ADDENDUM NUMBER ONE

DUPONT PUMP STATION AND BASIN IMPROVEMENTS – PHASE 2 (Contract B)
W-12-026-203

CITY OF CHATTANOOGA, TENNESSEE

The Bid Date shall be extended to Friday, January 9, 2020 at 2:00 PM.

The following changes shall be made to the Contract Documents, Specifications, and Drawings:

I. CONTRACT DOCUMENT

- A copy of the Meeting Minutes and sign-in sheet from the Pre-Bid meeting on December 3, 2019 is attached.
- A copy of the Railroad Permit is attached.
- A Geotechnical Report prepared by CDM Smith is attached. Contractors may refer to the data presented in this report; however, reliance on any interpretations of such data are at the Contractor's sole risk.

II. Q&A/COMMENTS

Note: Duplicate questions were provided by several potential bidders. While wording varied slightly, duplicates have been removed.

1. We paid a fee and picked up a thumb drive with the specifications and the drawings for the Dupont Pump Station and Basin Improvements – Phase 2 (Contract B). There were no geo reports on the thumb drive, and these are needed to properly bid this project. I am told that they were attached to Contract A, but we did not participate in that bidding. Can we please get a copy of the geo reports?

   Response: A copy of the Geotechnical Report is attached.

2. a. Can the bid date for "Contract B" be extended to the first of the year?
   b. Due to the erratic rock profiles along the TN River can an adequate Geotechnical Report be provided along the mainline of the piping?
   c. Can a bid item be added for Railroad Flagging?
   d. Can a copy of the Railroad Permit be provided to the bidders?

   Response:
   a. The Bid Date shall be extended to Friday, January 9, 2020 at 2:00 PM.
   b. A copy of the Geotechnical Report is attached.
   c. An allowance for railroad flagging will be added to the bid form in Addendum No. 2.
   d. A copy of the railroad permit is attached.

3. Who is responsible for providing a flagman for work around the RR?

   Response: The Contractor is responsible for the cost. An allowance will be added to the Bid Form in Addendum No. 2

4. Can the Engineer provide the executed RR permit in Addendum No. 1?

   Response: A copy of the Railroad permit is attached to Addendum No. 1.

5. Can the Engineer provide the CADD files for the design plans?

   Response: The CADD files will be provided to the successful bidder.

7. Are items on the bid form lump sum or itemized?

   Response: There is a mixture of Unit Price and Lump Sum Bid Items. The Bid Form is going to be reissued in Addendum No. 2.

8. Due to time constraints and the upcoming holidays, we are requesting the bid date be pushed back until after the first of the year.

   Response: The Bid Date shall be extended to Friday, January 9, 2020 at 2:00 PM.

December 12, 2019

____
Justin C Holland, Administrator
City of Chattanooga

PRE-BID CONFERENCE MINUTES
Dupont Pump Station and Basin Improvements – Phase 2 (Contract B)
CONTRACT #W-12-026-203
December 3, 2019
Training Facility, Moccasin Bend Wastewater Treatment Plant

1. Introductions
    a. Owner – City of Chattanooga
    b. Program Manager – Jacobs
    c. Engineer – CDM Smith

2. Project Scope/Description
    a. The project location is between the Rivermont Park (Dixie Drive) and the existing Dupont Pump Station (Memphis and Elm Street). The Project generally consists of the installation of 6,200 LF of 48-inch diameter gravity sewer. Project also includes several other gravity sewer connections and the demolition of the existing Dupont Pump Station.

3. Pre-Bid Conference Agenda

4. Bid Documents
    a. Refer to Section 00 21 13 Instructions to Bidders
    b. Purchase Bids from 8:00 a.m. to 4:30 p.m., Monday through Friday, at the City of Chattanooga Purchasing Department, 101 East 11th Street, Suite G13, Chattanooga, TN 37402, phone (423) 643-7230, fax (423) 643-7244.
    c. Cost of Contract Documents is $100 per set. No part of the purchase will be refunded for any reason.
    d. Bid Bond in the amount of 5% of Bid with Surety licensed to do business in TN and listed in U.S. Treasury Circular 570.
    e. No Bid withdrawn within 120 calendar days of receipt of Bids.

5. Qualifications
    a. Refer to Section 00 21 13 Instructions to Bidders, and Section 00 45 13 Statement of Bidder's Qualifications
        i. Bidder shall maintain permanent place of business
        ii. Must be licensed by State of Tennessee to perform work under contract
        iii. Bidder shall demonstrate adequate construction experience and sufficient equipment resources to properly perform work.
        iv. Owner reserves the right to reject any bid if bidder fails to satisfy qualifications.

6. Bidding Requirements
    a. Bid Bond in the amount of 5% of Bid with Surety licensed to do business in TN and listed in U.S. Treasury Circular 570.
    b. No Bid withdrawn within 120 calendar days of receipt of Bids.
    c. Section 00 45 77 – Contractor's Identification must be completed, with one copy attached to the bid package, and one copy inside the bid package.

7. Bidder Questions and Addenda
    a. Use Section 00 21 14 – Request for Bidder Information. Submit by fax, email or mail to City of Chattanooga Purchasing Department. bidinfo@chattanooga.gov.
    b. Questions received after December 10th, 2019 may not be answered. All questions about the meaning or intent of the Bidding Documents are to be submitted to Owner in writing. Questions and other inquiries shall be submitted to the City of Chattanooga Purchasing Department.
    c. Required to purchase set of plans and specifications to get on the plan holders list. Only bidders on plan holders list will receive addenda; which must be acknowledged in the Bid Form.

8. Bid Opening
    a. Date/Time – December 17th, 2019 at 2pm
    b. Location – City of Chattanooga Purchasing Department, 101 East 11th Street, Suite G13, Chattanooga, TN 37402

9. Contract Completion Time
    a. Substantial Completion within 270 Calendar Days of Notice to Proceed (Section 00 52 00 will be corrected via addendum to match Bid Advertisement)
    b. Final Completion within 300 calendar days of Notice to Proceed

10. Liquidated Damages
    a. $1,000 for each day after Substantial Completion if work is deemed to not be substantially complete, and $1,000 for each day after Final Completion if Contractor has not completed the work.

11. Project Specific Requirements
    a. Refer to Section 01 12 16 for Construction Constraints and Proposed Sequence of Construction.
    b. Norfolk Southern Rail Road Crossing Permit has already been obtained.

12. Site Access
    a. All work to be completed shall be on the City of Chattanooga's property or easements.
    b. If needed, the Contractor is responsible for acquiring all required right of entry and temporary construction easements on private properties in order to access existing sewers and preform the required work.

13. Safety
    a. Refer to Section 00 72 00 and 00 73 00 General Conditions

14. Work Hours
    a. Work Hour Restrictions – Work hours shall be 7:00 a.m. to 6:00 p.m. Monday through Friday.

15. Allowances
    a. The Contractor shall include in the Bid Total all allowances stated in the Contract Documents. These allowances shall cover the net cost of the services provided.
    b. Allowance totals will be added to Bid Form in Addendum No. 1.

16. Other Items
    a. It is the Contractors responsibility to repair any existing utilities that are damaged during construction.
    b. The items discussed here today are not intended to be all-inclusive. It is the Contractor's responsibility to review the Contract Documents and comply with all provisions.

17. Questions

All Questions included in Contract B - Addendum No. 1

Pre-Bid Conference - DuPont Pump Station and Basin Improvements
Phase 2 (Contract B) - Contract #W-12-026-203
Tuesday, December 03, 2019

CDM Smith
listen. think. deliver.

Name	Company	Email Address	Phone
Denny Brestle	Jacobs	denny.brestle@jacobs.com	865-388-0900
Steve Stewart	Cleary Const	estimating@clearyconst.com	270-487-1784
Cain Maynard	Sunbelt Pump	cain.maynard@sunbeltrentals.com	615-838-2854
BONNIE MUMPOWER DODSON	COC	BMUMPOWER@CHATTANOOGA.GOV	643 6031
MIKE MCBRAYER	THOMAS BROTHERS	MIKE@TBCCINC.NET	(423) 842-6233
David Ward	SBW Contractors	dward@sbwconstructors.com	865-306-2788
RANDY TAYLOR	Chattanooga	rdtaylor@chattanooga.gov	423-718-7509
RICK WOLF	CDM SMITH	wolfrf@cdmsmith.com	423-271-9025
Kadir Ameen	City	kameen@chattanooga.gov	643 6179
Tanner Dodd	WBCCI	tdodd@wbcci.com	423.333.6634
Derek Kirkpatrick	Cross Country	Dkirkpatrick@ccpipeline.com	404-821-1931

AECOM
1700 Market Street
Suite 1600
Philadelphia, PA 19103
www.aecom.com

215 735 0832 tel
215 735 0883 fax

September 16, 2019

William C. Payne
City Manager
City of Chattanooga
1250 Market Street, Department of Public Works Engineering Division, Suite 2100, Development Resource Center
Chattanooga, TN 37351

Subject: Chattanooga, Hamilton County, Tennessee
Milepost 1.57-CD, C&D Branch, Alabama Division

Norfolk Southern Activity No. 1274468
Proposed installation of one (1) 48-inch fiber glass water pipeline in a 60-inch steel casing pipe and the undocumented existing 36-inch concrete water pipeline and 30-inch ductile iron water pipeline to be abandoned

Dear Mr. Payne:

AECOM, as consultant for Norfolk Southern Railway Company, has reviewed the occupancy permit application for City of Chattanooga regarding the proposed installation of an underground pipe, submitted on August 13, 2019, your project number 129699-109746.

Enclosed are two original counterparts of the Standard Pipe License Agreement for signature on behalf of City of Chattanooga. Please return to **this AECOM office** the following:

- Two originals of the Standard Pipe License Agreement signed and witnessed (in BLUE ink). DO NOT date this agreement as it will not go into effect until it has been executed by Railway.
- A check in the amount of $38,000.00 (**payable to THE CINCINNATI, NEW ORLEANS AND TEXAS PACIFIC RAILWAY COMPANY**) to cover the one-time license and Risk Management Fees. Payment of the Risk Management Fee will satisfy all requirements for Railroad Protective Liability Insurance for the installation of the facility.
- The Certificate of Commercial General Liability Insurance as required in Paragraph 11, a, ii. of the agreement.
    - In order to avoid delay to your project, please ensure the certificate is completed exactly as indicated on the attached sample. The description of operations must state "**THE CINCINNATI, NEW ORLEANS AND TEXAS PACIFIC RAILWAY COMPANY is included as additional insured - Activity Number 1274468**"
    - Certificate Holder must be in the name of:
      THE CINCINNATI, NEW ORLEANS AND TEXAS PACIFIC RAILWAY COMPANY
      Attn: Director Risk Management
      Three Commercial Place
      Norfolk, VA 23510

After receipt of all of the above items in this office, you should anticipate **approximately two weeks** for receipt of authorization to proceed with construction. **Please do not schedule your construction until you are in receipt of a fully executed agreement**. No work on Norfolk Southern property is authorized until you are in receipt of a fully executed agreement and instructions are obtained from Railway's designated construction representative. The contact information for Railway's construction representative(s) will be provided upon return of the fully executed counterpart.

The terms and conditions of this agreement shall be valid for 60 calendar days after the date of this letter. If you are unable to execute the agreement within this 60 calendar day time frame, please advise this office in writing of your intent. This activity will be automatically cancelled in 60 calendar days if the items requested above are not returned, or we do not receive your request for a time extension. Reactivation of cancelled activities may require a new application along with appropriate application fees, and license agreements will be re-drafted in accordance with the current Norfolk Southern terms and conditions.

Very truly yours,
Angelina Discienzo

Angelina Discienzo
Contract Administrator
215-789-2168
angelina.discienzo@aecom.com

Sample CGL Certificate

Licensee/Lessee/Industry identified in the agreement must be the named insured. Norfolk Southern also requires the prime contactors CGL certificate

The amount in this " Each Occurrence" box must be at least $1,000,000.00 or the amount in this box combined with the "Each Occurrence" coverage of any Excess Liability must be at least $1,000,000.00

This box should contain the Name of the Railroad included as an additional insured. This certificate applies to all contracts/agreements between the named insured and Railway. **Add Railway activity #**

Name of Railway must be the **exact name of Railway** on Agreement: Example, Central of Georgia Railroad Company, Florida Railway Company ect.

ACORD. | **CERTIFICATE OF INSURANCE** | ISSUE DATE

PRODUCER:

This certificate is issued as a matter of information only and confers no rights upon the Certificate Holder. This Certificate does not amend, extend or alter the coverage afforded by the policies below.

COMPANIES AFFORDING COVERAGE

Company A

INSURED

Company B

Company C

Company D

Company E

This is to certify that the policies of insurance described herein have been issued to the insured named herein for the policy period indicated. Notwithstanding any requirement, term or condition of contract or other document with respect to which the certificate may be issued or may pertain, the insurance afforded by the policies described herein is subject to all the terms, conditions and exclusions of such policies. Limits shown may have been reduced by paid claims.

CO LT	TYPE OF INSURANCE	POLICY NUMBER	EFFECTIVE EXPIRATION	LIMITS OF LIABILITY	
A	GENERAL LIABILITY ☒ Commercial General Liability ☐ Claims Made ☒ Occurrence ☐ Owners' and Contractors' Protection ☐ ☐ General Aggregate Limit applies per: ☒ Policy ☐ Project ☐ Location			EACH OCCURRENCE FIRE DAMAGE MEDICAL EXPENSE PERS. AND ADVERTISING INJURY GENERAL AGGREGATE PRODUCTS AND COMP. OPER. AGG.	$ $ $ $ $ $
A	AUTOMOBILE LIABILITY ☒ Any Automobile ☐ All Owned Automobiles ☐ Scheduled Automobiles ☐ Hired Automobiles ☐ Non-owned Automobiles ☐			COMBINED SINGLE LIMIT BODILY INJURY (Per person) BODILY INJURY (Per accident) PROPERTY DAMAGE (Per accident) COMPREHENSIVE COLLISION	
A	WORKERS' COMPENSATION AND EMPLOYERS' LIABILITY			WC Statutory Limit ☒ Other ☐ EL EACH ACCIDENT EL DISEASE (Each employee) EL DISEASE (Policy Limit)	 $ $
B	EXCESS LIABILITY ☐ Occurrence ☒ Claims Made			EACH OCCURRENCE AGGREGATE	$ $
					$ $ $ $ $

CERTIFICATE HOLDER

Three Commercial Place
Norfolk, VA 23510

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING INSURER WILL ENDEAVOR TO MAIL 30 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO DO SO SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE INSURER, ITS AGENTS OR REPRESENTATIVES.

Authorized Representative

Page 1 of 2 | Certificate ID #

Use this address

Please do <u>NOT</u> purchase Railroad Protective Liability Insurance

THIS AGREEMENT, dated as of the _____ day of ______________, 20___ is made and entered into by and between

THE CINCINNATI, NEW ORLEANS AND TEXAS PACIFIC RAILWAY COMPANY, an Ohio corporation, whose mailing address is Three Commercial Place, Norfolk, Virginia 23510 (hereinafter called "Railway"); and

CITY OF CHATTANOOGA, a political subdivision of the State of Tennessee, whose mailing address is 1250 Market Street, Suite 2100, Chattanooga, Tennessee 37402 (hereinafter called "Licensee").

WITNESSETH

WHEREAS, Licensee proposes to install, construct, maintain, operate and remove one (1) 48-inch fiber glass water pipeline in a 60-inch steel casing pipe (hereinafter called the "Facilities") which will replace an existing undocumented 36-inch concrete water pipeline and 30-inch ductile iron water pipeline (hereinafter called the "Original Facilities") located in, under and across the right-of-way or property and any tracks of Railway, at or near:

- Milepost 1.57-CD, C&D Branch
- Latitude N 35.103755, Longitude W 85.257035
- Chattanooga, Hamilton County, Tennessee
- Valuation Section 1, Map 66A, Stationing 77+78

the same to be located in accordance with and limited to the installation shown on print of drawings marked Exhibits A, B and C, received by Railway on September 3, 2019, and Pipe Data Sheet, attached hereto and made a part hereof; and

WHEREAS, Licensee desires a license to use such right-of-way or property of Railway for the installation, construction, maintenance, operation and removal of the Facilities.

NOW, THEREFORE, for and in consideration of the premises, the payment of a non-refundable, non-assignable one-time fee in the amount of THIRTY-EIGHT THOUSAND AND 00/100 DOLLARS ($38,000.00) to cover the Risk Financing Fee (as hereinafter defined) in the amount of $1,000.00 and a one-time license fee in the amount of $37,000.00, and the covenants hereinafter set forth, Railway hereby permits and grants to Licensee, insofar as Railway has the right to do so, without warranty and subject to all encumbrances, covenants and easements to which Railway's title may be subject, the right to use and occupy so much of Railway's right-of-way or property as may be necessary for the installation, construction, maintenance, operation and removal of the Facilities and as may be necessary for the maintenance and operation of the Original Facilities until installation of the Facilities followed immediately by abandonment of the Original Facilities by filling with cement grout, compacted sand, flowable fill or other methods as approved by the Railway (said right-of-way or property of Railway being hereinafter collectively called the "Premises"), upon the following terms and conditions:

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1. Use and Condition of the Premises. The Premises shall be used by Licensee only for the installation, construction, maintenance, operation and removal of the Facilities and for no other purpose without the prior written consent of Railway, which consent may be withheld by Railway in its sole discretion. Licensee accepts the Premises in their current "as is" condition, as suited for the operation of the Facilities, and without the benefit of any improvements to be constructed by Railway.

2. Installation of the Facilities; Railway Support. Licensee shall, at its expense, install, construct, maintain and operate the Facilities on a lien-free basis and in such a manner as will not interfere with the operations of Railway, or endanger persons or property of Railway. Such installation, construction, maintenance and operation of the Facilities shall be in accordance with (a) the plans and specifications (if any) shown on the prints attached hereto and any other specifications prescribed by Railway, (b) applicable laws, regulations, ordinances and other requirements of federal, state and local governmental authorities, and (c) applicable specifications of the American Railway Engineering and Maintenance-of-Way Association, when not in conflict with the applicable plans, specifications, laws, regulations, ordinances or requirements mentioned in (a) and (b), above. All underground pipes must have secondary pipe containment if the material flowing through the pipeline poses a safety or environmental hazard. Any change to the character, capacity or use of the Facilities shall require execution of a new agreement.

3. Railway Support. Railway shall, at Railway's option, furnish, at the sole expense of Licensee, labor and materials necessary, in Railway's sole judgment, to support its tracks and to protect its traffic (including, without limitation, flagging) during the installation, construction, maintenance, repair, or removal of the Facilities.

4. Electronic Interference. Licensee will provide Railway with no less than sixty (60) days advance written notice prior to the installation and operation of cathodic protection in order that tests may be conducted on Railway's signal, communications and other electronic systems (hereinafter collectively called the "Electronic Systems") for possible interference. If the Facilities cause degradation of the Electronic Systems, Licensee, at its expense, will either relocate the cathodic protection or modify the Facilities to the satisfaction of Railway so as to eliminate such degradation. Such modifications may include, without limiting the generality of the foregoing, providing additional shielding, reactance or other corrective measures deemed necessary by Railway. The provisions of this paragraph 4 shall apply to the Electronic Systems existing as of the date of this Agreement and to any Electronic Systems that Railway may install in the future.

5. Corrective Measures. If Licensee fails to take any corrective measures requested by Railway in a timely manner, or if an emergency situation is presented which, in Railway's judgment, requires immediate repairs to the Facilities, Railway, at Licensee's expense, may undertake such corrective measures or repairs as it deems necessary or desirable.

6. Railway Changes. If Railway shall make any changes, alterations or additions to the line, grade, tracks, structures, roadbed, installations, right-of-way or works of Railway, or to the character, height or alignment of the Electronic Systems, at or near the Facilities, Licensee

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shall, upon thirty (30) days prior written notice from Railway and at its sole expense, make such changes in the location and character of the Facilities as, in the opinion of the chief engineering officer of Railway, shall be necessary or appropriate to accommodate any construction, improvements, alterations, changes or additions of Railway.

7. Assumption of Risk. Unless caused solely by the negligence of Railway or caused solely by the willful misconduct of Railway, Licensee hereby assumes all risk of damage to the Facilities and Licensee's other property relating to its use and occupation of the Premises or business carried on the Premises and any defects to the Premises; and Licensee hereby indemnifies Railway, its officers, directors, agents and employees from and against any liability for such damage.

8. Entry Upon Premises. Prior to commencement of any work to be performed on or about the Premises, Licensee shall notify the appropriate Division Engineer for the scheduling of protection and inspection. Within seventy-two (72) hours after the Division Engineer's actual receipt of such notification, the Division Engineer shall review the necessity and availability of flagmen for the proposed work and advise Licensee of such matters and the estimated cost therefor. No work shall be permitted on or about the Premises without the presence of Railway's flagman or the Division Engineer's waiver of the requirement for flag protection. Entry on or about the Premises or any other Railway right-of-way without the Division Engineer's prior approval shall be deemed trespassing. Licensee agrees to pay Railway, within thirty (30) days after delivery of an invoice therefor, for any protection and inspection costs incurred by Railway, in Railway's sole judgment, during any such entry.

9. Liens; Taxes. Licensee will not permit any mechanic's liens or other liens to be placed upon the Premises, and nothing in this Agreement shall be construed as constituting the consent or request of Railway, express or implied, to any person for the performance of any labor or the furnishing of any materials to the Premises, nor as giving Licensee any right, power or authority to contract for or permit the rendering of any services or the furnishing of any materials that could give rise to any mechanic's liens or other liens against the Premises. In addition, Licensee shall be liable for all taxes levied or assessed against the Facilities and any other equipment or other property placed by Licensee within the Premises. In the event that any such lien shall attach to the Premises or Licensee shall fail to pay such taxes, then, in addition to any other right or remedy available to Railway, Railway may, but shall not be obligated to, discharge the same. Any amount paid by Railway for any of the aforesaid purposes, together with related court costs, attorneys' fees, fines and penalties, shall be paid by Licensee to Railway within ten (10) days after Railway's demand therefor.

10. Indemnification. Licensee hereby agrees to indemnify and save harmless Railway, its officers, directors, agents and employees, from and against any and all liabilities, claims, losses, damages, expenses (including attorneys' fees) or costs for personal injuries (including death) and property damage to whomsoever or whatsoever occurring (hereinafter collectively called "Losses") that arise in any manner from (a) the installation, construction, maintenance, operation, presence or removal of, or the failure to properly install, construct, maintain, operate or remove, the Facilities, or (b) any act, omission or neglect of Licensee, its

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agents, servants, employees or contractors in connection therewith, unless caused solely by the negligence of Railway or caused solely by the willful misconduct of Railway.

11. Insurance.

(a) Without limiting in any manner the liability and obligations assumed by Licensee under any other provision of this Agreement, and as additional protection to Railway, Licensee shall, at its expense, pay the Risk Financing Fee set forth in subparagraph (i) below and shall procure and maintain with insurance companies satisfactory to Railway, the insurance policies described in subparagraphs (ii) and (iii).

(i) Upon execution of this Agreement, Licensee shall pay Railway a risk financing fee of $1,000.00 per installation (herein called the "Risk Financing Fee") to provide Railroad Protective Liability Insurance or such supplemental insurance (which may be self-insurance) as Railway, in its sole discretion, deems to be necessary or appropriate.

(ii) Prior to commencement of installation or maintenance of the Facilities or entry on Railway's property, Licensee, and its contractor if it employs one, shall procure and maintain for the course of said installation and maintenance, a general liability insurance policy naming Railway as an additional insured, and containing products and completed operations and contractual liability coverage, with a combined single limit of not less than $1,000,000 for each occurrence.

(iii) Prior to commencement of any subsequent maintenance of the Facility during the term of this Agreement, unless Railway elects to make available and Licensee pays the then current risk financing fee for each affected installation, Licensee, or its contractor if it employs one, shall furnish Railway with an original Railroad Protective Liability Insurance Policy naming Railway as the named insured and having a limit of not less than a combined single limit of $2,000,000 each occurrence and $6,000,000 aggregate. Such policy shall be written using Insurance Services Offices Form Numbers CG 00 35 01 10 01.

(b) All insurance required under preceding subsection (a) shall be underwritten by insurers and be of such form and content as may be acceptable to Railway. Prior to commencement of installation or maintenance of the Facilities or any entry on Railway's property, Licensee, or its contractor if it employs one, shall: furnish to Railway's Risk Manager, Three Commercial Place, Norfolk, Virginia 23510-2191 (or such other representative and/or address as subsequently given by Railway to Licensee in writing), for approval, the original policy described in subsection (a)(iii) and a certificate of insurance evidencing the existence of a policy with the coverage described in subsection (a)(ii).

12. Environmental Matters. Licensee assumes all responsibility for any environmental obligations imposed under applicable laws, regulations, ordinances or other requirements of federal, state and local governmental authorities relating to (a) the installation,

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construction, maintenance, operation or removal of the Facilities, including notification and reporting of any releases, and (b) any contamination of any property, water, air or groundwater arising or resulting, in whole or in part, from Licensee's operation or use of the Premises pursuant to this Agreement. In addition, Licensee shall obtain any necessary permits to install, construct, maintain, operate or remove the Facilities. Licensee agrees to indemnify and hold harmless Railway from and against any and all fines, penalties, demands or other Losses (including attorneys' fees) incurred by Railway or claimed by any person, company or governmental entity relating to (a) any contamination of any property, water, air or groundwater due to the use or presence of the Facilities on the Premises, (b) Licensee's violation of any laws, regulations or other requirements of federal, state or local governmental authorities in connection with the use or presence of the Facilities on the Premises or (c) any violation of Licensee's obligations imposed under this paragraph. Without limitation, this indemnity provision shall extend to any cleanup and investigative costs relating to any contamination of the Premises arising or resulting from, in whole or in part, Licensee's use of the Facilities or any other activities by or on behalf of Licensee occurring on or about the Premises. Licensee further agrees not to dispose of any trash, debris or wastes, including hazardous waste, on the Premises and will not conduct any activities on the Premises which would require a hazardous waste treatment, storage or disposal permit.

13. Assignments and Other Transfers.

(a) Licensee shall not assign, transfer, sell, mortgage, encumber, sublease or otherwise convey (whether voluntarily, involuntarily or by operation of law) this Agreement or any interest therein, nor license, mortgage, encumber or otherwise grant to any other person or entity (whether voluntarily, involuntarily or by operation of law) any right or privilege in or to the Premises (or any interest therein), in whole or in part, without the prior written consent of Railway, which consent may be withheld by Railway in its sole discretion. Any such assignment or other transfer made without Railway's prior written consent shall be null and void and, at Railway's option, shall constitute an immediate default of this Agreement. Notwithstanding the foregoing, upon prior written notice to Railway, Licensee may assign this Agreement to a parent, a wholly-owned subsidiary of Licensee or a wholly-owned subsidiary of Licensee's parent without Railway's consent; provided, however, that no such assignment shall relieve Licensee of its obligations under this Agreement.

(b) Railway shall have the right to transfer and assign, in whole or in part, all its rights and obligations hereunder and in or to the Premises. From and after the effective date of any such assignment or transfer, Railway shall be released from any further obligations hereunder; and Licensee shall look solely to such successor-in-interest of Railway for the performance of the obligations of "Railway" hereunder.

14. Meaning of "Railway". The word "Railway" as used herein shall include any other company whose property at the aforesaid location may be leased or operated by Railway. Said term also shall include Railway's officers, directors, agents and employees, and any parent company, subsidiary or affiliate of Railway and their respective officers, directors, agents and employees.

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15. Default; Remedies.

(a) The following events shall be deemed to be events of default by Licensee under this Agreement:

(i) Licensee shall fail to pay the Fee or any other sum of money due hereunder and such failure shall continue for a period of ten (10) days after the due date thereof;

(ii) Licensee shall fail to comply with any provision of this Agreement not requiring the payment of money, all of which terms, provisions and covenants shall be deemed material, and such failure shall continue for a period of thirty (30) days after written notice of such default is delivered to Licensee;

(iii) Licensee shall become insolvent or unable to pay its debts as they become due, or Licensee notifies Railway that it anticipates either condition;

(iv) Licensee takes any action to, or notifies Railway that Licensee intends to file a petition under any section or chapter of the United States Bankruptcy Code, as amended from time to time, or under any similar law or statute of the United States or any State thereof; or a petition shall be filed against Licensee under any such statute; or

(v) A receiver or trustee shall be appointed for Licensee's license interest hereunder or for all or a substantial part of the assets of Licensee, and such receiver or trustee is not dismissed within sixty (60) days of the appointment.

(b) Upon the occurrence of any event or events of default by Licensee, whether enumerated in this paragraph 15 or not, Railway shall have the option to pursue any remedies available to it at law or in equity without any additional notices to Licensee. Railway's remedies shall include, but not be limited to, the following: (i) termination of this Agreement, in which event Licensee shall immediately surrender the Premises to Railway; (ii) entry into or upon the Premises to do whatever Licensee is obligated to do under the terms of this License, in which event Licensee shall reimburse Railway on demand for any expenses which Railway may incur in effecting compliance with Licensee's obligations under this License, but without rendering Railway liable for any damages resulting to Licensee or the Facilities from such action; and (iii) pursuit of all other remedies available to Railway at law or in equity, including, without limitation, injunctive relief of all varieties.

16. Railway Termination Right. Notwithstanding anything to the contrary in this Agreement, Railway shall have the right to terminate this Agreement and the rights granted hereunder, after delivering to Licensee written notice of such termination no less than sixty (60) days prior to the effective date thereof, upon the occurrence of any one or more of the following events:

(a) If Licensee shall discontinue the use or operations of the Facilities; or

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(b) If Railway shall be required by any governmental authority having jurisdiction over the Premises to remove, relocate, reconstruct or discontinue operation of its railroad on or about the Premises; or

(c) If Railway, in the good faith judgment of its Superintendent, shall require a change in the location or elevation of its railroad on or about the location of the Facilities or the Premises that might effectively prohibit the use or operation of the Facilities; or

(d) If Railway, in the good faith judgment of its Superintendent, determines that the maintenance or use of the Facilities unduly interferes with the operation and maintenance of the facilities of Railway, or with the present or future use of such property by Railway, its lessees, affiliates, successors or assigns, for their respective purposes.

17. Condemnation. If the Premises or any portion thereof shall be taken or condemned in whole or in part for public purposes, or sold in lieu of condemnation, then this Agreement and the rights granted to Licensee hereunder shall, at the sole option of Railway, forthwith cease and terminate. All compensation awarded for any taking (or sale proceeds in lieu thereof) shall be the property of Railway, and Licensee shall have no claim thereto, the same being hereby expressly waived by Licensee.

18. Removal of Facilities; Survival. The Facilities are and shall remain the personal property of Licensee. Upon the expiration or termination of this Agreement, Licensee shall remove the Facilities from the Premises within thirty (30) days after the effective date thereof. In performing such removal, unless otherwise directed by Railway, Licensee shall restore the Premises to the same condition as existed prior to the installation or placement of Facilities, reasonable wear and tear excepted. In the event Licensee shall fail to so remove the Facilities or restore the Premises, the Facilities shall be deemed to have been abandoned by Licensee, and the same shall become the property of Railway for Railway to use, remove, destroy or otherwise dispose of at its discretion and without responsibility for accounting to Licensee therefor; provided, however, in the event Railway elects to remove the Facilities, Railway, in addition to any other legal remedy it may have, shall have the right to recover from Licensee all costs incurred in connection with such removal and the restoration of the Premises. Notwithstanding anything to the contrary contained in this Agreement, the expiration or termination of this Agreement, whether by lapse of time or otherwise, shall not relieve Licensee from Licensee's obligations accruing prior to the expiration or termination date, and such obligations shall survive any such expiration or other termination of this Agreement.

19. Entire Agreement. This Agreement contains the entire agreement of Railway and Licensee and supersedes any prior understanding or agreement between Railway and Licensee respecting the subject matter hereof; and no representations, warranties, inducements, promises or agreements, oral or otherwise, between the parties not embodied in this Agreement shall be of any force or effect.

AO

20. Attorneys' Fees. If Railway should bring any action under this Agreement, or consult or place the Agreement or any amount payable by Licensee hereunder, with an attorney concerning or for the enforcement of any of Railway's rights hereunder, then Licensee agrees in each and any such case to pay to Railway all costs, including but not limited to court costs and attorneys' fees, incurred in connection therewith.

21. Severability. If any clause or provision of this Agreement is illegal, invalid or unenforceable under present or future laws effective during the term of this Agreement, then and in that event, it is the intention of the parties hereto that the remainder of this Agreement shall not be affected thereby; and it is also the intention of the parties to this Agreement that in lieu of each clause or provision of this Agreement that is illegal, invalid or unenforceable, there be added as a part of this Agreement a clause or provision as similar in terms to such illegal, invalid or unenforceable clause or provision as may be possible and be legal, valid and enforceable.

22. Modifications; Waiver; Successors and Assigns. This Agreement may not be altered, changed or amended, except by instrument in writing signed by both parties hereto. No provision of this Agreement shall be deemed to have been waived by Railway unless such waiver shall be in a writing signed by Railway and addressed to Licensee, and no such waiver shall affect or alter this Agreement, but each and every covenant, condition, agreement and term of this Agreement shall continue in full force and effect. No nor shall any custom or practice that may evolve between the parties in the administration of the terms hereof shall be construed to waive or lessen the right of Railway to insist upon the performance by Licensee in strict accordance with the terms hereof. The terms and conditions contained in this Agreement shall apply to, inure to the benefit of, and be binding upon the parties hereto, and upon their respective successors in interest and legal representatives, except as otherwise herein expressly provided. If there shall be more than one Licensee, the obligations hereunder imposed upon Licensee shall be joint and several.

23. Notice. Any and all other notices, demands or requests by or from Railway to Licensee, or Licensee to Railway, shall be in writing and shall be sent by (a) postage paid, certified mail, return receipt requested, or (b) a reputable national overnight courier service with receipt therefor, or (c) personal delivery, and addressed in each case as follows:

If to Railway:
c/o Norfolk Southern Corporation
1200 Peachtree Street, NE – 12th Floor
Atlanta, Georgia 30309-3504
Attention: Director Real Estate

If to Licensee:
City of Chattanooga
1250 Market Street, Suite 2100
Chattanooga, Tennessee 37402
Attention: City Manager

AD

Either party may, by notice in writing, direct that future notices or demands be sent to a different address. All notices hereunder shall be deemed given upon receipt (or, if rejected, upon rejection).

24. Miscellaneous. All exhibits, attachments, riders and addenda referred to in this License are incorporated into this Agreement and made a part hereof for all intents and purposes. Time is of the essence with regard to each provision of this Agreement. This Agreement shall be construed and interpreted in accordance with and governed by the laws of the State in which the Premises are located. Each covenant of Railway and Licensee under this Agreement is independent of each other covenant under this Agreement. No default in performance of any covenant by a party shall excuse the other party from the performance of any other covenant. The provisions of Paragraphs 7, 9, 10, 12 and 18 shall survive the expiration or earlier termination of this Agreement.

25. Limitations of Grant. Licensee acknowledges that the license granted hereunder is a quitclaim grant, made without covenants, representations or warranties with respect to Railway's (a) right to make the grant, (b) title in the Premises, or (c) right to use or make available to others the Premises for the purposes contemplated herein. Railway is the owner and/or holder of the Premises subject to the terms and limitations under which it is owned or held, including without limitation conditions, covenants, restrictions, easements (including any pre-existing fiber optic easements or licenses), encroachments, leases, licenses, permits, mortgages, indentures, reversionary interests, fee interests, zoning restrictions and other burdens and limitations, of record and not of record, and to rights of tenants and licensees in possession, and Licensee agrees that the rights licensed hereunder are subject and subordinate to each and all of the foregoing. Licensee accepts this grant knowing that others may claim that Railway has no right to make it, and Licensee agrees to release, hold harmless and indemnify (and, at Railway's election, defend, at Licensee's sole expense, with counsel approved by Railway) Railway, its affiliated companies, and its and their respective officers, directors, agents and employees, from and against any detriments to, or liabilities of, any type or nature arising from such claims, including punitive damages and any forfeitures declared or occurring as a result of this grant.

26. Limitations Upon Damages. Notwithstanding any other provision of this Agreement, Railway shall not be liable for breach of this Agreement or under this Agreement for any consequential, incidental, exemplary, punitive, special, business damages or lost profits, as well as any claims for death, personal injury, and property loss and damage which occurs by reason of, or arises out of, or is incidental to the interruption in or usage of the Facilities placed upon or about the Premises by Licensee, including without limitation any damages under such claims that might be considered consequential, incidental, exemplary, punitive, special, business damages or lost profits.

[Remainder of page intentionally left blank]

AO

IN WITNESS WHEREOF, the parties hereto have executed this Agreement in duplicate, each part being an original, as of the date first above written.

Witness:

THE CINCINNATI, NEW ORLEANS AND TEXAS PACIFIC RAILWAY COMPANY

____
As to Railway

By: ______________________________
Real Estate Manager

Witness:

CITY OF CHATTANOOGA

____
As to Licensee

By: ______________________________

Title: ______________________________

Activity Number 1274468
AD: September 16, 2019
File No. 1781794v1

AD

AECOM

NORFOLK SOUTHERN

PIPE DATA SHEET

	CARRIER PIPE	CASING PIPE
CONTENTS TO BE HANDLED	sewer	Annular void filled with cement grout or cellular concrete
MAX. ALLOWABLE OPERATING PRESSURE	50 psi	N/A
NOMINAL SIZE OF PIPE	48"	60"
OUTSIDE DIAMETER	50.8"	60"
INSIDE DIAMETER	49.0"	58.3"
WALL THICKNESS	0.93"	0.844"
WEIGHT PER FOOT	133 lb/ft	533 lb/ft
MATERIAL	fiber glass reinforced polymer	steel
PROCESS OF MANUFACTURE	centrifugal casting process	rolled
SPECIFICATION	Section 33 23 19 (attached)	Section 33 05 25 (attached)
GRADE OR CLASS (Specified Minimum Yield Strength)	SN 46	35,000 psi
TEST PRESSURE	100 psi	N/A
TYPE OF JOINT	double bell coupling	welded
TYPE OF COATING	N/A	2 coats bitumastic enamel
DETAILS OF CATHODIC PROTECTION	N/A	N/A
DETAILS OF SEALS OR PROTECTION AT END OF CASING	brick and mortar	brick and mortar
CHARACTER OF SUBSURFACE MATERIAL	clayey sand/lean clay	clayey sand/lean clay
APPROXIMATE GROUND WATER LEVEL	609'	609'
SOURCE OF INFORMATION ON SUBSURFACE CONDITIONS	Geotechnical Investigation	Geotechnical Investigation

Proposed method of installation (refer to NSCE-8 Specification):

1 / 66A

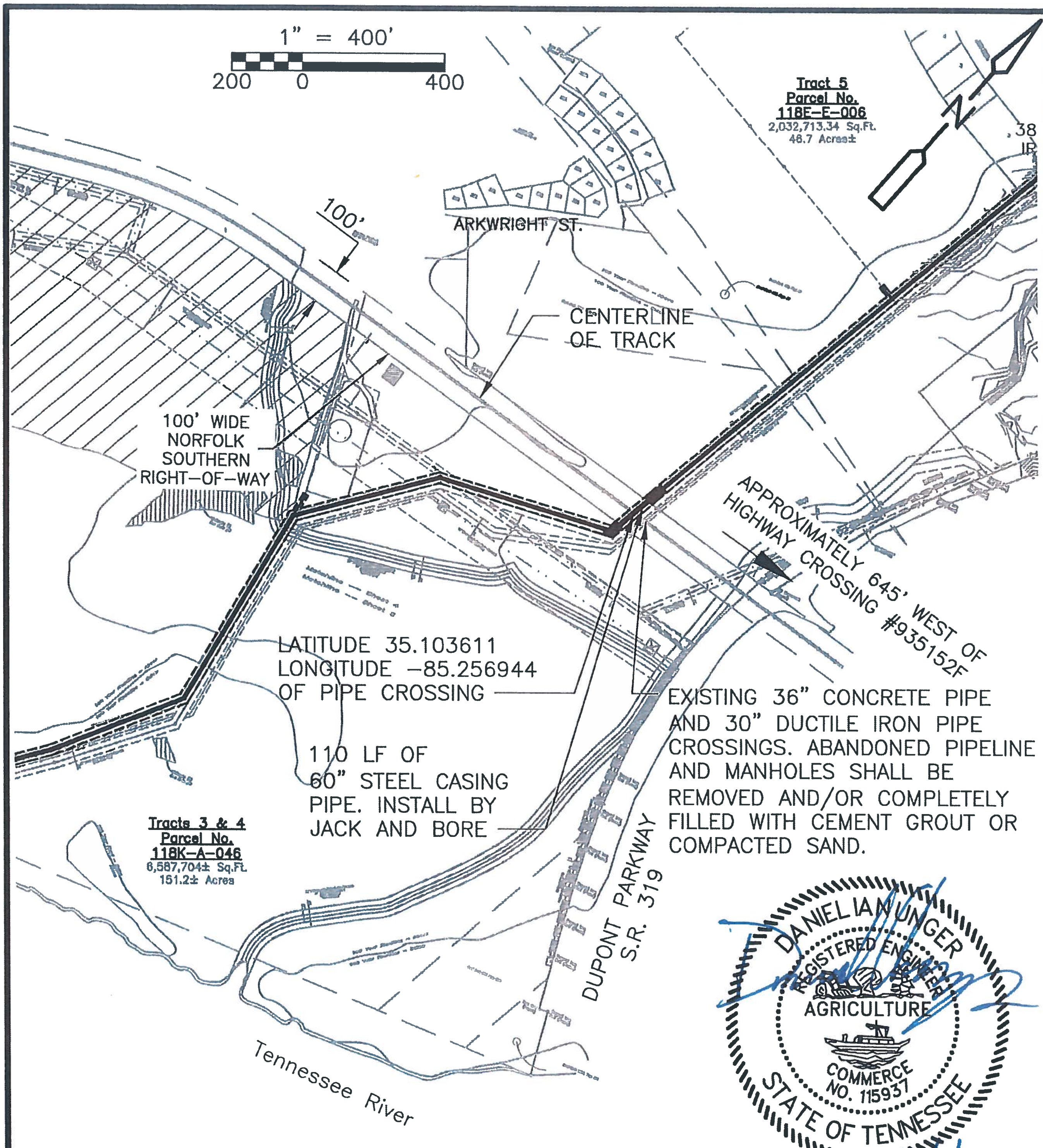
A-2 Received 9/3/19
Chattanooga, Tennessee
Cincinnati, New Orleans &
Texas Pacific Rwy Co
Lat: N 35.103755
Long: W 85.257035

- ☒ Bore and jack
- ☐ Jacking
- ☐ Tunneling (with Tunnel Liner Plate)
- ☐ Directional Bore/Horizontal Direction Drilling – Method A
- ☐ Directional Bore/Horizontal Direction Drilling – Method B
- ☐ Open Cut – *All installations directly under any track must be designed as a bored installation. Open cut installations will be considered on a case-by-case basis by Norfolk Southern's Division Superintendent at the time of installation.*
- ☐ Other (Specify): ______________________

Last Revised: 113018

1274468 - AD

EXHIBIT A



DANIEL IAN UNGER
REGISTERED ENGINEER
AGRICULTURE
COMMERCE
NO. 115937
STATE OF TENNESSEE
9/5/19

1
66A

A-2 Received 9/3/19
Chattanooga, Tennessee
Cincinnati, New Orleans &
Texas Pacific Rwy Co
Lat: N 35.103755
Long: W 85.257035

1274468-AO

GENERAL NOTES
1. CONTRACTOR SHALL FOLLOW ALL REQUIREMENTS OF NORFOLK SOUTHERN'S NSCE-8 SPECIFICATIONS.
2. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
3. BLASTING NOT PERMITTED.

CDM Smith	DATE JULY 2019		ADDENDUM NO.	FIGURE NO.
	CITY OF CHATTANOOGA HAMILTON COUNTY, TN	SHEET NO. / LOCATION		3

EXHIBIT B

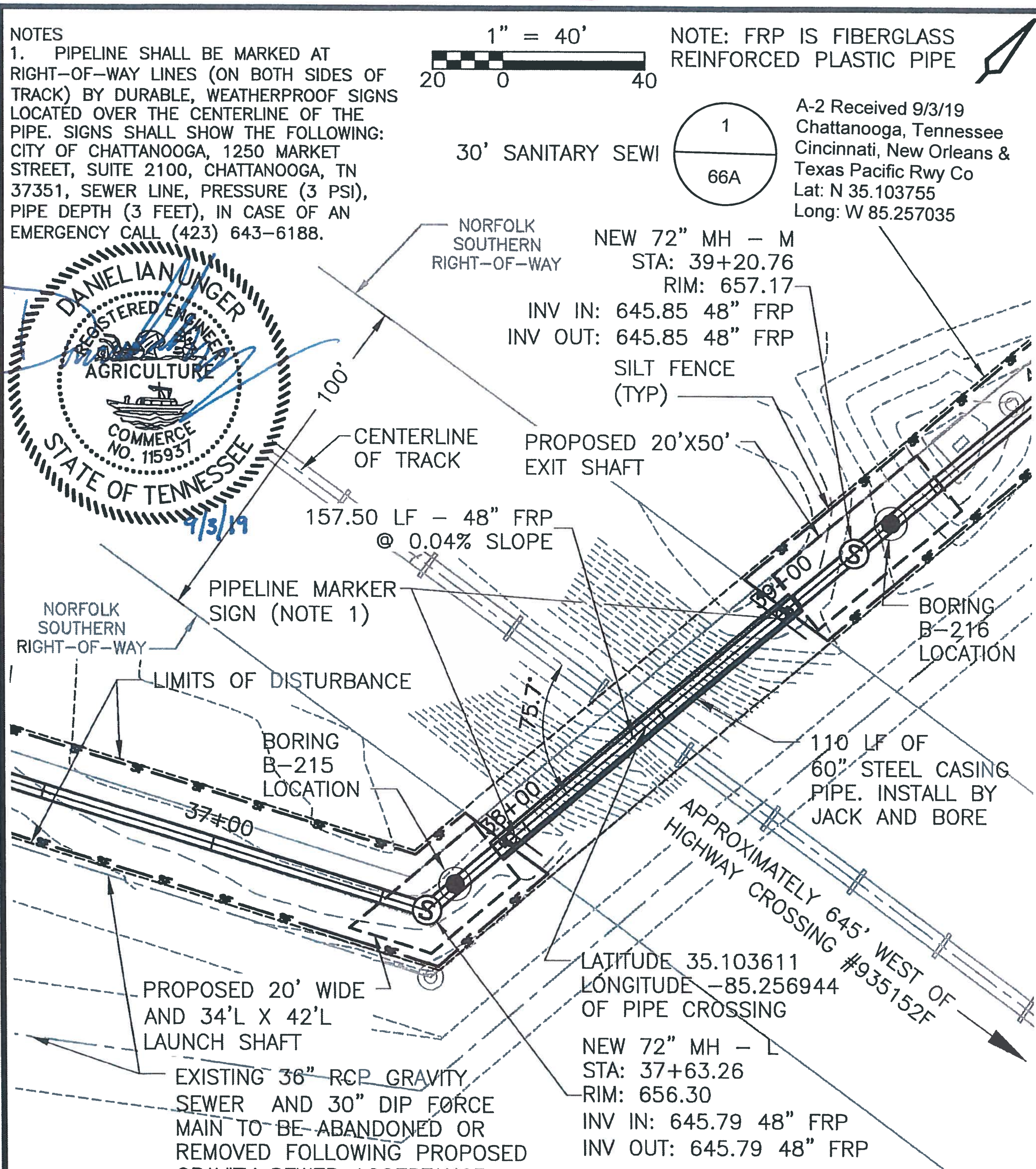
NOTES

1. PIPELINE SHALL BE MARKED AT RIGHT-OF-WAY LINES (ON BOTH SIDES OF TRACK) BY DURABLE, WEATHERPROOF SIGNS LOCATED OVER THE CENTERLINE OF THE PIPE. SIGNS SHALL SHOW THE FOLLOWING: CITY OF CHATTANOOGA, 1250 MARKET STREET, SUITE 2100, CHATTANOOGA, TN 37351, SEWER LINE, PRESSURE (3 PSI), PIPE DEPTH (3 FEET), IN CASE OF AN EMERGENCY CALL (423) 643-6188.

1" = 40'

NOTE: FRP IS FIBERGLASS REINFORCED PLASTIC PIPE

A-2 Received 9/3/19
Chattanooga, Tennessee
Cincinnati, New Orleans & Texas Pacific Rwy Co
Lat: N 35.103755
Long: W 85.257035



DANIEL IAN UNGER
REGISTERED ENGINEER
AGRICULTURE COMMERCE
NO. 115937
STATE OF TENNESSEE
9/3/19

CITY OF CHATTANOOGA CORPORATION SEAL TENNESSEE

GENERAL NOTES

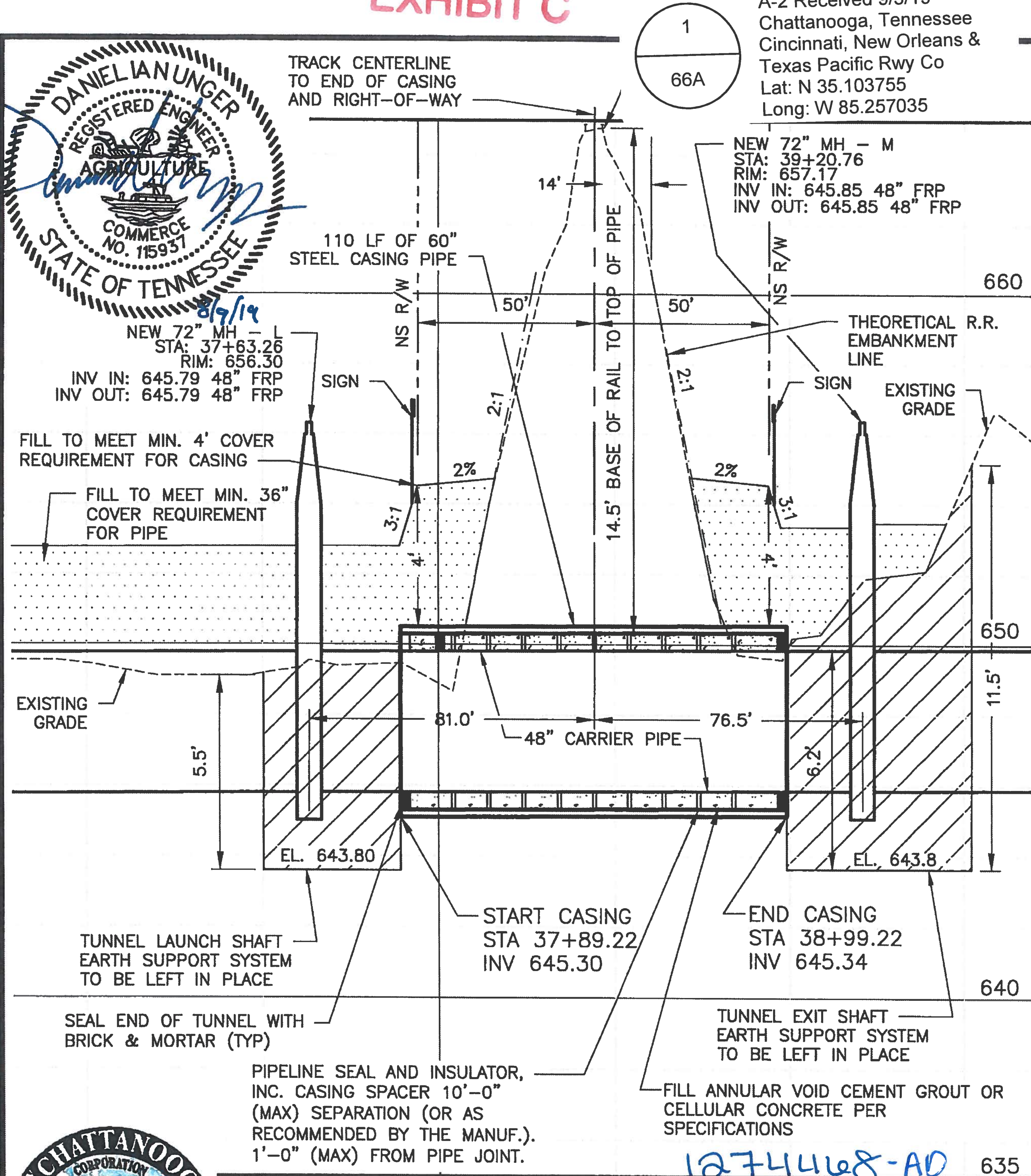
1. CONTRACTOR SHALL FOLLOW ALL REQUIREMENTS OF NORFOLK SOUTHERN'S NSCE-8 SPECIFICATIONS.
2. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON-FLAMMABLE SUBSTANCES.
3. BLASTING NOT PERMITTED.

1274468-AD

CDM Smith	DATE JULY 2019			ADDENDUM NO.	FIGURE NO.
		SHEET NO.	LOCATION		
	CITY OF CHATTANOOGA HAMILTON COUNTY, TN				1

EXHIBIT C

A-2 Received 9/3/19
Chattanooga, Tennessee
Cincinnati, New Orleans & Texas Pacific Rwy Co
Lat: N 35.103755
Long: W 85.257035



CITY OF CHATTANOOGA CORPORATION SEAL TENNESSEE

38+00

1" = 40'(HORZ.)
1" = 4'(VERT.)

20 0 40

GENERAL NOTES
1. CONTRACTOR SHALL FOLLOW ALL REQUIREMENTS OF NORFOLK SOUTHERN'S NSCE–8 SPECIFICATIONS.
2. PIPELINE AND CROSSING TO BE INSTALLED AND MAINTAINED IN ACCORDANCE WITH LAST APPROVED AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION SPECIFICATIONS FOR PIPELINES CONVEYING FLAMMABLE AND NON–FLAMMABLE SUBSTANCES.
3. BLASTING NOT PERMITTED.

CDM Smith	DATE JULY 2019	SHEET NO.	LOCATION	ADDENDUM NO.	FIGURE NO.
	CITY OF CHATTANOOGA HAMILTON COUNTY, TN				2

City of Chattanooga

Waste Resources Division
DuPont Gravity Sewer and Pump Station

Geotechnical Interpretive Report

Chattanooga, Tennessee

September 2019

CDM Smith

City of Chattanooga

Waste Resources Division

DuPont Gravity Sewer and Pump Station

Geotechnical Interpretive Report

September 2019

Prepared by:

Kermit Applegate, P.E.

Geotechnical Engineer

Prepared by:

Erdem O. Tastan, Ph.D, P.E.

Senior Geotechnical Engineer

Reviewed by:

Stephen L. Whiteside, PE

Vice President, Geotechnical Engineer

Reviewed by:

Danielle K. Neamtu, PE

Geotechnical Engineer

CDM Smith Project No. 129699-109746

Table of Contents

List of Figures

List of Tables

Appendices

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Section 1

Introduction

1.1 Project Description

The DuPont Pump Station and Basin Improvements – Phase 2 project scope consists of the design and construction of approximately 7,000 LF of 48-inch-diameter gravity sewer line from the existing DuPont Pump Station to Rivermont Park. It also includes the design and construction of a new wet-weather diversion structure and pump station in Rivermont Park. The new pump station will discharge into the existing DuPont Pump Station force main and will maximize its capacity. The project also involves the demolition of the existing Dupont Pump Station and existing diversion structure. The primary objective of this project is to reduce sanitary sewer overflows (SSOs) in the DuPont Parkway Pump Station drainage area and the Lupton drainage area through the construction of new wet-weather flow management facilities.

The location of the proposed structures and the alignment of the gravity sewer are shown on **Figure 1-1.** Existing site elevation at the pump station site varies between El. 652 feet and El. 655 feet. The final site grade will be at El. 660 feet to protect against 100-yr flood level of El. 659 feet. The pump station and diversion structure will be founded on mat foundations at approximately 26- feet below ground surface (ft-bgs). The electrical building will be founded on a strip foundation at approximately 5 ft-bgs, while the generator slab will be founded at approximately 3 ft-bgs. All depths indicate bottom of foundation.

The new 48-inch-diameter finished gravity sewer will be ductile iron (DIP) and constructed using mainly open-cut and pipe jacking techniques. Pipe jacking will be used under the railroad crossing as indicated on Figure 1-1.

The location for the pump station and associated structures was initially intended to be at the location about 447 feet west of the current site (**Figure 1-2**). This initial site was found to be underlain by large karstic voids and cavities and therefore was abandoned.

This report summarizes previous field investigations, recent field investigation, and laboratory testing programs for design of the proposed new pump station, structures, and finished sewer line.

1.2 Elevation Datum

All elevations noted herein are reported in feet in reference to the North American Vertical Datum of 1988 (NAVD88).

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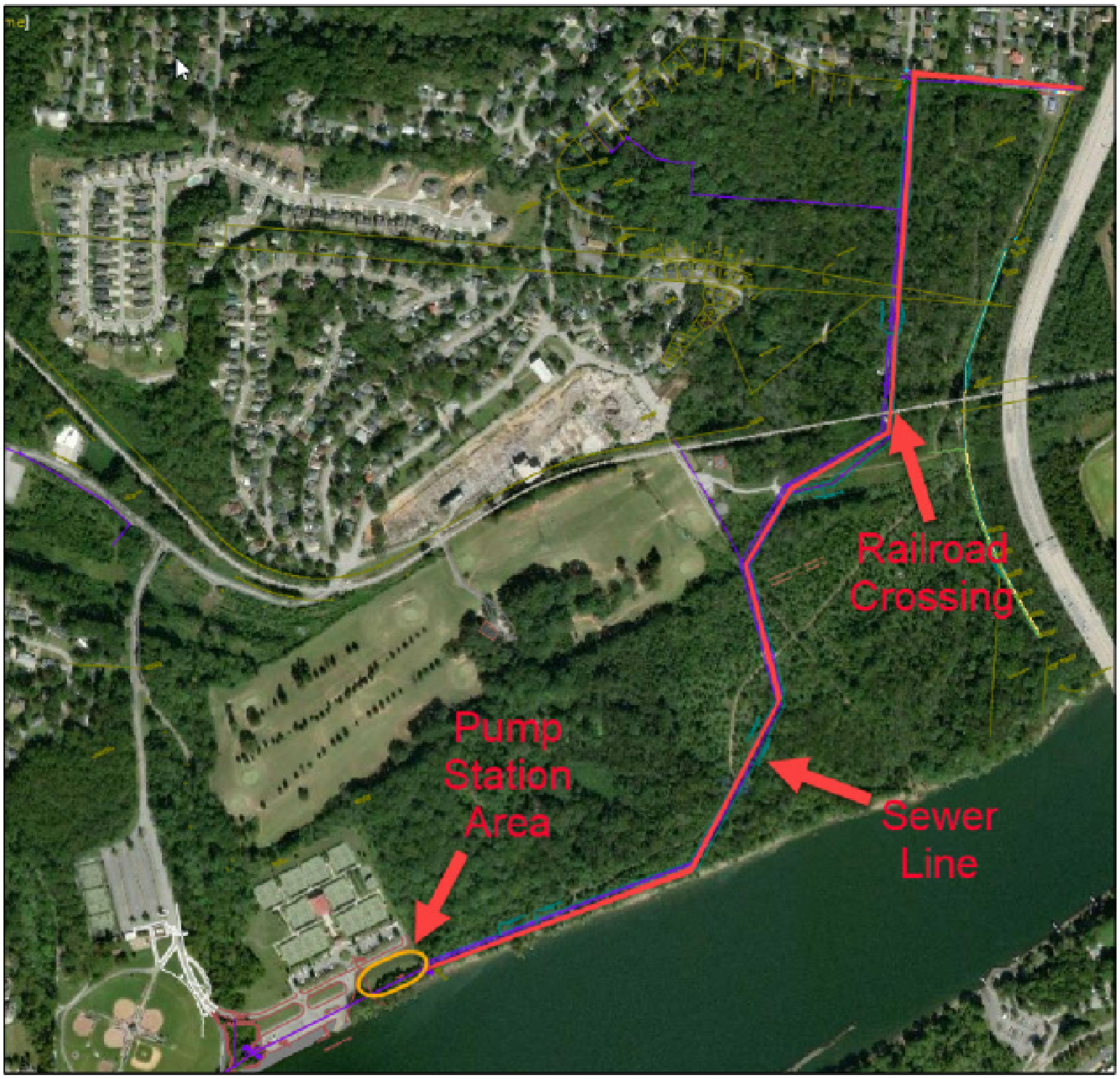

CDM Smith

Figure No. 1-1
Site Locus Plan
JULY 2019

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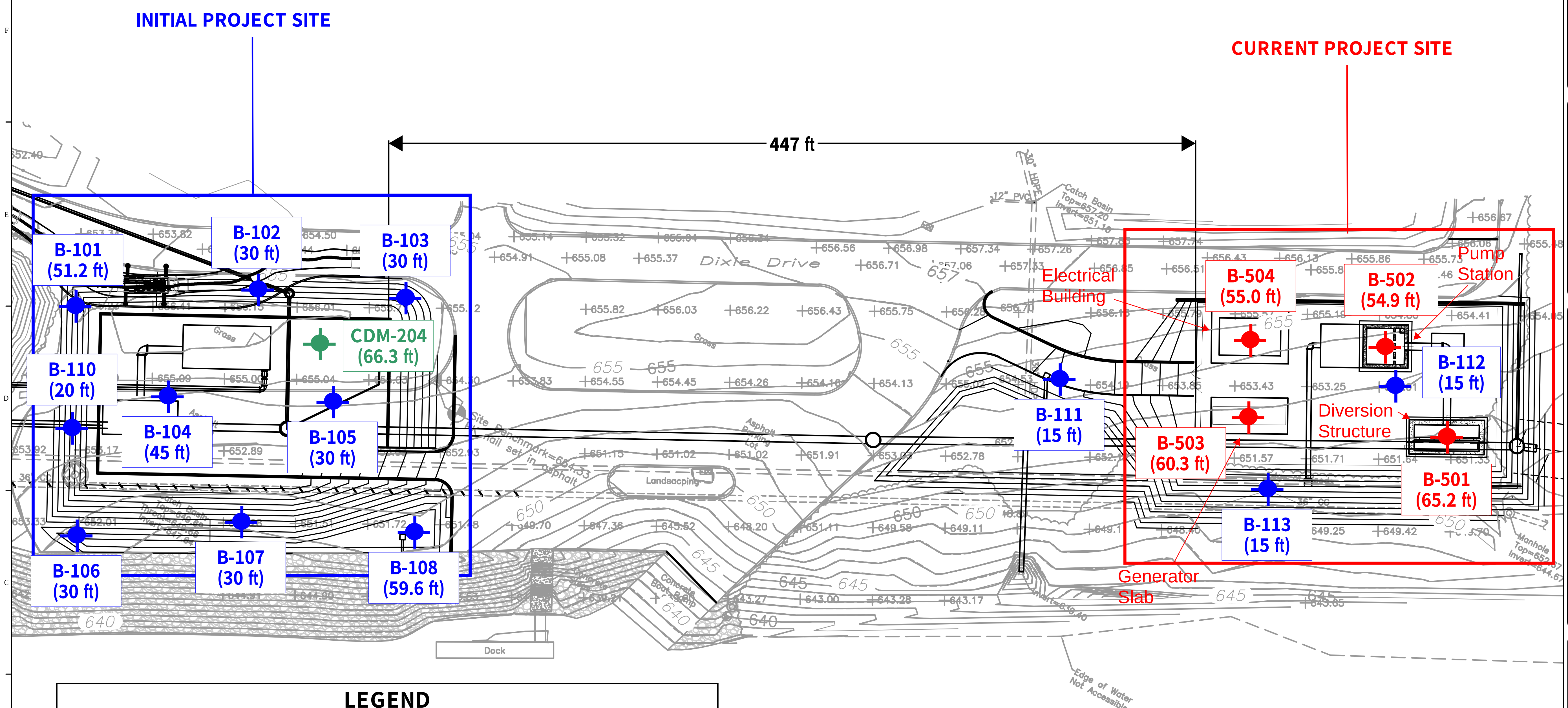
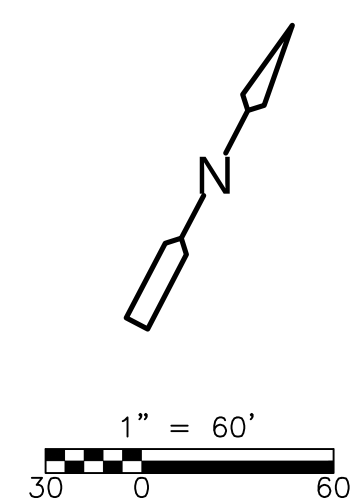


LEGEND

Symbol	Description
B-101 (DEPTH ft)	APPROXIMATE BORING LOCATION DRILLED BY TERRACON, INC. BETWEEN JULY 24 AND JULY 30, 2018 (PREVIOUS INVESTIGATION).
CDM-204 (DEPTH ft)	APPROXIMATE BORING LOCATION DRILLED BY TERRACON, INC. ON NOVEMBER 20, 2018 (PREVIOUS INVESTIGATION).
B-501 (DEPTH ft)	APPROXIMATE BORING LOCATION DRILLED BY S&ME BETWEEN FEBRUARY 25 AND MARCH 2, 2019 (RECENT INVESTIGATION).



CDM Smith

CDM Smith Inc.
651 East 4th Street Suite 100
Chattanooga, TN 37403
Tel: (423) 771-4495

DUPONT PUMP STATION AND BASIN IMPROVEMENTS - PHASE 2
CITY OF CHATTANOOGA, TN
CONSENT DECREE PROGRAM

REV	DATE	REVISION DESCRIPTION

THIS LINE IS ONE INCH LONG WHEN PLOTTED FULL SCALE

THIS DRAWING MUST BE USED IN CONJUNCTION WITH THE APPLICABLE OR GOVERNING TECHNICAL SPECIFICATIONS AND OTHER CONTRACT DOCUMENTS.

PROJECT NO: 129699-109746
DATE: FEBRUARY 2019
DISC. LEAD: DESIGNER: CHECKER:

SHEET TITLE

FIGURE 1-2 SITE LOCATION PLAN

GEOTECHNICAL DATA REPORT

SHEET

60% SUBMITTAL - NOT FOR CONSTRUCTION

CREATED: 3/11/2019 LAST SAVED: 3/21/2019 BY: CHERCHIAMD PLOT DATE: 3/21/2019

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1.3 Purpose and Scope

The purpose of this report is to provide geotechnical engineering recommendations for design and construction. Specifically, the scope of work included the following:

- Review subsurface information within the vicinity of the project site as collected during the preliminary and secondary field investigations;
- Drill four (4) test borings for the proposed structures and pipeline gravity sewer pipeline;
- Conduct geotechnical laboratory testing on select soil and rock samples to assist with classification and estimate the engineering properties of the materials;
- Perform geotechnical analyses and develop geotechnical engineering recommendations for design and construction of the proposed structures and gravity sewer pipeline; and
- Prepare this report presenting CDM Smith's recommendations and the data collected as part of the field investigations.

1.4 Report Limitations

The recommendations in this report have been prepared for the design of the Dupont Pump Station and Basin Improvements – Phase 2 project located in Chattanooga, Tennessee as understood at this time and described in this report. This report has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. In the event that changes in design or location of the proposed improvements occur, the conclusions and recommendations contained herein should not be considered valid unless verified in writing by CDM Smith.

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Section 2

Site and Subsurface Conditions

2.1 Site Conditions

2.1.1 General

The new 48-inch-diameter finished gravity sewer line will extend approximately 7,000 linear feet from DuPont Parkway to Dixie Drive in Chattanooga, Tennessee. The pump station will be just south of Dixie Drive, adjacent to the Champions Tennis Club. To the south of the site is the Tennessee River and to the west is Rivermont Park. A public easement runs through a heavily wooded area to the east, and bends to the north, crossing a railroad line and terminating at a residential neighborhood on the corner of Atlanta Drive and Elm Street. The plan view of the project extent is shown on Figure 1-1.

The existing site grades at the proposed pump station, electrical building, emergency generator building, and diversion structure range from about El. 652 to El. 655. Along the gravity sewer alignment, the existing grade ranges from El. 654 at the pump station site to El. 664 at Elm Street.

The finished gravity sewer alignment crosses under one (1) railroad as shown on Figure 1-1. The railroad crossing cannot be constructed using open-cut trenching, so trenchless construction techniques will be required.

2.2 Regional Geology

The project site is located within the Valley and Ridge Province. Subsurface conditions are characterized by parallel valleys and ridges oriented southwest-northeast consisting of Paleozoic sedimentary deposits. The bedrock in this region typically consists of sandstone underlain by limestone, dolomite, and shale. The limestone and dolomite are susceptible to dissolution along joints and bedding planes that results in weathering within the bedrock and near the overburden-bedrock interface. Cavities and large voids can develop as the weathering progresses. This geologic phenomenon is referred to as a Karstic condition. Soil or rock overlying voids can be stable due to arching; however, an unstable arch can develop as the void grows resulting in a sinkhole.

Based on the United States Geological Survey, the project site consists of the upper Knox Group, including Newala Formation, Mascot Dolomite, Kingsport Formation, Longview Dolomite, and Chepultepec Dolomite. Rocks are light gray, fine-grained dolomite with interbeds of blueish-gray limestone.

2.3 Subsurface Investigation Programs

2.3.1 General

Under subcontract to CDM Smith, Terracon, Inc., and S&ME, Inc. conducted subsurface investigation programs to provide site-specific information in the vicinity of the pump station and associated structures, and along the alignment of the gravity sewer. As shown on Figure 1-2, the initial site location was about 450 feet east of the current site. The general sequence of the field investigation activities was as follows:

1) Preliminary field investigation at the initial site location for the pump station and associated structures as well as the test borings along the sewer main.

2) Geophysical survey at the initial site location, after finding voids during preliminary field investigation.

3) Changing the layout at the initial site and drilling another test boring at the initial site.

4) After finding voids again following the layout change at the initial site, a geophysical field investigation at three alternative sites (Alternative Sites A, B and D).

5) Establishing the location of the current site, and final field investigation with four test borings at the current site location (Alternative Site B). The site was selected based on the results of the secondary geophysical surveys.

The investigations discussed above consisted of the following:

- A preliminary field investigation including twenty-five (25) test borings drilled by Terracon, Inc. was performed between July 24 and August 8, 2018 at the initial project site and along the gravity sewer alignment. The test boring logs and laboratory data are in the Geotechnical Data Report prepared by Terracon Consultants, Inc. (provided in **Appendix A**);

- A geophysical field investigation including three (3) electrical resistivity tomography (ERT) survey lines was performed by S&ME, Inc. on October 3, 2018. The interpreted ERT profiles are in the Revised Report for Geophysical Services prepared by S&ME, Inc. (provided in **Appendix B**);

- A secondary field investigation including one (1) test boring drilled by Terracon, Inc., with oversight from a CDM Smith representative, was performed on November 20, 2018 at the initial project site. The test boring log is provided in **Appendix C**;

- A secondary geophysical field investigation including nine (9) electrical resistivity tomography (ERT) survey lines was performed by S&ME, Inc. on October January 17, 2019 through January 18. The interpreted ERT profiles are in the Revised Report for Geophysical Services prepared by S&ME, Inc. (provided in Appendix B); and

- A final field investigation including four (4) test borings drilled by S&ME with oversight from a CDM Smith representative was performed between February 25 and March 2, 2019. The test boring logs are provided in Appendix C, and the laboratory data are available in the S&ME Laboratory Report provided in **Appendix D**.

Subsurface information from each investigation was reviewed and utilized to provide information regarding soil, bedrock, and groundwater conditions at the site.

2.3.2 Preliminary Field Investigation

2.3.2.1 Preliminary Geotechnical Investigation

A preliminary geotechnical investigation was performed by Terracon, Inc. between July 24 and August 8, 2018 at the initial project site for the pump station facility and along the proposed gravity sewer alignment. The exploration consisted of twenty-five (25) test borings with depths ranging from 15 feet to 60 ft-bgs using a track or truck-mounted drill rig equipped with an automatic Standard Penetration Test (SPT) hammer system and continuous-flight hollow stem auger drilling techniques. Thirteen (13) of the test borings were drilled at the initial proposed site of the pump station and associated buildings (100-Series), and twelve (12) of the test borings were drilled along the gravity sewer alignment (200-Series). Two (2) test borings (B-215 and B-216) were drilled at the railroad crossing where pipe jacking is anticipated.

Split spoon sampling was conducted at the test borings, and the number of blows required to advance a standard 2-inch outer diameter (OD) split-barrel sampler the last 12-inches of a typical 18-inch penetration with a 140-pound hammer falling 30-inches was recorded to determine the standard penetration resistance value (SPT-N). Auger refusal was encountered at test borings B-101, B-104, and B-108. At these locations, rock coring was performed. Rock cores were generally obtained in 5-foot runs using an NQ2-size wireline diamond-bit core barrel system. The percent recovery and Rock Quality Designation (RQD) were recorded. The RQD is defined as the sum, in inches, of all pieces of sound core, four inches in length or longer, divided by the length in inches of the entire core run, expressed as a percentage. The final boring logs were prepared from field logs and represent interpretations by a geotechnical engineer.

Laboratory testing was performed based upon assignments made by CDM Smith and included: moisture contents (ASTM D2216), Atterberg limits (ASTM D4318), grain size analysis (ASTM D422), one-dimensional consolidation testing (ASTM D2435/D2435M), consolidated-undrained triaxial compression 3-point testing (ASTM D4767), unconfined compressive strength testing of rock (ASTM D7012 – Method C), and flexible wall permeameter hydraulic conductivity testing. A Geotechnical Data Report was provided by Terracon, Inc. and is included in Appendix A.

All test borings were backfilled with grout to the ground surface upon completion.

2.3.2.2 Preliminary Geophysical Field Investigation Results

A large void was observed in test boring B-108 near the Tennessee River between 44.1 ft-bgs and 53.7 ft-bgs. Voids were not encountered in the other test borings around the site, so a geophysical field investigation was conducted to evaluate the extent of the karst feature. The geophysical investigation consisted of three (3) ERT survey lines oriented parallel to the Tennessee River at the initial pump station site.

ERT is an active geophysical technique that introduces a known amount of electrical current into the ground and measures the response to map electrical potentials in the subsurface material. Typically, clayey and moist soils conduct electricity more efficiently than dry sands, gravels, chert, and competent limestone/dolomite, i.e. clayey and moist soils exhibit a lower resistivity. The electrical resistivity also depends on the material within the pore or void space. If a cavity is filled with air, a high resistivity anomaly within the limestone/dolomite layer is expected. If a cavity is filled with water or clay, a low-resistivity anomaly within the limestone/dolomite layer is expected.

The results of the geophysical investigation indicated two (2) low-resistivity anomalies, as indicated in the geophysical report presented in **Appendix B**. The locations of the pump station and associated structures were adjusted to avoid the potential anomalies.

2.3.3 Secondary Field Investigation

2.3.3.1 Secondary Geotechnical Investigation

A secondary field investigation was conducted at the initial pump station facility to investigate the subsurface conditions beneath the relocated building footprints. The secondary field investigation consisted of one (1) test boring location (CDM-204) drilled by Terracon, Inc. on November 20, 2018. CDM-204 was drilled to a depth of 66.3 ft-bgs using an Acker drill rig equipped with an automatic SPT hammer system and continuous flight hollow stem auger drilling techniques.

Split-spoon sampling was conducted continuously from the ground surface to the depth of 15 feet and at 5-foot intervals thereafter to auger refusal. Representative soil samples from the test borings were collected and stored in glass jars for later review and laboratory testing. A CDM Smith representative visually classified the soil samples recovered in the field in general accordance ft-bgs, and rock coring was performed. Rock cores were generally obtained in 5-foot runs using an NQ2-size wireline diamond-bit core barrel system. The recovered rock cores were logged in the field by the CDM Smith representative and were stored in core boxes. The percent recovery and rock quality designation (RQD) were recorded.

The water level in the test boring was measured within the borehole and represents a 24-hour water level reading.

The test boring was backfilled with grout to the ground surface upon completion. The test boring log, prepared by CDM Smith, is included in Appendix C, and the rock core photographs are included in **Appendix E**.

Four (4) test borings were proposed for the secondary field investigation, but a large void from 45.1 feet bgs to 64.4 feet bgs was observed in the first test boring (CDM-204) conducted in this phase. Due to the void observed in the initial field investigation, the anomalies observed in the initial geophysical survey, and the void observed in test boring CDM-204, the secondary field investigation was terminated after completing test boring CDM-204.

2.3.3.2 Secondary Geophysical Field Investigation

A secondary geophysical field investigation was conducted to explore alternate pump station facility sites. The secondary geophysical investigation consisted of nine (9) ERT survey lines distributed throughout three (3) alternative sites: Alternative Site A, Alternative Site B, and Alternative Site D (**Figure 2-1**). Each alternative site had three (3) parallel ERT survey lines distributed throughout the site, as shown in the geophysical data report presented in Appendix B. Please note Alternative Site C was initially considered but was eliminated before the geophysical surveys. Thus, Alternative Site C is not shown on Figure 2-1.

Figure No. 2-1
Original (Initial) Site Location and Alternative Sites Considered
JULY 2019

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The results of the geophysical investigation indicated one (1) low-resistivity anomaly on the southwest portion of Alternative Site B, two (2) low-resistivity anomalies at Alternative Site D, and three (3) low-resistivity anomalies at Alternative Site A, as indicated in the geophysical report presented in Appendix B. Based on the results of the geophysical investigation, Alternative Site B was selected for further field investigation and potential relocation of the proposed pump station facility.

2.3.4 Final Subsurface Investigation

A final geotechnical field investigation was performed at Alternative Site B by S&ME, Inc. between February 25, 2019 and March 2, 2019. The exploration consisted of four (4) test borings with depths ranging from 54.9 to 65.2 ft-bgs using a truck-mounted CME-550X drill rig equipped with an automatic SPT hammer system and continuous flight hollow stem auger drilling techniques.

Split-spoon sampling was either conducted continuously from the ground surface to the depth of 20 feet and at 5-foot intervals thereafter to auger refusal or at 5-foot intervals from the ground surface to the depth of 20 feet and continuously thereafter to auger refusal. Representative soil samples from the test borings were collected and stored in plastic bags for later review and laboratory testing. A CDM Smith representative visually classified the soil samples recovered in the field in general accordance with the Burmister classification system. In addition to the split-spoon samples, four (4) Shelby tube samples were collected using 3-inch-outer-diameter, 16-gauge wall thickness, 24-inch-long samplers with a sharp cutting edge. Shelby tube samples produce a relatively undisturbed soil sample for laboratory testing.

Auger refusal was encountered in all four (4) test borings at depths ranging from 28.6 to 36.0 ft-bgs, and rock coring was performed. Rock cores were generally obtained in 5-foot runs using an NQ2-size wireline diamond-bit core barrel system. The recovered rock cores were logged in the field by the CDM Smith representative and were stored in core boxes. The percent recovery and rock quality RQD were recorded. Select rock core samples were transported to the S&ME Inc for geotechnical laboratory testing.

Laboratory testing was performed based upon assignments made by CDM Smith and included Atterberg limits, grain size analysis, unconsolidated-undrained triaxial compression testing, unconfined compressive strength testing of rock, and soil corrosivity tests. A geotechnical laboratory testing was provided by S&ME, Inc. and is included in **Appendix D**.

Water levels in the test borings, where recorded, were measured within the boring and represent 24-hour water level readings.

All test borings were backfilled with grout to the ground surface upon completion. The test boring logs, prepared by CDM Smith, are included in Appendix C, and the rock core photographs are included in Appendix E.

2.3.5 Geotechnical Laboratory Testing

Geotechnical laboratory tests were performed on select soil samples and rock cores based on assignments made by CDM Smith. Laboratory testing conducted for the preliminary investigation was performed by Terracon, Inc., and laboratory testing conducted for the final investigation was performed by S&ME, Inc.

The laboratory test program for the preliminary investigation was conducted by Terracon, Inc. and consisted of the following:

- Eighteen (18) grain size analyses performed in accordance with ASTM D422,
- Twenty (20) grain size analyses with hydrometers performed in accordance with ASTM D422 and D1140,
- Thirty (30) Atterberg limits tests performed in accordance with ASTM D4318,
- Seventy-three (73) moisture content analyses performed in accordance with ASTM D2216.
- Twenty-eight (28) USCS classifications made in accordance with ASTM D2187.
- Three (3) unconfined compressive strength (UCS) Tests performed on rock core samples in accordance with ASTM D2166.
- Two (2) one-dimensional consolidation tests performed in accordance with ASTM D2435/D2435M, and
- Three (3) flexible wall permeameter hydraulic conductivity tests performed in accordance with ASTM D5084.

All test results for the preliminary investigation are included in Appendix A. Summaries of the geotechnical laboratory test results for soil and rock are included in **Table 2-1** through **Table 2-4**.

The geotechnical laboratory test program for the final investigation was conducted by S&ME, Inc. This program consisted of the following:

- Five (5) grain size analyses performed in accordance with ASTM D6913.
- Four (4) grain size analyses with hydrometers performed in accordance with ASTM D6913 and D7928
- Eight (8) Atterberg limits tests performed in accordance with ASTM D4318.
- Eighteen (18) Moisture content analyses performed in accordance with ASTM D2216.
- Seven (7) USCS classifications made in accordance with ASTM D2187.
- Five (5) UCS Tests performed on rock core samples in accordance with ASTM D7012 Method C.
- Two (2) Corrosivity suite analyses performed in accordance with AASHTO T 289, ASTM D 512, and AWWA 4500-S D.
- One (1) three-point Unconsolidated Undrained (UU) test performed in accordance with ASTM D2850.

All test results are included in Appendix D. Summaries of the geotechnical laboratory test results for soil and rock are included in **Table 2-1** through **Table 2-4**.

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Table 2-1 Summary of Geotechnical Index Test Results

City of Chattanooga																		
Dupont Pump Station and Gravity Sewer																		
Chattanooga, TN																		
Exploration Number	Sample Number	Sample Depth (ft)	Strata	USCS Classification (1)	Grain Size Analysis (2)										Atterberg Limits (3)			Moisture Content (%) (4)
					Gravel (%)			Sand (%)				Fines (%)			LL (%)	PL (%)	PI (%)	
					Coarse	Fine		Coarse	Medium	Fine		Silt	Clay					
Preliminary Subsurface Investigation - Terracon - 100 Series																		
B-101	--	1	Upper Soils	CH	0.0			3.4				45.2	51.4		54	25	29	19.0
B-101	--	3.5	Upper Soils	--	--	--		--	--	--		--			--	--	--	20.0
B-101	--	8.5	Upper Soils	--	--	--		--	--	--		--			--	--	--	23.0
B-101	--	13.5	Upper Soils	--	--	--		--	--	--		--			--	--	--	25.0
B-101	--	23.5	Lower Soils	--	--	--		--	--	--		--			--	--	--	32.0
B-101	--	28.5	Lower Soils	ML	0.0			42.7				37.2	20.1		NV	NP	NP	41.0
B-102	--	20	Upper Soils	--	--	--		--	--	--		--			--	--	--	27.0
B-102	--	25	Upper Soils	CL	0.0			12.7				50.7	36.6		41	21	20	30.0
B-102	--	30	Upper Soils	--	0.1			23.2				48.0	28.7		--	--	--	42.0
B-103	--	2.5	Upper Soils	CH	0.0			3.3				43.2	53.5		52	24	28	20.0
B-103	--	6.5	Upper Soils	CL	0.0			4.2				95.8			47	23	24	24.0
B-103	--	10	Upper Soils	--	--	--		--	--	--		--			--	--	--	25.0
B-103	--	20	Lower Soils	--	--	--		--	--	--		--			--	--	--	28.0
B-103	--	25	Lower Soils	--	--	--		--	--	--		--			--	--	--	29.0
B-103	--	30	Lower Soils	ML	0.2			38.7				40.7	20.3		NV	NP	NP	44.0
B-104	--	2.5	Upper Soils	--	16.4			30.5				53.2			--	--	--	18.0
B-104	--	20	Upper Soils	CL	0.0			28.6				40.5	30.9		32	21	11	28.0
B-104	--	25	Lower Soils	ML	0.0			36.8				42.2	21.1		30	25	5	33.0
B-105	--	1	Upper Soils	--	0.0			13.6				86.4			--	--	--	--
B-105	--	5	Upper Soils	--	--	--		--	--	--		--			45	21	24	17.0
B-105	--	6.5	Upper Soils	--	27.5			29.0				22.0	21.4		--	--	--	26.0
B-105	--	15	Upper Soils	--	--	--		--	--	--		--			--	--	--	25.0
B-105	--	25	Upper Soils	CL	0.0			15.5				49.2	35.3		36	20	16	30.0
B-105	--	30	Upper Soils	--	--	--		--	--	--		--			--	--	--	44.0
B-106	--	2.5	Upper Soils	--	22.2			27.1				50.7			--	--	--	19.0
B-106	--	5	Upper Soils	--	--	--		--	--	--		--			--	--	--	18.0
B-106	--	6.5	Upper Soils	CH	--	--		--	--	--		--			--	--	--	27.0
B-106	--	10	Upper Soils	--	--	--		--	--	--		--			--	--	--	22.0

City of Chattanooga															
Dupont Pump Station and Gravity Sewer															
Chattanooga, TN															
Exploration Number	Sample Number	Sample Depth (ft)	Strata	USCS Classification (1)	Grain Size Analysis (2)							Atterberg Limits(3)			Moisture Content (%) (4)
					Gravel (%)		Sand (%)			Fines (%)		LL (%)	PL (%)	PI (%)	
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay				
B-106	--	15	Upper Soils	--	--	--	--	--	--	--		--	--	--	23.0
B-106	--	20	Upper Soils	CL	0.0		13.2			46.6	40.2	39	23	16	27.0
B-106	--	25	Lower Soils	--	--	--	--	--	--	--					27.0
B-106	--	30	Lower Soils	SM	35.4		41.2			12.4	10.9	31	29	2	35.0
B-107	--	2.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	16.0
B-107	--	5	Upper Soils	SC	21.7		28.5			17.9	31.9	43	19	24	16.0
B-107	--	10	Upper Soils	CH	8.7		12.3			38.6	40.4	50	24	26	36.0
B-107	--	20	Upper Soils	--	--	--	--	--	--	--		--	--	--	26.0
B-107	--	25	Lower Soils	ML	0.1		29.1			46.6	24.2	30	28	2	35.0
B-107	--	30	Lower Soils	--	8.6		78.5			12.9		--	--	--	15.0
B-108	--	3.5	Fill	--	--	--	--	--	--	--		49	20	29	17.0
B-108	--	6	Upper Soils	CH	--	--	--	--	--	--		--	--	--	27.0
B-108	--	8.5	Upper Soils	CL	0.0		5.5			94.5		48	25	23	35.0
B-108	--	13.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	26.0
B-108	--	18.5	Upper Soils	--	--	--	--	--	--	--		38	21	17	22.0
B-108	--	23.5	Upper Soils	CL	0.1		15.9			49.6	34.4	37	24	13	38.0
B-108	--	28.5	Lower Soils	--	45.5		48.4			6.1		--	--	--	10.0
B-110	--	2.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	15.0
B-110	--	5	Upper Soils	CL	11.7		24.2			27.0	37.2	40	21	19	19.0
B-110	--	6.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	24.0
B-110	--	10	Upper Soils	--	--	--	--	--	--	--		--	--	--	25.0
B-110	--	15	Upper Soils	CL	0.0		14.3			85.7		41	20	21	26.0
B-110	--	20	Upper Soils	--	--	--	--	--	--	--		--	--	--	28.0
B-112	--	2.5	Upper Soils	CL	2.0		8.8			38.0	51.3	44	23	21	23.0
B-112	--	5	Upper Soils	--	--	--	--	--	--	--		--	--	--	24.0
B-112	--	10	Upper Soils	CH	0.0		2.2			97.8		51	25	26	24.0
B-112	--	15	Upper Soils	--	--	--	--	--	--	--		--	--	--	25.0
B-113	--	5	Upper Soils	CH	0.0		2.0			44.3	53.7	50	26	24	23.0
Preliminary Subsurface Investigation - Terracon - 200 Series															
B-203	--	2.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	24.0

City of Chattanooga															
Dupont Pump Station and Gravity Sewer															
Chattanooga, TN															
Exploration Number	Sample Number	Sample Depth (ft)	Strata	USCS Classification [1]	Grain Size Analysis [2]							Atterberg Limits[3]			Moisture Content (%) [4]
					Gravel (%)		Sand (%)			Fines (%)		LL (%)	PL (%)	PI (%)	
					Coarse	Fine	Coarse	Medium	Fine	Silt	Clay				
B-203	--	5	Upper Soils	--	--	--	--	--	--	--		--	--	--	17.0
B-203	--	7.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	19.0
B-203	--	10	Upper Soils	--	--	--	--	--	--	--		--	--	--	22.0
B-203	--	15	Upper Soils	CL	0.0		10.9			89.1		39	21	18	24.0
B-203	--	20	Upper Soils	--	--	--	--	--	--	--		--	--	--	24.0
B-205	--	20	Upper Soils	CL	0.0		15.8			49.2	35.0	33	22	11	25.0
B-206	--	2.5	Fill	--	11.0		32.9			56.1		--	--	--	9.0
B-206	--	5	Upper Soils	--	--	--	--	--	--	--		--	--	--	20.0
B-206	--	7.5	Upper Soils	CL	11.3		21.9			66.8		32	20	12	21.0
B-206	--	10	Upper Soils	--	--	--	--	--	--	--		36	21	15	23.0
B-206	--	13.5	Upper Soils	--	--	--	--	--	--	--		--	--	--	21.0
B-207	--	15	Upper Soils	--	19.3		40.0			40.7		--	--	--	14.0
B-208	--	5	Fill	--	35.6		38.1			26.3		--	--	--	13.0
B-208	--	6.5	Upper Soils	--	2.9		24.9			72.2		--	--	--	28.0
B-208	--	10	Upper Soils	--	41.5		41.6			16.9		--	--	--	11.0
B-215	--	6.5	Upper Soils	CL	5.2		19.1			75.6		40	22	18	19.0
B-215	--	10	Upper Soils	SC	35.8		43.5			20.7		38	20	18	14.0
Final Subsurface Investigation - CDM Smith - 500 Series															
B-501	S-1	3.5-5	Upper Soils	CH	0.0		0.0	0.2	1.2	48.0	50.6	54	22	32	22.3
B-501	S-3	13.5-15	Upper Soils	CL								43	19	24	19.2
B-501	S-7	26-28	Upper Soils	--	0.0		1.0	2.0	40.0	58.0					
B-502	S-2	8-9.5	Upper Soils	CH	0.0		0.0	0.0	2.0	98.0		51	21	30	21.4
B-502	S-7	25.5-27.5	Upper Soils	--	0.0		0.3	2.4	45.6	29.4	22.2	NP	NP	NP	
B-503	S-2	2-4	Upper Soils	CL	0.0		1.7	1.0	4.3	38.5	54.5	47	21	26	21.2
B-503	ST-2	10-11	Upper Soils	CL	0.0		0.0	0.0	2.0	98.0		48	21	27	21.4
B-504	S-5	8-10	Upper Soils	CH	0.0		0.0	0.0	1.0	98.0		51	21	30	21.4
B-504	S-9	16-18	Upper Soils	CL	0.0		0.0	0.1	3.7	47.7	48.5	45	22	23	22.3

1 USCS classifications were performed in accordance with ASTM D-2487.
2 Grain size analysis tests performed in accordance with ASTM D-422 and ASTM D-1140.
3 Atterberg Limits analysis performed in accordance with ASTM D-4318.
4 Moisture content analysis performed in accordance with ASTM D-2216.

Abbreviations:

CH: Fat Clay — CL: Lean Clay
ML: Lean Silt — NP: Non-Plastic
SC: Clayey Sand — SM: Silty Sand

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Table 2-2 Summary of One-Dimensional (1-D) Consolidation Test Results

City of Chattanooga													
Dupont Pump Station and Gravity Sewer													
Chattanooga, TN													
Exploration Number	Sample Depth (ft)	Sample Elevation (2)	Moisture Content (%)		Void Ratio	Dry Density (pcf)	σ'_p	σ'_{vo}	OCR	Cc	Cr	Cv (ft^2/yr)	
			w_o		e_o		(tsf)	(tsf)				Min	Max
B-104	21	631	26.2		0.784	95.9	2.0	1.05	1.90	0.23	0.04	0.076	7.162
B-104	23	629	29.4		0.908	89.3	2	1.07	1.87	0.31	0.04	0.145	3.978

[1] 1-D Consolidation testing conducted in accordance with ASTM D2435.
[2] Elevations are approximate and referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Abbreviations
w_o = initial water content
e_o = initial void ratio
σ'_p = Pre-consolidation Pressure
σ'_{vo} = Estimated Existing Effective Vertical Stress
OCR = Overconsolidation Ratio
Cc = Compression Index
Cr = Recompression Index
Cv=Coefficient of consolidation

Table 2-3 Summary of Triaxial Test Results

City of Chattanooga							
Dupont Pump Station and Gravity Sewer							
Chattanooga, TN							
Exploration Number	Sample Depth (ft)	Sample Elevation (2)	Calculated Void Ratio	Dry Density (pcf)	Strain at Failure (%)	Unconfined Compressive Strength (tsf)	Undrained Shear Strength (tsf)
B-104	8-10	643	0.61	105	15.0	1.8	
B-104	10-12	641	0.91	88	4.6	0.85	
B-104	22-24	629	0.95	87	6.0	1.42	
B-502	19.5-21.5	633	0.74	98.7	--		0.5
B-502	19.5-21.5	633	0.77	97.3	--		
B-502	19.5-21.5	633	0.75	98	--		

[1] B104 samples were tested in accordance with ASTM D2166. B502 samples were tested in accordance with ASTM D2850 (UU Test).

[2] Elevations are approximate and referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

Table 2-4 Summary of Rock Core Test Results

City of Chattanooga					
Dupont Pump Station and Gravity Sewer					
Chattanooga, TN					
Exploration Number	Sample Number	Sample Depth (ft)	Wet Density (pcf)	Unconfined Compressive Strength (ksi)	Hydraulic Conductivity (ft/day)
B-101		--	145.0	18.2	--
B-104		--	156.0	18.9	--
B-104		--	160.7	18.1	--
B-101		36.1-41.1	168.1	--	1.83E-05
B-104		28.2-30.0	169.9	--	2.39E-05
B-108		33.6-39.6	168.6	--	6.69E-06
B-501	C-3	36.3-36.6	171.5	35.0	--
B-501	C-5	47.0-47.4	174.9	34.3	--
B-502	C-2	31.9-32.2	166.8	27.9	--
B-502	C-3	38.8-39.2	170.1	28.6	--
B-503	C-1	37.4-37.7	175.2	41.7	--

[1] Hydraulic Conductivity test performed using a flexible wall permeameter, ASTM D5084.

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2.4 Subsurface Conditions

The subsurface conditions encountered during the preliminary, secondary, and final field investigation phases, as interpreted from the test boring logs, are generally consistent with regional geologic data. The subsurface conditions at the proposed pump station facility and along the gravity sewer alignment consist of Surface Material, Miscellaneous Fill, Upper Soil, Lower Soil, and Bedrock. A summary of the subsurface conditions is included in **Table 2-5**.

2.4.1 Surficial Material

Surficial material consisting of topsoil or asphalt and aggregate base course was encountered in every test boring with thicknesses ranging from 0.3 feet to 0.8 feet.

2.4.2 Miscellaneous Fill

Fill was identified at four (4) test boring locations. All locations where Fill was encountered were part of the preliminary subsurface investigation (B-108, B-205 through B-206, and B-208). The Fill layer was encountered beneath surficial materials with thicknesses ranging from 2.7 feet to 5.7 feet. The Fill layer typically consisted of loose to medium dense, light brown and red or dark brown, lean CLAY, some fine to coarse gravel, some rock or chert fragments; or very loose, brown, fine to coarse SAND and fine to coarse GRAVEL, some clay. SPT N-Values range from 1 to 23 blows/foot (bl/ft) with an average value of 7.5 bl/ft at the test boring locations.

2.4.3 Upper Soils

Upper Soils were encountered beneath the surficial material or miscellaneous fill layers at all thirty (30) test boring locations. The upper soil layer consists of Fat Clay (CH), Lean Clay (CL), or Clayey Sand (SC/SC-SM). SPT N-Values in the Upper Soils at the preliminary investigation locations ranged from 0 to 42 bl/ft with an average of 11 bl/ft and at the final investigation locations ranged from 0 to greater than 50 bl/ft with an average of 11 bl/ft at the test boring locations. Clayey sand typically overlies the lean clay, but it sometimes is below the lean clay. As shown in **Table 2-5**, the low-blow count (<2) material can be observed immediately above the limestone. The sub-strata typically consisted of the following:

2.4.3.1 Fat Clay

Fat Clay ranged from 5.5 feet to 21.5 feet thick at the preliminary investigation borings (B-101 through B-103, B-107, B-112 through B-114, and CDM-204) and from 6.0 feet to 17.3 feet thick at the final investigation test borings (B-501 and B-503 through B-504). At the preliminary investigation locations, the Fat Clay typically consisted of medium stiff to stiff, dark brown, yellow and brown, or gray, high plasticity CLAY, trace mica. At the final investigation locations, the Fat Clay typically consisted of moist to wet, very soft to stiff, gray, dark gray, dark brown, or orange-brown, high plasticity CLAY, trace fine to coarse sand, trace mica.

2.4.3.2 Clayey Sand

Clayey Sand ranged from 5.7 feet to 14.5 feet thick at the preliminary investigation test borings (B-105, B-107, B-208, and B-215) and from 4.1 feet to 6.3 feet thick at the final investigation test borings (B-501 through B-502 and B-504). At the preliminary investigation locations, Clayey Sand typically consisted of loose to medium dense, brown or yellow to brown, fine to coarse SAND, some clay, little fine to coarse gravel, trace mica. At the final investigation locations, Clayey Sand typically consisted of wet, very loose to loose, dark gray, fine to coarse SAND, some clay, trace to little wood, trace mica.

2.4.3.3 Lean Clay

Lean Clay ranged from 3.0 feet to 22.5 feet thick at the preliminary investigation test borings (B-102 through B-106, B-108 through B-112, B-201 through B-216, and CDM-204) and from 4.0 feet to 24.5 feet thick at the final investigation test borings (B-501 and B-501 through B-504). At the preliminary investigation locations, Lean Clay typically consisted of very soft to stiff, gray, brown, or dark gray, low plasticity CLAY, “none” to little fine to coarse sand, trace mica. At the final investigation locations, Lean Clay typically consisted of moist to wet, very soft to stiff, brown, gray, tan, or dark gray, low plasticity CLAY, “none” to trace fine to coarse sand, trace mica.

2.4.4 Lower Soils

Lower Soils were encountered beneath Upper Soils at nine (9) test boring locations including seven (7) preliminary investigation locations and two (2) final investigation locations. Where encountered, Lower Soils ranged from 3.0 feet to 14.2 feet thick at the preliminary investigation locations (B-101, B-103 through B-104, B-106 through B-108, and CDM-204) and from 1.4 feet to 6.7 feet thick at the final investigation locations (B-503 through B-504). At the preliminary investigation locations, Lower Soils typically consisted of soft to medium stiff, dark brown, brown, or gray and brown, SILT, some fine to coarse sand, trace mica or loose to dense, dark gray, gray, or brown and gray, fine to coarse SAND, some silt, “none” to little fine to coarse gravel. At the final investigation locations, Lower Soils typically consisted of wet, dense, gray, fine to medium SAND or fine to coarse GRAVEL. SPT N-Values in the Lower Soils at the preliminary investigation locations ranged from 0 to greater than 50 bl/ft with an average of 18 bl/ft and at the final investigation locations ranged from 2 to 31 bl/ft with an average of 19 bl/ft at the test boring locations. As shown in **Table 2-5**, the low-blow count (<2) material can be observed immediately above the limestone.

2.4.5 Bedrock

Bedrock was cored where auger refusal was encountered at eight (8) test boring locations including four (4) preliminary investigation locations (B-101, B-104, B-108, and CDM-204) and four (4) the final investigation locations (B-501 through B-504). Bedrock consisted of regions of Voids and competent Limestone. Voids within the bedrock ranged from 0.1 ft to 15.7 ft thick and were often encountered as water-filled voids at various depths within a borehole. Competent rock encountered at the preliminary investigation locations typically consisted of gray or greenish gray, LIMESTONE, with shale parting and greenish gray dolomitic zones. Rock encountered at the final investigation locations typically consisted of moderately hard to very hard, slightly fractured to sound, fresh to slightly weathered, blue-gray or gray and white, LIMESTONE. Bedrock recovery values in the preliminary investigation locations ranged from 0 to 100 percent with an average of 72 percent, and the RQD values ranged from 0 to 88 percent with an average of 48 percent at the test boring locations. Bedrock recovery values in the final investigation locations ranged from 57 to 100 percent with an average of 93 percent, and the RQD values ranged from 21 to 100 percent with an average of 83 percent.

Table 2-5 Summary of Subsurface Explorations

City of Chattanooga Dupont Pump Station and Gravity Sewer Chattanooga, TN												
Exploration Number	Approximate Ground Surface El.[1] (ft)	Exploration Depth (ft)	Strata Thickness (ft)								Depth to Groundwater (ft)[2]	Groundwater Elevation (ft)[2]
			Surface	Fill	Upper Soils			Lower Soils	Bedrock			
					(CH)	(CL)	(SC/SC-SM)	(ML/SM/SP/GP)	Voids	Limestone		
Preliminary Subsurface Investigations - 100 Series												
B-101	654.0	51.2	0.5	--	21.5	--	--	14.2 (ML)	--	>15.0	31.0(NE)	623.0
B-102	657.0	30	0.5	--	21.5	>8.0	--	--	--	--	NE	--
B-103	657.0	30	0.5	--	5.5	11.0	--	>13.0 (ML)	--	--	NE	--
B-104	652.0	45	--	--	--	22.0	--	6.2 (ML) [3]	--	>16.8	NR	--
B-105	655.0	30	0.8	--	--	>14.7	14.5	--	--	--	NE	--
B-106	652.0	30	0.8	--	--	19.2	--	>10.0 (SM) [3]	--	--	27.0(NE)	625.0
B-107	652.0	30	0.8	--	15.5	--	5.7	>8.0 (ML) [3]	--	--	27.0(NE)	625.0
B-108	652.0	59.6	0.3	5.7	--	22.0 [3]	--	6.6 (SP)	9.6	>15.4	26.0(NE)	626.0
B-109	660.0	20	0.3	--	--	>19.7	--	--	--	--	NE	--
B-110	635.0	20	0.8	--	--	>19.2	--	--	--	--	NE	--
B-111	655.0	15	0.3	--	--	>14.7	--	--	--	--	NE	--
B-112	654.0	15	0.3	--	>7.0	7.7	--	--	--	--	NE	--
B-113	650.0	15	0.3	--	>14.7	--	--	--	--	--	NE	--
Preliminary Subsurface Investigations - 200 Series												
B-201	656.0	15	0.3	--	--	>14.7	--	--	--	--	NE	--
B-202	657.0	15	0.3	--	--	>14.7	--	--	--	--	NE	--
B-203	661.0	20	0.8	--	--	>19.2	--	--	--	--	NE	--
B-204	661.0	15	0.8	--	--	>14.2	--	--	--	--	NE	--
B-205	662.0	20	0.3	2.7	--	>17.0	--	--	--	--	NE	--
B-206	655.0	15	0.5	2.5	--	>12.0	--	--	--	--	NE	--
B-207	653.0	15	0.6	--	--	>14.4	--	--	--	--	NE	--
B-208	654.0	15	0.6	4.9	--	3.0	>6.5	--	--	--	NE	--
B-209	657.0	16	0.3	--	--	>15.7	--	--	--	--	NE	--
B-210	661.0	20	0.3	--	--	>19.7	--	--	--	--	NE	--
B-215	662.0	15	0.5	--	--	7.5	>7.0	--	--	--	NE	--
B-216	654.0	15	0.5	--	--	>14.5	--	--	--	--	NE	--
Preliminary Subsurface Investigations - CDM 200 Series												
CDM-204	655.5	66.3	0.5	--	9.0	31.0 [3]	--	3.0	18.7	>4.2	24.0	631.5

City of Chattanooga														
Dupont Pump Station and Gravity Sewer														
Chattanooga, TN														
Exploration Number	Approximate Ground Surface El.[1] (ft)	Exploration Depth (ft)	Strata Thickness (ft)										Depth to Groundwater (ft)[2]	Groundwater Elevation (ft)[2]
			Surface	Fill	Upper Soils				Lower Soils		Bedrock			
					(CH)	(CL)	(SC/SC-SM)		(ML/SM/SP/GP)		Voids	Limestone		
Final Subsurface Investigations - 500 Series														
B-501	651.9	65.2	--	--	--	22.5	6.3 [3]		--		1.2	>35.1	0.0	651.9
B-502	653.7	54.9	--	--	--	24.5	4.1 [3]		--		--	>26.3	0.2	653.5
B-503	652.8	60.3	--	--	17.3	12.0	--		6.7		0.3	>24.0	NR	--
B-504	654.6	55.0	--	--	6.0	18.0	5.0		1.4		0.3	>23.7	3.0	651.6

1 Elevations are approximate and referenced to the National Geodetic Vertical Datum of 1929 (NGVD29).

2 Groundwater level readings were taken during and upon completion of the test boring. Parenthetical values represent value after drilling if recorded as different than measurement during drilling.

3 A soft layer is present with blow counts less than or equal to 2 immediately above the limestone with occasional presence of stiff sand in between

Abbreviations:

> Indicates strata not fully penetrated
NE indicates not encountered

-- Indicates no value
NR Indicates not recorded

2.4.6 Groundwater Conditions

24-hour groundwater level measurements were recorded where encountered at each test boring location. When encountered at the preliminary investigation locations, groundwater was observed between 26 feet and 31 ft-bgs (approximately El. 623 to 626). When encountered at the final investigation locations, groundwater was observed between 0 feet and 3 feet bgs (approximately El. 651.6 to El. 653.5). Due to the proximity of the Tennessee River to the site, ground water levels will likely correspond to the river stage elevation. Flood conditions were active at the time of drilling for the 500-Series boring locations, which likely influenced the shallow groundwater readings.

2.5 Expected Variations in Subsurface Conditions

The interpretation of general subsurface conditions presented herein is based on soil, rock, and groundwater conditions observed at the test boring locations. However, subsurface conditions may vary between test boring locations. If conditions are found to be different from those described herein, recommendations contained in this report should be re-evaluated by CDM Smith and confirmed in writing.

Water levels measured in the test borings should not necessarily be considered to represent stabilized groundwater levels. In addition, water levels are expected to fluctuate with river level, season, temperature, climate, construction in the area, and other factors. Actual conditions during construction may be different from those observed at the time of the test borings.

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Section 3

Geotechnical Engineering Evaluation and Design Recommendations

3.1 General

Geotechnical engineering evaluations have been made as they relate to the Dupont Pump Station and Basin Improvements – Phase 2 project in Chattanooga, Tennessee. The locations of the structures are as shown on Figure 1-1 noted as current site. In general, these evaluations are based on the results of the subsurface investigations described in Section 2 of this report, published correlations with soil and rock properties and the minimum requirements of the International Building Code 2012 and Tennessee Building Code. In addition, recommended design criteria are based on performance tolerances, such as allowable settlement, as understood to relate to similar structures.

3.2 Geotechnical Considerations

A summary of the primary geotechnical considerations and evaluations related to the design of the proposed pump station, associated structures, and gravity sewer pipeline construction are described in the following sections.

3.2.1 Potential Karst Conditions within Bedrock

The site is considered susceptible to the typical carbonate dissolution hazards of karst topography, including sinkholes and caves. Several small and large voids have been documented in the area, as discussed in Section 2. Two (2) test borings encountered large voids in the bedrock including voids of 9.6 feet in test boring B-108, 15.7 feet in test boring CDM-204, and three test borings encountered minor voids of up to 0.8 feet in test boring B-501, 0.3 feet in test boring B-503, and up to 0.2 feet in test boring B-504. The large voids were encountered at the initial pump station facility site, approximately 447 feet west of the current project site. Much-smaller voids were encountered in the current project site. Pump station and diversion structures have below-grade foundations (approximately 26 feet below proposed grade), so any potential voids may threaten the structural integrity of these buildings. Given this, and the presence of soft soils immediately above the limestone, pump station and diversion structures are recommended to be founded on micropiles.

3.2.2 Site Development

As part of the site development, 4 to 9-feet of fill will be placed and compacted to elevate site grades above the 100-year flood level. Stability of the permanent slope adjacent to the diversion structure and settlement of the structures bearing on shallow foundations due to compression of the native soils under the new fill loads were considered in the design recommendations herein.

3.3 Pump Station Site Design Recommendations

3.3.1 Site Development

The global stability of the permanent embankment adjacent to the diversion structure was assessed for the end-of-construction condition and the 100-year flood stage condition. A river stage of El. 650 feet NAVD88 was used for the end-of-construction condition, and a river stage of El. 659 feet NAVD88 was used for the 100-year flood stage condition. A surcharge of 200 pounds per cubic foot was applied at the top of the slope in both analyses to account for maintenance vehicle traffic and potential equipment staging. An embankment with a 3H:1V slope, if constructed with good construction practices, is anticipated to have a factor of safety of approximately 2.4 at the end-of-construction and approximately 2.0 during a 100-year flood event. The factors of safety exceed the minimum criteria given in USACE EM1110-2-1902.

3.3.2 Pump Station and Diversion Structures

Based on the proposed project site layout, anticipated dimensions, depths and loadings of the proposed structures, subsurface soil conditions, and other design requirements, we recommend that the proposed pump station and diversion structures be supported on deep foundations consisting of micropiles bearing in the bedrock layer.

The micropiles are designed to derive their axial capacity through skin friction within the bedrock layer developed in accordance with procedures outlined in the Federal Highway Administration (FHWA) *Micropile Design and Construction Reference Manual* dated December 2005. The end bearing capacity of the drilled micropiles has not been considered in the socket design. Any skin friction within the Fill, Upper Soils, and Lower Soils layers has been neglected. All micropiles should be installed using a permanent casing above the bedrock layer to prevent loose, collapsible soils and weathered rock from caving in during installation and per Tennessee Building Code requirements.

The drilled micropiles are designed as Type A (gravity-grouted) micropiles with an allowable skin friction value of 21.6 kips per square foot (ksf) in the bedrock layer. For a 200-kip axial design capacity, a 7.5-inch-outside-diameter micropile requires about 9 feet of socket embedment length (i.e., bonded length) within the bedrock, and a 9.75-inch-outsidediameter micropile requires about 7 feet of socket embedment length. However, per Tennessee Building Code, 9.75-inch-oustide diameter is recommended. At least one (1) foot plunge depth into the limestone is required for the casing, where the permanent casing is embedded into the limestone by one foot. This depth should not be considered as part of the embedment length. To account for potential encounter of voids in the limestone, the following provisions should be followed during construction:

1. Less than 6-inch void, micropile bond zone length remains unchanged.
2. 6-inch void to 12-inch void, extend micropile bond zone length one foot.
3. Greater than 12-inch void, restart count of the micropile bond zone length from the bottom of the void.

A factor of safety of 2.0 was used to estimate the allowable axial capacity of the micropiles. The micropile axial capacity should be confirmed by static micropile load tests in accordance with

ASTM D1143 or tensile micropile load tests in accordance with ASTM D3689. A minimum of one micropile load test and one micropile proof test (i.e., micropile load test to 160% of the design load) should be conducted for the pump station and the diversion structure.

3.3.2.1 Micropile Spacing

Center-to-center spacing of the micropiles should be at least 3 micropile diameters to limit group interaction for the axial capacity. If a spacing of less than 3 diameters is used, micropile group effects should be considered for axial capacity.

3.3.2.2 Micropile Cap

Micropile caps that are exposed to freezing temperatures should extend at least 24 inches below any adjacent ground surface.

Micropiles should be embedded into the micropile cap or slab no less than 3 inches. Micropile connections into micropile caps or slab reinforcement shall be designed by the structural engineer in accordance with the Code.

3.3.2.3 Under-Slab Utilities

Under-slab utilities may be hung from the micropile-supported mat or grade beams. Connections should be designed to carry the weight of the soil over the utilities within a zone extending upward at 1H:2V from the springline of the utility. Flexible utility connections and oversized sleeves should be provided through foundation walls and grade beams where utilities transition from micropile-supported within the structure to soil supported outside the structure. These flexible connections and oversized sleeves should be designed to accommodate at least 0.5 inches of differential movement at the transition.

3.3.3 Electrical Building and Generator Structures

The electrical building will be supported on strip footings with a design width of 3 feet 4 inches, and the generator platform will be constructed on a slab-on-grade foundation with a thickened edge. The foundations may be designed for a maximum allowable bearing capacity of 3.2 ksf at the electrical building and 3.0 ksf at the generator building.

3.3.3.1 Foundation Depth

In accordance with the Code, all foundations supported on soil should bear below the frost depth. Unheated areas or areas adjacent to exterior ground surfaces should bear no less than 24 inches below any adjacent ground surface exposed to freezing.

3.3.3.2 Foundation Preparation

Foundation preparation shall consist of 12 inches of compacted structural fill or 12 inches of compacted crushed stone wrapped by non-woven geotextile, placed over fill. For any structure bearing upon structural fill or crushed stone, the extent of structural fill or crushed stone should be at a minimum of 2 feet horizontal distance from the edge of the foundation.

Foundation subgrade should be proof rolled by at least four passes of the appropriate compaction equipment prior to the placement of foundation preparation. If clay materials are encountered at subgrade, the final 6 inches of the excavation should be performed by a smooth-edge bucket.

3.3.3.3 Foundation Bearing Capacity

Based on our evaluation, allowable bearing capacity for the electrical building and generator platform is 3.2 ksf and 3.0 ksf, respectively. The allowable bearing capacities are sufficient to support the design structural pressures of 3.0 ksf and 1.5 ksf for the electrical building and generator platform, respectively.

3.3.3.4 Foundation Settlement

Based on our evaluation, settlement of the electrical building and generator platform, under the anticipated loads and designed as recommended above, are expected to be up to 2.0-inches of total settlement with an approximate differential settlement of 1-inch.

3.3.4 Design Groundwater

For the purpose of design, the groundwater level should be assumed to be at the 100-year flood level, which according to the FEMA Flood Map data is El. 659.

3.3.5 Lateral Loads on Below-Grade Walls

Below-grade portions of structures that are fixed against rotation at the top or will not sufficiently rotate enough should be designed for at-rest pressures from soil and groundwater based on equivalent fluid pressure of 60 pounds per cubic foot (pcf) above the design groundwater level and 90 pcf below the design groundwater level.

In addition to these pressures, a lateral pressure equal to 0.5 times surface vertical surcharge loads from building foundations, slabs, traffic or other loads should be applied over the full height of all walls. To eliminate the surcharge loading from adjacent building foundations on walls, the buildings should be separated such that a line extending at least 2.0 ft beyond the edge of the foundation, then outward and downward at a slope of 1H:1V does not intersect the adjacent structure. Walls to which vehicles can reasonably be expected to approach with in a distance equal to half the wall height should be designed for a minimum temporary uniform vertical surcharge of 300 psf. Earthquake-induced pressures developed in accordance with the Code should be included in the design of all below grade walls.

3.3.6 Resistance to Unbalanced Lateral Loads

Unbalanced lateral loads should be resisted by friction on the bottom of shallow foundations or micropile caps and grade beams. For purpose of design, a coefficient of 0.35 should be considered between the concrete and the underlying structural fill or crushed stone. However, should lateral loads exceed the friction available, the surplus loads may be resisted by passive pressures on the micropile caps and grade beams or mat foundations, provided the structure is appropriately designed for the pressure. Passive resistance up to a maximum equivalent fluid pressure of 150 pcf may be used provided the mat foundations, micropile caps and grade beams are backfilled with structural fill that is compacted to a density of at least 98 percent of the maximum dry density as determined by laboratory test ASTM D698. The resistance from the upper 2 feet of soil should be neglected due to the surface effects and the potential for settlement, disturbance, frost action and other factors. No frictional resistance may be assumed for micropile-supported structures.

3.3.7 Resistance to Buoyancy

Any structures that extend below the design groundwater level should be designed to resist hydrostatic pressures from the design groundwater level referenced above using the dead weight of the structure plus weight of fill placed directly over the structure and extension to the structure foundations. For purposes of design against uplift, the material used as backfill should be assumed to have a total unit weight, in place, of 120 pcf. In addition, for pile-supported structures, a tension capacity of up to 50 percent the design axial compression capacity of the piles may be used for design against uplift. A factor of safety of at least 1.25 should be used to evaluate uplift resistance under normal groundwater and 100-year flood conditions.

3.3.8 Earthquake Considerations

For purposes of determining design earthquake forces for the structures in accordance with the Code, the site should be considered as Site Class "D". Therefore, the spectral accelerations are modified for Site Class D when determining the design earthquake response accelerations and seismic design category for the seismic analysis at the site.

The sandy zone as part of lower soils layer immediately above the limestone bedrock could potentially liquefy under design accelerations. The resulting settlements are approximately 2 inches as obtained following the methodology proposed by Idriss and Boulanger (2008) under free field conditions. However, the pump station and diversion structures are founded on micropiles that are keyed into the bedrock, so these structures would not be subject to liquefaction settlement. The generator slab and electrical buildings will have at least 20 feet of clayey material in between the liquefiable zone and their foundations. This thick non-liquefiable zone is considered sufficient to reduce surface manifestation of liquefaction and reduce the impact on structural integrity based on the recommendations by Ishihara (1985).

3.4 Gravity Sewer Pipeline Recommendations

3.4.1 General

Cut-and-cover techniques are planned for the construction of the gravity sewer pipeline except where the alignment crosses a railroad, as shown in the Contract Drawings. Where the sewer crosses the railroad that cannot be open cut, trenchless construction technique, such as pipe jacking, should be used to mitigate disruption of the rail line.

3.4.2 Pipe Subgrade

The sewer pipeline will be installed by cut-and-cover methods in excavated trenches for most of the alignment. The existing soils, low plasticity clays, encountered along the pipeline are generally suitable for support of the proposed pipe.

If organic, loose, or otherwise unstable soils are encountered at subgrade level, these soils should be excavated to the top of the naturally deposited, suitable inorganic soils and replaced with compacted structural fill. Where compacted structural fill is placed for support of the sewer pipeline, the lateral limits of the fill should be defined as a line extending horizontally outward and downward at a 1H;1V slope from the springline of the pipe to a maximum depth of 4 feet.

3.4.3 Pipe Bedding

The pipe should be placed on a bedding of at least 6 inches of crushed stone, and the stone should wrap the pipe at least up to the elevation of the springline for effective material placement within the haunch area of the pipe. The stone will eliminate pipe contact with plastic clays that may be present in the subgrade at the bottom of the excavated trench.

If crushed stone is placed below the pre-construction groundwater level and over or against soils, a geotextile should be placed between the soils and the crushed stone to protect against the migration of fines into the pipe bedding.

3.4.4 Trench Backfill

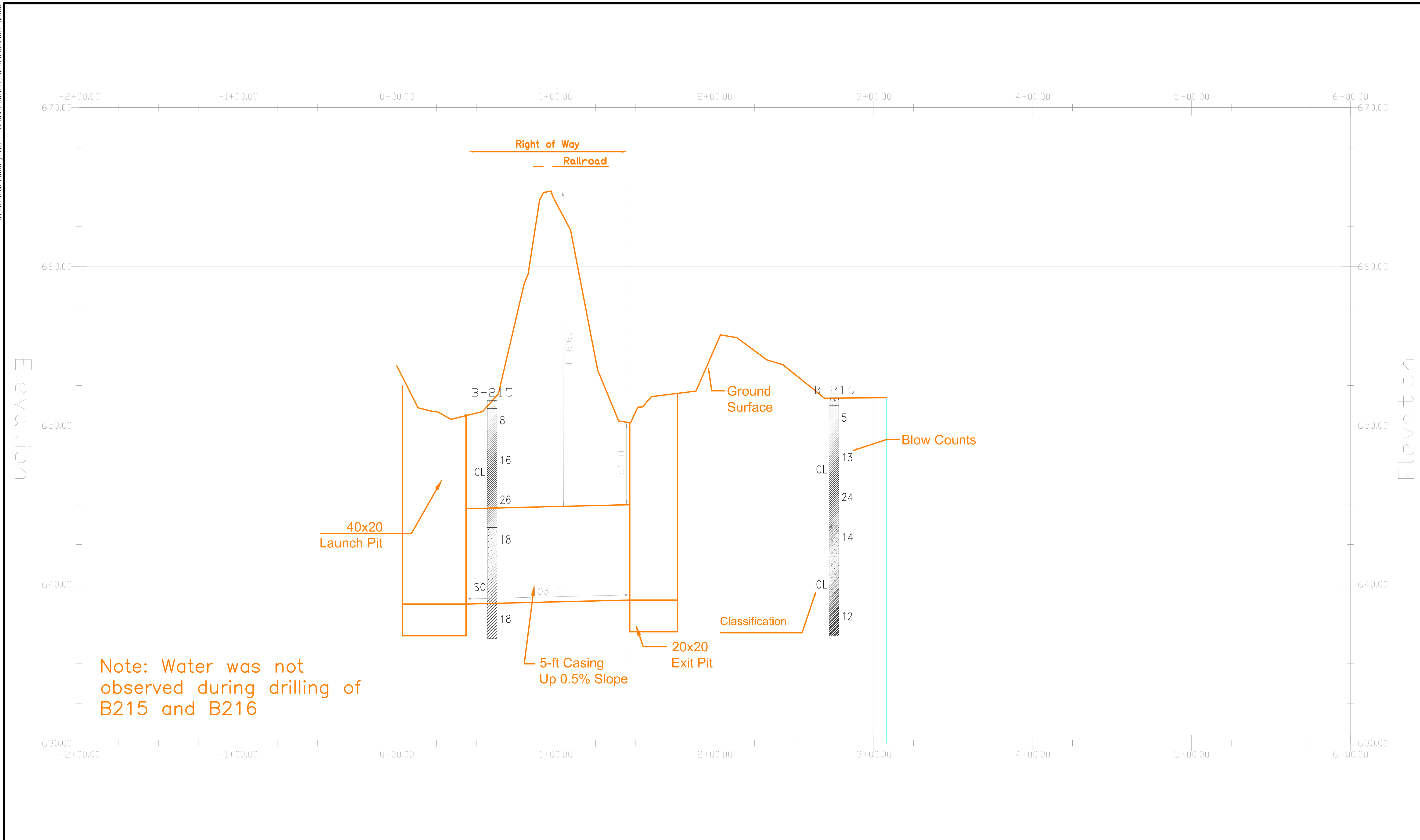
Select common fill should be brought to one foot above the crown of the pipe. Material meeting the criteria for common fill should be used above the select common fill. The remainder of the trench should be backfilled with common fill or select common fill. Refer to **Section 4** for a description of common/select common fill and compaction requirements.

3.5 Trenchless Crossing Recommendations

3.5.1 General

The gravity sewer alignment crosses a rail road as shown on Figure 1-1 and **Figure 3-2**. The railroad crossing will be constructed using trenchless techniques. The length of the railroad crossing is approximately 103 feet, and the depth of cover over the top of the casing is approximately 20 ft.

We recommend pipe jacking with steel casing for construction of the trenchless crossing and installation of the carrier pipe. Pipe jacking should consist of the installation of a minimum 60-inch diameter steel casing for the 48-inch diameter ductile iron pipe (DIP) as shown on Figure 3-1. The invert elevation of the pipeline is proposed to be at approximately El. 644, which provides a minimum soil cover of approximately 5 feet below the existing ground surface near the entry/exit pits at the toe of the railroad embankment. Immediately below the rail road tracks, the thickness of soil cover is approximately 20 feet.



CDM Smith

CITY OF CHATTANOOGA
DUPONT PUMP STATION AND GRAVITY SEWER
CHATTANOOGA, TN

FIGURE 3-1
TRENCHLESS CROSSING
APRIL 2019

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3.5.2 Pipejacking

3.5.2.1 General

Pipejacking consists of pushing a steel casing pipe into the ground using hydraulic jacks at the jacking pit. The material at the heading is excavated from within the steel casing using a continuous flight auger or hand mining. The casing is advanced along with simultaneous excavation of material from the face. This method is considered to be a suitable trenchless construction method for the proposed alignment.

The steel casing pipe will form a temporary liner into which the carrier pipe can be installed and grouted. Use of a casing pipe provides a means to jack through the anticipated earth without damaging the carrier pipe and to allow for proper alignment of the carrier pipe following jacking.

We recommend that pipe jacking be performed on a continuous basis, 24 hours per day, 7 days per week. Pipe jacking methods shall be in accordance with the contract drawings and project specifications. The joints shall be fully closed by welding or mechanical means to ensure tightness.

3.5.2.2 Temporary Ground Support

Temporary ground support of the trenchless crossing should be provided by a steel casing pipe.

Design of the temporary ground support is the responsibility of the Contractor and should be designed by a professional engineer, experienced in pipe jacking and should be registered in the State of Tennessee. The ground support system should be designed to resist the full earth, water, surcharge, and jacking loads acting on it. Surcharge loads from the railroad crossing must be considered. The design should meet the requirements of the contract drawings and project specifications.

Jacking operations should be conducted with an auger that has nearly the same outside diameter of the casing pipe with minimal overcut. Once installed, any voids between the casing pipe and the earth should be grouted using a cement-bentonite grout. Grout should completely fill any voids.

Grouting should be conducted as soon as jacking is completed. Grout pressure should not exceed one-half of the existing overburden pressure. Grout holes must be provided at 4.5-foot maximum intervals placed 120 degrees on center along the entire length of the casing pipe. Grout holes through the casing pipe can be used to insert lubricant which may be required if excessive jacking loads are encountered.

After completion of installation of the carrier pipe, the annulus between the casing pipe and carrier pipe should be filled with a cement grout.

3.5.2.3 Steel Casing Pipe

Based on the anticipated steel casing pipe diameter (60 inches), total crossing length (approximately 103 feet), design surcharge loads, soil overburden, and estimated jacking forces, we anticipate that casing pipe for pipe jacking will have minimum 0.875-inch-thick minimum side walls.

Casing segments, each assumed to be approximately 20 feet long, will be jacked from the entry pit and will need to be welded together or connected using a mechanical connection such as Permalok. The finished casing pipe should be relatively watertight.

3.5.2.4 Ground Conditions and Face Stability

Ground conditions along the trenchless alignment are expected to consist of the Upper Soil materials. These soils are expected to be excavatable in a pipe jacking operation.

Based on the groundwater conditions observed at the time of explorations and during monitoring well readings, groundwater is not expected at the pipeline invert at the trenchless crossing. Should groundwater conditions vary, in order to provide a stable excavation face, groundwater would need to be lowered to below the invert of the tunnel construction.

3.5.2.5 Entry and Exit Pits

A jacking (entry) pit and a receiving (exit) pit will be required at the trenchless crossing. The jacking (entry) pit is expected to be approximately 40 feet by 20 feet in plan area in order to accommodate the anticipated jacking equipment. The receiving (exit) pit is expected to be approximately 20 feet by 20 feet in plan area. All pits should extend to about 2 feet below the proposed pipe invert.

Based on the recommended minimum soil cover of casing pipe and the size of the casing, the depth of the jacking and receiving pits are expected to be about 15 feet below the existing ground surface.

The jacking and receiving pits should have a concrete mat poured at the bottom of the excavation to serve as a working mat. This mat is expected to be about 6 inches thick. The actual thickness of the mat will be determined by the Contractor and will be based on their construction equipment and procedures.

The bottom of the jacking and receiving pits may extend below the groundwater level based on the groundwater condition observed at time of excavation. If groundwater is encountered above the bottom of the pit, dewatering is required to lower the groundwater 2-feet below the bottom of excavation. A drainage layer should be provided under the concrete mat in order to provide a means by which to maintain a dry and stable excavation subgrade. At least 12 inches of compacted, crushed stone should be used as the drainage layer. The stone should be separated from the underlying soils by a geotextile to protect against the migration of fines into the stone.

Requirements for excavation support at the jacking and receiving pits are provided under Construction Considerations. The detailed design and construction of the jacking and receiving pits is the responsibility of the Contractor.

3.5.2.6 Settlements

Ground surface settlement along the tunnel alignment is anticipated to be less than 0.5 inch for the railroad crossing, provided the Contractor conducts all excavation from within the casing, employs proper dewatering/stabilization along the casing, and conducts pipe jacking operations in accordance with the standard of care for that industry.

We recommend that a system of monitoring points be installed along the tunnel alignments to monitor ground deformation.

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Section 4

Construction Considerations

4.1 General

The purpose of this section is to discuss issues related to geotechnical aspects of construction as required for development of the contract drawings and project specifications. Included are anticipated methods of construction required to achieve the recommendations presented herein and identification of potential construction-related problems. The proposed structures and pipeline are near existing facilities, and the impact of construction on those facilities has also been considered herein.

The Contractor will be required to base his/her construction methods and cost estimates on an independent interpretation of the subsurface conditions.

4.2 Excavation and Excavation Support

Excavations for the proposed pipelines are anticipated to generally encounter fill and clay and extend up to 15 feet below existing grade. Undermining of existing foundations must not occur. Excavation should not extend into the zone of influence of any existing structures or utilities without an approved excavation support system. The zone of influence is defined as extending 2 feet beyond the bottom exterior edge of the existing foundation then down and away at a 1 horizontal to 1 vertical (1H:1V) slope or at a 1H:1V slope from the springline of the utility. No excavations are anticipated for the proposed structures as the structures will be constructed within the existing intermediate basins.

The Contractor will be responsible for conducting the excavation work in accordance with the applicable federal and state laws and regulations, including OSHA. Where open excavations are feasible, the side slopes should be designed in accordance with OSHA regulations. The Contractor should be responsible for selection and the design of the means and methods for excavation and excavation support such as open-cut with stable side slopes, trench box, soldier pile and lagging, etc.

Use of excavation support may limit the amount of excavation spoils and serve to protect adjacent structures, utilities and roadways. Selection of the excavation support systems will likely be dependent upon subsurface strata, groundwater conditions, adjacent structures, surcharge loading, etc. Trench box systems should not be permitted within the zone of influence of existing structures, utilities or roadways or jacking or receiving pits. The Contractor should develop an excavation plan, including excavation support systems designed by a Professional Engineer licensed in the State of Tennessee. Additional design considerations may be required based on the Contractor’s planned construction methods.

4.3 Dewatering

As necessary, the Contractor will be responsible to design and implement a dewatering and drainage system that maintains a stable, undisturbed subgrade that is free from groundwater and surface water during all construction operations. Dewatering will be needed for the excavation for pump station and diversion structure building foundations. Dewatering may be needed for certain sections of the pipeline trench construction depending on the seasonal fluctuations.

The design of the dewatering system should be performed by a Professional Engineer registered in the State of Tennessee. To avoid disturbance of the subgrade, the water level in all excavations should be maintained at least 2 feet below the subgrade level during the entire period of excavation and fill placement.

Where applicable, the dewatering system should be designed in conjunction with the excavation support system selected by the Contractor. Depending on the depth of excavation and excavation support system selected, wells, well points and/or pumping from open sumps within the excavation may be required. Wells, well points and sumps must be adequately filtered to avoid loss of fines. The site should be graded to direct surface runoff away from the excavations.

The Contractor must be prepared to operate the dewatering system continuously, as required to complete the work and avoid floatation or uplift prior to completion of the facility. During periods where failure of the system would adversely impact work completed, the Contractor should provide a back-up system to ensure continuous operation.

The Contractor must design the dewatering system to not adversely impact adjacent structures or site features. All dewatering, handling and disposal of pumped water and any special testing should be conducted in accordance with local regulations, permits and specified requirements.

4.4 Protection and Preparation of Subgrade Soils

Care should be taken to avoid excess traffic on the excavated subgrade prior to placement of the structural fill, crushed stone and screened gravel or concrete foundations. Final excavation should be made using a smooth-edged bucket where possible. The exposed subgrade should be protected against precipitation, and the subgrade should not be allowed to freeze. Under no circumstances should fill or foundation concrete be placed on a disturbed, wet, or frozen subgrade.

Granular soil subgrades should be proof rolled with a vibratory compactor for at least four passes for the structures and two passes prior to placement of fill or pipeline bedding. Any unsuitable material present at the subgrade level should be removed and replaced with compacted structural fill or crushed stone wrapped in geotextile as recommended herein. A working mat is required below all structures and it shall consist of structural fill (12-inch minimum) or crushed stone (12-inch minimum).

4.5 Protection of Adjacent Structures

4.5.1 General

Excavation for the proposed pipelines and jacking and receiving pits will be made within the zone of influence of existing structures, railroads and utilities. Protection of existing structures, roadways, railroads and utilities is the responsibility of the Contractor. The construction procedures undertaken must be performed in a manner that does not negatively affect the existing facilities.

4.5.2 Deformation Monitoring

We recommend that surface monitoring points (SMPs), deformation monitoring points (DMPs) and crack monitors be established on the existing structures and utilities within 50 feet of the excavations. The points should be monitored during support of excavation installation, trenchless installation, excavation, foundation pier installation, and backfilling work.

DMPs should be installed and formal initial readings taken prior to any support of excavation installation, excavation or dewatering activities within 50 feet of the instrument. Crack monitoring devices should be installed, and formal initial readings taken prior to any excavation, dewatering, or support of excavation installation within 50 feet of the instrument.

Survey of the monitoring points should be performed at a minimum weekly prior to installation of excavation support systems, trenchless installation, excavation, dewatering and/or demolition activities within a 50-foot radius of each instrument. During the active construction operations, the Contractor should monitor all instruments twice per week. The monitoring frequency should increase to daily if threshold values are exceeded. Monitoring should continue bi-weekly after these active construction operations (completion of backfilling and compaction) are completed within a 50-foot radius of each instrument.

The Contractor should be prepared to alter the construction and implement remedial actions if settlement reaches the threshold values. If settlements exceeding the limiting values are measured, the Contractor should suspense all construction operation at the location related to ground deformation, stabilize the excavation and revise the excavation and/or dewatering methods to prevent additional settlement. The threshold and limiting values as follows:

Monitoring Instrument	Threshold Values	Limiting Values
SMP	0.5 inch	1 inch
DMP	0.25 inch	0.5 inch

4.5.3 Vibration Monitoring

Ground vibrations due to demolition activities and excavation support installation can cause damage to adjacent structures, roadways, utilities and other facilities. To avoid or mitigate this potential damage, limits on ground vibrations in the form of ground displacement, velocity or acceleration at given frequencies are typically established. The Bureau of Mines has established criteria to limit ground vibrations using the peak particle velocity (PPV) and frequency parameters. These limits have been established using the cracking of plaster walls in a residential house as a model.

The maximum peak particle velocities associated with demolition and vibratory or impact excavation support installation methods at the ground surface at existing adjacent structures and utilities should be as follows:

Frequency (Hz)	Max. Peak Particle Velocity (in. per sec.)
Over 40	2.0
30 to 40	1.5
20 to 30	1.0
Less than 20	0.5

In no case should the maximum peak particle velocities caused by pile driving exceed 2.0 inches per second at the closest facility (structure or utility) to the work.

A minimum of two seismographs should be located at adjacent/nearby structures and utilities during all demolition and excavation support installation activities to confirm compliance with the recommendations herein and record actual impact vibrations.

In addition, a preconstruction survey should be conducted on structures located within 150 feet of areas of demolition and vibratory or impact excavation support installation. The preconstruction survey should consist of visual inspection and documentation (written, photographic, and/or video) of the existing facility. If damage to adjacent facilities is reported, a similar survey should be conducted at the end of the work and the conditions recorded in the two surveys should be compared for indications of construction-related damage to the existing facilities.

4.6 Backfill

4.6.1 Structural Fill

Granular fill used as structural fill below foundations should consist of a mineral soil free of organic material, loam, debris, frozen soil or other deleterious material which may be compressible, or which cannot be properly compacted. Structural fill should conform to the following gradation requirements:

U.S. Standard Sieve Size	Percent Passing by Weight
1.5 inches	100
No. 4	20-90
No. 40	5-75
No. 200	0-50

Structural fill should have a maximum liquid limit of 50 percent, a maximum plasticity index of 25 percent, and a maximum dry density of at least 95 pounds per cubic foot (pcf) as determined by ASTM D698.

Structural fill should be placed in 8-inch-thick lifts, as placed, and compacted with suitable equipment to at least 98 percent of maximum dry density as determined by ASTM D698. Lift thickness should be reduced to 4 inches in confined areas accessible only to hand-guided compaction equipment. Structural fill should be placed within two percent of its optimum moisture content.

4.6.2 Common Fill

Common fill should consist of soil free of roots, vegetative matter, organic material, topsoil, loam, waste, debris, highly micaceous silt, frozen soil, or other objectionable material. It should not contain stone blocks, broken concrete, masonry rubble, or other similar materials. It should have physical properties such that it can be readily spread and compacted. It should contain stones no larger than six inches, have a maximum of 75 percent passing the No. 200 sieve, a maximum liquid limit of 60 percent, a maximum plasticity index of 30 percent, and exhibit a dry density of at least 90 pcf as determined by ASTM D698. Select common fill should meet the criteria of common fill except it should contain stones no larger than 2 inches.

Common fill and select common fill should be placed in maximum 12-inch-thick lifts, as placed, and compacted with suitable compaction equipment to at least 95 percent of the maximum dry density as determined by ASTM D698. Lift thickness should be reduced to 6 inches in confined areas accessible only to hand-guided compaction equipment. Common fill should be placed within three percent of its optimum moisture content.

4.6.3 Crushed Stone

Crushed stone should consist of hard, durable, angular or subangular particles of proper size and gradation, and should be free of sand, loam, clay, excess fines, and other deleterious materials. The material should conform to the requirements for TDOT No. 57 stone.

Crushed stone should be placed in maximum 6-inch-thick lifts, as placed, and compacted with suitable compaction equipment to at least 98 percent of the maximum dry density as determined by AASHTO T180. Lift thickness should be reduced to 4 inches in confined areas accessible only to hand-guided compaction equipment. Crushed stone should be placed within two percent of its optimum moisture content.

4.6.4 Trench Backfill

Trenches may be backfilled with select fill, common fill, and/or material excavated from the trench provided it meets the criteria of common fill. Criteria on backfill placement in the trench are described in Section 3.

4.7 Geotextile

Except where screened gravel and crushed stone are placed above the design groundwater level and/or against bedrock, a nonwoven geotextile should be used to separate it from the underlying subgrade soils to protect against the migration of fines into the pipeline bedding. The geotextile fabric should be Mirafi 140N or equivalent.

4.8 Micropile Installation

4.8.1 General

A specialty geotechnical contractor (Micropile Contractor) will be required to install the drilled micropiles as recommended herein. The drilled micropile submittal should include the shop drawings showing the drilled micropile layout and a work plan that outlines the proposed installation equipment and proposed drilled micropile materials. The Micropile Contractor should provide equipment capable of constructing micropiles to a depth equal to the deepest anticipated micropile tip elevation plus 30 feet. The Micropile Contractor should provide special drilling equipment including, but not limited to, rock core barrels, rock tools, air tools, and other equipment as necessary to excavate the borehole to the size and depths required. Blasting shall not be used to advance the excavation.

Micropile drilling operations should be performed in a continuous manner using rotary drilling equipment, and drilling methods should employ sufficient fluid pressure to provide complete removal of the drill cuttings from the hole. Permanent steel casing is required to maintain wall stability of the drilled boreholes through the overburden soils and weathered rock fragments/gravel and socketed into 7 feet into bedrock (9.75-inch diameter micropile). Any inflow of groundwater through the pervious soil layers also should be controlled using permanent casing.

Competent bedrock (i.e., continuous and unweathered) should be confirmed by a qualified geotechnical engineer or representative under the direction of the Engineer at the time of construction. After achieving the embedment depth into bedrock, the bottom of the borehole should be cleaned to the extent practical and approved by the Engineer.

Reinforcing bar should be placed into the borehole immediately after grouting and while the grout is still fluid or prior to placing the grout. Reinforcing bar should be set in the borehole with appropriate spacers so the reinforcing will remain in the specified tolerances. Concrete centralizers or other approved non-corrosive centering devices should be used within two feet of the top and bottom of the micropile. Centralizers should also be used at intervals not exceeding ten feet along the length of one micropile.

Concrete should be poured using a tremie pipe starting from the bottom of the hole. Reinforcing bar should extend far enough above the concrete to ensure that a sound connection can be made between reinforcing steel and the structural element it supports. The reinforcing bar should meet the specifications shown on the drawings, and the elevation of the top of the reinforcing should be checked after concrete is placed.

No micropile shall be left partially completed overnight and must be completed, grouted, and protected at the termination of each day's operation. Micropiles should not be installed within six times the diameter of a newly constructed micropile until the grout of the micropile has set for a minimum of 24 hours.

4.8.2 Obstructions and Differing Bedrock Conditions

Obstructions may be present in the fill and overburden layers at the site. The nature of the obstructions may include, but is not limited to, debris, abandoned foundations, cobbles or boulders. If the obstruction is located within the top 15 feet of the micropile which prevents micropile installation, pre-excavation may be used to remove the obstruction. Micropiles that encounter obstructions that cannot be removed may require that the micropile be relocated. The Contractor should be prepared to address potential difficulties associated with shallow voids in the bedrock or thin pinnacles/ledges of bedrock (over soil) that may be penetrated before obtaining satisfactory bedrock to construct the rock socket.

4.8.3 Micropile Load and Proof Tests

One (1) micropile load test should be conducted in accordance with ASTM D1143 or ASTM D3689 prior to installation of the production micropiles. Three sets of telltales or three pairs of strain gauges should be installed to measure and evaluate the loading/movement transferred to the bearing materials for the load-test micropile. The load test micropile should be cast with a minimum of three (3) ¾-inch diameter PVC Schedule 40 pipes, set to various depths within the micropile to allow for the installation of telltales to be used during the load testing, if that method is selected by the Contractor. The micropiles should not be load tested until the concrete strength has achieved the 28-day compressive strength. The micropiles should be loaded to at least 1.6 times the highest design load. During installation of the production micropiles, the Contractor should perform one proof testing on a micropile selected by the Engineer. Proof testing should not occur until the concrete strength has achieved the 28-day compressive strength. The proof-test micropile should be loaded to at least 160 percent of the design load either in compression or tension.

4.9 Trenchless Construction

The railroad crossing will be installed by pipe jacking as recommended in **Section 3** and specified in the Contract Documents to limit the impact of construction.

Excavation at the face should be conducted within the casing/shield to reduce the potential for disturbance outside the casing. As stated previously, a continuous flight auger or open face shield is expected to be adequate as long as proper dewatering can be employed to maintain groundwater levels at least 1 foot below the casing invert at all times during pipe jacking operations. The Contractor should anticipate the potential for obstructions and/or bedrock within the casing horizon and be equipped to hand-mine and remove such obstructions from the face of the excavation.

4.10 Construction Monitoring

It is recommended that a qualified Geotechnical Engineer or experienced technician under the direction of the Geotechnical Engineer be present during construction to confirm that the Contractor complies with the intent of these recommendations. Specifically, the field representative would undertake the following responsibilities:

- Observe the installation of the geotechnical instrumentation and review site monitoring data collected;

- Monitor the excavation and installation and performance of excavation support systems and observe for potential karstic activity or deformations;
- Confirm that appropriate dewatering and surface water control methods are employed;
- Confirm the removal of unsuitable materials present at foundation subgrade level and replacement with proper backfill material;
- Confirm that the subgrades are prepared, and conditions encountered are suitable for support of the proposed structures;
- Monitor drilled micropile load and proof test(s) and production drilled micropile installation;
- Observe, test and document placement and compaction of backfill material, where appropriate; and
- Monitor the pipe jacking operations including ground conditions encountered, face stability, excavation methods and rates and grouting operations.

In addition, the field representative would be present to identify and provide response should conditions encountered differ from those assumed during preparation of this report.

4.11 Closing

These recommendations have been prepared for the City of Chattanooga Dupont Pump Station and Gravity Sewer Line project located in Chattanooga, Tennessee as understood at this time and described in this report. These recommendations have been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. In the event that changes in the design or location of the alignment occur, the conclusions and recommendations contained herein should not be considered valid unless verified in writing by CDM Smith.

Section 5

References

1. Ishihara, K. (1985) "Stability of natural deposits during earthquakes" Proceedings of 11th International Conference on Soil Mechanics and Foundation Engineering. Vol. I, A. A. Balkema, Rotterdam, The Netherlands, 321-376.

2. Thomson, J. (1993) “Pipejacking and Microtunneling” Springer Science + Business Media Dordrecht, 1993

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CDM Smith

Appendix A

Geotechnical Data Report

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Geotechnical Data Report

DuPont Gravity Sewer and Pump Station
Chattanooga, Tennessee

October 26, 2018

Terracon Project No. E2175151

Prepared for:

CDM Smith
Knoxville, TN

Prepared by:

Terracon Consultants, Inc.
Chattanooga, Tennessee

October 26, 2018

CDM Smith
1100 Marion Street, Suite 300
Knoxville, TN 37921

Attn: Mr. Daniel Unger, P.E.
E: ungerdi@cdmsmith.com

Re: Geotechnical Data Report
DuPont Gravity Sewer and Pump Station
DuPont Parkway to Dixie Drive
Chattanooga, Tennessee
Terracon Project No. E2175151

Dear Mr. Unger:

This Geotechnical Data Report documents the results of field and laboratory programs described in the contract documents. Attached find:

- Boring logs with field and laboratory data (Boring Nos.B-101 through B-113; B-201-B-210; B-215 and B-216);
- Stratification based on visual soil and rock classification is included on the logs;
- Groundwater levels observed during and at completion of drilling;
- Site Location Plans and Boring Location Plans;
- Subsurface exploration conditions;
- Description of subsurface conditions; and
- Tabulated laboratory results and appendices of laboratory reports.

We appreciate the opportunity to be of continued service to you on this project. Should you have any questions or if we may be of further assistance, please contact us.

Sincerely,
Terracon Consultants, Inc.

JOHN D. CANNON REGISTERED ENGINEER AGRICULTURE COMMERCE No. 20106 STATE OF TENNESSEE

10-26-18

John D. Cannon, P.E.
Senior Engineer

Frank Whitman, P.E.
Senior Engineer

REPORT TOPICS

ATTACHMENTS

Geotechnical Data Report

DuPont Gravity Sewer and Pump Station
DuPont Parkway to Dixie Drive
Chattanooga, Tennessee
Terracon Project No. E2175151
October 26, 2018

INTRODUCTION

This data report presents the results of our subsurface exploration for the proposed Gravity sewer and Pump Station project to be located at DuPont Parkway to Dixie Drive in Chattanooga, Tennessee.

The geotechnical engineering scope of services for this project included the advancement of 25 test borings to depths ranging from approximately 15 to 60 feet below existing site grades.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from our site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The gravity sewer will extend from DuPont Parkway to Dixie Drive in Chattanooga, Tennessee. The pump station will be located at approximate GPS coordinates 35.0959, -85.2664.
Existing Improvements	The gravity sewer will follow an existing public easement. The planned alignment is mostly wooded. The pump station will be in an area that is currently partially asphalt-paved and partially grassed.
Existing Topography	The invert of the gravity sewer will start at approximate elevation 648.7 and end at 645.0.

PROJECT DESCRIPTION

Our initial understanding of the project was provided in our proposal and was discussed in the project planning stage and our final understanding of the project conditions is as follows:

Item	Description
Information Provided	Information was provided by Daniel Unger, P.E., with CDM Smith
Project Description	Gravity Sewer, about 7,000 LF, 48 inches in diameter, including 1 railroad crossing and 1 aerial creek crossing Pump station (20 to 22 feet deep) with an adjacent electrical building, emergency generator, and diversion structure
Estimated Start of Construction	2019

GEOTECHNICAL CHARACTERIZATION

Geology

The project site is in the Valley and Ridge, a geologic setting in which parallel valleys and ridges are oriented southwest–northeast. The area is characterized by ancient sedimentary rocks which have been subjected to thrust faulting, resulting in the formation of perpendicular joints – fractures along which there has been little if any movement – with one set oriented southwest-northeast and the other set southeast-northwest. The ridges tend to have a resistant cap of sandstone underlain by limestone, dolomite and shale sequences, similar to those found in the valleys. Limestone and dolomite are carbonate rocks which have an elevated potential to be impacted by weathering and solution activity, especially along joints and bedding planes. Solution activity can result in development of soft soil zones at the soil-rock interface, and weathering of bedrock along joints producing voids, slots (void or soil-filled) or caverns. Soil or rock overlying a void may remain stable due to arching, but when de-stabilized, can result in a surface breach, either a “drop out” or a sinkhole.

The rock formation underlying the site is the Chickamauga Group, a predominantly limestone sequence which may include greenish-gray calcareous shale, shaley limestone and dolomite.

Subsurface Profile

We have developed a general characterization of the subsurface soil and groundwater conditions based upon our review of the data and our understanding of the geologic setting. The following table provides our geotechnical characterization. As noted in **General Comments**, the characterization is based upon widely spaced exploration points across the site, and variations are likely.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density/Rock Strength
Surface	0.3 to 0.8	Topsoil or Asphalt pavement and aggregate base	N/A
Existing Fill [1]	3 to 6	Uncontrolled fill comprised of lean clay, gravelly lean clay, and sand and gravel.	Variable
Upper Soils	15 to 30 [2]	Lean clay, fat clay, sandy lean clay, clayey sand	Cohesive: Typically, stiff to hard with some zones of very soft to medium stiff Cohesionless: Lose to medium dense
Lower Soils	15 to 36.2 [3]	Sandy silt, silt, silty sand, sand, sand and gravel	Cohesive: Very soft to medium stiff Cohesionless: Typically, medium dense to dense
Bedrock	All other test borings terminated in this stratum	Limestone with some shale.	Medium strong

1. Only encountered at test borings B-108, B-205, B-206, B-208.
2. Test borings B-102, B-105, B-109 to B-113, B-201 to B-207, B-209, B-210, B-215, and B-216 terminated in this stratum.
3. Test borings B-103, B-106, and B-208 terminated in this stratum.

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ, the transition between materials may be gradual.

Groundwater Conditions

The boreholes were observed while drilling and after completion for the presence and level of groundwater. The water levels observed in the boreholes can be found on the boring logs in **Exploration Results** and are summarized below.

Boring Number	Approximate Depth to Groundwater while Drilling (feet) [1]	Approximate Depth to Groundwater after Drilling (feet) [1]
B-101	31 (el. 623)	Not encountered
B-106	27 (el.625)	Not encountered
B-107	27 (el.625)	Not encountered
B-108	26 (el.626)	Not encountered

1. Below ground surface

Groundwater was not observed in the remaining borings while drilling, or for the short duration the borings could remain open. However, this does not necessarily mean the borings terminated above groundwater, or the water levels summarized above are stable groundwater levels. A relatively long period may be necessary for a groundwater level to develop and stabilize in a borehole. Long term observations in piezometers or observation wells sealed from the influence of surface water are often required to define groundwater levels in materials of this type.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

The project site is located just downstream of the Chickamauga Dam on the Tennessee River. The pool elevation of the Tennessee River at the project site is heavily dependent upon TVA's management of the Tennessee River at the upstream dam and downstream Nickajack Dam. However, the Tennessee River pool elevation is generally between 630 and 640 feet, MSL under normal circumstances. According to NOAA, flood stage is at Elevation 651 feet.

GENERAL COMMENTS

As the project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather.

The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

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ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Field Exploration

CDM Smith prescribed the following boring locations:

Number of Borings	Planned Boring Depth (feet) [1]	Planned Location
8 (B-101 to B-108)	30 to 60 feet	Pump Station, Diversion Structure, Electrical Building, and Generator
2 (B-109 and B-110)	20 feet	Manholes near Pump Station
3 (B-111 to B-113)	15 feet	Parking Area
14 (B-201 to B-210)	15 to 20 feet	Gravity Sewer Alignment (approximate 500-foot spacing)
2 (B-215 and B-216)	15 feet	Railroad crossing for gravity sewer

1. Feet below the ground surface

Boring Layout and Elevations: Borings were staked and surveyed by CDM Smith.

Subsurface Exploration Procedures: We advanced soil borings with a track- or truck-mounted drill rig using continuous flight hollow stem augers. Four samples were obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling was performed using split-barrel or thin-walled sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. A standard 2-inch outer diameter split barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling a distance of 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The samples were placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer.

Test borings B-101, B-104, and B-108 extended to auger refusal. Upon encountering bedrock or refusal-to-drilling conditions at these locations, rock coring (using NQ2 rock core barrel) was performed.

Our exploration team prepared field boring logs as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information. Field logs include visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory tests.

Laboratory Testing

CDM Smith provided Terracon with the laboratory testing assignments for the sampled soil and rock strata. Procedural standards noted below are for reference to methodology in general. In some cases, local practices and professional judgement require method variations. Standards noted below include reference to other related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils
- ASTM D2435/D2435M Standard Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading
- ASTM D4767 Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils (3 point test)
- ASTM D7012 Standard Test Methods for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperature – Method C

SITE LOCATION AND EXPLORATION PLANS

EXPLORATION PLAN

DuPont Additional Borings ■ Chattanooga, TN
October 19, 2018 ■ Terracon Project No. E2175151

Terracon GeoReport

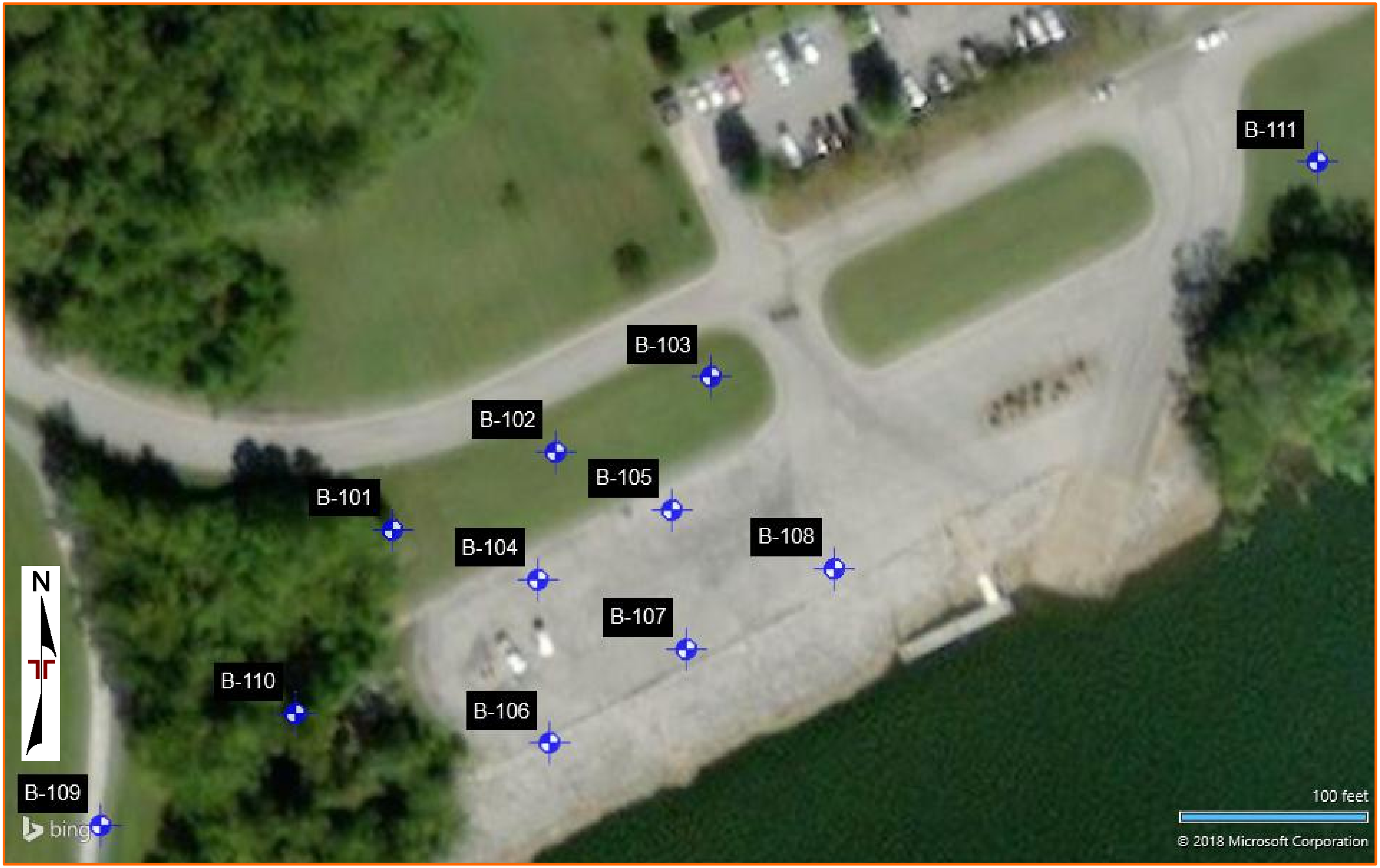


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

DuPont Additional Borings ■ Chattanooga, TN
October 19, 2018 ■ Terracon Project No. E2175151

Terracon GeoReport

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION PLAN

DuPont Additional Borings ■ Chattanooga, TN

October 19, 2018 ■ Terracon Project No. E2175151

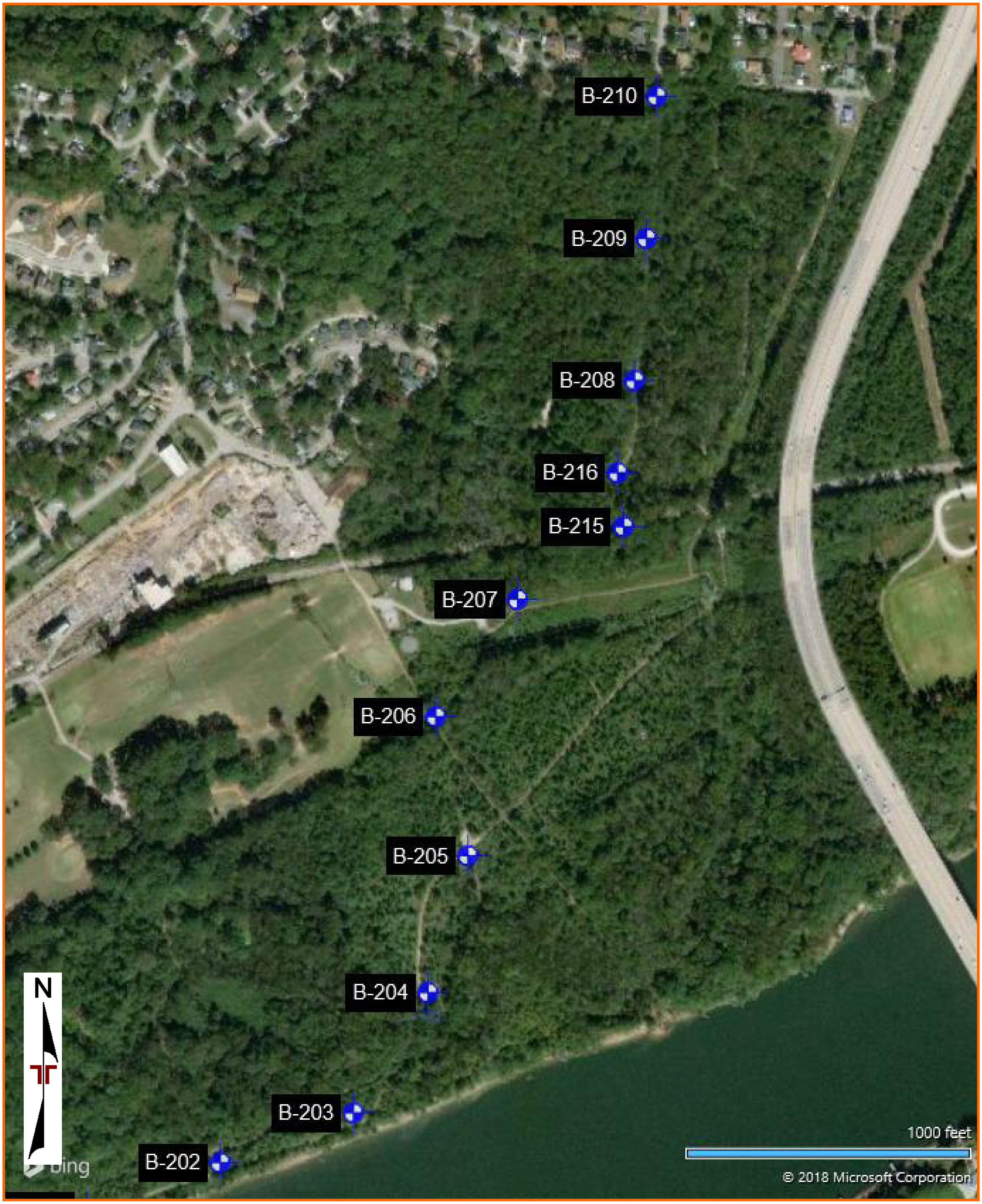


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B-101

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2667°

Approximate Surface Elev: 654 (Ft.) +/-

DEPTH	LOCATION / DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**ASPHALT**	653.5+/-													
0.5	**AGGREGATE**	653.5+/-													
	FAT CLAY (CH), trace mica, dark brown, very stiff				X	6-7-9 N=16	78		4.5 (HP)				19	54-25-29	97
			5		X	6-9-12 N=21	78		4.5 (HP)				20		
	stiff				X	3-5-9 N=14	89		4.5 (HP)						
			10		X	3-4-7 N=11	83		4.25 (HP)				23		
			15		X	3-4-5 N=9	83		2.25 (HP)				25		
			20		X	3-4-5 N=9									
22.0	**SANDY SILT (ML)**, trace mica, dark brown, medium stiff	632+/-													
			25		X	2-2-2 N=4	100		1.0 (HP)				32		
	soft				X	0-1-2 N=3	100		0.25 (HP)				41	NP	57
			30	▽											

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-36.2' - Hollow Stem Auger
36.2'-51.2' - NQ2 Wireline Core

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water encountered at 31' while drilling*

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-27-2018	Boring Completed: 07-27-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-101

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2667°

Approximate Surface Elev: 654 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDY SILT (ML), trace mica, dark brown, medium stiff *(continued)*					0-50/1"									
36.2	***Auger Refusal at 36.1'***	618+/-	35												
	Begin NQ2 Wireline Rock Core **SHALY LIMESTONE**, gray with dark red and green limestone partings		40			**RUN 1:** Depth: 36.2' - 41.2' Run Length: 5'	88	54		UC	18.2 (ksi)				
	-includes dark gray zones		45			**RUN 1:** Depth: 41.2' - 51.2' Run Length: 10'	79	62							
51.2	***Coring Terminated at 51.2 Feet***	603+/-	50												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-36.2' - Hollow Stem Auger
36.2'-51.2' - NQ2 Wireline Core

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

Water encountered at 31' while drilling

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-27-2018	Boring Completed: 07-27-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-102

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0961° Longitude: -85.2664°

Approximate Surface Elev: 657 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**TOPSOIL**	656.5+/-													
	FAT CLAY (CH), with silt, with mica, brown, stiff				X	3-5-6 N=11	56		4.5 (HP)						
			5		X	3-4-6 N=10	67		4.5 (HP)						
					X	4-5-7 N=12	89		4.25 (HP)						
			10		X	3-3-6 N=9	78		3.5 (HP)						
			15		X	2-3-5 N=8	94		2.5 (HP)						
			20		X	4-5-18 N=23	100		1.5 (HP)				27		
22.0	**LEAN CLAY (CL)**, gray, medium stiff	635+/-													
			25		X	2-2-2 N=4	100		0.25 (HP)				30	41-21-20	87
30.0		627+/-	30		X	2-2-3 N=5	67		1.0 (HP)				42		77
	Boring Terminated at 30 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018	Boring Completed: 07-25-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-103

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0962° Longitude: -85.2661°

Approximate Surface Elev: 657 (Ft.) +/-

Depth	Material Description	Elevation (Ft.)	Depth (Ft.)	Water Level Observations	Sample Type	Field Test Results	Recovery (%)	RQD (%)	Laboratory HP (tsf)	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
0.5	**TOPSOIL**	656.5+/-													
	FAT CLAY (CH), with mica, yellow and brown, stiff				SPT	2-4-5 N=9	61		4.5 (HP)				20	52-24-28	97
			5		SPT	3-4-7 N=11	61		4.5 (HP)						
6.0		651+/-													
	LEAN CLAY (CL), with mica, yellow and brown, stiff				SPT	3-5-6 N=11	100		3.75 (HP)				24	47-23-24	96
			10		SPT	3-4-5 N=9	89		3.0 (HP)				25		
			15		SPT	2-3-5 N=8	89		2.75 (HP)						
17.0		640+/-													
	SANDY SILT (ML), with mica, gray and brown, medium stiff		20		SPT	2-3-4 N=7	100		1.5 (HP)				28		
			25		SPT	1-2-2 N=4	100		0.75 (HP)				29		
30.0		627+/-	30		SPT	2-2-3 N=5	100		0.5 (HP)				44	NP	61
	Boring Terminated at 30 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018 | Boring Completed: 07-25-2018
Drill Rig: DR754 | Driller: N. Dotson
Project No.: E2175151

BORING LOG NO. B-104

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2664°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH (Ft.)	Material Description	ELEVATION (Ft.)
0.0 – 3.0	**LEAN CLAY (CL)**, with sand, yellow to red, medium stiff	649+/-
3.0 – 8.0	**LEAN CLAY (CL)**, dark gray, medium stiff to stiff -Shelby tubes pushed from 6'-8', 8'-10', and 10'-12' at nearby offset location	644+/-
8.0 – 22.0	**LEAN CLAY (CL)**, with sand, micaceous, brown, medium stiff to stiff very soft -Shelby tubes pushed from 20'-22' and 22'-24' at nearby offset location	630+/-
22.0 – 28.2	**SANDY SILT (ML)**, brown, soft to medium stiff	
28.2	***Auger Refusal at 28.2'***	624+/-
28.2 –	***Begin NQ2 Wireline Rock Core*** **DOLOMITIC LIMESTONE WITH SHALE PARTINGS**	

Approx. Depth (Ft.)	Sample Type	Field Test Results	Recovery (%)	RQD (%)	Laboratory HP (tsf)	Test Type	Compressive Strength (tsf)	Strain (%)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
1.0 – 2.5	Split spoon	2-3-4 N=7	44		3.0 (HP)				18		53
3.5 – 5.0	Split spoon	6-4-5 N=9	28		2.5 (HP)						
6.0 – 7.5	Shelby tube	2-3-4 N=7	67		2.25 (HP)						
8.5 – 10.0	Shelby tube	2-2-4 N=6	56		1.75 (HP)						
10.0 – 12.0	Shelby tube					UC	1.81	15	25		
13.5 – 15.0	Split spoon	2-3-4 N=7	100		1.0 (HP)						
18.5 – 20.0	Split spoon	W.O.H.	50		0.25 (HP)				27	33-22-11	71
20.0 – 22.0	Shelby tube					CU					
22.0 – 24.0	Shelby tube					UC	0.85	4.6	31		
23.5 – 25.0	Split spoon	0-0-3 N=3	100		0.25 (HP)				33	30-25-5	63
28.2 – 30.0	Rock core	**RUN 1:** Depth: 28.2' - 30' Run Length: 1.8'	100	88		UC	18.9 (ksi)				

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-28.2' - Hollow Stem Auger
28.2'-45.0' - NQ2 Wireline Core

Abandonment Method:

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:
Shelby tube samples obtained from offset boring.

WATER LEVEL OBSERVATIONS

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-27-2018	Boring Completed: 07-27-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-104

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2664°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
DOLOMITIC LIMESTONE WITH SHALE PARTINGS *(continued)* -includes calcite infilling	35		Core	**RUN 2:** Depth: 30' - 40' Run Length: 10'	58	28							
-includes red and green calcareous shale partings	40		Core	**RUN 3:** Depth: 40' - 45' Run Length: 5'	58	30							
45.0 / 607+/-	45												

Coring Terminated at 45 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-28.2' - Hollow Stem Auger
28.2'-45.0' - NQ2 Wireline Core

Abandonment Method:

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-27-2018	Boring Completed: 07-27-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-105

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0961° Longitude: -85.2662°

Approximate Surface Elev: 655 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)
0.3	**ASPHALT**	654.5+/-
0.8	**AGGREGATE**	654+/-
5.5	**LEAN CLAY (CL)**, trace sand, yellow to red, medium stiff to stiff	649.5+/-
20.0	**CLAYEY SAND (SC)**, with gravel, trace mica, brown, loose	635+/-
30.0	**LEAN CLAY (CL)**, with sand, gray, soft	625+/-

Boring Terminated at 30 Feet

Field Test Results	Recovery (%)	RQD (%)	Laboratory HP (tsf)	Strength Test: Test Type	Strength Test: Compressive Strength (tsf)	Strength Test: Strain (%)	Water Content (%)	Atterberg Limits LL-PL-PI	Percent Fines
2-4-3 N=7							26		86
4-5-8 N=13	72		3.0 (HP)				17	45-21-24	
2-2-3 N=5	67		1.25 (HP)				26		43
2-3-4 N=7	33		1.75 (HP)						
2-2-2 N=4	78		1.5 (HP)				25		
2-3-3 N=6	100		0.75 (HP)						
0-1-2 N=3	100		0 (HP)				30	36-20-16	84
1-5-13 N=18	100		0.25 (HP)				44		

Depth (Ft.): 5, 10, 15, 20, 25, 30

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-30-2018	Boring Completed: 07-30-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-106

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0957° Longitude: -85.2664°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**ASPHALT**	651.5+/-													
0.8	**AGGREGATE**	651+/-													
	GRAVELLY LEAN CLAY (CL), yellow to red, medium stiff to stiff				X	3-3-3 N=6	61		3.0 (HP)				19		51
			5		X	2-3-3 N=6	67		2.0 (HP)				18		
6.5	**LEAN CLAY (CL)**, gray, medium stiff to stiff	645.5+/-			X	2-2-3 N=5	78		1.0 (HP)				27		
			10		X	2-4-6 N=10	83		3.75 (HP)				22		
	brown		15		X	2-3-5 N=8	89		3.0 (HP)				23		
	micaceous				X	2-3-4 N=7	100		0.75 (HP)				27	39-23-16	87
20.0	**SILTY SAND (SM)**, dark gray, very loose	632+/-	20												
			25		X	W.O.H.	100		0.25 (HP)				27		
				▽ (27')											
28.5	**SILTY SAND (SM)**, with gravel, dark gray, dense	623.5+/-			X	9-15-15 N=30	83		0.5 (HP)				35	31-29-2	23
30.0	***Boring Terminated at 30 Feet***	622+/-	30												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water encountered at 27' while drilling*

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018	Boring Completed: 07-25-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-107

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0958° Longitude: -85.2662°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	Description
0.3	651.5+/-	**ASPHALT**
0.8	651+/-	**AGGREGATE**
6.5	645.5+/-	**CLAYEY SAND (SC)**, with gravel, yellow to brown, loose, (probable fill)
22.0	630+/-	**FAT CLAY (CH)**, with sand, trace mica, gray, soft to medium stiff; brown (at about 13 ft)
27.0	625+/-	**SILT (ML)**, with sand, brown, very soft
30.0	622+/-	**SAND (SP)**, brown and gray, dense

Boring Terminated at 30 Feet

DEPTH (Ft.) (approx.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	COMPRESSIVE STRENGTH (tsf)	STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1–2.5		X	3-2-3 N=5	61		2.0 (HP)				16		
3.5–5		X	2-3-3 N=6	61		2.25 (HP)				16	43-19-24	50
6–7.5		X	1-2-3 N=5	78		1.0 (HP)						
8.5–10		X	0-1-2 N=3	94		0.5 (HP)				36	50-24-26	79
13.5–15		X	2-3-4 N=7	100		1.5 (HP)						
18.5–20		X	2-3-4 N=7	21		1.25 (HP)				26		
23.5–25		X	1-1-1 N=2	20		0.25 (HP)				35	30-28-2	71
27	▽											
28.5–30		X	16-23-15 N=38	89						15		13

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

▽ *Water encountered at 27' while drilling*

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018	Boring Completed: 07-25-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-108

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2659°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**ASPHALT**	651.5+/-													
	FILL - LEAN CLAY (CL), with rock fragments, light brown and red					3-2-3 N=5	11		1.75 (HP)						
						2-3-3 N=6	22		2.0 (HP)				17	49-20-29	
6.0		646+/-	5												
	LEAN CLAY (CL), dark gray, medium stiff to stiff					1-2-3 N=5	56		2.75 (HP)				27		
						0-1-2 N=3	56		1.25 (HP)	UC	1.42	6	35 35	48-25-23	94
12.0		640+/-	10												
	LEAN CLAY (CL), dark brown with gray mottles, medium stiff					2-3-4 N=7	83		2.0 (HP)				26		
			15												
	with mica, brown, stiff					2-3-4 N=7	83		2.5 (HP)				22	38-21-17	
22.0		630+/-	20												
	LEAN CLAY (CL), with sand, micaceous, dark gray, soft					1-1-1 N=2	24		0.25 (HP)				38	37-24-13	84
27.0		625+/-	25	▽											
	SAND WITH GRAVEL (SP), gray, dense					16-23-15 N=38	78						10		6
			30												

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-33.6' - Hollow Stem Auger
33.6'-59.6' - NQ2 Wireline Core

Abandonment Method:

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

Shelby tubes obtained from offset boring.

WATER LEVEL OBSERVATIONS

▽ *Water encountered at 26' while drilling*

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-24-2018	Boring Completed: 07-24-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-108

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.096° Longitude: -85.2659°

Approximate Surface Elev: 652 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
33.6	**SAND WITH GRAVEL (SP)**, gray, dense *(continued)* ***Auger Refusal at 33.6'***	618.5+/-				50/1"	0								
35.0	***Begin NQ2 Wireline Rock Core*** **LIMESTONE**, gray	617+/-	35												
36.0	**CLAY**, red	616+/-													
40.0	**LIMESTONE WITH SHALE PARTINGS**, gray	612+/-	40			**RUN 1:** Depth: 33.6' - 39.6' Run Length: 6'	82	57		UC	18.1 (ksi)				
44.1	**LIMESTONE**, gray, with greenish gray dolomitic zones	608+/-	45			**RUN 2:** Depth: 39.6' - 44.1' Run Length: 4.5'	82	69							
53.7	**VOID**	598.5+/-	50			**RUN 3:** Depth: 44.1' - 53.7' Run Length: 9.6'	0	0							
59.6	**LIMESTONE WITH SHALE PARTINGS**, gray, greenish gray dolomite zones	592.5+/-	55			**RUN 4:** Depth: 53.7' - 59.6' Run Length: 5.9'	100	44							
	Coring Terminated at 59.6 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
0'-33.6' - Hollow Stem Auger
33.6'-59.6' - NQ2 Wireline Core

Abandonment Method:

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

Water encountered at 26' while drilling

No water observed after drilling

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-24-2018	Boring Completed: 07-24-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-109

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0956° Longitude: -85.2672°

Approximate Surface Elev: 660 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	659.5+/-													
	LEAN CLAY (CL), with silt, trace mica, dark brown, stiff				X	4-5-7 N=12	44		4.5 (HP)						
			5		X	4-5-7 N=12	61		4.5 (HP)						
					X	3-5-6 N=11	78		4.5 (HP)						
			10		X	3-4-5 N=9	67		3.5 (HP)						
	medium stiff		15		X	2-3-4 N=7	83		1.75 (HP)						
20.0		640+/-	20		X	2-3-4 N=7	100		1.25 (HP)						

Boring Terminated at 20 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018	Boring Completed: 07-25-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-110

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0958° Longitude: -85.2669°

Approximate Surface Elev: 635 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**ASPHALT**	634.5+/-													
0.8	**AGGREGATE**	634+/-													
	SANDY LEAN CLAY (CL), yellow to red, stiff				X	3-5-7 N=12	33		3.5 (HP)				15		
			5		X	3-4-5 N=9	78		3.25 (HP)				19	40-21-19	64
6.0		629+/-													
	LEAN CLAY (CL), brown, medium stiff				X	2-3-4 N=7	78		3.0 (HP)				24		
			10		X	2-3-4 N=7	100		1.5 (HP)				25		
			15		X	1-3-3 N=6	100		0.75 (HP)				26	41-20-21	86
20.0		615+/-	20		X	2-3-3 N=6	100		1.25 (HP)				28		
	Boring Terminated at 20 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with grout upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-25-2018	Boring Completed: 07-25-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-111

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0966° Longitude: -85.265°

Approximate Surface Elev: 655 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	654.5+/-													
	LEAN CLAY (CL), brown, medium stiff				X	2-3-3 N=6	44		4.5 (HP)						
					X	4-5-8 N=13	56		4.5 (HP)						
	stiff		5												
					X	3-4-6 N=10	67		3.75 (HP)						
					X	3-4-6 N=10	17		3.5 (HP)						
			10												
					X	2-3-5 N=8									
15.0		640+/-	15												
	Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-30-2018	Boring Completed: 07-30-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-112

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0968° Longitude: -85.2645°

Approximate Surface Elev: 654 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**TOPSOIL**	653.5+/-													
		LEAN CLAY (CL), trace mica, dark brown, stiff				X	3-6-4 N=10	56		4.0 (HP)				23	44-23-21	89
						X	4-5-7 N=12	22		3.5 (HP)				24		
				5		X	2-3-5 N=8									
	8.0		646+/-													
		FAT CLAY (CH), trace mica, dark brown, stiff				X	3-6-7 N=13	44		4.25 (HP)				24	51-25-26	98
				10												
	15.0		639+/-	15		X	3-7-9 N=16	44		4.25 (HP)				25		
		Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-30-2018	Boring Completed: 07-30-2018
Drill Rig: DR754	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-113

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0966° Longitude: -85.2646°

Approximate Surface Elev: 650 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	649.5+/-													
	FAT CLAY (CH), trace silt, brown, medium stiff to stiff				X	2-2-3 N=5	44		4.5 (HP)						
					X	3-4-6 N=10	78		3.25 (HP)				23	50-26-24	98
			5		X	2-3-5 N=8	89		3.5 (HP)						
			10		X	2-4-5 N=9	33		3.25 (HP)						
15.0		635+/-	15		X	3-9-6 N=15	100		2.5 (HP)						

Boring Terminated at 15 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 07-30-2018 | Boring Completed: 07-30-2018

Drill Rig: DR754 | Driller: N. Dotson

Project No.: E2175151

BORING LOG NO. B-201

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0971° Longitude: -85.2632°

Approximate Surface Elev: 656 (Ft.) +/-

GRAPHIC LOG	DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**TOPSOIL**	655.5+/-													
		LEAN CLAY (CL), brown, medium stiff to stiff				X	2-4-3 N=7	56								
						X	2-5-8 N=13	56								
				5												
		dark brown				X	2-5-7 N=12	44								
						X	3-6-6 N=12	56								
				10												
	15.0		641+/-	15		X	4-7-8 N=15	56								
		Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-07-2018	Boring Completed: 08-07-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-202

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0976° Longitude: -85.2617°

Approximate Surface Elev: 657 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	656.5+/-													
	LEAN CLAY (CL), brown, medium stiff to stiff				X	2-3-4 N=7	67								
					X	3-5-8 N=13	67								
			5		X	3-5-7 N=12	56								
			10		X	3-6-7 N=13	78								
15.0		642+/-	15		X	3-6-7 N=13	72								
	Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS
No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-07-2018	Boring Completed: 08-07-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-203

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.0981° Longitude: -85.2601°

Approximate Surface Elev: 661 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3 **ASPHALT**	660.5+/-													
0.8 **AGGREGATE**	660+/-													
LEAN CLAY (CL), with gravel, yellow to red, medium stiff to stiff				X	2-4-2 N=6	67						24		
				X	3-4-5 N=9	44						17		
6.0	655+/-	5												
LEAN CLAY (CL), brown, stiff				X	1-5-6 N=11	44						19		
				X	3-4-6 N=10	67						22		
		10												
				X	3-4-6 N=10	56						24	39-21-18	89
		15												
				X	3-5-7 N=12	100						24		
20.0	641+/-	20												
Boring Terminated at 20 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-07-2018	Boring Completed: 08-07-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-204

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.0992° Longitude: -85.2592°

Approximate Surface Elev: 661 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)
0.3	**ASPHALT**	660.5+/-
0.8	**AGGREGATE**	660+/-
6.0	**LEAN CLAY (CL)**, with gravel, yellow to red, very stiff to stiff	655+/-
15.0	**LEAN CLAY (CL)**, brown, stiff	646+/-
	Boring Terminated at 15 Feet	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1–2.5		X	9-10-10 N=20	78								
3.5–5		X	3-5-7 N=12	78								
6–7.5		X	4-5-9 N=14	78								
8.5–10		X	4-5-7 N=12	89								
13.5–15		X	3-5-6 N=11	56								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-07-2018	Boring Completed: 08-07-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-205

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.1006° Longitude: -85.2587°

Approximate Surface Elev: 662 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.3	**ASPHALT**	661.5+/-													
	3.0	**FILL - LEAN CLAY (CL)**, with chert fragments	659+/-			X	14-11-12 N=23	89		4.5 (HP)						
		LEAN CLAY (CL), brown, stiff		5		X	3-4-4 N=8	33		4.5 (HP)						
						X	4-5-6 N=11	56		4.5 (HP)						
	13.5	medium stiff	648.5+/-	10		X	4-4-3 N=7	56		4.25 (HP)						
		LEAN CLAY (CL), with sand, trace mica, gray, soft to medium stiff		15		X	1-1-2 N=3	22								
	20.0		642+/-	20		X	2-2-3 N=5	78		0.75 (HP)				25	33-22-11	84

Boring Terminated at 20 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-07-2018	Boring Completed: 08-07-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-206

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.1019° Longitude: -85.2591°

Approximate Surface Elev: 655 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**TOPSOIL**	654.5+/-													
3.0	**FILL - GRAVELLY LEAN CLAY (CL)**, dark brown	652+/-			X	6-6-3 N=9	33		4.5 (HP)				9		56
5.5	**SANDY LEAN CLAY (CL)**, gray, medium stiff	649.5+/-	5		X	1-3-5 N=8	56		1.75 (HP)				20		
12.0	**SANDY LEAN CLAY (CL)**, gray, soft to very soft	643+/-			X	0-1-2 N=3	44		1.25 (HP)				21	32-20-12	67
			10		X	0-0-1 N=1	22		0.25 (HP)				23	36-21-15	
15.0	**SANDY LEAN CLAY (CL)**, gray, stiff	640+/-	15		X	4-7-8 N=15	78		4.5 (HP)				21		

Boring Terminated at 15 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-06-2018	Boring Completed: 08-06-2018
Drill Rig:	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-207

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.103° Longitude: -85.2582°

Approximate Surface Elev: 653 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.6	**TOPSOIL**	652.5+/-													
	LEAN CLAY (CL), brown, stiff				X	3-4-5 N=9	89		3.0 (HP)						
			5		X	3-6-6 N=12	100		4.5 (HP)						
					X	3-4-5 N=9	100		2.25 (HP)						
			10		X	4-5-6 N=11	78		3.25 (HP)						
13.0		640+/-													
	SANDY LEAN CLAY (CL), brown, very stiff				X	8-17-11 N=28	67		3.25 (HP)				14		41
15.0		638+/-	15												
	Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-06-2018	Boring Completed: 08-06-2018
Drill Rig:	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-208

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc. Knoxville, TN

SITE: DuPont Parkway Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.1051° Longitude: -85.2568°

Approximate Surface Elev: 654 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.6	**TOPSOIL**	653.5+/-													
		FILL - SAND AND GRAVEL, with clay, brown				X	1-0-1 N=1	22								
	5.5		648.5+/-	5		X	0-1-0 N=1	33						13		26
	8.5	**LEAN CLAY (CL)**, brown, medium stiff	645.5+/-			X	4-2-2 N=4	89		1.0 (HP)				28		72
		SILTY CLAYEY SAND WITH GRAVEL (SC-SM), brown and red, medium dense		10		X	10-12-14 N=26	44						11		17
	15.0		639+/-	15		X	10-13-16 N=29	67								

Boring Terminated at 15 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon

51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-08-2018	Boring Completed: 08-08-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-209

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.1065° Longitude: -85.2566°

Approximate Surface Elev: 657 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	656.5+/-													
	LEAN CLAY (CL), brown, medium stiff				X	2-2-3 N=5	67		2.5 (HP)						
3.5		653.5+/-													
	LEAN CLAY (CL), with gravel, brown, stiff to very stiff				X	3-3-9 N=12	89								
			5		X	13-13-10 N=23	78								
					X	5-9-17 N=26	100		4.5 (HP)						
			10												
	hard		15		X	6-12-30 N=42	100		4.25 (HP)						
16.0		641+/-													

Boring Terminated at 16 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-08-2018	Boring Completed: 08-08-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-210

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.1079° Longitude: -85.2565°

Approximate Surface Elev: 661 (Ft.) +/-

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.3	**TOPSOIL**	660.5+/-													
	LEAN CLAY (CL), with gravel, with sand, brown, stiff				X	3-3-3 N=6	67		3.5 (HP)						
3.0		658+/-													
	LEAN CLAY (CL), with gravel, yellowish brown and red, very stiff to hard				X	3-6-27 N=33	44								
			5		X	3-11-25 N=36	56		4.5 (HP)						
					X	10-15-11 N=26	78		4.5 (HP)						
			10												
					X	6-11-9 N=20	78		4.5 (HP)						
			15												
					X	4-9-14 N=23	78		4.5 (HP)						
20.0		641+/-	20												
	Boring Terminated at 20 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-08-2018	Boring Completed: 08-08-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-215

PROJECT: DuPont Additional Borings

CLIENT: CDM Smith Inc.
Knoxville, TN

SITE: DuPont Parkway
Chattanooga, Tennessee

LOCATION See Exploration Plan

Latitude: 35.1037° Longitude: -85.2569°

Approximate Surface Elev: 662 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.5	**TOPSOIL**	661.5+/-													
	LEAN CLAY (CL), with sand, brown, stiff to very stiff				X	2-3-5 N=8	67		2.75 (HP)						
			5		X	2-6-10 N=16	78		4.5 (HP)						
					X	2-10-16 N=26	100		4.25 (HP)				19	40-22-18	76
8.0		654+/-													
	CLAYEY SAND (SC), with chert, red and yellowish brown, medium dense		10		X	7-8-10 N=18	67		4.0 (HP)				14	38-20-18	21
15.0		647+/-	15		X	7-8-10 N=18	67		4.5 (HP)						
	Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-08-2018	Boring Completed: 08-08-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

BORING LOG NO. B-216

PROJECT: DuPont Additional Borings

**CLIENT: CDM Smith Inc.
Knoxville, TN**

**SITE: DuPont Parkway
Chattanooga, Tennessee**

LOCATION See Exploration Plan

Latitude: 35.1043° Longitude: -85.257°

Approximate Surface Elev: 654 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	RECOVERY (%)	RQD (%)	LABORATORY HP (tsf)	STRENGTH TEST: TEST TYPE	STRENGTH TEST: COMPRESSIVE STRENGTH (tsf)	STRENGTH TEST: STRAIN (%)	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	0.5	**TOPSOIL**	653.5+/-													
		LEAN CLAY (CL), with trace fine gravel, brown, medium stiff to very s tiff				X	4-2-3 N=5	67		3.5 (HP)						
				5		X	4-5-8 N=13	67		4.25 (HP)						
	8.0	with light gray mottles	646+/-			X	6-9-15 N=24	78		4.5 (HP)						
		SANDY LEAN CLAY (CL), with fine gravel, brown and red, stiff		10		X	10-6-8 N=14	78		4.0 (HP)						
	15.0	-with coarse chert	639+/-	15		X	10-6-6 N=12	78		4.5 (HP)						
		Boring Terminated at 15 Feet														

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with soil cuttings upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Elevations interpolated from Google Earth Pro

Notes:

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

Boring Started: 08-08-2018	Boring Completed: 08-08-2018
Drill Rig: DR890	Driller: N. Dotson
Project No.: E2175151	

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity			Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits LL	PL	PI	Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI 50	pH	Resistivity (ohm-cm)	Sulfates (ppm)	
B-101	1	CH		19	97	54	25	29									
B-101	3.5			20													2
B-101	8.5			23													2
B-101	13.5			25													2
B-101	23.5			32													2
B-101	28.5	ML		41	57	NP	NP	NP									
B-102	20			27													2
B-102	25	CL		30	87	41	21	20									
B-102	30			42	77												2
B-103	2.5	CH		20	97	52	24	28									
B-103	6.5	CL		24	96	47	23	24									
B-103	10			25													2
B-103	20			28													2
B-103	25			29													2
B-103	30	ML		44	61	NP	NP	NP									
B-104	2.5			18	53												2
B-104	20	CL		28	71	32	21	11									
B-104	25	ML		33	63	30	25	5									
B-105	1				86												
B-105	5			17		45	21	24									
B-105	6.5			26	43												2
B-105	15			25													2
B-105	25	CL		30	84	36	20	16									
B-105	30			44													2
B-106	2.5			19	51												2

REMARKS
1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN
PH. 423-499-6111 FAX. 423-499-8099

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

EXHIBIT: B-1

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity			Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI 50	pH	Resistivity (ohm-cm)	Sulfates (ppm)	
						LL	PL	PI									
B-106	5			18													2
B-106	6.5	CH		27													2
B-106	10			22													2
B-106	15			23													2
B-106	20	CL		27	87	39	23	16									
B-106	25			27													2
B-106	30	SM		35	23	31	29	2									
B-107	2.5			16													2
B-107	5	SC		16	50	43	19	24									
B-107	10	CH		36	79	50	24	26									
B-107	20			26													2
B-107	25	ML		35	71	30	28	2									
B-107	30			15	13												2
B-108	3.5			17		49	20	29									
B-108	6	CH		27													2
B-108	8.5	CL		35	94	48	25	23									
B-108	13.5			26													2
B-108	18.5			22		38	21	17									
B-108	23.5	CL		38	84	37	24	13									
B-108	28.5			10	6												2
B-110	2.5			15													2
B-110	5	CL		19	64	40	21	19									
B-110	6.5			24													2
B-110	10			25													2
B-110	15	CL		26	86	41	20	21									

REMARKS

1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

Terracon

51 Lost Mound Dr, Ste 135
Chattanooga, TN

PH. 423-499-6111 FAX. 423-499-8099

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

EXHIBIT: B-2

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity			Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI_{50}	pH	Resistivity (ohm-cm)	Sulfates (ppm)	
						LL	PL	PI									
B-110	20			28													2
B-112	2.5	CL		23	89	44	23	21									
B-112	5			24													2
B-112	10	CH		24	98	51	25	26									
B-112	15			25													2
B-113	5	CH		23	98	50	26	24									
B-203	2.5			24													2
B-203	5			17													2
B-203	7.5			19													2
B-203	10			22													2
B-203	15	CL		24	89	39	21	18									
B-203	20			24													2
B-205	20	CL		25	84	33	22	11									
B-206	2.5			9	56												2
B-206	5			20													2
B-206	7.5	CL		21	67	32	20	12									
B-206	10			23		36	21	15									
B-206	18.5			21													2
B-207	15			14	41												2
B-208	5			13	26												2
B-208	6.5			28	72												2
B-208	10			11	17												2
B-215	6.5	CL		19	76	40	22	18									
B-215	10	SC		14	21	38	20	18									

REMARKS
1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample.
2. Visual Classification.
3. Submerged to approximate saturation.
4. Expansion Index in accordance with ASTM D4829-95.
5. Air-Dried Sample

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN
PH. 423-499-6111 FAX. 423-499-8099

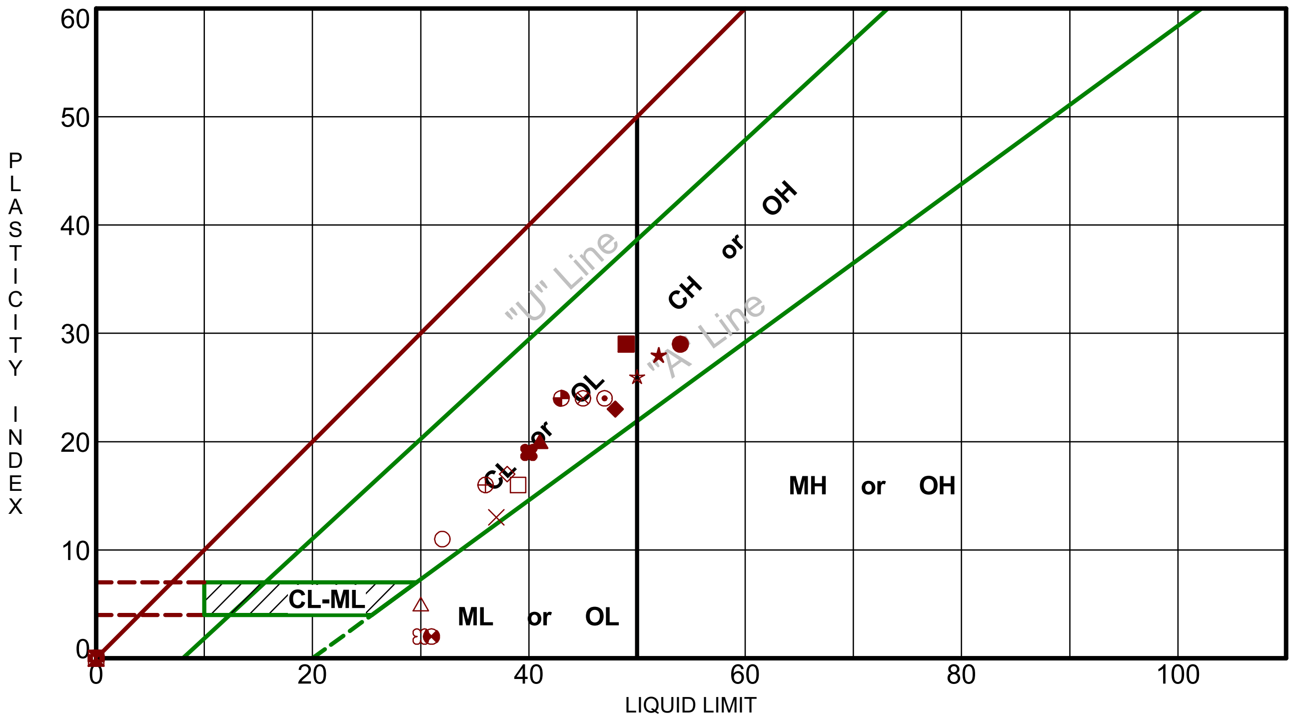
PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

EXHIBIT: B-3

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-101	1 - 2.5	54	25	29	97	CH	FAT CLAY
⧗	B-101	28.5 - 30	NP	NP	NP	57	ML	SANDY SILT
▲	B-102	25	41	21	20	87	CL	LEAN CLAY
★	B-103	2.5	52	24	28	97	CH	FAT CLAY
⊙	B-103	6.5	47	23	24	96	CL	LEAN CLAY
✿	B-103	30	NP	NP	NP	61	ML	SANDY SILT
○	B-104	20 - 22	32	21	11	71	CL	LEAN CLAY with SAND
△	B-104	25	30	25	5	63	ML	SANDY SILT
⊗	B-105	5	45	21	24			
⊕	B-105	25	36	20	16	84	CL	LEAN CLAY with SAND
□	B-106	20	39	23	16	87	CL	LEAN CLAY
◉	B-106	30	31	29	2	23	SM	SILTY SAND with GRAVEL
◕	B-107	5	43	19	24	50	SC	CLAYEY SAND with GRAVEL
☆	B-107	10	50	24	26	79	CH	FAT CLAY with SAND
✾	B-107	25	30	28	2	71	ML	SILT with SAND
■	B-108	3.5 - 5	49	20	29			
◆	B-108	8.5 - 10	48	25	23	94	CL	LEAN CLAY
◇	B-108	18.5 - 20	38	21	17			
×	B-108	23.5 - 25	37	24	13	84	CL	LEAN CLAY with SAND
✖	B-110	5	40	21	19	64	CL	SANDY LEAN CLAY

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

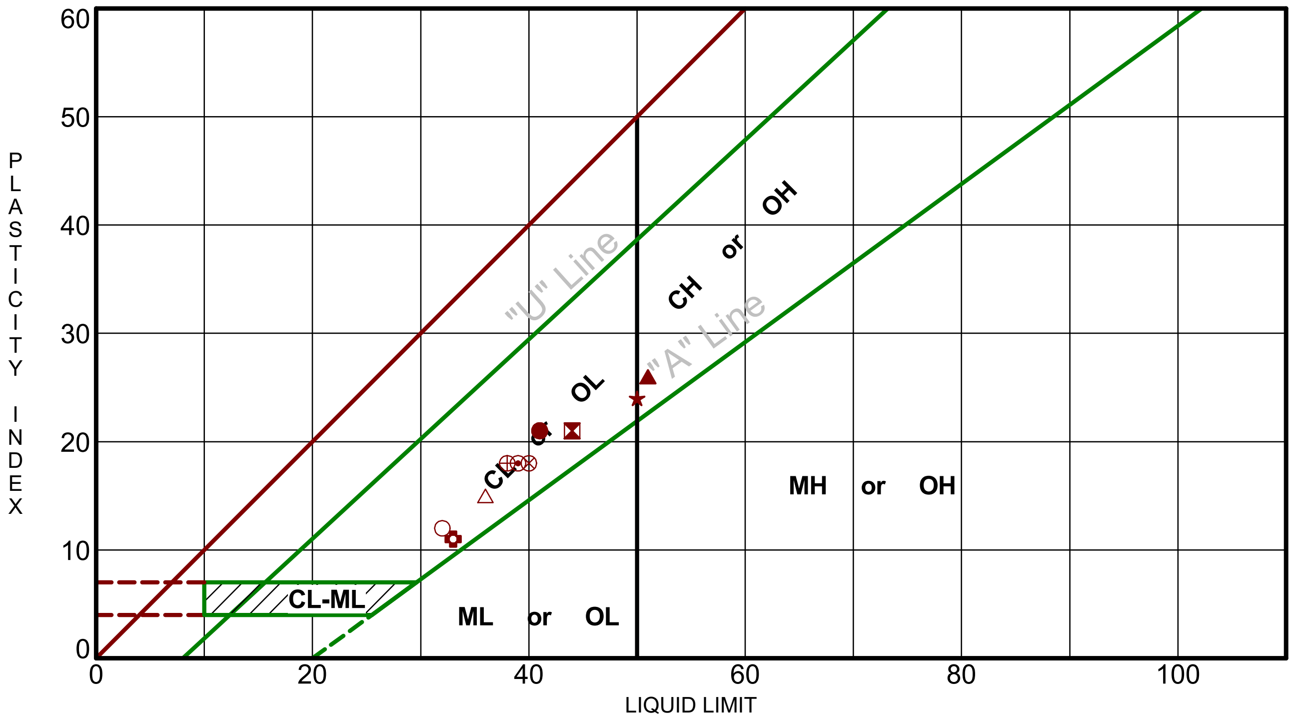
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● B-110	15	41	20	21	86	CL	LEAN CLAY
⧗ B-112	2.5	44	23	21	89	CL	LEAN CLAY
▲ B-112	10	51	25	26	98	CH	FAT CLAY
★ B-113	5	50	26	24	98	CH	FAT CLAY
⊙ B-203	15	39	21	18	89	CL	LEAN CLAY
✿ B-205	20	33	22	11	84	CL	LEAN CLAY with SAND
○ B-206	7.5	32	20	12	67	CL	SANDY LEAN CLAY
△ B-206	10	36	21	15			
⊗ B-215	6.5	40	22	18	76	CL	LEAN CLAY with SAND
⊕ B-215	10	38	20	18	21	SC	CLAYEY SAND with GRAVEL

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

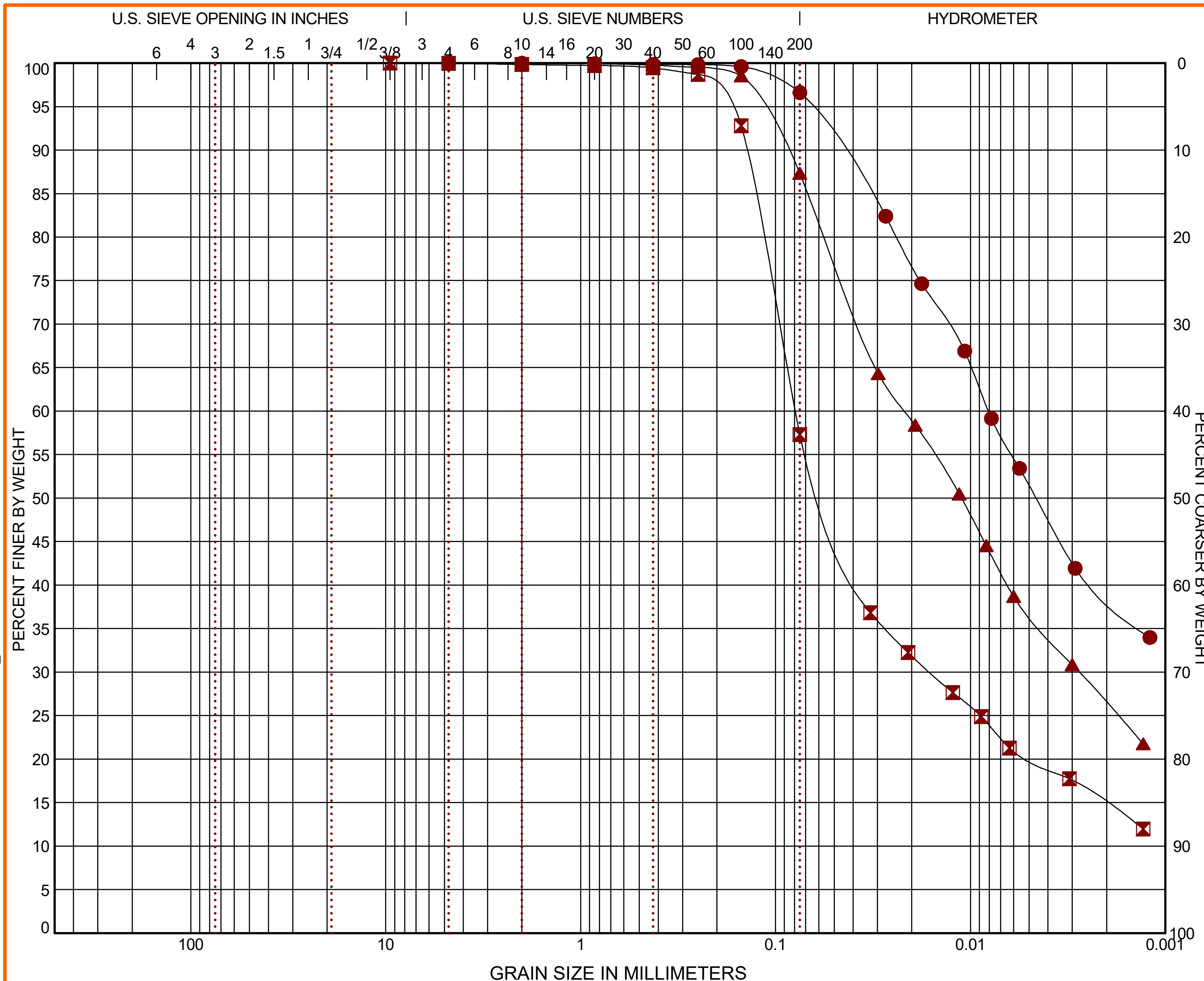
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-101	1 - 2.5	0.0	0.0	3.4	45.2		51.4	CH
⊠	B-101	28.5 - 30	0.0	0.0	42.7	37.2		20.1	ML
▲	B-102	25	0.0	0.0	12.7	50.7		36.6	CL

GRAIN SIZE	●	⊠	▲
D_{60}	0.008	0.079	0.022
D_{30}		0.016	0.003
D_{10}			

COEFFICIENTS	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
#4	100.0	3/8"	100.0	#10	100.0
#10	99.99	#4	99.95	#20	99.93
#20	99.92	#10	99.84	#40	99.76
#40	99.84	#20	99.72	#60	99.55
#60	99.82	#40	99.44	#100	98.54
#100	99.59	#60	98.69	#200	87.32
#200	96.6	#100	92.79		
		#200	57.3		

	SOIL DESCRIPTION
●	FAT CLAY (CH)
⊠	SANDY SILT (ML)
▲	LEAN CLAY (CL)

	REMARKS
●	
⊠	
▲	

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

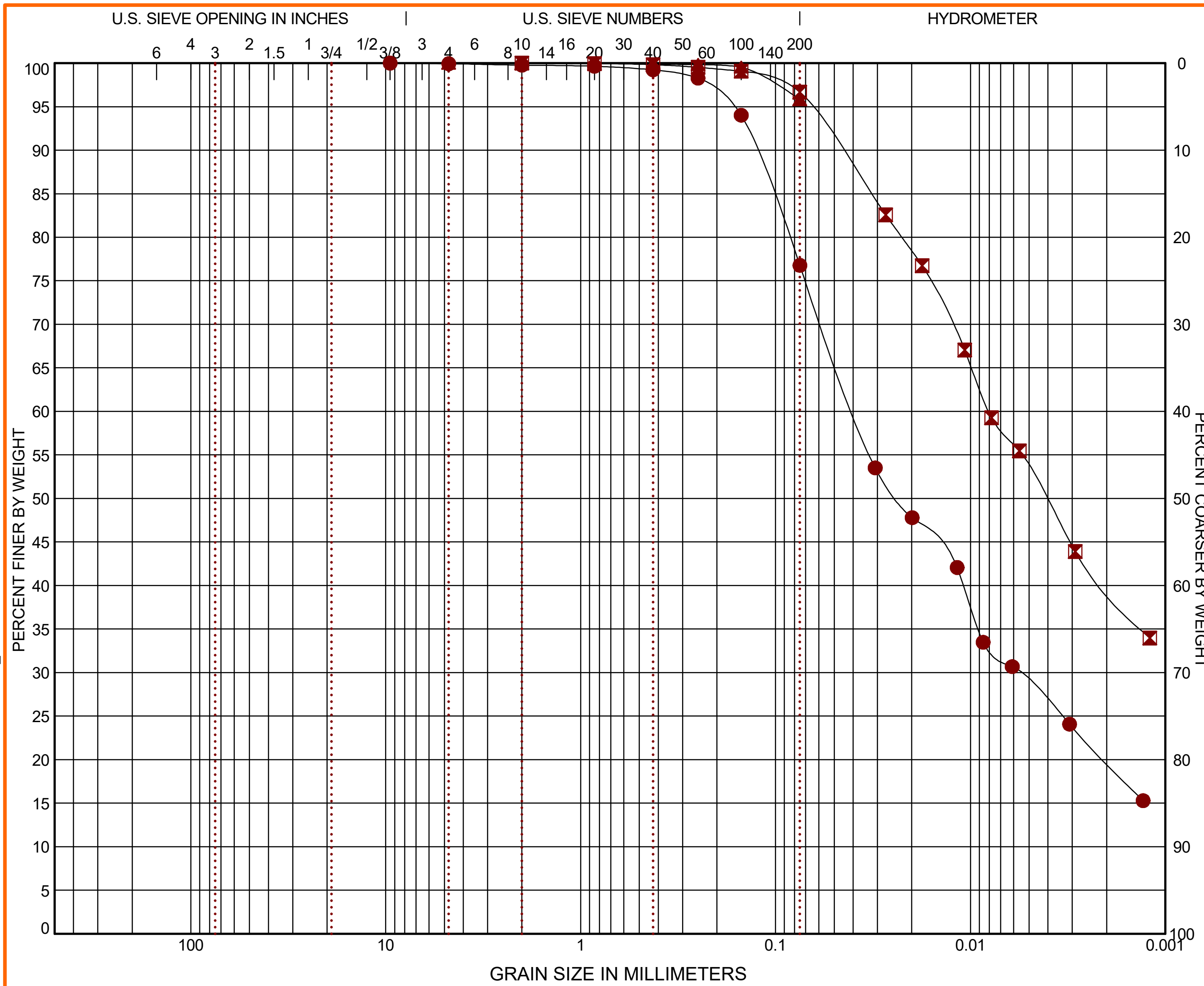
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-102	30	0.0	0.1	23.2	48.0		28.7	
⧗	B-103	2.5	0.0	0.0	3.3	43.2		53.5	CH
▲	B-103	6.5	0.0	0.0	4.2		95.8		CL

GRAIN SIZE

	●	⧗	▲
D_{60}	0.039	0.008	
D_{30}	0.006		
D_{10}			

COEFFICIENTS

	●	⧗	▲
C_C			
C_U			

● Sieve	● % Finer	⧗ Sieve	⧗ % Finer	▲ Sieve	▲ % Finer
3/8"	100.0	#10	100.0	#4	100.0
#4	99.93	#20	99.95	#10	99.97
#10	99.77	#40	99.82	#20	99.94
#20	99.64	#60	99.52	#40	99.9
#40	99.23	#100	99.06	#60	99.84
#60	98.27	#200	96.67	#100	99.54
#100	94.01			#200	95.81
#200	76.77				

SOIL DESCRIPTION

●	
⧗	FAT CLAY (CH)
▲	LEAN CLAY (CL)

REMARKS

●	
⧗	
▲	

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

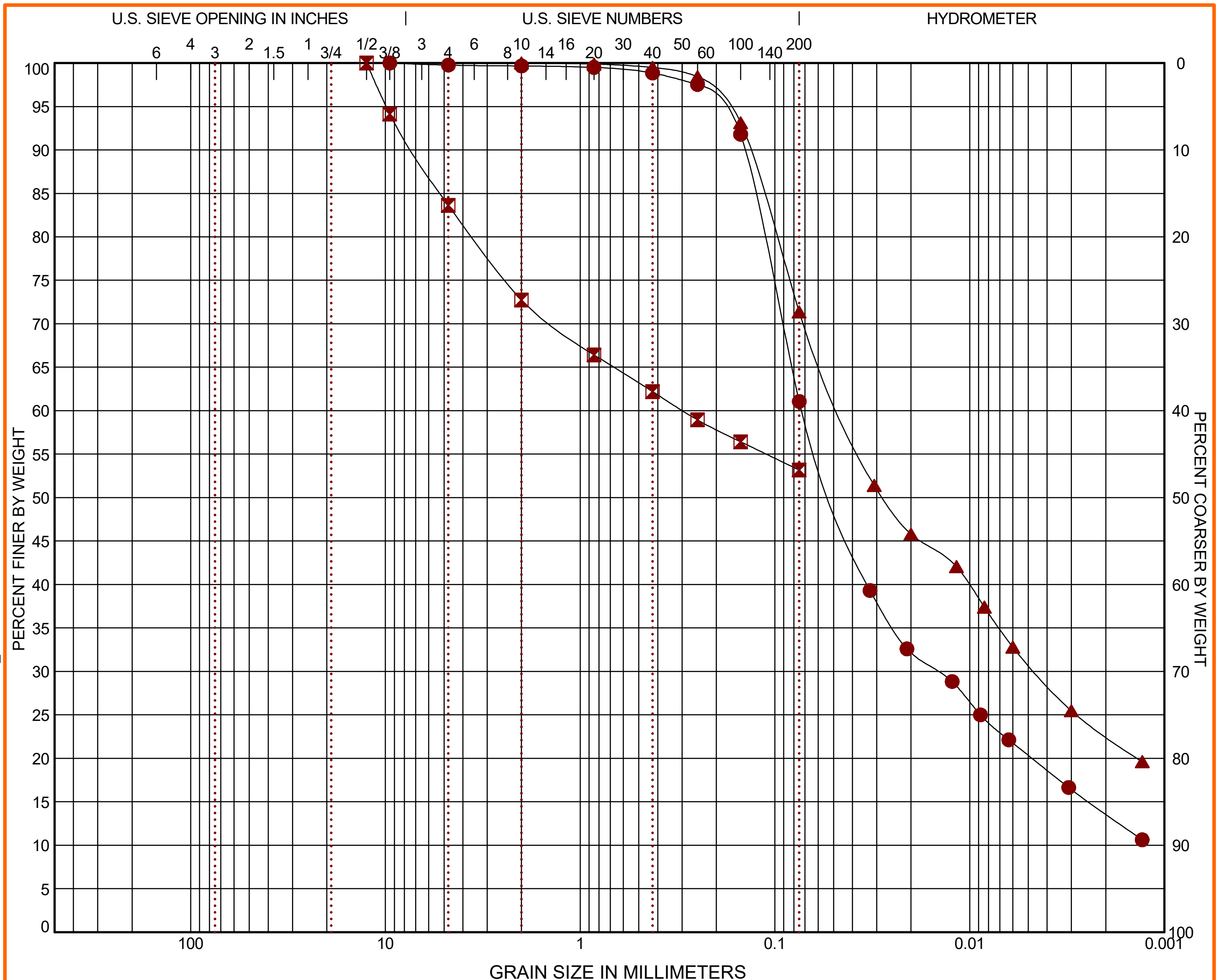
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-103	30	0.0	0.2	38.7	40.7		20.3	ML
⊠	B-104	2.5	0.0	16.4	30.5		53.2		
▲	B-104	20 - 22	0.0	0.0	28.6	40.5		30.9	CL

GRAIN SIZE	●	⊠	▲
D_{60}	0.072	0.297	0.045
D_{30}	0.015		0.005
D_{10}			

COEFFICIENTS	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
3/8"	100.0	1/2"	100.0	#10	100.0
#4	99.76	3/8"	94.13	#20	99.88
#10	99.66	#4	83.62	#40	99.49
#20	99.49	#10	72.74	#60	98.43
#40	98.85	#20	66.43	#100	93.13
#60	97.53	#40	62.2	#200	71.36
#100	91.79	#60	58.94		
#200	61.06	#100	56.42		
		#200	53.17		

	SOIL DESCRIPTION
●	SANDY SILT (ML)
⊠	
▲	LEAN CLAY with SAND (CL)

	REMARKS
●	
⊠	
▲	

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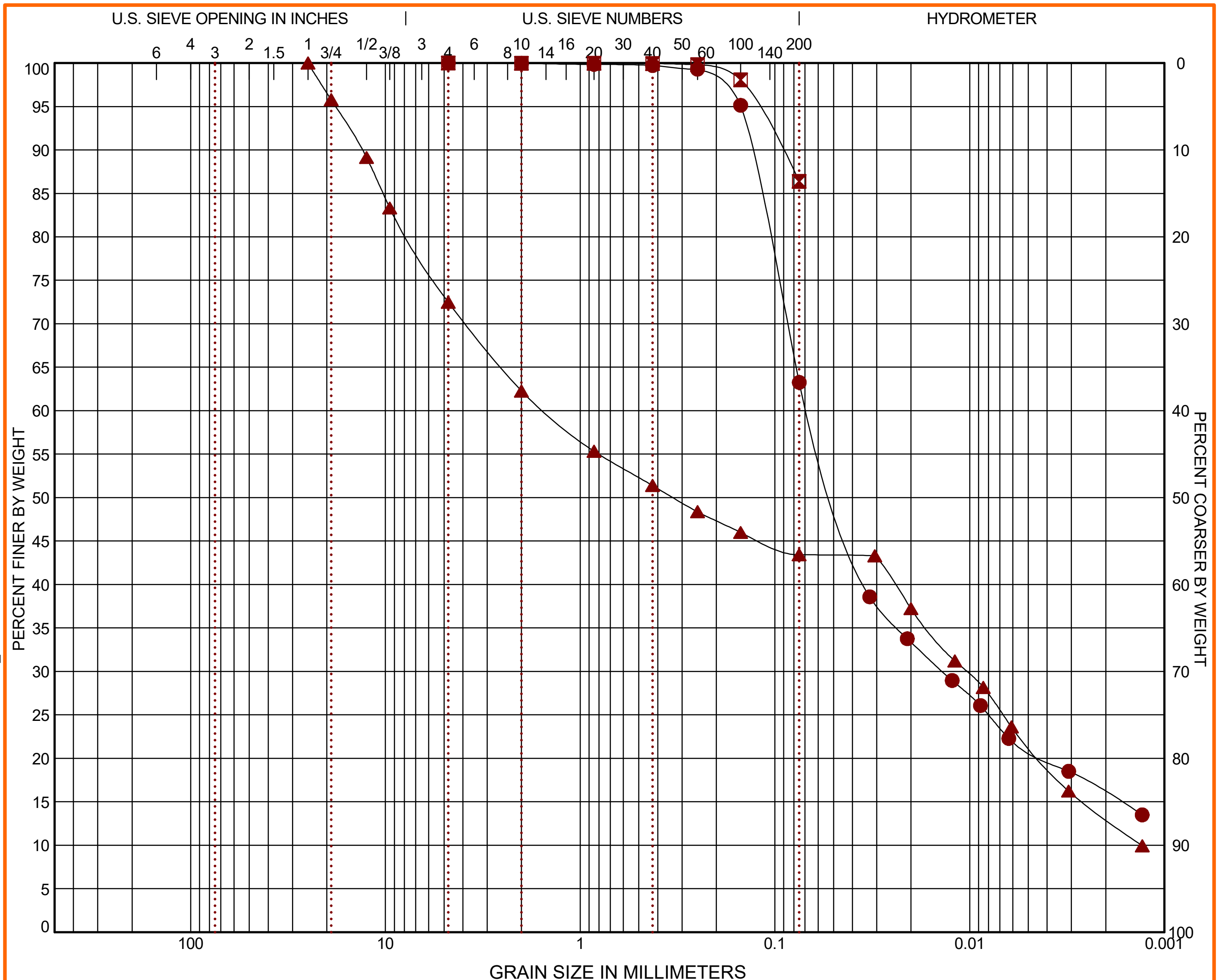
Knoxville, TN

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS 1 E2175151 DUPONT ADDITIONAL.GPJ TERRACON_DATATEMPLATE.GDT 8/20/18

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-104	25	0.0	0.0	36.8	42.2		21.1	ML
⊠	B-105	1 - 2.5	0.0	0.0	13.6		86.4		
▲	B-105	6.5	0.0	27.5	29.0	22.0		21.4	

GRAIN SIZE

	●	⊠	▲
D_{60}	0.067		1.513
D_{30}	0.014		0.01
D_{10}			0.001

COEFFICIENTS

	●	⊠	▲
C_C			0.05
C_U			1154.77

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
#4	100.0	#4	100.0	1"	100.0
#10	99.96	#10	99.98	3/4"	95.77
#20	99.84	#20	99.96	1/2"	89.13
#40	99.72	#40	99.94	3/8"	83.32
#60	99.29	#60	99.8	#4	72.48
#100	95.14	#100	98.05	#10	62.26
#200	63.25	#200	86.4	#20	55.34
				#40	51.39
				#60	48.38
				#100	45.98
				#200	43.43

SOIL DESCRIPTION

●	SANDY SILT (ML)
⊠	
▲	

REMARKS

●	
⊠	
▲	

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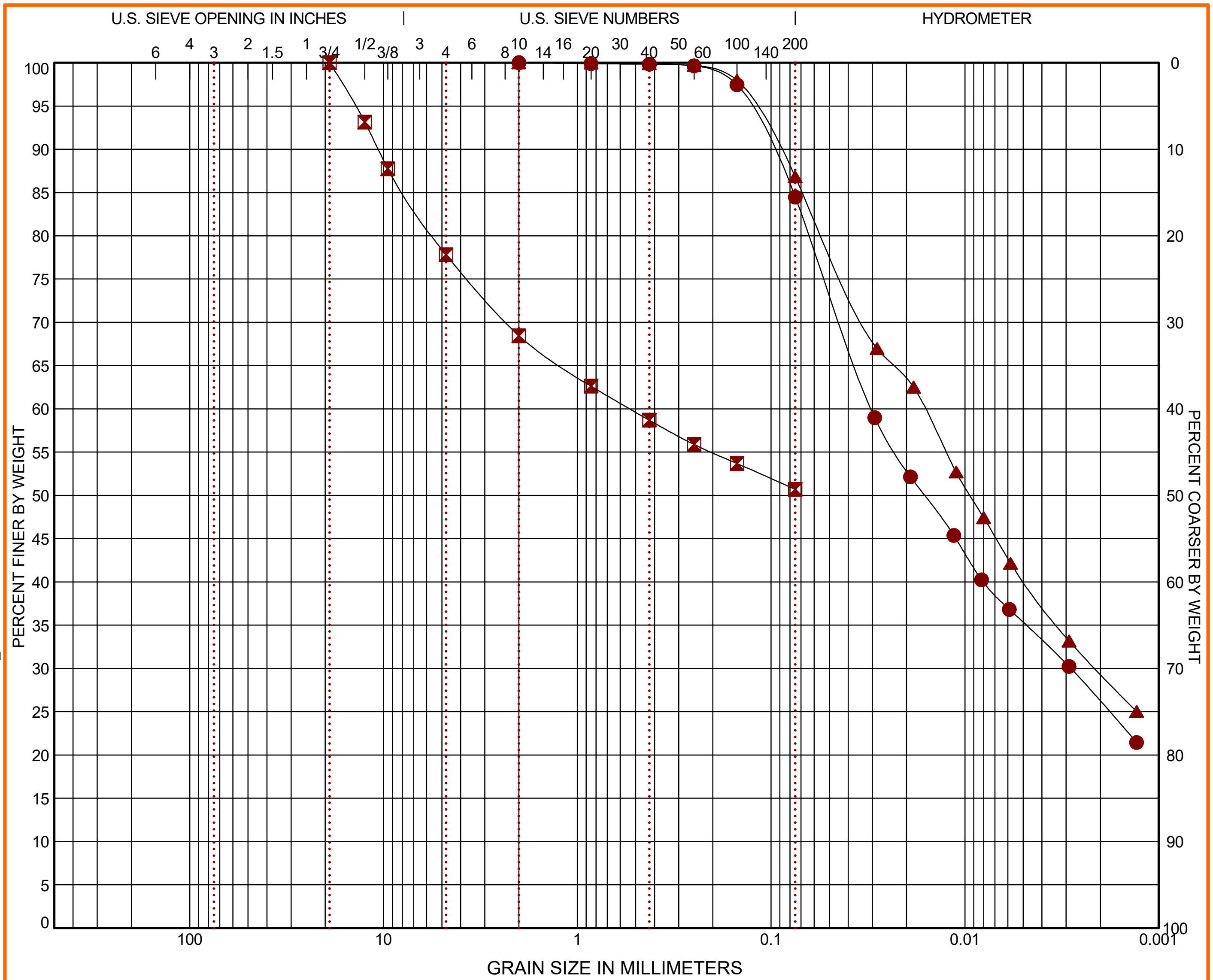
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-105**	25	0.0	0.0	15.5	49.2		35.3	CL
⊠	**B-106**	2.5	0.0	22.2	27.1		50.7		
▲	**B-106**	20	0.0	0.0	13.2	46.6		40.2	CL

GRAIN SIZE

	●	⊠	▲
D_{60}	0.03	0.536	0.016
D_{30}	0.003		0.002
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#10	100.0	3/4"	100.0	#10	100.0
#20	99.9	1/2"	93.14	#20	99.97
#40	99.83	3/8"	87.73	#40	99.91
#60	99.65	#4	77.81	#60	99.68
#100	97.45	#10	68.46	#100	97.96
#200	84.47	#20	62.62	#200	86.81
		#40	58.69		
		#60	55.89		
		#100	53.68		
		#200	50.68		

SOIL DESCRIPTION

●	LEAN CLAY with SAND (CL)
⊠	
▲	LEAN CLAY (CL)

REMARKS

●	
⊠	
▲	

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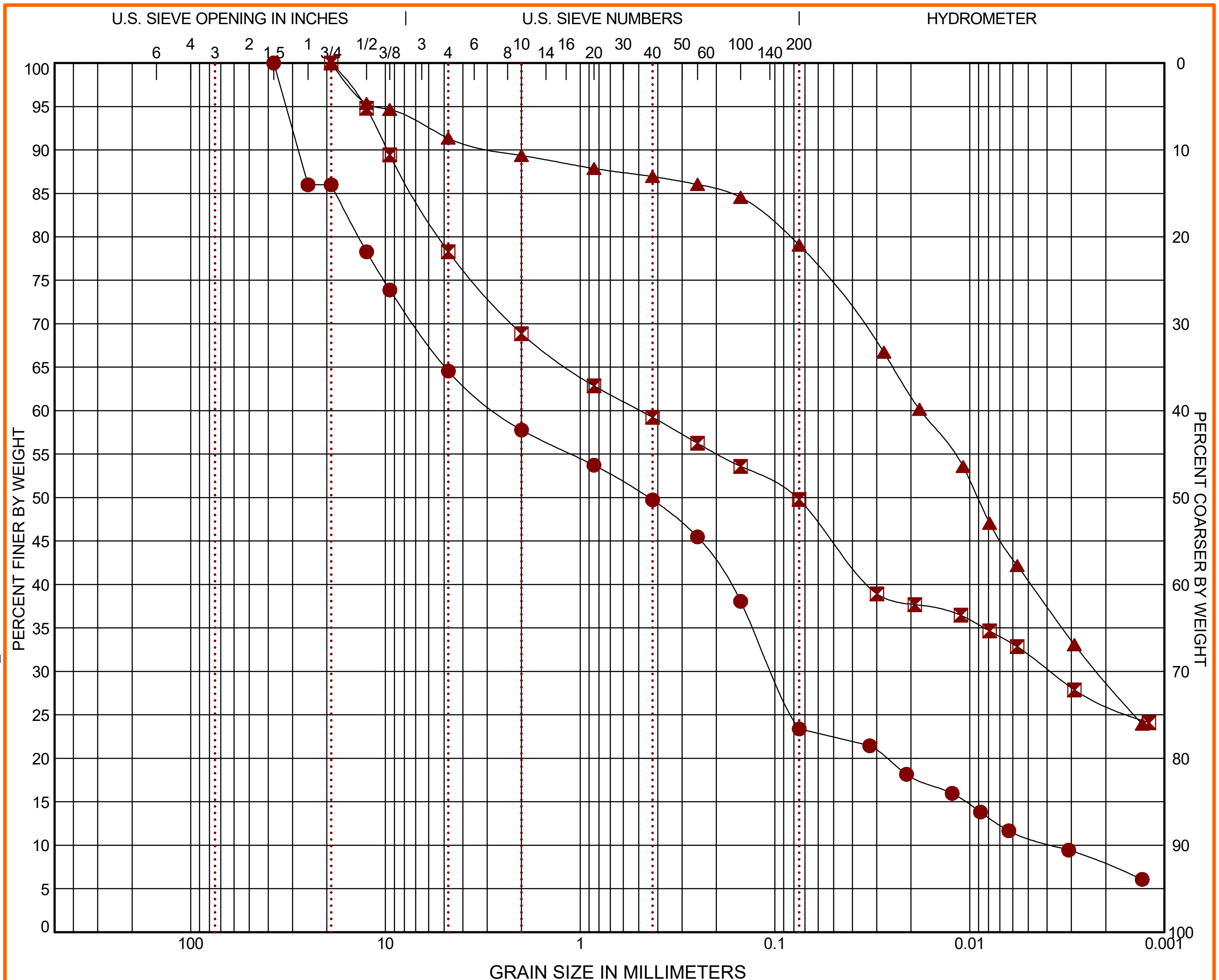
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-106**	30	0.0	35.4	41.2	12.4		10.9	SM
⊠	**B-107**	5	0.0	21.7	28.5	17.9		31.9	SC
▲	**B-107**	10	0.0	8.7	12.3	38.6		40.4	CH

GRAIN SIZE

	●	⊠	▲
D_{60}	2.657	0.491	0.018
D_{30}	0.103	0.004	0.002
D_{10}	0.004		

COEFFICIENTS

	●	⊠	▲
C_C	1.07		
C_U	717.12		

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1 1/2"	100.0	3/4"	100.0	3/4"	100.0
1"	85.99	1/2"	94.79	1/2"	95.34
3/4"	85.99	3/8"	89.42	3/8"	94.65
1/2"	78.28	#4	78.29	#4	91.34
3/8"	73.89	#10	68.87	#10	89.35
#4	64.56	#20	62.86	#20	87.86
#10	57.77	#40	59.24	#40	86.93
#20	53.73	#60	56.26	#60	86.04
#40	49.73	#100	53.6	#100	84.55
#60	45.48	#200	49.76	#200	79.05
#100	38.07				
#200	23.38				

SOIL DESCRIPTION

●	SILTY SAND with GRAVEL (SM)
⊠	CLAYEY SAND with GRAVEL (SC)
▲	FAT CLAY with SAND (CH)

REMARKS

●	
⊠	
▲	

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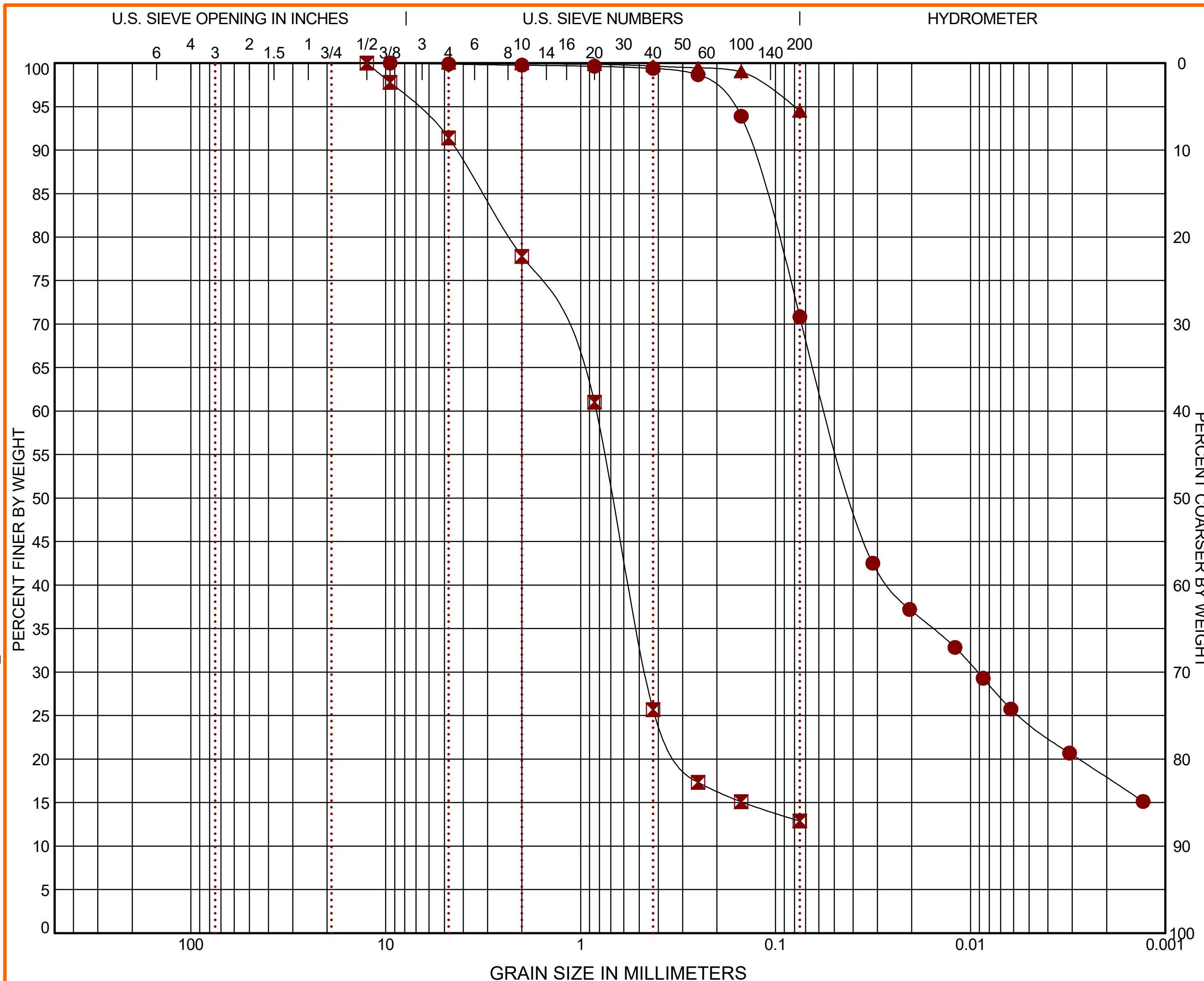
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-107	25	0.0	0.1	29.1	46.6		24.2	ML
⊠	B-107	30	0.0	8.6	78.5		12.9		
▲	B-108	8.5 - 10	0.0	0.0	5.5		94.5		CL

GRAIN SIZE

	●	⊠	▲
D_{60}	0.054	0.833	
D_{30}	0.009	0.463	
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
3/8"	100.0	1/2"	100.0	#4	100.0
#4	99.88	3/8"	97.77	#10	99.92
#10	99.75	#4	91.39	#20	99.85
#20	99.63	#10	77.78	#40	99.66
#40	99.38	#20	61.02	#60	99.47
#60	98.67	#40	25.67	#100	99.01
#100	93.89	#60	17.33	#200	94.48
#200	70.83	#100	15.1		
		#200	12.88		

SOIL DESCRIPTION

●	SILT with SAND (ML)
⊠	
▲	LEAN CLAY (CL)

REMARKS

●	
⊠	
▲	

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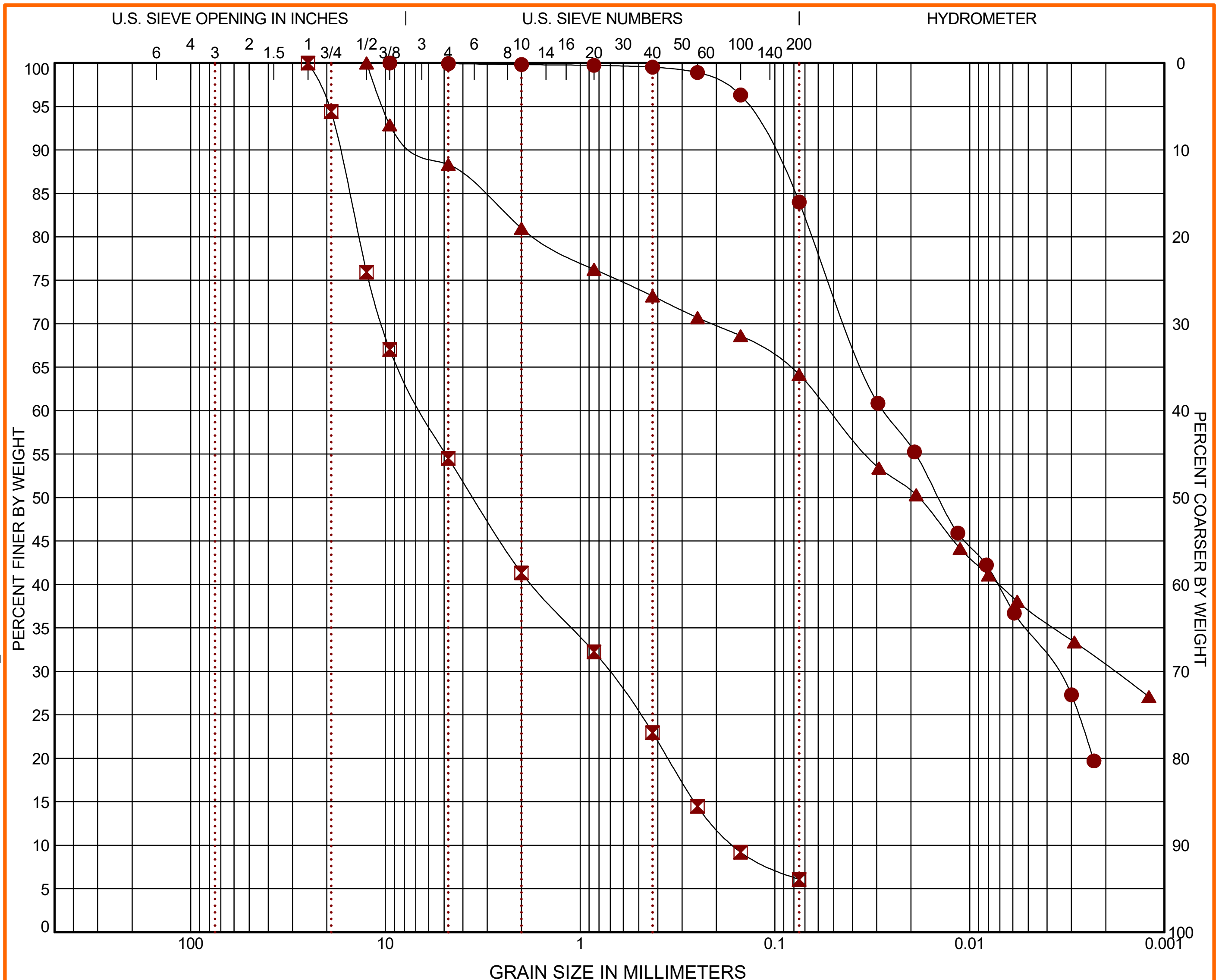
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-108	23.5 - 25	0.0	0.1	15.9	49.6		34.4	CL
⊠	B-108	28.5 - 30	0.0	45.5	48.4		6.1		
▲	B-110	5	0.0	11.7	24.2	27.0		37.2	CL

GRAIN SIZE

	●	⊠	▲
D_{60}	0.028	6.435	0.052
D_{30}	0.004	0.718	0.002
D_{10}		0.162	

COEFFICIENTS

	●	⊠	▲
C_C		0.49	
C_U		39.69	

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
3/8"	100.0	1"	100.0	1/2"	100.0
#4	99.93	3/4"	94.41	3/8"	92.87
#10	99.82	1/2"	75.95	#4	88.32
#20	99.73	3/8"	67.03	#10	80.97
#40	99.52	#4	54.52	#20	76.26
#60	98.91	#10	41.32	#40	73.19
#100	96.32	#20	32.26	#60	70.7
#200	84.0	#40	22.96	#100	68.62
		#60	14.47	#200	64.15
		#100	9.2		
		#200	6.08		

SOIL DESCRIPTION

●	LEAN CLAY with SAND (CL)
⊠	
▲	SANDY LEAN CLAY (CL)

REMARKS

●	
⊠	
▲	

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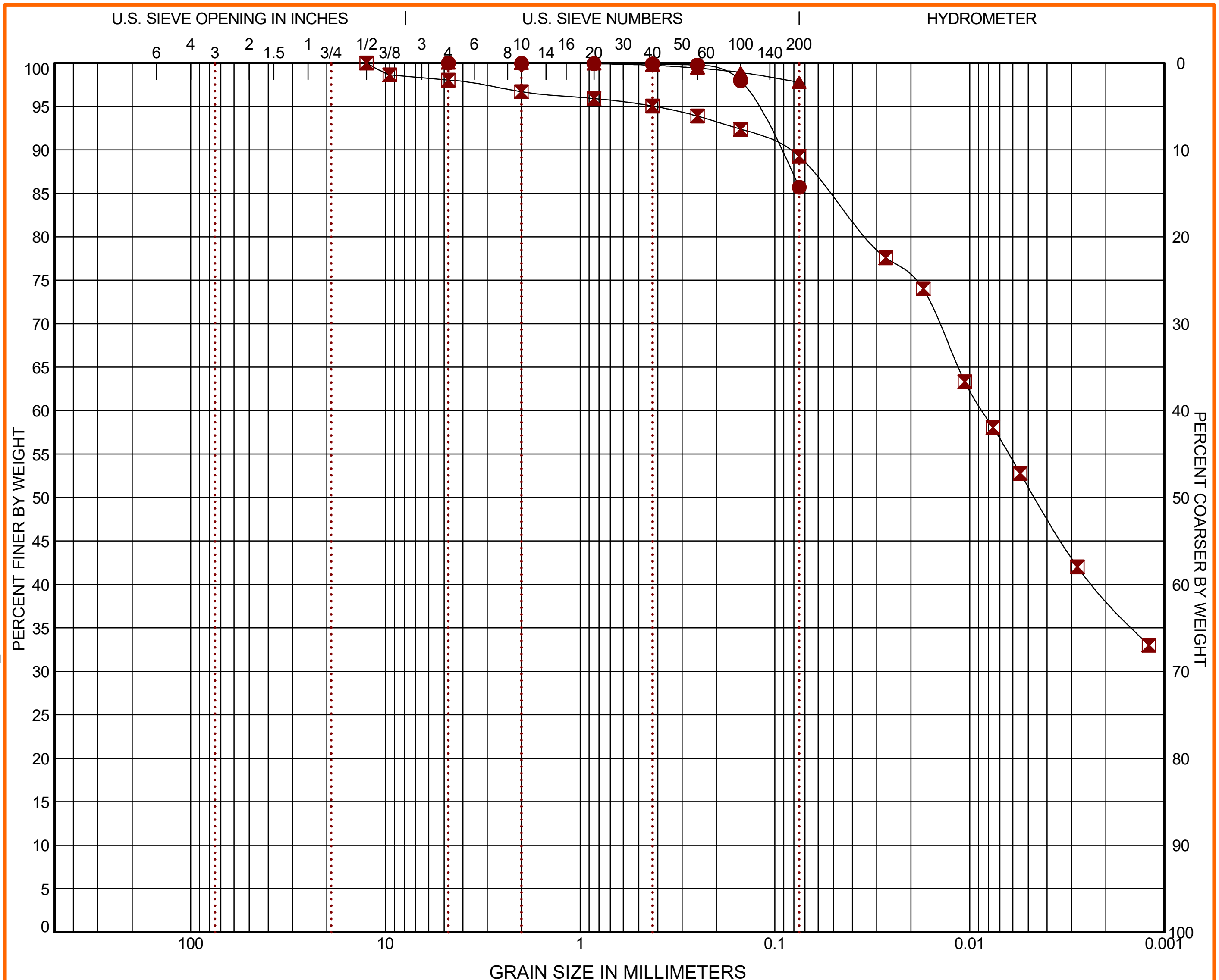
GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-110	15	0.0	0.0	14.3		85.7		CL
⊠	B-112	2.5	0.0	2.0	8.8	38.0		51.3	CL
▲	B-112	10	0.0	0.0	2.2		97.8		CH

GRAIN SIZE

	●	⊠	▲
D_{60}		0.009	
D_{30}			
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
#4	100.0	1/2"	100.0	#4	100.0
#10	99.94	3/8"	98.63	#10	99.95
#20	99.93	#4	98.03	#20	99.91
#40	99.89	#10	96.7	#40	99.74
#60	99.76	#20	95.91	#60	99.42
#100	97.96	#40	95.05	#100	98.9
#200	85.71	#60	93.9	#200	97.78
		#100	92.39		
		#200	89.26		

SOIL DESCRIPTION

●	LEAN CLAY (CL)
⊠	LEAN CLAY (CL)
▲	FAT CLAY (CH)

REMARKS

●	
⊠	
▲	

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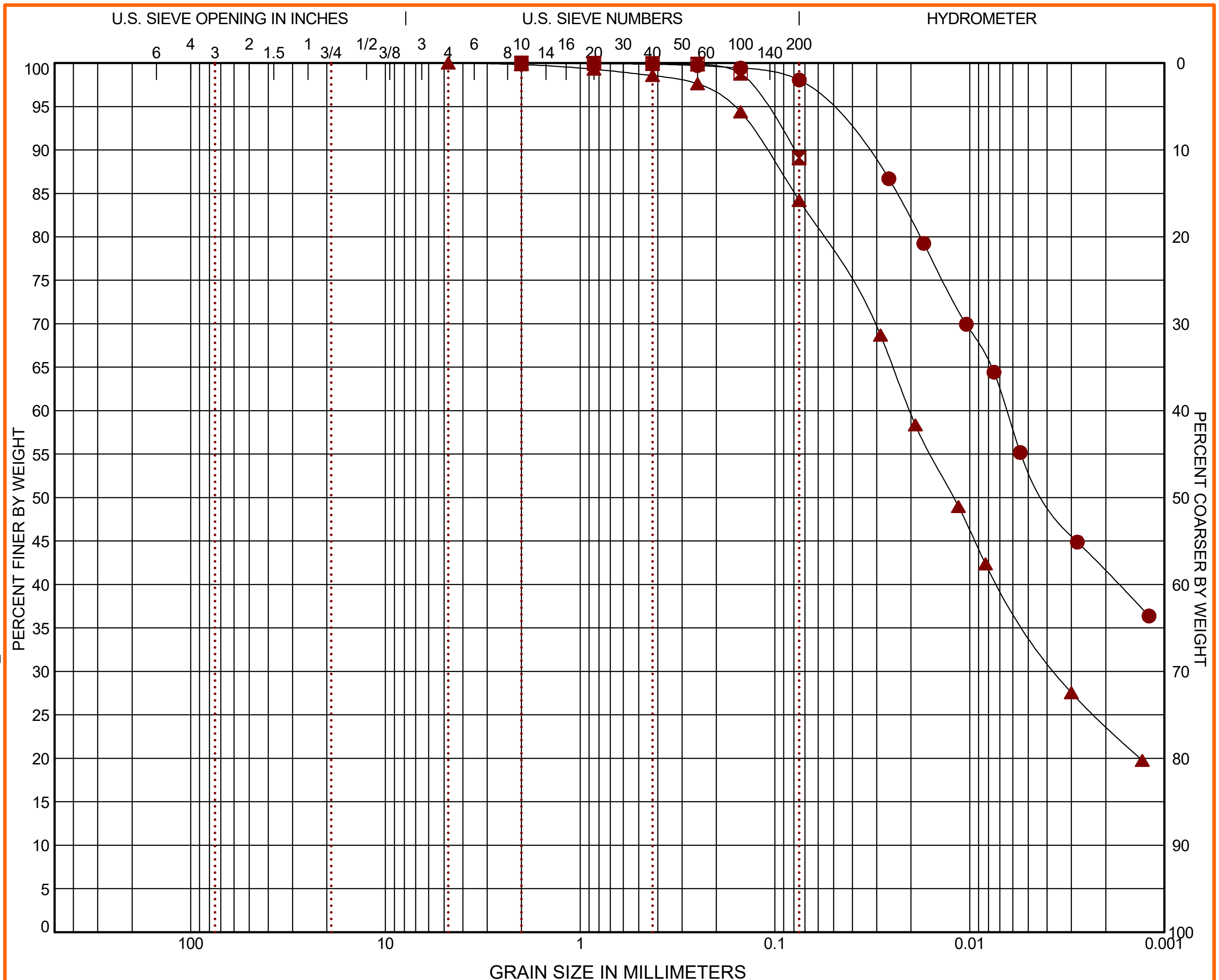

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	**B-113**	5	0.0	0.0	2.0	44.3		53.7	CH
⊠	**B-203**	15	0.0	0.0	10.9		89.1		CL
▲	**B-205**	20	0.0	0.0	15.8	49.2		35.0	CL

GRAIN SIZE

	●	⊠	▲
D_{60}	0.006		0.02
D_{30}			0.004
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
#10	100.0	#10	100.0	#4	100.0
#20	99.92	#20	99.98	#10	99.82
#40	99.86	#40	99.94	#20	99.29
#60	99.71	#60	99.87	#40	98.55
#100	99.42	#100	98.84	#60	97.63
#200	98.04	#200	89.08	#100	94.37
				#200	84.2

SOIL DESCRIPTION

●	FAT CLAY (CH)
⊠	LEAN CLAY (CL)
▲	LEAN CLAY with SAND (CL)

REMARKS

●	
⊠	
▲	

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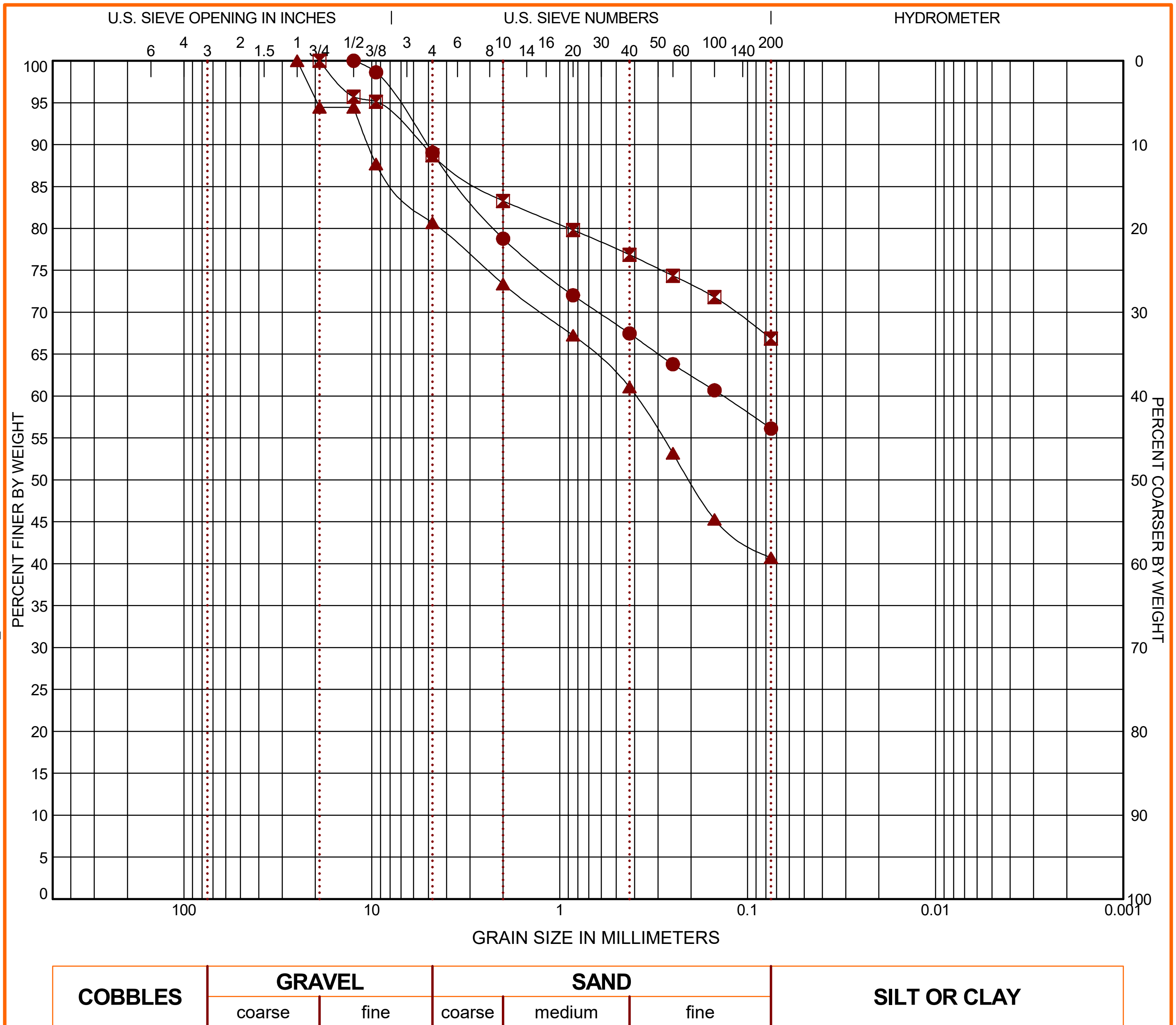

BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
● B-206	2.5	0.0	11.0	32.9		56.1		
⊠ B-206	7.5	0.0	11.3	21.9		66.8		CL
▲ B-207	15	0.0	19.3	40.0		40.7		

GRAIN SIZE

	●	⊠	▲
D_{60}	0.135		0.395
D_{30}			
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1/2"	100.0	3/4"	100.0	1"	100.0
3/8"	98.62	1/2"	95.71	3/4"	94.44
#4	89.03	3/8"	95.12	1/2"	94.44
#10	78.77	#4	88.74	3/8"	87.68
#20	72.03	#10	83.28	#4	80.67
#40	67.47	#20	79.81	#10	73.36
#60	63.8	#40	76.86	#20	67.25
#100	60.68	#60	74.36	#40	61.07
#200	56.12	#100	71.8	#60	53.18
		#200	66.85	#100	45.28
				#200	40.71

SOIL DESCRIPTION

●	
⊠	SANDY LEAN CLAY (CL)
▲	

REMARKS

●	
⊠	
▲	

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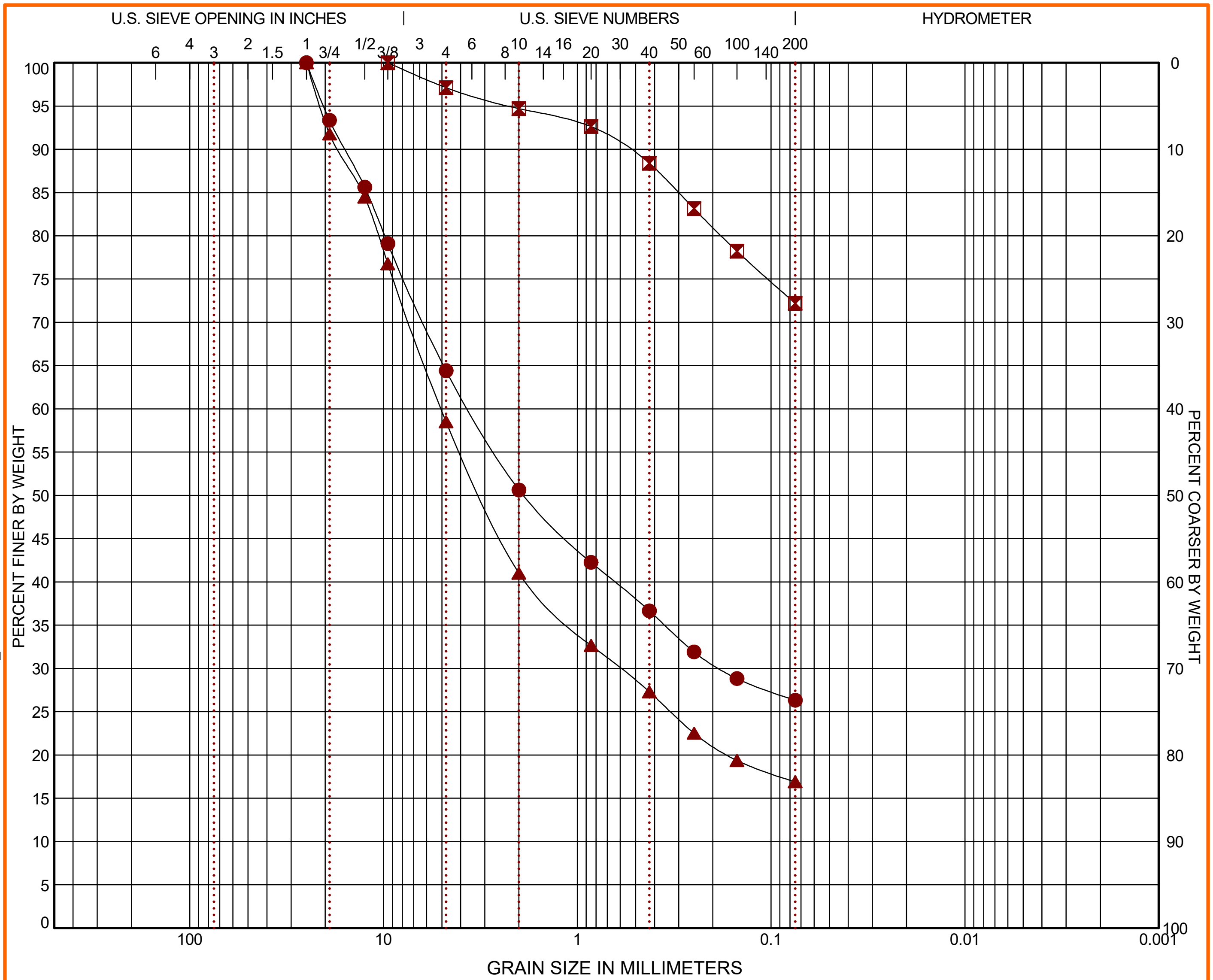

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-208	5	0.0	35.6	38.1		26.3		
⊠	B-208	6.5	0.0	2.9	24.9		72.2		
▲	B-208	10	0.0	41.5	41.6		16.9		

GRAIN SIZE

	●	⊠	▲
D_{60}	3.601		5.027
D_{30}	0.182		0.602
D_{10}			

COEFFICIENTS

	●	⊠	▲
C_C			
C_U			

● Sieve	● % Finer	⊠ Sieve	⊠ % Finer	▲ Sieve	▲ % Finer
1"	100.0	3/8"	100.0	1"	100.0
3/4"	93.35	#4	97.12	3/4"	91.77
1/2"	85.62	#10	94.69	1/2"	84.47
3/8"	79.1	#20	92.62	3/8"	76.76
#4	64.41	#40	88.39	#4	58.51
#10	50.63	#60	83.14	#10	41.01
#20	42.27	#100	78.22	#20	32.66
#40	36.66	#200	72.19	#40	27.31
#60	31.92			#60	22.52
#100	28.83			#100	19.37
#200	26.33			#200	16.9

SOIL DESCRIPTION

●	
⊠	
▲	

REMARKS

●	
⊠	
▲	

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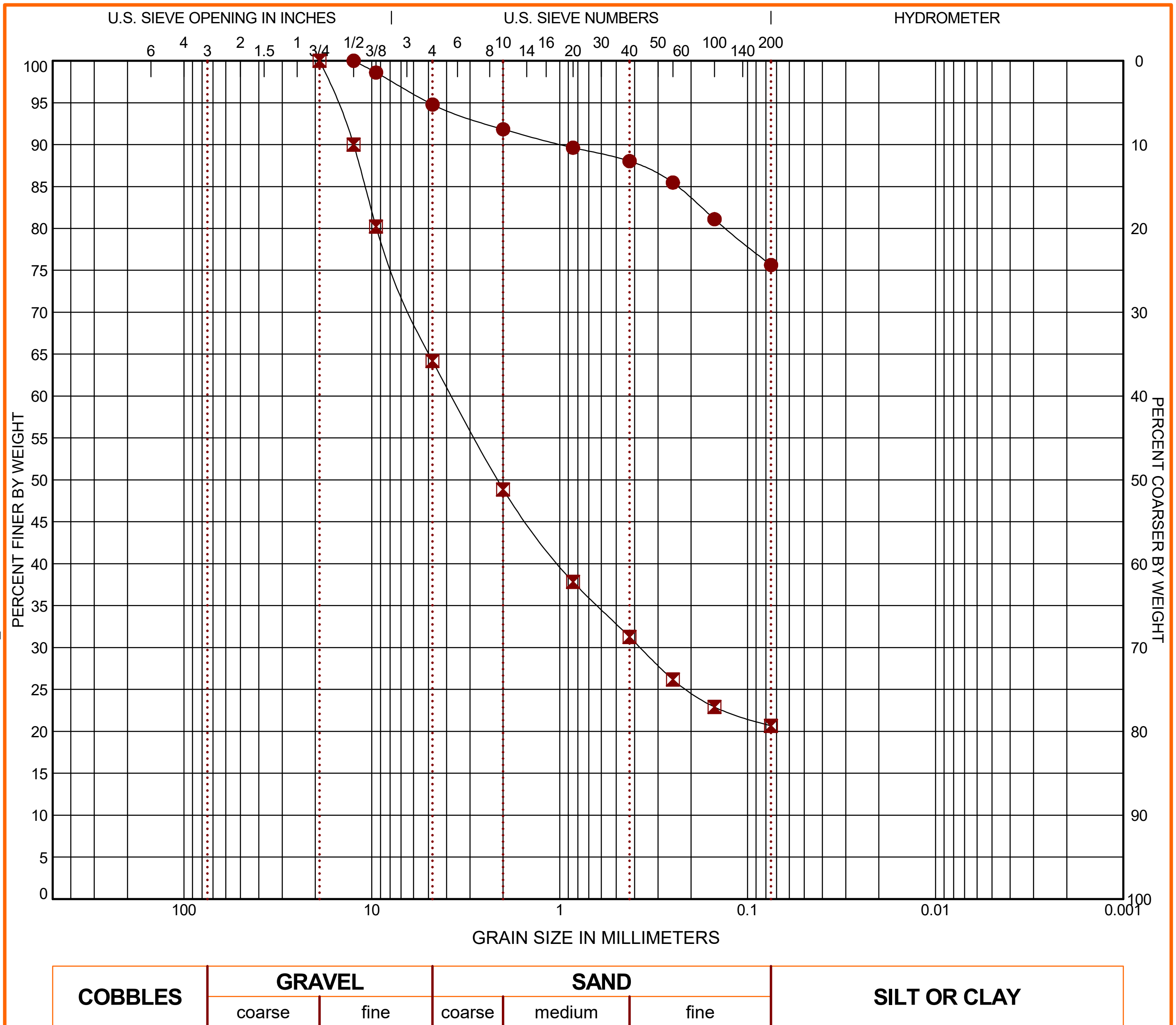
Chattanooga, TN

CLIENT: CDM Smith Inc.
Knoxville, TN

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	BORING ID	DEPTH	% COBBLES	% GRAVEL	% SAND	% SILT	% FINES	% CLAY	USCS
●	B-215	6.5	0.0	5.2	19.1		75.6		CL
⊠	B-215	10	0.0	35.8	43.5		20.7		SC

GRAIN SIZE

	●	⊠	
D_{60}		3.751	
D_{30}		0.372	
D_{10}			

COEFFICIENTS

	●	⊠	
C_C			
C_U			

●		⊠			
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
1/2"	100.0	3/4"	100.0		
3/8"	98.6	1/2"	89.99		
#4	94.77	3/8"	80.21		
#10	91.82	#4	64.18		
#20	89.63	#10	48.87		
#40	88.03	#20	37.84		
#60	85.47	#40	31.26		
#100	81.1	#60	26.19		
#200	75.63	#100	22.9		
		#200	20.68		

SOIL DESCRIPTION

●	LEAN CLAY with SAND (CL)
⊠	CLAYEY SAND with GRAVEL (SC)

REMARKS

●	
⊠	

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

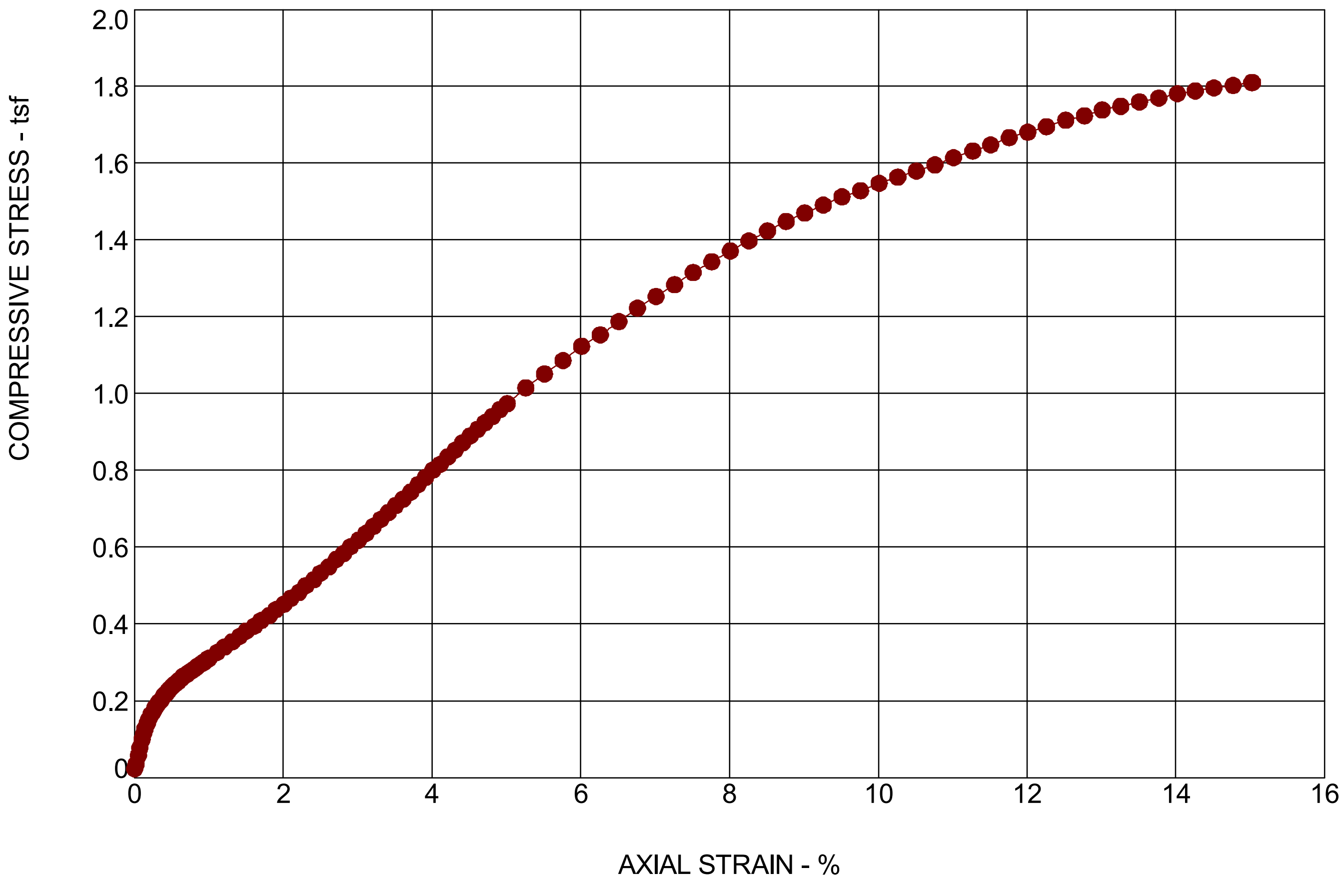
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

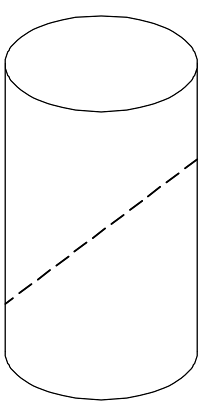
CLIENT: CDM Smith Inc.
Knoxville, TN

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	25
	Dry Density:	pcf	105
	Diameter:	in.	2.80
	Height:	in.	5.68
	Height / Diameter Ratio:		2.03
	Calculated Saturation:	%	110.70
	Calculated Void Ratio:		0.61
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	15.00
	Unconfined Compressive Strength	(tsf)	1.81
	Undrained Shear Strength:	(tsf)	0.90
	Strain Rate:	in/min	0.0560
Failure Mode: Shear (dashed)	Remarks:		



SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-104 @ 10 - 12 feet			
DESCRIPTION:	LL	PL	PI	Percent < #200 Sieve

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

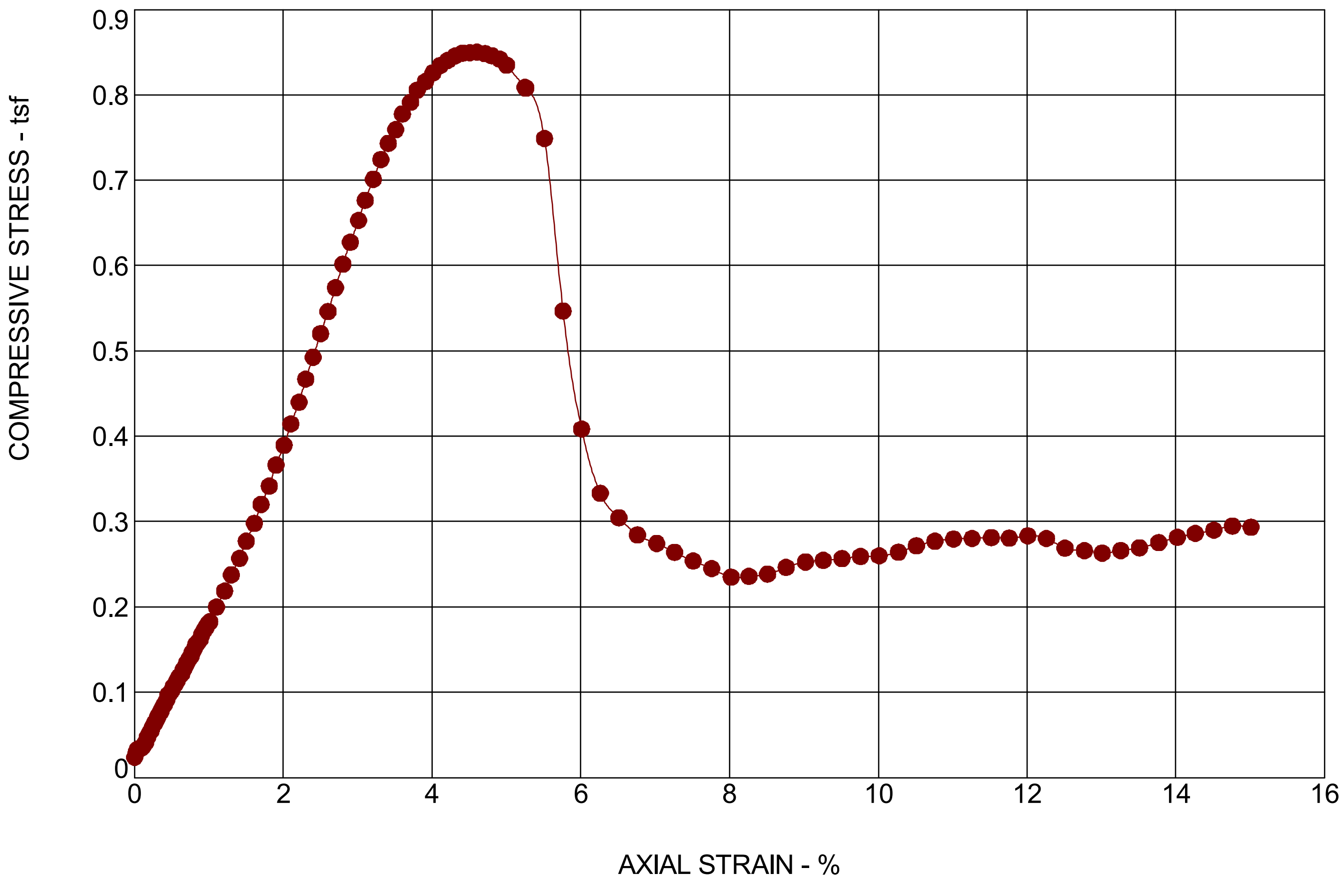
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

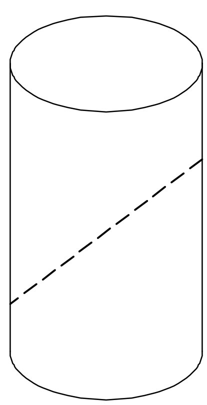
CLIENT: CDM Smith Inc.
Knoxville, TN

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	31
	Dry Density:	pcf	88
	Diameter:	in.	2.84
	Height:	in.	5.66
	Height / Diameter Ratio:		1.99
	Calculated Saturation:	%	92.51
	Calculated Void Ratio:		0.91
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	4.60
	Unconfined Compressive Strength	(tsf)	0.85
	Undrained Shear Strength:	(tsf)	0.43
	Strain Rate:	in/min	0.0560
	Remarks:		



Failure Mode: Shear (dashed)

SAMPLE TYPE: Shelby Tube	SAMPLE LOCATION: B-104 @ 22 - 24 feet			
DESCRIPTION:	LL	PL	PI	Percent < #200 Sieve

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

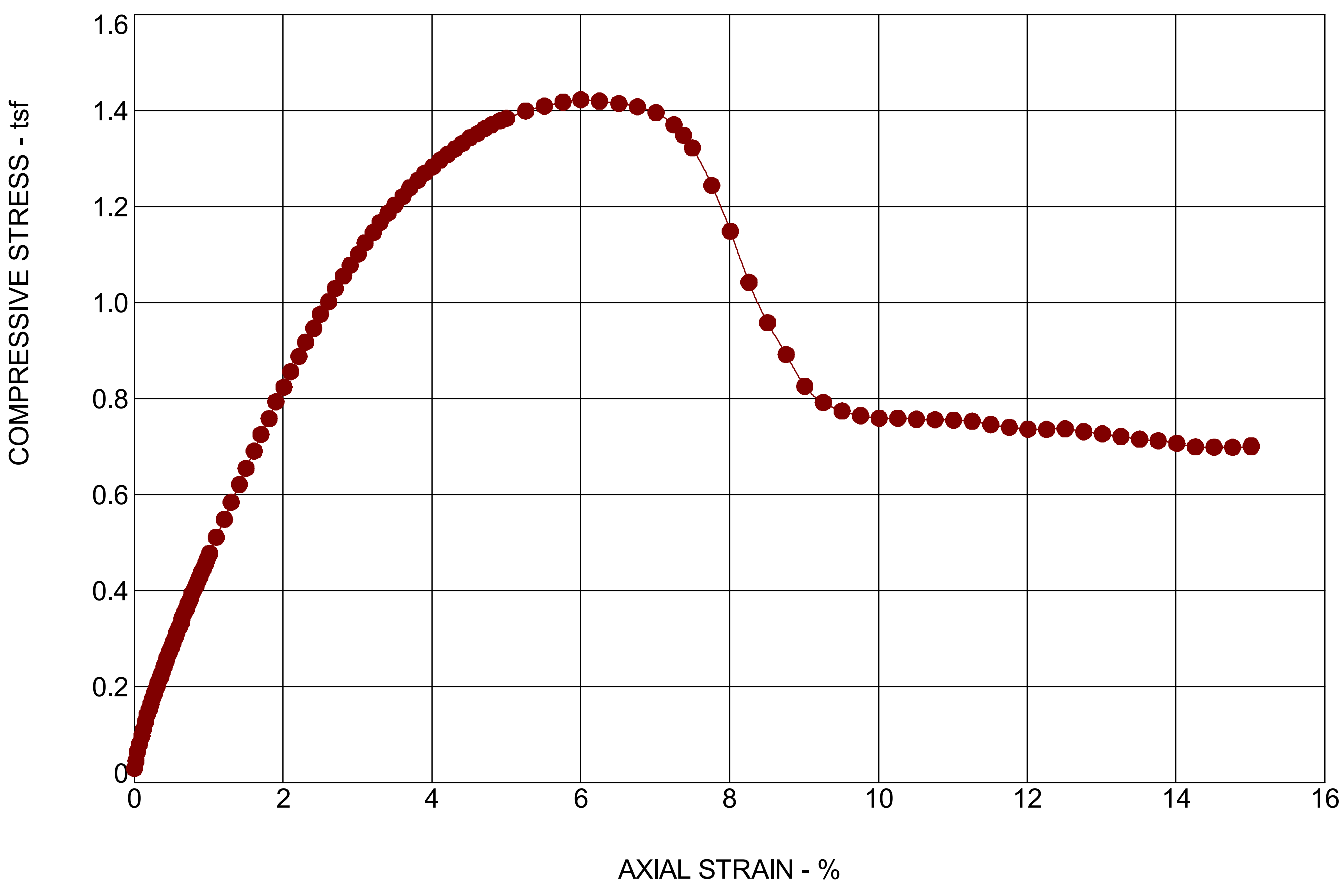
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

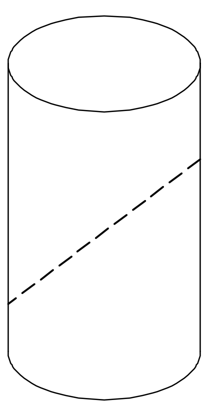
CLIENT: CDM Smith Inc.
Knoxville, TN

UNCONFINED COMPRESSION TEST

ASTM D2166



SPECIMEN FAILURE MODE	SPECIMEN TEST DATA		
	Moisture Content:	%	35
	Dry Density:	pcf	87
	Diameter:	in.	2.83
	Height:	in.	5.69
	Height / Diameter Ratio:		2.01
	Calculated Saturation:	%	100.09
	Calculated Void Ratio:		0.95
	Assumed Specific Gravity:		2.7
	Failure Strain:	%	6.00
	Unconfined Compressive Strength	(tsf)	1.42
	Undrained Shear Strength:	(tsf)	0.71
	Strain Rate:	in/min	0.0560
	Remarks:		



Failure Mode: Shear (dashed)

SAMPLE TYPE: Shelby Tube

SAMPLE LOCATION: B-108 @ 8 - 10 feet

DESCRIPTION:	LL	PL	PI	Percent < #200 Sieve

PROJECT: DuPont Additional Borings

SITE: DuPont Parkway
Chattanooga, Tennessee

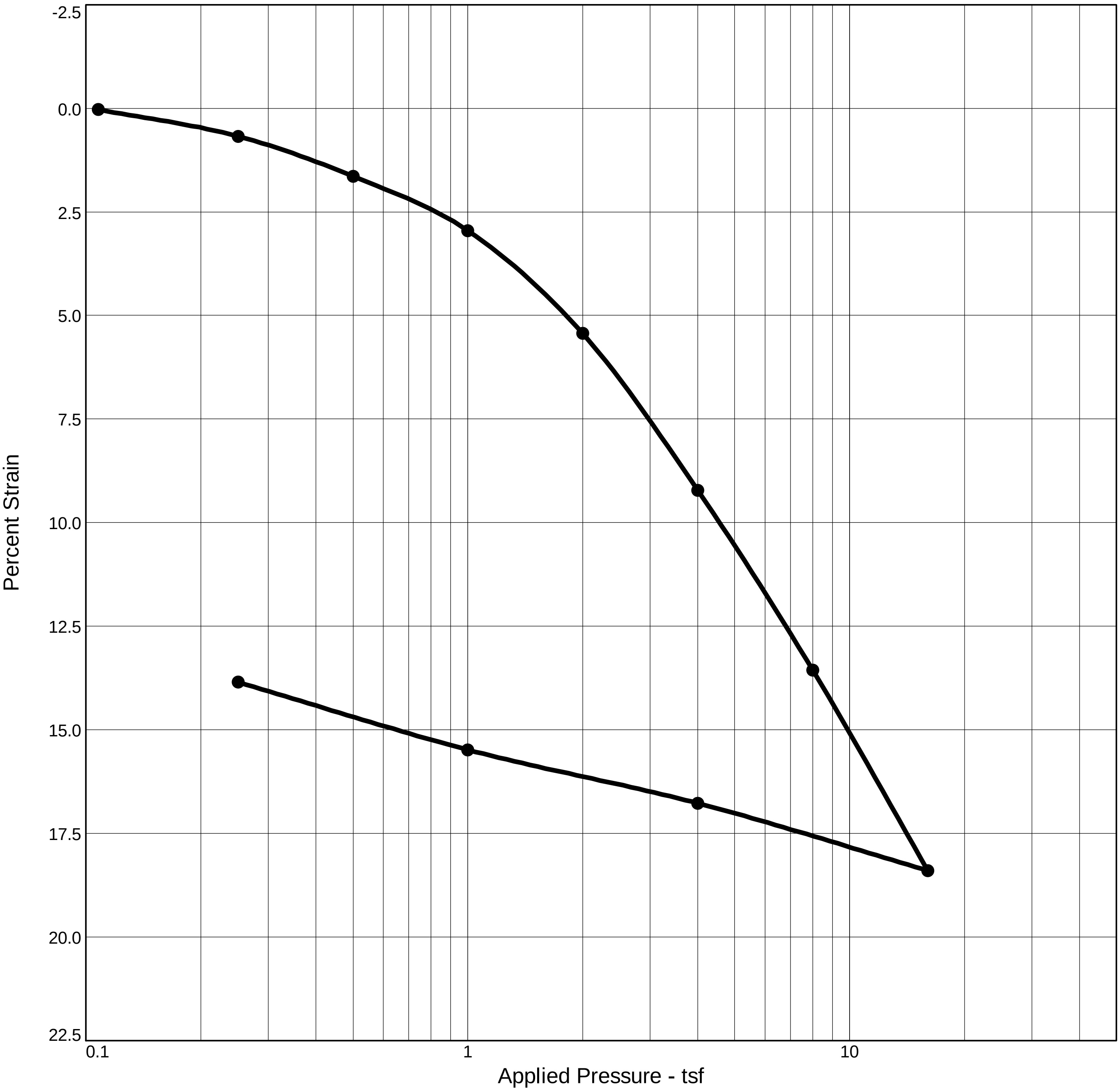
Terracon
51 Lost Mound Dr, Ste 135
Chattanooga, TN

PROJECT NUMBER: E2175151

CLIENT: CDM Smith Inc.
Knoxville, TN

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. UNCONFINED E2175151 DUPONT ADDITIONAL.GPJ TERRACON_DATATEMPLATE.GDT 9/28/18

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
87.4 %	29.4 %	89.3	X	X	2.7	1.07	2.4	0.31	0.04	0.908

MATERIAL DESCRIPTION	USCS	AASHTO
blue-gray sandy clay	X	X

Project No. E2175151 **Client:** CDM Smith, Inc

Project: DuPont Additional Borings

Source of Sample: B-104 **Depth:** 22.0-24.0 ft **Sample Number:** N/A

Terracon Consultants, Inc.

Chattanooga, TN

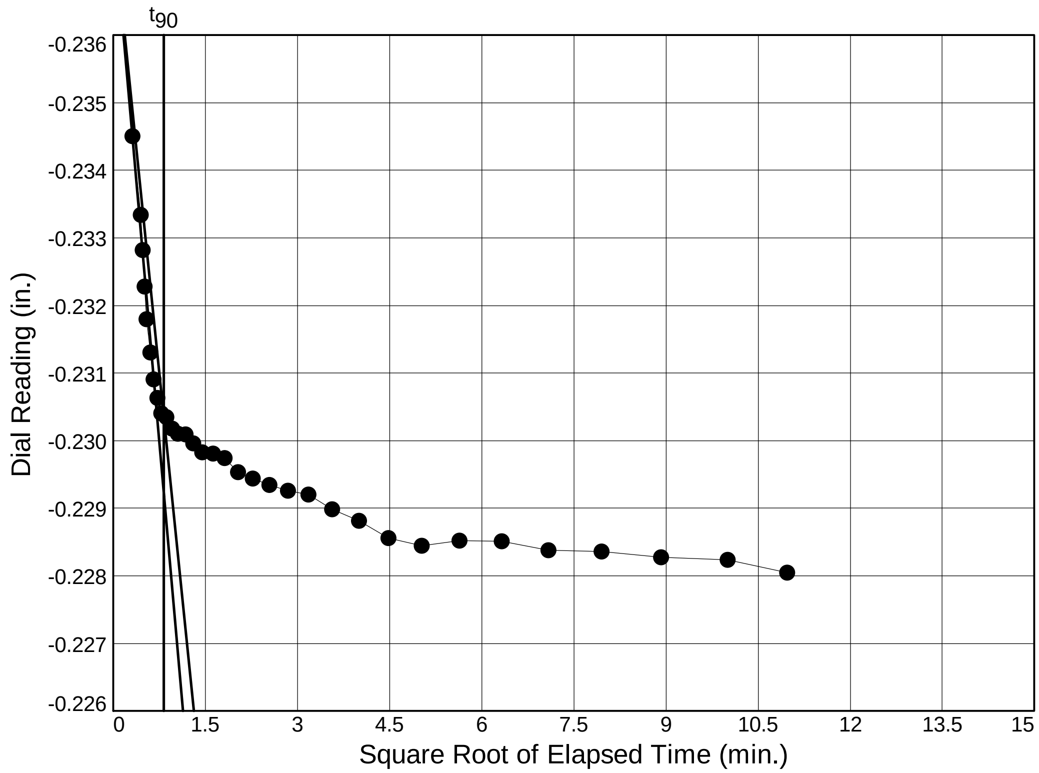
Remarks:

Swell pressure of 215.32 psf.

Dial Reading vs. Time

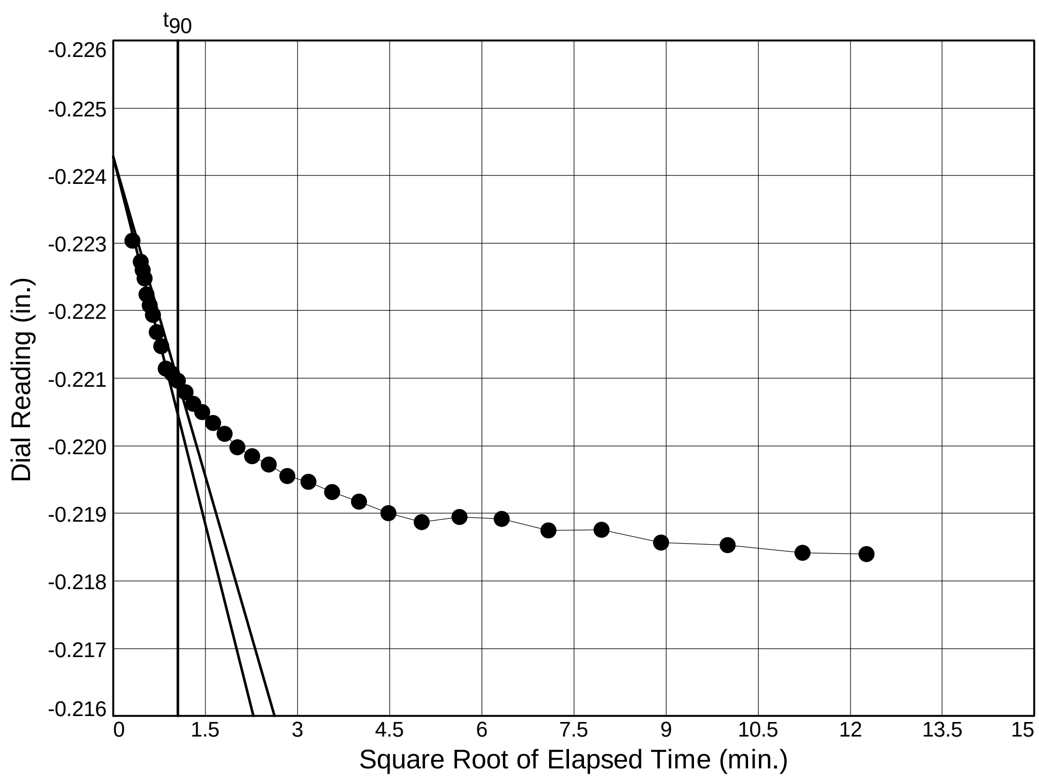
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 22.0-24.0 ft Sample Number: N/A



Load No.= 2
Load= 0.25 tsf
D_0 = -0.2377
D_{90} = -0.2304
D_{100} = -0.2296
T_{90} = 0.67 min.

C_v @ T_{90}
3.122 ft.^{2}/day



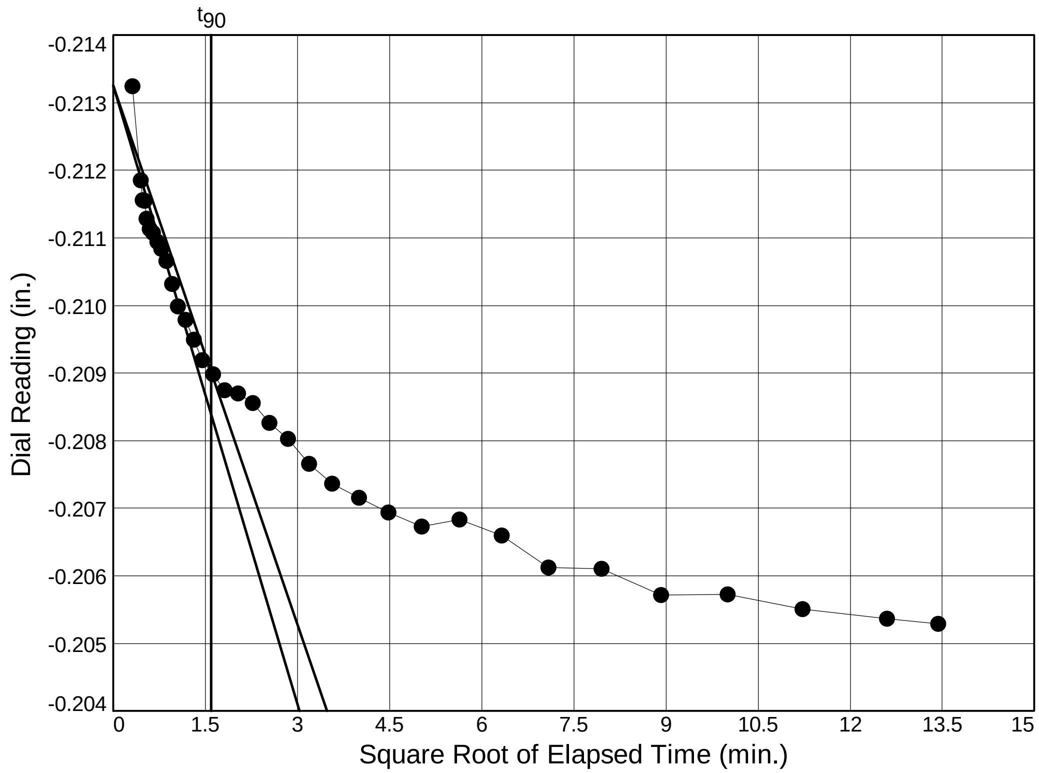
Load No.= 3
Load= 0.50 tsf
D_0 = -0.2243
D_{90} = -0.2210
D_{100} = -0.2206
T_{90} = 1.10 min.

C_v @ T_{90}
1.881 ft.^{2}/day

Dial Reading vs. Time

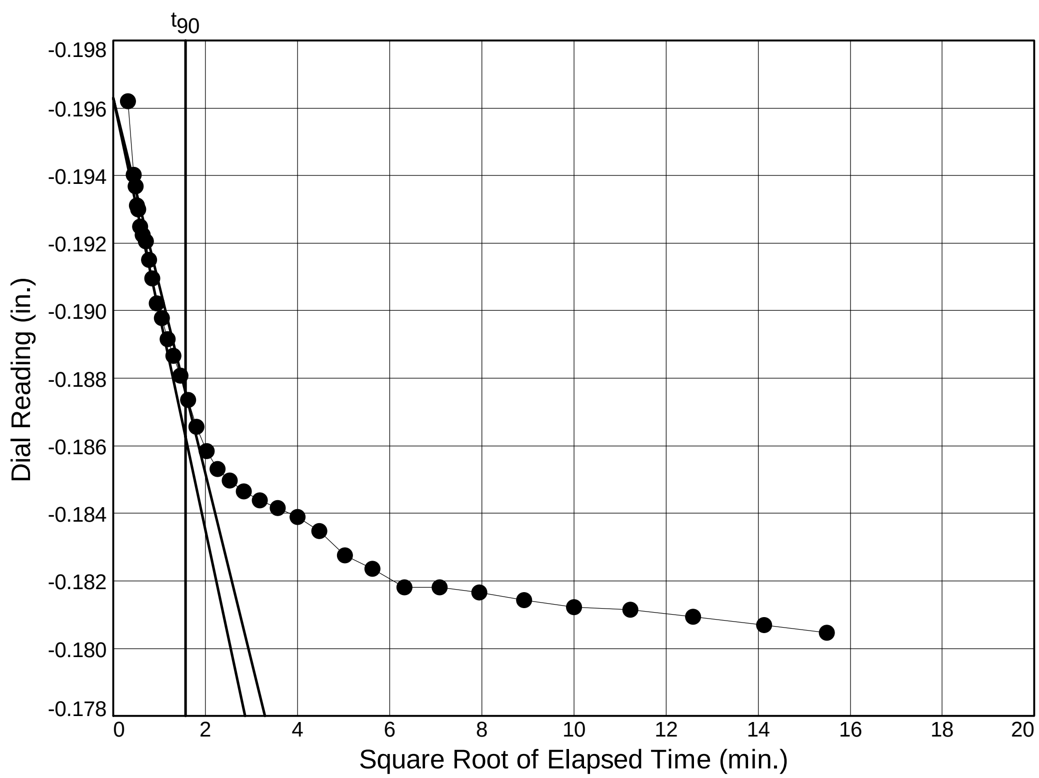
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 22.0-24.0 ft Sample Number: N/A



Load No.= 4
Load= 1.00 tsf
D_0 = -0.2132
D_{90} = -0.2090
D_{100} = -0.2085
T_{90} = 2.55 min.

C_v @ T_{90}
0.792 ft.^{2}/day



Load No.= 5
Load= 2.00 tsf
D_0 = -0.1963
D_{90} = -0.1876
D_{100} = -0.1866
T_{90} = 2.46 min.

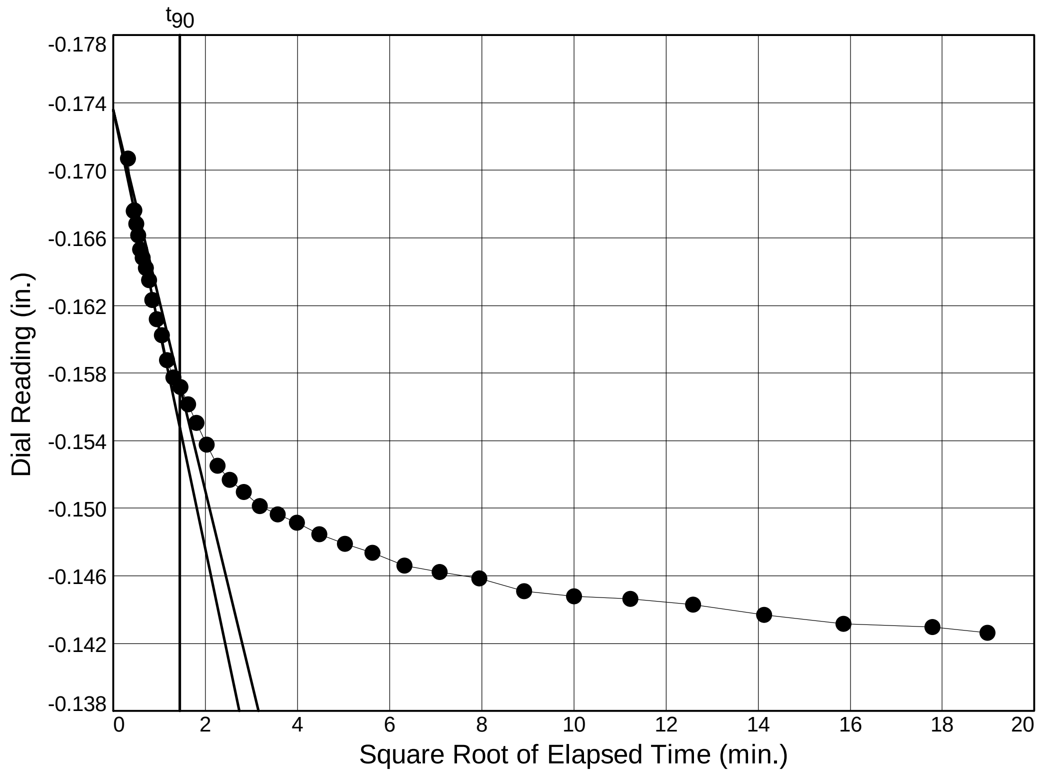
C_v @ T_{90}
0.791 ft.^{2}/day

Terracon Consultants, Inc.

Dial Reading vs. Time

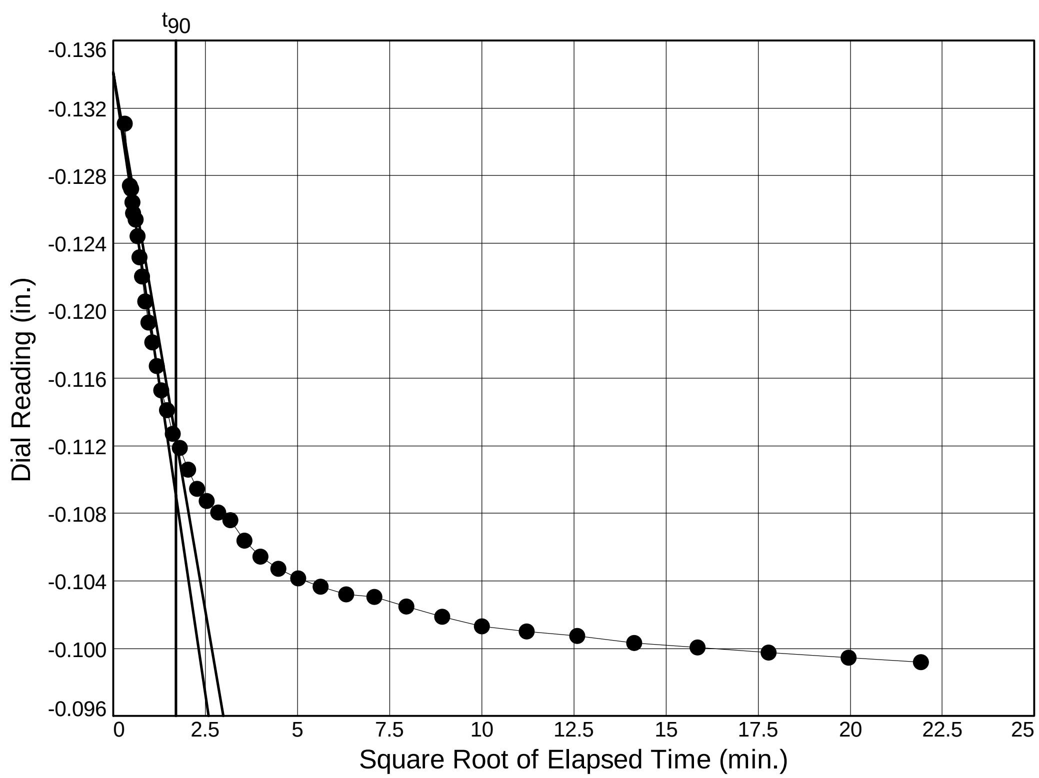
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 22.0-24.0 ft Sample Number: N/A



Load No.= 6
Load= 4.00 tsf
D_0 = -0.1736
D_{90} = -0.1572
D_{100} = -0.1554
T_{90} = 2.11 min.

C_v @ T_{90}
0.863 ft.^{2}/day



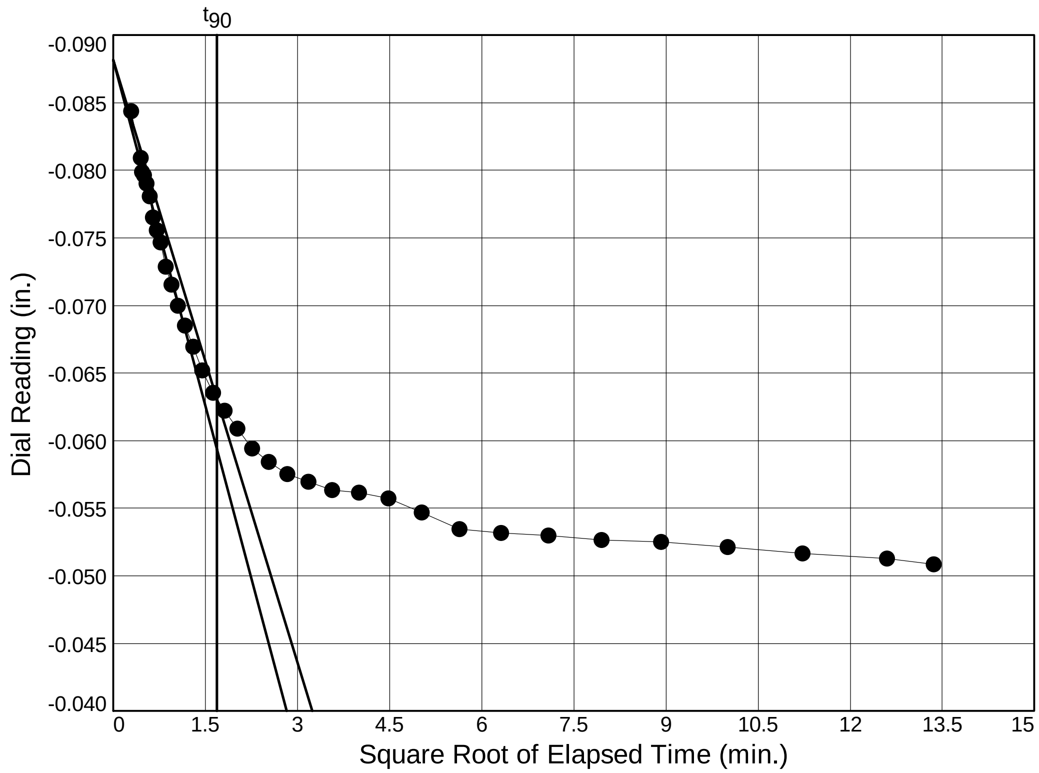
Load No.= 7
Load= 8.00 tsf
D_0 = -0.1341
D_{90} = -0.1123
D_{100} = -0.1099
T_{90} = 2.91 min.

C_v @ T_{90}
0.572 ft.^{2}/day

Dial Reading vs. Time

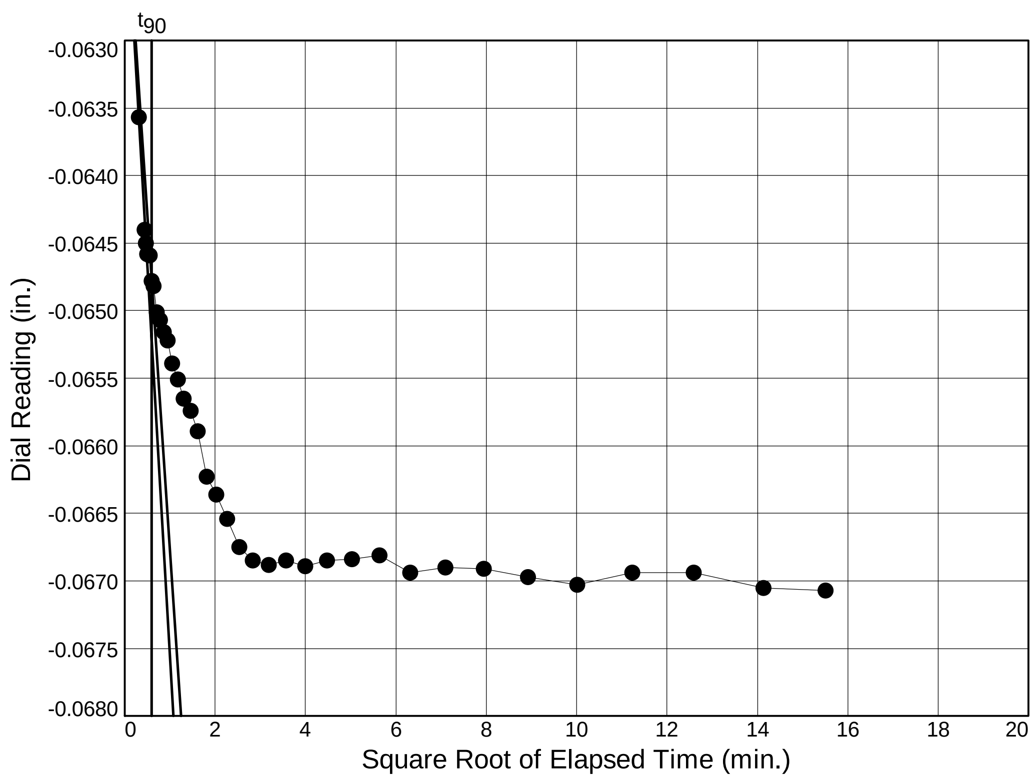
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 22.0-24.0 ft Sample Number: N/A



Load No.= 8
Load= 16.00 tsf
D_0 = -0.0882
D_{90} = -0.0630
D_{100} = -0.0603
T_{90} = 2.86 min.

C_v @ T_{90}
0.523 ft.^{2}/day



Load No.= 9
Load= 4.00 tsf
D_0 = -0.0618
D_{90} = -0.0648
D_{100} = -0.0651
T_{90} = 0.36 min.

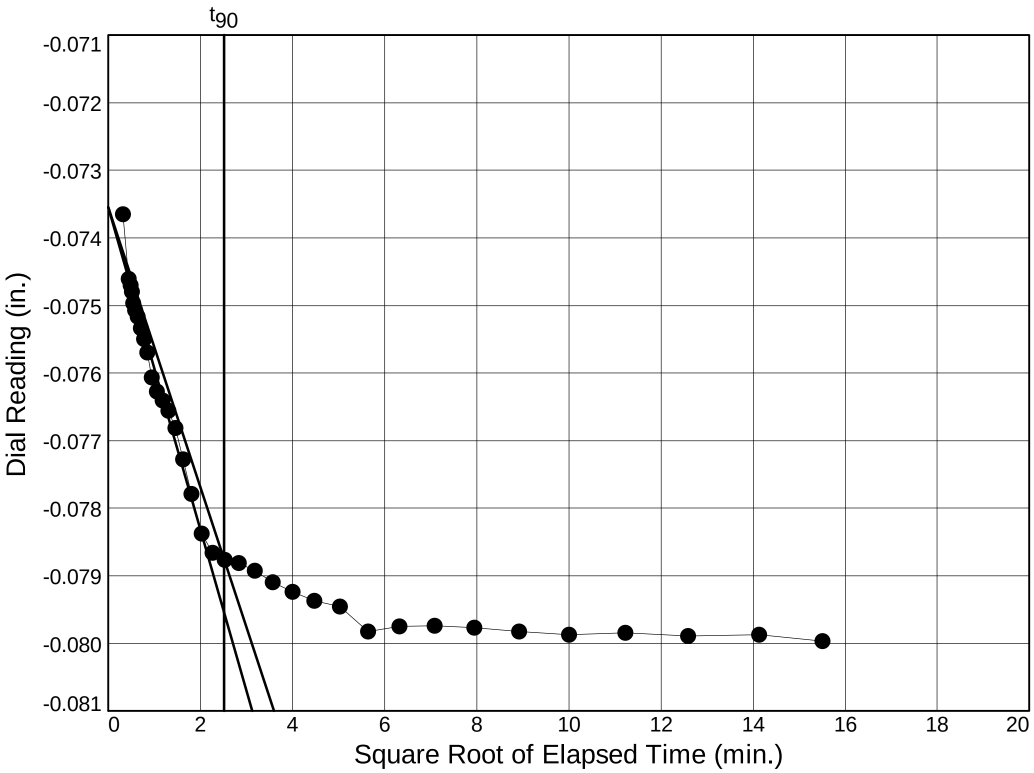
C_v @ T_{90}
3.978 ft.^{2}/day

Terracon Consultants, Inc.

Dial Reading vs. Time

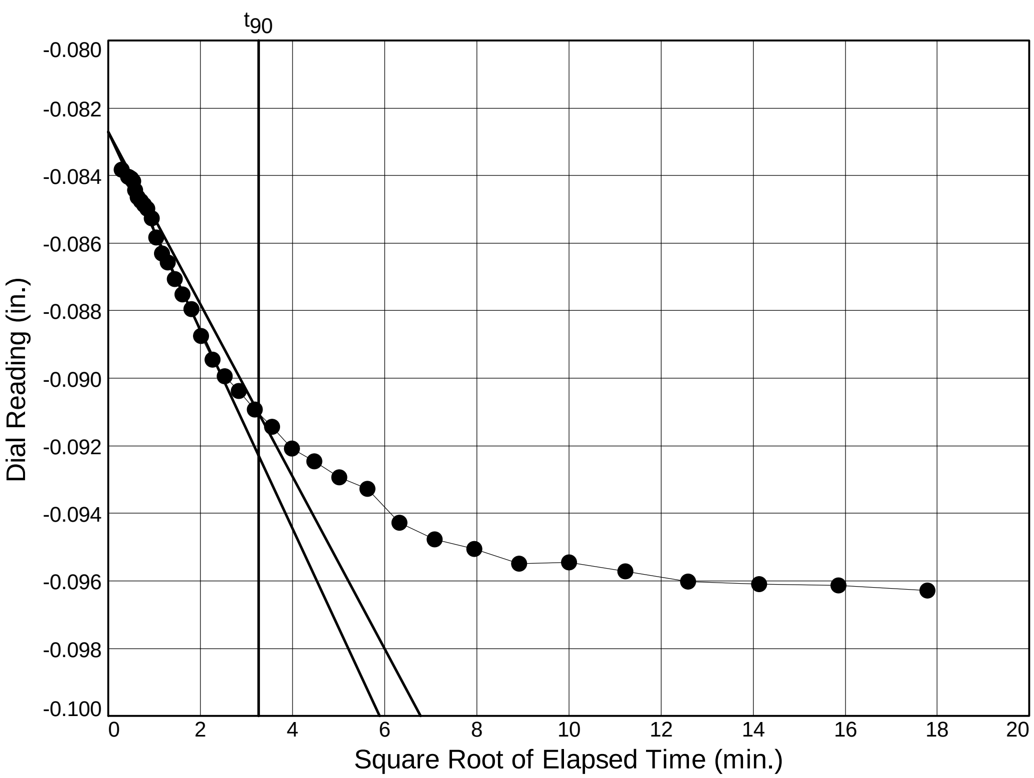
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 22.0-24.0 ft Sample Number: N/A



Load No.= 10
Load= 1.00 tsf
D_0 = -0.0736
D_{90} = -0.0788
D_{100} = -0.0793
T_{90} = 6.32 min.

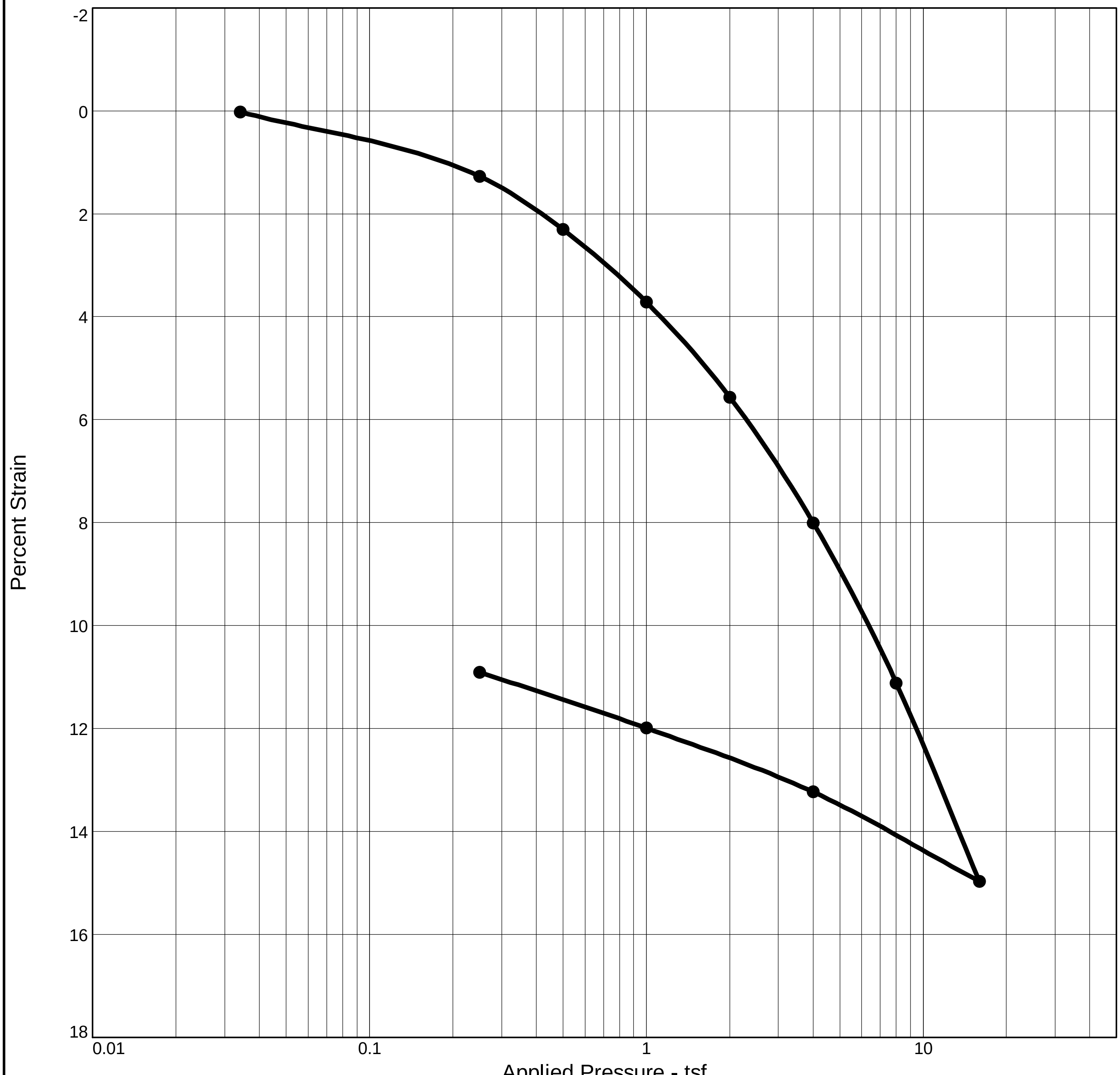
C_v @ T_{90}
0.236 ft.^{2}/day



Load No.= 11
Load= 0.25 tsf
D_0 = -0.0827
D_{90} = -0.0910
D_{100} = -0.0920
T_{90} = 10.66 min.

C_v @ T_{90}
0.145 ft.^{2}/day

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P_c (tsf)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
90.0 %	26.2 %	95.9	33	11	2.7	1.05	3.0	0.23	0.04	0.784

MATERIAL DESCRIPTION	USCS	AASHTO
lean clay with sand (CL)	CL	A-6(6)

Project No. E2175151 **Client:** CDM Smith, Inc

Project: DuPont Additional Borings

Source of Sample: B-104 **Depth:** 20.0-22.0 ft **Sample Number:** N/A

Terracon Consultants, Inc.

Chattanooga, TN

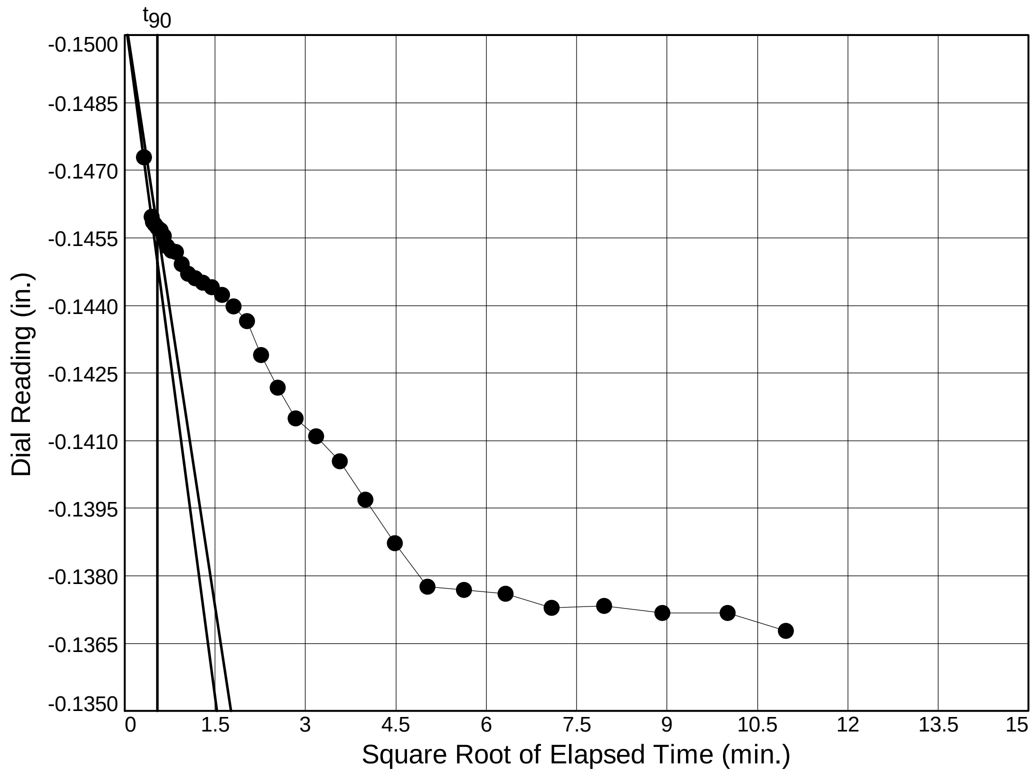
Remarks:

Swell pressure of 68.24 psf

Dial Reading vs. Time

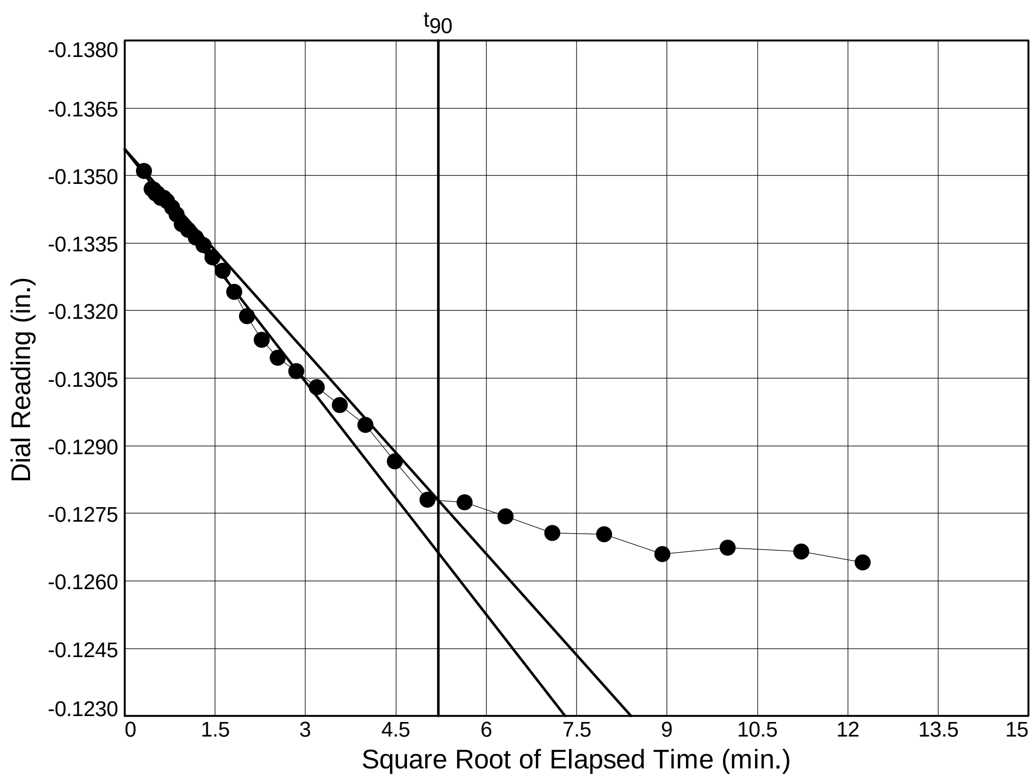
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 20.0-22.0 ft Sample Number: N/A



Load No.= 2
Load= 0.25 tsf
D_0 = -0.1505
D_{90} = -0.1457
D_{100} = -0.1452
T_{90} = 0.29 min.

C_v @ T_{90}
7.162 ft.^{2}/day



Load No.= 3
Load= 0.50 tsf
D_0 = -0.1356
D_{90} = -0.1278
D_{100} = -0.1269
T_{90} = 27.07 min.

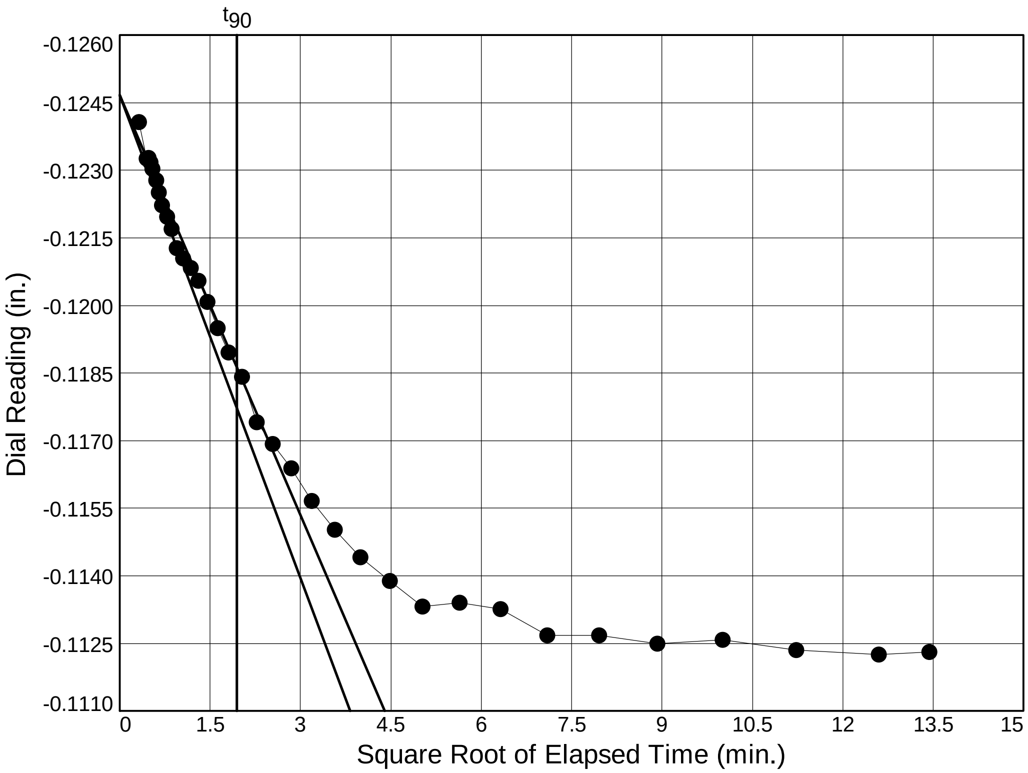
C_v @ T_{90}
0.076 ft.^{2}/day

Terracon Consultants, Inc.

Dial Reading vs. Time

Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 20.0-22.0 ft Sample Number: N/A



Load No.= 4

Load= 1.00 tsf

D_0 = -0.1247

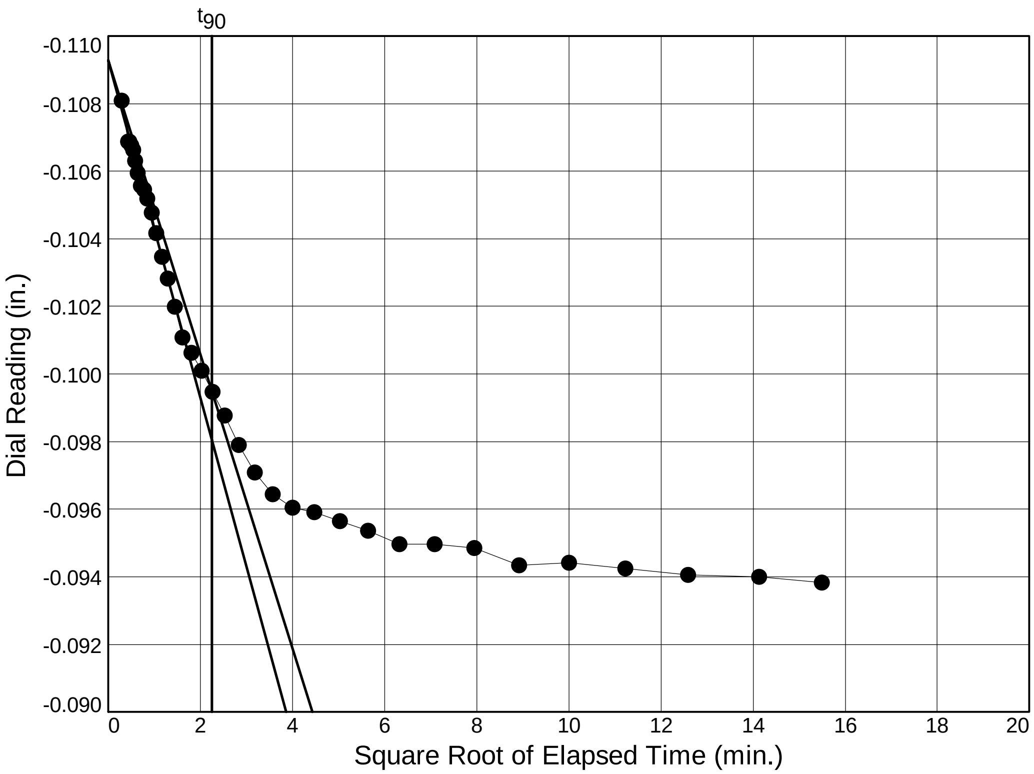
D_{90} = -0.1186

D_{100} = -0.1179

T_{90} = 3.79 min.

C_v @ T_{90}

0.526 ft.^{2}/day



Load No.= 5

Load= 2.00 tsf

D_0 = -0.1093

D_{90} = -0.0995

D_{100} = -0.0984

T_{90} = 5.07 min.

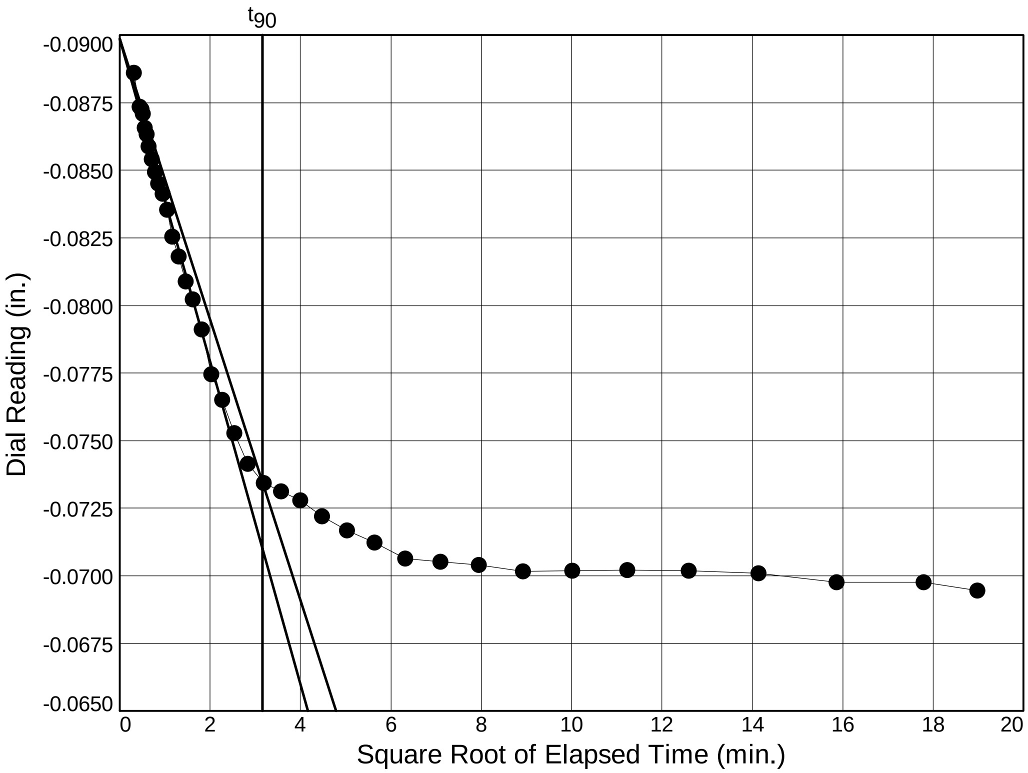
C_v @ T_{90}

0.380 ft.^{2}/day

Dial Reading vs. Time

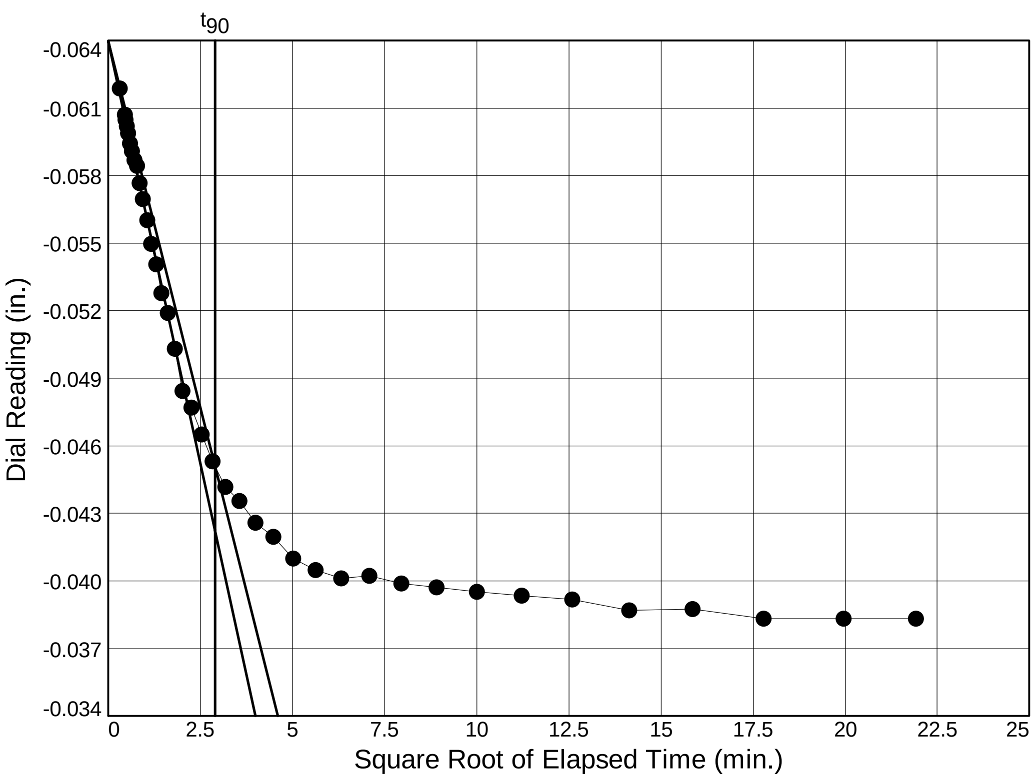
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 20.0-22.0 ft Sample Number: N/A



Load No.= 6
Load= 4.00 tsf
D_0 = -0.0899
D_{90} = -0.0735
D_{100} = -0.0717
T_{90} = 9.95 min.

C_v @ T_{90}
0.185 ft.^{2}/day



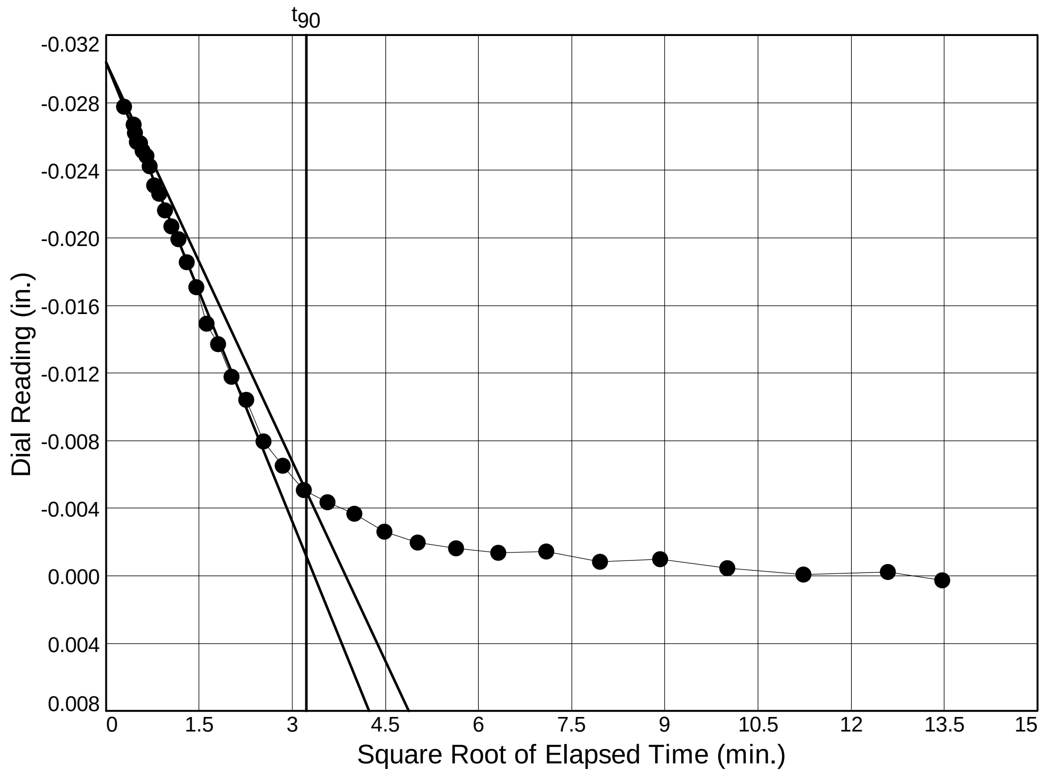
Load No.= 7
Load= 8.00 tsf
D_0 = -0.0640
D_{90} = -0.0451
D_{100} = -0.0430
T_{90} = 8.40 min.

C_v @ T_{90}
0.206 ft.^{2}/day

Dial Reading vs. Time

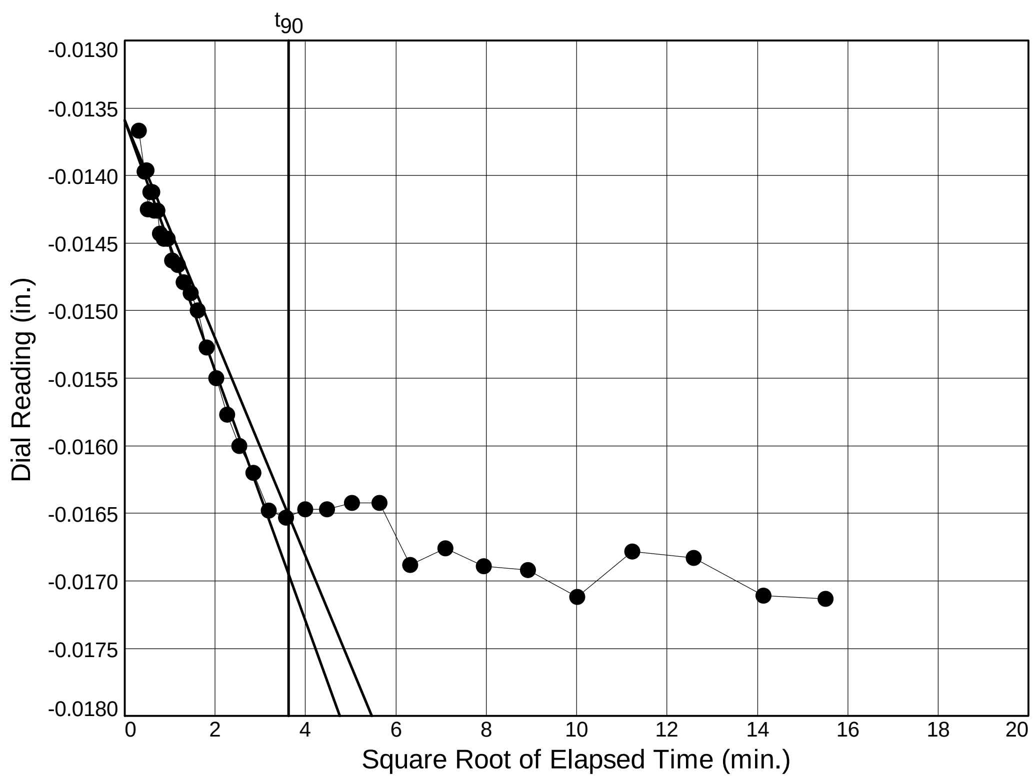
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 20.0-22.0 ft Sample Number: N/A



Load No.= 8
Load= 16.00 tsf
D_0 = -0.0304
D_{90} = -0.0050
D_{100} = -0.0022
T_{90} = 10.39 min.

C_v @ T_{90}
0.154 ft.^{2}/day



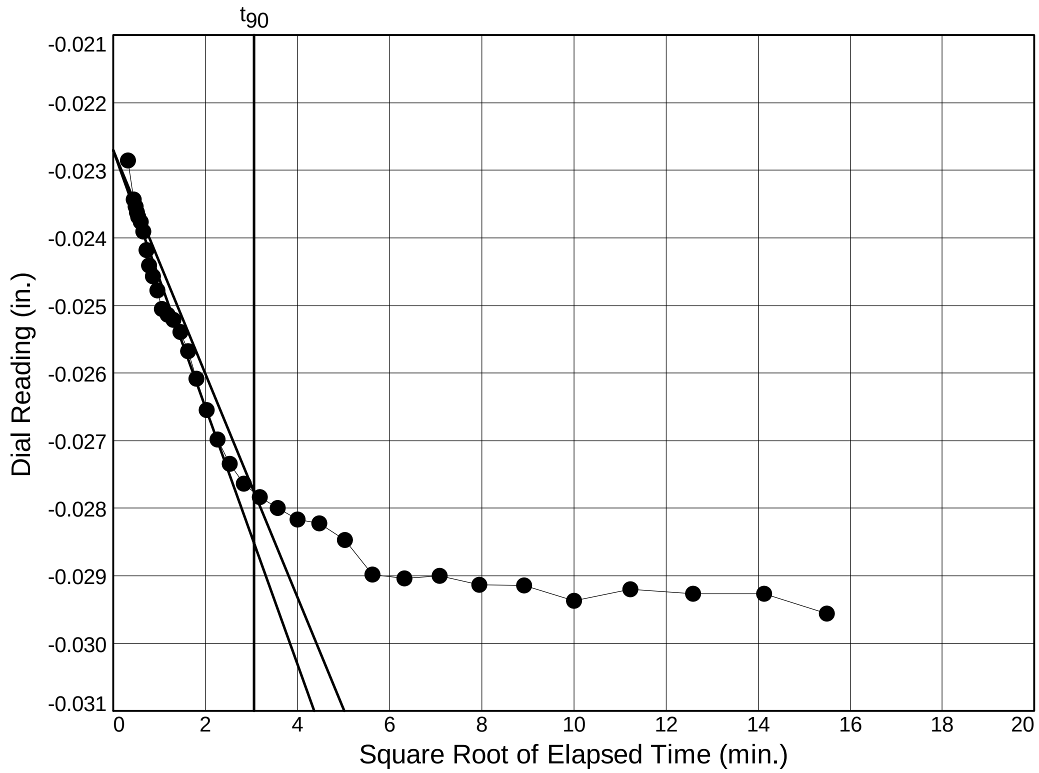
Load No.= 9
Load= 4.00 tsf
D_0 = -0.0136
D_{90} = -0.0165
D_{100} = -0.0168
T_{90} = 13.20 min.

C_v @ T_{90}
0.118 ft.^{2}/day

Dial Reading vs. Time

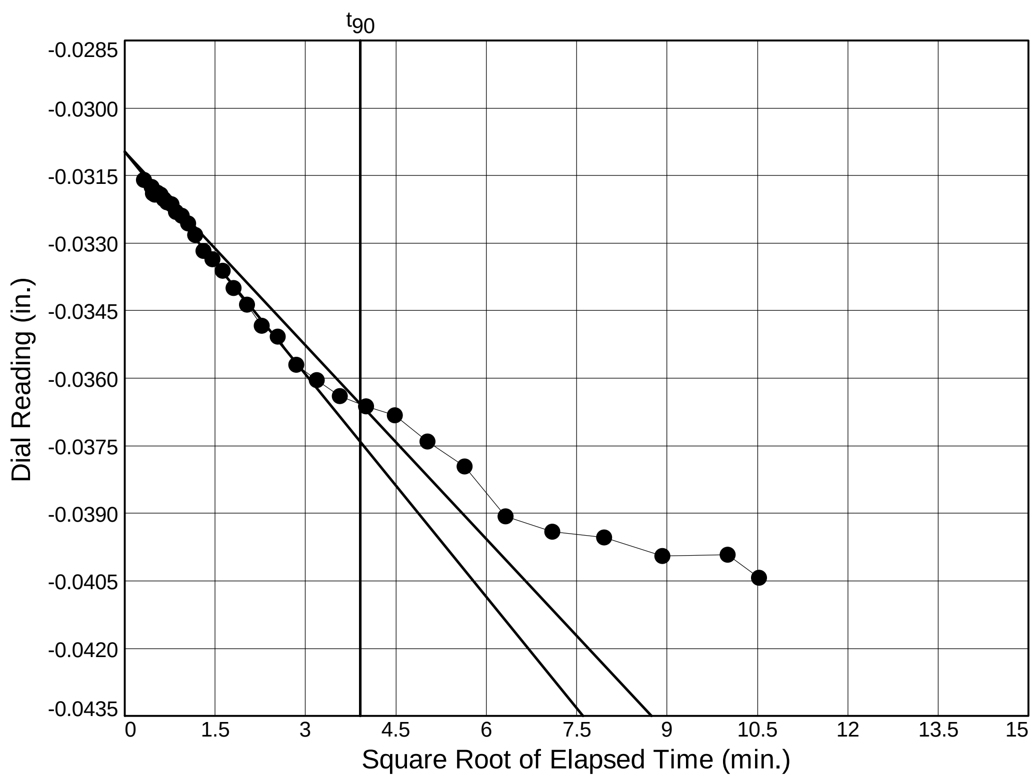
Project No.: E2175151
Project: DuPont Additional Borings

Source of Sample: B-104 Depth: 20.0-22.0 ft Sample Number: N/A



Load No.= 10
Load= 1.00 tsf
D_0 = -0.0227
D_{90} = -0.0278
D_{100} = -0.0283
T_{90} = 9.38 min.

C_v @ T_{90}
0.173 $ft.^2$/day



Load No.= 11
Load= 0.25 tsf
D_0 = -0.0310
D_{90} = -0.0366
D_{100} = -0.0372
T_{90} = 15.30 min.

C_v @ T_{90}
0.109 $ft.^2$/day

Terracon
51 Lost Mound Dr. Suite 135
Chattanooga, TN 37406
423-499-6111

Report of Compressive Strength of Rock Core Specimens

Project: DuPont Additional Borings **Date:** 8/31/2018

Project No.: E2175151

Specimen ID	Wet PCF	% Moisture	Dry PCF	Total Load (lbs)	Correction Factor	Compressive Strength (lbs./in.^{2})
B-101	145.0	0.0	145.0	55,700	1.000	18,200
B-104	156.0	0.0	156.0	57,860	1.000	18,925
B-108	160.7	0.0	160.7	55,690	1.000	18,105

Remarks:

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : DuPont Additional Borings

Date: 9/4/2018 — Panel Number : P-1

Project No. : E2175151 — Permometer Data

Boring No.:	B-101	a_p =	0.031416 cm^2	Set Mercury to Pipet Rp at beginning		Equilibrium	1.6 cm^3
Sample:	N/A	a_a =	0.767120 cm^2			Pipet **Rp**	**12.3** cm^3
Depth (ft):	36.1-41.1	M_1 =	0.030180	C =	0.000612	Annulus **Ra**	1.2 cm^3
Other Location:	N/A	M_2 =	1.040953	T =	0.0931418		

Material Description : Rock Core

SAMPLE DATA

Wet Wt. sample + ring or tare :			266.71	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			266.71	g
Diameter :	1.97	in	5.01	cm^2
Length :	1.98	in	5.03	cm
Area:	3.05	in^2	19.68	cm^2
Volume :	6.04	in^3	99.00	cm^3
Unit Wt.(wet):	**168.11**	pcf	**2.69**	g/cm^3
Unit Wt.(dry):	**168.11**	pcf	**2.69**	g/cm^3

	Before Test		After Test
Tare No.:	X	Tare No.:	
Wet Wt.+tare:	1.00	Wet Wt.+tare:	
Dry Wt.+tare:	1.00	Dry Wt.+tare:	
Tare Wt:	0.00	Tare Wt:	
Dry Wt.:	1	Dry Wt.:	
Water Wt.:	0	Water Wt.:	
% moist.:	**0.0**	% moist.:	

Assumed Specific Gravity: **2.70** Max Dry Density(pcf) = ______ OMC = ______

% of max = ______ +/- OMC = ______

Calculated % saturation: ______ Void ratio (e) = ______ Porosity (n)= ______

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 11.2 cm Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
9/4/2018	600	12.25	0.086314	21	0.977	8.04E-09	2.28E-05	
9/4/2018	1200	12.2	0.136314	21	0.977	6.36E-09	1.80E-05	
9/4/2018	1800	12.15	0.186314	21	0.977	5.81E-09	1.65E-05	
9/4/2018	2400	12.1	0.236314	21	0.977	5.54E-09	1.57E-05	

SUMMARY

ka = 6.44E-09 cm/sec Acceptance criteria = 95 %

ki			Vm	
k1 =	8.04E-09	cm/sec	24.9	%
k2 =	6.36E-09	cm/sec	1.2	%
k3 =	5.81E-09	cm/sec	9.7	%
k4 =	5.54E-09	cm/sec	13.9	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**6.44E-09**	cm/sec	**1.83E-05**	ft/day
Void Ratio	e =				
Porosity	n =				
Bulk Density	g =	**2.69**	g/cm^3	**168.1**	pcf
Water Content	W =	**0.00**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**6.60E-14**	cm^2	(at 20 deg C)	

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : DuPont Additional Borings

Date: 9/4/2018 — Panel Number : P-1

Project No. : E2175151 — Permometer Data

Boring No.:	B-104	a_p =	0.031416 cm^2	Set Mercury to Pipet Rp at beginning	Equilibrium	1.6	cm^3
Sample:	N/A	a_a =	0.767120 cm^2		Pipet **Rp**	**12.5**	cm^3
Depth (ft):	28.2-30.0	M_1 =	0.030180	C = 0.00062	Annulus **Ra**	1.2	cm^3
Other Location:	N/A	M_2 =	1.040953	T = 0.0919346			

Material Description : Rock Core

SAMPLE DATA

Wet Wt. sample + ring or tare :			273.13	g				
Tare or ring Wt. :			0.0	g		Before Test		After Test
Wet Wt: of Sample :			273.13	g	Tare No.:	X	Tare No.:	
Diameter :	1.97	in	5.01	cm^2	Wet Wt.+tare:	1.00	Wet Wt.+tare:	
Length :	2.01	in	5.10	cm	Dry Wt.+tare:	1.00	Dry Wt.+tare:	
Area:	3.05	in^2	19.68	cm^2	Tare Wt:	0.00	Tare Wt:	
Volume :	6.12	in^3	100.30	cm^3	Dry Wt.:	1	Dry Wt.:	
Unit Wt.(wet):	**169.93**	pcf	**2.72**	g/cm^3	Water Wt.:	0	Water Wt.:	
Unit Wt.(dry):	**169.93**	pcf	**2.72**	g/cm^3	% moist.:	**0.0**	% moist.:	

Assumed Specific Gravity: **2.70** — Max Dry Density(pcf) = ____ — OMC = ____

% of max = ____ — +/- OMC = ____

Calculated % saturation: ____ — Void ratio (e) = ____ — Porosity (n)= ____

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 — Back Pressure (psi) = 50.00 — Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 11.3 cm — Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)
9/4/2018	600	12.35	0.127296	21	0.977	1.19E-08	3.37E-05
9/4/2018	1200	12.3	0.177296	21	0.977	8.29E-09	2.35E-05
9/4/2018	1800	12.25	0.227296	21	0.977	7.10E-09	2.01E-05
9/4/2018	2400	12.2	0.277296	21	0.977	6.52E-09	1.85E-05

Reset = *

SUMMARY

ka = 8.45E-09 cm/sec — Acceptance criteria = 95 %

ki			Vm	
k1 =	1.19E-08	cm/sec	40.6	%
k2 =	8.29E-09	cm/sec	1.8	%
k3 =	7.10E-09	cm/sec	15.9	%
k4 =	6.52E-09	cm/sec	22.9	%

$$Vm = \frac{|ka - ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**8.45E-09**	cm/sec	**2.39E-05**	ft/day
Void Ratio	e =				
Porosity	n =				
Bulk Density	g =	**2.72**	g/cm^3	**169.9**	pcf
Water Content	W =	**0.00**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**8.66E-14**	cm^2	(at 20 deg C)	

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : DuPont Additional Borings

Date: 9/4/2018 Panel Number : P-1

Project No. : E2175151

Permometer Data

Boring No.:	B-108	a_p =	0.031416 cm^2			Set Mercury to Pipet Rp at beginning	Equilibrium	1.6	cm^3
Sample:	N/A	a_a =	0.767120 cm^2				Pipet **Rp**	**12.4**	cm^3
Depth (ft):	33.6-39.6	M_1 =	0.030180	C =	0.0006129		Annulus **Ra**	1.2	cm^3
Other Location:	N/A	M_2 =	1.040953	T =	0.0930009				

Material Description : Rock Core

SAMPLE DATA

Wet Wt. sample + ring or tare :			267.89	g				
Tare or ring Wt. :			0.0	g	Before Test		After Test	
Wet Wt: of Sample :			267.89	g	Tare No.:	X	Tare No.:	
Diameter :	1.97	in	5.01	cm^2	Wet Wt.+tare:	1.00	Wet Wt.+tare:	
Length :	1.98	in	5.04	cm	Dry Wt.+tare:	1.00	Dry Wt.+tare:	
Area:	3.05	in^2	19.68	cm^2	Tare Wt:	0.00	Tare Wt:	
Volume :	6.05	in^3	99.15	cm^3	Dry Wt.:	1	Dry Wt.:	
Unit Wt.(wet):	**168.60**	pcf	**2.70**	g/cm^3	Water Wt.:	0	Water Wt.:	
Unit Wt.(dry):	**168.60**	pcf	**2.70**	g/cm^3	% moist.:	**0.0**	% moist.:	

Assumed Specific Gravity: **2.70** Max Dry Density(pcf) = ______ OMC = ______

% of max = ______ +/- OMC = ______

Calculated % saturation: ______ Void ratio (e) = ______ Porosity (n)= ______

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 11.2 cm Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)
9/4/2018	600	12.35	0.002581	21	0.977	2.40E-10	6.79E-07
9/4/2018	1200	12.3	0.052581	21	0.977	2.45E-09	6.93E-06
9/4/2018	1800	12.25	0.102581	21	0.977	3.19E-09	9.04E-06
9/4/2018	2400	12.2	0.152581	21	0.977	3.56E-09	1.01E-05

Reset = *

SUMMARY

ka = 2.36E-09 cm/sec Acceptance criteria = 95 %

ki			Vm	
k1 =	2.40E-10	cm/sec	89.8	%
k2 =	2.45E-09	cm/sec	3.6	%
k3 =	3.19E-09	cm/sec	35.1	%
k4 =	3.56E-09	cm/sec	51.1	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**2.36E-09**	cm/sec	**6.69E-06**	ft/day
Void Ratio	e =				
Porosity	n =				
Bulk Density	g =	**2.70**	g/cm^3	**168.6**	pcf
Water Content	W =	**0.00**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**2.42E-14**	cm^2	(at 20 deg C)	

SUPPORTING INFORMATION

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

DuPont Additional Borings ■ Chattanooga, Tennessee
October 26, 2018 ■ Terracon Project No. E2175151

Terracon GeoReport

SAMPLING

Rock Core

Shelby Tube

Standard Penetration Test

WATER LEVEL

Water Initially Encountered

Water Level After a Specified Period of Time

Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

N	**Standard Penetration Test Resistance (Blows/Ft.)**
(HP)	**Hand Penetrometer**
(T)	**Torvane**
(DCP)	**Dynamic Cone Penetrometer**
UC	**Unconfined Compressive Strength**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (tsf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium Stiff	0.50 to 1.00	4 - 8
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 15
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	> 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL		**RELATIVE PROPORTIONS OF FINES**	
Descriptive Term(s) of other constituents	Percent of Dry Weight	**Descriptive Term(s) of other constituents**	**Percent of Dry Weight**
Trace	<15	Trace	<5
With	15-29	With	5-12
Modifier	>30	Modifier	>12

GRAIN SIZE TERMINOLOGY		**PLASTICITY DESCRIPTION**	
Major Component of Sample	**Particle Size**	**Term**	**Plasticity Index**
Boulders	Over 12 in. (300 mm)	Non-plastic	0
Cobbles	12 in. to 3 in. (300mm to 75mm)	Low	1 - 10
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)	Medium	11 - 30
Sand	#4 to #200 sieve (4.75mm to 0.075mm	High	> 30
Silt or Clay	Passing #200 sieve (0.075mm)		

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ³ 4 and 1 £ Cc £ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ³ 6 and 1 £ Cc £ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A"	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ³ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ³ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ³ 30% plus No. 200 predominantly sand, add "sandy" to group name.

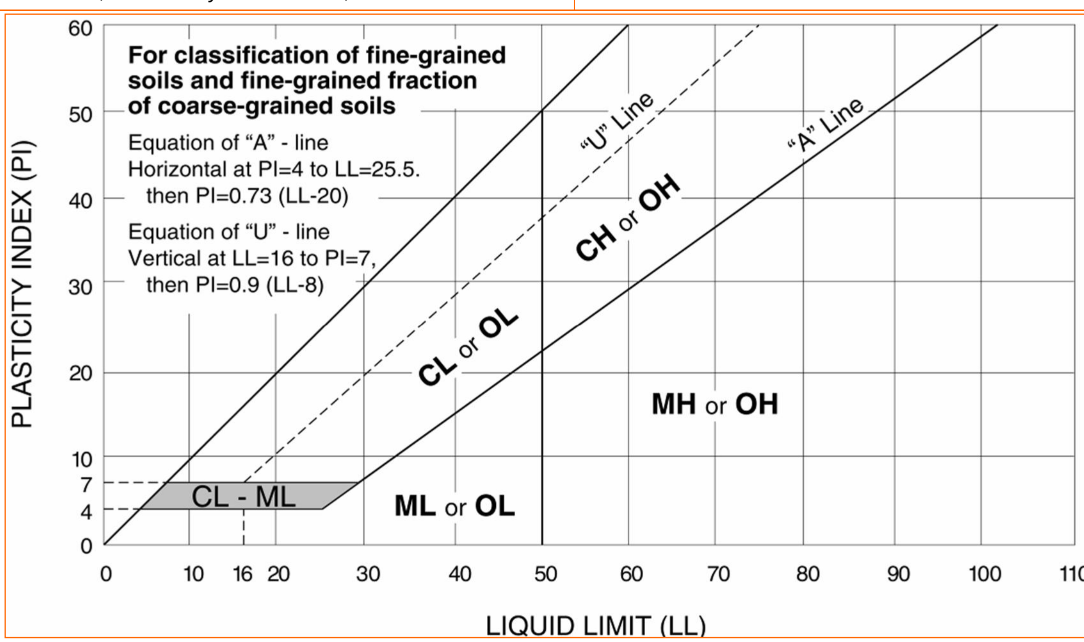
[M] If soil contains ³ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ³ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

DuPont Gravity Sewer and Pump Station ■ Chattanooga, Tennessee

October 26, 2018 ■ Terracon Project No. E2175151

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements

Appendix B

Report for Geophysical Services

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October 12, 2018

CDM Smith
4600 Park Rd #240
Charlotte, North Carolina 28209

Attention: Mr. Erdem Onur Tastan, Ph.D., P.E.

Reference: **Report for Geophysical Services**
DuPont Pump Station and Basin Improvements Phase 2
Chattanooga, Tennessee
S&ME Project No. 1281-18-061

Dear Mr. Tastan:

S&ME, Inc. (S&ME) has performed geophysical services at the above referenced site located in Chattanooga, Tennessee. These services were performed in general accordance with S&ME Proposal No. 121800346 dated August 15, 2018.

♦ Project Information

CDM Smith is performing consulting services for a proposed new pump station facility within the existing boat ramp area located on Dixie Drive in Chattanooga, Tennessee (**Figure 1**). During the test boring program conducted by CDM Smith for the proposed facility, an approximate 11-foot vertical void was encountered in one of the borings (B-108). Depth to the top of rock at B-108 is about 33 feet below ground surface (bgs) with the encountered top of the void at about 45 feet bgs. The water table is just above the soil/rock interface, so the void is anticipated to be water-filled. The site is mostly covered by asphalt pavement with two sewer utilities (30 inch and 36 inches in diameter) running east-west across the site at about 5 feet bgs and electrical lines for the existing light poles. CDM Smith requested S&ME provide geophysical services within the areas of the proposed facility in an effort to identify potential karst features such as voids, bedrock joints/fractures, etc.

♦ Methodology and Field Services

On October 3 and 4, 2018, S&ME completed an Electrical Resistivity Tomography (ERT) survey within the accessible portions of the site. ERT is an active geophysical technique that involves the introduction of a known amount of current into the ground and measuring the response in order to identify variations in subsurface electrical potentials. By introducing a known amount of current into the ground, the measured voltage potential at the surface is used to calculate the resistivity of a particular volume of subsurface media.

In general, clayey and moist soils result in lower resistivity (higher conductivity) readings, while dry sands, gravels, chert, and competent limestone/dolomite exhibit higher resistivity values. The resistivity of materials also partially depends on the substance filling its pore or void space. If a cavity or fracture is air-filled, a highly resistive anomaly within the limestone/dolomite unit is expected. If it is water- or clay-filled, an anomaly more conductive than the surrounding limestone/dolomite unit is expected. Natural variations in porosity and grain size distribution can also cause such anomalies. It is important to note that actual ground resistivity is not collected during a resistivity survey. The survey is used to collect the apparent resistivity of a volume of material that is dependent upon electrode spacing. Actual resistivities are later determined through a data inversion process.

The ERT method requires that a series of small current and potential stainless-steel electrodes be inserted into the ground and data collected using various array configurations (Dipole-Dipole, Wenner, etc.). The electrodes are connected to a transmitter/recording instrument (resistivity meter) that generates the induced current and stores the resulting measurements for later processing and analysis. The configuration of the collected data (array) is dependent on the objectives of the investigation (e.g., vertical soil and bedrock profiling, cavity detection, fracture mapping, etc.). ERT measurements are acquired from the voltage potential difference measured between two electrodes and are dependent upon the distance between the electrodes. Material included between the electrodes is essentially averaged. Therefore, limitations of this method exist dependent upon the resolution of data acquisition needed versus the depth of a target.

We used an AGI SuperSting™ R8/IP resistivity system configured with 56 electrodes in general accordance with ASTM D6431-99 (2010) "*Using DC Resistivity for Subsurface Investigations*". A total of three ERT profiles at 275 feet in length were collected at the site using the Dipole-Dipole array configuration (**Figure 2**). Line locations were generally based site access and to avoid potential influence from the existing buried utilities. However, the beginnings of Lines 2 and 3 were slightly shortened due to shallow interference identified during data processing which may be related to the buried electrical lines. Electrodes for each profile were spaced at 5 feet. Due to the presence of asphalt pavements, 1/2 inch diameter holes were required at each electrode location in order for the electrodes to be inserted directly into the underlying soils. Each hole was backfilled with a flowable asphalt sealant at the end of the survey. The ERT data was processed using AGI's EarthImager 2D software and Golden Software's Surfer® was used to grid and plot the data. Elevations used for our models were based on provided plans and not actual field survey measurements performed by S&ME and should be considered approximate. ERT data profiles are presented in **Figure 2**.

♦ Results

The ERT results depicted in **Figure 2** indicate a varying resistivity contrast across the surveyed area that range from approximately 10 ohm-meters (ohm/m) to 200 ohm/m. Presented depths of the ERT profiles are at about 60 feet below ground surface (bgs).

- In general, the ERT profiles exhibit two layers (Layer 1 and 2). The upper Layer 1 is primarily characterized by conductive material less than about 50 ohm/m and the lower. Layer 2 generally consists of material greater than about 50 ohm/m with the interpreted upper surface about 5 to 15 feet bgs. Based on the provided borings, Layer 1 is related to the soil overburden and Layer 2 is related to limestone bedrock.
- Two anomalous subsurface features were also identified in the ERT data sets (Anomalies A and B).
- Anomaly A is characterized by a conductive area within the interpreted bedrock (Layer 2) and was identified along each of the three profiles. The east-west trending anomaly is consistent with possible water/clay-filled voids, joints, and/or fractures within the bedrock.
- Anomaly B appears to be generally characterized by a topographic low along the surface of the interpreted bedrock along Line 2. However, the interpreted bedrock within this feature also exhibits relatively lower resistivity values that may be related to water/clay-filled voids, joints, and/or fractures.

Limitations

The geophysical method used for this survey has inherent limitations. Buried site metallic features (e.g., utilities, etc.) and overhead transmission lines can produce excessive noise and/or false responses in ERT data. As such, ERT profile locations are generally positioned where possible influence is limited. Depth of exploration for an ERT survey is limited by the allowable length of the collected data profile. Limiting factors due to site constraints such as property boundaries, surficial obstructions, utilities, etc. can reduce profile lengths. Regardless of the thoroughness of a geophysical study, there is always a possibility that actual conditions may not match the interpretations. The results should be considered accurate only to the degree implied by the methods used and the method's limitations and data coverage. Accordingly, the possibility exists that not all features at a project site will be located due to either subsurface soil conditions or the occurrence of features outside the lateral limits and below the depth of penetration of the methods used. As with most surface geophysical methods, resolution of the subsurface will also decrease with depth. As such, the size and/or contrast of subsurface features compared to the imaged subsurface media must be significant enough to produce the anticipated response. The location and/or determination (or the lack thereof) of subsurface features was based on our review of provided information and of the geophysical survey. Under no circumstances will S&ME assume any responsibility for damages resulting from the presence of subsurface features that may exist but were not identified by our survey.

Closure

S&ME appreciates the opportunity to assist you during this phase of the project. If you should have any questions concerning this report or if we may be of further assistance, please contact us.

Sincerely,

S&ME, Inc.

Jason B. Cox, PG (GA)
Project Geophysicist

Kevin D. Hon, PG
Geophysical Group Leader

Attachments: Site Vicinity Map, Figure 1
Geophysical Data Profiles – ERT Lines 1 through 3, Figure 2

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Attachments

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED OCTOBER 11, 2016)

SITE VICINITY MAP

DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2
CHATTANOOGA,, TENNESSEE

SCALE:
NOT TO SCALE

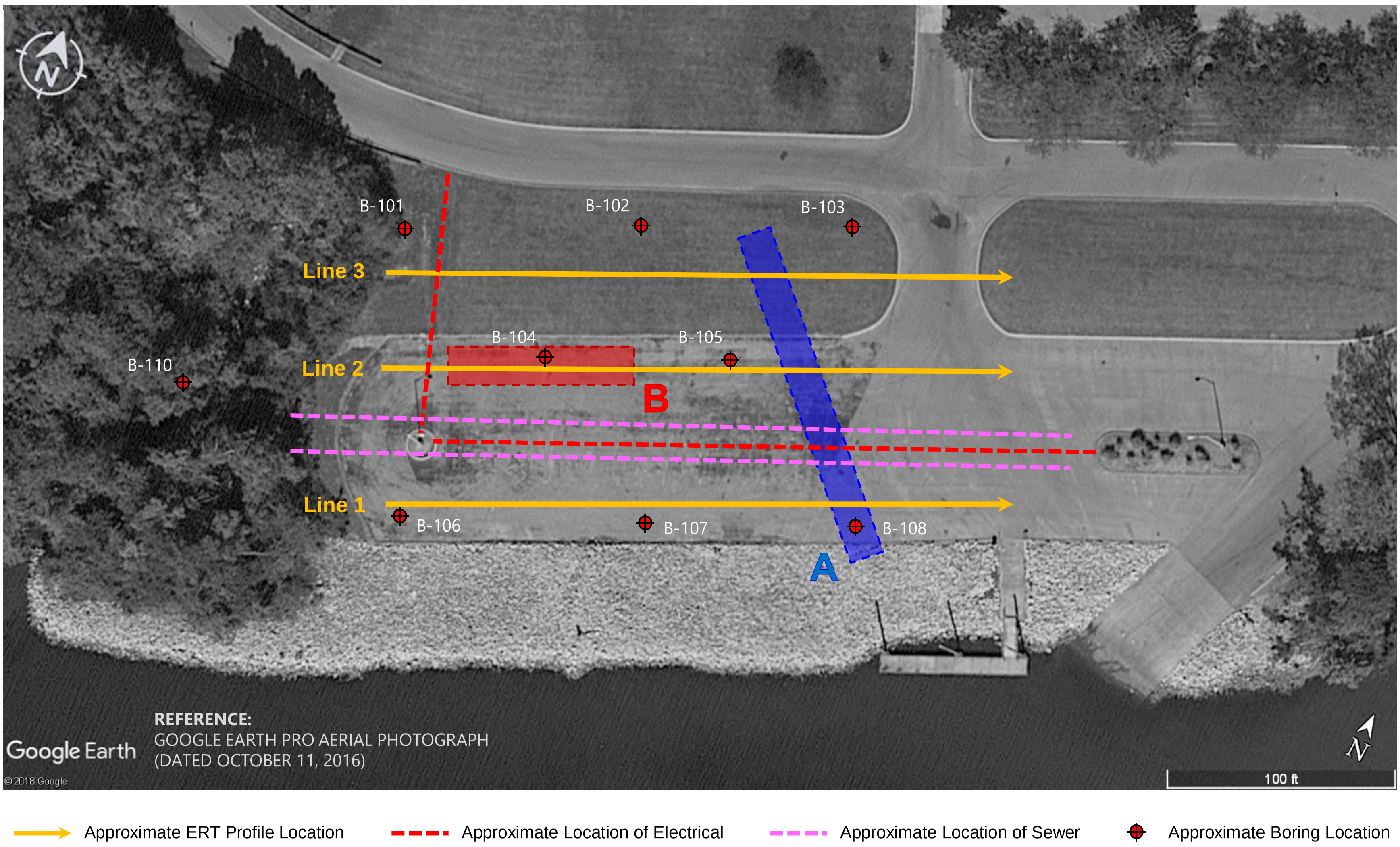
DATE:
10/12/2018

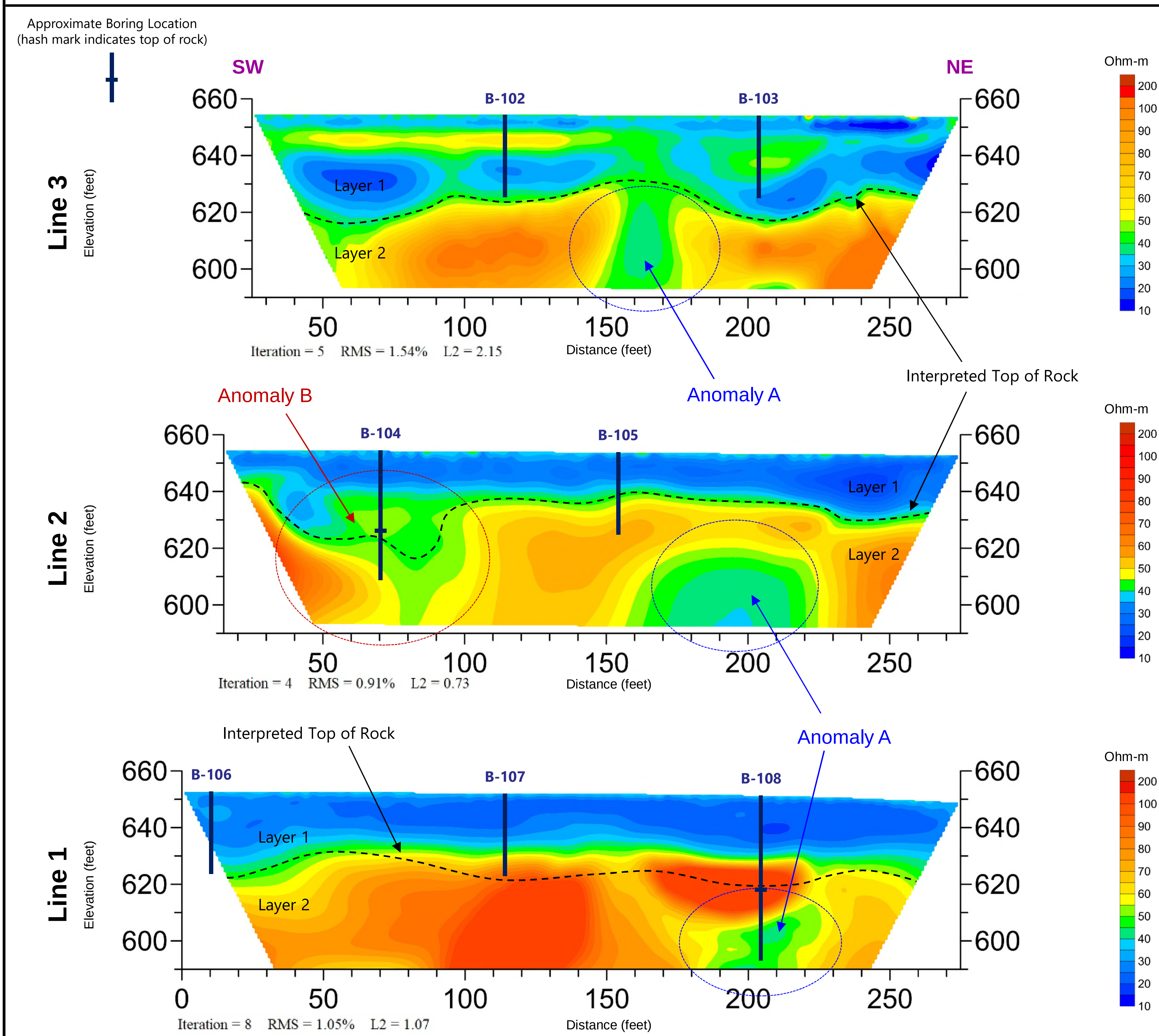
PROJECT NUMBER
1281-18-061

FIGURE NO.
1

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY





GEOPHYSICAL DATA PROFILES – ERT LINES 1 THROUGH 3	SCALE: AS SHOWN
DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2 CHATTANOOGA,, TENNESSEE	DATE: 10/12/2018 PROJECT NUMBER 1281-18-061

FIGURE NO. **2**

January 30, 2019

CDM Smith
4600 Park Rd #240
Charlotte, North Carolina 28209

Attention: Mr. Erdem Onur Tastan, Ph.D., P.E.

Reference: **Revised Report for Geophysical Services**
DuPont Pump Station and Basin Improvements Phase 2
Chattanooga, Tennessee
S&ME Project No. 1281-18-061R2

Dear Mr. Tastan:

S&ME, Inc. (S&ME) has performed geophysical services at the above referenced site located in Chattanooga, Tennessee. These services were performed in general accordance with S&ME Proposal No. 121800346CO1 dated January 9, 2019. This report has been revised based on comments in an email from CDM Smith on January 30, 2019.

♦ Project Information

CDM Smith is performing consulting services for a proposed new pump station facility located near Dixie Drive in Chattanooga, Tennessee (**Figure 1**). During the test boring program conducted by CDM Smith for the original location of the proposed facility, an approximate 11-foot vertical void was encountered in one of the borings (B-108). Depth to the top of rock at B-108 is about 33 feet below ground surface (bgs) with the encountered top of the void at about 45 feet bgs. The water table is just above the soil/rock interface so the encountered void is likely water-filled. S&ME previously performed geophysical services within the original proposed area and identified potential karst features such as voids and bedrock joints/fractures. CDM Smith requested S&ME provide additional geophysical services at three alternative sites for the proposed facility (Sites A, B, and D).

♦ Methodology and Field Services

Between October 3, 2018 and January 17, 2018, S&ME completed Electrical Resistivity Tomography (ERT) surveys within the accessible portions of the original site and Sites A, B, and D (**Figure 2**). ERT is an active geophysical technique that involves the introduction of a known amount of current into the ground and measuring the response in order to identify varying electrical potentials in subsurface material. By introducing a known amount of current into the ground, the measured voltage potential at the surface is used to calculate the resistivity of a particular volume of subsurface media.

In general, clayey and moist soils result in lower resistivity (higher conductivity) readings, while dry sands, gravels, chert, and competent limestone/dolomite exhibit higher resistivity values. The resistivity of materials also partially depends on the substance filling its pore or void space. If a cavity or fracture is air-filled, a highly resistive anomaly within the limestone/dolomite unit is expected. If it is water- or clay-filled, an anomaly more conductive than the surrounding limestone/dolomite unit is expected. Natural variations in porosity and grain size distribution can also cause such anomalies. It is important to note that actual ground resistivity is not collected during a resistivity survey. The survey is used to collect the apparent resistivity of a volume of material that is dependent upon electrode spacing. Actual resistivities are later determined through a data inversion process.

The ERT method requires that a series of small current and potential stainless-steel electrodes be inserted into the ground and data collected using various array configurations (Dipole-Dipole, Wenner, etc.). The electrodes are connected to a transmitter/recording instrument (resistivity meter) that generates the induced current and stores the resulting measurements for later processing and analysis. The configuration of the collected data (array) is dependent on the objectives of the investigation (e.g., vertical soil and bedrock profiling, cavity detection, fracture mapping, etc.). ERT measurements are acquired from the voltage potential difference measured between two electrodes and are dependent upon the distance between the electrodes. Material included between the electrodes is essentially averaged. Therefore, limitations of this method exist dependent upon the resolution of data acquisition needed versus the depth of a target.

An AGI SuperSting™ R8/IP resistivity system configured with 56 electrodes was used in general accordance with ASTM D6431-99 (2010) "*Using DC Resistivity for Subsurface Investigations*". A total of twelve (12) ERT profiles ranging between about 275 and 330 feet in length were collected using the Dipole-Dipole array configuration; Lines 1, 2, and 3 at the original site, Lines 4, 5, and 6 at Site B, Lines 7, 8, and 9 at Site D, and Lines 10, 11, and 12 at Site A (**Figure 2**). Line locations were generally based on site access and, if possible, to avoid potential influence from existing buried utilities. However, the beginnings of Lines 2 and 3, and the end of Line 12, were slightly shortened due to shallow interference identified during data processing which are likely related to buried electrical lines and/or structures within those areas. Electrodes for each profile were spaced at 5 feet. Where asphalt pavements were encountered, 1/2 inch diameter holes were required in order for the electrodes to be inserted directly into the underlying soils. Each drilled hole was backfilled with a flowable asphalt sealant at the end of the survey.

ERT data was processed using AGI's EarthImager 2D software and Golden Software's Surfer® was used to grid and plot the data. Elevations used for our models were based on provided plans from CDM Smith and/or from the Hamilton County GIS website rather than actual field survey measurements performed by S&ME and should be considered approximate. ERT data profiles are presented in **Figures 3 through 6**.

♦ Results

The ERT results depicted in **Figure 3 through 6** indicate a varying resistivity contrast across the surveyed areas that generally range from approximately 10 ohm-meters (ohm-m) to 200 ohm-m. Presented depths of the ERT profiles are at about 40 to 60 feet below ground surface (bgs).

- In general, the ERT profiles exhibit two layers (Layer 1 and 2). The upper Layer 1 is primarily characterized by relatively conductive material less than about 50 ohm-m and the underlying Layer 2 generally consists of material greater than about 50 ohm-m. Based on the provided borings, Layer 1 is interpreted to be related to the soil overburden and Layer 2 is interpreted to be related to the limestone bedrock.

- Eight anomalous subsurface features were also identified in the ERT data sets (Anomalies A through H); Anomalies A and B at the original site, Anomaly C at Site B, Anomalies D and E at Site D, and Anomalies F, G, and H at Site A.
- Anomalies A, F, and G are characterized by conductive areas within the interpreted bedrock (Layer 2) and are consistent with possible water/clay-filled voids (A and F) and/or joints/fractures within the bedrock (G).
- Anomalies B, C, D, E, and H appear to be generally characterized by a topographic low along the surface of the interpreted bedrock. However, the interpreted bedrock within several of these features also exhibit relatively lower resistivity values that may be related to water/clay-filled voids, joints, and/or fractures (B and C).
- In addition, the buried structures located at the end of Line 11 and south of Line 6 may have influenced the ERT data sets. As such, Anomaly H may instead be associated with a buried structure and the higher conductivity values exhibited in Line 6 may have masked the actual subsurface conditions so potential features along Line 6 were not interpreted.
- Interpreted anomalies are also summarized in the table below.

Anomaly	Site	ERT Line	Description
A	Original	1, 2 and 3	Possible water/clay-filled voids within the bedrock
B	Original	2	Topographic low along bedrock surface with possible joints/fractures
C	B	4 and 5	Topographic low along bedrock surface with possible joints/fractures
D	D	7	Topographic low along bedrock surface
E	D	7	Topographic low along bedrock surface
F	A	12	Possible water/clay-filled voids within the bedrock
G	A	12	Possible joints/fractures within the bedrock
H	A	11	Topographic low along bedrock surface (possibly influenced by buried structure)

♦ Limitations

The geophysical method used for this survey has inherent limitations. Buried site metallic features (e.g., utilities, etc.) and overhead transmission lines can produce excessive noise and/or false responses in ERT data. As such, ERT profile locations are generally positioned where possible influence is limited. Depth of exploration for an ERT survey is limited by the allowable length of the collected data profile. Limiting factors due to site constraints such as property boundaries, surficial obstructions, utilities, etc. can reduce profile lengths. Regardless of the thoroughness of a geophysical study, there is always a possibility that actual conditions may not match the interpretations. The results should be considered accurate only to the degree implied by the methods used and the method's limitations and data coverage. Accordingly, the possibility exists that not all features at a project site will be located due to either subsurface soil conditions or the occurrence of features outside the lateral limits and below the depth of penetration of the methods used. As with most surface geophysical methods, resolution of the subsurface will also decrease with depth. As such, the size and/or contrast of subsurface features compared to the imaged subsurface media must be significant enough to produce the anticipated response. The location and/or determination (or the lack thereof) of subsurface features was based on our review of provided information and of the geophysical survey. Under no circumstances will S&ME assume any responsibility for damages resulting from the presence of subsurface features that may exist but were not identified by our survey.

Closure

S&ME appreciates the opportunity to assist you during this phase of the project. If you should have any questions concerning this report or if we may be of further assistance, please contact us.

Sincerely,

S&ME, Inc.

Jason B. Cox, PG (GA)
Project Geophysicist

Kevin D. Hon, PG
Geophysical Group Leader

Attachments: Site Vicinity Plan, Figure 1
Geophysical Location Plan, Figure 2
Geophysical Data Profiles – ERT Lines 1 through 3 (Original Site), Figure 3
Geophysical Data Profiles, ERT Lines 4 through 6 (Alternative Site B), Figure 4
Geophysical Data Profiles, ERT Lines 7 through 9 (Alternative Site D), Figure 5
Geophysical Data Profiles, ERT Lines 10 through 12 (Alternative Site A), Figure 6

Attachments

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED OCTOBER 11, 2016)

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY

SITE VICINITY PLAN

DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2
CHATTANOOGA, HAMILTON COUNTY, TENNESSEE

SCALE:
NOT TO SCALE

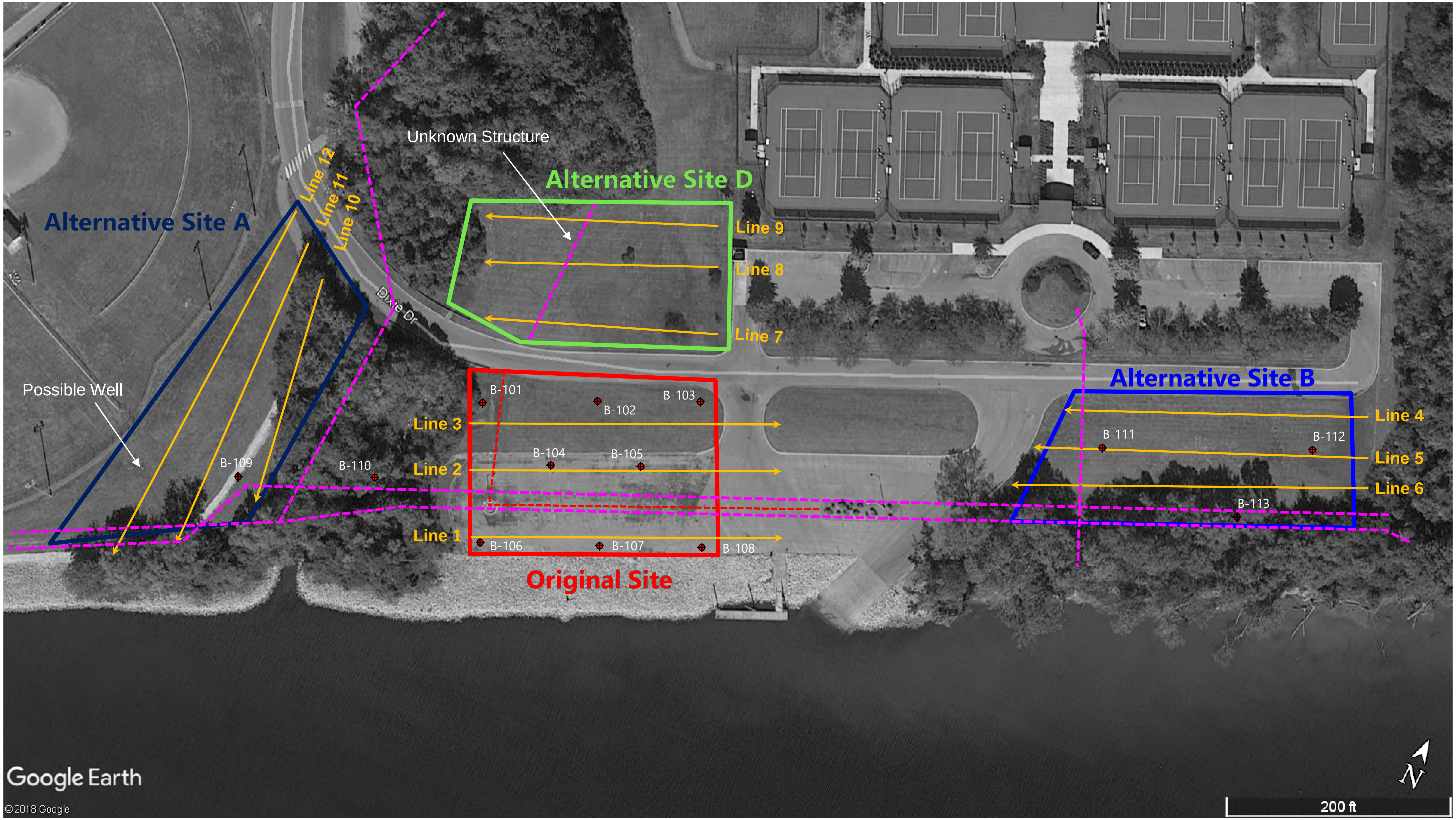
DATE:
1/30/2019

PROJECT NUMBER
1281-18-061R2

FIGURE NO.
1

REFERENCE:
GOOGLE EARTH PRO AERIAL PHOTOGRAPH
(DATED OCTOBER 11, 2016)

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY



LEGEND

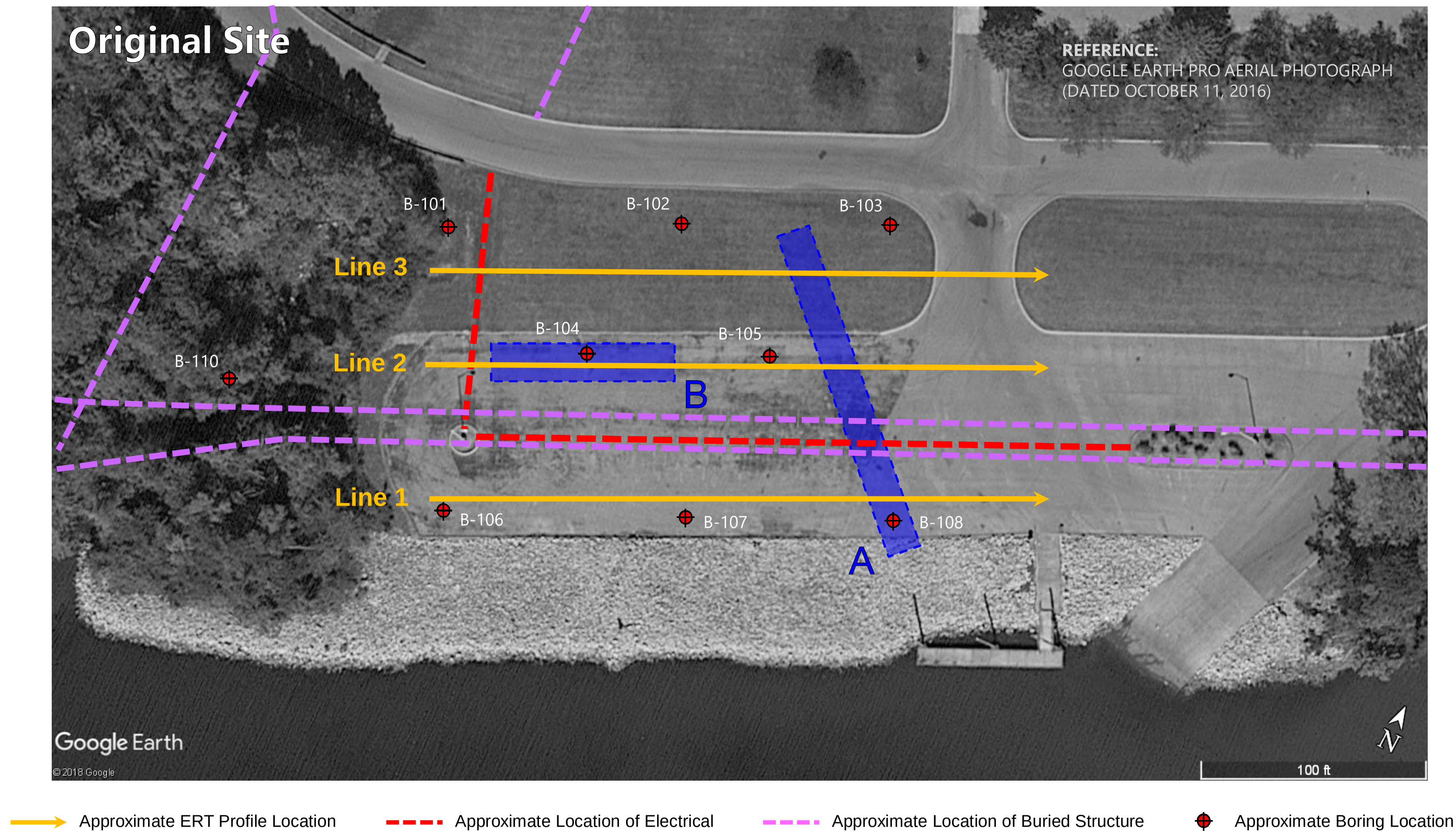
- Approximate ERT Profile Location
- Approximate Location of Electrical
- Approximate Location of Buried Structure
- Approximate Boring Location

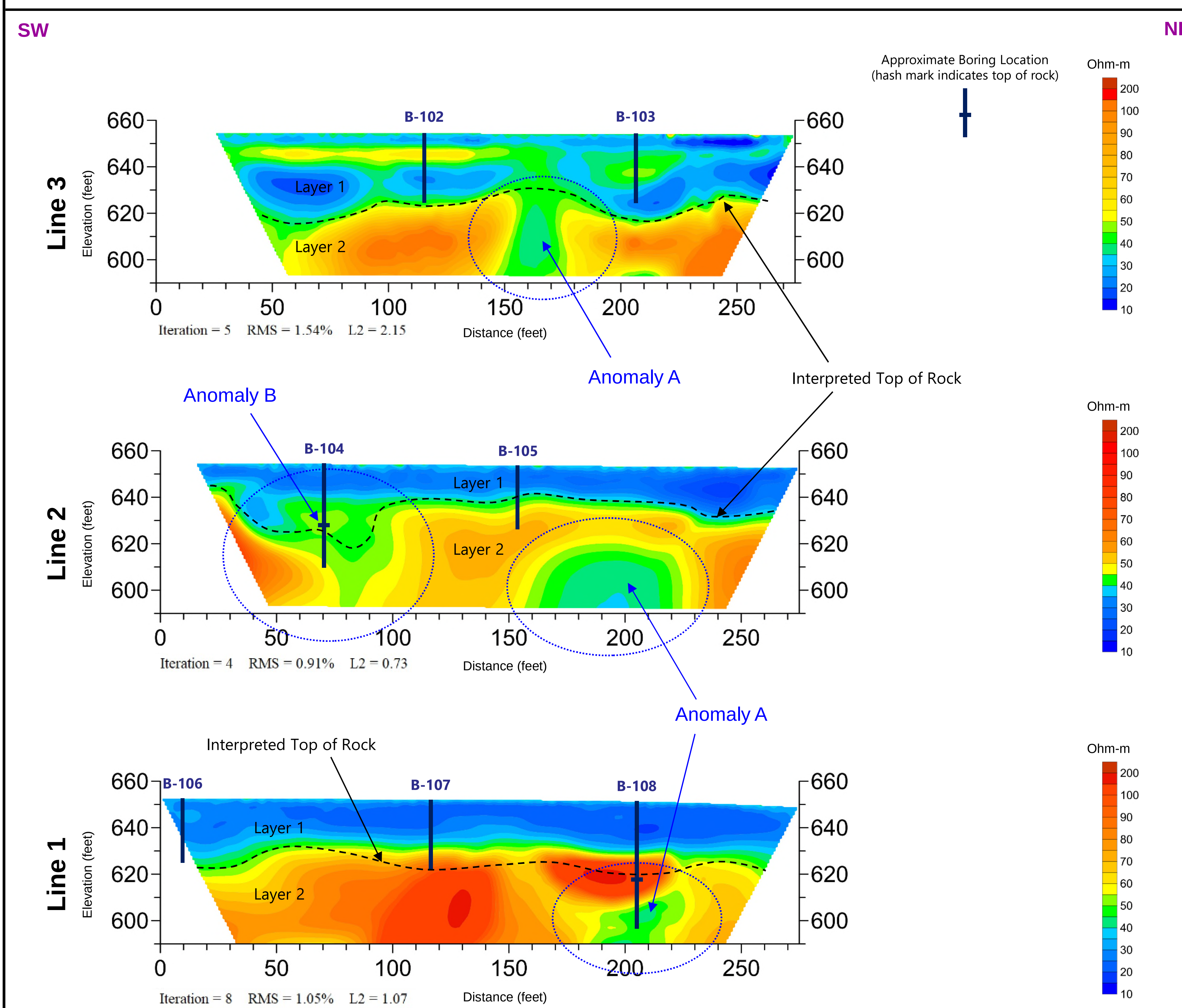
GEOPHYSICAL LOCATION PLAN

DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2
CHATTANOOGA, HAMILTON COUNTY, TENNESSEE

SCALE:	NOT TO SCALE
DATE:	1/30/2019
PROJECT NUMBER	1281-18-061R2
FIGURE NO.	2

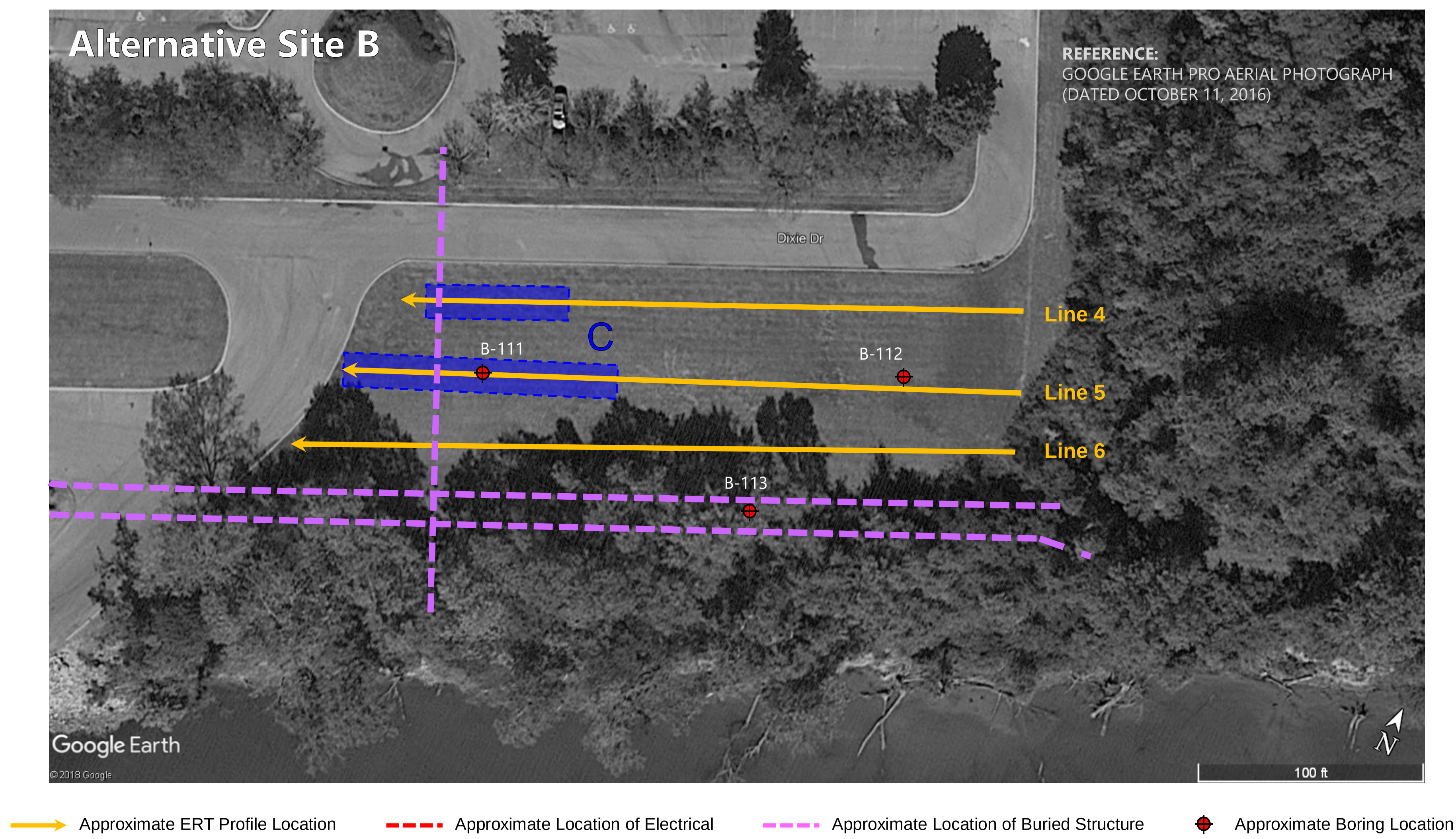
DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY

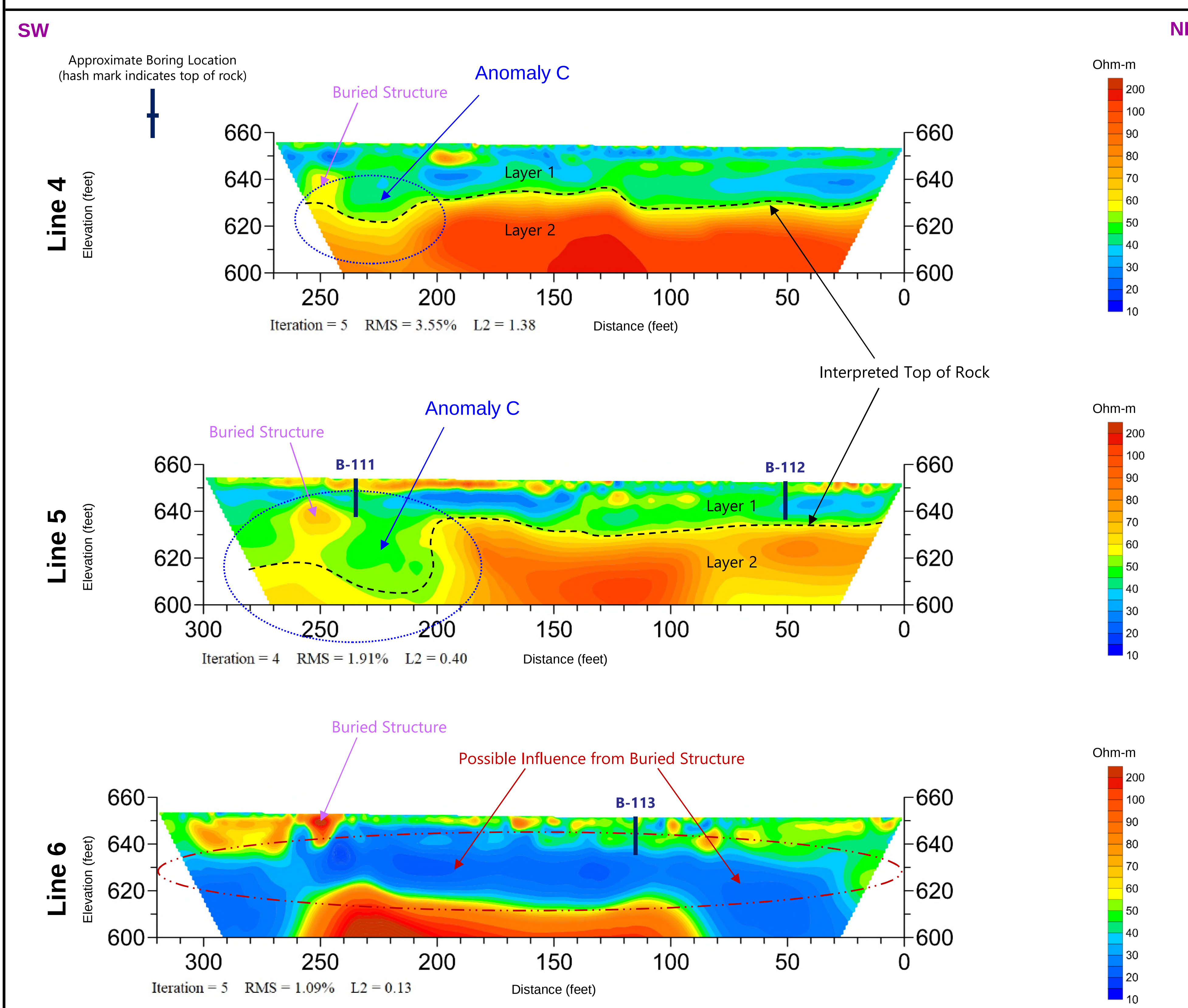




GEOPHYSICAL DATA PROFILES – ERT LINES 1 THROUGH 3 (ORIGINAL SITE)	SCALE: AS SHOWN	FIGURE NO.
DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2 CHATTANOOGA, HAMILTON COUNTY, TENNESSEE	DATE: 1/30/2019 PROJECT NUMBER 1281-18-061R2	3

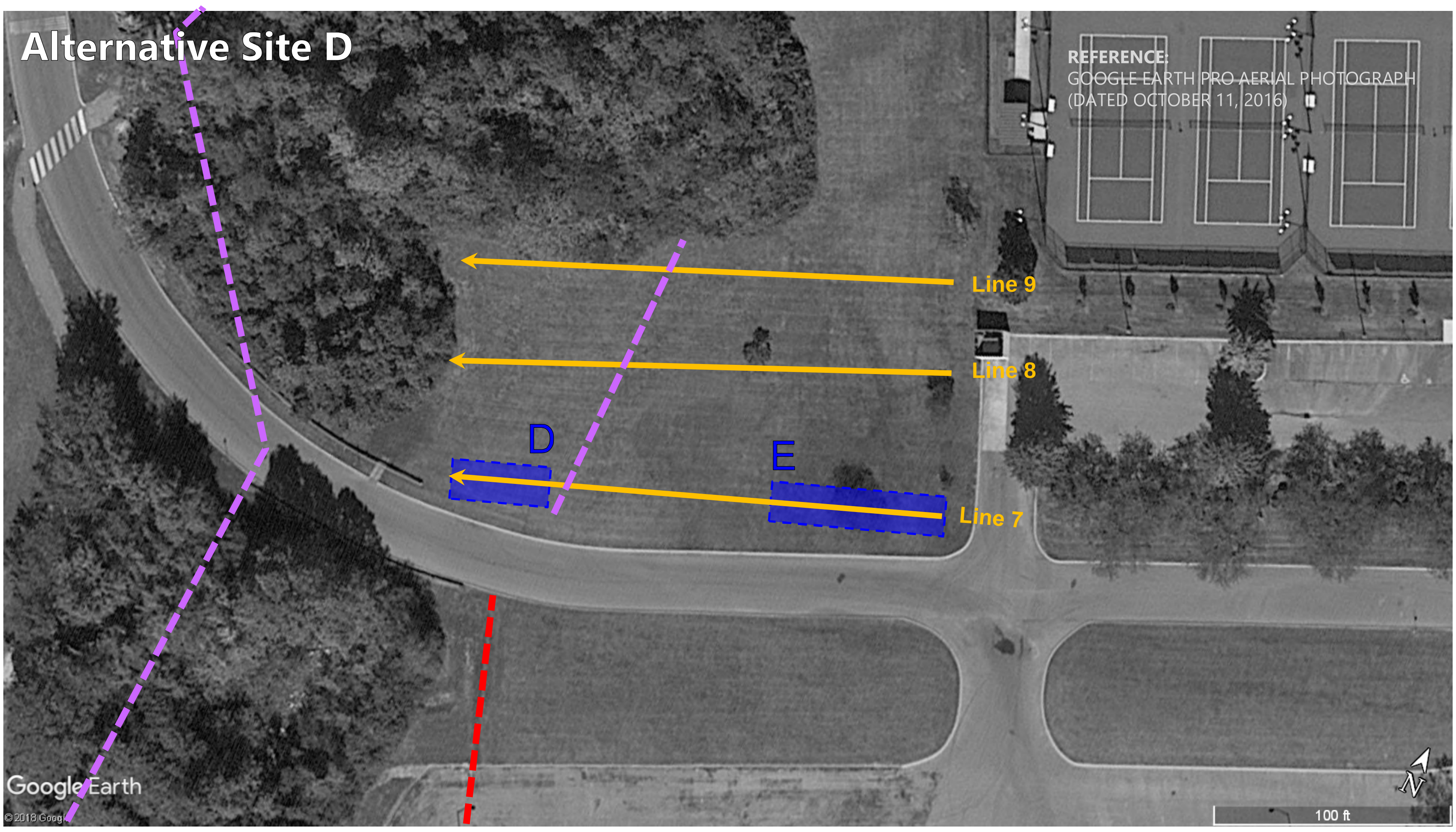
DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY



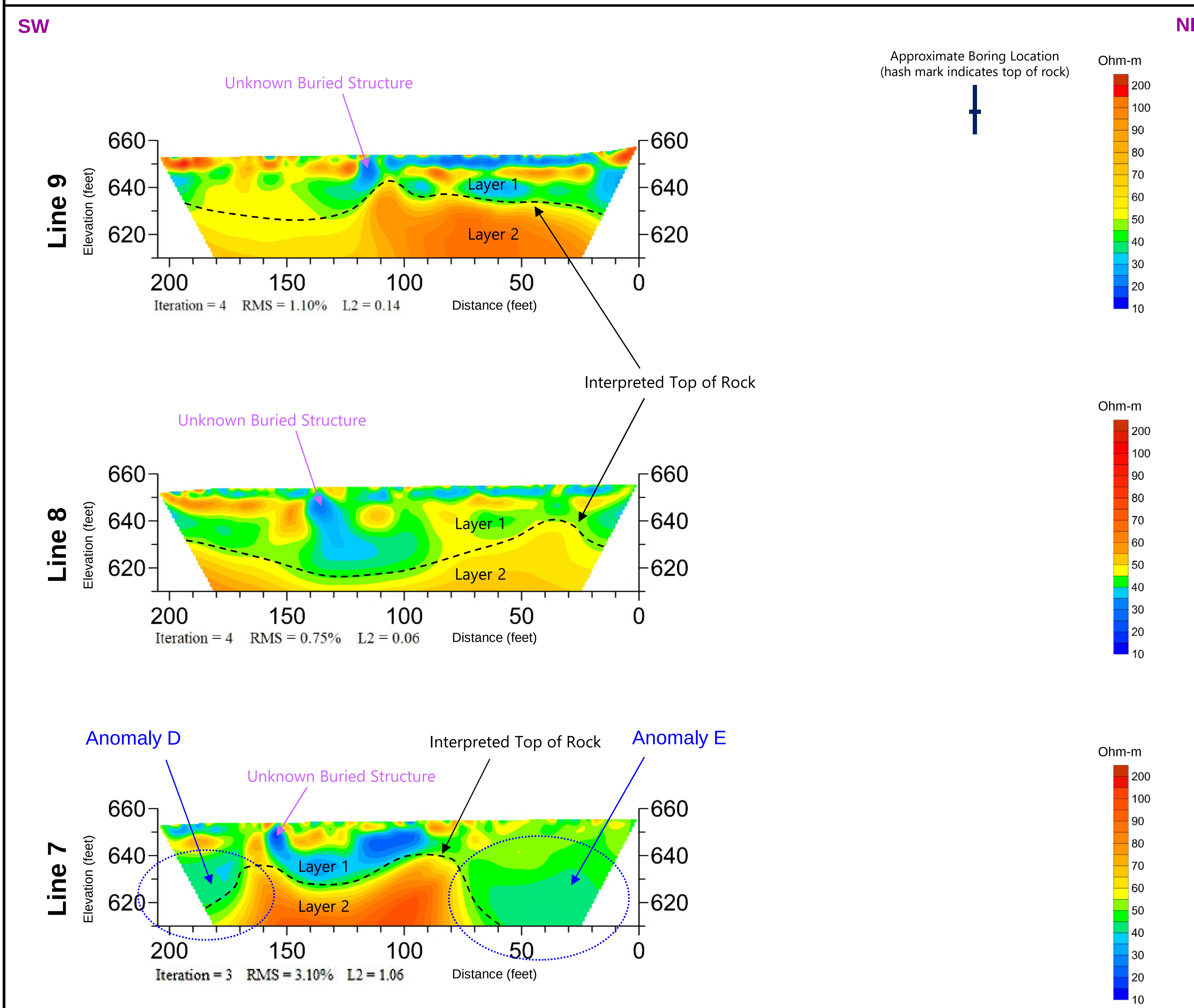


GEOPHYSICAL DATA PROFILES – ERT LINES 4 THROUGH 6 (ALTERNATIVE SITE B) DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2 CHATTANOOGA, HAMILTON COUNTY, TENNESSEE	SCALE: AS SHOWN DATE: 1/30/2019 PROJECT NUMBER 1281-18-061R2	FIGURE NO. **4**

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY



Approximate ERT Profile Location
Approximate Location of Electrical
Approximate Location of Buried Structure
Approximate Boring Location

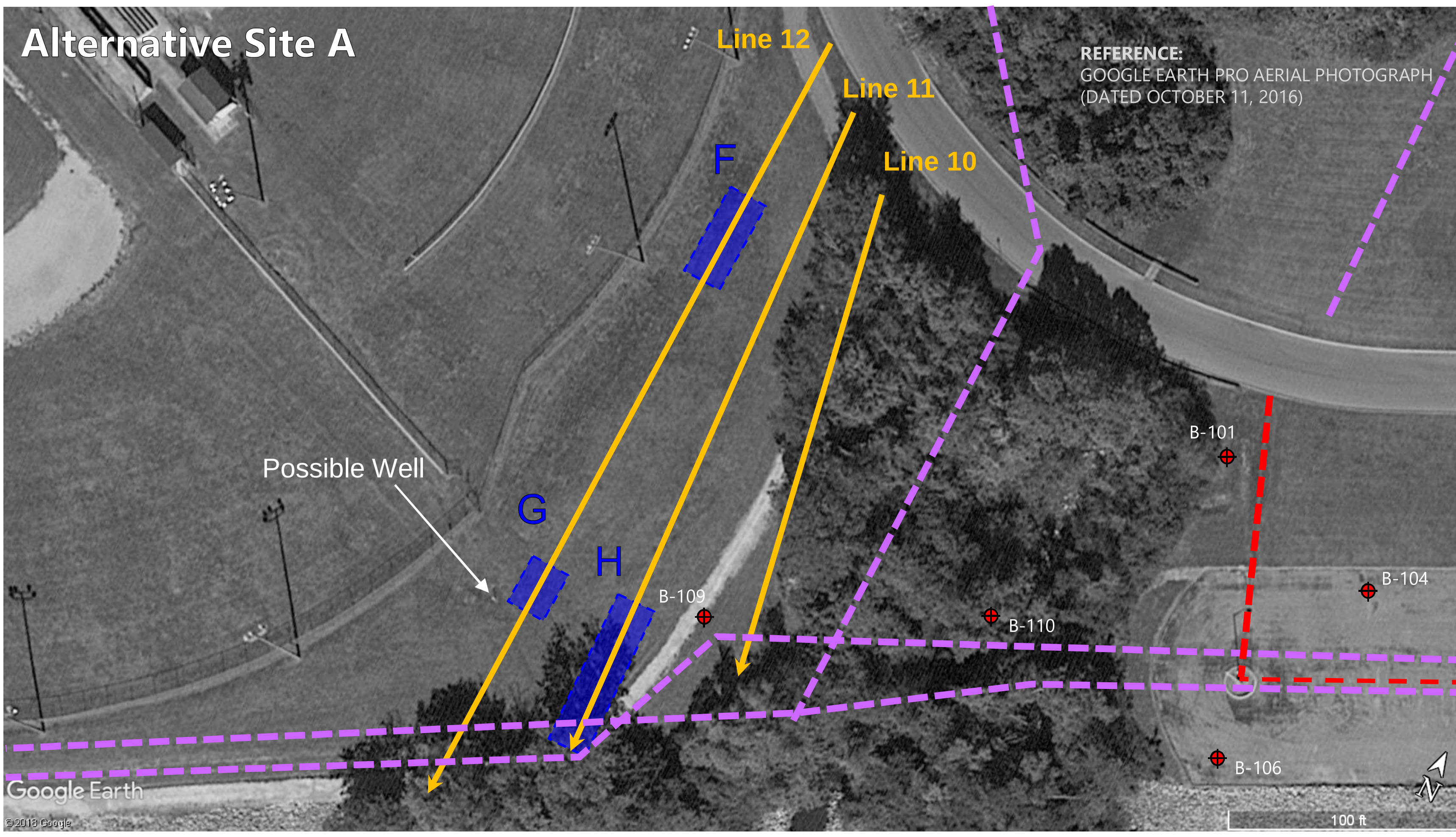


GEOPHYSICAL DATA PROFILES – ERT LINES 7 THROUGH 9 (ALTERNATIVE SITE D)

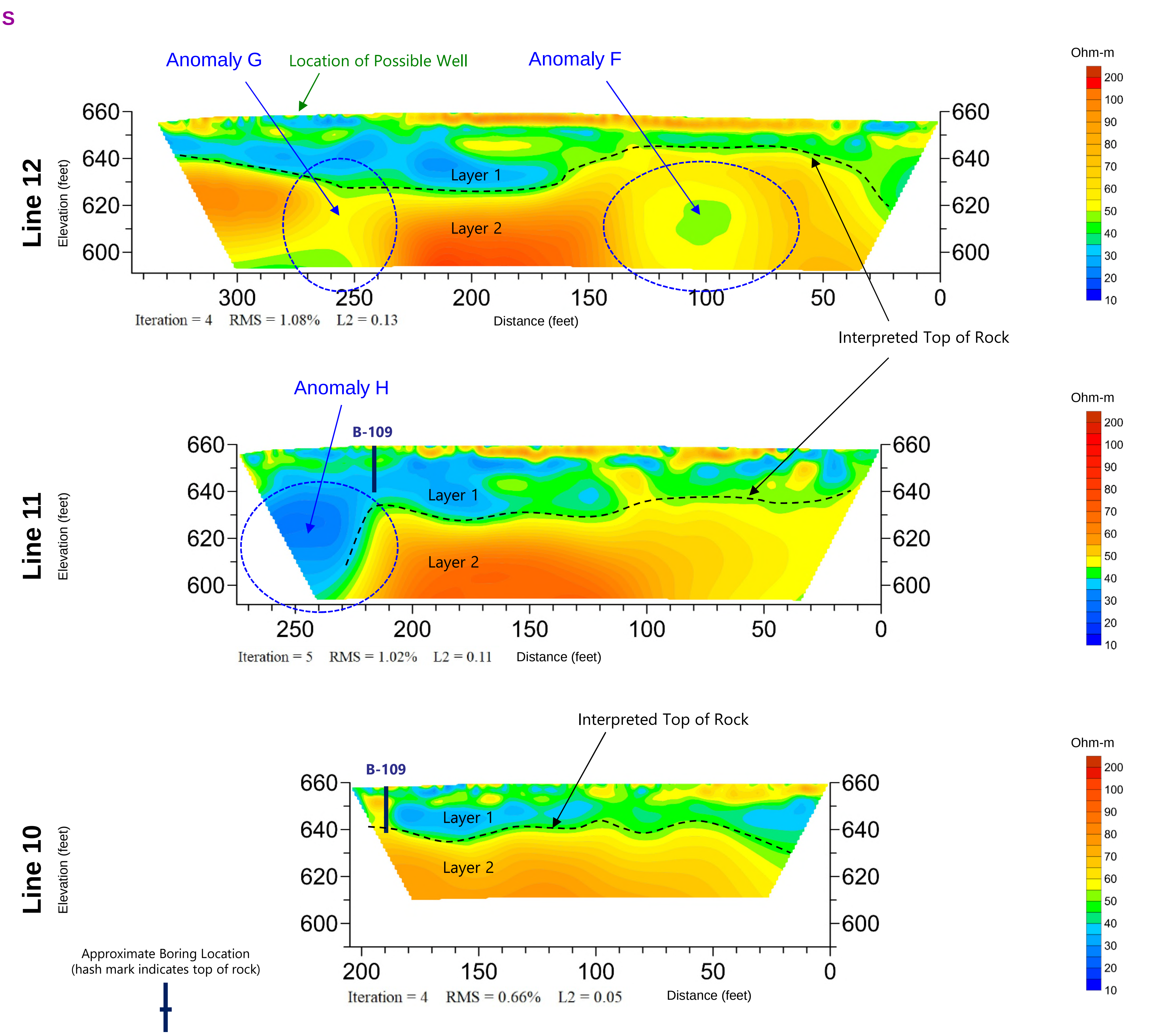
DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2
CHATTANOOGA, HAMILTON COUNTY, TENNESSEE

SCALE: AS SHOWN
DATE: 1/30/2019
PROJECT NUMBER 1281-18-061R2
FIGURE NO. 5

DRAWING / PLAN FOR ILLUSTRATION PURPOSES ONLY



Approximate ERT Profile Location | Approximate Location of Electrical | Approximate Location of Buried Structure | Approximate Boring Location



GEOPHYSICAL DATA PROFILES – ERT LINES 10 THROUGH 12 (ALTERNATIVE SITE A)

DUPONT PUMP STATION AND BASIN IMPROVEMENTS PHASE 2
CHATTANOOGA, HAMILTON COUNTY, TENNESSEE

SCALE: AS SHOWN
DATE: 1/30/2019
PROJECT NUMBER 1281-18-061R2

FIGURE NO. 6

Appendix C

CDM Smith Test Boring Logs

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CDM Smith

BOREHOLE LOG
CDM-204

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Drilling Contractor: Terracon, Inc.
Drilling Method/Rig: HSA/Acker
Drillers: Richard
Drilling Date: Start: 11/20/2018 **End:** 11/20/2018
Borehole Coordinates: See Boring Location Plan
Surface Elevation (ft.): 655.5
Total Depth (ft.): 66.3
Depth to Initial Water Level (ft-bgs): 24.0
Abandonment Method: Backfilled with grout.
Logged By: KNA

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
			655.5 0		0		TOPSOIL	6" of Topsoil.
SS	S-1	24/20		6	3 3 5		CL	Moist, medium stiff, brown and dark brown, lean **CLAY**, trace roots.
SS	S-2	24/24		10	4 5 5 8			Moist, stiff, brown, lean **CLAY**, trace roots.
SS	S-3	24/24	650.5 5	11	2 4 7 9			Moist, stiff, brown, lean **CLAY**, trace roots.
SS	S-4	24/22		10	2 4 6 6			Moist, stiff, brown with gray, lean **CLAY**.
SS	S-5	24/18	645.5	10	2 4 6 7			Moist, stiff, brown, lean **CLAY**.
SS	S-6	24/18	10	8	WOH 4 4 7			Moist, stiff, brown, lean **CLAY**.
SS	S-7	24/18	640.5	9	1 4 5 7			Moist, stiff, brown, lean **CLAY**.
			15					

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
PWR - Partially Weathered Rock

REMARKS

Hammer weight = 140 pounds, drop height = 30 inches
Split spoon = 2 inches OD, 24 inches long
WOH = Weight of hammer
REC = Recovery
RQD = Rock Quality Designation
24-hour water level reading for depth to initial water level

Reviewed by: EOT **Date:** 3-11-19

CDM Smith

BOREHOLE LOG
CDM-204

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
							CL	
SS	S-8	24/18	635.5 20	11	3 5 6 9			Moist, stiff, brown, black and gray, lean **CLAY**, trace fine sand.
SS	S-9	24/18	630.5 25	2	WOH WOH 2 4		CH	Moist to wet, very soft, gray, fat **CLAY**. (Black, decayed wood from 23' to 24')
SS	S-10	24/18	625.5 30	2	WOH WOH 2 3			Wet, very soft, dark gray, fat **CLAY**, trace sand.
							SW	Wet, dense, gray, fine to medium **SAND**. (Gravel in tip)
SS	S-11	24/18	620.5 35	31	3 10 21 16			
							CL	Wet, very soft, tan, **CLAY**, some gravel.
SS	S-12	24/18	615.5 40	2	1 1 1 1			

CDM Smith

BOREHOLE LOG
CDM-204

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
							CL	
NQ2	C-1	96/16	610.5 / 45					Wet, severe weathering, extremely fractured, light gray, **LIMESTONE**.
							VOID	Water filled **VOID** from 45.1 feet to 47.1 feet bgs.
								Wet, severe weathering, extremely fractured, light gray, **LIMESTONE**.
			605.5 / 50				VOID	Water filled **VOID** from 47.5 feet to 63.2 feet bgs.
NQ2	C-2	120/0	600.5 / 55 595.5 / 60					
NQ2	C-3	57.6/26.5						Wet, hard, moderately weathered, slightly fractured, gray **LIMESTONE**. **REC=46%; RQD=21%**
			590.5				VOID	Water filled **VOID** from 63.4 feet to 64.4 feet bgs.

CDM Smith

BOREHOLE LOG
CDM-204

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. / Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
								Wet, hard, moderately weathered, slightly fractured, gray **LIMESTONE**.
								Boring terminated at 66.3 feet bgs.
			585.5 / 70					
			580.5 / 75					
			575.5 / 80					
			570.5 / 85					

CDM Smith

BOREHOLE LOG
B-501

Client: City of Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Location: Chattanooga, TN
Project Number: 109746

Drilling Contractor: S&ME/Tri-State
Surface Elevation (ft.): 651.9
Drilling Method/Rig: HSA/CME-550X
Total Depth (ft.): 65.2
Drillers: Freeman
Depth to Initial Water Level (ft-bgs): 0.0
Drilling Date: Start: 2/28/2019 **End:** 3/1/2019
Abandonment Method: Backfilled with grout.
Borehole Coordinates: See Boring Location Plan
Logged By: KNA

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. / Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
			651.9 / 0				CL	
SS	S-1	18/18	646.9 / 5	14	5 6 8			Moist, stiff, brown, **CLAY**
SS	S-2	18/16	641.9 / 10	10	4 4 6			Moist, stiff, brown, **CLAY**, trace mica
SS	S-3	18/18	636.9 / 15	9	3 4 5			Moist, stiff, brown, **CLAY**, trace mica - Pockets of wet, light gray/tan, CLAY.

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
- PWR - Partially Weathered Rock

REMARKS

Hammer weight = 140 pounds, drop height = 30 inches
Split spoon = 2 inches OD, 24 inches long
WOH = Weight of hammer
REC = Recovery
RQD = Rock Quality Designation
24-hour water level reading for depth to initial water level

Reviewed by: EOT **Date:** 3-11-19

CDM Smith

BOREHOLE LOG
B-501

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
							CL	
SS	S-4	18/18	631.9 / 20	6	2 3 3			Moist to wet, medium stiff, **CLAY**, trace mica - Pockets of wet, tan, CLAY.
SS	S-5	24/24		9	3 4 5 6			Wet, stiff, brown, orange and gray, **CLAY**, trace mica
SS	S-6	24/24		0	WOH WOR WOH 2			Wet, very soft, dark gray, **CLAY**, some fine to coarse sand
							SC	
ST	ST-1	24/22	626.9 / 25	--	P U S H			Wet, dark gray, **CLAY**, some fine to coarse sand
SS	S-7	24/24		3	2 1 2 3			Wet, very loose, dark gray, fine to coarse **SAND**, some clay - 2" wood fragments in spoon tip.
SS	S-8	10/6		>50	9 50/4"			Wet, very dense, dark gray, fine to coarse **SAND** - Rock fragments in tip. Auger refusal encountered at 28.8 ft bgs. Begin rock coring.
NQ	C-1	17/13	621.9 / 30					Hard, fresh, blue-gray, fine grained, **LIMESTONE**; primary joint set horizontal, close, rough, stepped, fresh, tight; secondary joint set vertical, rough, planar, discolored, tight. **REC = 76%**
NQ	C-2	60/48						Hard to very hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set shallow, moderately close, rough, stepped, fresh, partly open. **REC = 80%, RQD = 72%**
							VOID	Water-filled **VOID** from 33.7 to 34.2 ft bgs.
NQ	C-3	60/56	616.9 / 35 611.9 / 40					Hard to very hard, fresh, blue-gray and white, fine grained **LIMESTONE**; primary joint set horizontal, moderately close, rough, stepped, fresh to discolored, partly open; secondary joint set steep, wide, rough, stepped, discolored, open. **REC = 93%, RQD = 93%**

CDM Smith

BOREHOLE LOG
B-501

Client: City of Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Location: Chattanooga, TN
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
NQ	C-4	60/49	606.9 45					Hard to very hard, fresh, blue-gray and white, fine grained**LIMESTONE**; primary joint set shallow, moderately close, rough, planar, fresh, tight. **REC = 82%, RQD = 63%** - Becomes highly fractured near void
							VOID	Water-filled **VOID** from 43.7 to 44.5 ft bgs.
NQ	C-5	60/59	601.9 50					2" Flint 45.1 to 45.3 ft bgs. Hard, fresh, blue-gray, fine grained**LIMESTONE**; primary joint set horizontal, wide, rough, stepped, fresh, partly open; secondary joint set steep, very wide, rough, planar, discolored, tight. **REC = 99%, RQD = 99%**
NQ	C-6	60/56.5	596.9 55					Hard to very hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, wide, rough, stepped, fresh, open; secondary joint set steep, very wide, rough, planar, discolored, partly open. **REC = 94%, RQD = 94%**
NQ	C-7	60/63	591.9 60					Hard, fresh, blue-gray, black and white, fine grained **LIMESTONE**; primary joint set shallow, close, rough, planar, fresh, open to partly open. **REC = 100%, RQD = 92%** - Flint seams 55.1 to 56 ft bgs and 57.2 to 58 ft bgs.
NQ	C-8	60/57	586.9					Hard to very hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set shallow, moderately close, rough stepped, partly open. **REC = 95%, RQD = 95%**

CDM Smith

BOREHOLE LOG
B-501

Client: City of Chattanooga, TN | **Project Name:** Dupont Pump Station and Basin Improvements

Project Location: Chattanooga, TN | **Project Number:** 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
								Boring terminated at 65.2 ft bgs.
			581.9 / 70					
			576.9 / 75					
			571.9 / 80					
			566.9 / 85					

CDM Smith

BOREHOLE LOG
B-502

Client: City of Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Location: Chattanooga, TN
Project Number: 109746

Drilling Contractor: S&ME/Tri-State
Surface Elevation (ft.): 653.7
Drilling Method/Rig: HSA/CME-550X
Total Depth (ft.): 54.9
Drillers: Freeman
Depth to Initial Water Level (ft-bgs): 0.2
Drilling Date: Start: 2/26/2019 **End:** 2/27/2019
Abandonment Method: Backfilled with grout.
Borehole Coordinates: See Boring Location Plan
Logged By: KNA

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. / Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
			653.7 / 0				CL	
SS	S-1	18/18		15	5 6 9			Moist, stiff, brown and gray, **CLAY**, trace roots
			648.7 / 5					
SS	S-2	18/18		14	6 6 8			Moist, stiff, brown, tan and gray, **CLAY**
			643.7 / 10					
SS	S-3	18/18		12	5 5 7			Moist, stiff, brown, **CLAY**, trace mica - Wet, gray, vertical seams.
			638.7 / 15					

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
- PWR - Partially Weathered Rock

REMARKS

Hammer weight = 140 pounds, drop height = 30 inches
Split spoon = 2 inches OD, 24 inches long
WOH = Weight of hammer
REC = Recovery
RQD = Rock Quality Designation
24-hour water level reading for depth to initial water level

Reviewed by: EOT **Date:** 3-11-19

CDM Smith

BOREHOLE LOG
B-502

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
							CL	
SS	S-4	18/18		7	2 3 4			Moist, medium stiff, brown and tan, **CLAY**, trace mica - Gray seams.
ST	ST-1	24/24	633.7 / 20	--	P U S H			
SS	S-5	24/24		9	4 3 6 4			Wet, stiff, brown and gray-black, **CLAY**, little fine to coarse sand, trace mica
SS	S-6	24/24	628.7 / 25	2	WOH WOR 2 3		SC	Wet, very soft, brown and gray-black, **CLAY**, little fine to coarse sand, trace mica Wet, very loose, dark gray, fine to coarse SAND, some clay, trace mica
SS	S-7	24/24		2	1 1 1 2			Wet, very loose, dark gray, fine to coarse SAND, some clay, little wood, trace mica
SS	S-8	3/0		>50	50/3"			No Recovery. Begin rock coring at 28.6 ft bgs.
NQ	C-1	16/15	623.7 / 30					Moderately hard, slightly weathered, gray and white, dolomitic **LIMESTONE**; primary joint set shallow, close, rough, stepped, discolored, open. **REC = 94%, RQD = 94%**
NQ	C-2	60/60						Moderately hard to hard, slightly weathered, blue-gray, dolomitic **LIMESTONE**; primary joint set horizontal, close to moderately close, rough, stepped, discolored, open; secondary joint set steep, wide, rough, planar, discolored, partly open. **REC = 100%, RQD = 77%**
NQ	C-3	60/59.5	618.7 / 35					Moderately hard to hard, fresh, blue and gray, fine grained **LIMESTONE**; primary joint set horizontal to shallow, close to moderately close, rough, planar, fresh, tight to partly open. **REC = 99%, RQD = 84%** - Clayey sand infilling.
			613.7 / 40					Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set

CDM Smith

BOREHOLE LOG
B-502

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
NQ	C-4	60/59						horizontal, close, rough, stepped, fresh, tight to open. **REC = 99%, RQD = 93%** Very hard flint seam 43.1 to 43.3 ft bgs.
NQ	C-5	60/59	608.7 45					Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, close, rough, stepped, fresh to discolored, partly open to open. **REC = 99%, RQD = 74%** -Very hard, fresh, dark gray and white, aphanitic FLINT; primary joint set shallow, close, rough, stepped, fresh, open encountered from 45.0 to 46.3 ft bgs and from 47.5 to 48 ft bgs.
NQ	C-6	60/58.5	603.7 50					Moderately hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal to shallow, moderately close, rough, stepped, fresh, tight to partly open. **REC = 98%, RQD = 98%**
			598.7 55					Boring terminated at 54.9 ft bgs.
			593.7 60					
			588.7					

CDM Smith

BOREHOLE LOG
B-503

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Drilling Contractor: S&ME/Tri-State
Drilling Method/Rig: HSA/CME-550X
Drillers: Freeman
Drilling Date: Start: 3/1/2019 **End:** 3/2/2019
Borehole Coordinates: See Boring Location Plan
Surface Elevation (ft.): 652.8
Total Depth (ft.): 60.3
Depth to Initial Water Level (ft-bgs): NR
Abandonment Method: Backfilled with grout.
Logged By: KNA

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
			652.8 0					
SS	S-1	24/22		5	4 3 2 2		CL	Moist, medium stiff, brown, **CLAY** and fine to coarse **GRAVEL**, trace roots
SS	S-2	24/23		7	3 2 5 5			Moist, medium stiff, brown-gray, **CLAY**, trace fine to coarse gravel, trace roots
SS	S-3	24/24	647.8 5	12	5 5 7 8			Moist, stiff, brown, **CLAY**
SS	S-4	24/24		11	4 5 6 8			Moist, stiff, brown, **CLAY** - Pockets of wet, gray clay
SS	ST-1	24/3		--	P U S H			Moist, brown **CLAY** - 3" recovery, sample abandoned
ST	ST-2	24/12	642.8 10	--	P U S H			12" Recovery (estimated 10 to 11 ft bgs), water drained from bottom of tube when extracted.
SS	S-5	24/12		5	3 3 2 4		CH	Moist to wet, medium stiff, orange-brown, **CLAY**
SS	S-6	24/24	637.8 15	9	4 4 5			Moist to wet, stiff, orange-brown, **CLAY**, trace mica

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
- PWR - Partially Weathered Rock

REMARKS

Hammer weight = 140 pounds, drop height = 30 inches
Split spoon = 2 inches OD, 24 inches long
WOH = Weight of hammer
REC = Recovery
RQD = Rock Quality Designation
24-hour water level reading for depth to initial water level

Reviewed by: EOT **Date:** 3-11-19

CDM Smith

BOREHOLE LOG
B-503

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
					6		CH	
SS	S-7	24/24		10	3 4 6 5			Moist to wet, stiff, orange-brown, **CLAY** - Pockets of wet, gray/tan clay
SS	S-8	24/24	632.8 / 20	9	3 3 6 5			Moist to wet, stiff, brown, tan and black, **CLAY** - Pockets of wet, gray/tan clay
SS	S-9	18/18	627.8 / 25	4	1 2 2			Wet, soft, dark gray, **CLAY**, some fine to coarse sand, little mica
SS	S-10	5.5/2		>50	50/5.5"			Wet, hard, dark gray, **CLAY**, some fine to coarse sand, little mica - Wood chips in tip. Auger refusal at 29.3 ft bgs.
			622.8 / 30 617.8 / 35				SP	Sand encountered to 35.9 ft bgs. Casing flushed until competent rock was reached. Solid material observed 33.1 to 33.5 ft bgs.
NQ	C-1	52/33						Medium hard to hard, slightly weathered, blue-gray, fine grained **LIMESTONE**; primary joint set steep, close, rough, stepped, discolored, open. **REC = 63%, RQD = 52%**
							VOID	4" **VOID** encountered 37.6 to 37.9 ft bgs.
			612.8 / 40					

CDM Smith

BOREHOLE LOG
B-503

Client: City of Chattanooga, TN **Project Name:** Dupont Pump Station and Basin Improvements
Project Location: Chattanooga, TN **Project Number:** 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
NQ	C-2	60/56						Medium hard to hard, slightly weathered, blue-gray, fine grained **LIMESTONE**; primary joint set shallow, close, rough, stepped, fresh, open. **REC = 93%, RQD = 72%** - Very hard, highly fractured to slightly fractured, dark gray, FLINT encountered from 42.5 to 43.4 ft bgs and from 44.7 to 45.2 ft bgs.
			607.8 / 45					
NQ	C-3	60/59.5						Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, close, rough, stepped, fresh, open. **REC = 94%, RQD = 75%** - Several core pieces were approximately 3.5" in length.
			602.8 / 50					
NQ	C-4	60/60						Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, moderately close, rough, stepped, fresh to slightly discolored, partly open. **REC = 100%, RQD = 98%**
			597.8 / 55					
NQ	C-5	60/60						Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, moderately closerough, planar, partly open. **REC = 94%, RQD = 87%** - Quartz inclusions 55.2 to 55.5 ft bgs.
			592.8 / 60					Boring terminated at 60.3 ft bgs.
			587.8					

CDM Smith

BOREHOLE LOG
B-504

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Drilling Contractor: S&ME/Tri-State
Drilling Method/Rig: HSA/CME-550X
Drillers: Freeman
Drilling Date: Start: 2/25/2019 **End:** 2/26/2019
Borehole Coordinates: See Boring Location Plan
Surface Elevation (ft.): 654.6
Total Depth (ft.): 55
Depth to Initial Water Level (ft-bgs): 3.0
Abandonment Method: Backfilled with grout.
Logged By: KNA

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
			654.6 / 0					
SS	S-1	24/20		4	2, 2, 2, 3		CL	Moist, soft, dark brown, **CLAY** & **SILT**, trace roots
SS	S-2	24/16		6	2, 2, 4, 3			Moist, medium stiff, dark brown, **CLAY** & **SILT**, trace roots Moist, medium stiff, orange and white, **CLAY**, some fine to coarse gravel
SS	S-3	24/24	649.6 / 5	13	1, 5, 8, 10		CH	Moist, stiff, dark brown and dark gray, **CLAY**
SS	S-4	24/20		15	4, 7, 8, 9			Moist, stiff, dark brown and dark gray, **CLAY**
SS	S-5	24/22		13	3, 7, 6, 7			Moist, stiff, brown, **CLAY**
			644.6 / 10					
SS	S-6	24/24		13	4, 6, 7, 8		CL	Moist, stiff, orange-brown, **CLAY**
SS	S-7	24/24		12	3, 5, 7, 8			Moist, stiff, brown, **CLAY** - Wet, gray vertical seams
SS	S-8	24/24	639.6 / 15	13	3, 6, 7			Moist, stiff, brown and black, **CLAY**, trace mica

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
- PWR - Partially Weathered Rock

REMARKS

Hammer weight = 140 pounds, drop height = 30 inches
Split spoon = 2 inches OD, 24 inches long
WOH = Weight of hammer
REC = Recovery
RQD = Rock Quality Designation
24-hour water level reading for depth to initial water level

Reviewed by: EOT **Date:** 3-11-19

CDM Smith

BOREHOLE LOG
B-504

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
					7		CL	
SS	S-9	24/24		10	4 4 6 7			Moist, stiff, brown, **CLAY**
ST	ST-1	24/24	634.6 / 20	--	P U S H			Moist, brown, **CLAY**
SS	S-10	18/18	629.6 / 25	6	2 2 4			Moist, medium stiff, brown, tan and gray, **CLAY**
							SC	Wet, loose, dark gray, fine to coarse **SAND**, some clay - Water in S-11 spoon.
SS	S-11	18/18	624.6 / 30	25	1 13 12			Wet, loose, dark gray, fine to coarse **SAND**, some clay
							GP	Wet, medium dense, white and gray, fine to coarse **GRAVEL** - Gravel is angular rock fragments. Auger refusal encountered at 30.4 ft bgs. Begin rock coring.
NQ	C-1	56/32	619.6 / 35					Medium hard, moderately weathered, blue-gray, fine grained **LIMESTONE**; primary joint set moderately dipping to steep, very close, rough, stepped, discolored to decomposed, open. **REC = 57%, RQD = 21%**
							VOID	**VOID** encountered 30.9 to 31.1 ft bgs. Appears to be filled with clayey sand.
							VOID	**VOID** encountered 33.4 to 33.5 ft bgs. Appears to be filled with clayey sand.
NQ	C-2	60/59	614.6 / 40					Hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, close to moderately close, rough, stepped, discolored to fresh, open. **REC = 98%, RQD = 80%** - Flint observed 39.5 to 39.7 ft bgs and 39.9 to 40.1 ft bgs.

CDM Smith

BOREHOLE LOG
B-504

Client: City of Chattanooga, TN
Project Location: Chattanooga, TN
Project Name: Dupont Pump Station and Basin Improvements
Project Number: 109746

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in or Drilling Rate (min/ft)	Graphic Log	USCS Designation	Material Description
NQ	C-3	60/60	609.6 / 45					Hard, fresh, blue gray, fine grained **LIMESTONE**, primary joint set horizontal to shallow, moderately close, rough, planar and stepped, fresh, slightly open. **REC = 100%, RQD = 100%** - 6" seam of very hard, dark gray and white, FLINT encountered 41.6 to 42.1 ft bgs.
NQ	C-4	60/58.5	604.6 / 50					Hard, fresh, blue gray, fine grained **LIMESTONE**, primary joint set horizontal to shallow, moderately close, rough, planar and undulating, fresh, slightly open to tight. **REC = 98%, RQD = 98%**
NQ	C-5	58/60	599.6 / 55					Medium hard to hard, fresh, blue-gray, fine grained **LIMESTONE**; primary joint set horizontal, close to moderately close, rough, undulating, fresh, partly open to tight. **REC = 100%, RQD = 100%**
			594.6 / 60					Boring terminated at 55.0 ft bgs.
			589.6					

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Appendix D

S&ME Geotechnical Laboratory Testing Report

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April 22, 2019

CDM Smith
4600 Park Road #240
Charlotte, North Carolina 28209

Attention: Mr. Erdem Onur Tastan, Ph.D., P.E.

Reference: Laboratory Testing Services Report
DuPont WTP
Chattanooga, Tennessee
S&ME Project No. 1281-18-061

Dear Mr. Tastan:

S&ME, Inc. provided drilling and laboratory testing services at the above referenced project. Services were performed in general accordance with the scope of services outlined in the Standard Form of Agreement between Engineer and Subcontractor for Drilling Services dated February 18, 2019. Attached you will find laboratory reports documenting the laboratory testing services performed.

Should you have any questions regarding this information, or if we can be of any further assistance, please contact us at your convenience.

Sincerely,

S&ME, Inc.

David Grass, PE
Project Engineer

Attachments: Laboratory Testing Reports

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	3/27/2019
Project Name:	Dupont WTP		Test Date(s)	3/26/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-501	Sample #: S-1	Sample Date: 2/28/2019	
Location: Onsite Boring	Offset: N/A	Depth: 3.5'-5'	
Sample Description:	Strong Brown Fat Clay		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	97	21	11				D	I	
A	Tare Weight	15.40	15.13	13.60				80.57	80.61	
B	Wet Soil Weight + A	27.04	27.20	25.15				91.39	91.46	
C	Dry Soil Weight + A	23.00	22.94	21.03				89.42	89.48	
D	Water Weight (B-C)	4.04	4.26	4.12				1.97	1.98	
E	Dry Soil Weight (C-A)	7.60	7.81	7.43				8.85	8.87	
F	% Moisture (D/E)*100	53.2%	54.5%	55.5%				22.3%	22.3%	
N	# OF DROPS	35	23	19				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**22.3%**		

One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**54**
Plastic Limit	**22**
Plastic Index	**32**
Group Symbol	**CH**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/26/2019	David Grass, PE	3/27/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

This report shall not be reproduced, except in full, without the written approval of S&ME, Inc.

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

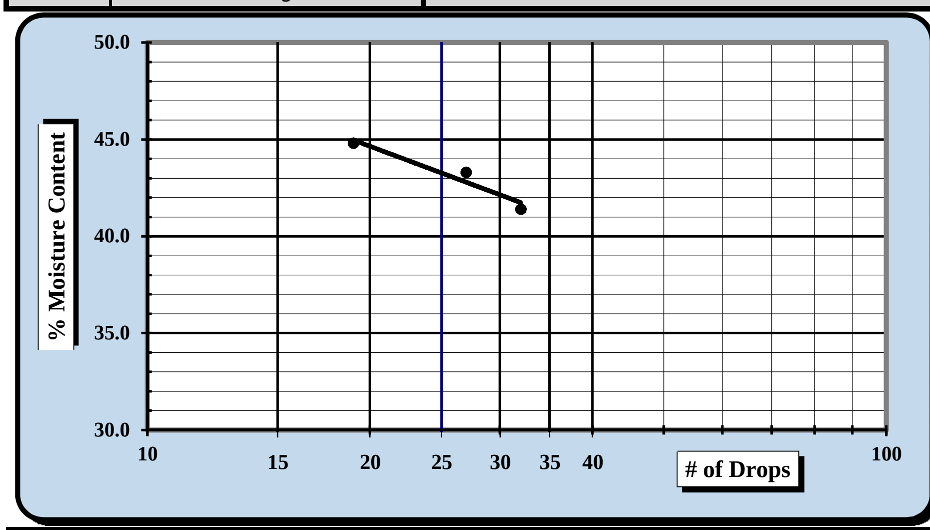
S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	3/29/2019
Project Name:	Dupont WTP		Test Date(s)	3/25/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-501	Sample #: S-3		Sample Date: 2/28/2019
Location: Onsite Boring	Offset: N/A		Depth: 13.5'-15'
Sample Description:	Yellowish Brown Clay		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	48	97	44				C	X	
A	Tare Weight	13.75	15.41	13.68				81.65	81.65	
B	Wet Soil Weight + A	20.20	19.78	18.46				92.92	92.96	
C	Dry Soil Weight + A	18.31	18.46	16.98				91.12	91.13	
D	Water Weight (B-C)	1.89	1.32	1.48				1.80	1.83	
E	Dry Soil Weight (C-A)	4.56	3.05	3.30				9.47	9.48	
F	% Moisture (D/E)*100	41.4%	43.3%	44.8%				19.0%	19.3%	
N	# OF DROPS	32	27	19				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**19.2%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**43**
Plastic Limit	**19**
Plastic Index	**24**
Group Symbol	**CL**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/25/2019	David Grass, PE	3/29/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

S&ME, Inc. - Atlanta: 4350 River Green Parkway, Suite 200, Duluth, GA 30096

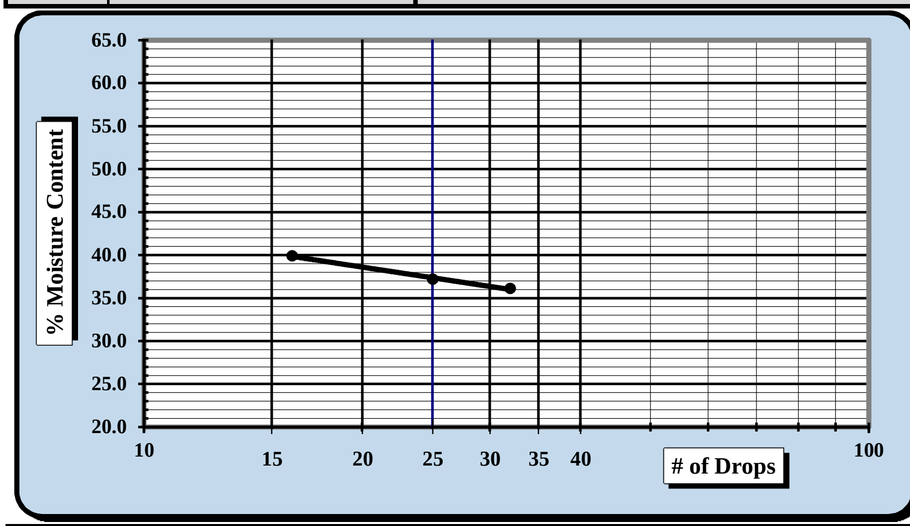
Project #:	1281-18-061	Report Date:	3/29/19
Project Name:	Dupont WTP	Test Date(s)	3/27-3/29/19
Client Name:	CDM Smith		
Client Address:	4600 Park Road, #240, Charlotte, NC 28209		

Boring #: B-502	Sample #: ST-1	Sample Date: N/A
Location: N/A	Offset: N/A	Elevation: 19.5'-21.5'

Sample Description: Dark yellowish brown clay with some sand and a trace of mica

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	25128	4/4/2018	Grooving tool	26551	2/23/2019
LL Apparatus	31336	2/23/2019	Grooving tool		
Oven	31332	2/21/2019	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	1	2	3	4	5	6	7	8	9
A	Tare Weight	14.95	15.19	15.41				15.71	16.00	
B	Wet Soil Weight + A	28.98	30.38	29.02				23.52	23.13	
C	Dry Soil Weight + A	25.26	26.26	25.14				22.24	21.97	
D	Water Weight (B-C)	3.72	4.12	3.88				1.28	1.16	
E	Dry Soil Weight (C-A)	10.31	11.07	9.73				6.53	5.97	
F	% Moisture (D/E)*100	36.1%	37.2%	39.9%				19.6%	19.4%	
N	# OF DROPS	32	25	16				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*								**19.5%**	



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**37**
Plastic Limit	**20**
Plastic Index	**17**
Group Symbol	**CL**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☐ Air Dried ☑

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Jimmy Hanson — 3/29/2019
Technician Name — *Date* — *Technical Responsibility* — *Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

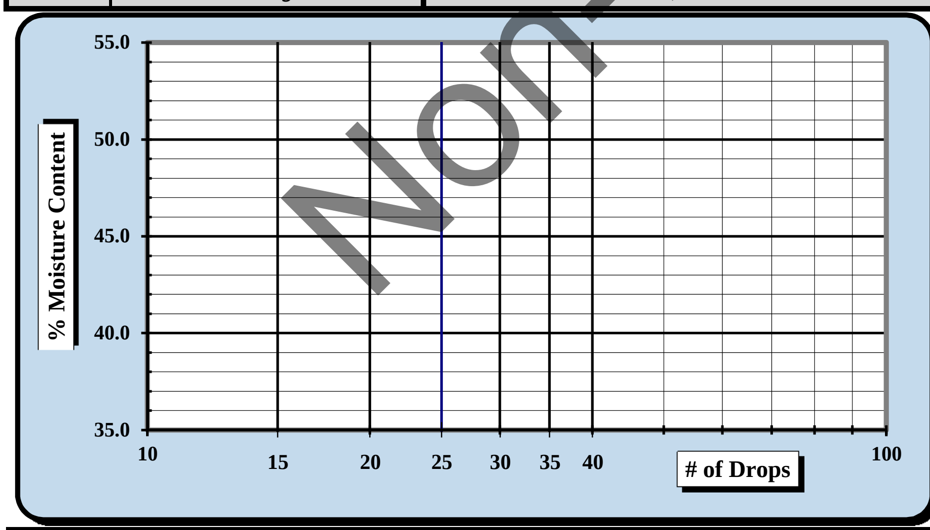
Project #:	1281-18-061	*Log #: 19-066*	Report Date:	4/2/2019
Project Name:	Dupont WTP		Test Date(s)	3/29/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-502	Sample #: S-7	Sample Date: 2/26/2019	
Location: Onsite Boring	Offset: N/A	Depth: 25.5'-27.5'	
Sample Description:	Dark Gray Sandy Silt		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Non-Plastic

Pan #		Liquid Limit						Plastic Limit		
	Tare #:									
A	Tare Weight									
B	Wet Soil Weight + A									
C	Dry Soil Weight + A									
D	Water Weight (B-C)									
E	Dry Soil Weight (C-A)									
F	% Moisture (D/E)*100									
N	# OF DROPS							*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*									



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☒
Liquid Limit
Plastic Limit
Plastic Index
Group Symbol
Multipoint Method ☐
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/29/2019	David Grass, PE	4/3/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	3/29/2019
Project Name:	Dupont WTP		Test Date(s)	3/27/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-503	Sample #: S-2	Sample Date: 3/1/2019
Location: Onsite Boring	Offset: N/A	Depth: 2'-4'

Sample Description: Yellowish Brown Lean Clay

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	9	48	21				D	I	
A	Tare Weight	15.05	13.75	15.13				80.57	80.61	
B	Wet Soil Weight + A	26.32	25.42	27.27				91.56	91.43	
C	Dry Soil Weight + A	22.76	21.78	23.30				89.64	89.54	
D	Water Weight (B-C)	3.56	3.64	3.97				1.92	1.89	
E	Dry Soil Weight (C-A)	7.71	8.03	8.17				9.07	8.93	
F	% Moisture (D/E)*100	46.2%	45.3%	48.6%				21.2%	21.2%	
N	# OF DROPS	27	33	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**21.2%**		

One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**47**
Plastic Limit	**21**
Plastic Index	**26**
Group Symbol	**CL**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/27/2019	David Grass, PE	3/29/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	4/3/2019
Project Name:	Dupont WTP		Test Date(s)	4/1/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #:	B-503	Sample #: ST-2	Sample Date: 3/1/2019
Location:	Onsite Boring	Offset: N/A	Depth: 10'-11'
Sample Description:	Yellowish Brown Lean Clay		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	6	14	89				C	X	
A	Tare Weight	15.31	13.69	15.25				81.66	81.65	
B	Wet Soil Weight + A	27.24	24.42	25.17				92.89	92.71	
C	Dry Soil Weight + A	23.45	20.92	21.84				90.89	90.78	
D	Water Weight (B-C)	3.79	3.50	3.33				2.00	1.93	
E	Dry Soil Weight (C-A)	8.14	7.23	6.59				9.23	9.13	
F	% Moisture (D/E)*100	46.6%	48.4%	50.5%				21.7%	21.1%	
N	# OF DROPS	32	24	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**21.4%**		

One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**48**
Plastic Limit	**21**
Plastic Index	**27**
Group Symbol	**CL**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/24/2019	David Grass, PE	3/27/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

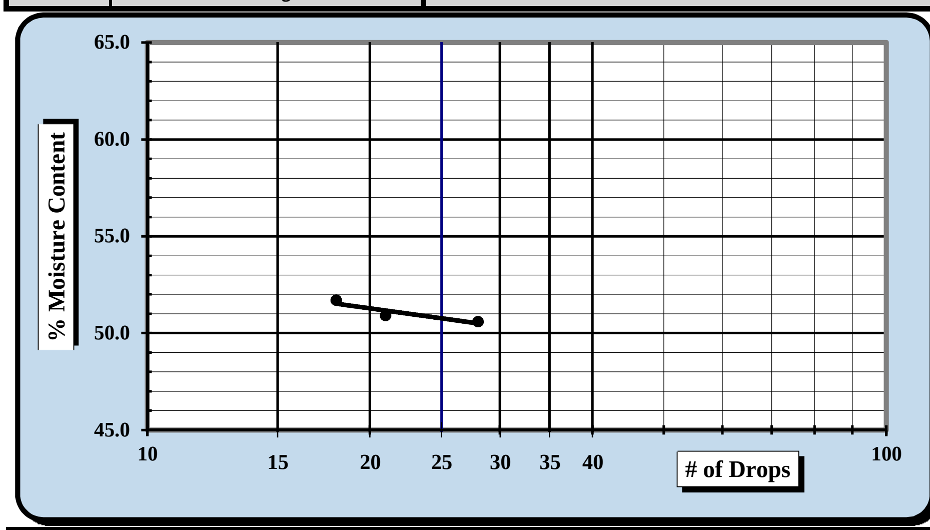
S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	3/27/2019
Project Name:	Dupont WTP		Test Date(s)	3/24/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-504	Sample #: S-5	Sample Date: 2/25/2019	
Location: Onsite Boring	Offset: N/A	Depth: 8'-10'	
Sample Description:	Yellowish Brown Fat Clay		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	13	21	91				L	M	
A	Tare Weight	13.51	15.13	13.09				81.35	81.35	
B	Wet Soil Weight + A	22.85	25.39	24.27				92.47	92.40	
C	Dry Soil Weight + A	19.71	21.93	20.46				90.49	90.48	
D	Water Weight (B-C)	3.14	3.46	3.81				1.98	1.92	
E	Dry Soil Weight (C-A)	6.20	6.80	7.37				9.14	9.13	
F	% Moisture (D/E)*100	50.6%	50.9%	51.7%				21.7%	21.0%	
N	# OF DROPS	28	21	18				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**21.4%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic	☐
Liquid Limit	**51**
Plastic Limit	**21**
Plastic Index	**30**
Group Symbol	**CH**
Multipoint Method	☑
One-point Method	☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Rick Setzer	3/24/2019	David Grass, PE	3/27/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

Form No. TR-D4318-T89-90
Revision No. 1
Revision Date: 7/26/17

LIQUID LIMIT, PLASTIC LIMIT, & PLASTIC INDEX

ASTM D 4318 ☒ AASHTO T 89 ☐ AASHTO T 90 ☐

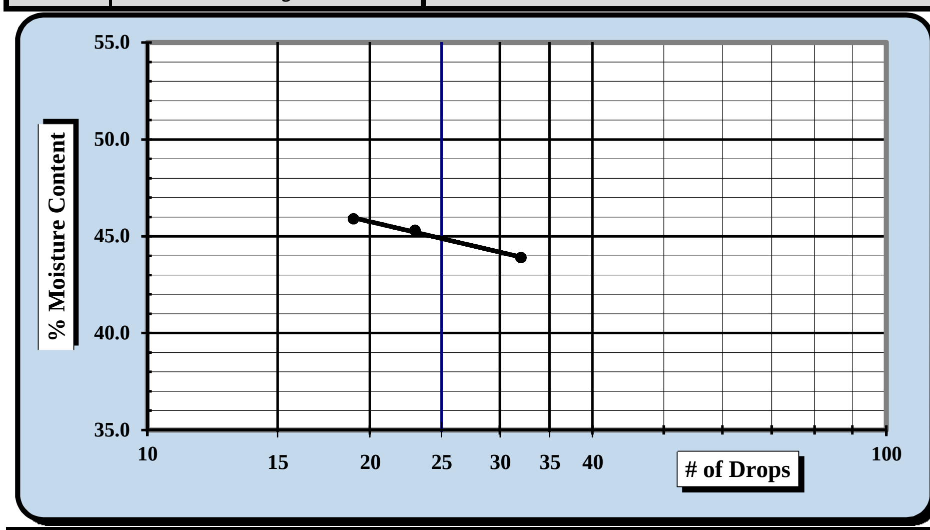
S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	*Log #: 19-066*	Report Date:	3/29/2019
Project Name:	Dupont WTP		Test Date(s)	3/28/2019
Client Name:	CDM Smith			
Client Address:	4600 Park Rd #240 Charlotte, NC 28209			

Boring #: B-504	Sample #: S-9		Sample Date: 2/25/2019
Location: Onsite Boring	Offset: N/A		Depth: 16'-18'
Sample Description:	Dark Brown Lean Clay		

Type and Specification	*S&ME ID #*	*Cal Date:*	*Type and Specification*	*S&ME ID #*	*Cal Date:*
Balance (0.01 g)	22533	9/17/2018	Grooving tool	33327	2/12/2019
LL Apparatus	22738	4/24/2018	Grooving tool		
Oven	22617	9/26/2018	Grooving tool		

Pan #		Liquid Limit						Plastic Limit		
	Tare #:	94	24	89				M	L	
A	Tare Weight	15.59	15.33	15.23				81.35	81.35	
B	Wet Soil Weight + A	26.86	29.93	28.81				88.73	87.61	
C	Dry Soil Weight + A	23.42	25.38	24.54				87.37	86.48	
D	Water Weight (B-C)	3.44	4.55	4.27				1.36	1.13	
E	Dry Soil Weight (C-A)	7.83	10.05	9.31				6.02	5.13	
F	% Moisture (D/E)*100	43.9%	45.3%	45.9%				22.6%	22.0%	
N	# OF DROPS	32	23	19				*Moisture Contents determined by ASTM D 2216*		
LL	LL = **F** * FACTOR									
Ave.	*Average*							**22.3%**		



One Point Liquid Limit

N	Factor	N	Factor
20	0.974	26	1.005
21	0.979	27	1.009
22	0.985	28	1.014
23	0.99	29	1.018
24	0.995	30	1.022
25	1.000		

NP, Non-Plastic ☐

Liquid Limit	**45**
Plastic Limit	**22**
Plastic Index	**23**
Group Symbol	**CL**

Multipoint Method ☑
One-point Method ☐

Wet Preparation ☐ Dry Preparation ☑ Air Dried ☐

Notes / Deviations / References:

ASTM D 4318: Liquid Limit, Plastic Limit, & Plastic Index of Soils

Tyler Thompson	3/28/2019	David Grass, PE	3/29/2019
Technician Name	*Date*	*Technical Responsibility*	*Date*

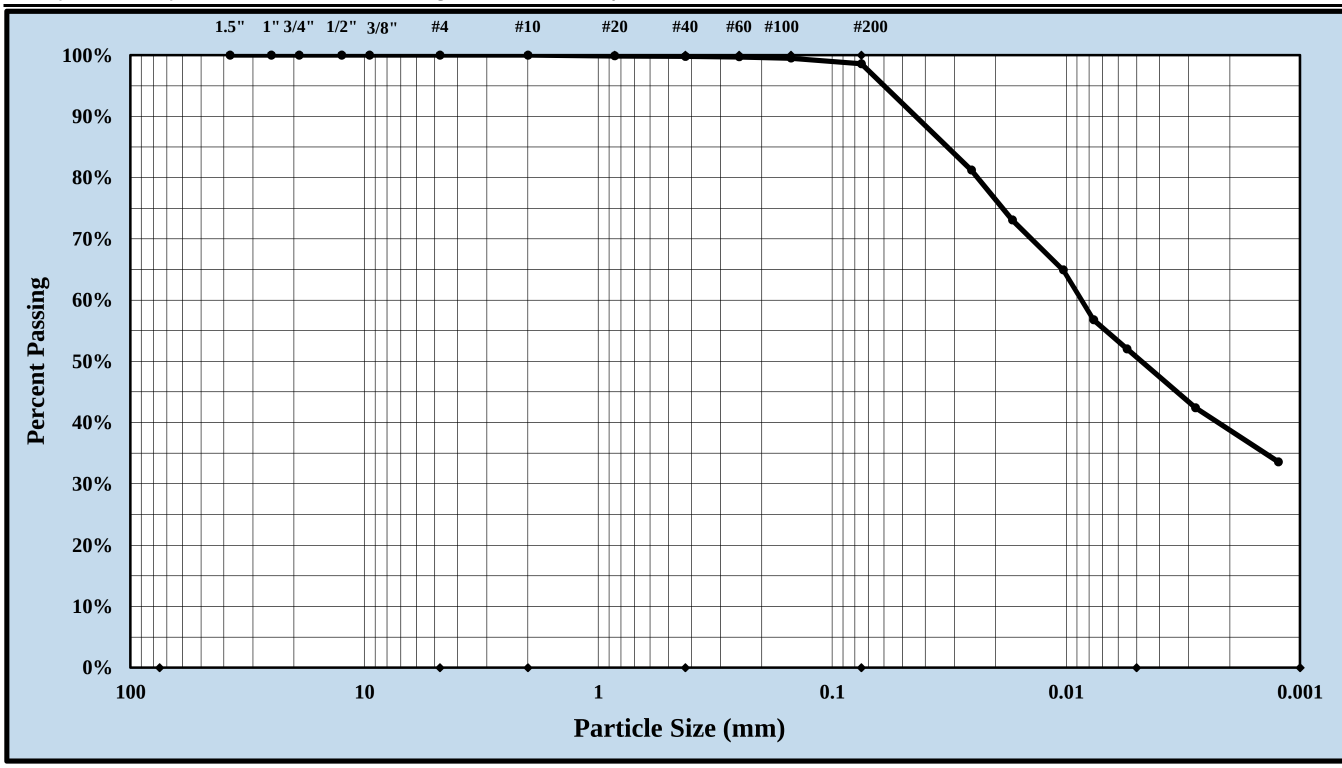
Form No. TR-D422-3
Revision No. 2
Revision Date: 08/29/17

PARTICLE SIZE ANALYSIS OF SOIL

ASTM D 6913 & D 7928

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

S&ME Project #:	1281-18-061	Report Date:	4/2/2019
Project Name:	Dupont WTP	Test Date(s):	3/28 - 4/1/2019
Client Name:	CDM Smith		
Address:	4600 Park Rd #240 Charlotte, NC 28209		
Boring #:	B-501 Sample #: S-1	Sample Date:	2/28/2019
Location:	Onsite Boring Offset: N/A	Depth:	3.5'-5'
Sample Description:	Strong Brown Fat Clay		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size:	#100	Gravel:	0.0%	Silt	48.0%
Silt & Clay (% Passing #200):	98.6%	Total Sand:	1.4%	Clay	50.6%
Apparent Relative Density	2.650				
Liquid Limit	54	Plastic Limit	22	Plastic Index	32
Coarse Sand:	0.0%	Medium Sand:	0.2%	Fine Sand:	1.2%

Description of Sand and Gravel Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus A Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 5.04g

References / Comments / Deviations: AASTM D 4318, D 2487

Apparent Relative Density is assumed.

David Grass, PE	____________	Project Engineer	4/2/2019
Technical Responsibility	*Signature*	*Position*	*Date*

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Form No TR-D6913-GR-01
Revision No. 1
Revision Date: 9/5/17

SIEVE ANALYSIS OF SOIL

Single sieve set ASTM D6913

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #: 1281-18-061 Log #: 19-066 Record Date: 3/29/2019

Project Name: Dupont WTP

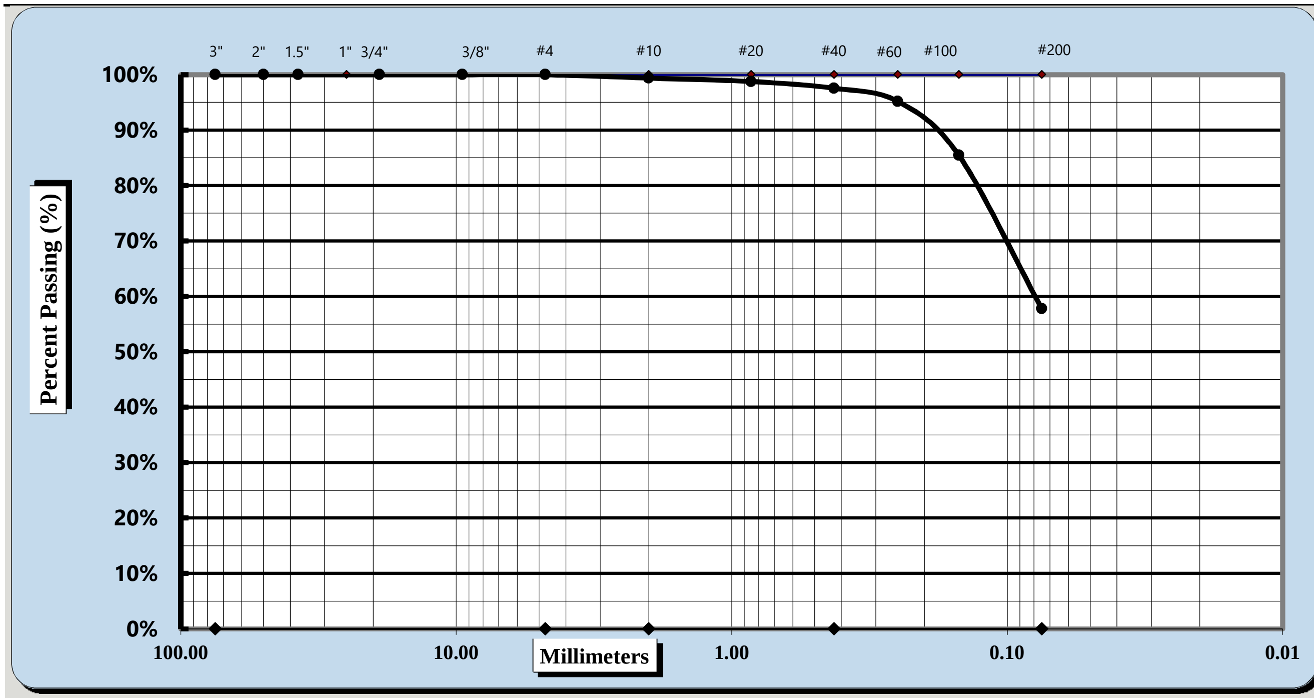
Client Name: CDM Smith

Received By: D. Grass Sampled by: Drillers Date Sampled: 2/28/2019

Location: Onsite Boring

Boring/Sample Id. B-501 / S-7 Type: SS Depth: 26'-28'

Sample Description: Brownish Gray Sandy Clay



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: A Procedure for obtaining Specimen: Moist Dispersion Process: Agitation

Maximum Particle Size	#10	Coarse Sand	1%	Fine Sand	40%
Gravel	0%	Medium Sand	2%	Silt & Clay	58%
Liquid Limit	50	Plastic Limit	TNP	Plastic Index	TNP
Maximum Dry Density	TNP	Bulk Gravity (C127)	TNP	% Absorption	TNP
Optimum Moisture	TNP	Natural Moisture	TNP	CBR	TNP

Notes / Deviations / References:

David Grass, PE		Project Engineer	4/1/2019
Technical Responsibility	*Signature*	*Position*	*Date*

Form No TR-D6913-GR-01
Revision No. 1
Revision Date: 9/5/17

SIEVE ANALYSIS OF SOIL

Single sieve set

ASTM D6913

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #: 1281-18-061 | Log #: 19-066 | Record Date: 3/29/2019

Project Name: Dupont WTP

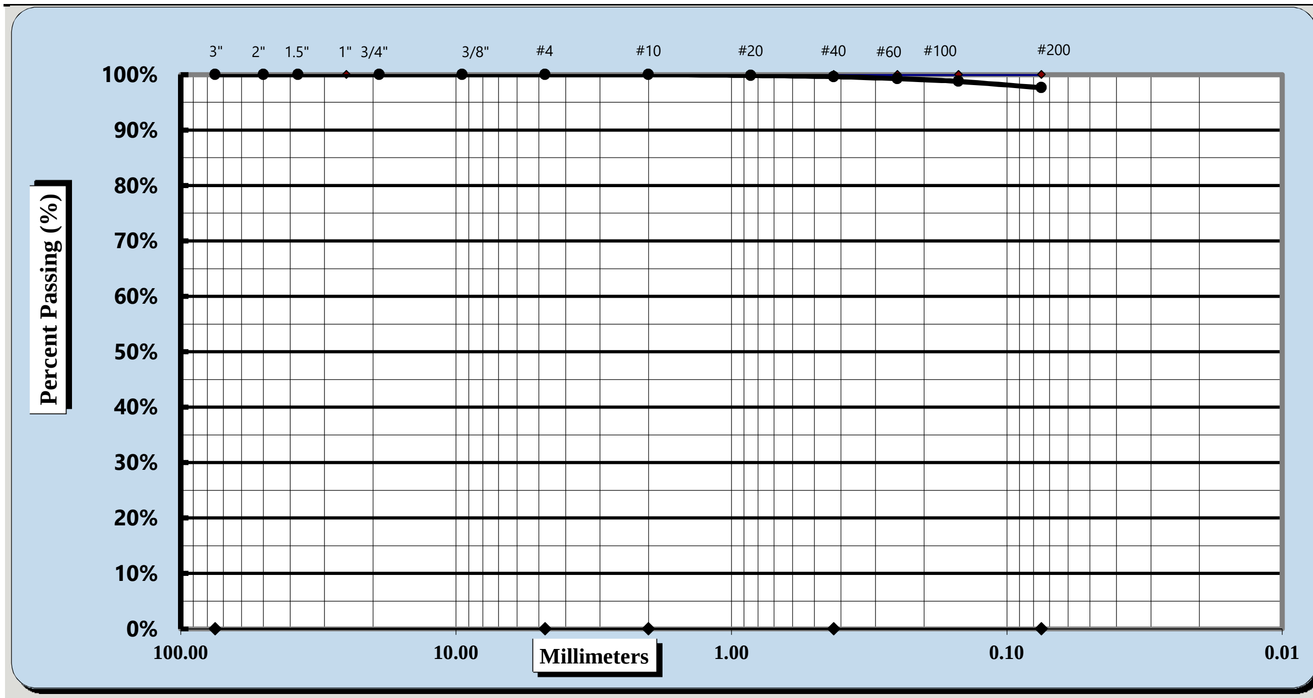
Client Name: CDM Smith

Received By: D. Grass | Sampled by: Drillers | Date Sampled: 2/26/2019

Location: Onsite Boring

Boring/Sample Id. B-502/S-2 | Type: SS | Depth: 8'-9.5'

Sample Description: Yellowish Brown Fat Clay



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: A | Procedure for obtaining Specimen: Moist | Dispersion Process: Agitation

Maximum Particle Size	#10	Coarse Sand	0%	Fine Sand	2%
Gravel	0%	Medium Sand	0%	Silt & Clay	98%
Liquid Limit	51	Plastic Limit	21	Plastic Index	30
Maximum Dry Density	TNP	Bulk Gravity (C127)	TNP	% Absorption	TNP
Optimum Moisture	TNP	Natural Moisture	TNP	CBR	TNP

Notes / Deviations / References:

TNP - Test Not Performed

David Grass, PE		Project Engineer	4/1/2019
Technical Responsibility	*Signature*	*Position*	*Date*

Form No: TR-D422-WH-1Gb
Revision No. 1
Revision Date: 8/10/17

SIEVE ANALYSIS OF SOILS

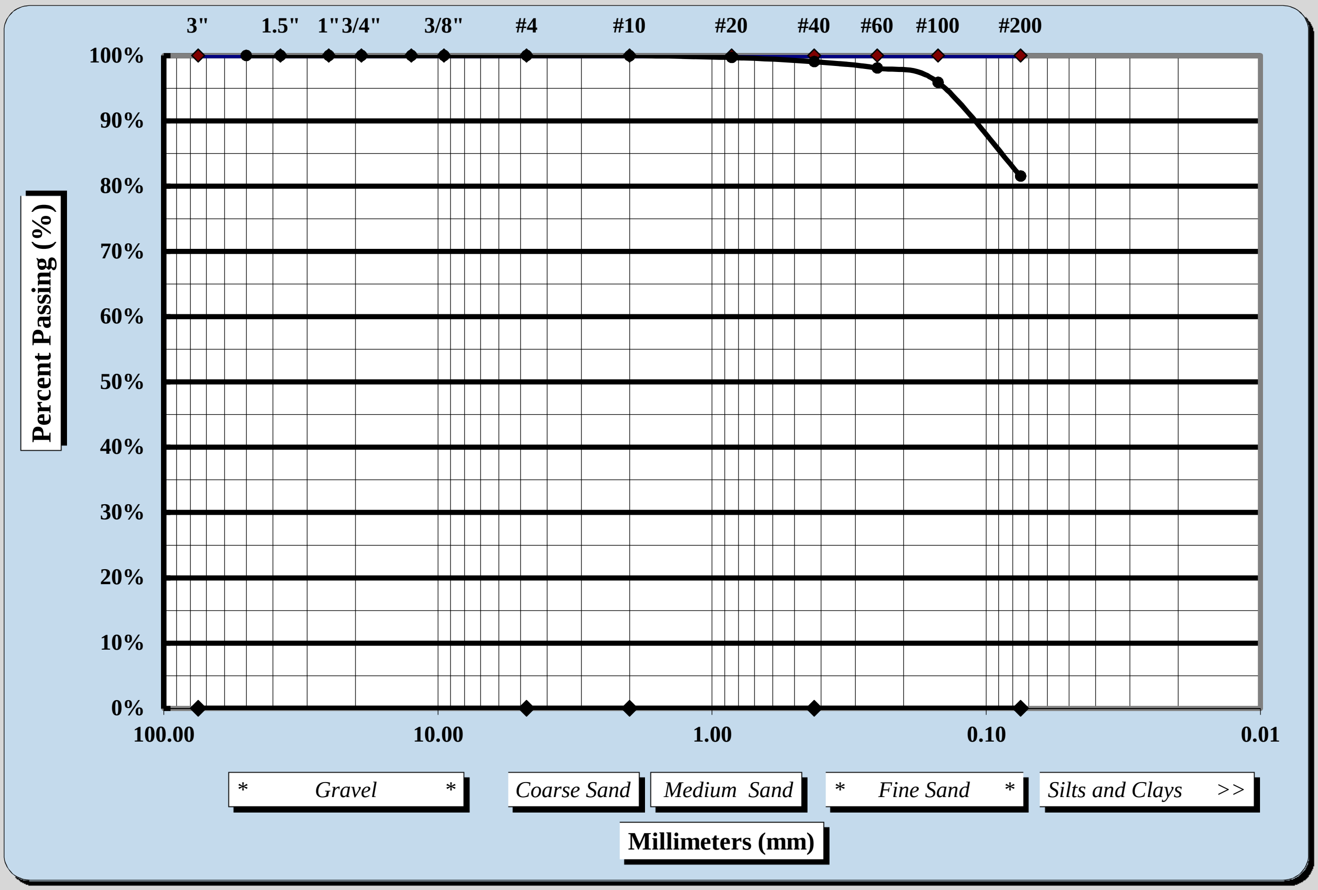
ASTM D 6913

S&ME, Inc. - Atlanta: 4350 River Green Parkway, Suite 200, Duluth, GA 30096

Project #:	1281-18-061	Report Date:	3/29/19
Project Name:	Dupont WTP	Test Date(s):	3/27-3/29/19
Client Name:	CDM Smith		
Client Address:	4600 Park Road, #240, Charlotte, NC 28209		

Sample Id. B-502	Type: U.D.	Sample Date: N/A	
Location: N/A	Sample: ST-1	Elevation: 19.5'-21.5'	

Sample Description: Dark yellowish brown clay with some sand and a trace of mica



Maximum Particle Size	2mm	Coarse Sand	0.0%	Fine Sand	17.5%
Gravel	0.0%	Medium Sand	0.9%	Silt & Clay	81.5%
Liquid Limit	37	Plastic Limit	20	Plastic Index	17

Coarse Sand	0.0%	Medium Sand	0.9%	Fine Sand	17.5%

Description of Sand & Gravel Particles: Rounded ☐ Angular ☐
Hard & Durable ☐ Soft ☐ Weathered & Friable ☐

Notes / Deviations / References:

Jacob T. David		Staff Professional II	4/17/2019
Technical Responsibility	*Signature*	*Position*	*Date*

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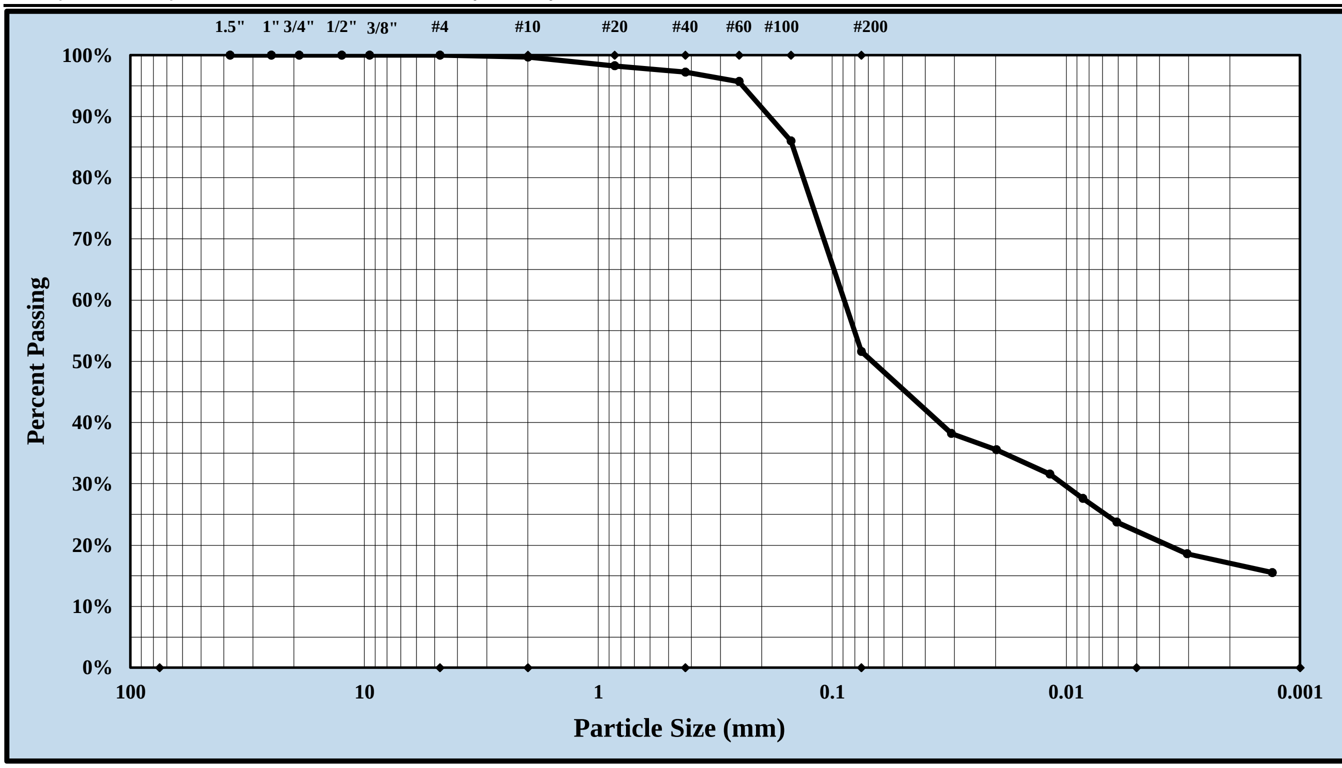
Form No. TR-D422-3
Revision No. 2
Revision Date: 08/29/17

PARTICLE SIZE ANALYSIS OF SOIL

ASTM D 6913 & D 7928

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

S&ME Project #:	1281-18-061	Report Date:	4/3/2019
Project Name:	Dupont WTP	Test Date(s):	3/28 - 4/1/2019
Client Name:	CDM Smith		
Address:	4600 Park Rd #240 Charlotte, NC 28209		
Boring #:	B-502 Sample #: S-7	Sample Date:	2/26/2019
Location:	Onsite Boring Offset: N/A	Depth:	25.5'-27.5'
Sample Description:	Dark Gray Sandy Silt		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size:	#10	Gravel:	0.0%	Silt	29.4%
Silt & Clay (% Passing #200):	51.6%	Total Sand:	48.4%	Clay	22.2%
Apparent Relative Density	2.650				
Liquid Limit	NP	Plastic Limit	NP	Plastic Index	NP
Coarse Sand:	0.3%	Medium Sand:	2.4%	Fine Sand:	45.6%

Description of Sand and Gravel Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus A Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 5.01

References / Comments / Deviations: AASTM D 4318, D 2487

Apparent Relative Density is assumed.

David Grass, PE	____________________	Project Engineer	4/3/2019
Technical Responsibility	*Signature*	*Position*	*Date*

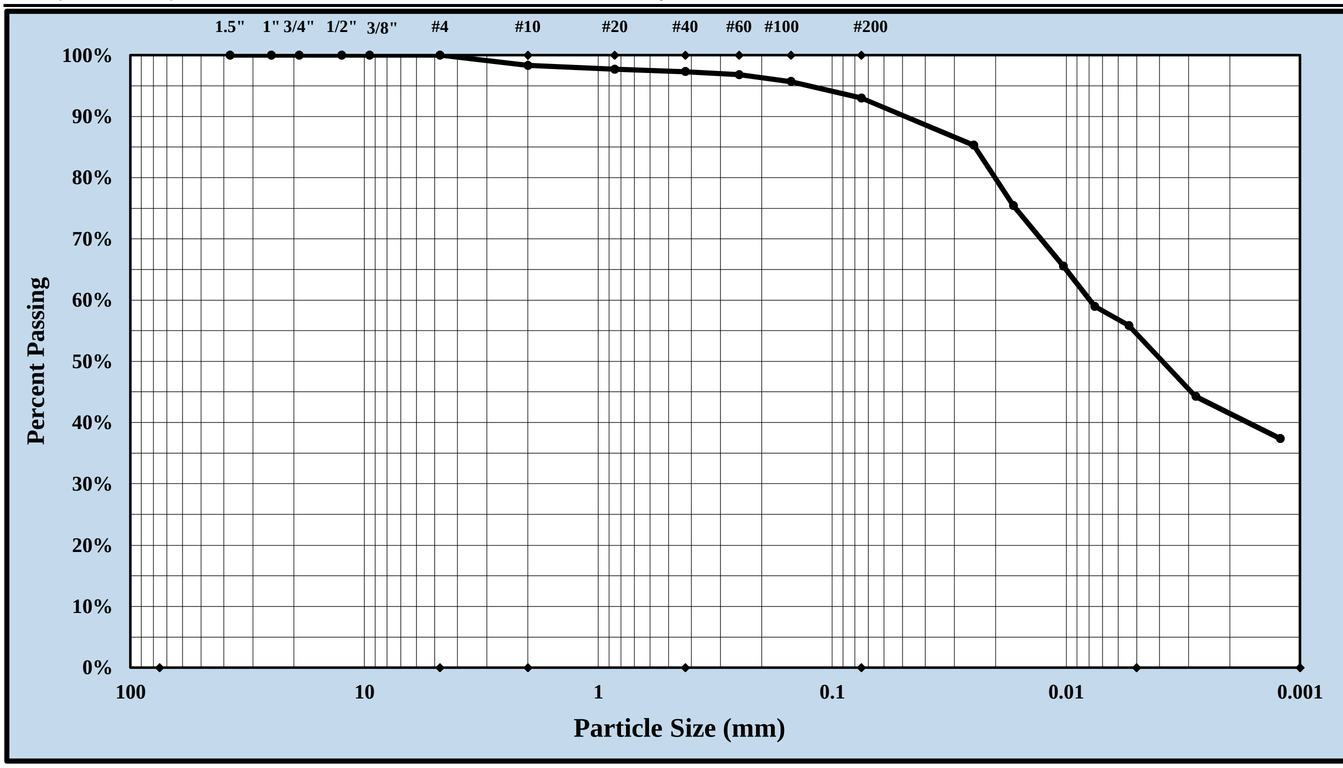
Form No. TR-D422-3
Revision No. 2
Revision Date: 08/29/17

PARTICLE SIZE ANALYSIS OF SOIL

ASTM D 6913 & D 7928

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

S&ME Project #:	1281-18-061	Report Date:	4/3/2019
Project Name:	Dupont WTP	Test Date(s):	3/28 - 4/1/2019
Client Name:	CDM Smith		
Address:	4600 Park Rd #240 Charlotte, NC 28209		
Boring #:	B-503 Sample #: S-2	Sample Date:	3/1/2019
Location:	Onsite Boring Offset: N/A	Depth:	2'-4'
Sample Description:	Yellowish Brown Lean Clay		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size:	#20	Gravel:	0.0%	Silt	38.5%
Silt & Clay (% Passing #200):	93.0%	Total Sand:	7.0%	Clay	54.5%
Apparent Relative Density	2.650				
Liquid Limit	47	Plastic Limit	21	Plastic Index	26
Coarse Sand:	1.7%	Medium Sand:	1.0%	Fine Sand:	4.3%

Description of Sand and Gravel Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

Mechanical Stirring Apparatus A Dispersion Period: 1 min. Dispersing Agent: Sodium Hexametaphosphate: 5.06

References / Comments / Deviations: AASTM D 4318, D 2487

Apparent Relative Density is assumed.

David Grass, PE	____________________	Project Engineer	4/2/2019
Technical Responsibility	*Signature*	*Position*	*Date*

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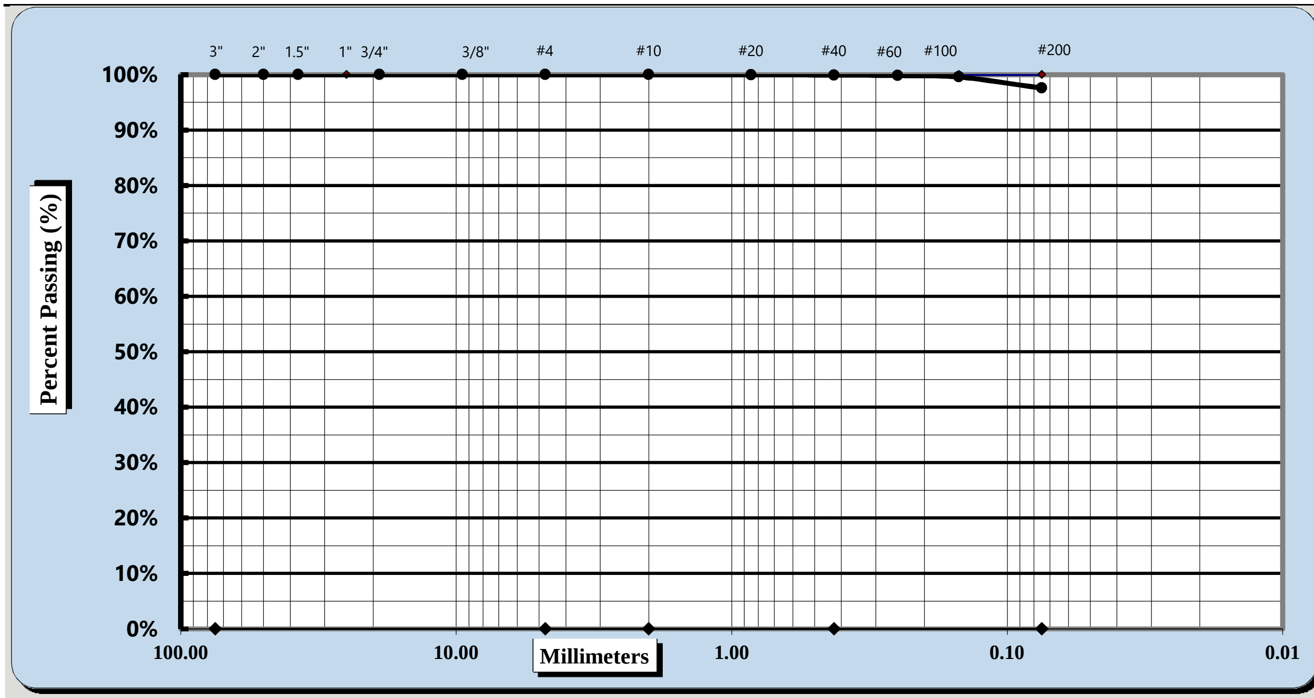
Form No TR-D6913-GR-01
Revision No. 1
Revision Date: 9/5/17

SIEVE ANALYSIS OF SOIL

Single sieve set ASTM D6913

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #: 1281-18-061	Log #: 19-066	Record Date:	4/3/2019
Project Name: Dupont WTP			
Client Name: CDM Smith			
Received By: D. Grass	Sampled by: Drillers	Date Sampled:	3/1/2019
Location: Onsite Boring			
Boring/Sample Id. B-503 / ST-2	Type: UD	Depth: 10'-11'	
Sample Description: Yellowish Brown Lean Clay			



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: A Procedure for obtaining Specimen: Moist Dispersion Process: Agitation

Maximum Particle Size	#100	Coarse Sand	0%	Fine Sand	2%
Gravel	0%	Medium Sand	0%	Silt & Clay	98%
Liquid Limit	48	Plastic Limit	21	Plastic Index	27
Maximum Dry Density	TNP	Bulk Gravity (C127)	TNP	% Absorption	TNP
Optimum Moisture	TNP	Natural Moisture	TNP	CBR	TNP

Notes / Deviations / References:

TNP - Test Not Performed

David Grass, PE	____________________	Project Engineer	4/1/2019
Technical Responsibility	*Signature*	*Position*	*Date*

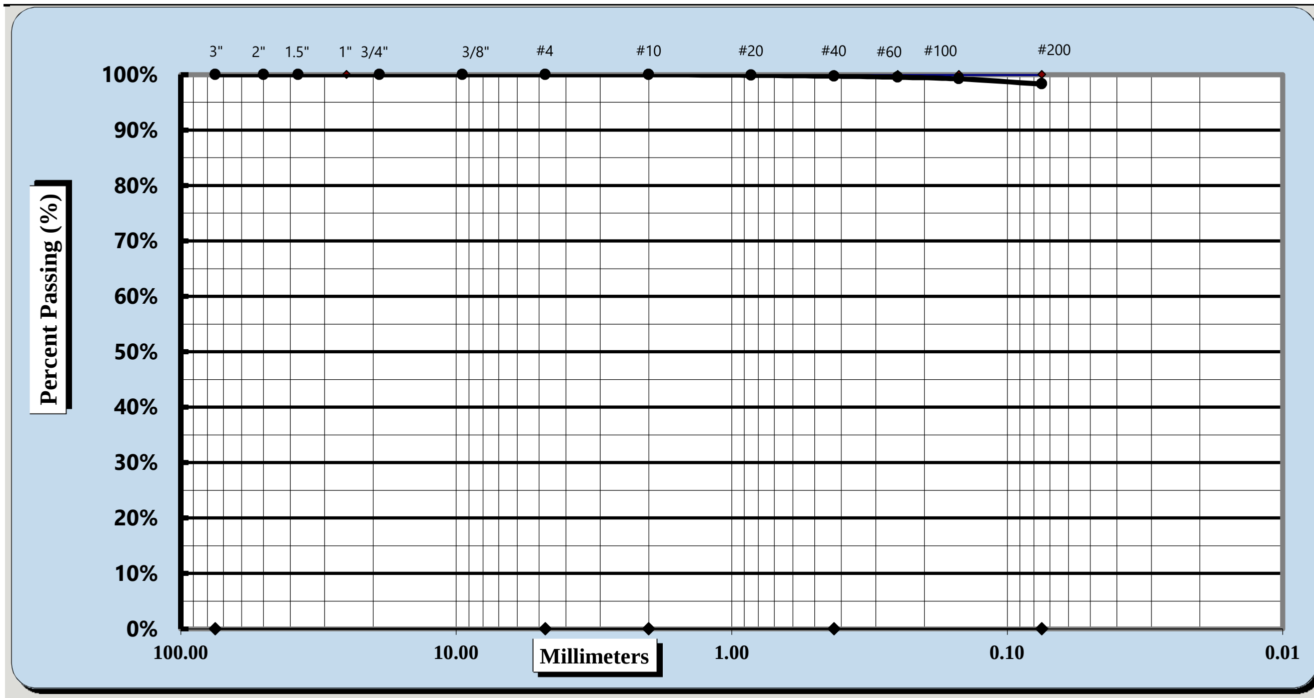
Form No TR-D6913-GR-01
Revision No. 1
Revision Date: 9/5/17

SIEVE ANALYSIS OF SOIL

Single sieve set ASTM D6913

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

Project #:	1281-18-061	Log #: 19-066		Record Date:	3/29/2019
Project Name:	Dupont WTP				
Client Name:	CDM Smith				
Received By:	D. Grass	Sampled by:	Drillers	Date Sampled:	2/25/2019
Location:	Onsite Boring				
Boring/Sample Id.	B-504 / S-5	Type:	SS	Depth:	8'-10'
Sample Description:	Yellowish Brown Fat Clay				



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Method: A Procedure for obtaining Specimen: Moist Dispersion Process: Agitation

Maximum Particle Size	#10	Coarse Sand	0%	Fine Sand	1%
Gravel	0%	Medium Sand	0%	Silt & Clay	98%
Liquid Limit	51	Plastic Limit	21	Plastic Index	30
Maximum Dry Density	TNP	Bulk Gravity (C127)	TNP	% Absorption	TNP
Optimum Moisture	TNP	Natural Moisture	TNP	CBR	TNP

Notes / Deviations / References:

TNP - Test Not Performed

David Grass, PE		Project Engineer	4/1/2019
Technical Responsibility	*Signature*	*Position*	*Date*

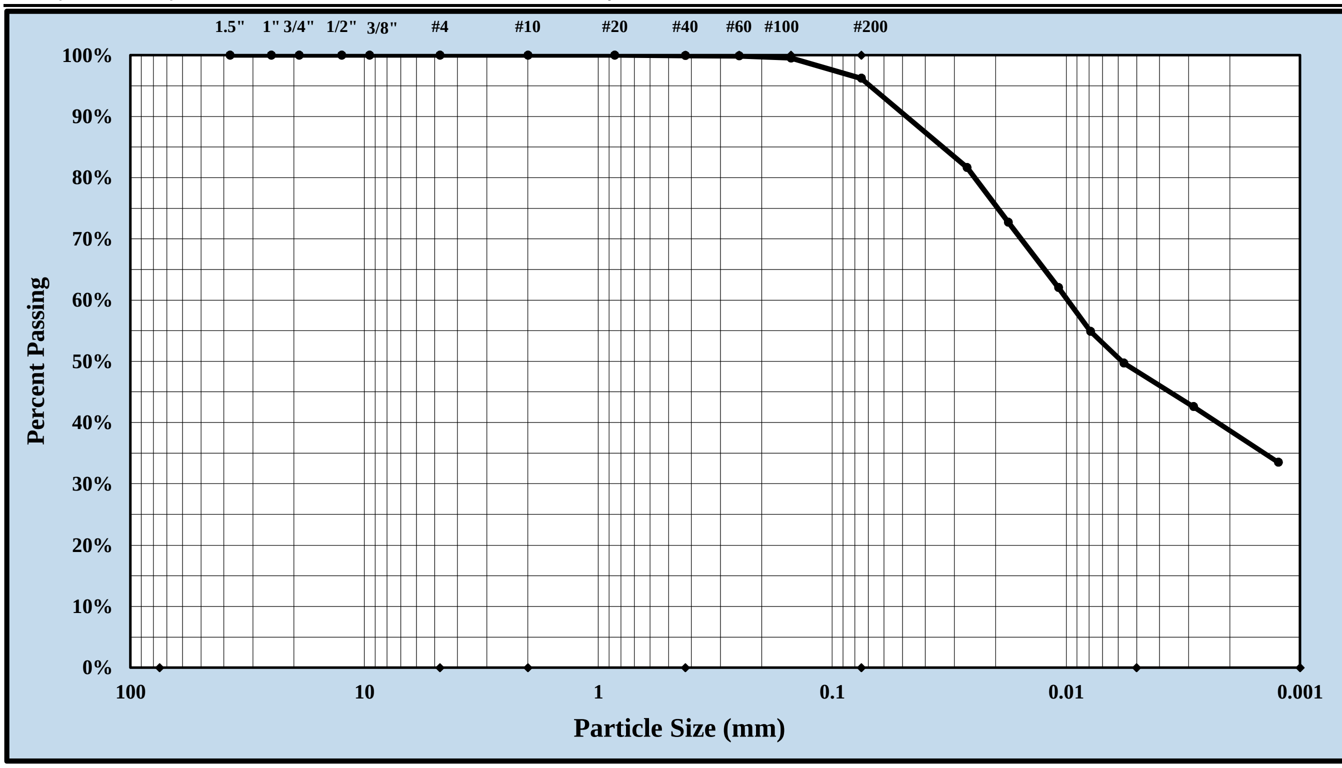
Form No. TR-D422-3
Revision No. 2
Revision Date: 08/29/17

PARTICLE SIZE ANALYSIS OF SOIL

ASTM D 6913 & D 7928

S&ME, Inc. - Chattanooga: 4291 Highway 58, Suite 101, Chattanooga, TN 37416

S&ME Project #:	1281-18-061	Report Date:	4/2/2019
Project Name:	Dupont WTP	Test Date(s):	3/28 - 4/1/2019
Client Name:	CDM Smith		
Address:	4600 Park Rd #240 Charlotte, NC 28209		
Boring #:	B-504 Sample #: S-9	Sample Date:	2/25/2019
Location:	Onsite Boring Offset: N/A	Depth:	16'-18'
Sample Description:	Dark Brown Lean Clay		



Cobbles	< 300 mm (12") and > 75 mm (3")	Fine Sand	< 0.425 mm and > 0.075 mm (#200)
Gravel	< 75 mm and > 4.75 mm (#4)	Silt	< 0.075 and > 0.005 mm
Coarse Sand	< 4.75 mm and >2.00 mm (#10)	Clay	< 0.005 mm
Medium Sand	< 2.00 mm and > 0.425 mm (#40)	Colloids	< 0.001 mm

Maximum Particle Size:	#20	Gravel:	0.0%	Silt	47.7%
Silt & Clay (% Passing #200):	96.2%	Total Sand:	3.8%	Clay	48.5%
Apparent Relative Density	2.650				
Liquid Limit	45	Plastic Limit	22	Plastic Index	23
Coarse Sand:	0.0%	Medium Sand:	0.1%	Fine Sand:	3.7%

Description of Sand and Gravel: Rounded ☐ Angular ☒ Hard & Durable ☒ Soft ☐ Weathered & Friable ☐

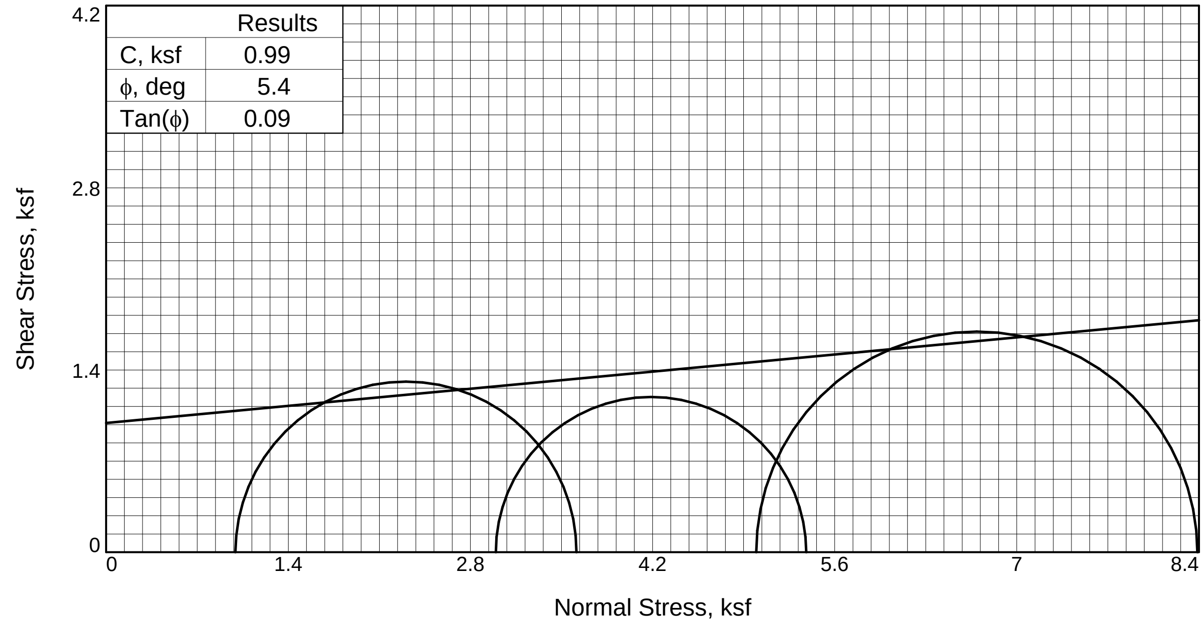
Mechanical Stirring Apparatus A   Dispersion Period: 1 min.   Dispersing Agent: Sodium Hexametaphosphate: 5.09

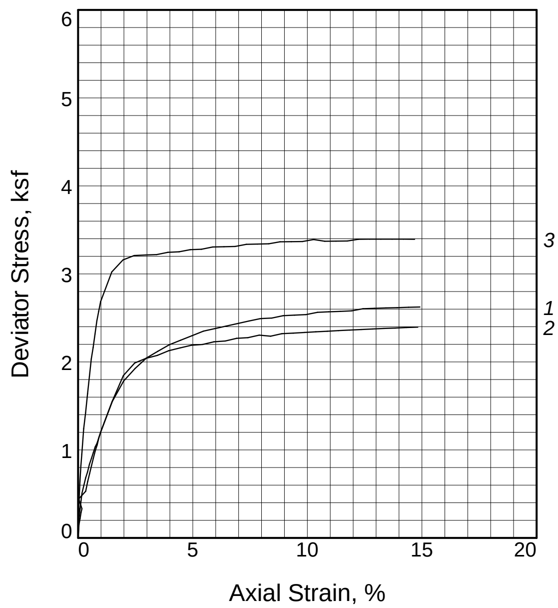
References / Comments / Deviations: AASTM D 4318, D 2487

Apparent Relative Density is assumed.

David Grass, PE	____________	Project Engineer	4/2/2019
Technical Responsibility	*Signature*	*Position*	*Date*

C & phi are not test results but an interpretation of the test results. The designer is responsible for interpreting test data as provided by S&ME.





Sample No.		1	2	3
Initial	Water Content, %	26.1	27.5	26.4
	Dry Density, pcf	98.7	97.3	98.0
	Saturation, %	97.1	99.0	96.6
	Void Ratio	0.7386	0.7645	0.7510
	Diameter, in.	2.874	2.877	2.872
	Height, in.	6.035	6.073	6.132
At Test	Water Content, %	26.1	27.5	26.4
	Dry Density, pcf	98.7	97.3	98.0
	Saturation, %	97.1	99.0	96.6
	Void Ratio	0.7386	0.7645	0.7510
	Diameter, in.	2.874	2.877	2.872
	Height, in.	6.035	6.073	6.132
Strain rate, %/min.		1.00	1.00	1.00
Back Pressure, psi		0.00	0.00	0.00
Cell Pressure, psi		6.90	20.80	34.70
Fail. Stress, ksf		2.62	2.39	3.39
Ult. Stress, ksf		2.63	2.40	3.40
σ_1 Failure, ksf		3.62	5.38	8.39
σ_3 Failure, ksf		0.99	3.00	5.00

Type of Test:
Unconsolidated Undrained

Sample Type: Intact

Description: Dark yellowish brown clay with some sand and a trace of mica

LL= 37 **PL=** 20 **PI=** 17

Assumed Specific Gravity= 2.75

Remarks: Trimmed specimens to length.

Figure 1

Client: CDM Smith 4600 Park Road, #240, Charlotte, NC 28209

Project: Dupont WTP

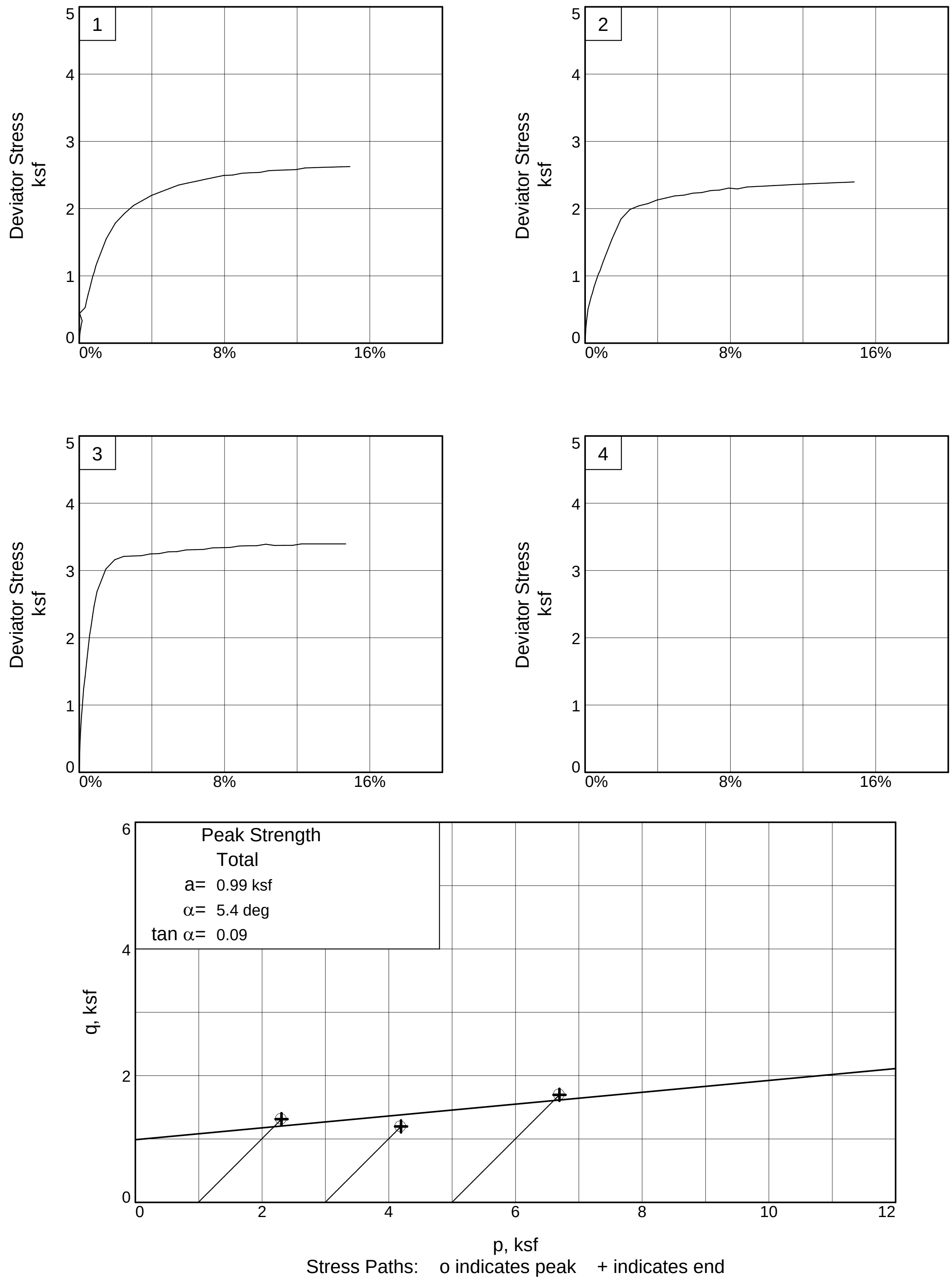
Location: B-502

Sample Number: ST-1 **Depth:** 19.5'-21.5'

Proj. No.: 1281-18-061 **Date Sampled:** 3/4/19

TRIAXIAL SHEAR TEST REPORT
S&ME, Inc.
Duluth, Georgia

Tested By: Jimmy Hanson



C & phi are not test results but an interpretation of the test results. The designer is responsible for interpreting test data as provided by S&ME.

Client: CDM Smith 4600 Park Road, #240, Charlotte, NC 28209
Project: Dupont WTP
Location: B-502 **Depth:** 19.5'-21.5' **Sample Number:** ST-1
Project No.: 1281-18-061 **Figure** 2

S&ME, Inc.

Tested By: Jimmy Hanson

Form No: TR-D4972-1
Revision No. 0
Revision Date: 07/10/08
Sample Log No.: 43-2830

pH of Soil

AASHTO T 289

Quality Assurance

S&ME, Inc., 1413 Topside Road, Louisville, TN 37777

Project #:	**1281-18-061**	Report Date:	4/10/2019
Project Name:	Dupont WTP	Test Date(s):	4/9/2019
Client Name:	CDM Smith		
Client Address:	4600 Park Road #240, Charlotte, NC 28209		
Sample ID:	B-501	Sample No:	S-4
		Depth:	18.5 - 20.5 ft

Sample Description: Light yellowish brown clay

Equipment:

Balance		*S&ME ID#*	*18435*	*Cal. Date:*	*4/2/2019*	*Due:*	*4/2/2020*
Sieve:	*#10*	*S&ME ID#*	*2481*	*Cal. Date:*	*1/29/2019*	*Due:*	*7/29/2019*
pH Meter:		*S&ME ID#*	*16576*	*Cal. Date:*	*4/9/2019*		

pH Meter Calibration

Buffer Solution	*Results*
pH buffer 4.0	***4.01***
pH buffer 7.0	***7.00***
pH buffer 10.0	***10.10***
Buffer Temperature ^{0}C	***23.6°C***

Measuring pH of Soil

Beaker #: 6

Measurements	
Weight of Air Dry Soil (g)	***30.0***
Distilled Water (ml)	***30.0***
Temperature ^{0}C	***23.5°C***
pH Reading	***4.6***

Notes / Deviations / References: AASHTO T 289 Determining pH of Soil for Use in Corrosion Testing

Tori Igoe — *Technician Name*
4/9/2019 — *Date*

Michael D. Kelso, E.I. — *Technical Responsibility*
[signature] — *Signature*
Staff Professional — *Position*
4/10/2019 — *Date*

Form No: TR-D4972-1
Revision No. 0
Revision Date: 07/10/08

Sample Log No.: 43-2830

pH of Soil

AASHTO T 289

Quality Assurance

S&ME, Inc., 1413 Topside Road, Louisville, TN 37777

Project #:	**1281-18-061**	Report Date:	4/10/2019
Project Name:	Dupont WTP	Test Date(s):	4/9/2019
Client Name:	CDM Smith		
Client Address:	4600 Park Road #240, Charlotte, NC 28209		
Sample ID:	B-504	Sample No:	S-3
		Depth:	4 - 6 ft

Sample Description: Light yellowish brown clay

Equipment:

Balance		*S&ME ID#*	*18435*	*Cal. Date:*	*4/2/2019*	*Due:*	*4/2/2020*
Sieve:	*#10*	*S&ME ID#*	*2481*	*Cal. Date:*	*1/29/2019*	*Due:*	*7/29/2019*
pH Meter:		*S&ME ID#*	*16576*	*Cal. Date:*	*4/9/2019*		

pH Meter Calibration

Buffer Solution	***Results***
pH buffer 4.0	***4.01***
pH buffer 7.0	***7.00***
pH buffer 10.0	***10.10***
Buffer Temperature ^{0}C	***23.6°C***

Measuring pH of Soil

Beaker #: 6

Measurements	
Weight of Air Dry Soil (g)	***30.0***
Distilled Water (ml)	***30.0***
Temperature ^{0}C	***23.5°C***
pH Reading	***4.8***

Notes / Deviations / References: AASHTO T 289 Determining pH of Soil for Use in Corrosion Testing

Tori Igoe
Technician Name

4/9/2019
Date

Michael D. Kelso, E.I.
Technical Responsibility

Signature

Staff Professional
Position

4/10/2019
Date

Microbac Laboratories, Inc., Maryville

CERTIFICATE OF ANALYSIS

1904972

S & ME, Inc.

Michael Kelso
1413 Topside Rd.
Louisville, TN 37777

Project Name: 1281-18-061

Project / PO Number: N/A
Received: 04/02/2019
Reported: 04/09/2019

Analytical Testing Parameters

Client Sample ID: B-501
Sample Matrix: Soil
Lab Sample ID: 1904972-01
Collected By: Client
Collection Date: 02/28/2019 12:00

Analyses Subcontracted to: TestAmerica Nashville

Anions, Ion Chromatography Soluble	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: 9056							
Chloride	<10.1	10.1	mg/Kg	**H**		04/05/19 1759	SW1
Sulfate	**10.3**	10.1	mg/Kg	**H**		04/05/19 1759	SW1

Client Sample ID: B-504
Sample Matrix: Soil
Lab Sample ID: 1904972-02
Collected By: Client
Collection Date: 02/25/2019 12:00

Analyses Subcontracted to: TestAmerica Nashville

Anions, Ion Chromatography Soluble	Result	RL	Units	Note	Prepared	Analyzed	Analyst
Method: 9056							
Chloride	<9.85	9.85	mg/Kg	**H**		04/05/19 1815	SW1
Sulfate	**15.1**	9.85	mg/Kg	**H**		04/05/19 1815	SW1

Definitions

H: Sample was prepped or analyzed beyond the specified holding time
MDL: Minimum Detection Limit
RL: Reporting Limit

Form No. TR-43-D7012C-02
Revision No. : 0
Revision Date: 08/22/18

UNCONFINED COMPRESSION
(ASTM D7012 Method C)

S&ME, Inc. - Knoxville 1413 Topside Road, Louisville, TN 37777

Project Name: Dupont WTP
Project Number: 1281-18-061

Report Date: April 5, 2019
Reviewed By: Jason B. Burgess

Boring No.	Sample No.	Depth (ft)	Dimensions, in.		Shape	Area	Unit Weight	Loading Rate	Maximum	Strength	Moisture
			Length	Diameter	(See Key)	(in^2)	(lbs/ft^3)	(psi/sec)	Load (lbs)	(psi)	(%)
B-501	RC	36.25 - 36.60	4.21	1.87	A	2.75	171.5	111	96,333	35,030	0.1
B-501	RC	47.00 - 47.40	4.16	1.87	A	2.75	174.9	108	94,426	34,337	0.1
B-502	RC	31.85 - 32.20	4.07	1.87	A	2.75	166.8	105	68,489	24,905	0.3
B-502	RC	38.80 - 39.15	4.19	1.87	A	2.75	170.1	102	78,679	28,611	0.1
B-503	RC	37.35 - 37.70	4.26	1.86	A	2.72	175.2	112	113,293	41,652	0.1

NOTES: Effective (as received) unit weight as determined by RTH 109-93.
Loading rates were selected to target reaching failure between 2 and 15 minutes.
Test results for specimens not meeting the requirements of ASTM D4543-08$^{\epsilon 1}$ may differ from a test specimen that meets the requirements of ASTM D4543.

SHAPE KEY

ASTM D4543-08$^{\epsilon 1}$ *Standard Practice for Preparing Rock Core as Cylindrical Test Specimens and Verifying Conformance to Dimensional and Shape Tolerance* Section 1.2 - "Rock is a complex engineering material that can vary greatly as a function of lithology, stress history, weathering, moisture content and chemistry, and other natural geologic processes. As such, it is not always possible to obtain or prepare rock core specimens that satisfy the desirable tolerances given in this practice. Most commonly, this situation presents itself with weaker, more porous, and poorly cemented rock types and rock types containing significant or weak (or both) structural features. For these and other rock types which are difficult to prepare, all reasonable efforts shall be made to prepare a specimen in accordance with this practice and for the intended test procedure. However, when it has been determined by trial that this is not possible, prepare the rock specimen to the closest tolerances practicable and consider this to be the best effort and report it as such and if allowable or necessary for the intended test, capping the ends of the specimen as discussed in this practice is permitted."

A Test specimen measurements met the desired shape tolerances of ASTM D4543-08$^{\epsilon 1}$ (side straightness, end flatness & parallelism, and end perpendicularity to axis)

B Test specimen measurements met the desired shape tolerances of ASTM D4543-08$^{\epsilon 1}$ for end flatness & parallelism, and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness. Specimen prepared to closest tolerances practicable.

C Test specimen measurements met the desired shape tolerances of ASTM D4543-08$^{\epsilon 1}$ for end flatness & parallelism. Specimen did not meet the desired tolerances for side straightness and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.

D Test specimen measurements met the desired shape tolerances of ASTM D4543-08$^{\epsilon 1}$ for end flatness. Specimen did not meet the desired tolerances for side straightness, parallelism and end perpendicularity to axis. Specimen prepared to closest tolerances practicable.

E Test specimen measurements met the desired shape tolerances of ASTM D4543-08$^{\epsilon 1}$ for end flatness and end perpendicularity to axis. Specimen did not meet the desired tolerance for side straightness and parallelism. Specimen prepared to closest tolerances practicable.

PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)

1413 Topside Road, Louisville, TN 37777

Project:	Dupont WTP	**Diameter (in):**	1.87	**Date:**	4/3/2019
Project No.:	1281-18-061	**Length (in):**	4.21	**Tested by:**	VLI
Boring Id:	B-501	**Unit Weight (pcf):**	171.5	**Reviewed by:**	BKP
Sample No.:	RC	**Moisture Content (%):**	0.1		
Depth (ft):	36.25 - 36.60				

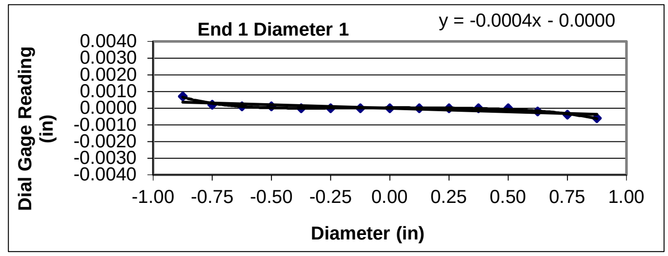
Deviation From Straightness (Procedure S1)

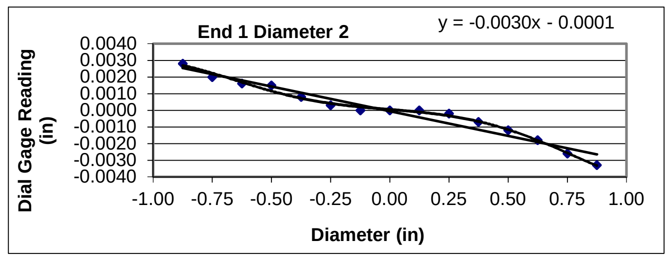
Is the maximum gap ≤ 0.02 in.? **YES**

Straightness Tolerance Met? **YES**

End Flatness and Parallelism Readings (Procedure FP1)

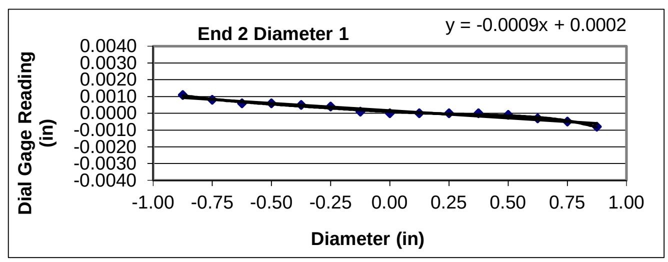
Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0007	0.0028	0.0011	0.0011
- 6/8	0.0002	0.0020	0.0008	0.0006
- 5/8	0.0001	0.0016	0.0006	0.0004
- 4/8	0.0001	0.0015	0.0006	0.0002
- 3/8	0.0000	0.0008	0.0005	0.0000
- 2/8	0.0000	0.0003	0.0004	0.0000
- 1/8	0.0000	0.0000	0.0001	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	0.0000
2/8	0.0000	-0.0002	0.0000	0.0000
3/8	0.0000	-0.0007	0.0000	0.0000
4/8	0.0000	-0.0012	-0.0001	-0.0004
5/8	-0.0002	-0.0018	-0.0003	-0.0007
6/8	-0.0004	-0.0026	-0.0005	-0.0010
7/8	-0.0006	-0.0033	-0.0008	-0.0013

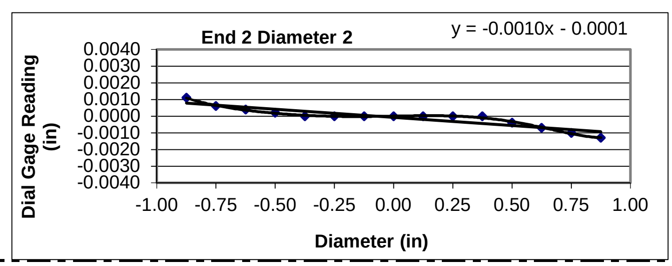




Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? **YES**





Parallelism is met when the angular difference between best fit lines on opposing ends is ≤ 0.25°.

Parrallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00042
	Angle of Best Fit Line:	-0.02390
End 2:	Slope of Best Fit Line:	-0.00088
	Angle of Best Fit Line:	-0.05042
	Max Angular Difference:	**0.03**

Parrallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00296
	Angle of Best Fit Line:	-0.16960
End 2:	Slope of Best Fit Line:	-0.00098
	Angle of Best Fit Line:	-0.05615
	Max Angular Difference:	**-0.11**

Parallelism Tolerance Met? **YES**

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043.

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0013	0.0007	**YES**
End 1 Diam 2	0.0061	0.0033	**YES**
End 2 Diam 1	0.0019	0.0010	**YES**
End 2 Diam 2	0.0024	0.0013	**YES**

Perpendicularity Tolerance Met? **YES**

PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)

1413 Topside Road, Louisville, TN 37777

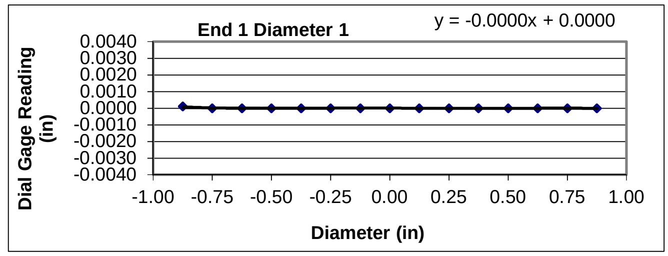
Project:	Dupont WTP	**Diameter (in):**	1.87	**Date:**	4/3/2019
Project No.:	1281-18-061	**Length (in):**	4.16	**Tested by:**	VLI
Boring Id:	B-501	**Unit Weight (pcf):**	174.9	**Reviewed by:**	BKP
Sample No.:	RC	**Moisture Content (%):**	0.1		
Depth (ft):	47.00 - 47.40				

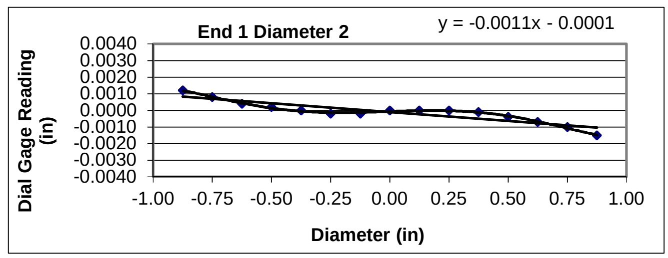
Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? **YES** Straightness Tolerance Met? **YES**

End Flatness and Parallelism Readings (Procedure FP1)

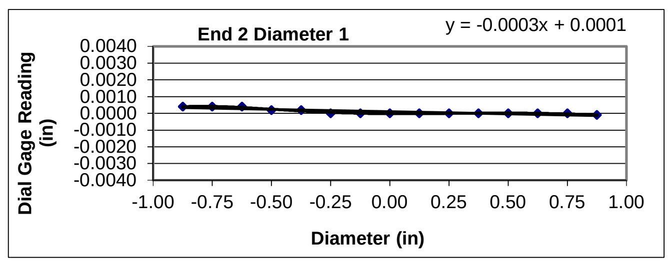
Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0001	0.0012	0.0004	0.0025
- 6/8	0.0000	0.0008	0.0004	0.0021
- 5/8	0.0000	0.0004	0.0004	0.0015
- 4/8	0.0000	0.0002	0.0002	0.0012
- 3/8	0.0000	0.0000	0.0002	0.0007
- 2/8	0.0000	-0.0002	0.0000	0.0003
- 1/8	0.0000	-0.0002	0.0000	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	0.0000
2/8	0.0000	0.0000	0.0000	-0.0002
3/8	0.0000	-0.0001	0.0000	-0.0005
4/8	0.0000	-0.0004	0.0000	-0.0009
5/8	0.0000	-0.0007	0.0000	-0.0017
6/8	0.0000	-0.0010	0.0000	-0.0022
7/8	0.0000	-0.0015	-0.0001	-0.0025

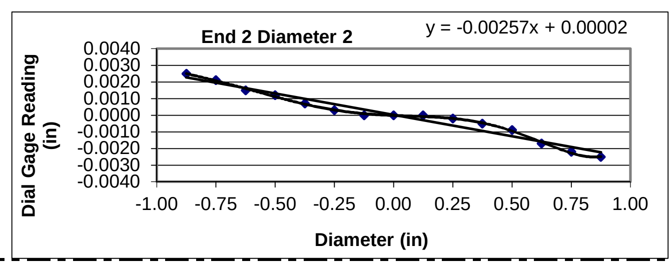




Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? **YES**





Parallelism is met when the angular difference between best fit lines on opposing ends is ≤ 0.25°.

Parrallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00002
	Angle of Best Fit Line:	-0.00115
End 2:	Slope of Best Fit Line:	-0.00027
	Angle of Best Fit Line:	-0.01522
	Max Angular Difference:	**0.01**

Parrallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00107
	Angle of Best Fit Line:	-0.06106
End 2:	Slope of Best Fit Line:	-0.00257
	Angle of Best Fit Line:	-0.14700
	Max Angular Difference:	**0.09**

Parallelism Tolerance Met? **YES**

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043.

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0001	0.0001	**YES**
End 1 Diam 2	0.0027	0.0014	**YES**
End 2 Diam 1	0.0005	0.0003	**YES**
End 2 Diam 2	0.0050	0.0027	**YES**

Perpendicularity Tolerance Met? **YES**

PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)

1413 Topside Road, Louisville, TN 37777

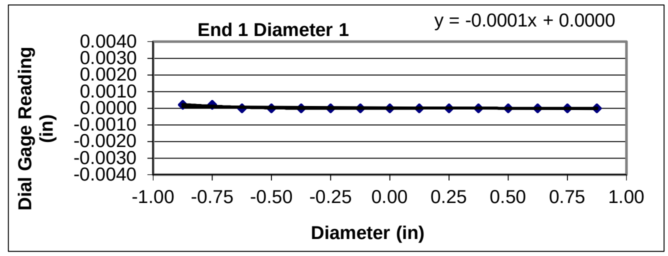
Project:	Dupont WTP	**Diameter (in):**	1.87	**Date:**	4/3/2019
Project No.:	1281-18-061	**Length (in):**	4.07	**Tested by:**	VLI
Boring Id:	B-502	**Unit Weight (pcf):**	166.8	**Reviewed by:**	BKP
Sample No.:	RC	**Moisture Content (%):**	0.3		
Depth (ft):	31.85 - 32.20				

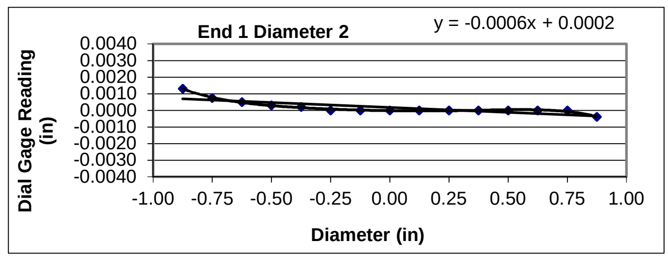
Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? **YES** Straightness Tolerance Met? **YES**

End Flatness and Parallelism Readings (Procedure FP1)

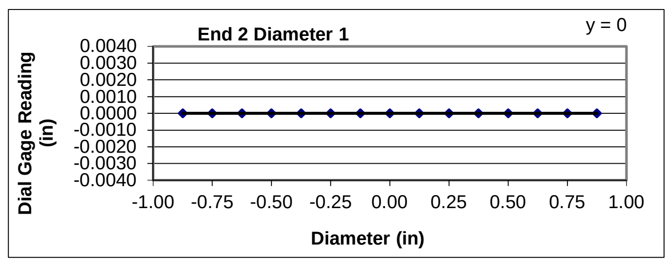
Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0002	0.0013	0.0000	0.0018
- 6/8	0.0002	0.0007	0.0000	0.0014
- 5/8	0.0000	0.0005	0.0000	0.0013
- 4/8	0.0000	0.0003	0.0000	0.0010
- 3/8	0.0000	0.0002	0.0000	0.0007
- 2/8	0.0000	0.0000	0.0000	0.0001
- 1/8	0.0000	0.0000	0.0000	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	0.0000
2/8	0.0000	0.0000	0.0000	-0.0003
3/8	0.0000	0.0000	0.0000	-0.0006
4/8	0.0000	0.0000	0.0000	-0.0012
5/8	0.0000	0.0000	0.0000	-0.0017
6/8	0.0000	0.0000	0.0000	-0.0019
7/8	0.0000	-0.0004	0.0000	-0.0022

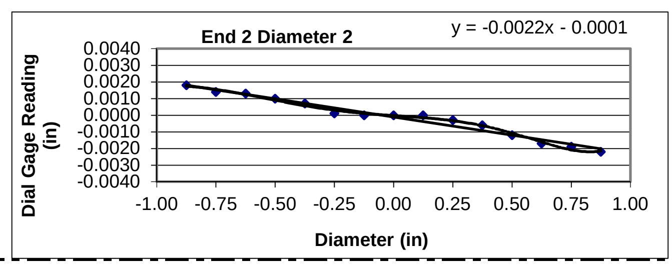




Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? **YES**





Parallelism is met when the angular difference between best fit lines on opposing ends is ≤ 0.25°.

Parrallelism Diameter 1

End 1:	Slope of Best Fit Line:	-0.00007
	Angle of Best Fit Line:	-0.00426
End 2:	Slope of Best Fit Line:	0.00000
	Angle of Best Fit Line:	0.00000
	Max Angular Difference:	**0.00**

Parrallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00059
	Angle of Best Fit Line:	-0.03379
End 2:	Slope of Best Fit Line:	-0.00218
	Angle of Best Fit Line:	-0.12490
	Max Angular Difference:	**0.09**

Parallelism Tolerance Met? **YES**

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043.

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0002	0.0001	**YES**
End 1 Diam 2	0.0017	0.0009	**YES**
End 2 Diam 1	0.0000	0.0000	**YES**
End 2 Diam 2	0.0040	0.0021	**YES**

Perpendicularity Tolerance Met? **YES**

PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)

1413 Topside Road, Louisville, TN 37777

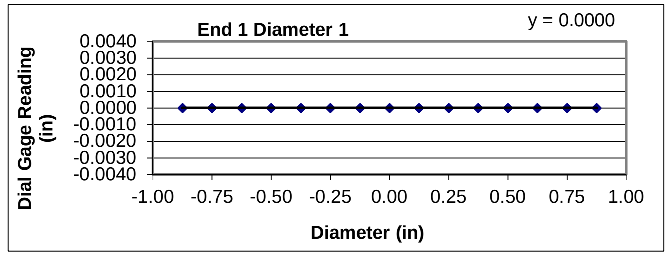
Project:	Dupont WTP	**Diameter (in):**	1.87	**Date:**	4/3/2019
Project No.:	1281-18-061	**Length (in):**	4.19	**Tested by:**	VLI
Boring Id:	B-502	**Unit Weight (pcf):**	170.1	**Reviewed by:**	BKP
Sample No.:	RC	**Moisture Content (%):**	0.1		
Depth (ft):	38.80 - 39.15				

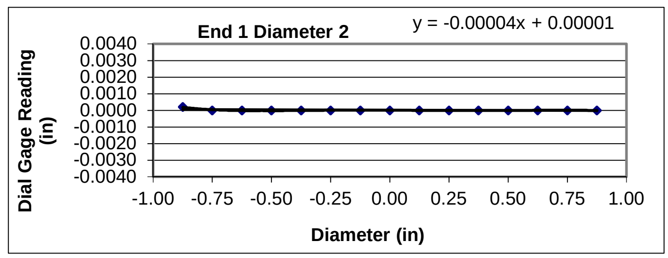
Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? **YES** Straightness Tolerance Met? **YES**

End Flatness and Parallelism Readings (Procedure FP1)

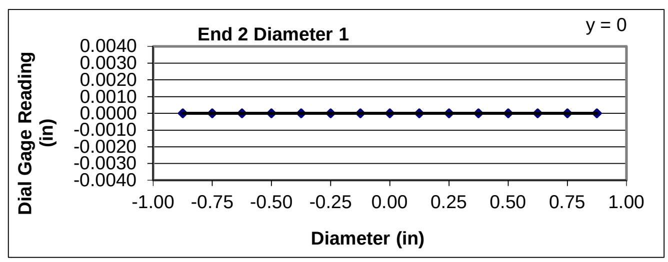
Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0000	0.0002	0.0000	0.0011
- 6/8	0.0000	0.0000	0.0000	0.0009
- 5/8	0.0000	0.0000	0.0000	0.0005
- 4/8	0.0000	0.0000	0.0000	0.0003
- 3/8	0.0000	0.0000	0.0000	0.0002
- 2/8	0.0000	0.0000	0.0000	0.0001
- 1/8	0.0000	0.0000	0.0000	0.0000
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	0.0000
2/8	0.0000	0.0000	0.0000	-0.0001
3/8	0.0000	0.0000	0.0000	-0.0001
4/8	0.0000	0.0000	0.0000	-0.0001
5/8	0.0000	0.0000	0.0000	-0.0001
6/8	0.0000	0.0000	0.0000	-0.0001
7/8	0.0000	0.0000	0.0000	-0.0003

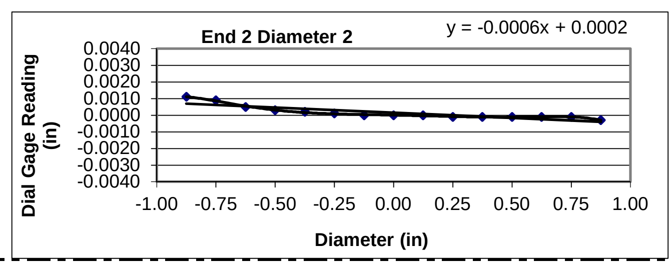




Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? **YES**





Parallelism is met when the angular difference between best fit lines on opposing ends is ≤ 0.25°.

Parrallelism Diameter 1

End 1:	Slope of Best Fit Line:	0.00000
	Angle of Best Fit Line:	0.00000
End 2:	Slope of Best Fit Line:	0.00000
	Angle of Best Fit Line:	0.00000
	Max Angular Difference:	**0.00**

Parrallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00004
	Angle of Best Fit Line:	-0.00229
End 2:	Slope of Best Fit Line:	-0.00062
	Angle of Best Fit Line:	-0.03552
	Max Angular Difference:	**0.03**

Parallelism Tolerance Met? **YES**

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043.

	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0000	0.0000	**YES**
End 1 Diam 2	0.0002	0.0001	**YES**
End 2 Diam 1	0.0000	0.0000	**YES**
End 2 Diam 2	0.0014	0.0007	**YES**

Perpendicularity Tolerance Met? **YES**

PREPARING ROCK CORE AS CYLINDRICAL TEST SPECIMENS AND VERIFYING CONFORMANCE TO DIMENSIONAL AND SHAPE TOLERANCES (ASTM D4543)

1413 Topside Road, Louisville, TN 37777

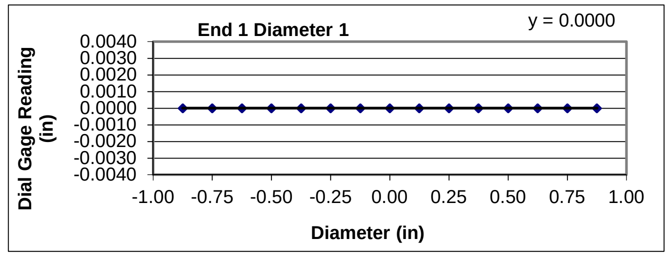
Project:	Dupont WTP	**Diameter (in):**	1.86	**Date:**	4/3/2019
Project No.:	1281-18-062	**Length (in):**	4.26	**Tested by:**	VLI
Boring Id:	B-503	**Unit Weight (pcf):**	175.2	**Reviewed by:**	BKP
Sample No.:	RC	**Moisture Content (%):**	0.1		
Depth (ft):	37.35 - 37.40				

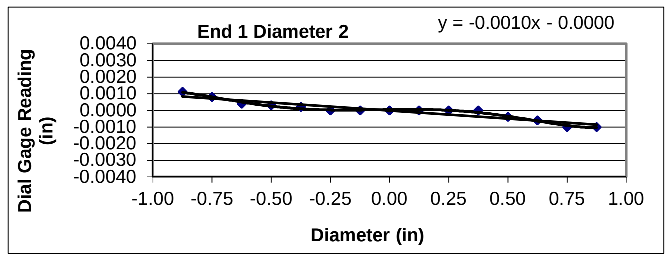
Deviation From Straightness (Procedure S1)

Is the maximum gap ≤ 0.02 in.? **YES** Straightness Tolerance Met? **YES**

End Flatness and Parallelism Readings (Procedure FP1)

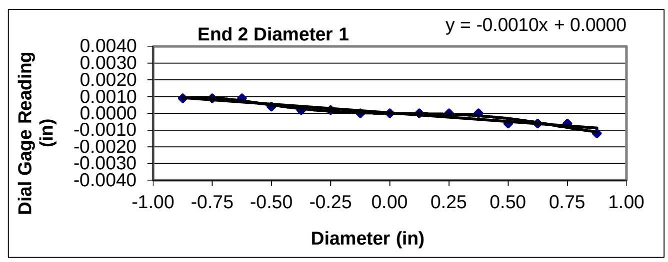
Position	End 1	End 1(90)	End 2	End 2(90)
- 7/8	0.0000	0.0011	0.0009	0.0033
- 6/8	0.0000	0.0008	0.0009	0.0026
- 5/8	0.0000	0.0004	0.0009	0.0025
- 4/8	0.0000	0.0003	0.0004	0.0018
- 3/8	0.0000	0.0002	0.0002	0.0009
- 2/8	0.0000	0.0000	0.0002	0.0002
- 1/8	0.0000	0.0000	0.0000	0.0001
0	0.0000	0.0000	0.0000	0.0000
1/8	0.0000	0.0000	0.0000	0.0000
2/8	0.0000	0.0000	0.0000	-0.0002
3/8	0.0000	0.0000	0.0000	-0.0011
4/8	0.0000	-0.0004	-0.0006	-0.0015
5/8	0.0000	-0.0006	-0.0006	-0.0025
6/8	0.0000	-0.0010	-0.0006	-0.0033
7/8	0.0000	-0.0010	-0.0012	-0.0040

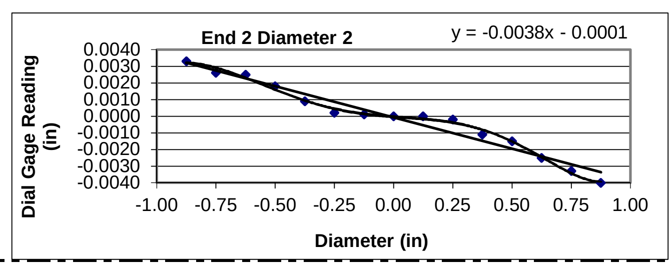




Flatness is met when the difference at any point between a smooth curve drawn through points and a visual best fit line is ≤ 0.001 in.

Flatness Tolerance Met? **YES**





Parallelism is met when the angular difference between best fit lines on opposing ends is ≤ 0.25°.

Parrallelism Diameter 1

End 1:	Slope of Best Fit Line:	0.00000
	Angle of Best Fit Line:	0.00000
End 2:	Slope of Best Fit Line:	-0.00103
	Angle of Best Fit Line:	-0.05926
	Max Angular Difference:	**0.06**

Parrallelism Diameter 2

End 1:	Slope of Best Fit Line:	-0.00097
	Angle of Best Fit Line:	-0.05550
End 2:	Slope of Best Fit Line:	-0.00376
	Angle of Best Fit Line:	-0.21543
	Max Angular Difference:	**0.16**

Parallelism Tolerance Met? **YES**

Perpendicularity (Procedure P1) is met when the difference between max and min readings along each line divided by the diameter is ≤ 0.0043.

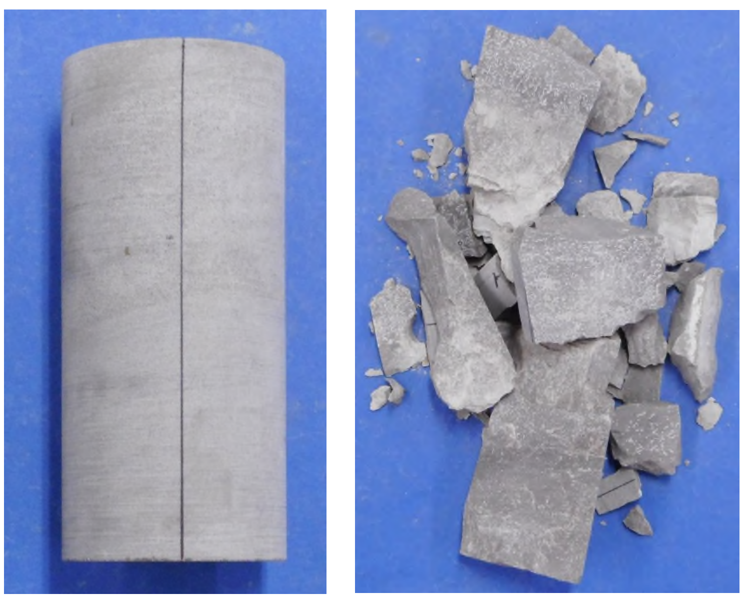
	Difference b/w max & min	Divide by Diameter	Meets Tolerance
End 1 Diam 1	0.0000	0.0000	**YES**
End 1 Diam 2	0.0021	0.0011	**YES**
End 2 Diam 1	0.0021	0.0011	**YES**
End 2 Diam 2	0.0073	0.0039	**YES**

Perpendicularity Tolerance Met? **YES**

Date: 4/4/2019

Photographer: Ben Painter

1	**Location / Orientation**	B-501 (36.25' – 36.60')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



Date: 4/4/2019

Photographer: Ben Painter

2	**Location / Orientation**	B-501 (47.00' – 47.40')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)


Date: 4/4/2019

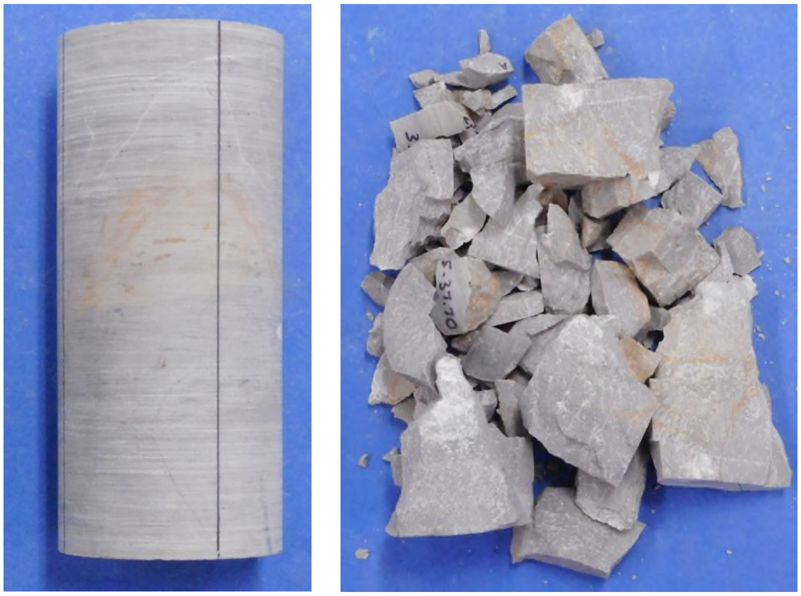
Photographer: Ben Painter

3	**Location / Orientation**	B-502 (31.85' – 32.20')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)


Date: 4/4/2019

Photographer: Ben Painter

4	**Location / Orientation**	B-502 (38.80' – 39.15')
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)



Date: 4/4/2019

Photographer: Ben Painter

5	**Location / Orientation**	B-503 (37.35’ – 37.70’)
	Remarks	Unconfined Compressive Strength of Rock Core Specimen Before/After (ASTM D7012 Method C)

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