Addendum No. 1

Project:	Kuwahee WWTP Return Activated Sludge Pumping System Upgrade
Control No:	**1045**
Issued:	**To all listed plan holders**
Date:	**November 14, 2017**

This addendum forms a part of the Agreement described above. The original Contract Documents and any prior addenda remain in full force and effect except as modified by the following, which shall take precedence over any contrary provisions in prior documents.

See attached sheet for specifics of this addendum.

Each Bidder/Proposer shall acknowledge receipt of this addendum by affixing his signature below, by noting this addendum on his Bid/Proposal Form, and by attaching this addendum to his Bid/Proposal. **Failure to acknowledge this addendum could be cause for bid/proposal rejection.**

ACKNOWLEDGMENT

The undersigned acknowledges receipt of this addendum and the Bid submitted is in accordance with information, instructions and stipulations set forth herein.

BIDDER / PROPOSER _____

AUTHORIZED SIGNATURE_____

DATE _____

BID OPENING AND BID SCHEDULE CHANGE

1. Section 00030 – Advertisement for Bids

- DELETE Section 00030 in its entirety and REPLACE with revised Section 00030, attached. Please use the revised form (00030) Bid Contractor Cover Sheet, page 3. In addition, the Section 00030 Advertisement for Bids is of an obsolete version and a change concerning the bid opening date has been made on the revised version supplied with this addendum.

2. Section 00140 – Information for Bidders

- DELETE Section 00140, page 1 and REPLACE with revised Section 00140, page 1, attached. In addition, the Section 00140, page 1 is of an obsolete version and a change concerning the bid opening date has been made on the revised version supplied with this addendum.

3. Clarification

- The geotechnical report titled "Pump Foundations of Kuwahee WWTP Return Activated Sludge Pumping System Upgrade", referenced in Specification Section 02360 – Drilled Micropiles, has been provided as part of this addendum for informational purposes only, and it is the CONTRACTOR'S responsibility to perform any additional studies, if necessary.

END

SECTION 00030
ADVERTISEMENT FOR BIDS

PROJECT:

KNOXVILLE UTILITIES BOARD
KUWAHEE WWTP RETURN ACTIVATED SLUDGE PUMPING SYSTEM UPGRADE
KNOXVILLE, TENNESSEE

Control Number: 1045

Separate sealed bids for the **Kuwahee WWTP Return Activated Sludge Pumping System Upgrade**, will be received by the Knoxville Utilities Board, an agency of the City of Knoxville, (the "OWNER") 4505 Middlebrook Pike, Knoxville, Tennessee 37921, until **2:00 P.M.**, local time on **November 30, 2017**, and then at said time publicly opened and read aloud.

The Instructions to Bidders, Form of Agreement, Specifications, Forms of Bid Bond and of Performance and Payment Bonds, and other Bidding Documents may be examined at:

Knoxville Utilities Board

Procurement Department

4505 Middlebrook Pike

Knoxville, TN 37921

One full copy of the Bidding Documents may be obtained at Knoxville Utilities Board Procurement Department, 4505 Middlebrook Pike, Knoxville, TN 37921 at no cost to the bidder. Complete sets of Bidding Documents must be used in preparing Bids; the OWNER does not assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

The OWNER, in making copies of the bidding documents available on the above terms, does so only for the purpose of obtaining bids for the work and does not confer a license or grant for any other use.

The OWNER reserves the right to reject any or all Bids and to waive any informalities or minor defects therein. All bidders must agree that such rejection shall be without liability on the part of the OWNER for any damage or claim, including but not limited to loss of profits, savings or

income, or any indirect, consequential, incidental, exemplary, punitive or special damages brought by any bidder because of such rejections, nor shall the bidders seek any recourse of any kind against the OWNER because of such rejections. The filing of any Bid in response to this invitation shall constitute an agreement by the bidder to these conditions.

All bidders must be licensed Contractors as required by the Contractors Licensing Act of 1994, as amended (TCA Title 62, chapter 6). Sealed bid envelope exterior labeling must conform to the requirements of KUB Specification 00140 Paragraph 29. The Bid Contractor Cover Sheet is provided on page 3 of this Section (00030 Instruction to Bidders). In Case of joint ventures, each party must complete its own Cover Sheet.

All Bids must be made out on the bid form provided with the Bidding Documents. Each bidder must turn in a security deposit with its Bid. The deposit is five percent (5%) of the Bid amount, subject to the conditions stated in the Instructions to Bidders. The successful bidder shall also be required to execute performance and payment Bonds in such amounts as required by the Bidding Documents, furnished by the bidder and which are used by the bidder, (or the bidder's permitted Subcontractors) in performing the Work. No bidder may withdraw his Bid within sixty (60) days after the actual opening date of the Bid.

It is the bidder's responsibility to determine if sales or use taxes are required to be paid on the Work and to what extent. If sales and/or use taxes are payable in connection with the Work, all such taxes must be included in the Bid.

The OWNER encourages bids by qualified minority and/or woman owned business enterprises (MBE, WBE) and also encourages the use of qualified minority and/or woman owned businesses as Subcontractors.

Owner: Knoxville Utilities Board
Knoxville, Tennessee

By: Michelle Wilson
Acting Procurement Manager
Procurement Department

BID CONTRACTOR COVER SHEET

Knoxville Utilities Board requires that this form shall be firmly attached to the outside of the envelope containing the Bid.

Knoxville Utilities Board, Knoxville, Tennessee

PROJECT: KUWAHEE WWTP RETURN ACTIVATED SLUDGE PUMPING SYSTEM UPGRADE

CONTROL NUMBER: 1045

OPENS: 2:00 PM (local time) on November 30, 2017

PART 1 - BIDDER AS PRIME CONTRACTOR: Bidder shall complete this part in accordance with the State of Tennessee T.C.A. Title 62, Chapter 6. (Include **all classifications and sub-classifications** for Bidder's License Number listed)

BIDDER: _____

LICENSE NO: _____

CLASSIFICATION(S): _____

LICENSE EXPIRATION DATE: _____

PART 2 – BIDDER'S ELECTRICAL, PLUMBING, HVAC, or MASONRY SUBCONTRACTORS. Bidder shall complete this part in accordance with the State of Tennessee TCA Title 62, Chapter 6 requirement for listing Electrical, Plumbing, HVAC or Masonry Subcontractors on Bid Cover Sheets.

ELECTRICAL SUBCONTRACTOR:

NAME: _____
LICENSE NO: _____ EXPIRATION DATE: _____
CLASSIFICATION(S): _____

PLUMBING SUBCONTRACTOR:

NAME: _____
LICENSE NO: _____ EXPIRATION DATE: _____
CLASSIFICATION(S): _____

HVAC OR GEOTHERMAL HEATING AND COOLING SUBCONTRACTOR:

NAME: _____
LICENSE NO: _____ EXPIRATION DATE: _____
CLASSIFICATION(S): _____

MASONRY SUBCONTRACTOR:

NAME: _____
LICENSE NO: _____ EXPIRATION DATE: _____
CLASSIFICATION(S): _____

SECTION 00140
INFORMATION FOR BIDDERS

1. Separate sealed bids for the **Kuwahee WWTP Return Activated Sludge Pumping System Upgrade**, **Control Number: 1045**, will be received by the Knoxville Utilities Board, an agency of the City of Knoxville, (the "OWNER") 4505 Middlebrook Pike, Knoxville, Tennessee 37921, until **2:00 p.m. local time, on November 30, 2017**, and then at said time publicly opened and read aloud.

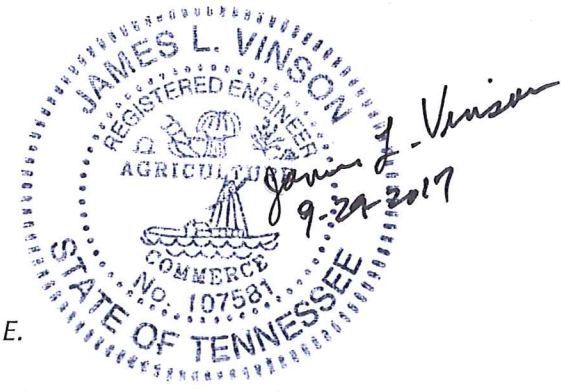
2. **Description of work:** Replacement of existing Return Activated Sludge Pumps in the Blower Building at the Kuwahee WWTP including but not limited to: demolition of existing RAS pumps, motors, supports, and associated piping as shown on the drawings; demolition of existing foam control spray pumps, motors, supports, and associated piping as shown on the drawings; installation of micropiles and structural drawings as shown on the drawings; installation of four vertical solids handling RAS Pumps, motors, supports, and associated piping as shown on the drawings; installation of HVAC, electrical, and instrumentation as shown on the drawings; other work as shown on the Drawings and/or as specified herein.

3. **A mandatory <u>on-site</u> pre-bid meeting will be held on November 7, 2017, at 2:00PM, EST, located at KUB's Kuwahee Wastewater Treatment Plant, (Admin. Building) 2015 Neyland Dr., Knoxville, TN 37916. You must attend this meeting to be eligible to bid.** In addition, the meeting will begin promptly at 2:00pm, and once the meeting commences, no bids will be accepted by KUB from bidders arriving late to the meeting. Meeting attendees must bring HARD HATS, SAFETY GLASSES WITH SIDE SHIELDS AND BOOTS WITH TOE PROTECTION to participate in the on-site walk through.

4. **This work is to be bid only by KUB pre-qualified contractors in the following areas: 2.5 Wastewater Plant Construction, Unlimited.** Bids will not be accepted from contractors who are not pre-qualified in the referenced category prior to the bid opening.

5. **Our <u>proposed</u> schedule is as follows:**
   A. Bid documents available on October 25, 2017.
   B. **Mandatory <u>on-site</u> pre-bid meeting will be held on November 7, 2017, at 2:00PM, EST, located at KUB's Kuwahee Wastewater Treatment Plant, (Admin. Building) 2015 Neyland Dr., Knoxville, TN 37916.**
   C. Cut off for questions at 5:00PM, November 20, 2017.
   D. Issue addendum if required 3:30PM, on November 27, 2017.
   E. **Bid opening on November 30, 2017, at 2:00PM, EST**, in the Procurement Conference Room at the KUB Hoskins Operations Center, 4505 Middlebrook Pike.
   F. Award project on or before December 4, 2017.
   G. Notice to Proceed on or before December 18, 2017.
   H. Required Substantial Completion within **<u>450</u>** days from commence date on Notice to Proceed.

Memorandum



To: *Eric Goodman, P.E.*

From: *James Vinson, P.E.*
John Briand

Reviewed By: *Danielle Neamtu, P.E.*

Date: *July 10, 2017*
Rev: *September 29, 2017*

Subject: *Geotechnical Design Memorandum*
Pump Foundations for Kuwahee WWTP Return Activated Sludge Pumping System Upgrade
(PN 115043)
Knoxville Utilities Board
Knoxville, Tennessee

1.0 Introduction

1.1 Project Description

CDM Smith has been retained by the Knoxville Utilities Board (KUB) to provide design services for the Return Activated Sludge (RAS) Pumping System Upgrade at the Kuwahee Wastewater Treatment Plant (WWTP) located along Neyland Drive in Knoxville, Tennessee. The proposed improvements will include the addition of four new RAS pumps. Two slabs will support two pumps each within the existing Nitrification Pump & Blower Building (NPBB), as shown on the attached **Figure 1**. The slabs will be structurally independent of the existing building foundation. This memorandum summarizes the geotechnical investigation and presents geotechnical recommendations for design and construction of the foundations of the new RAS pumps.

The NPBB is located to the east of the Nitrification Reactors and west of Primary Clarifiers 1 and 2. The NPBB has approximate plan dimensions of 90 feet (ft) x 54 ft and a total interior building height of approximately 51 ft. The proposed slabs will both have plan dimensions of approximately 16 ft x 4 ft and will be placed directly on the top of the existing building slab at

approximately EL 807.5 ft, which is about 24.5 to 32.5 ft below the grades along the building's perimeter.

1.2 Purpose and Scope

The purpose of this memorandum is to summarize subsurface conditions encountered in the vicinity of the proposed pump foundations and to provide geotechnical engineering recommendations for their design and construction. Specifically, the scope of work included the following:

- Review existing facility drawings and available subsurface information;
- Drill two geotechnical test borings (B-301 and B-302) to explore subsurface conditions and to obtain soil and bedrock samples;
- Conduct geotechnical laboratory testing for selected soil and rock samples to verify visual classification and to assist in assignment of engineering properties of subsurface materials;
- Perform geotechnical analyses and develop geotechnical engineering recommendations for design and construction of the proposed foundations; and
- Prepare this memorandum, which presents CDM Smith's recommendations and data collected as part of the subsurface investigation program.

1.3 Elevation Datum

Elevations noted herein are referenced to the North American Vertical Datum of 1988 (NAVD88).

2.0 Site and Subsurface Conditions

2.1 Site Conditions

Located in an urban setting, the Kuwahee WWTP is abutted by Stephenson Drive, railroad tracks and commercial properties to the north, by Neyland Drive to the east, by the Tennessee River to the south, and by Third Creek to the west. The proposed RAS Pumping System Upgrade will be within the NPBB in the northwestern portion of the site. Based upon available structural design plans, this building is founded on 30-inch drilled piers socketed a minimum of 6 inches into bedrock.

2.2 Geology

The project site is in the Appalachian Valley and Ridge Physiographic Province. This province is characterized by elongated, northeasterly-trending ridges formed on highly resistant limestones, sandstones, and shales. Based on published geologic mapping, the site lies within the Lenoir Limestone, which consists of silty, brown and/or gray, finely crystalline, thick-bedded limestone. Residual soils formed from weathering and decomposition of the Lenoir Limestone typically consist of brown and yellow clay and brown and gray sand, gravel, and rock fragments. The

overburden soils encountered in the test borings for this investigation consist of fill overlain by alluvial soils associated with the Tennessee River.

Limestone is a carbonate rock and may appear to be very hard and resistant. However, limestone may be soluble in slightly acidic water. It is prone to dissolution and development of karst features which can include a random bedrock surface and irregular weathering, pinnacled bedrock, "floating" boulders, sinkholes, and solution cavities. A certain degree of risk with respect to sinkhole formation and subsidence should be considered with any site located within geologic areas underlain by potentially soluble rock units, like the Lenoir Limestone.

Of the twelve test borings performed during the previous and recent CDM Smith subsurface investigations at the Kuwahee WWTP, three voids were encountered including voids of 3.0 ft in test boring CDM-103, 0.3 ft in test boring B-4 and 0.3 ft in test boring B-204. Based on conversations with KUB, it is our understanding that karst conditions were encountered during construction of the equalization pump station and storage facility at the western edge of the Kuwahee WWTP.

2.3 Subsurface Investigations

2.3.1 Previous Subsurface Investigations

CDM Smith has conducted several subsurface investigations at the Kuwahee WWTP. These investigations have included the following:

- In early 2017, CDM Smith completed the subsurface investigation for the Composite Correction Plan – Phase 2 (CCP – Phase 2) project. The geotechnical design report has not been issued at this time;
- In 2011, CDM Smith prepared a geotechnical design report for the Composite Correction Plan – Phase 1 (CCP – Phase 1) project titled *Knoxville Utilities Board, Kuwahee WWTP, Composite Correction Plan, Knoxville Tennessee, Geotechnical Investigation and Design Recommendations Report* dated February 2011; and
- In 2009, CDM Smith prepared a geotechnical design report for the Emergency Generator Facility (EGF) project titled *Knoxville Utilities Board, Kuwahee WWTP, Emergency Generator Facility, WO# 44, Knoxville Tennessee, Geotechnical Investigation and Design Recommendations Report* dated May 2009.

The approximate test boring locations from these previous explorations are shown on Figure 1. The reader may refer to the test boring logs, geotechnical laboratory testing results and previous reports referenced above for further information.

2.3.2 Recent Subsurface Investigation

The subsurface exploration for the proposed RAS pump foundations consisted of geotechnical test borings B-301 and B-302, which were drilled by Total Depth Drilling, Inc., on April 24, 2017.

The test borings were drilled to depths of 45 and 50 ft using a truck-mounted CME 55 drill rig and were backfilled with cement grout upon completion of drilling activities. Test boring locations were determined by taping from existing site features and are shown on Figure 1.

After coring the asphalt pavement at each test boring location, vacuum excavation was conducted to a depth of approximately 8.5 ft to verify that shallow utilities were not present. Below 8.5 feet, the test borings were advanced to the top of bedrock using 3¼-inch inside diameter hollow stem augers. Split-spoon sampling was conducted at five-foot intervals from the bottom of the vacuum excavation until auger refusal was encountered at 28 and 40 ft in test borings B-301 and B-302, respectively. Split-spoon sampling was conducted in general accordance with ASTM D1586 (using a 2-inch outside-diameter sampler that is driven 18 inches by blows from a 140-pound automatic hammer falling freely for 30-inches). The number of blows required to drive the sampler each 6-inch increment was recorded, and the Standard Penetration Resistance (SPT) N-value was determined as the sum of the blows over the last 12 inches of penetration.

Upon encountering auger refusal in the test borings, rock coring was conducted in general accordance with ASTM D2113. A wireline core barrel was used to collect NQ-size core specimens, which have a diameter of approximately 2 inches. The recovered rock cores were logged in the field by a CDM Smith representative. Recovery (REC) and Rock Quality Designation (RQD) values were determined for each core run. The REC is defined as the sum of all pieces of rock core divided by the length of the entire core run, expressed as a percentage. The RQD is defined as the sum of all pieces of sound rock core measuring 4 inches in length or longer divided by the length of the entire core run, expressed as a percentage.

A CDM Smith representative was on-site to observe drilling of the test borings and to visually classify the soil samples recovered in general accordance with the Burmister classification system. Representative soil samples from each split-spoon were collected, logged and stored in sealed plastic bags. Recovered rock core specimens were placed in wooden boxes for storage as well.

The test boring logs are included in **Attachment A**. Photographs of recovered rock cores are included in **Attachment B**.

2.4 Geotechnical Laboratory Testing

Geotechnical laboratory tests were performed on selected split-spoon and rock core samples obtained from the test borings to assist with soil and rock characterization. Geotechnical laboratory tests were performed by K.S. Ware, LLC, and consisted of the following:

- Two sieve analyses with hydrometer - ASTM D6913 and ASTM D7928;
- Two sieve analyses with No. 200 wash - ASTM D6913;
- Two Atterberg limits - ASTM D4318; and

- Two uniaxial compressive strength of intact rock cores - ASTM D7012 Method C.

A summary of the geotechnical laboratory soil and rock test results are presented in **Tables 1** and **2**, respectively. The laboratory test results are also included in **Attachment C**.

2.5 Subsurface Conditions

Based on test borings B-301 and B-302, the generalized stratigraphy adjacent to the NPBB consists of fill over alluvium over limestone. A summary of the subsurface conditions encountered at the test boring locations is presented in **Table 3.**

2.5.1 Fill

Below an asphalt pavement section, fill was about 22 to 23 ft thick. While a small fraction of brick fragments was detected, the fill was typically soft to stiff, reddish brown to red, Silty CLAY, some fine to coarse sand, little fine gravel. SPT N-values in the fill ranged from 3 to 11 blows per foot (bpf) with an average of 7 bpf.

For the sample collected between depths of 23.5 to 25 ft from test boring B-302, the liquid limit was 31%; the plastic limit was 17%; and the plasticity index was 14%. The USCS classification of this sample was CL (Lean Clay).

2.5.2 Alluvial Soils

Underlying the fill, the alluvial soils were found to be about 11 and 17 ft thick at test borings B-301 and B-302, respectively. At test boring B-301, the alluvial soils were wet, loose, gray and brown, fine to coarse GRAVEL, some silty clay, trace fine sand. The alluvial soils at test boring B-302 typically consisted of moist to wet, very soft to stiff, reddish brown, CLAY and SILT to Silty Clay and to some fine to coarse SAND, trace fine gravel (mica present). SPT N-values in this layer were 8 bpf at test boring B-301 and weight of rod (i.e., N-value of 0 bpf) to 15 bpf at test boring B-302. The average SPT N-value for all split-spoon samples in the alluvium was about 6 bpf.

For the sample collected between depths of 35 to 36.5 ft from test boring B-302, the liquid limit was 54%; the plastic limit was 29%; and the plasticity index was 25%. The USCS classification of this sample was CH (Fat Clay).

2.5.3 Limestone Bedrock

Below the alluvial soils layer, limestone bedrock was sampled as hard, fresh, gray, aphantic to fine-grained, LIMESTONE. For the core sampling intervals, the rock core recovery ranged from 96% to 99% with RQD ranging from 92% to 96% where the entire core run was within the limestone layer. One additional core run (R-2) in test boring B-301 had a recovery and RQD of 42%; however, the REC and RQD values for this core run included alluvial gravel and is therefore not representative of the nature of the sampled limestone bedrock.

The uniaxial compressive strength of the bedrock was 14,640 and 9,550 psi at 35 to 36.5 ft at B-301 and at 40.2 to 40.9 ft at B-302, respectively. A similar range of unconfined compressive

strengths for limestone bedrock was determined in past CDM Smith investigations at the Kuwahee WWTP.

2.6 Groundwater Conditions

Measurements of groundwater level depths in the borings were performed at the completion of drilling on April 24, 2017. The groundwater level was about 22 ft (EL 809 ft) in test boring B-301 and about 28 ft (EL 810.8 ft) in test boring B-302. At the time of drilling, no standing water was observed above the lower floor slab of the NPBB at about EL 807.5 ft.

These and other groundwater level measurements made at the Kuwahee WWTP are presented in the attached **Table 3**. Note that in the previous geotechnical investigations, two groundwater monitoring wells were installed in test borings B-1 and B-203. The groundwater levels measured in the monitoring wells were at EL 829.9 ft in test boring B-1 and varied between EL 808.8 to EL 808.5 ft in test boring B-203.

2.7 Variation in Subsurface Conditions

Interpretation of general subsurface soil conditions presented herein are based on soil, rock and groundwater conditions observed during the recent test boring program. However, subsurface conditions likely vary between exploration locations. If conditions are found to be different than assumed, recommendations contained in this memorandum should be reevaluated by CDM Smith and confirmed in writing.

Water levels measured in test borings B-301 and B-302 should not necessarily be considered to represent stabilized groundwater levels. In addition, water levels are expected to fluctuate with time due to changes in the river level, season, temperature, construction in the area, and possibly other factors. Therefore, groundwater conditions at the time of construction may be different from those observed at the time of the explorations.

3.0 Geotechnical Design Recommendations

Geotechnical engineering analyses and recommendations have been made in relation to the proposed pump foundations for the RAS Pumping System Upgrade project. In general, these recommendations have been based on the results of the subsurface investigation, published correlations with soil and bedrock properties and the minimum requirements of the *International Building Code 2012 (Code)*. In addition, recommended design criteria are based on performance tolerances understood to relate to similar structures.

3.1 Foundation Design Recommendations

3.1.1 Foundation Selection

The primary considerations for the selection of foundations supporting the RAS pumps are as follows:

- Potential for unsuitable bearing conditions at foundation subgrade: Based upon the test borings conducted to date, weak alluvial soils and/or fill may be present at foundation subgrade. Such materials would likely not be considered suitable for shallow foundation support of the pumps due to anticipated settlement tolerances, and mitigation would likely be problematic given shallow groundwater, limited information of as-built NPBB foundation system, etc.

- Existing structure founded on deep foundations: According to the record drawings, the NPBB is supported by drilled piers socketed a minimum of 6 inches into bedrock. However, since as-built information is not available, impacts of a shallow foundation on existing drilled piers cannot be confidently assessed.

- Space limitations within the existing building: The RAS pump foundations are to be constructed within the NPBB near the footprint of existing pumps that will be demolished as part of the upgrade project. Space limitations dictate construction methodologies that minimize the size of construction equipment for new foundation construction.

- Impact of construction on existing operations: During construction, many of the normal operations within the building must be maintaining without interruption or interference from the proposed construction. Vibrations due to construction activities should be minimized to the extent possible.

Considering the uncertainties associated with subsurface conditions, structure layout and loading, and the constraints mentioned above, we recommend that the proposed new RAS pumps bear on structural slabs supported by micropiles bearing in limestone bedrock. Micropiles typically have diameters of 3 to 12 inches and are drilled and grouted piles that often include a high capacity steel element inserted in the hole prior to pile grouting.

3.1.2 Micropile Axial Capacity

Micropiles with a minimum diameter of 6 inches in bedrock are considered suitable for the anticipated loads for the proposed structures. 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's *Micro Pile Design and Construction Guidelines* dated June 2000. The end bearing capacity of the drilled micropiles has not been considered in the socket design. The fill and alluvial soil layers are not considered as a suitable foundation support for this structure, and any contribution from skin friction in soils have been neglected. All micropiles should be permanently cased above bedrock.

The drilled micropiles are designed as Type A (gravity grouted) micropiles with an allowable skin friction value of 21.6 kips per square foot in the bedrock layer. For the 40-kip axial design capacity, the 6-inch diameter Type A drilled micropiles are estimated to have a minimum embedment length (i.e., bonded length) within the bedrock of at least seven feet.

A factor of safety of 3.75 has been used in estimating the aforementioned allowable axial capacity (i.e., 150% of typically recommended factor of safety) of the micropiles. The micopiles' axial capacity will not be verified by a static pile load test due to the low design axial pile capacities and the limited number of production piles.

3.1.3 Pile Spacing

Center-to-center spacing of the micropiles should be at least two feet. In addition, the foundations of the existing NPBB should similarly have a clear zone from the nearest micropile of at least two feet.

3.1.4 Pile Cap

In accordance with the *Code*, pile caps that are exposed to freezing temperatures should extend at least 24 inches below any adjacent ground surface. Pile connections into the slabs and reinforcement details should be designed by the structural engineer.

3.1.5 Foundation Settlement

Based on our evaluation, settlements of the micropile-supported structures will primarily be due to elastic compression of the micropiles. The magnitude of total and differential settlements of the pump slabs are anticipated to be less than 1 and ½-inch, respectively.

3.2 Seismic 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 shall be modified for Site Class D when determining the design earthquake response accelerations and seismic design category for the seismic analysis at the site. Based on the SPT N-values and/or fines content of the subsurface soils, the soils at the site are not considered susceptible to liquefaction.

3.3 Resistance to Unbalanced Lateral Loads

A lateral load resistance of up to 2 kips can be developed from each micropile pile from the fixity associated with the rock socket. The top of pile deflection under these lateral loads is anticipated to be less than 0.5 inch. No frictional resistance may be assumed for pile supported structures.

4.0 Construction Considerations

4.1 General

Several geotechnical aspects of construction that should be incorporated into the contract drawings and project specifications are discussed below. The Contractor will be required to base his construction methods and cost estimates on an independent interpretation of the subsurface conditions.

4.2 Micropile Installation

4.2.1 General

A specialty geotechnical 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. Based on the groundwater levels encountered in the test borings, it is anticipated that the groundwater level may be near the lower level slab of the NPBB. Dewatering may be required prior to installation of the micropile foundations in order to perform construction in the dry and prevent groundwater from entering the below-grade structure. Refer to **Section 4.3** for construction considerations related to dewatering.

4.2.2 Potential Obstructions and Differing Bedrock Conditions

Because the test borings were not advanced within the NPBB at the future locations of the micropiles and as-built information for the NPBB is unavailable, there is some uncertainty associated with subsurface conditions below the building's floor slab. Based on available subsurface data, it appears probable that relatively uniform bedrock will be encountered near EL 798 ft. However, 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 a satisfactory socket of continuous bedrock. Furthermore, difficult drilling conditions may be encountered during installation of the micropiles above bedrock due to obstructions in fill, river cobbles/gravel, or subfootings associated with the NPBB.

4.3 Dewatering

The Contractor will be responsible to design and implement a dewatering system that allows the work to be performed in the dry and prevents groundwater from entering the below-grade structure. The design of the dewatering system should be performed by a registered Professional Engineer in the State of Tennessee. We recommend that the groundwater level be maintained below the top of the existing lower level slab during the entire period of micropile installation and repair of the base slab.

Wells, well points and/or pumping from open sumps outside the existing structure may be required. Wells, well points and sumps must be adequately filtered to avoid loss of fines.

The Contractor must be prepared to operate the dewatering system continuously. During periods where failure of the system would adversely impact completed construction, 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 all federal, state and local regulations, permits and specified requirements.

4.4 Construction Monitoring

It is recommended that a qualified Geotechnical Engineer, or Resident Engineer in consultation with the Geotechnical Engineer, be present during construction to confirm that the Contractor complies with the intent of these recommendations. Specifically, the field representative would observe the drilled micropile installation. In addition, the field representative would be present to identify and provide a response should subsurface conditions encountered differ from those assumed during preparation of the micropiles' geotechnical design.

5.0 Limitations

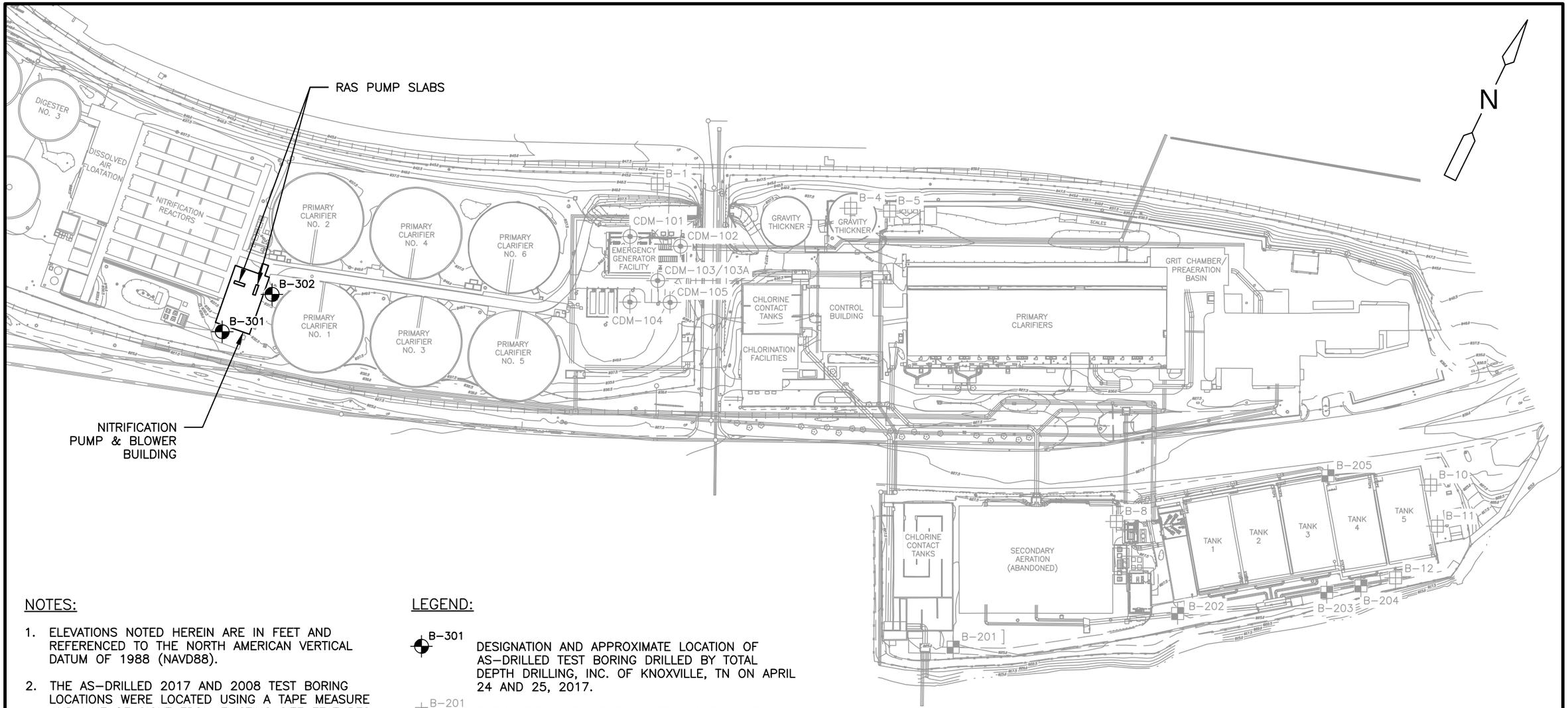
These recommendations have been prepared for the Kuwahee WWTP RAS Pumping System Upgrade project, located in Knoxville, Tennessee, as understood at this time and described in this memorandum. These recommendations have been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made. In the event that changes in the design or location of the structures occur, the conclusions and recommendations contained herein should not be considered valid unless verified in writing by CDM Smith.

Attachments:

Figure 1 – Test Boring Location Plan

Table 1 - Summary of the Geotechnical Laboratory Index Test Results
Table 2 - Summary of the Geotechnical Laboratory Rock Test Results
Table 3 - Summary of the Subsurface Investigation Program

Attachment A – Test Boring Logs
Attachment B – Rock Core Photo Logs
Attachment C – Geotechnical Laboratory Test Results



NOTES:

1. ELEVATIONS NOTED HEREIN ARE IN FEET AND REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
2. THE AS–DRILLED 2017 AND 2008 TEST BORING LOCATIONS WERE LOCATED USING A TAPE MEASURE AND LINE OF SIGHT FROM EXISTING SITE FEATURES.
3. THE AS–DRILLED 2010 TEST BORING LCOATIONS WERE SURVEYED BY CANNON & CANNON, INC. OF KNOXVILLE, TN.
4. TEST BORINGS, SITE FEATURES AND STRUCTURE LOCATIONS ARE APPROXIMATE.

LEGEND:

B–301 — DESIGNATION AND APPROXIMATE LOCATION OF AS–DRILLED TEST BORING DRILLED BY TOTAL DEPTH DRILLING, INC. OF KNOXVILLE, TN ON APRIL 24 AND 25, 2017.

B–201 — DESIGNATION AND APPROXIMATE LOCATION OF AS–DRILLED TEST BORING DRILLED BY TOTAL DEPTH DRILLING, INC. OF KNOXVILLE, TN BETWEEN JANUARY 24 AND 27, 2017.

B–1 — DESIGNATION AND APPROXIMATE LOCATION OF AS–DRILLED TEST BORING DRILLED BY S&ME, INC. OF KNOXVILLE, TN BETWEEN JUNE 8 AND 14, 2010.

CDM–101 — DESIGNATION AND APPROXIMATE LOCATION OF AS–DRILLED TEST BORING DRILLED BY S&ME, INC. OF KNOXVILLE, TN ON DECEMBER 1 AND 2, 2008.

1" = 150'

75 0 150

CDM Smith

KNOXVILLE UTILITIES BOARD

RAS PUMPING SYSTEM UPGRADE
KUWAHEE WWTP
KNOXVILLE, TENNESSEE

FIGURE NO. 1

TEST BORING LOCATION PLAN
SEPTEMBER 2017

Knoxville Utilities Board
RAS Pumping System Upgrade
Knoxville, Tennessee

Table 1
Summary of Geotechnical Laboratory Index Test Results

Test Boring Number	Sample Number	Sample Depth (ft)	Layer	Moisture Content[1] (%)	Atterberg Limits[2]			Sieve Analysis[3]			
					LL	PL	PI	% Gravel	% Sand	% Silt	% Clay
B-301	S-1	8.5 - 10	Fill	--	--	--	--	18.5	29.1	52.4	
B-302	S-2	13.5 - 15	Fill	--	--	--	--	3.1	19.8	77.1	
B-302	S-4	23.5 - 25	Fill	30.9[4]	31	17	14	5.5	39.4	27.3	27.8
B-302	S-6	35 - 36.5	Alluvial Soils	54.7[4]	54	29	25	4.7	30.5	27.3	37.5

Notes:

1 Moisture content tests were performed in accordance with ASTM D 2216.
2 Atterberg Limit tests were performed in accordance with ASTM D 4318.
3 Sieve analyses performed in accordance with ASTM D 6913 and ASTM D7928.
4 Moisture content values were the average of moisture contents from liquid limit tests.

Abbreviations:

-- Test Not Performed
LL Liquid Limit
PL Plastic Limit
PI Plasticity Index

Knoxville Utilities Board
RAS Pumping System Upgrade
Knoxville, Tennessee

Table 2
Summary of Geotechnical Laboratory Rock Test Results

Test Boring Number	Core Run	Sample Depth (ft)	Layer	Compressive Strength[1&2] (psi)
B-301	R-3	35.0 - 36.5	Limestone	14,640
B-302	R-1	40.2 - 40.9	Limestone	9,550

Notes:

1. Uniaxial compressive strength testing conducted by K. S. Ware & Associates, LLC of Bowling Green, KY
2. Uniaxial compressive strength conducted in accordance with ASTM D7012 method C.

Abbreviations:

psi	Pounds per Square Inch
ft	Foot

KUB Kuwahee WWTP
RAS Pumping System Upgrade
Knoxville, Tennessee

Table 3
Summary of Subsurface Investigation Program

Test Boring Number	Approximate Ground Surface Elevation (ft) [1]	Exploration Depth (ft) [2]	Layer Thickness (ft)				Auger Refusal Depth (ft)	Groundwater Depth (ft) [2&3]	Comments
			Fill	Alluvial Soils	Weathered Rock Fragments	Limestone			
B-301	831.0	45.0	22[7]	10.9	NE	>12.1	28.0	22.0	Rock coring performed from 28 to 45 ft.
B-302	838.8	50.0	23[7]	17.0	NE	>10.0	40.0	28.0	Rock coring performed from 40 to 50 ft.

Notes:

1	Elevations are in feet and referenced to the National American Vertical Datum of 1988 (NAVD88).
2	Indicated depths are depths below ground surface at the time of drilling.
3	Groundwater levels were measured at the time of drilling and may not represent the stabilized groundwater level
4	Vacuum excavation to 8.5 feet below ground surface to confirm utility clearance

Abbreviations:

>	Indicates strata not fully penetrated
NE	Not encountered

Attachment A

Test Boring Logs

CDM Smith

BOREHOLE LOG
B-301

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

Drilling Contractor: Total Depth Drilling
Surface Elevation (ft.): 831
Drilling Method/Rig: 3 1/4" HSA/CME-55 Truck
Total Depth (ft.): 45
Drillers: Tim Hall
Depth to Initial Water Level (ft-bgs): 22
Drilling Date: Start: 04-24-17 **End:** 04-24-17
Abandonment Method: Grout
Borehole Coordinates:
Field Screening Instrument: PP
See Test Boring Location Plan
Logged By: JLV

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			831.0 0					0-0.6': Asphalt 0.6-2.3': Base course 2.3-8': Moist to wet, reddish brown, Silty CLAY, some fine to coarse sand, little fine gravel, occasional brick fragments **-FILL-** 0.5-8.5': Vacuum excavation
HA	HA-1	96/50	826.0 5	N/A	VAC		Fill	
SS	S-1	18/7	821.0 10	7	4 4 3			Moist to wet, medium stiff, brown, Silty CLAY, some fine to coarse sand, little fine gravel (Pocket Penetrometer = 0.25 tsf)
SS	S-2	18/6	816.0	6	7 4 2			Dry to moist, loose, gray and reddish brown, fine to coarse GRAVEL and Silty CLAY, trace fine sand (Pocket Penetrometer = 1.25 tsf)

EXPLANATION OF ABBREVIATIONS

DRILLING METHODS:
HSA - Hollow Stem Auger
SSA - Solid Stem Auger
HA - Hand Auger
AR - Air Rotary
DTR - Dual Tube Rotary
FR - Foam Rotary
MR - Mud Rotary
RC - Reverse Circulation
CT - Cable Tool
JET - Jetting
D - Driving
DTC - Drill Through Casing

SAMPLING TYPES:
AS - Auger/Grab Sample
CS - California Sampler
BX - 1.5" Rock Core
NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer Weight: 140 lb
Hammer Drop Height: 30 inches
Spoon Size: 2 inch O.D., 24 inches long
ft-bgs = feet below ground surface
NR = not recorded
PP = pocket penetrometer
RQD = rock quality designation
REC = recovery

Reviewed by: J. Briand **Date:** 05-12-17

BOREHOLE KUWAHEE PUMP STATION LOGS_05152017.GPJ CDM_CORP.GDT 7/10/17

CDM Smith

BOREHOLE LOG
B-301

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			816.0					
			15				Fill	Moist to wet, soft, light reddish brown, Silty CLAY, some fine to coarse gravel, trace fine sand (Pocket Penetrometer = 0.5 tsf)
SS	S-3	18/13	811.0	3	WOH 1 2			
			20					
								-ALLUVIAL SOILS-
SS	S-4	18/8	806.0	8	7 4 4			Wet, loose, gray and brown, fine to coarse GRAVEL, some silty clay, trace fine sand
			25				GC	
NQ	R-1	24/0	801.0					28': Auger refusal, switch to rock coring **RUN 1: 28 to 30 feet below ground surface** REC = 0%, RQD = 0% No recovery
			30					**RUN 2: 30 to 35 feet below ground surface** REC = 42%, RQD = 42% 30-32.9': Gray, fine to coarse GRAVEL 32.9-35': Hard, fresh, gray, aphantic to fine grained, LIMESTONE, jointing horizontal to low angle, sound, rough, stepped, open
NQ	R-2	60/28						
			796.0					**-LIMESTONE-**
			35				Limestone	**RUN 3: 35 to 40 feet below ground surface** REC = 96%, RQD = 96% Hard, fresh, gray, aphantic to fine grained, LIMESTONE, jointing horizontal to low angle, sound, rough, stepped, open
NQ	R-3	60/57.75						

CDM Smith

BOREHOLE LOG
B-301

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			791.0 40					
NQ	R-4	60/59.5					Limestone	**RUN 4: 40 to 45 feet below ground surface** REC = 99%, RQD = 96% Hard, fresh, gray, aphantic to fine grained, LIMESTONE, jointing horizontal to low angle, sound, rough, stepped, open
			786.0 45					Boring terminated at 45 ft-bgs.
			781.0 50					
			776.0 55					
			771.0 60					

CDM Smith

BOREHOLE LOG
B-302

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

Drilling Contractor: Total Depth Drilling
Surface Elevation (ft.): 838.8
Drilling Method/Rig: 3 1/4" HSA/CME-55 Truck
Total Depth (ft.): 50
Drillers: Tim Hall
Depth to Initial Water Level (ft-bgs): 28
Drilling Date: Start: 04-24-17 **End:** 04-24-17
Abandonment Method: Grout
Borehole Coordinates:
Field Screening Instrument: PP
See Test Boring Location Plan
Logged By: JLV

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			838.8 0					0-0.3': Asphalt 0.3-2': Base course 2-8': Moist, reddish brown, Silty CLAY, some fine to coarse gravel, trace fine sand **-FILL-** 0.5-8.5': Vacuum excavation
HA	HA-1	96/50	833.8 5	N/A	VAC		Fill	
SS	S-1	18/14	828.8 10	8	2 4 4			Moist, medium stiff, reddish brown, Silty CLAY, trace fine to coarse sand, trace fine gravel (Pocket Penetrometer = 1.25 tsf)
SS	S-2	18/18	823.8	11	3 3 8			Moist, stiff, red, Silty CLAY, little fine to coarse sand, trace fine gravel (Pocket Penetrometer = 1.75 tsf)

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:
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NX - 2.1" Rock Core
GP - Geoprobe
HP - Hydro Punch
SS - Split Spoon
ST - Shelby Tube
WS - Wash Sample
OTHER:
AGS - Above Ground Surface

REMARKS

Hammer Weight: 140 lb
Hammer Drop Height: 30 inches
Spoon Size: 2 inch O.D., 24 inches long
ft-bgs = feet below ground surface
NR = not recorded
PP = pocket penetrometer
RQD = rock quality designation
REC = recovery

Reviewed by: J. Briand **Date:** 05-12-17

BOREHOLE KUWAHEE PUMP STATION LOGS_05152017.GPJ CDM_CORP.GDT 7/10/17

CDM Smith

BOREHOLE LOG
B-302

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			823.8 15				Fill	
SS	S-3	18/18		7	1 3 4			Moist, medium stiff, red, Silty CLAY, little fine to coarse sand, trace fine gravel (Pocket Penetrometer = 3.0 tsf)
			818.8 20					21-23': Increased drilling resistance
SS	S-4	18/18		15	3 6 9			**-ALLUVIAL SOILS-** Moist, stiff, light reddish brown, CLAY and SILT, and fine to coarse SAND, trace fine gravel (mica present) (Pocket Penetrometer = 2.25 tsf)
			813.8 25				CL	26-28': Hard drilling
SS	S-5	18/14		2	WOH WOH 2			Moist to wet, very soft, brown, CLAY and SILT and fine to coarse SAND, trace fine gravel (mica present) (Pocket Penetrometer = 0.5 tsf)
			808.8 30					
SS	S-6	18/18	803.8 35	WOR	WOR WOR WOR		CH	Wet, very soft, light brown, Silty CLAY, some fine to coarse sand, trace fine gravel (Pocket Penetrometer < 0.25 tsf)

BOREHOLE KUWAHEE PUMP STATION LOGS_05152017.GPJ CDM_CORP.GDT 7/10/17

CDM Smith

BOREHOLE LOG
B-302

Client: Knoxville Utilities Board
Project Name: RAS Pumping System Upgrade
Project Location: Knoxville, Tennessee
Project Number: 10561-115043

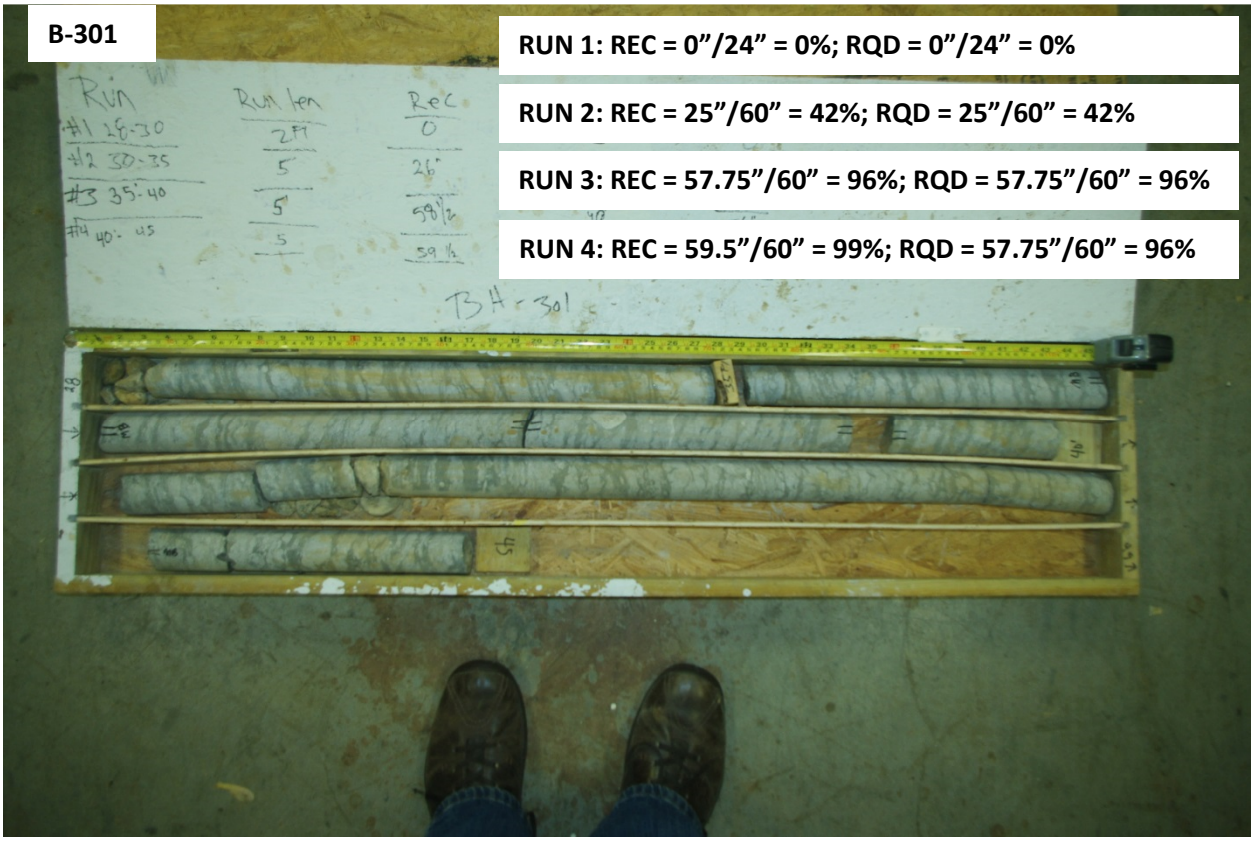
Sample Type	Sample Number	Sample Adv/Rec (inches)	Elev. Depth (ft.)	N-Value	Blows per 6-in	Graphic Log	USCS Designation	Material Description
			798.8 / 40				CH	
SS	S-7	0/0		--	10/0"			No recovery 40': Auger refusal, switch to rock coring
NQ	R-1	60/59						**RUN 1: 40 to 45 feet below ground surface** REC = 98%, RQD = 92% Hard, fresh, gray, aphantic to fine grained, LIMESTONE, jointing horizontal to low angle, sound, rough, stepped, open
			793.8 / 45				Limestone	
NQ	R-2	60/59.5						**RUN 1: 45 to 50 feet below ground surface** REC = 99%, RQD = 94% Hard, fresh, gray, aphantic to fine grained, LIMESTONE, jointing horizontal to low angle, sound, rough, stepped, open
			788.8 / 50					Boring terminated at 50 ft-bgs.
			783.8 / 55					
			778.8 / 60					

Attachment B

Rock Core Photo Logs

KUB Kuwahee WWTP RAS Pumping System Upgrade

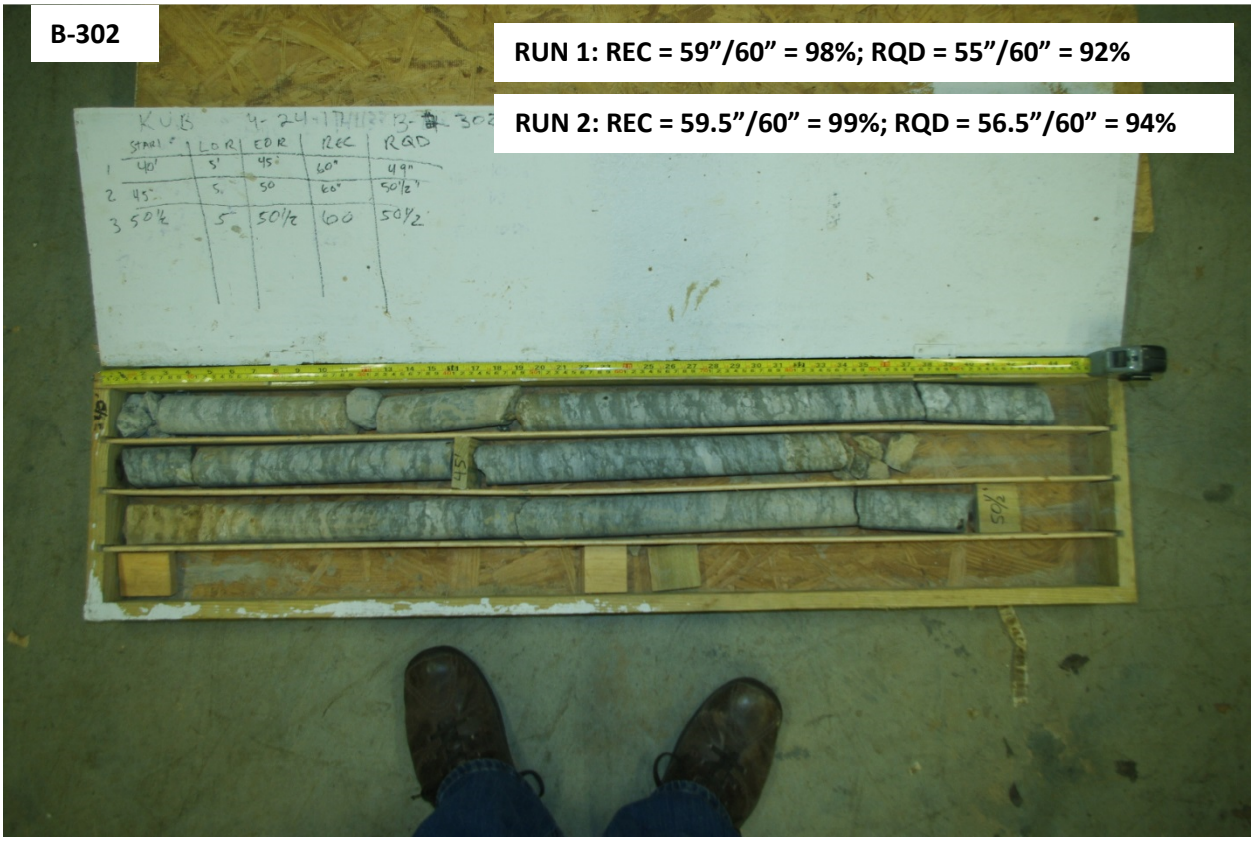
Knoxville, Tennessee



Sample Taken 04/24/2017

Core Picture 1
B-301: R-1 to R-4

CDM Smith



Sample Taken 04/24/2017

Core Picture 2
B-302: R-1 & R-2

Attachment C

Geotechnical Laboratory Test Results

K. S. Ware & Associates, L.L.C.
Geotechnical • CEI • Environmental

603 Dutch Valley Drive
Knoxville, TN 37918
tel: 615-255-9702
fax: 615-256-5873

REPORT OF MATERIAL IN SOILS FINER THAN NO. 200 SIEVE, ASTM D1140 AND SIEVE ANALYSIS ASTM C136

Project Name: CDM Smith Kuwahee WWTP
Sample ID: B301 S-1
Project Number: 300-17-0004
Test Date: 5/1/2017
Sample Description: Brown Gravely Clay
Date Received: 4/26/2017
Equipment Used: Balance, Sieves, Oven, Water, Wetting Agent, Tare Containers

No. 200 Wash

Original Oven Dry Mass of Sample (grams): 174.60
Oven Dry Mass of Sample Retained on No. 200 (grams): 83.98
Percentage Passing No. 200 Sieve: **51.9%**

Sieve Analysis

Sieve Size	Diameter (mm)	Mass Retained on Sieve (grams)	Cumulative Mass Retained on Sieve (grams)	Percent Retained on Sieve	Total Percent Passing Sieve
3 inch	75	0.00	0.00	0.0%	100.0%
2 inch	50	0.00	0.00	0.0%	100.0%
1.5 inch	37.5	0.00	0.00	0.0%	100.0%
1 inch	25.0	0.00	0.00	0.0%	100.0%
3/4 inch	19.0	0.00	0.00	0.0%	100.0%
3/8 inch	9.5	23.14	23.14	13.3%	86.7%
No. 4	4.75	9.18	32.32	18.5%	81.5%
No. 10	2.00	8.07	40.39	23.1%	76.9%
No. 16	1.18	3.88	44.27	25.4%	74.6%
No. 30	0.60	4.74	49.01	28.1%	71.9%
No. 40	0.425	3.60	52.61	30.1%	69.9%
No. 60	0.250	7.24	59.85	34.3%	65.7%
No. 100	0.150	10.01	69.86	40.0%	60.0%
No. 200	0.075	13.18	83.04	47.6%	52.4%

Remarks :

Submitted By: Adam Dusheck
Date: 5/1/2017
Reviewed By:
Date:

K. S. Ware & Associates, L.L.C.
Geotechnical • CEI • Environmental

54 Lindsley Avenue
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REPORT OF MATERIAL IN SOILS FINER THAN NO. 200 SIEVE, ASTM D422 AND SIEVE ANALYS ASTM C136

Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B301 S-1
Project Number:	300-17-0004	Test Date:	5/1/2017
Sample Description:	Brown Gravely Clay		
Date Received:	4/26/2017		

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REPORT OF MATERIAL IN SOILS FINER THAN NO. 200 SIEVE, ASTM D1140 AND SIEVE ANALYSIS ASTM C136

Project Name: CDM Smith Kuwahee WWTP
Sample ID: B302 S-2
Project Number: 300-17-0004
Test Date: 5/1/2017
Sample Description: Light Brown Silty Clay
Date Received: 4/26/2017
Equipment Used: Balance, Sieves, Oven, Water, Wetting Agent, Tare Containers

No. 200 Wash

Original Oven Dry Mass of Sample (grams): 157.47
Oven Dry Mass of Sample Retained on No. 200 (grams): 36.07
Percentage Passing No. 200 Sieve: **77.1%**

Sieve Analysis

Sieve Size	Diameter (mm)	Mass Retained on Sieve (grams)	Cumulative Mass Retained on Sieve (grams)	Percent Retained on Sieve	Total Percent Passing Sieve
3 inch	75	0.00	0.00	0.0%	100.0%
2 inch	50	0.00	0.00	0.0%	100.0%
1.5 inch	37.5	0.00	0.00	0.0%	100.0%
1 inch	25.0	0.00	0.00	0.0%	100.0%
3/4 inch	19.0	0.00	0.00	0.0%	100.0%
3/8 inch	9.5	3.40	3.40	2.2%	97.8%
No. 4	4.75	1.55	4.95	3.1%	96.9%
No. 10	2.00	1.48	6.43	4.1%	95.9%
No. 16	1.18	1.91	8.34	5.3%	94.7%
No. 30	0.60	3.77	12.11	7.7%	92.3%
No. 40	0.425	3.12	15.23	9.7%	90.3%
No. 60	0.250	5.99	21.22	13.5%	86.5%
No. 100	0.150	6.60	27.82	17.7%	82.3%
No. 200	0.075	8.31	36.13	22.9%	77.1%

Remarks :

Submitted By: Adam Dusheck
Date: 5/1/2017
Reviewed By:
Date:

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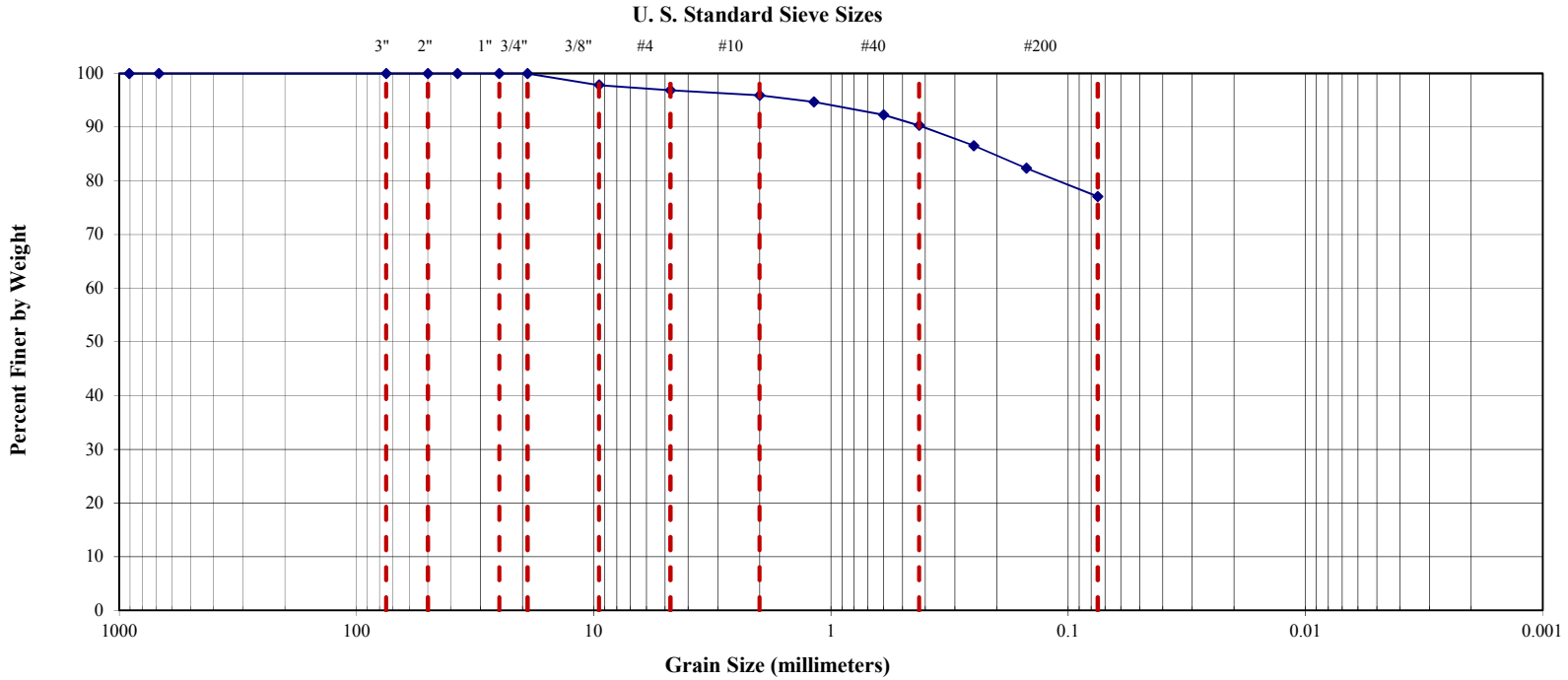
REPORT OF MATERIAL IN SOILS FINER THAN NO. 200 SIEVE, ASTM D422 AND SIEVE ANALYS ASTM C136



Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-2
Project Number:	300-17-0004	Test Date:	5/1/2017
Sample Description:	Light Brown Silty Clay		
Date Received:	4/26/2017		

K. S. Ware & Associates, L.L.C.
Geotechnical • CEI • Environmental

603 Dutch Valley Drive
Knoxville, TN 37918
tel: 615-255-9702
fax: 615-256-5873

REPORT OF PARTICLE SIZE ANALYSIS OF SOILS, ASTM D422

Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-4
Project Number:	300-17-0004	Test Date:	5/2/2017
Sample Description:	Light Brown Silty Clay		
Date Received:	4/26/2017		
Equipment Used:	Balance, Stirring Apparatus, Hydrometer, Sedimentation Cylinder, Thermometer, Sieves, Temperature Constant Room, Beaker, Timing Device		

CONSTANTS:

Hydrometer Type:	151H	Dispersing Agent:	Sodium Hexa Meta Phosphate
Zero Correction:	0.003	Specific Gravity Of Solids:	2.70
Meniscus:	0.001	Center or Gravity Constant (cm):	19.84
Viscosity of Water @ 70°F:	0.00001	Hygroscopic Moisture (%):	2.0%

Sieve Analysis to #10:

Total Air Dry Sample (grams): **697.00**

Sieve #	Diameter (mm)	Mass Retained (Grams)	Cumulative Mass Retained (Grams)	Percent Passing* (%)
1.5 in.	38.1 mm	0.00	0	100.0
1 in.	25 mm	0.00	0	100.0
3/4 in.	19.1mm	0.00	0	100.0
3/8 in.	9.51mm	13.00	13	98.1
#4	4.75mm	25.50	38.5	94.5
#10	2.0mm	66.50	105	84.9
Pan	N/A	592.00	697	2015.66

*Percent Passing is adjusted for Hydroscopic Moisture

Hydrometer Readings

Elapsed Time (Min)	Temp (C)	Actual Hyd. Reading	Corr. Hyd. Reading	Act. % Finer	Adj. % Finer	L	L/t	K	D.mm
2	21.3	1.020	1.017	53.8	45.7	11	5.5000	0.01319	0.0309
5	21.3	1.019	1.016	50.6	43.0	11.3	2.2600	0.01319	0.0198
15	21.3	1.017	1.014	44.3	37.6	11.8	0.7867	0.01319	0.0117
30	21.3	1.015	1.012	37.9	32.2	12.3	0.4100	0.01319	0.0084
60	21.3	1.014	1.011	34.8	29.5	12.6	0.2100	0.01319	0.0060
250	23.6	1.012	1.009	28.5	24.2	13.1	0.0524	0.01277	0.0029
1440	20.1	1.011	1.008	25.3	21.5	13.4	0.0093	0.01340	0.0013

Post Hydrometer Sieve Analysis

Sieve #	Diameter (mm)	Mass Retained (Grams)	Percent Passing (%)
16	1.18mm	0.18	84.63
30	0.6mm	0.53	84.04
40	0.425mm	1.09	83.09
70	0.212mm	3.71	78.66
100	0.150mm	9.38	69.07
200	0.08mm	17.67	55.05

Remarks :

Submitted By: Adam Dusheck Date: 5/4/2017

Reviewed By: Date:

K. S. Ware & Associates, L.L.C.
Geotechnical • CEI • Environmental

54 Lindsley Avenue
Nashville, Tennessee 37210
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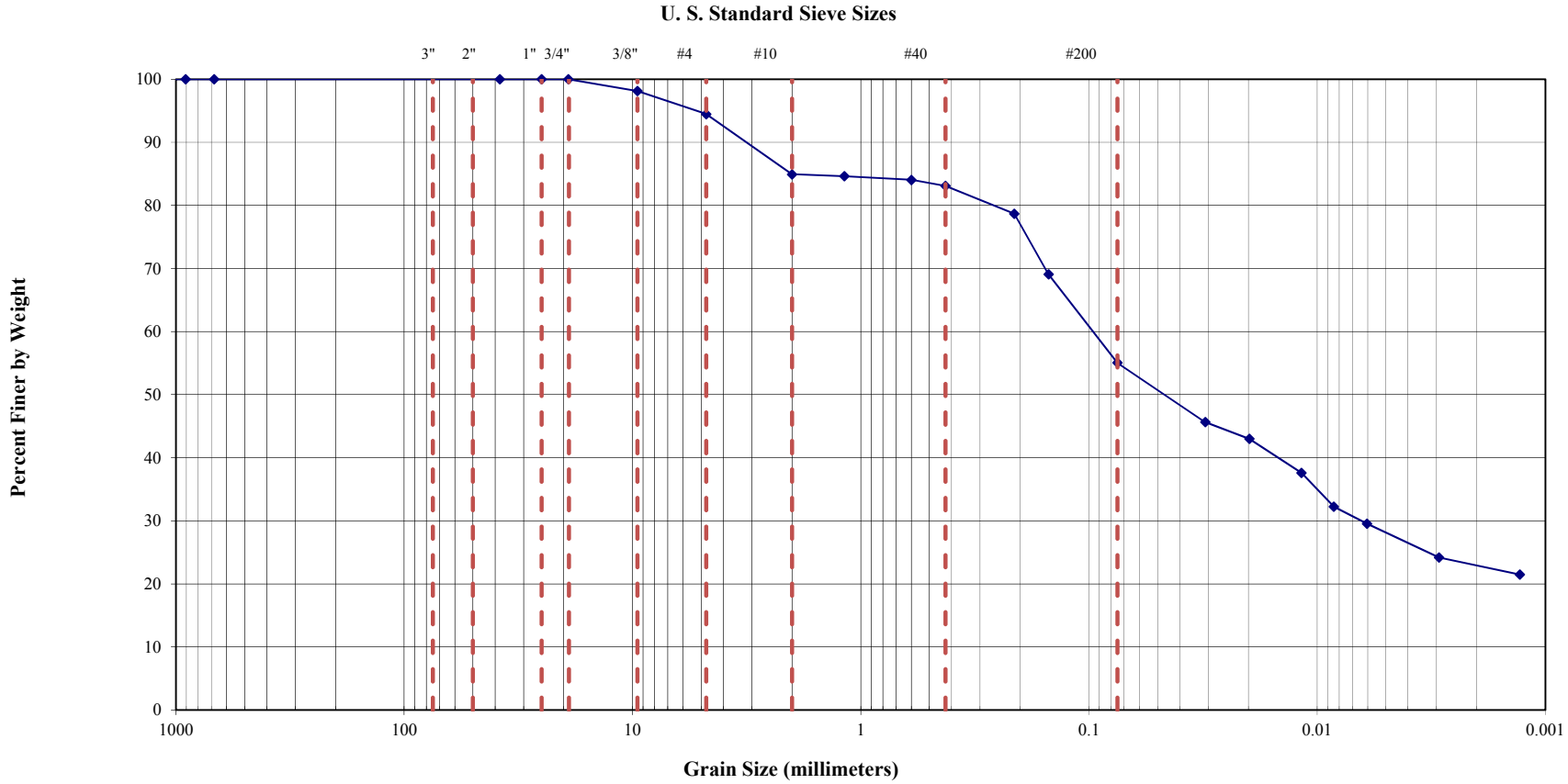
REPORT OF PARTICLE SIZE ANAYSIS OF SOILS, ASTM D422



Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-4
Project Number:	300-17-0004	Test Date:	5/2/2017
Sample Description:	Light Brown Silty Clay		
Date Received:	4/26/2017		

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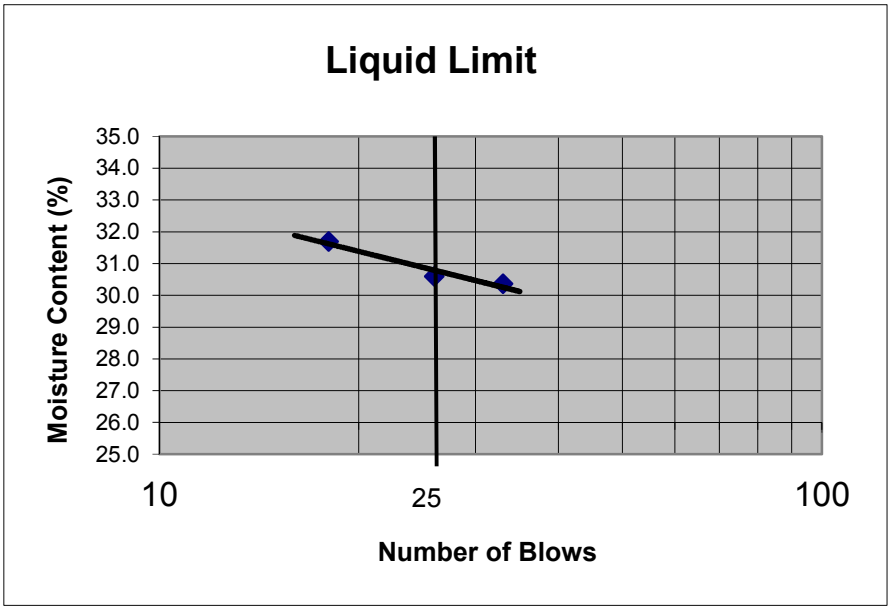
REPORT OF LIQUID LIMIT, PLASTIC LIMIT & PLASTICITY INDEX, ASTM D4318

Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-4
Project Number:	300-17-0004	Test Date:	5/1/2017
Sample Description:	Light Brown Silty Clay		
Date Received:	4/26/2017		
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestle, Spatula, Grooving Tool		

	Liquid Limit			Plastic Limit	
Tare No	1	2	3	4	5
Wet Soil and Tare	37.49	42.54	40.25	18.51	19.45
Dry Soil and Tare	32.06	35.90	33.93	17.85	18.71
Wt. of Water	5.43	6.64	6.32	0.66	0.74
Tare Wt.	14.18	14.20	13.99	13.94	14.20
Dry Soil	17.88	21.70	19.94	3.91	4.51
Moisture content%	30.4	30.6	31.7	16.9	16.4
No. Of blows	33	26	18	**Average:**	17
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **31**

Plastic Limit: **17**

Plasticity Index: **14**

USCS CLASSIFICATION:

CL

BASED ON PLASTICITY OF MINUS #40 FRACTION

Remarks : _____

Submitted By: Adam Dusheck Date: 5/3/2017

Reviewed By: _____ Date: _____

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REPORT OF PARTICLE SIZE ANALYSIS OF SOILS, ASTM D422

Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-6
Project Number:	300-17-0004	Test Date:	5/2/2017
Sample Description:	Brown Silty Clay		
Date Received:	4/26/2017		
Equipment Used:	Balance, Stirring Apparatus, Hydrometer, Sedimentation Cylinder, Thermometer, Sieves, Temperature Constant Room, Beaker, Timing Device		

CONSTANTS:

Hydrometer Type:	151H	Dispersing Agent:	Sodium Hexa Meta Phosphate
Zero Correction:	0.003	Specific Gravity Of Solids:	2.70
Meniscus:	0.001	Center or Gravity Constant (cm):	19.84
Viscosity of Water @ 70°F:	0.00001	Hygroscopic Moisture (%):	4.0%

Sieve Analysis to #10:

Total Air Dry Sample (grams): **449.50**

Sieve #	Diameter (mm)	Mass Retained (Grams)	Cumulative Mass Retained (Grams)	Percent Passing* (%)
1.5 in.	38.1 mm	0.00	0	100.0
1 in.	25 mm	0.00	0	100.0
3/4 in.	19.1mm	0.00	0	100.0
3/8 in.	9.51mm	7.00	7	98.4
#4	4.75mm	14.00	21	95.3
#10	2.0mm	74.00	95	78.9
Pan	N/A	354.50	449.5	2015.66

*Percent Passing is adjusted for Hydroscopic Moisture

Hydrometer Readings

Elapsed Time (Min)	Temp (C)	Actual Hyd. Reading	Corr. Hyd. Reading	Act. % Finer	Adj. % Finer	L	L/t	K	D.mm
2	21.3	1.028	1.025	79.1	62.4	8.9	4.4500	0.01319	0.0278
5	21.3	1.026	1.023	72.8	57.4	9.4	1.8800	0.01319	0.0181
15	21.3	1.023	1.020	63.3	49.9	10.2	0.6800	0.01319	0.0109
30	21.3	1.021	1.018	56.9	44.9	10.7	0.3567	0.01319	0.0079
60	21.3	1.019	1.016	50.6	39.9	11.3	0.1883	0.01319	0.0057
250	23.6	1.015	1.012	38.0	29.9	12.3	0.0492	0.01277	0.0028
1440	20.1	1.012	1.009	28.5	22.5	13.1	0.0091	0.01340	0.0013

Post Hydrometer Sieve Analysis

Sieve #	Diameter (mm)	Mass Retained (Grams)	Percent Passing (%)
16	1.18mm	0.83	77.56
30	0.6mm	2.31	75.24
40	0.425mm	3.14	73.93
70	0.212mm	4.57	71.69
100	0.150mm	6.34	68.91
200	0.08mm	8.95	64.81

Remarks :

Submitted By: Adam Dusheck Date: 5/4/2017

Reviewed By: Date:

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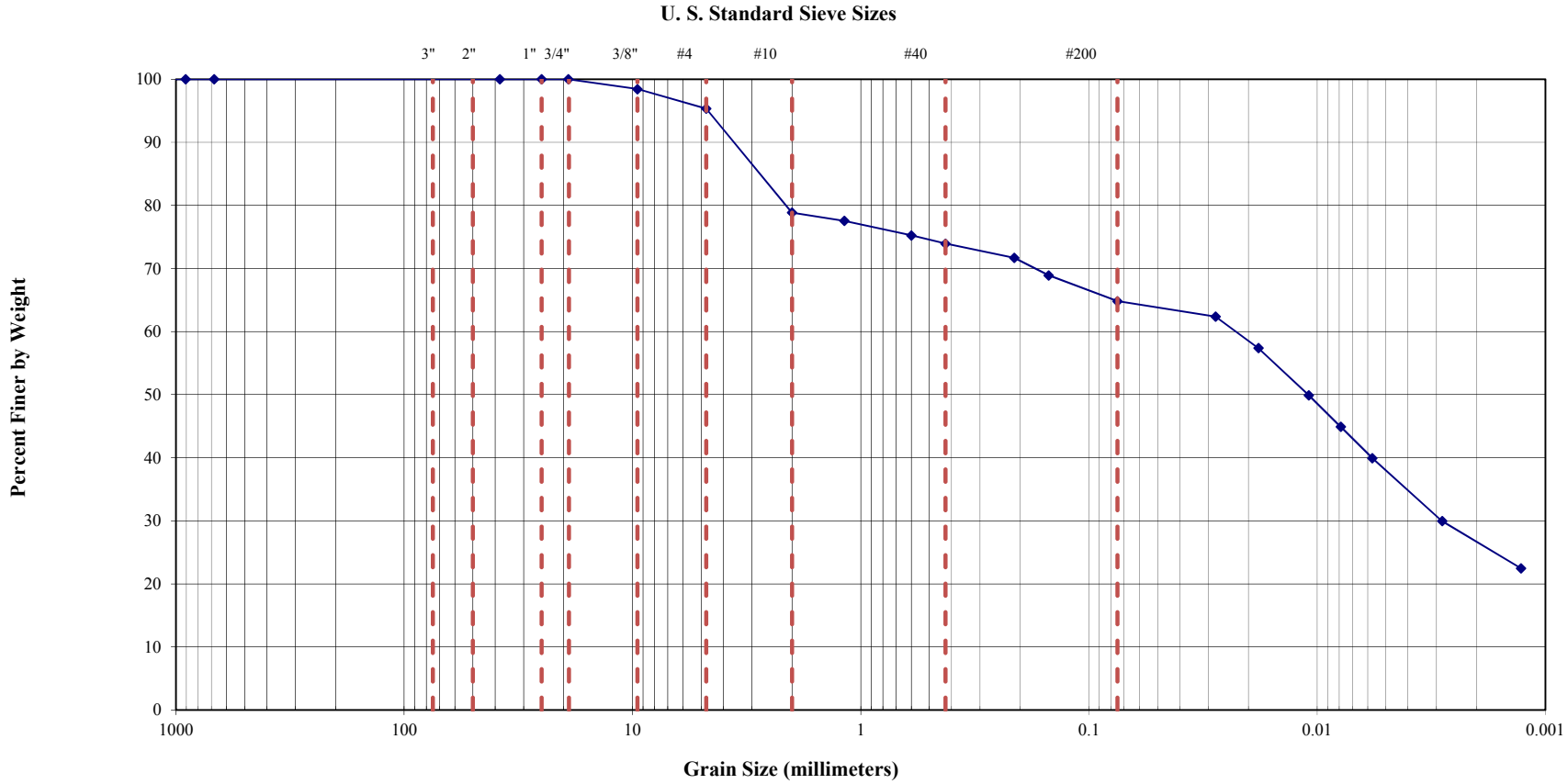
REPORT OF PARTICLE SIZE ANAYSIS OF SOILS, ASTM D422



Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-6
Project Number:	300-17-0004	Test Date:	5/2/2017
Sample Description:	Brown Silty Clay		
Date Received:	4/26/2017		

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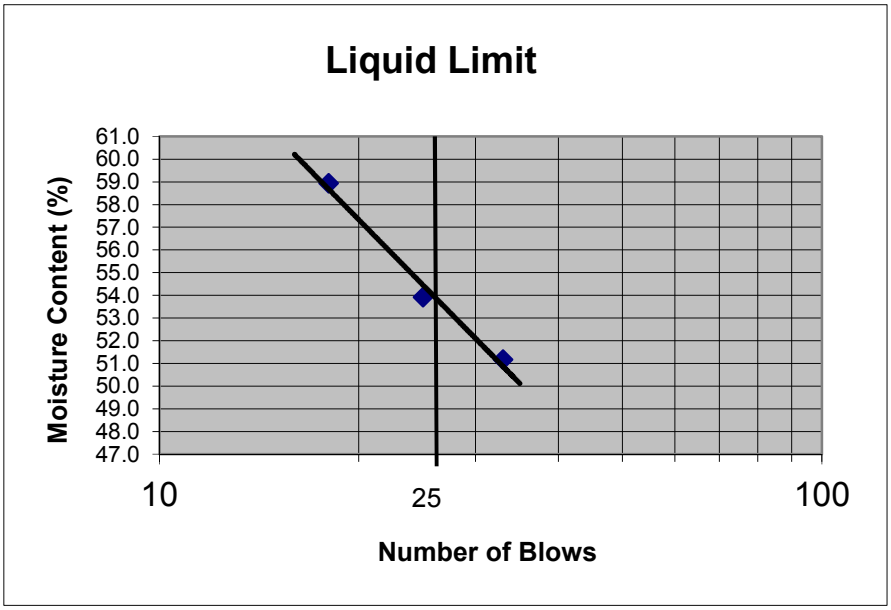
REPORT OF LIQUID LIMIT, PLASTIC LIMIT & PLASTICITY INDEX, ASTM D4318

Project Name:	CDM Smith Kuwahee WWTP	Sample ID:	B302 S-6
Project Number:	300-17-0004	Test Date:	5/1/2017
Sample Description:	Brown Silty Clay		
Date Received:	4/26/2017		
Equipment Used:	LLD, Oven, Ohaus 3kg Scale, Metal Tares, Mortar and Pestle, Spatula, Grooving Tool		

	Liquid Limit			Plastic Limit	
Tare No	1	2	3	4	5
Wet Soil and Tare	50.50	47.64	43.45	18.75	19.99
Dry Soil and Tare	40.41	38.34	35.17	17.69	18.60
Wt. of Water	10.09	9.30	8.28	1.06	1.39
Tare Wt.	20.69	21.09	21.12	14.00	13.89
Dry Soil	19.72	17.25	14.05	3.69	4.71
Moisture content%	51.2	53.9	58.9	28.7	29.5
No. Of blows	33	25	18	**Average:**	29
Required Blows	***25-35***	***20-30***	***15-25***		



Liquid Limit: **54**

Plastic Limit: **29**

Plasticity Index: **25**

USCS CLASSIFICATION:

CH

BASED ON PLASTICITY OF MINUS #40 FRACTION

Remarks : _____

Submitted By: Adam Dusheck Date: 5/3/2017

Reviewed By: _____ Date: _____

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UNCONFINED COMPRESSIVE STRENGTH OF ROCK CORES (ASTM D7012 Method C)

Project Name: CDM Smith Kuwahee WWTP
Sample Type: NQ Rock Cores
Project Number: 300-17-0004
Test Date: 5/4/2017
Sample Description:
Date Received: 4/26/2017

Sample ID	Depth (ft)	Average Diameter (in)	Average Height (in)	L/D Ratio	Surface Area (in^2)	Total Load (lbs)	Compressive Strength	
							PSI	KSF
B301	35.0-36.5	1.865	5.043	2.704	2.733	40009	14640	2110
B302	40.2-40.9	1.862	5.038	2.705	2.723	26004	9550	1380

Remarks : Results reported may differ from results obtained from a test specimen that meets the requirements of Practice D4543

Submitted By: _____ Date: _____
Reviewed By: _____ Date: _____