SECTION 018100 – GEOTECHNICAL DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Report of explorations and tests of subsurface conditions at the site.

1.2 RELATED SECTION

A. Section 312000 – Earth Moving

B. Section 312319 - Dewatering

1.3 INVESTIGATION

A. Soil and subsurface investigations were conducted at the site, the results of which are to be found in the report titled “Report of Geotechnical Exploration” issued by Goodwyn, Mills and Cawood (GMC)., dated April 30, 2019 GMC Project Number GGRE180005.

B. The GMC Geotechnical Report provides Owner’s information for Bidders’ convenience and is intended to supplement rather than serve in lieu of Bidders’ own investigations. It is made available for Bidders’ convenience and information, but is not a warranty of existing conditions.

C. Bidders are urged to examine soils investigation data and to make their own investigation of the site before bidding.

1.4 INTERPRETATION

A. Soil investigation data is provided only for information and the convenience of bidders.

B. Owner and Engineer disclaim all responsibility for the accuracy, true location, and extent of the soils investigation that has been prepared by others. They further disclaim responsibility for interpretations of that data by bidders, as in projecting soil-bearing values, rock profiles, soil stability and the presence, level, and extent of underground water.

C. Owner and Engineer disclaim all responsibility for the existence of other soil and subsurface investigations previously prepared for Owner, Engineer, or others. It is the sole responsibility of the Bidder to obtain other soil and subsurface investigations that may be available for interpretation, at no additional cost to the Owner.

D. Bidders are urged to examine Report Limitations of the GMC Geotechnical Report that addresses the purpose, basis, and warranties relevant to that report.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 018100

PURRYSBURG WATER TREATMENT PLANT IMPROVEMENTS

Purrysburg, Jasper County, South Carolina

April 30, 2019

REPORT OF GEOTECHNICAL EXPLORATION

Prepared By

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GMC PROJECT NUMBER: GGRE180005

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April 30, 2019

Mr. Jim Vaughn
Goodwyn, Mills and Cawood, Inc.
35 Abercorn Street
Suite 210
Savannah, GA 31401

RE: REPORT OF GEOTECHNICAL EXPLORATION
PURRYSBURG WTP IMPROVEMENTS
PURRYSBURG, JASPER COUNTY, SOUTH CAROLINA
GMC PROJECT NO. GGRE180005

Dear Mr. Vaughn,

Goodwyn, Mills and Cawood, Inc. (Geotechnical & Construction Services Division) is pleased to provide this report of geotechnical exploration performed for the above referenced project. This report includes the results of field and laboratory testing, general site preparation recommendations based on specific site conditions, and recommendations for foundation design.

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to call us.

Sincerely,

GOODWYN, MILLS, AND CAWOOD, INC.

Kevin W. Wales
Executive Vice President

Patrick O'Leary, PE
Project Engineer
Licensed South Carolina

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER
PJO
No. 34753
4/30/19
PATRICK J. O'LEARY

Michael J. McNeill
Senior Geotechnical Professional

SOUTH CAROLINA
Goodwyn Mills & Cawood Inc. No. 339
CERTIFICATE OF AUTHORIZATION

Cc: Mr. Mitch Freeman, PE – GMC
Mr. Jim Vaughn, PE – GMC
Mr. Tony Reid, PE - GMC

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1.0 PROJECT INFORMATION AND SCOPE OF WORK

1.1 Existing Site

A geotechnical exploration has been conducted for the proposed improvements at the Purrysburg Water Treatment Plant (WTP) on Purrysburg Road in Purrysburg, SC. The project area for the improvements will generally be in the east and south portion of the existing WTP. The project area currently consists of open areas of grass and bare earth.


View of site on January 4, 2019

1.2 Planned Construction

The proposed construction will consist of the following structures:

- A PAC contactor tank approximately 31' x 62' with 24' tall walls (maximum 22' water height) bearing at or near existing grade
- A static mix basin attached to the PAC
- Flocculation/sedimentation basins at or near existing grade, matching the existing structures
- Filters with a bearing depth approximately 5 to 10 feet below grade, matching the existing structures
- An expansion to the control building
- A 140-foot diameter above ground clearwell

At the time this report was prepared, no structural loading information was available. Based on our experience with similar types of structures, we anticipate area loading to be less than 3 kips per square foot, and wall loads to be less than 2 kips per linear foot.

GMC was provided with previous geotechnical reports for the plant site for our review and information:

- Geotechnical Investigation – Purrysburg WTP – dated 11/26/01 by Geo-Systems Design & Testing, Inc.
- Geotechnical Investigation – 250,000 Gallon Elevated Water Tank – dated 5/24/02 by Geo-Systems Design & Testing, Inc.

1.3 Scope of Work

The purpose of this exploration was to characterize the subsurface soil conditions at the site, and to provide the following:

- A brief summary of our test procedures and the results of all field and laboratory testing
- A review of the site conditions and geologic setting
- A review of subsurface soil stratigraphy including the individual Boring Records, Subsurface Diagrams, and a Boring Location Plan
- General recommendations for site preparation, excavation considerations, preparation of existing soils for proposed construction activities, and construction of compacted fills
- Information regarding groundwater conditions, along with recommendations for controlling groundwater in excavations during construction
- Soil liquefaction potential/considerations
- IBC seismic site class
- Design and construction recommendations for foundations, including foundation bearing capacities, bearing depths, and installation recommendations
- Estimated settlements
- Lateral earth pressure parameters
- Recommendations for design and construction of concrete slabs-on-grade

The scope of services for the geotechnical exploration did not include any environmental assessment for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below or around this site. Any statements, if any, in this report or on the boring records regarding odors, colors, or unusual or suspicious items or conditions are strictly for the information of the client.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 Field Exploration

The site subsurface conditions were explored by drilling a total of nine (9) soil test borings to depths ranging from 46 to 100 feet below existing ground surface at the approximate locations shown in Figure 1 below and on the Boring Location Plan in the Appendix. The borings had a planned termination depth of 50 feet, except for boring B-7, which had a planned termination depth of 100 feet. The boring locations were selected by GMC and were located in the field by GMC personnel estimating distances from existing structures. The ground surface elevations shown on the boring records were approximated from previous borings drilled at the site near the approximate locations of GMC's borings and are considered approximate. Field-testing employed by GMC was in general accordance with ASTM standards or generally accepted methods. The borings, structural areas, and termination or auger refusal depths are in the following table.

Boring No.	Structure	Termination or Auger Refusal (AR) Depth (feet)
B-1, B-2	PAC contactor tank	50
B-3	Flocculation/sedimentation basins	50
B-4	Flocculation/sedimentation basins	50
B-5	Filters	50
B-6	Control building expansion	50
B-7	Clearwell	100
B-8	Clearwell	47 (AR)
B-9	Clearwell	46 (AR)

Figure 1: Approximate Boring Locations on Google Earth Aerial Imagery date 3/12/2018

The borings were performed between January 17th and February 8th, 2019, using a truck-mounted drill rig equipped with a rotary head and mud rotary drilling methods. Soils were sampled using a two-inch outside diameter split barrel sampler driven with an automatic hammer. Split-spoon sampling and standard penetration testing were conducted at standard intervals in the borings. The retrieved samples were identified according to project number, boring number and depth, and were placed in polyethylene plastic bags to protect against moisture loss. Bulk soil samples were collected from auger cuttings within the upper 10 feet of the ground surface at borings B-1 and B-4. Two (2) undisturbed Shelby (UD) tube samples were attempted but the soil sample slid out of the tube during retrieval. Soil sampling and drilling was performed in general accordance with the procedures for "Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils" (ASTM 1586) and corrected to N_{60} values based on the energy efficiency of the hammer.

2.2 Laboratory Analyses

The laboratory-testing program included visual classification of all soil samples and laboratory testing of selected samples. Grain size analyses, Atterberg limits, and natural moisture content tests were performed on selected split-spoon samples and the bulk samples. In addition, two (2) modified Proctor tests were performed on the bulk samples. The triaxial shear testing and one-dimensional consolidation testing proposed for the UD tubes were not performed due to the UD tubes not able to be collected. The laboratory-testing program was conducted in general accordance with applicable ASTM standards and the results are summarized in the Appendix.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

Published geologic information indicates that the site is underlain by the Coastal Plain Unit. The Coastal Plain Unit is bounded on the west by the Piedmont Unit. The common boundary between the Piedmont Unit and the Coastal Plain Unit is the “Fall Line”. The Coastal Plain Unit is a compilation of wedge-shaped formations that begin at the “Fall Line” and dip towards the Atlantic Ocean with ground surface elevations typically less than 300 feet. The Coastal Plain is underlain by Mesozoic/Paleozoic basement rock. This wedge of sediment is comprised of numerous geologic formations that range in age from late Cretaceous period to Recent. The sedimentary soils of these formations consist of unconsolidated sand, clay, gravel, marl, cemented sands, and limestone that were deposited over the basement rock. The marl and limestone are considered in geotechnical engineering as an IGM. The basement rock consists of granite, schist, and gneiss similar to the rocks of the Piedmont Unit. The thickness of the Coastal Plain sediments varies from zero at the “Fall Line” to more than 4,000 feet at the southern tip of South Carolina near Hilton Head Island. The thickness of the Coastal Plain sediments along the Atlantic coast varies from ~1300 feet at Myrtle Beach to ~4000 feet at Hilton Head Island.

The area is formed of older, generally well-consolidated layers of sands, silts, or clays that were deposited by marine or fluvial action during a period of retreating ocean shoreline. Predominantly, sediments lie in nearly horizontal layers; however, erosional episodes occurring between depositions of successive layers are often expressed by undulations in the contacts between the formations. Due to their age, sediments exposed at the ground surface are often heavily eroded. Ridges and hills are either capped by terrace gravels or wind-deposited sands. Younger alluvial soils may mask these sediments in swales or stream valleys.

3.2 Subsurface Conditions

The descriptions given below are for materials that were encountered in the specific boring locations during the course of the fieldwork. The subsurface descriptions contained herein are of a generalized nature to highlight the major soil stratification features and soil characteristics. The boring records included in the Appendix should be reviewed for specific information as to specific boring locations. The stratification shown on the boring records and subsurface profiles represent conditions only at the actual boring locations. Variations may occur and should be expected between boring locations. In addition, the stratifications represent the approximate boundary between subsurface materials, and the transition may be gradual. The results of laboratory tests, consisting of Atterberg limits, grain size, and natural moisture contents performed on selected soil samples, are contained in the Appendix.

The borings generally encountered four main soil strata:

Strata	Soil Type	Approx. depth to bottom of strata from existing grade (feet)	Range of SPT N_{60} Values (bpf)	Relative Density / Consistency	Borings encountered
1	Lean and fat sandy CLAY (CL/CH) / Clayey SAND (SC)	9 to 11	8-34	Loose to dense/ Medium to hard	All borings
2	Poorly graded fine SAND (SP) / Fine SAND with silt (SP-SM)	28.5 to 31	4-25	Very loose to medium	All borings
3	Fat CLAY (CH)	21 to 31	10-19	Stiff to very stiff	B-3 and B-6
4	Elastic Silt (MH) with sand	28.5 to 100	9-50+	Stiff to hard	All borings

3.3 Groundwater Information

Groundwater was encountered in the borings at depths of about 8 to 9 feet below existing grade during drilling and at a depth of about 5 feet after 24 hours. The borings were backfilled at the end of the drilling operations. The groundwater information presented in this report is based on conditions at the time of our field activities. Groundwater levels may vary due to seasonal conditions and recent rainfall. Excavations below this depth will need to account for groundwater and the likelihood of flowing sands below this depth.

3.4 Seismic Characteristics

Areas of South Carolina, mainly along the coastal areas between Charleston and Savannah, Georgia, are at a higher risk of seismic activity. From a geotechnical standpoint, a seismic event could result in a condition called liquefaction occurring at this site. Liquefaction is caused by a build-up of excess pore water pressures in saturated granular soils during vibrational loadings (earthquake). The resulting damage to structures bearing over these soils are large settlements and displacements. Submerged sands, such as those at this site generally below 9 feet from the ground surface, are the most susceptible.

A liquefaction analysis was performed using the following parameters taken from Seismicmaps.org/U.S. Seismic Design Maps:

Design Code Reference Document: IBC-2015
Risk Category: III
Site Class: D - Stiff Soil

Type	Value	Description
S_S	0.36	MCER ground motion. (for 0.2 second period)
S_1	0.133	MCER ground motion. (for 1.0s period)
S_{MS}	0.544	Site-modified spectral acceleration value
S_{M1}	0.301	Site-modified spectral acceleration value
S_{DS}	0.363	Numeric seismic design value at 0.2 second SA
S_{D1}	0.201	Numeric seismic design value at 1.0 second SA
S_{DC}	D	Seismic design category
F_a	1.512	Site amplification factor at 0.2 second
F_v	2.269	Site amplification factor at 1.0 second
PGA	0.191	MCEG peak ground acceleration
F_{PGA}	1.418	Site amplification factor at PGA
PGA_M	0.271	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	0.36	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.432	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.133	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.159	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.834	Mapped value of the risk coefficient at short periods
C_{R1}	0.832	Mapped value of the risk coefficient at a period of 1 s

4.0 RECOMMENDATIONS

4.1 General

Based on the information provided for the new structures, we understand the proposed grade of the site will remain at or near the existing grades and the structures will be founded at similar depths to the existing structures. The proposed structures will be above grade structures and will be at or near grade with the exception of the filters, which will be founded 5 to 10 feet below grade. The main considerations that will need to be addressed at this site and during construction include:

1. The presence of fat clays (CH) and high moisture soils in the upper 5 feet of the borings;
2. Groundwater levels at or above proposed foundation bearing depths for the filters and other utility excavations;
3. Liquefaction of the sand strata below 10 feet across the site and the resulting settlement potential; and
4. Consolidation settlement of the loose sands below the clearwell and PAC structure.

4.2 Site Preparation

Surface vegetation and deleterious materials in the planned construction area should be completely removed. Based on our observations, we recommend 6 inches of stripping be budgeted to remove organics and root zones in the areas adjacent to the existing structure on the site. It should be noted that deeper depths of organics may be present in lower lying areas of the site or in drainage features.

PAC Contactor

Borings B-1 and B-2 drilled in this area encountered an upper 6 to 8 feet of moderate to highly plastic sandy clay (CH) with natural moisture contents ranging from 21% and 26%. These soils will likely be difficult to manage during construction. **We recommend that the upper 3 feet of material below the proposed subgrade elevation be removed and replaced with select off-site borrow material.** The subgrade soils may need to be scarified and recompacted prior to the first lift of fill being placed. The select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

Flocculation/Sedimentation Basins and Clearwell

Borings B-3, B-4, and B-7 through B-9 were drilled in these areas and encountered an upper 6 to 8 feet of clayey sand (SC) with some zones of highly plastic sandy clay (CH) with natural moisture contents ranging from 14% and 25%. We recommend that once the area is excavated to the planned subgrade elevation, the subgrade should be proofrolled with a loaded dump truck to verify the existing subgrade soils are suitable for slab support. Proofrolling consists of repeated passes with a loaded dump truck to locate areas of soft soil. Areas that rut or pump excessively will indicate those soils that will need remediation. If the layer of soft/pumping soils is relatively thin, less than about 1 foot, an attempt can be made to scarify, moisture condition, and compact the materials. Whether or not these soils will be problematic will be a function of prevailing weather conditions. If the soils are wet and adequate drying conditions are not present, this may not be practical. Deeper areas of soft/pumping soils should be removed until the thickness is such that the remaining material can be moisture conditioned and properly compacted. We recommend a GMC geotechnical engineer or qualified soils' technician observe the proofrolling operations.

If any material should need to be removed, select fill should be brought in and the select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

Filters

Borings B-5 and B-6 encountered an upper 8 to 12 feet of highly plastic sandy clay (CH) and clayey sand (SC) with natural moisture contents ranging from 16% to 20%. The groundwater level will likely be encountered below a depth of about 5 feet in this area. Planned excavations of 5 to 10 feet are planned for these structures; therefore, groundwater will need to be addressed during excavation. We recommend that the soils be excavated to the planned subgrade elevation and evaluated by the geotechnical engineer. The area should be sloped to drain towards the corners of the excavation and the water level be maintained by being pumped from sumps. The sump pumps may need to remain in place during construction and removed once the structures have been completed. We recommend that a geotextile separation/stabilization fabric (such as a Mirafi HP-270 or equal) be placed on the subgrade and a minimum of 12 inches of #57 stone be placed and densified over the geotextile. The structures can then be constructed on this layer.

Excavations adjacent to structures should be designed not to undermine existing foundations or structures. In addition, the structures should be monitored during excavation and dewatering for signs of distress.

General

Generally, soils with SPT N-values of ≤10 bpf are less stable and may require undercutting or recompaction in place. Due to the moisture-sensitive nature of the fine-grained soils, additional undercutting and/or stabilization will likely be required if proper site maintenance, protection from surface water, and equipment traffic control are not implemented. At the end of each day, the grading contractor should "weatherproof" exposed soil subgrades, and provide positive drainage for surface water flow if inclement weather is expected. The contractor should have water trucks available to wet subgrades exposed to prolonged dry periods. Twisting and turning of construction equipment over exposed soils, especially during and after rain events, should be avoided, or otherwise degradation of the prepared subgrade soils will occur.

4.3 Groundwater Management

As discussed, we anticipate groundwater to impact below grade excavations. If surface or rain water becomes an issue in open excavations, installation of interceptor ditches or permanent trench drains may be required. Pumping from shallow sumps can be used for temporary dewatering during construction. Extra precaution should be taken when preparing any such areas for concrete placement. In the event that water becomes a problem during concrete placement, pumps should be utilized to remove the water before the concrete is placed.

4.4 Time of Year Site Preparation Considerations

During periods of heavy rain, the near surface soils can become saturated and conditions of standing or ponding water at the ground surface can occur. The near-surface soils are deemed to be moisture sensitive and may lose their strength properties if exposed to excessive moisture. The time of the year that the sitework begins can affect the project considerably. In this area, the "wet season" is generally between the months of November and May, and the "dry season" from June to October. There are many considerations that need to be addressed prior to bidding a project that could affect the budget based on the time of year a project starts earthwork activities. The time of the year that the geotechnical borings were performed can provide a false sense of actual near surface conditions depending on the time of year and weather conditions. Below are considerations that should be addressed based on the time of the year earthwork is started.

"Wet" Season

During the wet season, the amount of undercutting may be greater, therefore resulting in greater excavation costs. The soils are typically proofrolled to determine their suitability for the placement of new fill or subgrade support. During the wet season, the surface soils have a higher moisture content and will tend to pump, therefore, hindering the placement of new fill. In addition, the drying time, time period between rain events, and temperature is not conducive to scarify soils, allow drying, and recompacting. At this time, the decision should be made to try either scarify/dry/compact the in-place soils, which could take time, or undercut and replace with suitable material, which could increase the sitework costs. Based on our experience, the amount of undercut could be 2 to 3 feet more (or greater in localized areas), whereas in drier weather, lesser amounts of undercutting may be necessary, if recompaction or stabilization of soils left in place can be achieved. Some undercut soils are not always "unsuitable" soil and can be moisture conditioned and reused as fill, if drying conditions are favorable.

The site contractor shall be responsible for maintaining a firm, unyielding and stable subgrade condition. Should the near surface soils become wet, the contractor should be prepared to mitigate these conditions by repeated aeration and exposure to sunlight or by admixture treatment.

"Dry" Season

During the dry season, the surface soils have a lower moisture content and will tend to "bridge" or "crust" softer underlying soils. They will generally allow the placement of new fill, but the crust can break down if repeated passes with heavily loaded equipment is persistent. In addition, new fill from cuts or other sources may need to be moisture conditioned prior to compaction. The soils can dry significantly, requiring the addition of water for proper compaction. Water trucks should be used, as required, by the contractor to condition the soils within the required specifications.

4.5 Fill Placement

Select fill material beneath buildings/structures should meet the following characteristics:

Property	Requirement
Liquid Limit (LL) and Plasticity Index (PI)	LL ≤ 50 and PI ≤ 25
Maximum Dry Density (ASTM D-698)	≥ 100 pcf
Maximum Particle Size	3 inches or less
Organic Matter	≤ 5%
Fill Loose Lift Thickness	8 inches or less (4 inches or less for walk-behind compaction equipment)

The following table summarizes the compacted fill requirements:

Location	Test Method	Compaction Required (minimum)	Moisture Content
Upper 18 inches below pavements	ASTM D1557 (modified)	95%	-2% to +2% of optimum moisture
Building Areas and 5 feet beyond perimeter	ASTM D1557 (modified)	95%	-2% to +2% of optimum moisture
All other areas	ASTM D1557 (modified)	92%	-2% to +2% of optimum moisture

On site soils classified as SC, SM, SP, ML, and CL should be suitable for use as compacted fill. **Soils classified as elastic silt (MH) and fat clay (CH) should not be used as fill material under structures or roadways.** Any zones of debris or highly organic material should be segregated and not used beneath buildings or pavements. Samples of the proposed fill materials should be provided to the geotechnical engineer for testing and evaluation prior to placement. Density tests should be performed to document compaction and moisture content of any earthwork involving soils and other applicable materials. Density tests should be performed frequently, with a recommended minimum of one test per 5,000 square feet per lift of fill.

4.6 Shallow Foundations

Based on the provided bearing elevations of the proposed structures, and the recommended site preparation methods previously discussed, it is our opinion that shallow foundations can be used to support the structures, if the anticipated settlements (both compression and liquefaction) are acceptable. The foundations should:

- Be founded a minimum of 18 inches below exterior adjacent grade.
- Foundations may be sized using a net allowable soil bearing pressure of 2,000 pounds per square foot (psf).
- The clearwell should be founded on a ringwall foundation using a net allowable soil bearing pressure of 2,000 psf.
- Even though computed footing dimensions may be less, column footings and continuous footings should have minimum dimensions of 24 inches and 18 inches, respectively. This allows for hand cleaning of materials disturbed during the excavation process and reduces the potential for punching shear failure.

The geotechnical engineer or his representative should observe all foundation excavations, prior to concrete placement. The engineer can provide geotechnical guidance to the owner's design team should any unforeseen foundation problems develop during construction. If any areas of foundation surfaces prove to be unsuitable, the foundation should be over-excavated.

The condition of the soils at the planned bearing elevations for each structure may vary, depending on the planned final subgrade elevation. If required by field conditions and directed by the geotechnical engineer, we recommend that an allowance be included in the budget to over-excavate footing excavations through existing loose soils where present. The over-excavated area can be backfilled with "lean" concrete, controlled low strength material (CLSM) with minimum 28-day strength of 1500 psi, or compacted well-graded crushed stone up to the planned foundation bearing depth.

Foundation concrete should be placed the same day they are excavated so that disturbance of the foundation bearing soils can be reduced. Foundation bearing surfaces should not be disturbed or left exposed during inclement weather. Saturation of the on-site soils can cause a loss of strength and increased compressibility. Excavations for footings should be hand cleaned to remove any loose soil or mud from the foundation bearing surface. If construction occurs during inclement weather and concreting is not possible immediately after excavation, we recommend that a thin layer (approximately 2 inches) of lean concrete or flowable fill be placed on the bearing surface for protection after we have observed and evaluated the exposed bearing surfaces.

4.7 Settlement Considerations

Consolidation data from the previous geotechnical reports were reviewed along with the information gathered in our borings. The laboratory data indicates the soils in the upper 10 to 12 feet are over-consolidated and the primary settlements would occur in the loose sandy zone below 12 feet.

Based on our analysis, the following settlements of foundations designed with an allowable bearing pressure of 2,000 psf would be:

Structure	Approx. total settlement (inches)	Approx. differential settlement (inches)	Approx. total settlement due to liquefaction (inches)	Borings encountered
Clearwell	1.6 – center 0.75 - edge	0.86	< 0.1	B-7, B-8, B-9
PAC Contactor	< 1	< 0.5	< 1	B-1, B-2
Filters/ Flocculation and Sedimentation Basin/ Control Building	< 1	< 0.5	4.47	B-3, B-4, B-5, B-6

We recommend that the clearwell and PAC be pre-filled prior to all permanent piping connections are made. The permanent connections should be flexible to withstand the potential settlements due to liquefaction.

A liquefaction analysis was performed using the soil profiles of B-4 and B-7. A factor of safety of greater than 1.1 is considered safe against liquefaction. The analysis of the soil profile B-4, assuming one (1) foot of ground improvement (125 psf), yielded a liquefaction potential of greater than 4 inches. The results are presented in the Appendix.

For the analysis of soil profile B-7, assuming one (1) foot of ground improvement, yielded a liquefaction potential of about 2.3 inches. When a ground improvement surcharge of 1250 psf was added (modeling the clearwell), the liquefaction was reduced to less than 0.1 inch. The clearwell will act like ground improvement once the tank has been filled and the sandy soils have compressed under the load of the clearwell. We believe the PAC will act accordingly.

If the above referenced settlements are not tolerable, we recommend a deep foundation consisting of augercast piles or driven precast concrete piles be used to support the structure. Recommendations for these foundations can be provided if requested.

4.8 Slabs-on-grade

If any grade slabs for buildings will be constructed, an effective vapor barrier should be used to reduce slab dampness due to soil moisture. We note that penetrations of the vapor barrier by construction staking and traffic should be kept to a minimum as they will greatly reduce the barrier effectiveness. We recommend that slabs be supported on a minimum of 4 inches of crushed aggregate or sand compacted to at least 92% of modified Proctor maximum dry density.

Slab subgrades are often disturbed between completion of grading and slab construction due to weather, footing, utility line installation, and other construction activities. For this reason, we recommend that slab subgrades be evaluated by a Geotechnical Engineer prior to slab construction. This can be accomplished by proofrolling with heavy rubber-tired construction equipment. Areas determined by the Geotechnical Engineer to be unsatisfactory for slab support should be undercut to stable materials and replaced with properly compacted structural fill.

Care should be taken so that fines from the subgrade are not allowed to contaminate the granular layer. If fines do contaminate this layer, capillary rise and subsequent damage to moisture sensitive floor coverings could occur. On most projects, there is some time lag between initial grading and the time when the contractor is ready to place concrete for the slab-on-grade. Inclement weather just prior to placement of concrete for the slab-on-grade can result in trapped water in the granular layer.

4.9 Below Grade Walls

Below grade walls must be designed to resist the lateral earth pressures that will be induced by the weight of the backfill materials, hydrostatic pressures on the walls and any adjacent slab or foundation surcharge loads exerted on the walls. Below grade walls that are not designed to resist hydrostatic pressures should be supported as outlined above and backfilled with a free draining material such as crushed stone/gravel or clean sand (less than 10% passing a No. 200 sieve). **A drainage system should be provided near or at the base of the walls to collect and remove groundwater or seepage and to prevent buildup of hydrostatic pressures.**

Walls that support buildings or otherwise need to have little horizontal movement at the top should be designed for "at rest" earth pressure conditions. Walls that are free to deflect should be designed for "active" earth pressure conditions. The "passive" earth pressure state should be used for soils supporting the retaining structure, such as toe backfill.

Relatively free-draining crushed stone/gravel or sand should be used as backfill. Samples of all backfill material should be evaluated for use as backfill. The design values and recommendations presented above assume that the backfill behind the wall will be horizontal with no surcharge loads and that a permanent drainage system will be installed behind the retaining wall to prevent the development of hydrostatic pressures. The noted backfill should extend from the wall and upward from the top of the footing on a line 30 degrees from the vertical.

The course-grained soils such as sands and gravels (SC, SM, SP, SW, GW, GP) are acceptable to be used as backfill behind the walls. The fine-grained soils (CL, CH, ML, and MH) will not be acceptable to be used as backfill behind the walls. Using a select material can significantly reduce the horizontal loads on the wall as well as improve the effectiveness of the wall drainage system.

The table below presents recommended values of earth pressure coefficients for the select backfill materials:

Soil Parameter	Backfill Type		
	SM, SC	SP, SW	GW, GP
Soil Unit Weight (pcf)	120	125	130
Buoyant unit Weight (pcf)	58	63	68
Angle of Internal Friction, Φ, deg	32	34	38
At rest Pressure Coefficient, K_o	0.47	0.44	0.38
Active Pressure Coefficient, K_a	0.31	0.28	0.24
Passive Pressure Coefficient, K_p	3.25	3.54	4.20
Coefficient of Friction, tan Φ	0.62	0.67	0.78
At-rest Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	56	55	50
	89	90	88
Active Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	37	35	31
	80	80	78
Passive Equivalent Fluid Pressure, pcf (Above GWT, below GWT)	391	442	546
	251	285	348

GWT - Ground Water Table

For analysis of sliding resistance of the base of the retaining walls, the ultimate coefficient of friction may be taken as 0.35 between concrete and firm soil.

Compaction of backfill behind walls should be performed by appropriate manual equipment. The wall should be properly braced and heavy equipment should not be allowed behind the wall. No equipment or construction loads should be allowed within 10 feet of retaining walls or half the distance of the freestanding wall-height. This will help prevent any surcharge loads from adding lateral earth pressures above that previously recommended to the retaining wall.

Below grade walls should be braced during any backfilling operations and monitored for movement. If the footing construction precedes the subgrade preparation, then the footings should either be embedded below the subgrade a sufficient distance to achieve the required horizontal component or the footing should include a shear key to prevent movement.

4.10 Backfilling of Utility Trenches

Backfilling of storm drain and utility trenches must be performed in a controlled manner to reduce settlement of the fill and cracking of overlying floor slabs and pavements. We recommend that utility trenches be backfilled with acceptable borrow or dense-graded crushed stone in 6-inch loose lifts compacted with mechanical piston tampers to the project requirements. Should seepage occur in utility trenches, it may be necessary to "floor" the trench with dense-graded gravel. Open-graded crushed stone such as #57 can serve as a channel for seepage toward structures and therefore is not recommended for use as general utility trench backfill.

4.11 Subgrade Restoration

Typically, due to the movement of heavy equipment and weather conditions, the subgrade soil can become disturbed during construction. As a result, these soils have a tendency to lose shear strength and support capability. Therefore, additional effort on the Contractor's part will be required to reduce traffic and limit disturbance of soils. It is essential that the subgrade be restored to a properly compacted condition based on optimum moisture and density.

4.12 Drainage Considerations

Adequate drainage should be provided at the site to reduce possible increased moisture content of the foundation soils. We recommend that driveway areas, walkways, and the ground surface be sloped away from the structures on all sides. Roof drainage should be collected by gutters and downspouts and transmitted by pipe to the storm water drainage system or discharge a minimum of 5 feet away from the building.

5.0 REPORT LIMITATIONS

5.1 General

The recommendations submitted are based on the available soil information obtained by GMC and design details furnished by GMC for the proposed project. If there are any revisions to the plans for this project or if deviations from the subsurface conditions noted in this report are encountered during construction, we should be notified immediately to determine if changes in the foundation, or other, recommendations are required. If GMC is not retained to perform these functions, GMC cannot be responsible for the impact of those conditions on the performance of the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans are more complete, the geotechnical engineer should be provided the opportunity to review the design plans to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations.

We emphasize that this report was prepared for design and informational purposes only and may not be sufficient to prepare an accurate construction budget. Contractors reviewing this report should acknowledge that the information and recommendations contained herein are for design and informational purposes only. A more comprehensive exploration and testing program would be required to assist the contractor in preparing the final building pad preparation, grading, and foundation construction budgets. In no case should this report be utilized as a substitute for development of earthwork specifications.

The information contained in this report is not intended, nor is sufficient, to aid in the design of segmental or mechanically stabilized earth (MSE) retaining walls. Segmental or MSE wall designers and builders should not rely on this report and should perform independent analysis to determine all necessary soil characteristics for use in their wall design, including but not limited to, soil shear strengths, bearing capacities, global stability, etc.

5.2 Construction Testing

Field observations, monitoring, and quality assurance testing during earthwork and foundation installation are an extension of the geotechnical design. We recommend that Goodwyn, Mills, and Cawood, Inc. be allowed to continue our involvement in the project through these phases of remediation and/or construction.

Quality assurance observations and testing related to earthwork should be performed by competent personnel under the general administrative supervision of a geotechnical engineer familiar with the design requirements and considerations of this project. We recommend that qualified geotechnical personnel observe proofrolling and associated undercutting, as required, foundation excavations and subgrades, evaluate the materials to be used as fill, and test the compaction of fill and backfill.

APPENDIX

Site Location Map

Boring Location Plan

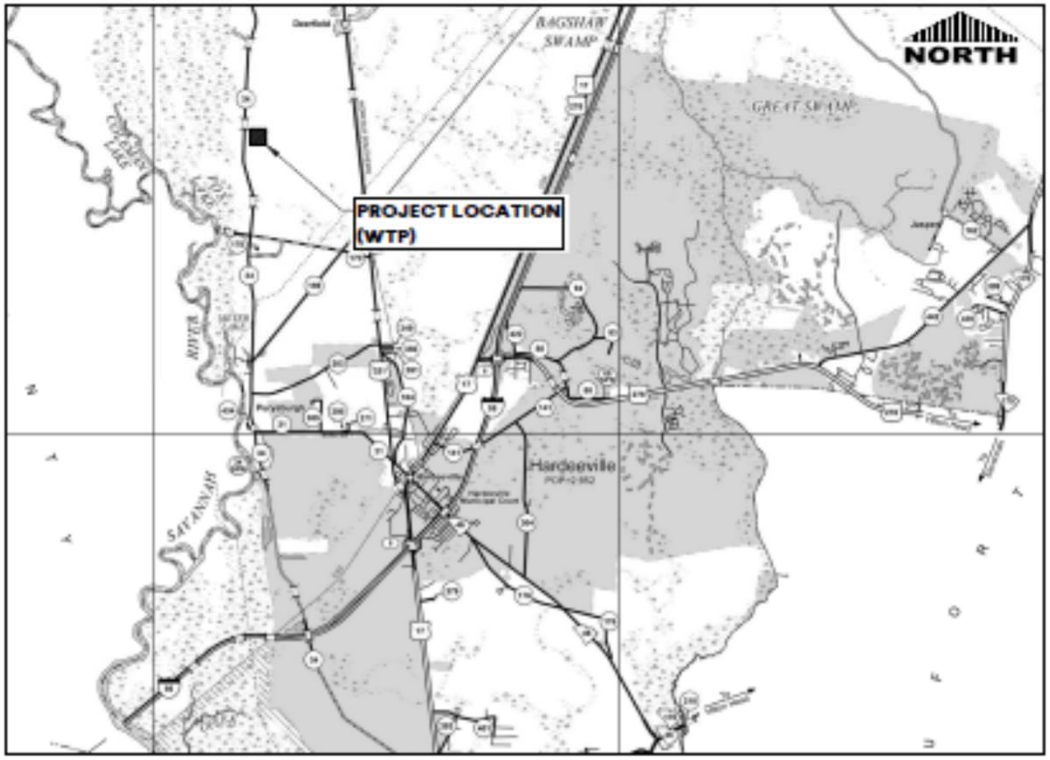
Soil Classification Chart

Subsurface Diagrams

Boring Records

Summary of Laboratory Results

Field and Laboratory Procedures



VICINITY MAP
NOT TO SCALE

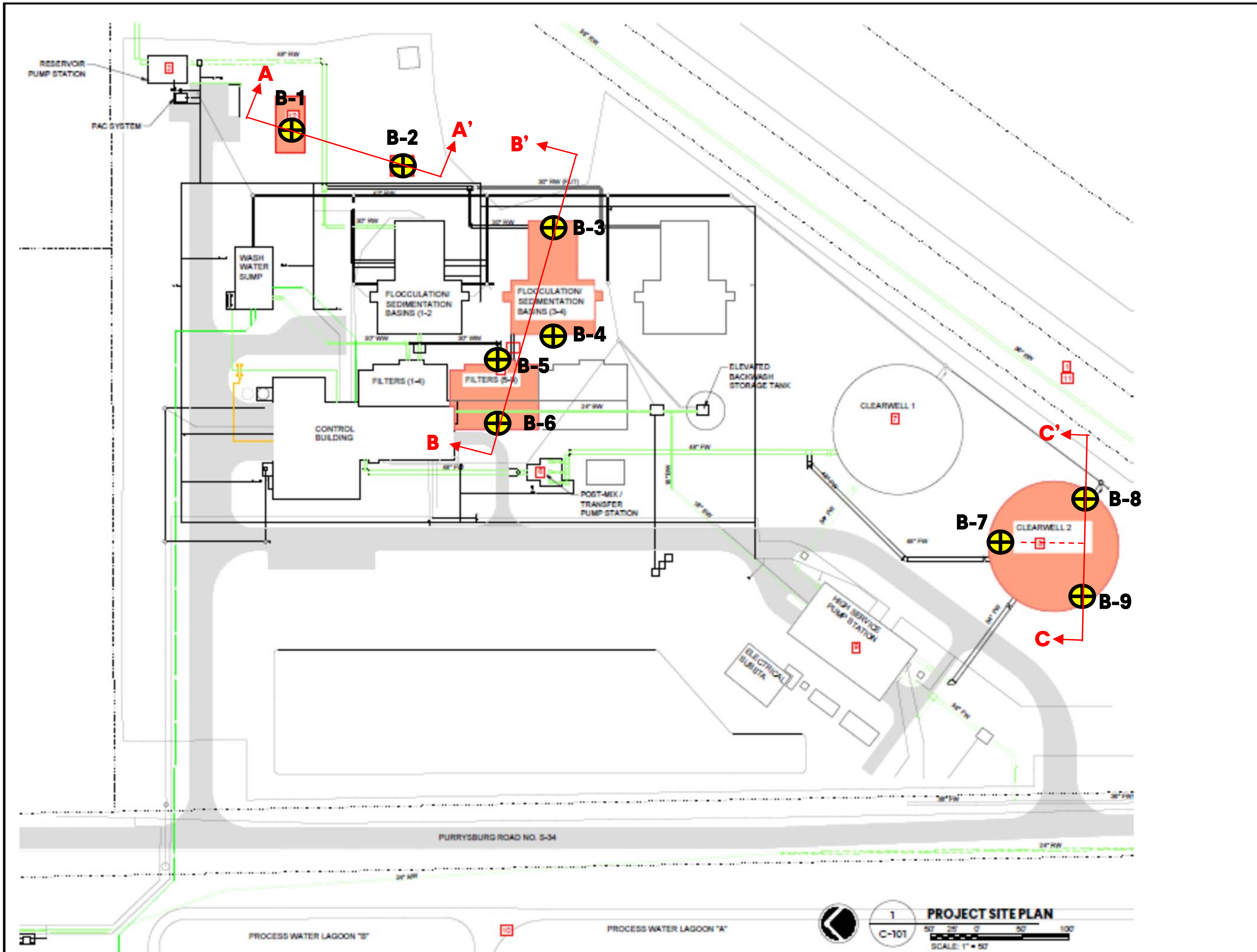
LOCATION MAP
STATE OF SOUTH CAROLINA

REF. SHEET:
DESCRIPTION:

SITE LOCATION MAP
Purrysburg WTP

GMC #
DATE: 4-8-19
DRAWN BY:

GMC



REF. SHEET:
DESCRIPTION:

BORING LOCATION PLAN
Purrysburg WTP

GMC #
DATE: 4-8-19
DRAWN BY:

GMC

SOIL CLASSIFICATION CHART

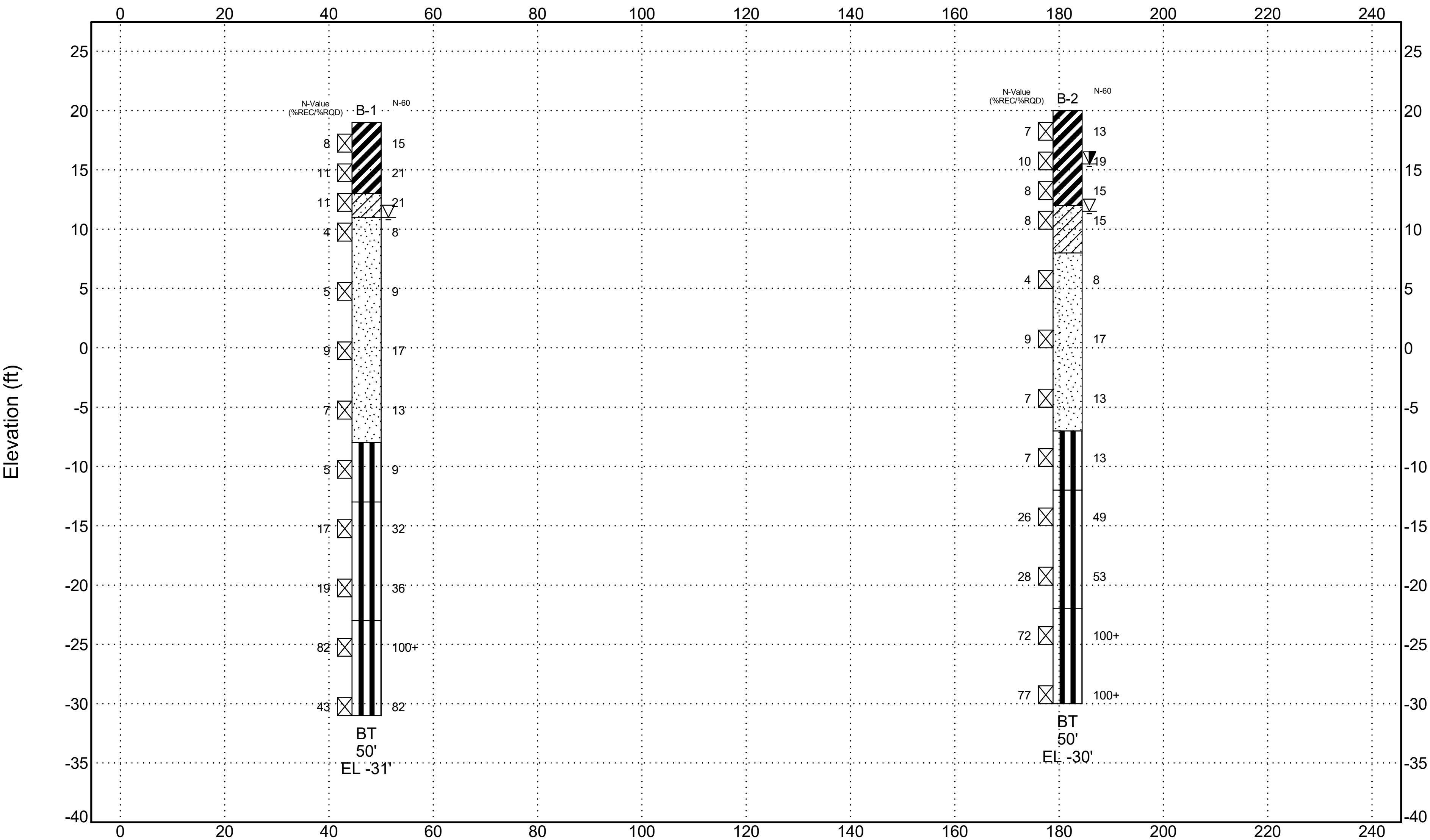
MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SUBSURFACE DIAGRAM A-A'

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC

CH SC SP MH



BT - Boring Termination
AR - Auger Refusal

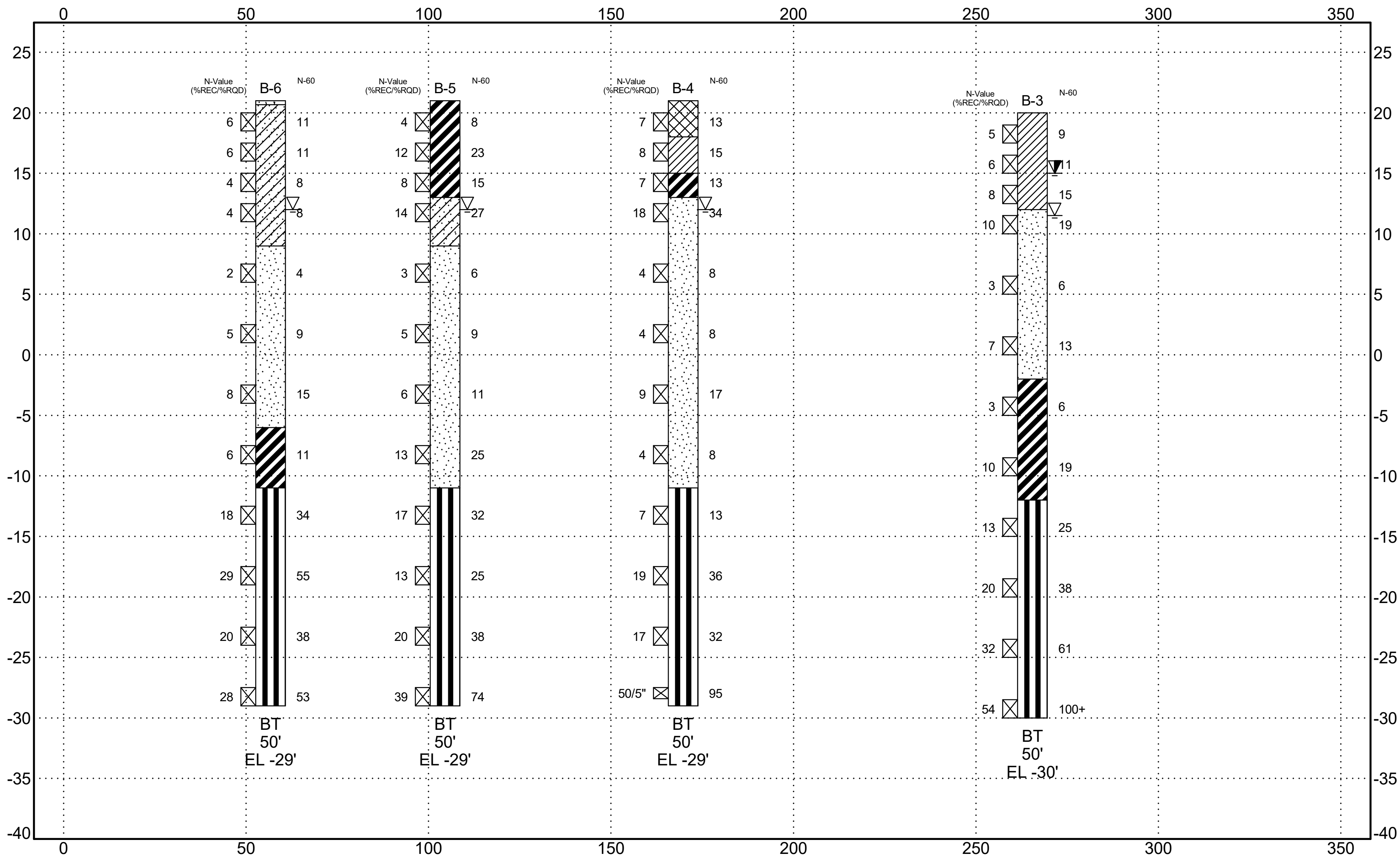
BT-AR DEPTH+ELEV LOG GGRE180005 PURRYSBURG WTP.GPJ GMC DATA TEMPLATE.GDT 5/1/19

GMC

SUBSURFACE DIAGRAM
B-B'

CL | SP | CH | MH | FILL | SC | TOPSOIL

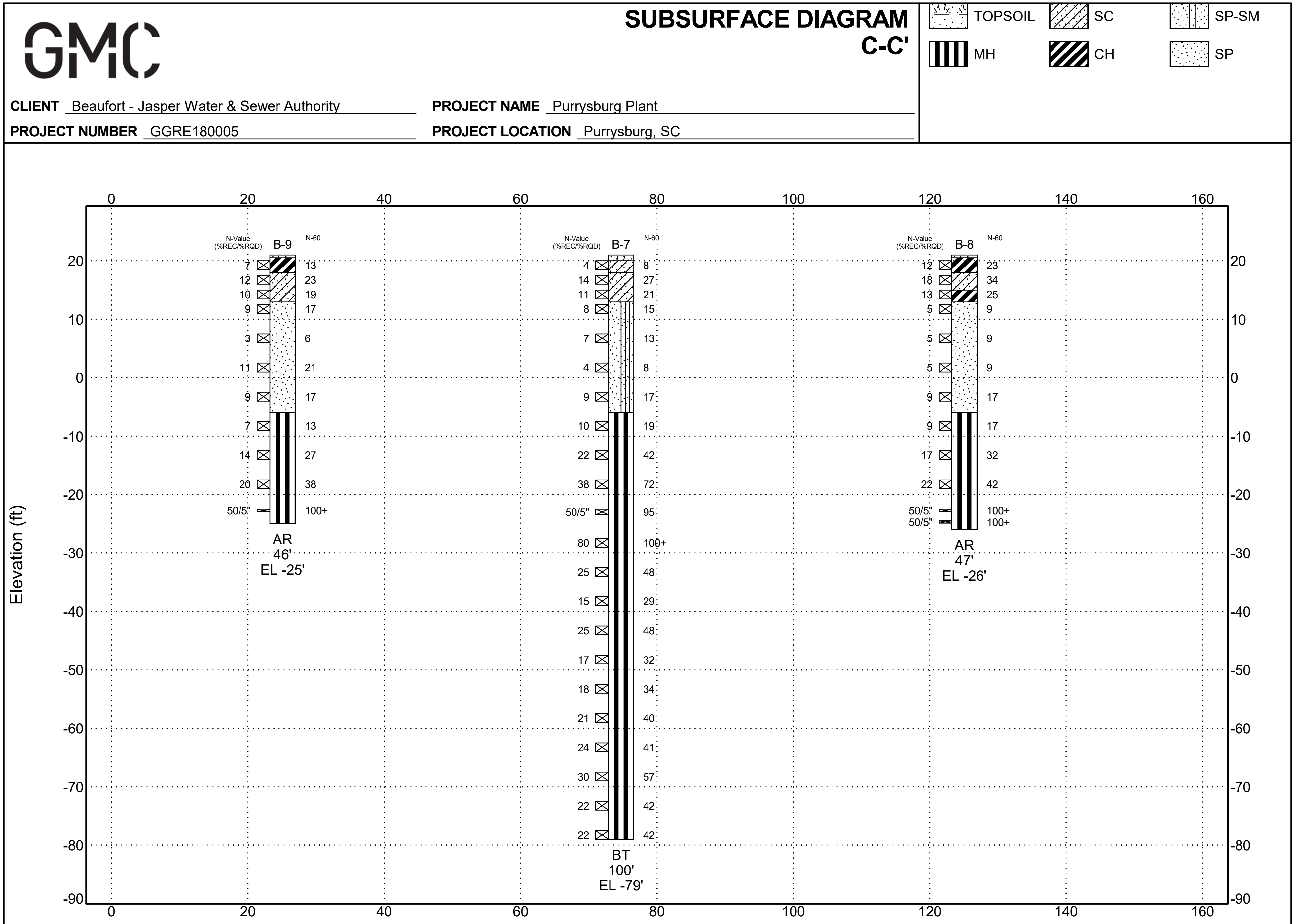
CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC



BT - Boring Termination
AR - Auger Refusal

SUBSURFACE DIAGRAM C-C'

CLIENT Beaufort - Jasper Water & Sewer Authority	**PROJECT NAME** Purrysburg Plant
PROJECT NUMBER GGRE180005	**PROJECT LOCATION** Purrysburg, SC



BT - Boring Termination
AR - Auger Refusal

GMC

BORING NUMBER B-1

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 1/17/19 **COMPLETED** 1/17/19
GROUND ELEVATION 19 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
AT TIME OF DRILLING 8.00 ft / Elev 11.00 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
	0	SANDY FAT CLAY (CH), brownish-gray, stiff to very stiff	SS 1		3-3-5 (8)	15		23				
			SS 2		3-5-6 (11)	21		26	54	21	33	58
		SILTY SAND (SM), grayish-brown, stiff, fine	SS 3		5-5-6 (11)	21						
10	10	POORLY GRADED SAND (SP), brownish-gray to gray, loose to medium, medium to fine, moist to wet	SS 4		2-2-2 (4)	8						
			SS 5		2-2-3 (5)	9						
0	20		SS 6		3-4-5 (9)	17		18				8
			SS 7		3-3-4 (7)	13						
-10	30	ELASTIC SILT with SAND (MH), olive gray, medium	SS 8		2-2-3 (5)	9						
		ELASTIC SILT with SAND (MH), olive gray, hard	SS 9		7-7-10 (17)	32						
-20	40		SS 10		6-8-11 (19)	36		69				
		ELASTIC SILT with SAND (MH), olive gray, hard	SS 11		20-32-50 (82)	100+						
-30	50		SS 12		8-15-28 (43)	82						
		Boring was terminated at 50.0 feet.										

GMC

BORING NUMBER B-2

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 1/22/19 **COMPLETED** 1/22/19
GROUND ELEVATION 20 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
AT TIME OF DRILLING 8.50 ft / Elev 11.50 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
24hrs AFTER DRILLING 4.50 ft / Elev 15.50 ft

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	0		SANDY FAT CLAY (CH), brown to brownish gray, stiff to very stiff	SS 1		3-3-4 (7)	13		21				
				SS 2		3-4-6 (10)	19		22				
				SS 3		3-3-5 (8)	15						
10	10		SILTY SAND (SM), gray, medium, fine, moist	SS 4		3-4-4 (8)	15		25	26	22	4	29
			POORLY GRADED SAND (SP), gray, loose to medium, medium to fine, wet	SS 5		2-2-2 (4)	8						
0	20			SS 6		3-4-5 (9)	17						
				SS 7		3-3-4 (7)	13						
-10	30		ELASTIC SILT with SAND (MH), olive gray, stiff	SS 8		2-3-4 (7)	13						
			ELASTIC SILT with SAND (MH), olive gray, hard	SS 9		7-11-15 (26)	49		69	101	75	26	81
-20	40			SS 10		8-12-16 (28)	53						
			ELASTIC SILT with SAND (MH), olive gray, hard	SS 11		11-22-50 (72)	100+						
-30	50			SS 12		15-27-50 (77)	100+						
			Boring was terminated at 50.0 feet.										

GMC

BORING NUMBER B-3

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 1/22/19 **COMPLETED** 1/22/19
GROUND ELEVATION 20 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
∇ **AT TIME OF DRILLING** 8.50 ft / Elev 11.50 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
▼ **24hrs AFTER DRILLING** 5.00 ft / Elev 15.00 ft

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	0		SANDY LEAN CLAY (CL), brownish gray, stiff	SS 1		3-3-2 (5)	9		21	42	21	21	57
				SS 2		2-3-3 (6)	11		22				
				SS 3		2-3-5 (8)	15		6				
			POORLY GRADED SAND (SP), brownish gray, loose and very loose, fine, moist to wet	SS 4		4-4-6 (10)	19						
10	10												
				SS 5		2-2-1 (3)	6						
				SS 6		2-3-4 (7)	13						
0	20												
			FAT CLAY (CH), olive gray, medium to very stiff										
				SS 7		2-1-2 (3)	6						
				SS 8		4-4-6 (10)	19						
-10	30												
			ELASTIC SILT with SAND (MH), olive gray, very stiff to hard										
				SS 9		5-6-7 (13)	25						
				SS 10		6-8-12 (20)	38						
-20	40												
				SS 11		5-8-24 (32)	61		83	97	67	30	76
				SS 12		12-23-31 (54)	100+						
-30	50												
			Boring was terminated at 50.0 feet.										

BORING NUMBER B-4

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 2/5/19 **COMPLETED** 2/5/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
∇ **AT TIME OF DRILLING** 9.00 ft / Elev 12.00 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	0	LEAN CLAY (CL), brownish-gray, stiff- FILL	SS 1		2-2-5 (7)	13						
		SANDY LEAN CLAY (CL), brownish-gray, stiff	SS 2		4-4-4 (8)	15		14				
		SANDY FAT CLAY (CH), brownish-gray, stiff	SS 3		2-3-4 (7)	13		24	57	20	37	58
10	10	∇ POORLY GRADED SAND (SP), grayish-brown to brownish-gray, loose to dense, medium to fine, moist to wet	SS 4		5-8-10 (18)	34		15				
			SS 5		2-2-2 (4)	8						
0	20		SS 6		2-2-2 (4)	8						
			SS 7		4-4-5 (9)	17		22	NP	NP	NP	11
-10	30		SS 8		3-3-1 (4)	8						
		ELASTIC SILT with SAND (MH), olive gray, stiff to hard	SS 9		2-3-4 (7)	13						
-20	40		SS 10		7-8-11 (19)	36						
			SS 11		7-8-9 (17)	32						
			SS 12		38-50/5"	95						
-30	50	Boring was terminated at 50.0 feet.										

BORING NUMBER B-5

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 2/8/19 **COMPLETED** 2/8/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
▽ **AT TIME OF DRILLING** 9.00 ft / Elev 12.00 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	0	FAT CLAY (CH), brownish-gray, medium to stiff										
			SS 1		2-2-2 (4)	8		16				
			SS 2		3-7-5 (12)	23						
			SS 3		2-3-5 (8)	15						
		▽ CLAYEY SAND (SC), brownish-gray, medium, fine										
	10		SS 4		3-5-9 (14)	27						
10		POORLY GRADED SAND with SILT (SP-SM), gray, loose to medium, medium to fine, wet										
			SS 5		2-2-1 (3)	6		20	NP	NP	NP	9
	20		SS 6		2-2-3 (5)	9						
0			SS 7		2-3-3 (6)	11						
	30		SS 8		3-7-6 (13)	25		18				
-10		ELASTIC SILT with SAND (MH), olive gray, very stiff to hard										
			SS 9		5-6-11 (17)	32						
	40		SS 10		5-5-8 (13)	25						
-20			SS 11		6-8-12 (20)	38						
	50		SS 12		8-13-26 (39)	74		55	88	44	44	78
-30		Boring was terminated at 50.0 feet.										

GMC

BORING NUMBER B-6

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 2/5/19 **COMPLETED** 2/5/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
▽ **AT TIME OF DRILLING** 9.00 ft / Elev 12.00 ft
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

MATERIAL DESCRIPTION
Organic Laden Material (OLM), 4 inches
CLAYEY SAND (SC), brownish-gray, medium to loose
POORLY GRADED SAND (SP), brownish gray to gray, medium, medium to fine, wet
FAT CLAY (CH), olive gray, stiff
ELASTIC SILT with SAND (MH), olive gray, hard
Boring was terminated at 50.0 feet.

SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
SS 1		2-3-3 (6)	11		17				
SS 2		3-3-3 (6)	11		20	29	11	18	46
SS 3		2-2-2 (4)	8						
SS 4		2-1-3 (4)	8						
SS 5		1-1-1 (2)	4		24				
SS 6		2-1-4 (5)	9						
SS 7		2-4-4 (8)	15						
SS 8		2-3-3 (6)	11		78	106	33	73	60
SS 9		5-7-11 (18)	34						
SS 10		10-12-17 (29)	55						
SS 11		6-8-12 (20)	38						
SS 12		8-12-16 (28)	53						

ELEVATION (ft): 20, 10, 0, -10, -20, -30
DEPTH (ft): 0, 10, 20, 30, 40, 50

BORING NUMBER B-7

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 2/7/19 **COMPLETED** 2/7/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
AT TIME OF DRILLING ---
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
20	0		Organic Laden Material (OLM), 12 inches										
			CLAYEY SAND (SC), brownish dark gray, loose, trace organics, FILL	SS 1		2-2-2 (4)	8		16	27	13	14	36
			CLAYEY SAND (SC), grayish orange, medium, fine, moist	SS 2		4-6-8 (14)	27		19				
				SS 3		5-5-6 (11)	21						
10	10		POORLY GRADED SAND with SILT (SP-SM), light brown to gray, loose to medium, medium to fine, wet	SS 4		3-4-4 (8)	15		23	NP	NP	NP	14
				SS 5		2-3-4 (7)	13						
0	20			SS 6		2-2-2 (4)	8		30				
				SS 7		3-4-5 (9)	17						
-10	30		ELASTIC SILT with SAND (MH), olive dark gray, very stiff to hard	SS 8		5-5-5 (10)	19						
				SS 9		7-10-12 (22)	42						
-20	40			SS 10		6-8-30 (38)	72						
				SS 11		42-50/5"	95						
-30	50			SS 12		10-30-50 (80)	100+		85				
				SS		10-10-15	48						

(Continued Next Page)

BORING NUMBER B-7

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority **PROJECT NAME** Purrysburg Plant

PROJECT NUMBER GGRE180005 **PROJECT LOCATION** Purrysburg, SC

ELEVATION (ft)	DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
			ELASTIC SILT with SAND (MH), olive dark gray, very stiff to hard *(continued)*	13		(25)							
	60			SS 14		5-5-10 (15)	29						
-40													
				SS 15		10-10-15 (25)	48						
	70			SS 16		5-5-12 (17)	32		102				
-50													
				SS 17		6-7-11 (18)	34						
	80			SS 18		8-8-13 (21)	40						
-60													
				SS 19		9-10-14 (24)	41						
	90			SS 20		11-13-17 (30)	57						
-70													
				SS 21		10-10-12 (22)	42						
	100			SS 22		7-9-13 (22)	42						
-80			Boring was terminated at 100.0 feet.										
	110												
-90													

BORING NUMBER B-8

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 1/31/19 **COMPLETED** 1/31/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
AT TIME OF DRILLING ---
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
20	0	Organic Laden Material (OLM), 6 inches										
		FAT CLAY (CH), grayish-orange, very stiff, fine	SS 1		4-5-7 (12)	23						
		CLAYEY SAND (SC), orangish-gray, dense, fine	SS 2		6-8-10 (18)	34		18				
		SANDY FAT CLAY (CH), orangish-gray, very stiff, fine	SS 3		4-5-8 (13)	25		31	52	16	36	58
		POORLY GRADED SAND (SP), light brown to gray, loose to medium, medium to fine, wet	SS 4		3-2-3 (5)	9		18				
10	10											
			SS 5		3-3-2 (5)	9						
			SS 6		2-2-3 (5)	9						
0	20											
			SS 7		3-4-5 (9)	17						
		ELASTIC SILT with SAND (MH), olive dark gray, very stiff to hard										
			SS 8		4-4-5 (9)	17						
-10	30											
			SS 9		5-7-10 (17)	32						
			SS 10		7-10-12 (22)	42		66	125	62	63	90
-20	40											
			SS 11		50/5"	100+						
			SS 12		50/5"	100+						
		Auger refusal was encountered at 47.0 feet.										
-30	50											

BORING NUMBER B-9

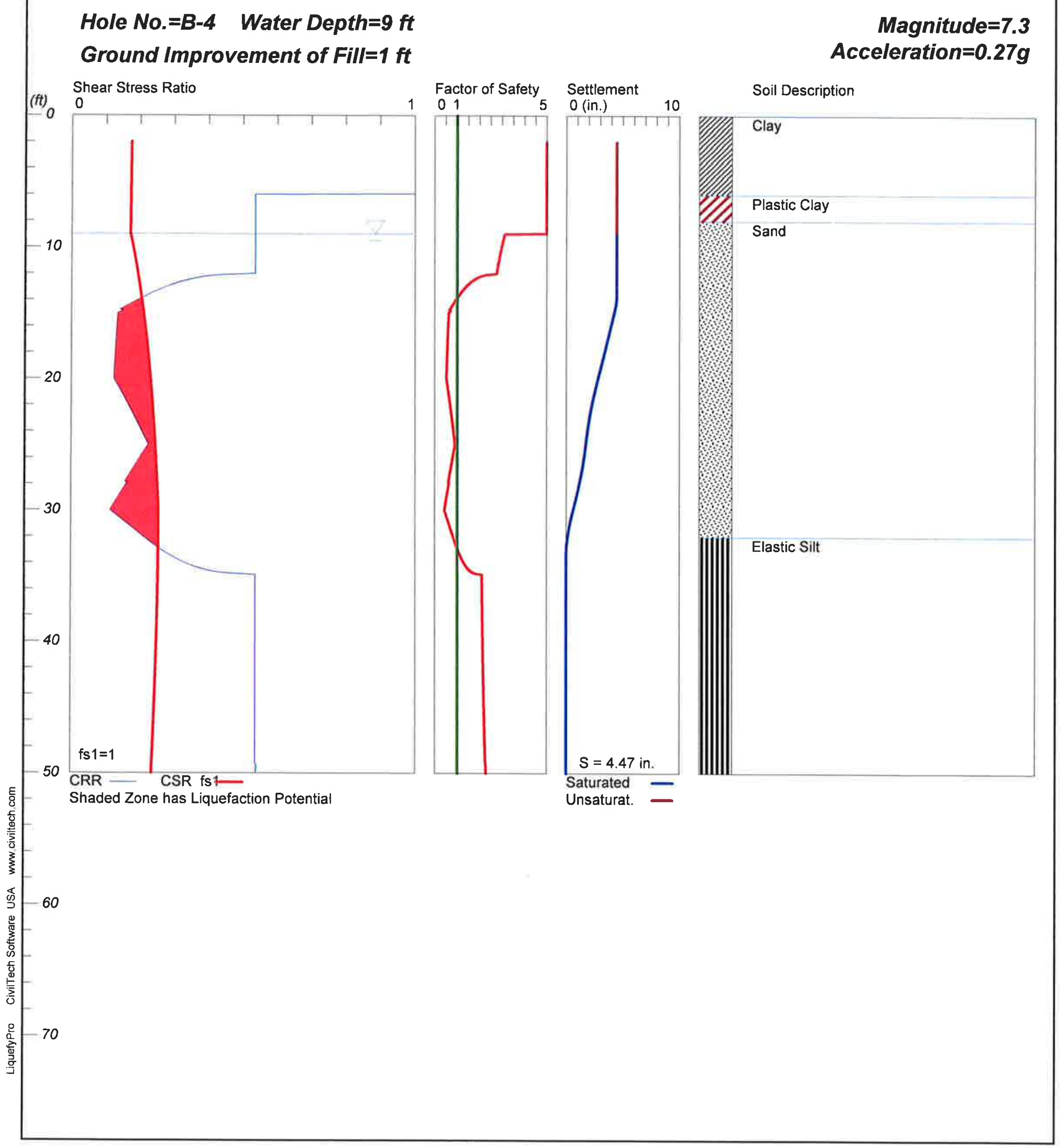
GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC
DATE STARTED 1/31/19 **COMPLETED** 1/31/19
GROUND ELEVATION 21 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Whitaker Laboratory Inc.
GROUND WATER LEVELS:
DRILLING METHOD CME 45 truck, Auto Hammer, Mud rotary with SPT
AT TIME OF DRILLING ---
LOGGED BY T. Ford **CHECKED BY** K. Wales
AT END OF DRILLING ---
NOTES Elevation approximated from previous reports
AFTER DRILLING ---

ELEVATION (ft)	DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	N-60	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
20	0	Organic Laden Material (OLM), 6 inches										
		SANDY FAT CLAY (CH), brownish-gray, stiff, fine, FILL	SS 1		2-3-4 (7)	13		25				
		CLAYEY SAND (SC), brownish-gray, medium, fine	SS 2		3-5-7 (12)	23		22	39	17	22	39
			SS 3		5-5-5 (10)	19						
10	10	POORLY GRADED SAND (SP), light brown to gray, loose to medium, medium to fine, wet	SS 4		4-4-5 (9)	17		21				
			SS 5		2-1-2 (3)	6						
0	20		SS 6		5-5-6 (11)	21		17				9
			SS 7		3-4-5 (9)	17						
-10	30	ELASTIC SILT with SAND (MH), olive dark gray, stiff to hard	SS 8		3-3-4 (7)	13						
			SS 9		4-5-9 (14)	27						
-20	40		SS 10		5-8-12 (20)	38						
			SS 11		50/5"	100+						
-30	50	Auger refusal was encountered at 46.0 feet.										

LIQUEFACTION ANALYSIS

Purrysburg WTP

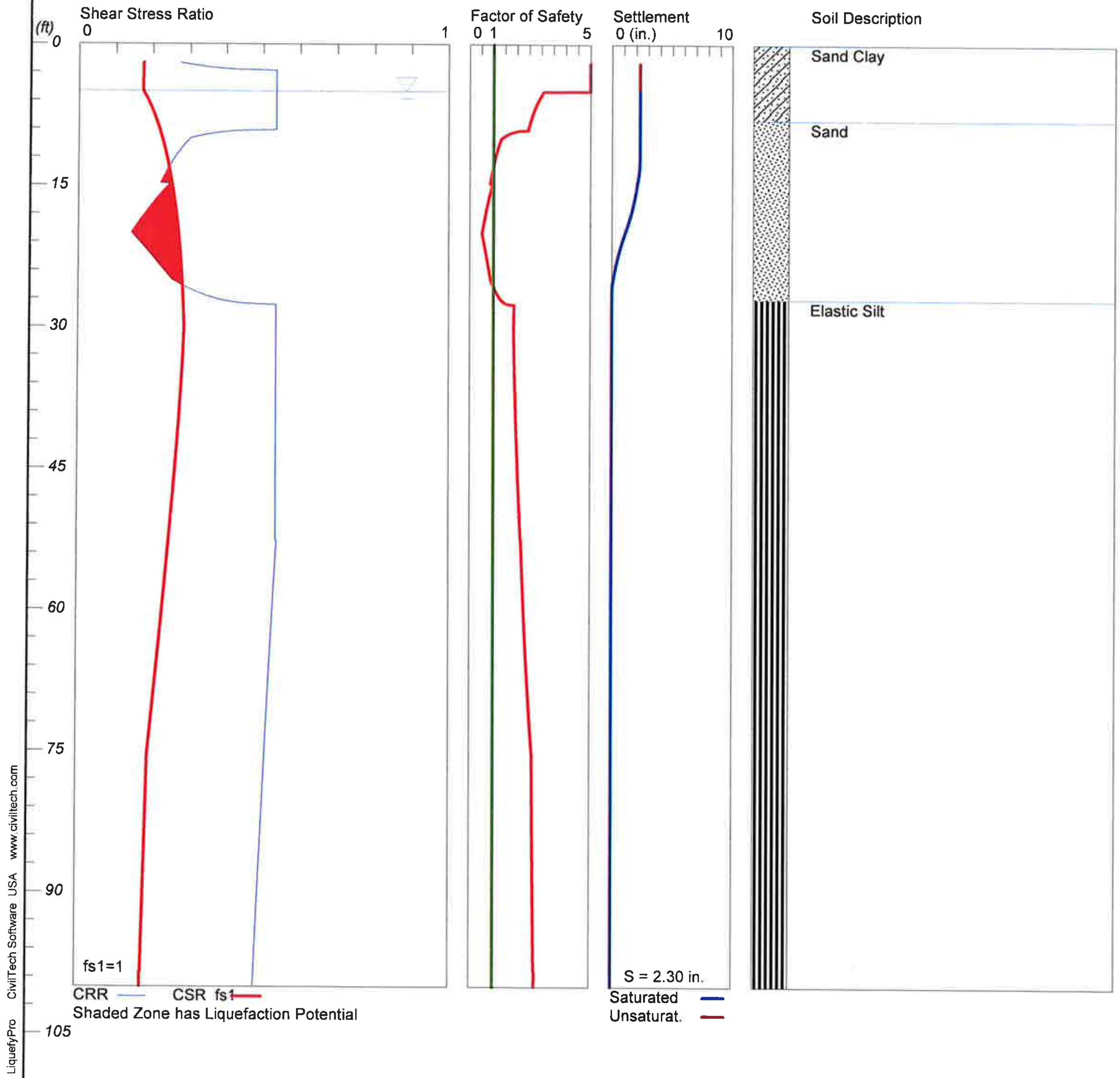


LIQUEFACTION ANALYSIS

Purrysburg WTP

Hole No.=B-7 Water Depth=5 ft
Ground Improvement of Fill=1 ft

Magnitude=7.3
Acceleration=0.27g

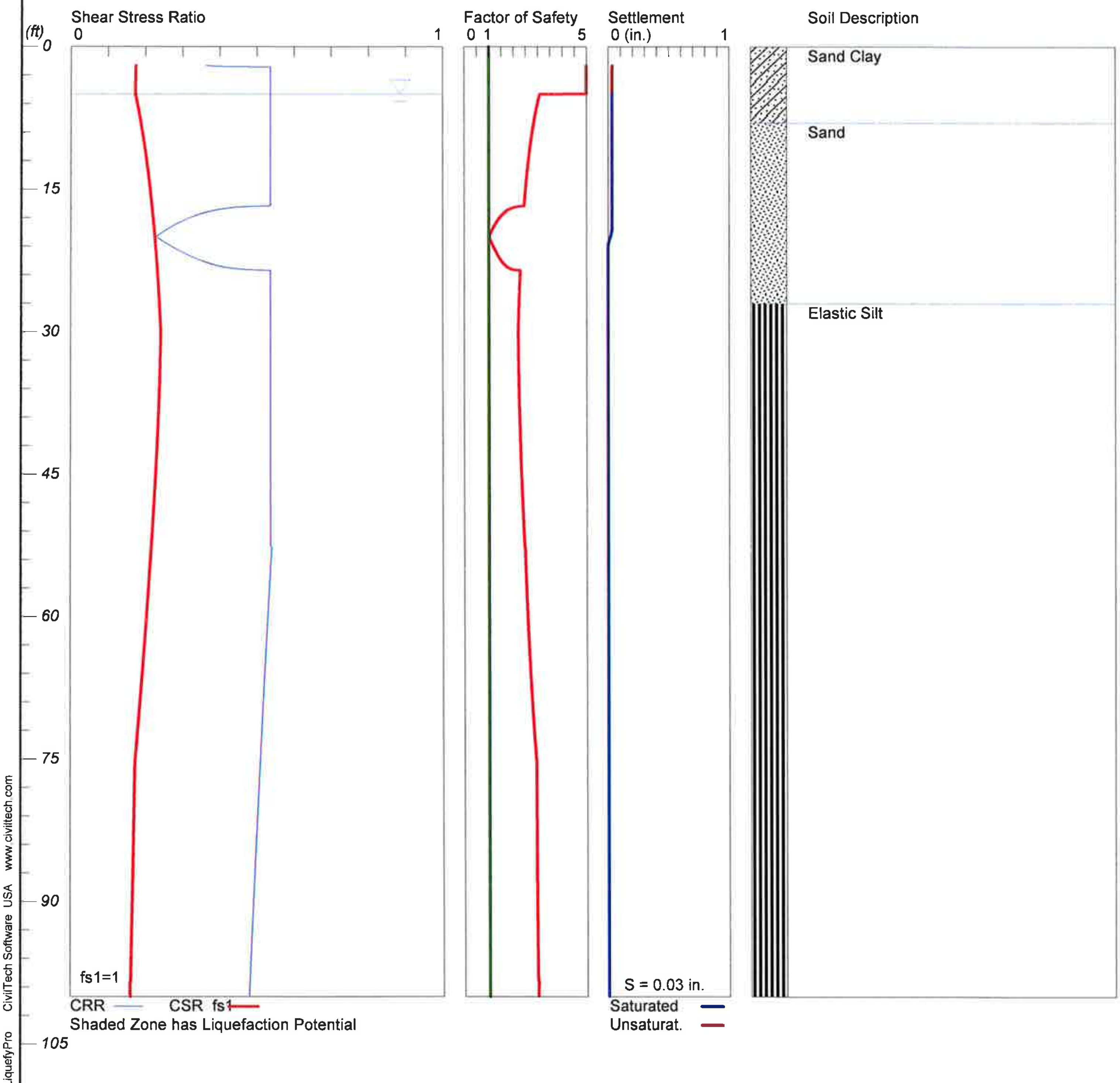


LIQUEFACTION ANALYSIS

Purrysburg WTP

Hole No.=B-7 Water Depth=5 ft
Ground Improvement of Fill=10 ft

Magnitude=7.3
Acceleration=0.27g



SUMMARY OF LABORATORY RESULTS

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC

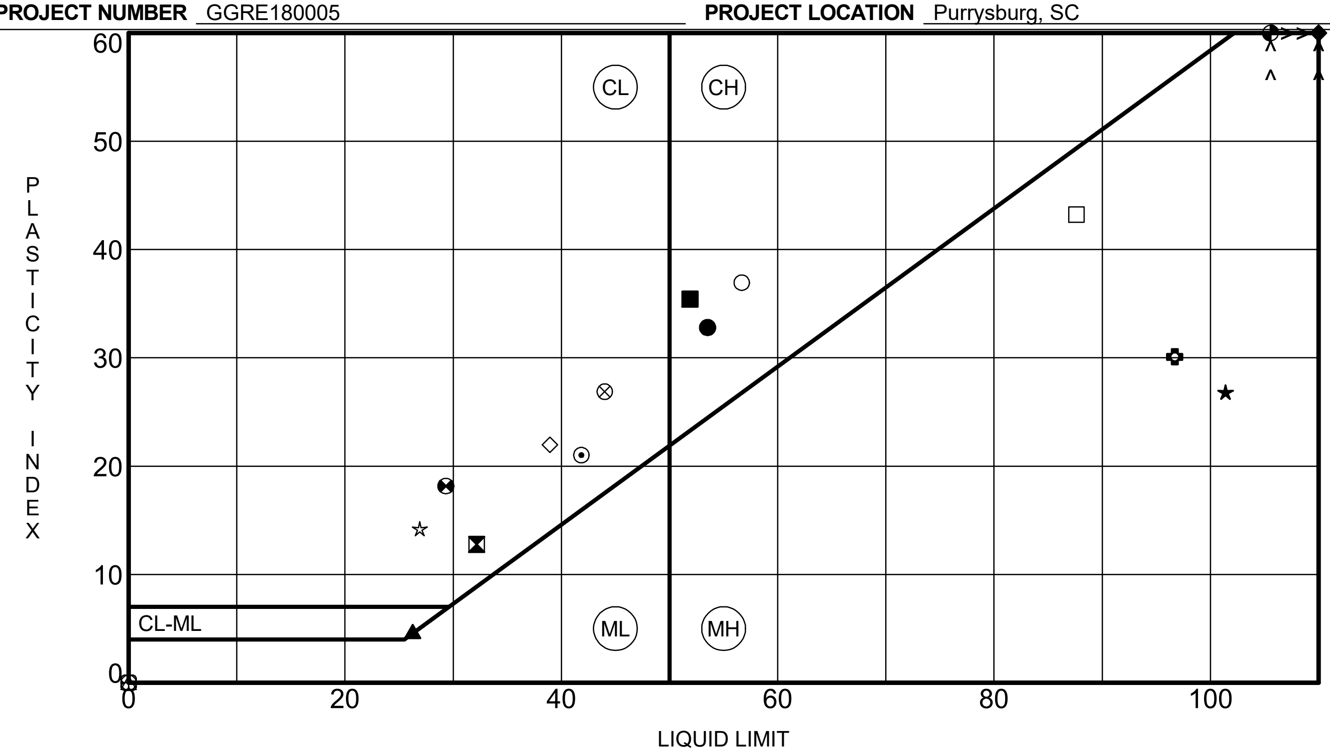
Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Max. Sieve Size Tested (mm)	%<#200 Sieve	Natural Moisture (%)	Class-ification	Opt. Moisture Content (%)	Max Dry Density (pcf)	Specific Gravity
B-1	1-2.5						23.4				
B-1	3.5-5	54	21	33	4.75	58	26.5	CH			
B-1	18.5-20				4.75	8	18.3				
B-1	38.5-40						68.6				
B-1A	0-10	32	19	13	4.75	51	25.6	CL	11.1	125.7	
B-2	1-2.5						21.1				
B-2	3.5-5						22.2				
B-2	8.5-10	26	22	4	2	29	25.3	SM			
B-2	33.5-35	101	75	26	2	81	69.4	MH			
B-3	1-2.5	42	21	21	4.75	57	20.7	CL			
B-3	3.5-5						21.7				
B-3	6-7.5						5.7				
B-3	43.5-45	97	67	30	2	76	83.4	MH			
B-4	3.5-5						14.2				
B-4	6-7.5	57	20	37	2	58	23.6	CH			
B-4	8.5-10						15.2				
B-4	23.5-25	NP	NP	NP	4.75	11	21.8	SP-SM			
B-4A	0-10	44	17	27	25	55	21.5	CL	12.8	117.7	
B-5	1-2.5						16.1				
B-5	13.5-15	NP	NP	NP	4.75	9	19.9	SP-SM			
B-5	28.5-30						18.4				
B-5	48.5-50	88	44	44	2	78	55.3	MH			
B-6	1-2.5						17.0				
B-6	3.5-5	29	11	18	4.75	46	20.4	SC			
B-6	13.5-15						23.9				
B-6	28.5-30	106	33	73	4.75	60	78.4	CH			
B-7	1-2.5	27	13	14	25	36	16.4	SC			
B-7	3.5-5						19.3				
B-7	8.5-10	NP	NP	NP	4.75	14	23.0	SM			
B-7	18.5-20						30.2				
B-7	48.5-50						84.8				
B-7	68.5-70						102.0				
B-8	3.5-5						18.0				
B-8	6-7.5	52	16	36	9.5	58	30.9	CH			
B-8	8.5-10						18.4				
B-8	38.5-40	125	62	63	2	90	66.0	MH			
B-9	1-2.5						25.2				
B-9	3.5-5	39	17	22	2	39	21.5	SC			
B-9	8.5-10						20.6				
B-9	18.5-20				9.5	9	16.9				

ATTERBERG LIMITS' RESULTS

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority **PROJECT NAME** Purrysburg Plant

PROJECT NUMBER GGRE180005 **PROJECT LOCATION** Purrysburg, SC

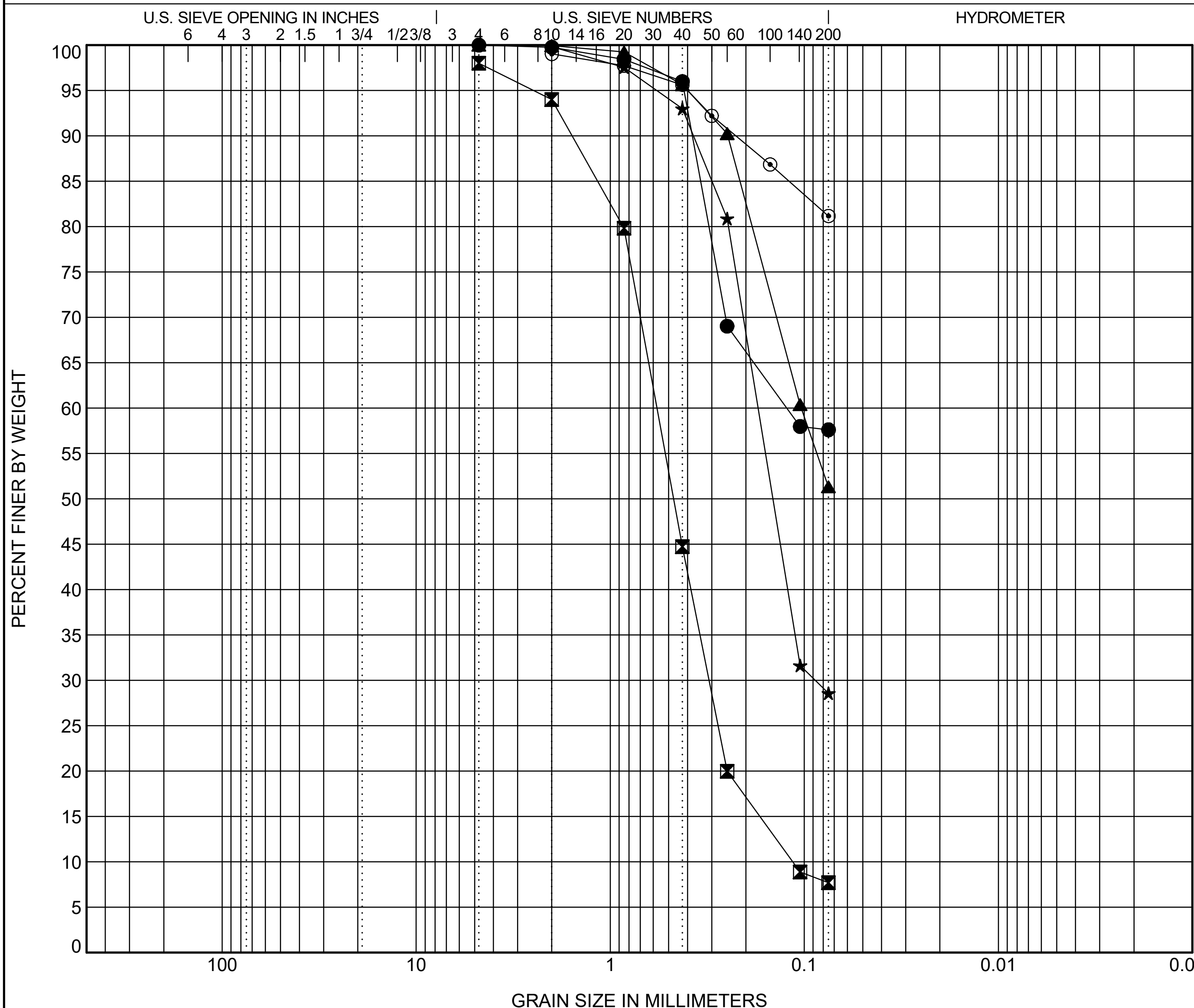


	Specimen Identification		LL	PL	PI	Fines	Classification
●	B-1	3.5-5.0	54	21	33	58	SANDY FAT CLAY(CH)
⧗	B-1A	0.0-10.0	32	19	13	51	SANDY LEAN CLAY(CL)
▲	B-2	8.5-10.0	26	22	4	29	SILTY SAND(SM)
★	B-2	33.5-35.0	101	75	26	81	ELASTIC SILT with SAND(MH)
⊙	B-3	1.0-2.5	42	21	21	57	SANDY LEAN CLAY(CL)
✿	B-3	43.5-45.0	97	67	30	76	ELASTIC SILT with SAND(MH)
○	B-4	6.0-7.5	57	20	37	58	SANDY FAT CLAY(CH)
△	B-4	23.5-25.0	NP	NP	NP	11	POORLY GRADED SAND with SILT(SP-SM)
⊗	B-4A	0.0-10.0	44	17	27	55	SANDY LEAN CLAY(CL)
⊕	B-5	13.5-15.0	NP	NP	NP	9	POORLY GRADED SAND with SILT(SP-SM)
□	B-5	48.5-50.0	88	44	44	78	ELASTIC SILT with SAND(MH)
⊛	B-6	3.5-5.0	29	11	18	46	CLAYEY SAND(SC)
◕	B-6	28.5-30.0	106	33	73	60	SANDY FAT CLAY(CH)
☆	B-7	1.0-2.5	27	13	14	36	CLAYEY SAND(SC)
⌘	B-7	8.5-10.0	NP	NP	NP	14	SILTY SAND(SM)
■	B-8	6.0-7.5	52	16	36	58	SANDY FAT CLAY(CH)
◆	B-8	38.5-40.0	125	62	63	90	ELASTIC SILT(MH)
◇	B-9	3.5-5.0	39	17	22	39	CLAYEY SAND(SC)

GRAIN SIZE DISTRIBUTION

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

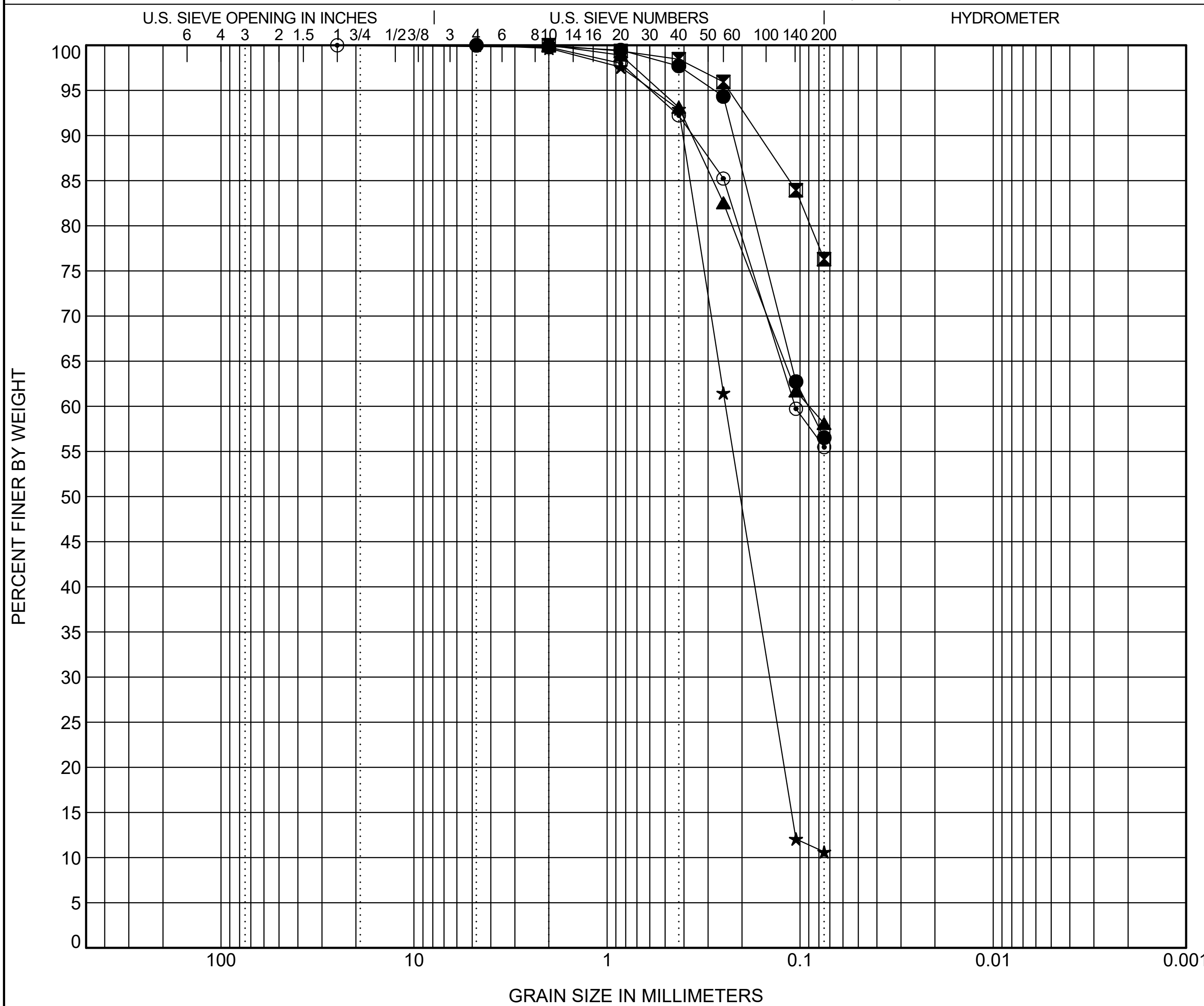
Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	B-1	3.5-5.0	**SANDY FAT CLAY(CH)**	54	21	33		
⧗	B-1	18.5-20.0					1.46	5.02
▲	B-1A	0.0-10.0	**SANDY LEAN CLAY(CL)**	32	19	13		
★	B-2	8.5-10.0	**SILTY SAND(SM)**	26	22	4		
⊙	B-2	33.5-35.0	**ELASTIC SILT with SAND(MH)**	101	75	26		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1	3.5-5.0	4.75	0.123			0.0	42.4	57.6	
⧗	B-1	18.5-20.0	4.75	0.575	0.31	0.115		90.3	7.7	
▲	B-1A	0.0-10.0	4.75	0.104			0.0	48.7	51.3	
★	B-2	8.5-10.0	2	0.173	0.088			71.3	28.6	
⊙	B-2	33.5-35.0	2					17.9	81.2	

GRAIN SIZE DISTRIBUTION

CLIENT Beaufort - Jasper Water & Sewer Authority **PROJECT NAME** Purrysburg Plant

PROJECT NUMBER GGRE180005 **PROJECT LOCATION** Purrysburg, SC



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-3	1.0-2.5	**SANDY LEAN CLAY(CL)**	42	21	21		
⊠	B-3	43.5-45.0	**ELASTIC SILT with SAND(MH)**	97	67	30		
▲	B-4	6.0-7.5	**SANDY FAT CLAY(CH)**	57	20	37		
★	B-4	23.5-25.0	**POORLY GRADED SAND with SILT(SP-SM)**	NP	NP	NP	1.31	3.76
⊙	B-4A	0.0-10.0	**SANDY LEAN CLAY(CL)**	44	17	27		

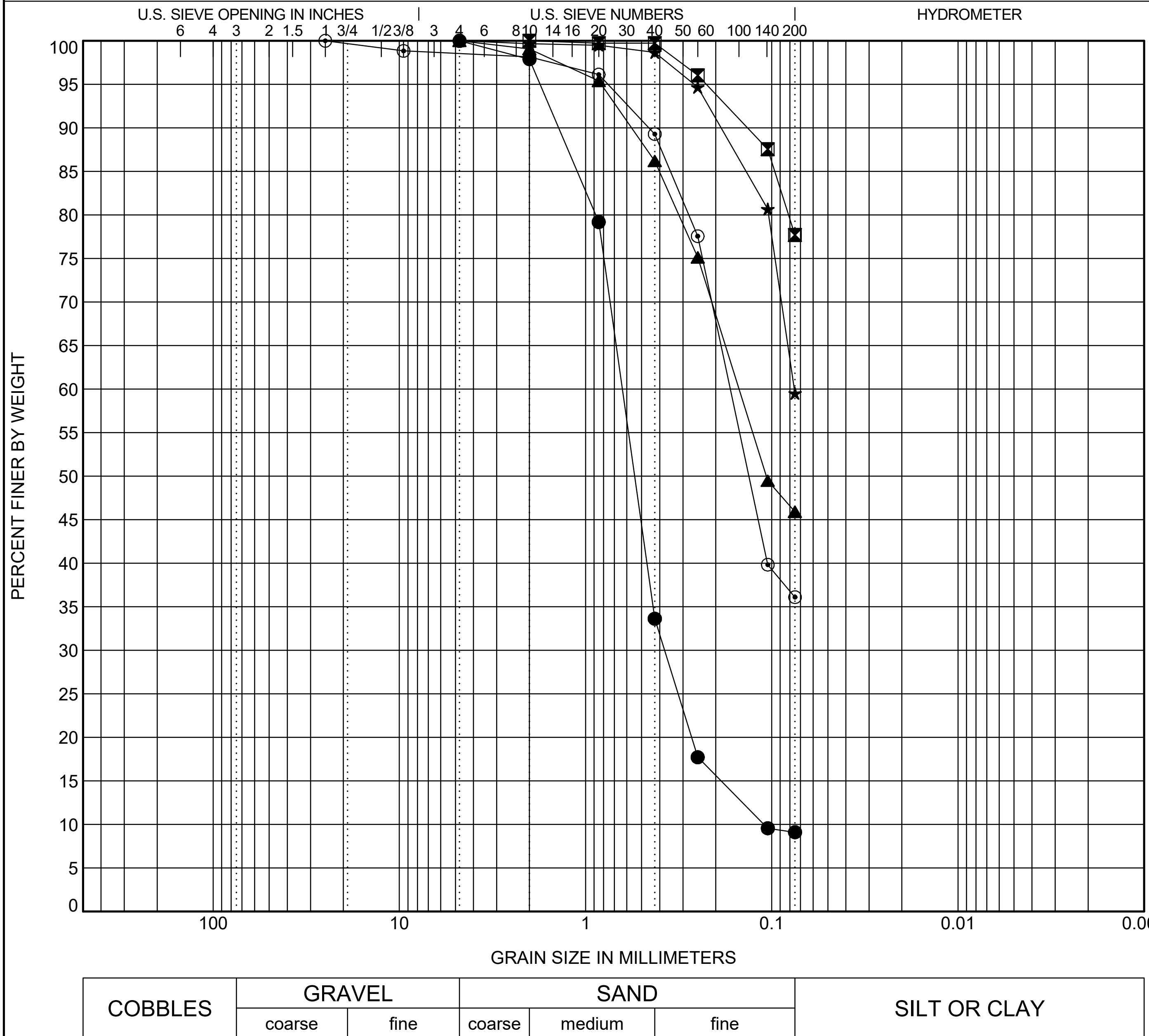
	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-3	1.0-2.5	4.75	0.091			0.0	43.5	56.5	
⊠	B-3	43.5-45.0	2				0.0	23.7	76.3	
▲	B-4	6.0-7.5	2	0.09			0.0	41.9	58.1	
★	B-4	23.5-25.0	4.75	0.244	0.144		0.0	89.4	10.6	
⊙	B-4A	0.0-10.0	25	0.106			0.1	44.4	55.5	

GRAIN SIZE DISTRIBUTION

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority **PROJECT NAME** Purrysburg Plant

PROJECT NUMBER GGRE180005 **PROJECT LOCATION** Purrysburg, SC



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-5**	**13.5-15.0**	**POORLY GRADED SAND with SILT(SP-SM)**	**NP**	**NP**	**NP**	**2.03**	**5.77**
⊠	**B-5**	**48.5-50.0**	**ELASTIC SILT with SAND(MH)**	**88**	**44**	**44**		
▲	**B-6**	**3.5-5.0**	**CLAYEY SAND(SC)**	**29**	**11**	**18**		
★	**B-6**	**28.5-30.0**	**SANDY FAT CLAY(CH)**	**106**	**33**	**73**		
⊙	**B-7**	**1.0-2.5**	**CLAYEY SAND(SC)**	**27**	**13**	**14**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
●	**B-5**	**13.5-15.0**	**4.75**	**0.635**	**0.377**	**0.11**	**0.0**	**90.9**	**9.1**
⊠	**B-5**	**48.5-50.0**	**2**				**0.0**	**22.3**	**77.7**
▲	**B-6**	**3.5-5.0**	**4.75**	**0.15**			**0.0**	**54.1**	**45.9**
★	**B-6**	**28.5-30.0**	**4.75**	**0.076**			**0.0**	**40.5**	**59.5**
⊙	**B-7**	**1.0-2.5**	**25**	**0.167**			**1.5**	**62.4**	**36.1**

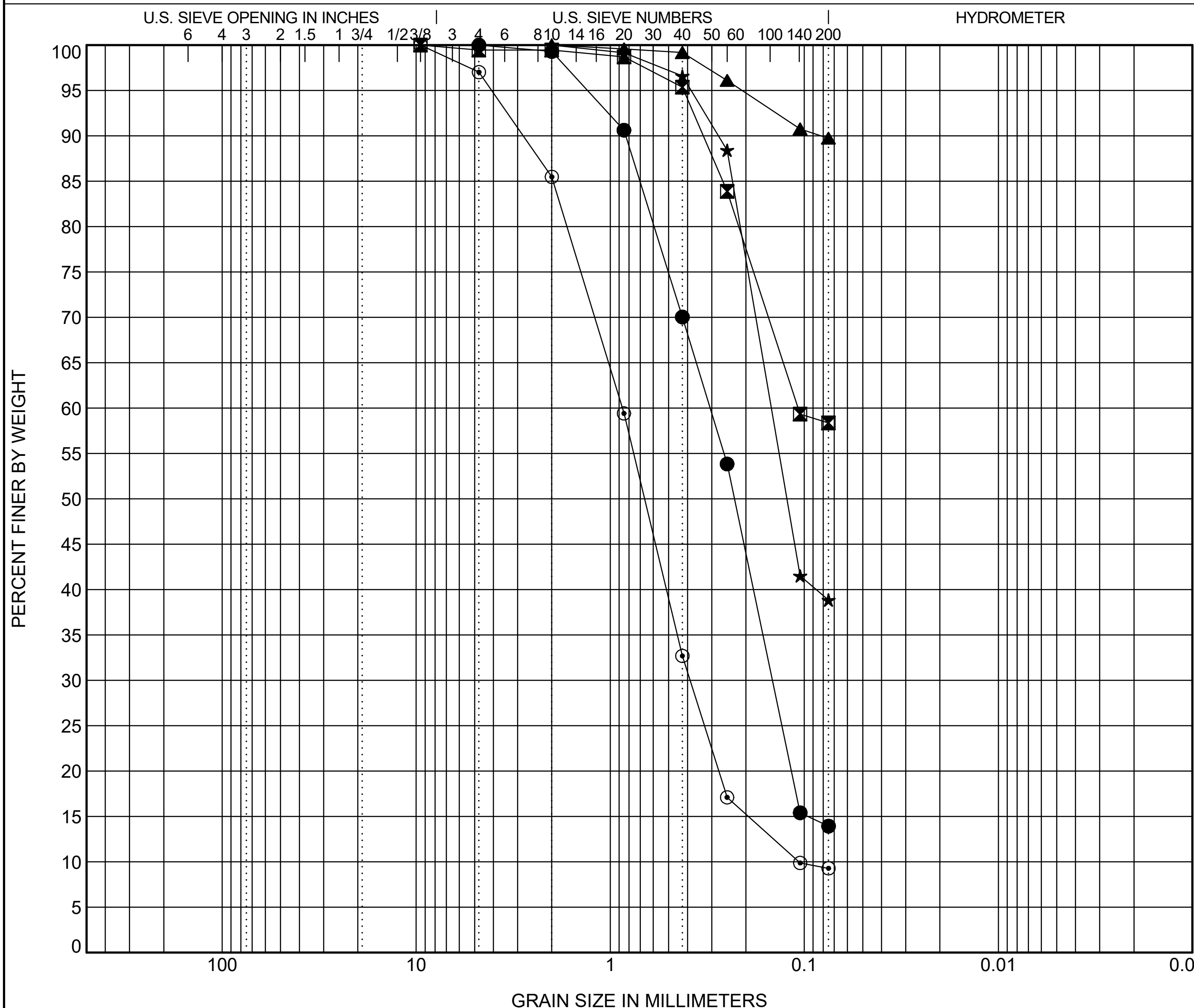
7.GRAIN SIZE GGRE180005 PURRYSBURG WTP.GPJ GMC DATA TEMPLATE.GDT 4/7/19

GRAIN SIZE DISTRIBUTION

GMC

CLIENT Beaufort - Jasper Water & Sewer Authority **PROJECT NAME** Purrysburg Plant

PROJECT NUMBER GGRE180005 **PROJECT LOCATION** Purrysburg, SC



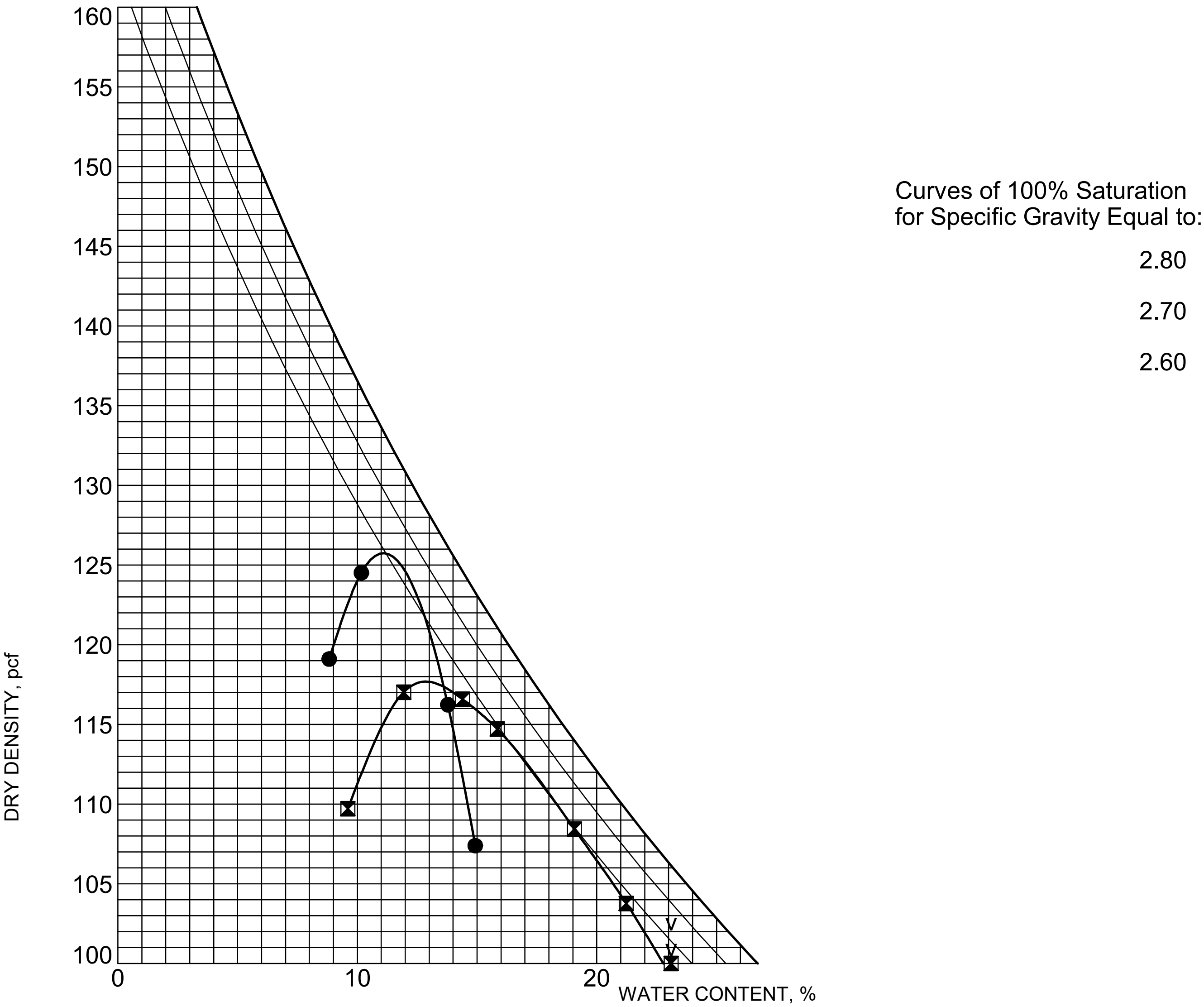
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-7**	**8.5-10.0**	**SILTY SAND(SM)**	**NP**	**NP**	**NP**		
⧗	**B-8**	**6.0-7.5**	**SANDY FAT CLAY(CH)**	**52**	**16**	**36**		
▲	**B-8**	**38.5-40.0**	**ELASTIC SILT(MH)**	**125**	**62**	**63**		
★	**B-9**	**3.5-5.0**	**CLAYEY SAND(SC)**	**39**	**17**	**22**		
⊙	**B-9**	**18.5-20.0**					**1.63**	**8.13**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-7**	**8.5-10.0**	**4.75**	**0.306**	**0.146**		**0.0**	**86.1**	**13.9**	
⧗	**B-8**	**6.0-7.5**	**9.5**	**0.107**			**0.5**	**41.1**	**58.4**	
▲	**B-8**	**38.5-40.0**	**2**				**0.0**	**10.3**	**89.7**	
★	**B-9**	**3.5-5.0**	**2**	**0.148**			**0.0**	**61.2**	**38.8**	
⊙	**B-9**	**18.5-20.0**	**9.5**	**0.867**	**0.388**	**0.107**	**3.0**	**87.7**	**9.3**	

MOISTURE-DENSITY RELATIONSHIP

CLIENT Beaufort - Jasper Water & Sewer Authority
PROJECT NAME Purrysburg Plant
PROJECT NUMBER GGRE180005
PROJECT LOCATION Purrysburg, SC



	SAMPLE	DEPTH	Description of Materials
●	**B-1A**	**0.0**	**SANDY LEAN CLAY(CL) Bulk Sample from 0-10'**
⧗	**B-4A**	**0.0**	**SANDY LEAN CLAY(CL) Bulk Sample from 0-10'**

	SAMPLE	DEPTH	Test Method	LL	PL	PI	% -200	Max DD	Optimum WC
●	**B-1A**	**0.0**	**ASTM D1557 Method A**	**32**	**19**	**13**	**51.3**	**125.7 PCF**	**11.1 %**
⧗	**B-4A**	**0.0**	**ASTM D1557 Method A**	**44**	**17**	**27**	**55.5**	**117.7 PCF**	**12.8 %**

FIELD TEST PROCEDURES

General

The general field procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C), are summarized in the American Society for Testing and Materials (ASTM) Standard D420 which is entitled "Investigating and Sampling Soil and Rock". This recommended practice lists recognized methods for determining soil and rock distribution and groundwater conditions. These methods include geophysical and in-situ methods as well as borings.

The detailed collection methods used during this exploration are presented in the following paragraphs.

Standard Drilling Techniques

General: To obtain subsurface samples, borings are drilled using one of several alternate techniques depending upon the subsurface conditions. These techniques are as follows:

In Soils:

a) Continuous hollow stem augers.
b) Rotary borings using roller cone bits or drag bits, and water or drilling mud to flush the hole.
c) "Hand" augers.

In Rock:

a) Core drilling with diamond-faced, double or triple tube core barrels.
b) Core boring with roller cone bits.

Hollow Stem Auger: A hollow stem augers consists of a hollow steel tube with a continuous exterior spiral flange termed a flight. The auger is turned into the ground, returning the cuttings along the flights. The hollow center permits a variety of sampling and testing tools to be used without removing the auger.

Rotary Borings: Rotary drilling involves the use of roller cone or drag type drill bits attached to the end of drill rods. A flushing medium, normally water or bentonite slurry, is pumped through the rods to clear the cuttings from the bit face and flush them to the surface. Casing is sometimes set behind the advancing bit to prevent the hole from collapsing and to restrict the penetration of the drilling fluid into the surrounding soils. Cuttings returned to the surface by the drilling fluid are typically collected in a settling tank, to allow the fluid to be recirculated.

Hand Auger Boring: Hand auger borings are advanced by manually twisting a 4" diameter steel bucket auger into the ground and withdrawing it when filled to observe the sample collected. Posthole diggers are sometimes used in lieu of augers to obtain shallow soil samples. Occasionally these hand auger borings are used for driving 3-inch diameter steel tubes to obtain intact soil samples.

Core Drilling: Soil drilling methods are not normally capable of penetrating through hard cemeted soil, weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound, continuous rock. Material that cannot be penetrated by auger or rotary soil-drilling methods at a reasonable rate is designated as "refusal material". Core drilling procedures are required to penetrate and sample refusal materials.

Prior to coring, casing may be set in the drilled hole through the overburden soils, to keep the hole from caving and to prevent excessive water loss. The refusal materials are then cored according to ASTM D2113 using a diamond studded bit fastened to the end of a hollow, double or triple tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovery is measured, and the core is placed, in sequence, in boxes for storage and transported to our laboratory.

Sampling and Testing in Boreholes

General: Several techniques are used to obtain samples and data in soils; however, the most common methods in this area are:

a) Standard Penetrating Testing
b) Water Level Readings

These procedures are presented below. Any additional testing techniques employed during this exploration are contained in other sections of the Appendix.

Standard Penetration Testing: At regular intervals, the drilling tools are removed and soil samples obtained with a standard 2-inch diameter split tube sampler connected to an A or N-size rod. The sampler is first seated 6 inches to penetrate any loose cuttings, and then driven an additional 12 inches with blows of a 140-pound safety hammer falling 30 inches. Generally, the number of hammer blows required to drive the sampler the final 12 inches is designated the "penetration resistance" or "N" value, in blows per foot (bpf). The split barrel sampler is designed to retain the soil penetrated, so that it may be returned to the surface for observation. Representative portions of the soil samples obtained from each split barrel sample are placed in jars, sealed and transported to our laboratory.

The standard penetration test, when properly evaluated, provides an indication of the soil strength and compressibility. The tests are conducted according to ASTM Standard D1586. The depths and N-values of standard penetration tests are shown on the Boring Records. Split barrel samples are suitable for visual observation and classification tests but are not sufficiently intact for quantitative laboratory testing.

Water Level Readings: Water table readings are normally taken in the borings and are recorded on the Boring Records. In sandy soils, these readings indicate the approximate location of the hydrostatic water table at the time of our field exploration. In clayey soils, the rate of water seepage into the borings is low and it is generally not possible to establish the location of the hydrostatic water table through short-term water level readings. Also, fluctuation in the water table should be expected with variations in precipitation, surface run-off, evaporation, and other factors. For long-term monitoring of water levels, it is necessary to install piezometers.

The water levels reported on the Boring Records are determined by field crews immediately after the drilling tools are removed, and several hours after the borings are completed, if possible. The time lag is intended to permit stabilization of the groundwater table, which may have been disrupted by the drilling operation.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the cave-in zone. The cave-in depth is measured and recorded on the Boring Records.

Boring Records

The subsurface conditions encountered during drilling are reported on a field boring record prepared by the Driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of coarse gravel, cobbles, etc., and observations of ground water. It also contains the driller's interpretation of the soil conditions between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are kept on file in our office.

After the drilling is completed, a geotechnical professional classifies the soil samples and prepares the final Boring Records, which are the basis for all evaluations and recommendations. The following terms are taken from ASTM D2487 or Deere's Technical Description of Rock Cores for Engineering Purposes, Rock Mechanical Engineering Geology 1, pp. 18-22.

Relative Density of Cohesionless Soils From Standard Penetration Test		Consistency of Cohesive Soils	
Very Loose	≤ 4 bpf	Very Soft	≤ 2 bpf
Loose	5 - 10 bpf	Soft	3 - 4 bpf
Medium	11 – 30 bpf	Medium	5 - 8 bpf
Dense	31 - 50 bpf	Stiff	9 - 15 bpf
Very Dense	> 50 bpf	Very Stiff	16 - 30 bpf
(bpf = blows per foot, ASTM D 1586)		Hard	> 30 bpf

Relative Hardness of Rock	Particle Size Identification	
Very Soft Rock disintegrates or easily compresses to touch; can be hard to very hard soil.	Boulders	Larger than 12"
	Cobbles	3" - 12"
Soft Rock may be broken with fingers.	Gravel	
	Coarse	3/4" - 3"
Moderately Soft Rock may be scratched with a nail, corners and edges may be broken with fingers.	Fine	4.76mm - 3/4"
	Sand	
	Coarse	2.0 - 4.76 mm
Moderately Hard Rock a light blow of hammer is required to break samples.	Medium	0.42 - 2.00 mm
	Fine	0.42 - 0.074 mm
Hard Rock a hard blow of hammer is required to break sample.	Fines (Silt or Clay)	Smaller than 0.074 mm

Rock Continuity

$$\textbf{RECOVERY} = \frac{\text{Total Length of Core}}{\text{Length of Core Run}} \times 100\ \%$$

Description	Core Recovery %
Incompetent	Less than 40
Competent	40 - 70
Fairly Continuous	71 - 90
Continuous	91 - 100

Relative Quality of Rocks

$$\textbf{RQD} = \frac{\text{Total core, counting only pieces} > 4\text{" long}}{\text{Length of Core Run}} \times 100\ \%$$

Description	RQD %
Very Poor	0 - 25 %
Poor	25 - 50 %
Fair	50 - 75 %
Good	75 - 90 %
Excellent	90 - 100 %

LABORATORY TESTING

GENERAL

The laboratory testing procedures employed by Goodwyn, Mills and Cawood, Inc. (GM&C) are in general accordance with ASTM standard methods and other applicable specifications.

Several test methods, described together with others in this Appendix, were used during the course of this exploration. The Laboratory Data Summary sheet indicates the specific tests performed.

SOIL CLASSIFICATION

Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply his past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Boring Records".

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary; grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D-2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

MOISTURE CONTENT

Moisture contents are determined from representative portions of the specimen. The soil is dried to a constant weight in an oven at 100° C and the loss of moisture during the drying process is measured. From this data, the moisture content is computed.

ATTERBERG LIMITS

Liquid Limit (LL), Plastic Limit (PL) and Shrinkage Limit (SL) tests are performed to aid in the classification of soils and to determine the plasticity and volume change characteristics of the materials. The Liquid Limit is the minimum moisture content at which a soil will flow as a heavy viscous fluid. The Plastic Limit is the minimum moisture content at which the soil behaves as a plastic material. The Shrinkage Limit is the moisture content below which no further volume change will take place with continued drying. The Plasticity Index (PI) is the numeric difference of Liquid Limit and Plastic Limit and indicates the range of moisture content over which a soil remains plastic. These tests are performed in accordance with ASTM D4318, D4943 and D427.

PARTICLE SIZE DISTRIBUTION

The distribution of soils coarser than the No. 200 (75-mm) sieve is determined by passing a representative specimen through a standard set of nested sieves. The weight of material retained on each sieve is determined and the percentage retained (or passing) is calculated.

A specimen may be washed through only the No. 200 sieve, if the full range of particle sizes is not required. The percentage of material passing the No. 200 sieve is reported.

The distribution of materials finer than the No. 200 sieve is determined by use of a hydrometer. The particle sizes and distribution are computed from the time rate of settlement of the different size particles while suspended in water. These tests are performed in accordance with ASTM D-421, D-422 and D-1140.

COMPACTION TESTS (Moisture-Density Relationships)

Compaction tests are performed on representative soil samples to determine the maximum dry density and optimum moisture content. The results of the tests are used in conjunction with other tests to determine the desired engineering properties relating to settlement, bearing capacity, shear strength, and permeability. The results may also be used as a standard to determine the percent compaction of soil fills.

The two most commonly used compaction tests are the standard proctor test and the modified proctor test. They are performed in accordance with ASTM Specifications D-698 and D-1557, respectively. Generally, the standard proctor compaction test is run on samples from building areas and areas where moderate building loads are anticipated. The modified compaction test is generally used for analyses of highways and other areas where large building loads are expected. Both tests have three alternative methods.

Test	Method	Hammer Wt.	Hammer Fall	Mold Diameter	Run on Material Finer Than	No. Layers	No. of Blows/ Layer
	A	5.5 lb.	12”	4”	No. 4 sieve	3	25
Standard	B	5.5 lb.	12”	6”	3/8” sieve	3	56
D-698	C	5.5 lb.	12”	6”	3/4” sieve	3	56
	A	10 lb.	18”	4”	No. 4 sieve	5	25
Modified	B	10 lb.	18”	6”	3/8” sieve	5	56
D-1557	C	10 lb.	18”	6”	3/4” sieve	5	56

Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.

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May 23, 2019

Mr. Jim Vaughn, PE
Goodwyn, Mills and Cawood, Inc.
35 Abercorn Street
Suite 210
Savannah, GA 31401

RE: ADDENDUM TO REPORT OF GEOTECHNICAL EXPLORATION
PROPOSED STAGING AREA FOR CONTRACT DEWATERING
PURRYSBURG WTP IMPROVEMENTS
PURRYSBURG, JASPER COUNTY, SOUTH CAROLINA
GMC PROJECT NO. GGRE180005
ADDENDUM NO. 1

Dear Mr. Vaughn,

Goodwyn, Mills and Cawood, Inc. (Geotechnical & Construction Services Division) is pleased to provide this Addendum to the report of geotechnical exploration performed for the above referenced project. This letter includes the results of field testing and general site preparation recommendations.

Field Exploration

On May 9, 2019, GMC personnel performed two (2) hand auger borings at the proposed location of the Staging Area for Contract Dewatering. The locations were provided to us via GPS coordinates and are shown below:

Approximate Hand Auger Locations

Dynamic Cone Penetrometer tests (DCP) were performed in the borings as they were advanced. This test is intended to provide data that can be correlated to the standard penetration test (SPT). A 1.5-inch O.D. cone is seated to penetrate any loose cuttings, then driven three, 1-3/4" increments with blows from a 15-pound weight falling 20 inches. The average number of blows required to drive the cone three increments is an index to soil strength and compressibility.

The soils encountered in the borings consisted of the following:

Boring No./ Location	Soil Description	DCP Blows				
		Test Depth*	1st 1-3/4"	2nd 1-3/4"	3rd 1-3/4"	Avg.
HA-1 32.357050, -81.125503	Top soil	0-5"	0	0	0	0
	Sandy, medium to high plasticity CLAY (CL-CH)	-1.5	10	8	9	8
	Clayey SAND (SC)	-2.5	9	10	10	10
	Clayey SAND (SC)	-2.8	25	0	0	0
HA-2 32.356883, -81.125498	Clayey SAND (SC)	-1	5	6	6	6
	Clayey SAND (SC)	-2	10	10	10	10
	Clayey SAND (SC)	-3	7	8	8	8
	Clayey SAND (SC)	-4	5	7	8	7
	Clayey SAND (SC) - Water filling Auger Hole	-5	n/a	0	0	0

<u>Recommendations</u>

We understand this area may be raised by placing new fill up to 5 feet in thickness. Based on the conditions encountered, the upper 2 to 2.5 feet consists of loose and medium sands and clays underlain by very loose and loose sands the groundwater between 3 and 5 feet below grade. Generally, soils with SPT/DCP values of ≤10 bpf are less stable and may require undercutting or recompaction in place. However, in this location, the groundwater level could impact the excavations if undercutting is required. In this area, we recommend the following:

1. Surface vegetation and deleterious materials in the planned construction area should be completely removed. Based on our observations, we recommend 6 inches of stripping be budgeted to remove organics and root zones in the area. It should be noted that deeper depths of organics may be present in lower lying areas of the site or in drainage features.
2. We recommend that once the area is excavated to the planned subgrade elevation, the subgrade should be proofrolled with a loaded dump truck to verify the existing subgrade soils are suitable for new fill placement. Proofrolling consists of repeated passes with a loaded dump truck to locate

areas of soft soil. Areas that rut or pump excessively will indicate those soils that will need remediation. If the layer of soft/pumping soils is relatively thin, less than about 1 foot, an attempt can be made to scarify, moisture condition, and compact the materials. Whether or not these soils will be problematic will be a function of prevailing weather conditions. If the soils are wet and adequate drying conditions are not present, this may not be practical. We recommend a GMC geotechnical engineer or qualified soils' technician observe the proofrolling operations.

3. In lieu of undercutting, a stabilization geotextile fabric such as a Mirafi HP270 (or similar properties) should be placed on the subgrade for stabilization prior to fill placement. The manufacturers installation guidelines should be followed. A 12-inch layer of granular material should be placed on the fabric and compacted as an initial lift. The initial lift should be compacted to between 90 and 92% modified Proctor density (ASTM D-1557). After the initial lift, select fill should be brought in and used up to the required subgrade elevation. The select material should be compacted to 95% of the soils modified Proctor density (ASTM D-1557) and within +/-2 percentage points of its optimum moisture content (OMC).

We appreciate the opportunity to perform this study on this phase of the project for you and look forward to continued participation during the construction phase of this project. If you have any questions pertaining to this report, or if we may be of further service, please do not hesitate to call us.

Sincerely,

GOODWYN, MILLS, AND CAWOOD, INC.

Kevin W. Wales
Executive Vice President

SOUTH CAROLINA LICENSED PROFESSIONAL ENGINEER
5-23-19
No. 25912
KEVIN R. LAIRD

Kevin R. Laird, PE
Regional Vice President
Licensed South Carolina 25912

SOUTH CAROLINA
Goodwyn Mills & Cawood Inc.
No. 339
CERTIFICATE OF AUTHORIZATION

Cc: Mr. Mitch Freeman, PE – GMC
Mr. Tony Reid, PE – GMC
Mr. Mitch Freeman, PE - GMC

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. All concrete structures designed to hold water shall be constructed of Class A reinforced concrete, and all structures shall be made completely watertight. The General Specifications for Reinforced Concrete included herein set forth the requirements for mix design details of constructing reinforcement, etc.

B. All surfaces of concrete structures that will be exposed after backfilling shall be formed with prefabricated plywood or metal forms. All exposed surfaces shall be rubbed with a Carborundum stone until all form marks have been removed and all exposed surfaces shall be formed true to within a plus or minus 1/8" tolerance.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcing, mix design, placement procedures, and finishes.

B. Cast-in-place concrete includes the following:
1. Foundations and footings
2. Slabs-on-grade
3. Fill for steel deck
4. Foundation walls
5. Shear walls
6. Load-bearing building walls
7. Building frame members
8. Equipment pads and bases
9. Fill for steel pan stairs

1.3 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Related work specified elsewhere includes:
1. Section 03 20 00 – Anchorage in Concrete

1.4 SUBMITTALS

A. General: Submit the following according to Conditions of the Contract and Section 013300.