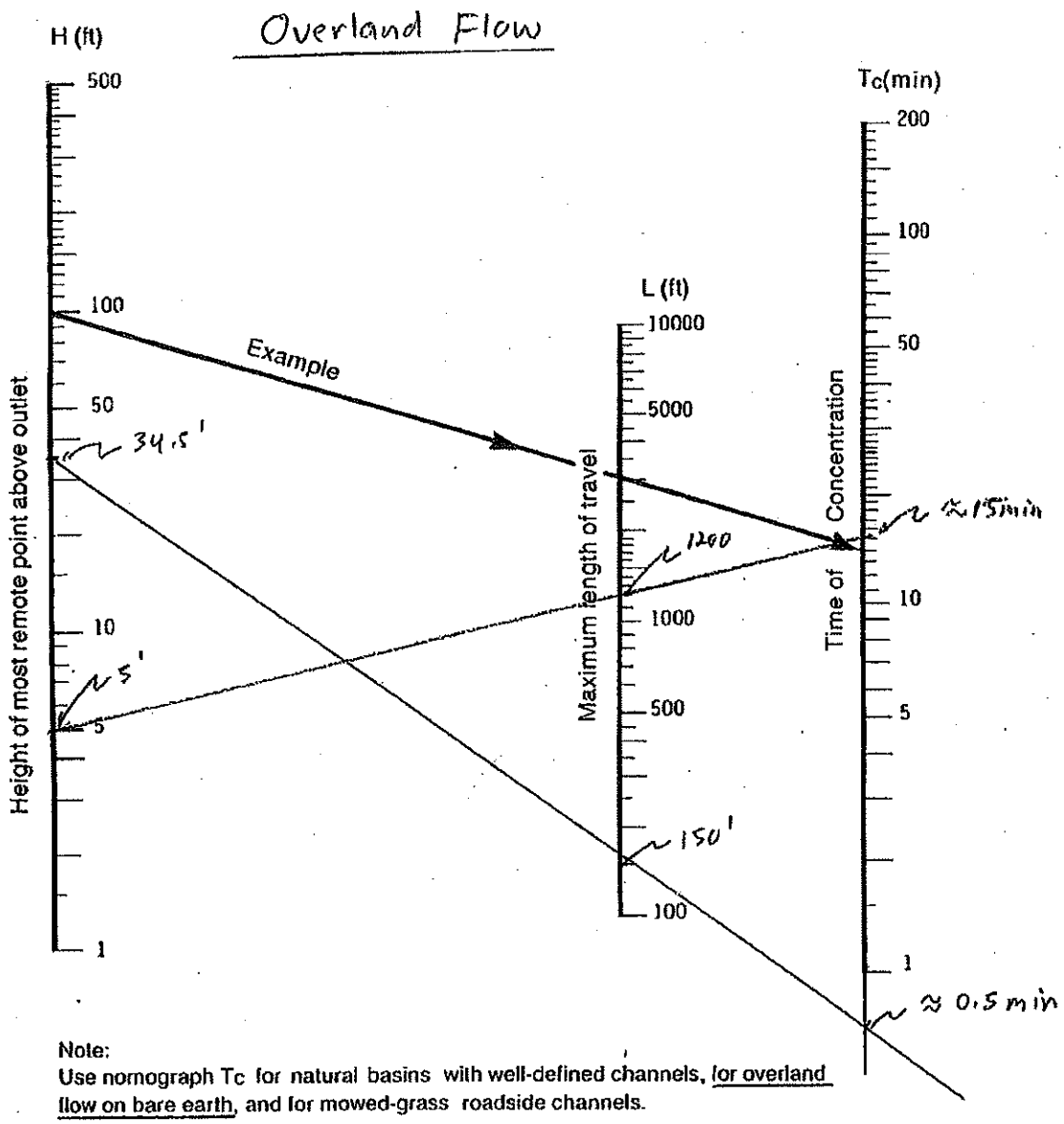
Source: American Society of Civil Engineers

The overland flow portion of flow time may be determined from Figure 8.03a. The flow time (in minutes) in the channel can be estimated by calculating the average velocity in feet per minute and dividing the length (in feet) by the average velocity.

Step 4. Determine the rainfall intensity, frequency, and duration (Figures 8.03b through 8.03g—source: North Carolina State Highway Commission; Jan. 1973). Select the chart for the locality closest to your location. Enter the "duration" axis of the chart with the calculated time of concentration, Tc. Move vertically until you intersect the curve of the appropriate design storm, then move horizontally to read the rainfall intensity factor, i, in inches per hour.

Step 5. Determine peak discharge, Q (ft^3/sec), by multiplying the previously determined factors using the rational formula (Sample Problem 8.03a).

ATTACHMENT B



Note:
Use nomograph Tc for natural basins with well-defined channels, for overland flow on bare earth, and for mowed-grass roadside channels.

For overland flow, grassed surfaces, multiply Tc by 2.

For overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

For concrete channels, multiply Tc by 0.2.

Figure 8.03a Time of concentration of small drainage basins.

ATTACHMENT C

Raleigh, North Carolina 35.8706N, 78.7864W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	5.58	4.46	3.74	2.58	1.62	0.94	0.66	0.40	0.24	0.14
10	7.08	5.66	4.78	3.46	2.25	1.33	0.95	0.58	0.34	0.021
25	7.78	6.19	5.24	3.88	2.58	1.54	1.11	0.68	0.41	0.24
100	8.64	6.86	5.78	4.43	3.05	1.85	1.36	0.84	0.51	0.30

Fayetteville, North Carolina 35.0583N, 78.8583W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.11	4.88	4.09	2.83	1.77	1.04	0.74	0.44	0.26	0.15
10	7.96	6.36	5.36	3.88	2.53	1.54	1.10	0.66	0.39	0.23
25	8.94	7.13	6.02	4.46	2.97	1.83	1.32	0.80	0.47	0.28
100	10.44	8.29	6.99	5.35	3.69	2.29	1.69	1.03	0.62	0.36

Wilmington, North Carolina 34.2683N, 77.9061W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.39	5.92	4.96	3.42	2.15	1.28	0.91	0.56	0.33	0.19
10	9.70	7.75	6.54	4.74	3.08	1.94	1.39	0.87	0.51	0.30
25	10.98	8.75	7.40	5.48	3.65	2.38	1.73	1.08	0.64	0.38
100	12.92	10.27	8.65	6.63	4.56	3.18	2.37	1.49	0.89	0.53

Washington, North Carolina 35.5333N, 77.0167W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.41	5.12	4.29	2.96	1.86	1.10	0.78	0.47	0.27	0.16
10	8.38	6.70	5.65	4.09	2.66	1.64	1.19	0.72	0.42	0.25
25	9.48	7.55	6.38	4.73	3.15	1.99	1.46	0.88	0.52	0.31
100	11.16	8.87	7.47	5.72	3.94	2.58	1.93	1.18	0.70	0.42

Manteo Airport, North Carolina 35.9167N, 75.7000W

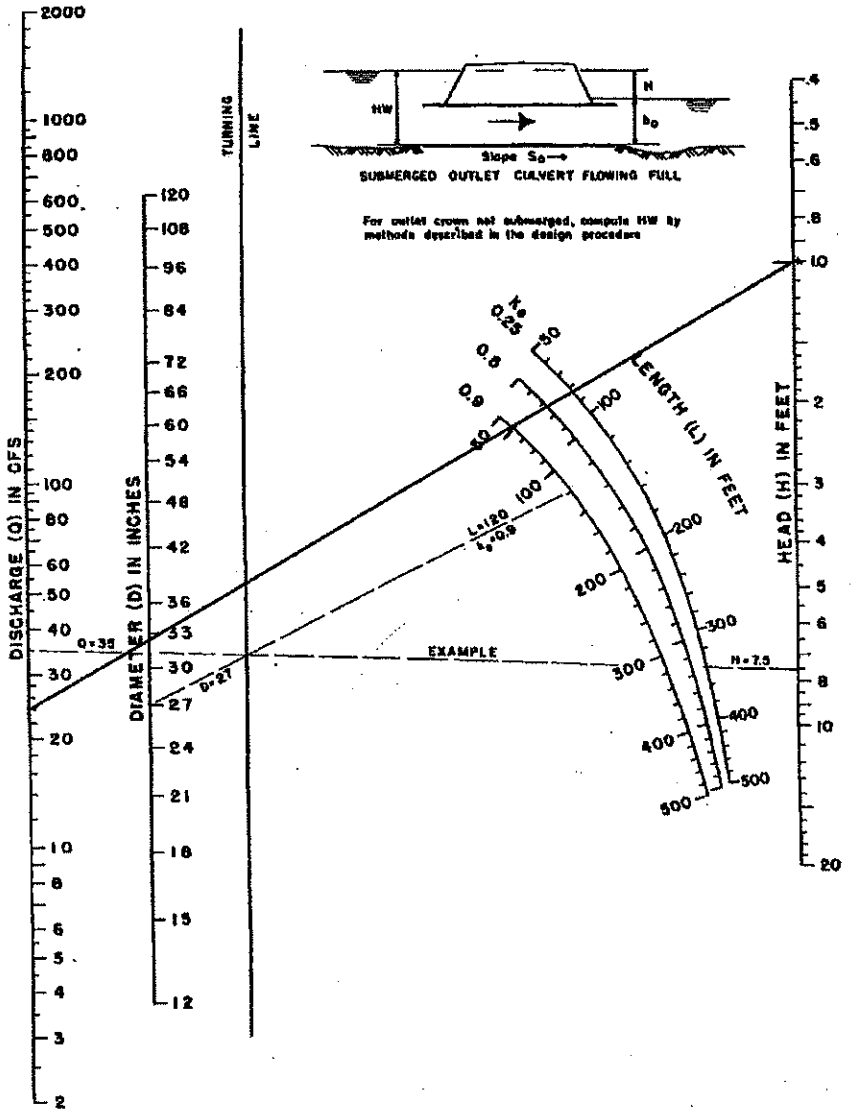
ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	6.46	5.16	4.32	2.99	1.87	1.08	0.79	0.48	0.29	0.17
10	8.47	6.77	5.71	4.14	2.69	1.62	1.20	0.74	0.44	0.27
25	9.56	7.62	6.44	4.77	3.17	1.96	1.47	0.91	0.54	0.33
100	11.26	8.95	7.54	5.77	3.98	2.54	1.95	1.21	0.73	0.44

Cape Hatteras, North Carolina, 35.2322N, 75.6225W

ARI* (years)	5 min.	10 min.	15 min.	30 min.	60 min.	120 min.	3 hr.	6 hr.	12 hr.	24 hr.
2	7.20	5.75	4.82	3.33	2.09	1.29	0.94	0.58	0.34	0.20
10	9.41	7.52	6.35	4.60	2.99	1.93	1.43	0.89	0.53	0.31
25	10.66	8.49	7.18	5.31	3.54	2.33	1.75	1.09	0.65	0.38
100	12.53	9.95	8.39	6.42	4.42	3.03	2.32	1.45	0.88	0.51

ATTACHMENT D

Exhibit 20
Culvert capacity under outlet control
Standard circular CMP



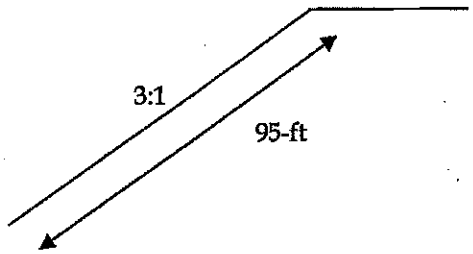
HEAD FOR
STANDARD
C. M. PIPE CULVERTS
FLOWING FULL
n = 0.024

BUREAU OF PUBLIC ROADS JAN. 1963

Task: 1 Design permanent/ temporary stabilization for the Cell No. 4 closure slopes.

Reference North American Green ECMDS® version 4.3- slope protection design

Given
Slope length: 95 ft
Side slope: 3:1
Vegetation coverage: Fair condition
Project location: Dare County NC, US
Soil Type: sand



1- Permanent slope stability

The following assumptions were made for the permanent slope stability analysis
- Reinforcement material SC250
- Bunch-type vegetatic
- Fairly dense vegetation
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 4.9 (*See Attachment 1*)

2- Temporary slope stability

The following assumptions were made for the temporary slope stability analysis
- Reinforcement material SC250
- Bunch-type vegetation
- Fairly dense vegetation
- Duration 12 months
- Beginning month is December
- Project Location - Norfolk Virginia (Closest City)

The analysis performed using North American Green ECMDS® shows that the slope is stable with a safety factor of 3.5 (*See Attachment 2*)

Conclusion: SC250 reinforcement material is capable of providing both temporary and permanent stabilization for the Dare County Cell No. 4 closure slope.

Attachment 1
North American Green Permanent Slope Protection Analysis

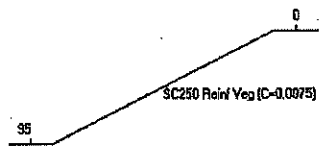
CDM

North American Green - ECMDS Version 4.3 | 7/16/2009 | 02:28 PM | COMPUTED BY: Patrick Stout

PROJECT NAME: Dare County Cell No 4 | PROJECT NO.: 17952-56960 | SLOPE DESCRIPTION: Landfill Closure Sideslopes

County	United States
State/Region	Virginia
City	Norfolk
Annual R Factor	250
Total Slope Length (ft)	95
Protection Type	Permanent
Protection Period (months)	
Beginning Month	
Adjusted R Value	250.
Slope Gradient (H:1)	3
Soil Type	Sand
K Factor	0.1
Soil Loss Tolerance (in)	0.03

Slope Gradient = 3:1



Not to Scale

Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)			SLT (in)	SF	Remarks
1	0	95	SC250 Reinf.	Bunch Type	50-75%	0.830	0.006			0.03	4.819	STABLE
2												
3												
	0	95		Composite		0.830	0.006					

Vegetation Density=Percentage of soil coverage provided by vegetation
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
MSLbare=Maximum Soil Loss potential on unprotected soil (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Composite=Average soil loss from total slope length (uniform inches)

C=Cover material performance factor (Fraction of soil loss of unprotected)
ASLmat=Average Soil Loss potential w/material (uniform inches)
MSLmat=Maximum Soil Loss potential w/material (uniform inches)
SF=Safety Factor

"

****
NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3
NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.
USER SPECIFIED - PERMANENT BACK-UP COMPUTATIONS
****

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960
COMPUTED BY: Patrick Stout DATE: 7/16/2009
SLOPE DESCRIPTION: Landfill Closure Sideslopes

***** INPUT PARAMETERS *****

Slope Gradient: 3:1
Slope Degrees = tan^(-1) (1/3) = 18.43 degrees
Slope Length: 95 feet (29.0 meters)
Soil Type: Sand
K Factor: K= 0.10 t*ac*h/100*ac*ft*tonf*in (K= 0.01 t*ha*h/ha*MJ*mm)
Annual R Factor: 260 100ft*t*in/ac*hr*yr (4425 MJ*mm/ha*h*y)
for United States, Virginia, Norfolk
PRECIPDIST = 100

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL	TYPE	Density FACTOR	C
1	95 feet/29.0 meters	SC250 Reinf. Ve	Bunch Type		0.008

SLT = 0.03 inches (0.08 centimeters)
ADJR = 260 * 100.0 / 100 =260.0 100ft*tonf*in/ac*hr*yr (4425.2 MJ*mm/ha*h*yr)
Soil Loss Factor (SLF) = 1.46 inches (3.72 cm)

***** CALCULATIONS *****

REACH NUMBER: ***1***
CUMHORZL1 =95 * cos(18.4) = 90.1 feet (27.5 meters)
LS 1 Factor = 5.36
Cumulative LS 1 Factor = 5.36
ASLBARE 1 = .00595 * 260 * 0.10 * 5.36 =0.830 in (2.108 cm)
MSLBARE 1 = .00595 * 260 * 0.10 * 1.46 *5.36 =1.215 in (3.085 cm)
ASLMAT 1 = 0.0075 * 0.830 =0.006 in (0.016 cm)
MSLMAT 1 = 0.0075 * 1.215 =0.009 in (0.023 cm)
SF 1 = 0.030 / 0.006 =4.819

COMPASLBARE 1 =0.830 * [(95 - 0) / 95] = 0.830 in (2.108 cm)

TOTCOMPASLBARE = 0.830 in (2.108 cm)

COMPASLMAT 1 =0.006 * [(95 - 0) / 95] = 0.006 in (0.016 cm)
TOTCOMPASLMAT = 0.006 in (0.016 cm)

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.

Attachment 2
North American Green Temporary Slope Protection Analysis

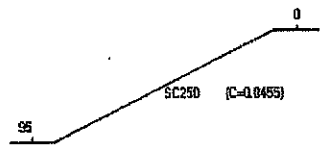
CDM

North American Green - ECMDS Version 4.3 | 7/16/2009 | 02:28 PM | COMPUTED BY: Patrick Stout

PROJECT NAME: Dare County Cell No 4 | PROJECT NO.: 17952-66960 | SLOPE DESCRIPTION: Landfill Closure Sideslopes

County	United States
State/Region	Virginia
City	Norfolk
Annual R Factor	250
Total Slope Length (ft)	95
Protection Type	Temporary
Protection Period (months)	12
Beginning Month	December
Adjusted R Value	250
Slope Gradient (H:1)	3
Soil Type	Sand
K Factor	0.1
Soil Loss Tolerance (in)	0.25

Slope Gradient = 3:1



Not to Scale

Reach	Cum. Dist. Begin (ft)	Cum. Dist. End (ft)	Material	Vegetation Type Growth Habit	Density	ASL bare (in)	ASL mat (in)	MSL bare (in)	MSL mat (in)	SLT (in)	SF	Remarks	Staple
1	0	95	SC250			0.686	0.040	1.531	0.070	0.25	3.590	STABLE	D
2													
3													
	0	95		Composite		0.686	0.040						

Vegetation Density=Percentage of soil coverage provided by vegetation
ASLbare=Average Soil Loss potential of unprotected soil (uniform inches)
MSLbare=Maximum Soil Loss potential on unprotected soil (uniform inches)
SLT=Soil Loss Tolerance for slope segment (uniform inches)
Composite=Average soil loss from total slope length (uniform inches)

C=Cover material performance factor (Fraction of soil loss of unprotected)
ASLmat=Average Soil Loss potential w/material (uniform inches)
MSLmat=Maximum Soil Loss potential w/material (uniform inches)
SF=Safety Factor

"

****
NORTH AMERICAN GREEN EROSION CONTROL MATERIALS DESIGN SOFTWARE VERSION 4.3
NORTH AMERICAN GREEN SLOPE PROTECTION - ENGLISH/S.I.
USER SPECIFIED - TEMPORARY BACK-UP COMPUTATIONS
****

PROJECT NAME: Dare County Cell No 4 Expansion PROJECT NO.: 17952-56960
COMPUTED BY: Patrick Stout DATE: 7/16/2009
SLOPE DESCRIPTION: Landfill Closure Sideslopes

***** INPUT PARAMETERS *****

Slope Gradient: 3:1
Slope Degrees = tan^(-1) (1/3) = 18.43 degrees
Slope Length: 95 feet (29.0 meters)
Soil Type: Sand
K Factor: K= 0.10 t*ac*h/100*ac*ft*tonf*in (K= 0.01 t*ha*h/ha*MJ*mm)
Annual R Factor: 260 100ft*t*in/ac*hr*yr (4425 MJ*mm/ha*h*y)
for United States, Virginia, Norfolk
Protection Period: 12 months from December to December, over 1 whole year(s)
Cumulative Annual R Factor For The Beginning Month: 97.0 %
Cumulative Annual R Factor For The End Month: 97.0 %

PRECIPDIST = 97.0 - 97.0 + (100 * 1) = 100.0

REACH NO.	CUMULATIVE DISTANCE TO END OF REACH	MATERIAL	C FACTOR
1	95 feet/29.0 meters	SC250	0.046

SLT = 0.25 inches (0.64 centimeters)
ADJR = 260 * 100.0 / 100 =260. 100ft*tonf*in/ac*hr*yr (4425.2MJ*mm/ha*h*yr)
Soil Loss Factor (SLF) = 1.73 inches (4.39 cm)

***** CALCULATIONS *****

REACH NUMBER: ***1***
CUMHORZL1 =95 * cos(18.4) = 90.1 feet (27.5 meters)
LS 1 Factor = 5.72
Cumulative LS 1 Factor = 5.72
ASLBARE 1 = .00595 * 260 * 0.10 * 5.72 =0.886 in (2.250 cm)
MSLBARE 1 = .00595 * 260 * 0.10 * 1.73 *5.72 =1.531 in (3.888 cm)
ASLMAT 1 = 0.0455 * 0.886 =0.040 in (0.102 cm)

MSLMAT 1 = 0.0455 * 1.531 =0.070 in (0.177 cm)
SF 1 = 0.250 / 0.070 = 3.590

COMPASLBARE 1 =0.886 * [(95 - 0) / 95] = 0.886 in (2.250 cm)
TOTCOMPASLBARE = 0.886 in (2.250 cm)

COMPASLMAT 1 =0.040 * [(95 - 0) / 95] = 0.040 in (0.102 cm)
TOTCOMPASLMAT = 0.040 in (0.102 cm)

For additional computation details, see the North American Green Users Manual and the Natural Resource Conservation Service RUSLE Documentation.
"

CDM				
CLIENT	Dare County	COMPUTED BY / DATE	WPS	03/30/09
PROJECT	Dare County Cell No. 4 C&D Landfill	CHECKED BY / DATE	WMB	-
DETAIL	Cell No. 4 Sediment Fence	REVISION NO. / DATE	-	-
PROJECT NO.	17952-56960	REVIEWED BY / DATE	-	-

Calculation Brief Title: Phase No. 4 Sediment Fence

1.0 Objective

Ensure that the drainage area is no greater than 1/4 acre per 100 feet of sediment fence and that the sediment fence meets the North Carolina Department of Environment and Natural Resources (NCDENR) Sedimentation and Erosoin Control Planning and Design Manual.

2.0 Procedure

1. Determine the drainage area for each sediment fence using AutoCAD.
2. Using the parameters provided in the NCDENR ESC Planning and Design Manual, design the sediment fence.

3.0 References / Data Sources

1. Refer to attached Dare County Cell ESC Permit drawings.
2. Refer to NCDENR ESC Planning and Design Manual.

4.0 Assumptions / Limitations

1. Sediment Fence corresponding to drainage area DA-1, DA-2 and DA-3 are the only drainage areas acting as the primary treatment device and the remaining drainage areas will be used as an treatment device to capture as much sediment as possible prior to entering the filter basins.

5.0 Calculations

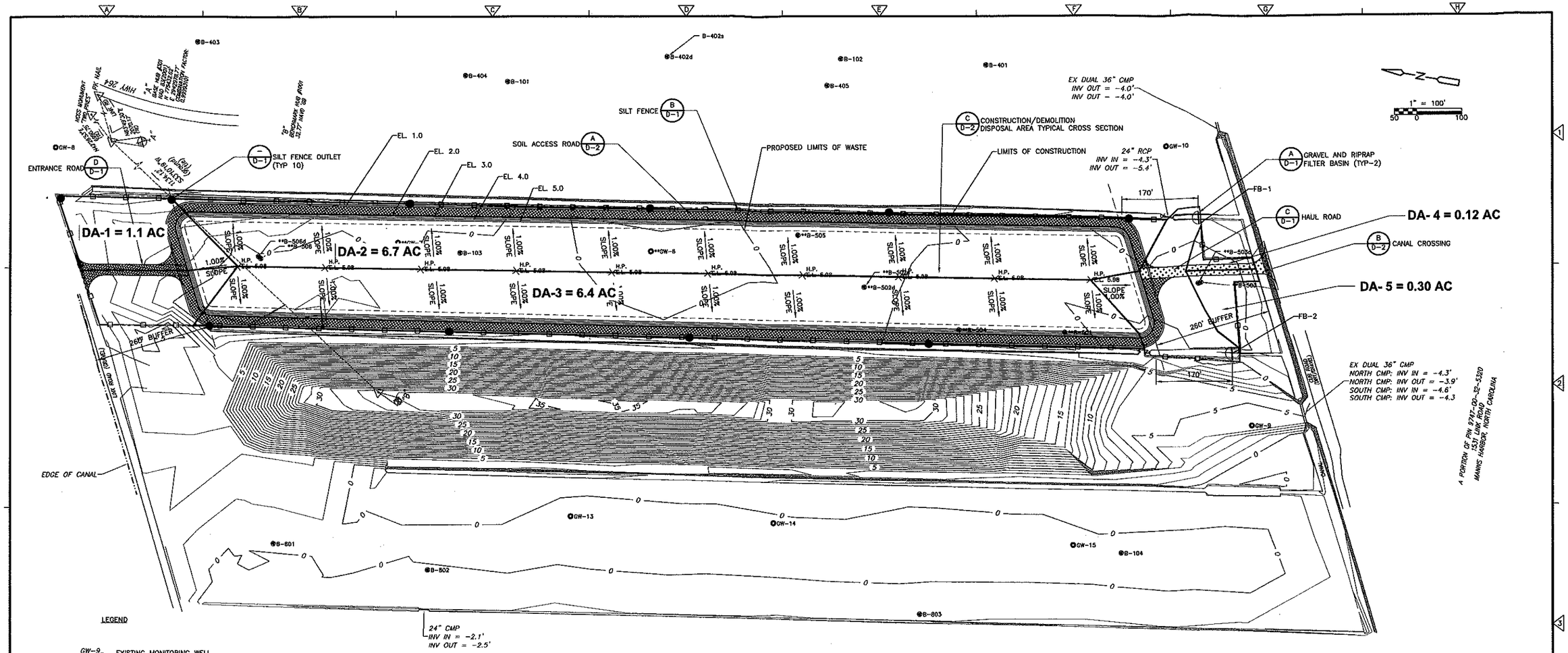
5.1 Calculations:

Location	Slope	Slope Length (ft)	Drainage Area (ft^2)	Drainage Area (Acres)	Length of Silt Fence (FT)	Area (ft^2) per 100 ft Length	Area (Acres) per 100 ft Length	CHECK
DA-1	<2%	100	43560	1.00	424	10274	0.24	<0.25
DA-2	<2%	100	291852	6.70	2187	13345	0.31	<0.25
DA-3	<2%	100	278784	6.40	2088	13352	0.31	<0.25
DA-4	<2%	100	5100	0.12	182	2802	0.06	<0.25
DA-5	<2%	100	12900	0.30	199	6482	0.15	<0.25

(Refer to Sheet C-3A for drainage areas)

5.0 Calculations

Based on the NCDENR ESC Planning and Design Manual Guidelines, drainage areas 2 & 3 do not meet the requirements. However the sediment fence in these areas are a preliminary treatment device and are not the primary treatment device (filter basins 1 & 2). Therefore these segments of sediment fence do not have to meet the requirements. Sediment fence along drainage areas 1, 4 and 5 do meet the requirements.



LEGEND

- GW-9 EXISTING MONITORING WELL
- P-1 EXISTING PIEZOMETER
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- H.P. EL. 0.00 HIGH POINT
- FB-1 FILTER BASIN
- SILT FENCE
- HAUL ROAD
- PROPOSED SOIL ACCESS ROAD
- ENTRANCE ROAD
- LIMITS OF CONSTRUCTION
- SILT FENCE OUTLET

GENERAL CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND/OR RELOCATE ALL EXISTING UTILITIES, DRAINAGE STRUCTURES, MONITORING WELLS, ETC. IN COORDINATION WITH THE APPROPRIATE UTILITIES, AGENCY, OR COMPANY WITHIN 72 HOURS PRIOR TO CONSTRUCTION. CONTRACTOR IS RESPONSIBLE FOR LOCATING, PROTECTING, MAINTAINING, AND RESTORING ALL SITE UTILITIES AND BUILDING SERVICES.
2. NO HAUL ROUTE SHALL BE USED FOR MATERIAL TRANSPORT UNTIL NO THE ROUTE HAS BEEN COORDINATED WITH THE OWNER.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR REPAIRING OR REPLACING, AT NO ADDITIONAL COST TO THE OWNER, ANY EXISTING MONITORING WELLS, DRAINAGE STRUCTURES, ETC. DAMAGED DURING CONSTRUCTION.
4. CONTRACTOR'S TRAILER SHALL BE LOCATED WITHIN STAGING AREAS AS DESIGNATED BY THE OWNER ON THIS SHEET. CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL NECESSARY UTILITY CONNECTIONS, A POTABLE WATER SUPPLY, AND TEMPORARY SANITARY SERVICE FOR TRAILER.
5. LOCATIONS, ELEVATIONS, AND DIMENSIONS OF EXISTING UTILITIES, STRUCTURES, AND OTHER FEATURES ARE SHOWN ACCORDING TO THE BEST INFORMATION AVAILABLE AT THE TIME OF THESE PLANS BUT DO NOT PURPORT TO BE ABSOLUTELY CORRECT. PRIOR TO CONSTRUCTION THE CONTRACTOR SHALL VERIFY AND AGREE TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL EXISTING UTILITIES, STRUCTURES, OR PRESERVATION AREAS AND OTHER FEATURES AFFECTING HIS WORK.
6. THE CONTRACTOR SHALL REPLACE ALL PAVING (ASPHALT, STONE, OR CONCRETE), STABILIZED EARTH, CURBS, DRIVEWAYS, SIDEWALKS, MAILBOXES, DRAINAGE CULVERTS, FENCES, ETC. WITH THE SAME TYPE OF MATERIAL THAT WAS REMOVED OR DAMAGED DURING CONSTRUCTION.
7. STORM DRAINAGE PIPE LENGTHS SHOWN ARE APPROXIMATE AND MAY BE ADJUSTED AS REQUIRED IN THE FIELD, UPON APPROVAL BY ENGINEER.
8. EXISTING DRAINAGE DITCHES SHALL HAVE SEDIMENT AND DEBRIS REMOVED AND SHALL BE REPAIRED AND ALL NEW EROSION CONTROL AND SEDIMENTATION CONTROL DEVICES SHALL BE IN PLACE PRIOR TO ANY CLEARING AND GRUBBING. THEY SHALL BE INSTALLED TO THE LIMITS OF CONSTRUCTION SHOWN ON THE DRAWINGS, REQUIRED IN THE SPECIFICATIONS AND IN ACCORDANCE WITH ALL REGULATORY AGENCY REQUIREMENTS.
9. THE LIMITS OF DISTURBANCE SHOWN ON THE PLANS SHALL BE STRICTLY OBSERVED BY THE CONTRACTOR. ALL INGRESS AND EGRESS AND TRAFFIC PATTERNS ON THE SITE SHALL BE WITHIN THE LIMITS OF DISTURBANCE.
10. CONTRACTOR SHALL VERIFY THE EXISTANCE AND ACCURACY OF BENCHMARK AND CONTROL DATA PRIOR TO INITIATING CONSTRUCTION. CONTRACTOR SHALL NOTIFY ENGINEER IF DISCREPANCES ARE FOUND.
11. CONTRACTOR SHALL STAKE OUT LIMITS OF WORK (INCLUDING CUT/FILL SLOPES) PRIOR TO INITIATING EXCAVATION AND BACKFILL ACTIVITIES. SURVEY DATA SHALL BE SUBMITTED TO ENGINEER FOR REVIEW. CONTRACTOR SHALL SEED AND MULCH ALL DISTURBED AREAS PER SPECIFICATIONS EXCEPT FOR ROAD SURFACES AND AREA WITHIN PROPOSED EDGE OF WASTE.
12. CONTROL POINTS PROVIDED ARE BASED ON A LOCAL COORDINATE SYSTEM. COORDINATE WITH QUIBLE & ASSOC., PC (PHONE NO. 252-261-3300) PRIOR TO LAYING OUT WORK.

SURVEY NOTES:

1. TOPOGRAPHIC SURVEY DATE 04/12-05/11-09 BY MCKIM AND CREED, PA.
2. REFERENCE DB 530, PG 733 & PL C, SL 32B.
3. DRAWING VERTICAL DATUM BASED ON GPS RAPID STATIC SESSIONS, OPUS REPORT NUMBERS 000023442, 000023441, 000023439 & 000031628 DATUM NAVD '88, FEET.
4. HORIZONTAL DATUM NAD 83(2007) AND VERTICAL DATUM VERIFICATION BASED UPON RAPID STATIC GPS SESSIONS 000381637, 000381747, 000180456, 000177169, 000147860, 000242228 AND 000237065.
5. CONDITIONS WITHIN SURVEY AREA MAY HAVE CHANGE SINCE DATE OF SURVEY.

REV. NO.	DATE	DRWN	CHKD	REMARKS

DESIGNED BY: P. STOUT
DRAWN BY: P. STOUT
SHEET CHK'D BY: K. YANG
CROSS CHK'D BY: M. BRINCHEK
APPROVED BY:
DATE: DECEMBER 2009

CDM
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5400 Glenwood Avenue, Suite 300
Raleigh, NC 27612
Tel: (919) 787-5620 Fax: (919) 781-5730
North Carolina Firm Licensure: F-0412
consulting • engineering • construction • operations

DARE COUNTY
NORTH CAROLINA
CONSTRUCTION & DEMOLITION DEBRIS LANDFILL
PHASE IV CONSTRUCTION DRAWINGS

DRAINAGE AREA MAP

PROJECT NO. 17952 56960
FILE NAME: C003ALFPL.DWG
SHEET NO.
C-3A

PERMIT SET

12/30/09 9:32:38 AM L:\17952-56960\CONFORMED DRAWINGS\1000A\C003LFPL_DRAINAGE_AREAS.DWG

Appendix F

STORMWATER INSPECTIONS FOR GENERAL PERMIT NCG010000 – LAND DISTURBING ACTIVITIES

PROJECT:_____**MONITORING FOR THE WEEK BEGINNING:**_____

All erosion and sedimentation control facilities and stormwater discharge outfalls must be inspected at least once (twice, if on 303(d) listed stream for construction related parameters*) per seven calendar days and within 24 hours of a rainfall of 0.5 inches per 24 hours. Permittee must keep a record of inspections.

RAINFALL: Gauge must be maintained on site

Date Of Rain	Amount (inches)	Name

By this signature, I certify (in accordance with Part II Section B, 10 of the NCG010000 permit) that this report is accurate and complete to the best of my knowledge:

_____

(Signature of Permittee or Designee)

EROSION AND SEDIMENTATION CONTROL FACILITIES INSPECTED: Identification of all facilities may require additional pages.

Facility Identification (all measures)	Date of inspection	Time of inspection	Name of inspector	Operating Properly (Y/N)	Describe corrective actions taken (may need to attach additional information)

OBSERVATIONS OF RUNOFF AT STORMWATER DISCHARGE OUTFALLS: Take immediate corrective action to control the discharge of sediments outside the disturbed limits of the site. May require additional pages.

Stormwater Discharge Outfall Identification	Date of inspection	Time of inspection	Name of inspector	Clarity (1-10)	Floating solids (1-10)	Suspended Solids (1-10)	Oil sheen (Y/N)	Other obvious indicators of stormwater pollution (list & describe)	Visible sediment leaving the site? (Y/N)	If yes, describe actions taken to prevent future releases (may need to attach additional information)	Describe measures taken to clean up sediment outside of the disturbed limits (may need to attach additional information)

Clarity: Choose the number which best describes the clarity of the discharge where 1 is clear and 10 is very cloudy
Floating Solids: Choose the number which best describes the amount of floating solids in the discharge where 1 is no solids and 10 the surface is covered in floating solids
Suspended Solids: Choose the number which best describes the amount of suspended solids in the discharge where 1 is no solids and 10 is extremely muddy

Has all land disturbing construction been completed? _____ (Y/N) Has the final permanent ground cover been completed & established? _____ (Y/N)

* 303(d) listed streams for construction related parameters – The latest approved list may be obtained from the Division of Water Quality, or from the following website location: *http://h2o.enr.state.nc.us/su/construction303d*