Michael Baker
INTERNATIONAL

GEOTECHNICAL FINDINGS AND RECOMMENDATIONS REPORT
for
Camp Santiago Joint Training Center Facility Restoration
Puerto Rico

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1.0 INTRODUCTION AND PROJECT OVERVIEW

1.1 Introduction

This Geotechnical Report by Michael Baker International, Inc. (Michael Baker) presents the results of a geotechnical investigation to support the United States Army Corps of Engineers (USACE) in the proposed design and construction of the Facility Restoration at Camp Santiago Joint Training Center (Camp Santiago) in Puerto Rico. The geotechnical investigation was performed in accordance with the scope of services described in Michael Baker's Geotechnical Work Plan to USACE dated January 2020.

The Proposed Restoration at Camp Santiago includes design and construction of barracks, battalion and brigade headquarter buildings, dining facilities, supply buildings, new pavements, and new sewage and water lines. The purpose of this geotechnical investigation is to determine subsurface conditions at the project site and provide recommendations in support of the design and construction of the facility of the proposed buildings and pavement areas.

1.2 Site

Camp Santiago is a joint military training installation located in the foothills of the Cordillera Central Mountains; the site is approximately 2.5 miles west-northwest of Coco, Salinas County, Puerto Rico and approximately 3 miles southeast of Mariano Colón, Coamo County, Puerto Rico. Relief at the project site is gentle with a maximum elevation of approximately 190 feet above mean sea-level (feet-msl) (57.9 meters-msl) and minimum elevation of approximately 150 feet-msl (45.7 meters-msl) (Figure 1). The project site is situated adjacent to an isolated mountain in the north, whereas a larger range exists to the west, with plains located to the south and east. The site drains to the south into a tributary of the Rio Nigua.

1.3 Proposed Structures and Structural Loads

The Facility Restoration included the following proposed buildings:

- 10 two-story Barracks Buildings (Barracks),
- 2 one-story Dining Facilities (DFAC),
- 13 one-story Headquarters, Administrative and Supply Buildings (HQ),
- 3 one-story Headquarters, Administrative and Supply Buildings (HQ5) and
- 1 one-story Headquarters, Administrative and Supply Building (HQ6).

Attachment 1 of this report presents the layout of the proposed structures.

The foundation analyses and recommended foundation design criteria are based on unfactored foundation loading information (e.g. Allowable Stress Design) provided by USACE; see Attachment 1 for the detailed load information for each proposed structure and Table 12 for the summary of structural information for the proposed buildings

1.4 Scope of Work

This work has been performed in general accordance with the Geotechnical Work Plan prepared by Michael Baker for USACE for Camp Santiago, Puerto Rico, dated January 2020. The geotechnical scope of services has been performed as Task Order W912ER20F0138 of the overall Contract #W912-QR-18-D0014.

Michael Baker's geotechnical scope of work consisted of a geotechnical literature review, geotechnical field investigation, foundation analysis, and geotechnical engineering report development.

The following tasks were completed for the preparation of this report:

- Conducted a geological background review of site conditions.
- Performed a site reconnaissance.
- Performed a geotechnical subsurface investigation consisting of 49 test borings and 10 test pits.
- Performed field soil resistivity and percolation tests.
- Conducted laboratory testing of selected soil samples.
- Performed geotechnical analyses.
- Provided geotechnical recommendations for design and construction

Review comments on the draft Geotechnical Findings and Recommendations Report submission, dated August 2020 were received from USACE on August 28, 2020. Responses to these comments are provided in Attachment 10, and the report was revised as necessary.

2.0 LITERATURE REVIEW

Refer to the Geologic Background Information provided in Attachment 2 of this report. All figures referenced in this section are located in this attachment.

2.1 Soils

According to the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Web Soil Survey, the soils at the project site are not public information. However, the General Soil Map of Puerto Rico (Figure 4) indicates that the soils in the area are of the NRCS identified Coamo Series, Guamani Series, or the Vives Series.

The Coamo clay loam (ClB) is a gently sloping mixed loamy alluvium derived from volcanic and sedimentary rock over mixed gravelly alluvium derived from volcanic and sedimentary rock, having a depth to bedrock greater than 80 inches. Generally, it has a liquid limit of approximately 31 percent and a plasticity index of 16 percent, indicating a medium plasticity soil, with a low shrink-swell potential. The soil is identified as well drained, with a depth to the water table of more than 80 inches, and typically classifies as Unified Soil Classification System (USCS) lean clay (CL).

The Guamini silty clay loam (Gm) is a gently sloping medium textured sediment over sand, pebbles, and cobbles at foot of slopes with a depth to bedrock greater than 80 inches. Generally, it has a liquid limit of approximately 17 percent and a plasticity index of 8 percent, indicating a low plasticity soil, with no shrink-swell potential information available. The soil is identified as well drained with a depth to the water table more than 80 inches. No information regarding the USCS classification could be found in the NRCS data, however based on the Atterberg limits, the soil likely classifies as a USCS inelastic silt (ML).

The Vives silty clay loam (Vs) is gently sloping fine and moderately fine textured sediments on foot-slopes with a depth to bedrock greater than 80 inches. Generally, it has a liquid limit of approximately 40 percent and a plasticity index of 19 percent, indicating a medium to high plasticity soil, with a low shrink-swell potential. The soil is identified as moderately well drained with a depth to the water table more than 80 inches. No information regarding the USCS classification could be found in the NRCS data; however, based on the Atterberg limits, the soil likely classifies as a USCS lean clay (CL).

In addition to the three soil types listed, a generally unmapped soil series known as the Camp Santiago Series exists within the NRCS archives and is located within the vicinity of the site. Per the NRCS description the Camp Santiago Series soil consisted of gently to moderately sloping well drained, moderately permeable soils on foot slopes and toe slopes of volcanic mountains from material that weathered from extrusive volcanic residuum. The NRCS also identifies the Coamo and Guamani series as geographically associated soils.

Based on the geographic and geomorphological features identified in Figure 1, the project site is located on a piedmont plain. Piedmont plains are found in arid climates which are dissected by incised stream channels and dotted with residual bedrock knobs. The project site exists on the both a piedmont and alluvial plain. As previously discussed, the project site is located at the foot of an isolated mountain to

the north and is in the drainage path of the large continuous mountain range to the west. A unique situation has developed where the project site is situated on the old alluvial plain formed by the mountains to the west, which is likely covered with the piedmont materials from the mountain to the north.

As it relates to soils, the northern and northeastern extent of the project site is likely composed of Camp Santiago soils formed in the piedmont, which is likely overlaying alluvial plain material from the western plain outwash which thickens to the south. The southern and southeastern portion of the site are likely Coamo series soils which is based on the distance from the range to the west; it is not likely that large proportions of boulders and cobbles (Guamani Series) were transported several miles. If any exist, it is likely from construction or a result of sedimentation from the northern mountain. Vives soils, which are identified as fine, excellent farming material, likely exist further to the south and the east at a maximum extent from the mountains.

2.2 Geology

According to the Preliminary Report on the Geology of the Coamo Quadrangle, Puerto Rico, bedrock at the site is of the Santonian and Campanian aged, Guayama series, Cariblanco Formation, the Maestrichtian and Campanian aged, Guayama series, Coamo Formation, a Tertiary aged porphyritic diorite dike, and Quaternary colluvium (alluvium per new GIS based mapping).

The Cariblanco Formation is composed of volcaniclastic conglomerate, sandstone, and siltstone. Volcaniclastic rock is sedimentary rock that is composed of volcanic clasts and sediments as opposed to the traditional siliciclastic sedimentary rocks, which are largely composed of quartz and lithics.

The Coamo Formation is mapped as the primary bedrock at the project site, it is composed of tuff-breccia, tuffaceous conglomerate, tuff, siltstone, limestone, as well as tuffaceous and calcareous sandstone. Specifically, in the northwestern portion of the project site the rock is partly tuffaceous calcareous sandstone and siltstone. In the southeastern portion of the project site bedrock is identified primarily as tuff-breccia, and tuffaceous conglomerate. Tuff is a volcanic rock that is formed by the lithification of the ash and debris distributed by pyroclastic flows during volcanic eruptions.

The porphyritic diorite dike is located at the northwestern extent of the project site and the alluvium/colluvium is in the west-northwestern corner of the project site. The alluvium/colluvium is up to 60 feet thick near the project site (Rodriguez-Martinez). The anticipated composition of the alluvium and colluvium is as discussed in Section 2.1.

The Rio Jeuyes Fault, a normal fault (Glover III), intersects the site longitudinally. The upthrown rock unit is of the Cariblanco Formation in the northeast and the downthrown unit is of the Coamo Formation in the southwest. The Rio Jeuyes Fault is not believed to have been active since the Maestrichtian age, however, Puerto Rico still exists within an active tectonic zone.

2.3 Landslides

According to available landslide susceptibility mapping in Puerto Rico (Figure 6), the project site is in an area moderately susceptible to landslides. However due to the low relief of the project site, potential for landslides as a result of construction is not anticipated to be an issue.

2.4 Seismicity

Seismic design for the project location considers the regional seismicity of the area. The project site is in one of the most seismically active zones in the world. Puerto Rico is located at the convergence between two tectonic plates, the North American plate and the Caribbean plate, which is accompanied by a complex fault system.

In the past century, the four largest earthquakes to occur within 150 miles (250 km) of the site include:

- July 29, 1943 a Magnitude 7.7 earthquake occurred approximately 85 miles (135 km) northwest of Camp Santiago.
- January 07, 2020 a Magnitude 6.4 earthquake occurred approximately 35 miles (55 km) southwest of Camp Santiago.
- January 13, 2014 a Magnitude 6.4 earthquake occurred approximately 80 miles (130 km) northwest of Camp Santiago.
- October 11, 2009 a Magnitude 6.1 earthquake occurred approximately 125 miles (200 km) northeast of Camp Santiago.

3.0 FIELD INVESTIGATION

The field investigation program completed by Michael Baker consisted of 49 test borings, 10 test pits, 1 percolation test, and 16 field soil resistivity tests. Detailed discussion of the field investigation program is presented in the following sections. A Plan of as-drilled test borings and test pits is presented in Attachment 4 of this report.

3.1 Site Reconnaissance

Site reconnaissance was conducted prior to the drilling of the test borings. Site Reconnaissance Photographs are presented in Attachment 3 of this report.

The site is former barracks and administration buildings that were not in use. There were a few buildings being used for storage and administrative activities, but the vast majority of the building were vacant. Some of the buildings showed hurricane damage and were without roofs and/or door. The buildings were one story concrete block or concrete buildings. The land was general level with no large slopes or embankments. No signs of structural distress or foundation disturbance due to subsurface conditions was observed among the existing structures at the site.

The borings were located by a surveyor with utility clearance provided by Jaca & Sierra Engineering, PSC. Minor relocation of a few borings resulted from the utility clearance. Once the borings were cleared of utilities, drilling of the borings commenced.

3.2 Drilling Equipment and Methods

The test borings were drilled by Jaca & Sierra Engineering, PSC (Jaca & Sierra) of San Juan, Puerto Rico. Drilling operations took place across two mobilizations; the first being in February 2020 and the second being in May 2020.

A total of 49 borings were drilled for the proposed buildings included:

- Three borings for each of the proposed barracks (total of 30 barracks borings);
- One boring for each of the proposed Dining Facilities (total of 2 Dining Facilities borings);
- One boring for each of the Headquarters, Administrative and Supply buildings (total of 17 Headquarters, Administrative and Supply Buildings borings).

Each boring was advanced approximately 20 feet (6 meters) through the soil overburden, except for test boring 306B1 which was terminated at approximately 60 feet (18 meters).

Michael Baker provided an on-site representative to monitor drilling and sampling on a fulltime basis, log each borehole, field classify soil samples, and select representative samples for subsequent laboratory testing.

The borings were drilled using a track-mount drill rig. Each boring was advanced through the soil overburden with hollow stem augers to the specified termination depth. Standard penetration tests (SPTs) were completed with a split-barrel sampler. After completing the drilling program, borings were backfilled with cuttings.

The detailed boring logs prepared by Michael Baker and a general subsurface profile are presented in Attachment 4. A summary of the test borings is presented in Table 1.

3.3 Soils

The soil encountered at the test borings and test pits generally consisted of fill and native soil. Minor amounts of topsoil were identified in only ten of the borings at a thickness equal to or less than 2 feet (0.61 meters). The fill was encountered either beneath the topsoil or at the ground surface in approximately one third of the borings and varied in thickness from approximately 1.1 feet (0.34 meters) to 9 feet (2.74 meters). Beneath the topsoil and fill, native soil was encountered throughout the remaining sampled intervals. The native soils were visually classified as brown silty sand with varying amounts of clay and gravel-size rock fragments and described as moist to dry and medium dense to very dense. Bedrock was not encountered in any of the borings. However, one test boring, 310B3, did encounter weathered bedrock (brecchia) at a depth of 4.0 feet (1.22 meters).

3.4 Groundwater

Water levels were typically recorded immediately after drilling "0-hour" and after one-day "24-hour".

Groundwater was generally encountered at depths greater than 11.5 feet (3.5 meters). Groundwater elevations generally ranged from 134 feet (41 meters) msl to 164 feet (50 meters) msl.

Two test borings (304B2 and 304B3) encountered groundwater at a depth less than one meter from the ground surface; however, these measurements are believed to have been affected by a nearby leaking water line and are not considered indicative of the groundwater table.

Water level measurements have been made in the test borings at the times and under the conditions indicated herein. It should be noted that ground water levels might fluctuate due to variations in season, rainfall, temperature, site grading and other factors not evident at the times these measurements were made.

Refer to the test boring logs (Attachment 4) and the groundwater summary table (Table 2) for detailed information on the groundwater measurements recorded in the test borings during the subsurface investigation program.

3.5 Test Pits

Ten test pits, including 5 tests pits to investigate new pavement areas and 5 test pits to investigate new sewer lines, were competed during this field exploration program. One additional test pit was excavated to perform percolation testing. Test pits were excavated in general accordance with applicable portions of ASTM D 2488 and ASTM D 5434. Test pits were generally advanced to a depth of 4.5 to 5 feet (1.37 to 1.52 meters) below existing ground surface for the pavement areas and the proposed sewage system. A Michael Baker representative was present during the test pit excavations to observe and log each test pit and monitor bulk soil sample collection for subsequent laboratory testing. Visual classifications of the test pit soils included a 1.0 to 2.5 foot (0.30 to 0.76 meters) thick layer of fill described as brown silty sand and silty gravel underlain by native soil described as silty sand, sandy silt, and sandy clay. No

groundwater was observed in any of the test pits. The detailed pits logs prepared by Michael Baker are presented in Attachment 4 A summary of the test borings is presented in Table 1.

3.6 Soil Percolation Field Tests

The percolation test was performed in accordance with Regulations for the Control of Underground Injection, Appendix A, Section E, Puerto Rico Environmental Quality Board ("Reglamento para el Control de la Inyección Subterránea, Apéndice A, Sección E, Junta de Calidad Ambiental de Puerto Rico" in Spanish), September 14, 1983. The procedure requires an excavation of 1-foot-wide by 1-foot-long by 2-feet-deep. Testing is started by filling the excavation with water; after allowing for the soil to saturate, the test is made by refilling the hole with a column of water of 1-foot depth. The rate of water level drop is measured by keeping a record of elapsed time and the corresponding relative water level from fixed reference for the last 6 inches of water in the test hole. The result of the percolation test is presented as the average time of the column of water to drop 1 inch (average of the last 6 inches). The recorded percolation at the site is 60 minutes per inch. The results of field percolation tests are presented in Attachment 4.

3.7 Soil Resistivity Field Tests

Soil resistivity is a measure of how much the soil resists or conducts electric current. Four (4) resistivity tests with four (4) different pin spacings were conducted on four unique samples at the site. Total resistivity measurements ranged from 16,844 to 61,253 ohm-cm. The results of field resistivity tests are presented in Attachment 4 and a summary of the test results are presented in Table 3.

4.0 LABORATORY TESTING

Laboratory testing was performed by Jaca & Sierra Testing Laboratories, a USACE validated geotechnical testing laboratory. The laboratory tests were performed on representative samples collected from the test borings and test pits; the type and number of tests selected were dependent upon field conditions and materials encountered during the field investigation. The laboratory testing was performed in general accordance with the test methods listed below. Detailed laboratory test results from Jaca & Sierra are included in Attachment 5. Summary tables of the laboratory test results are included in Tables 4 through 11.

Testing included the following:

- 103 moisture content and soil classifications - ASTM D 2216, ASTM D422 & D4318
- 30 visual manual description of soil - ASTM D 2488
- 10 modified Proctors - ASTM D 1557 Procedure C
- 10 California bearing ratio tests - ASTM D 1883/1557
- 10 organic content tests - ASTM D 2974
- 6 unit weights - ASTM D 2216
- 10 chloride and sulfate tests - USEPA SW-846 6010B
- 6 carbonate content of soil tests - ASTM D4373
- 6 collapsible potential of soil tests - ASTM D 5333
- 5 soil pH tests - SW846 9045C
- 5 soil tests for the parameters Boron, Calcium, Copper, Iron, Magnesium, Manganese, Phosphorus, Potassium and Zinc - SW846 6010/3051
- 5 total solids test - S2540G

Testing of rock was not performed because rock was not encountered during execution of the geotechnical test boring drilling program.

4.1 Soil Classification and Moisture Content

Moisture contents of the selected soil samples ranged from 2% to 21%; however, the moisture content was generally 12% or less. Laboratory soil classification were provided in general accordance with USCS; descriptions of the selected soil samples were predominately silty sand (SM). The remaining soil sample classifications (at a much lower frequency of occurrence) included silty, clayey sand (SC-SM), clayey sand (SC), sandy lean clay (CL), and sandy silt (ML). The visual classifications provided by Jaca & Sierra were predominately silty sand (SM). See Table 4 for the soil classification and moisture content testing results.

4.2 Modified Proctor

The Modified Proctor test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density for a given energy departed to the soil. Maximum dry density ranged from 105.9 pound per cubic foot (pcf) to

131.0 pcf. Optimum moisture content of the site soils ranged from 8.7% to 16.3%. See Table 5 for the Modified Proctor testing results.

4.3 California Bearing Ratio

The California Bearing Ratio (CBR) test is a penetration test for evaluation of the mechanical strength of natural ground, subgrades and base courses. A three-point CBR test was performed on bulk samples that were collected from test pits at Camp Santiago. Compaction efforts are reported for 95% and 100% compaction for each sample. For the 95% compaction effort, CBR values ranged from 2 to 18; for the 100% compaction effort, CBR values ranged from 3 to 30. See Table 6 for the CBR test results.

4.4 Unit Weights

Dry densities for the laboratory tested bulk samples ranged from 82.3 to 95.5 pcf. See Table 11 for the unit weight test results.

4.5 Soil Chemistry

Soil chemistry testing was performed in accordance with the Work Plan dated January 2020. Results are as follows:

- Total solids ranged from 87.6% to 93.1%;
- Total Phosphorus ranged from 59.6% to 314%;
- Boron ranged from 82.7 milligrams per kilogram (mg/kg) to 110 mg/kg;
- Calcium ranged from 17,418 mg/kg to 91,902 mg/kg;
- Copper ranged from 33.1 mg/kg to 109 mg/kg;
- Iron ranged from 26,317 mg/kg to 38,505 mg/kg;
- Magnesium ranged from 9,168 mg/kg to 41,829 mg/kg;
- Manganese ranged from 449 mg/kg to 663 mg/kg;
- Potassium ranged from 722 mg/kg to 2,649 mg/kg;
- Zinc ranged from 46.2 mg/kg to 73.7 mg/kg;
- Chloride ranged from 24.6 mg/kg to 1,300 mg/kg;
- Sulfate ranged from 12.3 mg/kg to 581 mg/kg;
- pH (in water) ranged from 7.3 to 7.9; and
- pH (in calcium chloride) ranged from 7.1 to 7.8.

See Table 7 for the soil chemistry test results.

4.6 Organic Content

The Organic content in the site soils ranged from 3.5% to 8.3%. See Table 8 for the organic content test results.

4.7 Carbonate Content

Carbonate content was reported as calcite equivalents ranging from 1% to 31%. See Table 9 for the carbonate content test results.

4.8 Soil Collapse Potential

Collapsible potential of soil testing presented the strain and void ratios of the soil samples versus the applied stress trials. Collapse potential of the site soils was considered as the change in void ratio upon wetting per UFC 3-220-10 Figure 6; this change in void ratio was observed at an applied stress of 2 tons per square foot (tsf) in all the soil samples. The collapse potential of the laboratory tested soils ranged from 0.1 to 3.3 percent. See Table 10 for the collapsible potential of soil test results.

5.0 ANALYSES

5.1 Development of Soil Parameters

Soil parameters used in the analyses, including moist and saturated unit weight, effective friction angle, and effective cohesion, were developed for the native soils based on the laboratory testing and published correlations with test boring SPT blow counts from the EM 1110-2-2504, 1994.

The subgrade modulus was estimated based on guidance provided by the US Army Corps of Engineers Manual TM 5-809-12, Concrete Floor Slabs on Grade Subjected to Heavy Loads dated August 1987.

Lateral earth pressures coefficients (K_a, K_o, K_p) were estimated from Rankine's theory. These values are estimated for horizontal soil surfaces only. Deviations from horizontal will change the earth pressure coefficients.

The soil design parameter development calculations are provided in Attachment 6.

5.2 Collapsible Soils

Based on the laboratory tests performed, the severity of the potential issues in regard to collapsible soils ranges from "no problem" to moderate trouble" based on UFC 3-220-10N Figure 6 presented in Attachment 6.

According to UFC 3-220-10N, collapsing soils are distinguished by their potential to undergo large decrease in volume upon increase in moisture content even without increase in external loads. Examples of soils exhibiting this behavior are loess, weakly cemented sands and silts where cementing agent is soluble (e.g., soluble gypsum, halite, etc.) and certain granite residual soils; a common feature of collapsible soils is the loose bulky grains held together by capillary stresses. Deposits of collapsible soils are usually associated with regions of moisture deficiency. The site soils were not visually described as cemented and were generally medium dense to dense; therefore, the collapse potential of the site soils is assumed to be low.

5.3 Shallow Foundation Analysis

Shallow foundation analyses were conducted for:

- strip footings for the DFAC and HQ structures,
- square footings for the Barracks Structures, and
- mat foundation for the canopy structure at HQ6.

Footing sizes for each structure type were based on the preferred footing shape, the provided loadings, the available bearing capacity of the site soils, and a maximum allowable settlement of 1.0 inch. See Table 13 for a summary of the shallow foundation calculations.

Depth to groundwater was conservatively assumed as the highest water level recorded across the borings drilled for each structure type.

5.3.1 Bearing Capacity

As described in Section 3.2, shallow foundations at Camp Santiago will be founded on medium dense to dense silty sand. The soil parameters derived in the parameter development analysis (Section 5.1) were used to calculate allowable bearing capacity for each structure type. Ultimate bearing capacity was computed using the general bearing capacity equation and bearing capacity factors presented in the AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020. A Factor of Safety of 3.0 was used to compute an allowable bearing capacity in accordance with UFC 3-220-01 Table 2-3. For load cases where extreme limit states were considered (i.e. seismic loading), a Factor of Safety of 2.0 was used to compute an allowable bearing capacity. This was based on general guidance in UFC 3-220-01 Table 2-3.

The detailed bearing capacity calculations are presented in Attachment 7. Please note that allowable bearing capacity is based on an equivalent uniform bearing pressure applied over the effective footing width. Where moments are imposed on a footing, foundation pressures are higher at one end of the footing and lower at the opposite end; it is permissible from a design standpoint to have foundation contact pressures at the footing toe that exceed the allowable bearing capacity determined as described above. Therefore, the maximum allowable foundation contact pressure at the toe of the footing was also calculated, where applicable, to provide additional design guidance.

Foundations were also checked for sliding resistance, using AASHTO (2020) Section 10.6.3.4 criteria and a minimum Factor of Safety of 1.5.

5.3.2 Settlement

The site soils are generally medium dense to dense silty sand; therefore, settlement is estimated to be primarily elastic. The elastic settlement for each structure was calculated using the Hough Method in accordance with AASHTO (2020). A representative soil boring for each structure type was considered in the analysis to determine a maximum estimated foundation settlement for the calculated bearing pressure imposed by the provided loadings, based on a minimum required footing size determined from the analyses. Design footing sizes were increased, if necessary, to maintain estimated foundation settlements within the 1.0-inch threshold. The detailed settlement calculations can be found in Attachment 7.

5.4 Deep Foundation Analysis

Due to the 23.4-kip net uplift load at the HQ5 structures, shallow foundations are not feasible; therefore, 12-inch outside diameter pipe piles were considered for the HQ5 foundations. Pile axial and lateral capacity calculations are provided in Attachment 8. See Table 13 for a summary of the deep foundation calculations.

5.4.1 Axial Pile Capacity

Axial capacity of the pipe piles was calculated using AASHTO (2020) methodology. A Factor of Safety of 3.0 was applied, assuming that load testing would not be performed for construction control, in accordance with UFC 3-220-01 Table 2-3.

Per AASHTO (1995) for driven piles subject to uplift load, the nominal uplift capacity was taken as 70% of the total side friction calculated for axial compression. A Factor of Safety of 2.0 was used to calculate allowable uplift capacity, considering the uplift loading is due to wind, in accordance with IBC (2012) Section 1810.3.3.1.5.

5.4.2 Lateral Pile Capacity

A laterally loaded pile analysis was performed using LPile 2018 to the determine maximum pile head deflection of the proposed pipe pile. The analysis was based on available subsurface data, including subsurface conditions encountered in the HQ5 borings and the following design assumptions:

- Top of Pile is at El. 50 meters-msl;
- Soil overburden above the water table can be modeled as Reese Sand with an average unit weight of 120 pcf, a friction angle of 30 degrees, and a k value of 90 pounds per cubic inch (pci);
- Soil overburden below the water table can be modeled as Reese Sand with an average unit weight of 62.6 pcf, a friction angle of 30 degrees, and a k value of 60 pci;
- Groundwater table is at El. 36 meters-msl;
- Cyclic loading with 5000 cycles of loading;
- Maximum service loading considered;
- Loading evenly distributed across 4 piles;
- Minimum pile spacing of 3 pile diameters;
- P-Multiplier of 0.4 applied to account for lateral group effects;
- Pinned head condition (conservative).

Pushover Analysis

To provide further design flexibility, a laterally loaded pile pushover analysis was completed to estimate the maximum lateral capacity per pile using LPile 2018, based on a maximum allowable pile head deflection of 0.50 inches. The pushover analysis was performed considering the maximum axial loading and lateral group effects; two separate analyses were conducted, considering configurations with 5 pile diameter spacing and with 3 pile diameter spacing.

5.5 Liquefaction Susceptibility Analysis

Liquefaction susceptibility analyses were completed for all of the test borings to account for the variability in the SPT N-Values and groundwater readings. Sands above the water-table or with SPT N-Values greater than 30 are classified as non-liquefiable per Youd et. al (2001); therefore, the initial screening process to identify potentially liquefiable soils at the site was completed by selecting all test borings with SPT N-Values less than 30 blows per foot (bpf) below the design groundwater table.

Design groundwater tables to be used in liquefaction susceptibility analyses were developed for each of the northwest, central, and southeast portions of the site and were determined based on the shallowest groundwater reading recorded in the test borings drilled for each designated area. See Table 15 for the groundwater depths considered in the liquefaction analyses.

Peak ground acceleration design parameters to be used in liquefaction susceptibility analyses, presented in Section 6.1.3, were developed in accordance with ASCE 7-16 based on earthquake ground motions that correlate to a probability of ground motion exceedance equal to 2% in 50 years. A site adjusted peak ground surface acceleration (PGA_M) of 0.489g was used in the liquefaction susceptibility analysis. Due to the lack of Deaggregation data for Puerto Rico, the design earthquake magnitude (M_w) considered in the analysis was selected to be in the range of 7.7 (the maximum recorded earthquake in the past century within 250 km of the site) and 6.5 (an estimated mean design earthquake magnitude). Please note that the mean design earthquake magnitude was estimated based on historical earthquake mapping from the USGS Earthquake Catalog tool as presented in Attachment 9.

The liquefaction analysis was performed in accordance with the simplified procedure established in Youd et. al. 2001 and complemented by Cetin et al 2009. Liquefaction potential at the site is considered low when the capacity to demand ratio is calculated higher than 1.3, medium when calculated between 1.1 and 1.3, and high when calculated at 1.1 or lower. Shear wave velocity in the soil was assumed to be 175 m/s (575 feet per second) based on typical shear wave velocity considered for site class D in the AASHTO table 3.10.3.1-1 for this analysis.

The liquefaction susceptibility analysis indicated that liquefaction potential is high in three isolated areas at the project site;

- HQ Building 444 (boring 444B1) from 13.5 to 19.5 feet below ground surface (ft-bgs);
- DFAC Building 302 (boring 302B1) from 13.5 to 19.5 feet-bgs; and
- Barracks Building 454 (boring 454B3) from 13.5 to 16.5 feet-bgs.

The soil settlements due to seismic-induced liquefaction calculated considering the maximum design earthquake, Magnitude 7.7, were estimated to be approximately 1.3 inches at Building 444, 1.1 inches at Building 302, and 0.5 inches at Building 454. The soil settlements due to seismic-induced liquefaction calculated considering the estimated mean design earthquake, Magnitude 6.5, were estimated to be approximately 1.3 inches at Building 444, 0.6 inches at Building 302, and 0.0 inches at Building 454.

Building 458 (boring 458B3) was considered to have a medium liquefaction potential considering the maximum design earthquake; potential liquefaction induced settlements at this building were minimal at less than 0.4 inches. All other buildings at the site were determined to have low potential for liquefaction (considering the maximum design earthquake) based on the available filed data and are not subject to liquefaction induced settlements.

Due to the limited depth of the borings, liquefaction potential was only able to be analyzed to an approximate depth of 19.5 feet-bgs. Since the liquefiable layers identified in borings 302B1 and 444B1 were located at the bottom of the sampling interval, it is possible that the potential liquefaction induced settlements could be greater than what the analysis suggests. In general, blow counts did increase with depth across the site. Deeper site soils (deeper than 20 feet) were encountered at test boring 306B1; however, the subsurface condition at test boring 306B1 was generally more dense (i.e. less susceptible to liquefaction) than borings 302B1 and 444B1 and may not be indicative of the subsurface conditions below 19.5 feet at borings 302B1 and 444B1.

See Table 15 for a summary of the liquefaction analyses. See Attachment 9 for the detailed liquefaction calculations.

6.0 RECOMMENDATIONS

Based on the subsurface conditions encountered at the time of the field investigation, Michael Baker provides the following recommendations for the proposed buildings and pavement areas.

6.1 Parameters

6.1.1 Soil Design Parameters

Barracks Structures, HQ Structures, and HQ5 Structures

- Cohesionless Soils (silty SAND)
- Effective Friction Angle (Φ) = 30 degrees
- Moist Unit Weight = 120 pcf
- Effective Cohesion = 0 psf
- Active Earth Pressure coefficient, K_a = 0.33
- At-Rest Earth Pressure coefficient, K_0 = 0.50
- Passive Earth Pressure coefficient, K_p = 3.00

DFAC Structures and Canopy Structure at HQ6

- Cohesionless Soils (silty SAND)
- Effective Friction Angle (Φ) = 32 degrees
- Moist Unit Weight = 120 pcf
- Effective Cohesion = 0 psf
- K_a = 0.31
- K_0 = 0.47
- K_p = 3.25

6.1.2 Corrosion Potential

The following criteria, obtained from AASHTO (2020) (Article 10.7.5), is considered as indicative of potential pile deterioration or a corrosive environment.

- Resistivity less than 2,000 ohm-cm,
- pH less than 5.5,
- pH between 5.5 and 8.5 in soils with high organic content,
- Sulfate concentrations greater than 1,000 ppm,
- Landfills and cinder fills,
- Soils subject to mine or industrial drainage,

The chemical analysis and field resistivity test results indicate that the site does not present a corrosive environment.

6.1.3 Seismic Parameters

Using the OSHPD Seismic Design Maps web application, detailed summary reports were generated that provide earthquake ground motion parameters for designing structures in accordance with ASCE 7-16. The short term and one second spectral response accelerations obtained from OSHPD were confirmed using ASCE 7-16 Figure 22-6, which is based on a target risk of structural collapse equal to 1% in 50 years. The Maximum Considered Earthquake Geometric Mean (MCE_G) PGA was confirmed using ASCE 7-16 Figure 22-12, which is based on a probability of ground motion exceedance equal to 2% in 50 years.

Based on the test boring data, the depth to the top of rock is generally greater than 60 feet at the site. The site is classified as Site Class D by its soil stiffness as identified by the SPT blow counts in accordance ASCE 7-16.

The mapped acceleration parameters for the project, according to standard, ASCE/SEI 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures, are presented below:

- Site Class D – Stiff Soil (based on a weighted average of the N values of the upper 100 feet of soil at 444B1 - see Attachment 9 for the full calculation)
- Risk Category IV (based on IBC 2018 Table 1604.5)
- Maximum Considered Earthquake Geometric Mean (MCE_G) Spectral Response Acceleration for peak ground acceleration, PGA_M, for a probability of ground motion exceedance equal to 2% in 50 years:
    - Peak ground acceleration (PGA) is 0.375g (ASCE 7-16 Figure 22-12)
    - Site coefficient based on site class for peak ground acceleration (F_{PGA}) = 1.225 (ASCE 7-16 Table 11.8-1)
    - PGA_M = 0.459g (ASCE 7-16 Eqn 11.8-1)
- Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration for short periods, S_{MS}, for a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility:
    - Mapped spectral acceleration (short period, 0.2 seconds), S_S, is 0.937g (ASCE 7-16 Figure 22-6)
    - Site coefficient based on site class for short periods (F_a) = 1.125 (ASCE 7-16 Table 11.4-1)
    - S_{MS} = 1.054g (ASCE 7-16 Eqn 11.4-1)
    - S_{DS} = 0.703g (design spectral response acceleration parameter) (ASCE 7-16 Equation 11.4-3)
- MCE_R Spectral Response Acceleration for 1-second periods, S_{M1}, for a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility:
    - Mapped spectral acceleration (1-second period), S_1, is 0.353g (ASCE 7-16 Figure 22-6)
    - Since S_1 is greater than 0.2g, the parameters provided below are only valid if the seismic response coefficient (C_s) is determined in accordance with ASCE 7-16 Section 11.4.8, otherwise a ground motion hazard analysis will need to be performed.
        - Site coefficient based on site class for 1-second periods (F_v) = 1.95 (ASCE 7-16 Table 11.4-2)
        - S_{M1} = 0.690 (ASCE 7-16 Eqn 11.4-2)

- S_{D1} = 0.459 (design spectral response acceleration parameter) (ASCE 7-16 Eqn 11.4-4)

6.2 Collapsible Soils

Based on the laboratory tests performed, the severity of the potential issues in regard to collapsible soils at the site ranges from "no problem" to "moderate trouble" based on UFC 3-220-10N Figure 6. In general, the collapse potential of the site soils is considered to be low.

6.3 Shallow Foundations

A Declaration of Soil Bearing Capacity certification is provided in Attachment 7; however, it needs to be emphasized that the allowable soil bearing capacities calculated for each proposed structure type (i.e. Barracks, DFAC HQ, HQ5, and the Canopy at HQ6) at this site is a function of, among other things, the recommended minimum shallow foundation dimensions, which varies across the proposed structures. Accordingly, the Shallow Foundation Recommendations Summary Table (Table 13) is to be considered the most accurate information with respect to allowable soil bearing capacity and shallow foundation design guidance for this project.

A summary of the shallow foundation recommendations for each structure is provided in Table 13 and discussed below.

6.3.1 Barracks Structures

Spread footings bearing on soil are recommended to support the Barracks structures. Based on the provided loading, the recommended minimum footing size for the Barracks structures are 8 feet by 8 feet; with the exception of Barracks Buildings 458 and 460, where minimum footing sizes of 9 feet by 9 feet are recommended to maintain estimated foundation settlements at 1 inch maximum. All footings should be placed a minimum of 36 inches below finished grade to provide adequate bearing capacity and sliding resistance. Maximum settlement is estimated at 1.0 inch for Barracks Buildings 458 and 460, and 0.8 inches at all other Barracks buildings.

6.3.2 HQ Structures

HQ Buildings 306 to 330

Strip footings bearing on medium dense to dense silty sand are recommended to support the HQ structure Buildings 306 to 330. Based on the provided loading, the minimum recommended footing width is 5.5 feet. All footings should be placed a minimum of 36 inches below finished grade to provide adequate bearing capacity and sliding resistance. Maximum settlement is estimated at 0.8 inches.

HQ Buildings 440 to 446

Strip footings bearing on medium dense to dense silty sand are recommended to support the HQ structure Buildings 440 to 446. Due to lower average blow count soils (N<25) and increased settlement susceptibility at the location of these HQ structures, wider/deeper strip footings are recommended to

maintain estimated foundation settlements at 1 inch maximum. Based on the provided loading, the minimum recommended footing width is 9 feet for a footing embedment of 48 inches, or 8 feet for a footing embedment of 60 inches. As indicated, maximum settlement is estimated at 1.0 inch for these strip footing options.

As an alternative to the large strip footing sizes indicated above, 12" diameter pipe piles, similar to those recommended for foundation support at the HQ5 structures (refer to Section 6.4, below), could be considered for bearing support of the foundations at HQ Buildings 440 to 446. However, for HQ Building 444, where liquefaction potential is high, additional analyses would need to be performed as part of the deep foundation design to assess the strength loss due to liquefaction and the ability of the piles to resist the settlement and potential downdrag forces caused by liquefaction.

6.3.3 DFAC Structures

Strip footings bearing on medium dense to dense silty sand are recommended to support the DFAC Structures. Based on the provided loading, the minimum recommended footing width is 4.5 feet. All footings at these structures should be placed a minimum of 36 inches below finished grade to provide adequate bearing capacity and sliding resistance. Maximum settlement is expected to be 0.9 inches.

6.3.4 Canopy Structure at HQ6

A mat foundation bearing on medium dense to dense silty sand is recommended to support the Canopy Structures at HQ6. Based on the provided drawings, the size of the mat is approximately 13.5 feet wide by 37 feet long. The proposed mat should be placed a minimum of 36 inches below finished grade. Maximum settlement is estimated to be negligible (less than 0.1 inches) for the proposed mat foundation at this structure.

6.4 Deep Foundations

Referring to the discussion in Section 5.4, the recommended foundation type for the HQ5 structures is driven pipe piles. Based on the provided loading, Michael Baker recommends a minimum of four (4) 12-inch outside diameter steel pipe piles for the most heavily loaded foundations, spaced at a minimum of 3 pile diameters (36 inches) center to center. Minimum pile lengths of 20 feet are recommended. The recommended minimum steel pipe wall thickness is 0.375 inches.

Different pile configurations can be considered at these structures, using the following criteria:

- Minimum 12-inch outside diameter, 0.375-inch wall thickness steel pipe piles
- Minimum pile length of 20 feet
- Allowable geotechnical axial compressive capacity of 40 kips per pile.
- Allowable uplift capacity of 12 kips per pile.
- Based on a maximum pile head deflection of 0.5 inches, the maximum allowable shear loads are as follows:
    - 11 kips per pile, based on a minimum spacing of 5 pile diameters (60 inches)
    - 6.7 kips per pile, based on a minimum spacing of 3 pile diameters (36 inches)

A drivability analysis was not performed for the proposed deep foundations; however, based on the relatively short proposed pile lengths and the SPT N-Values encountered at the site, drivability is not expected to be a significant issue.

The foundation pile cap will need to be designed to transfer the structure loadings, including potential uplift forces, to the piling. This includes determination of the minimum required embedment of the pipe piles in the concrete pile cap.

Refer to Table 13 for a summary of the deep foundation recommendations and Attachment 8 for the detailed deep foundation calculations.

6.5 Liquefaction Mitigation

Potential liquefaction induced settlement at the project site are discussed in Section 5.5 If these settlements are not within the tolerable limits for a seismic event, the following mitigation measures are recommended.

6.5.1 Ground Improvement

Michael Baker recommends consideration for rammed aggregate stone columns as a ground improvement method. The advantages of stone columns include the following:

- Bearing Capacity Improvement
- Reduction of Total and Differential Settlement
- Reduction in Liquefaction Potential of Sands

Typical column layout would include a rectangular grid pattern with 24-inch diameter stone columns spaced on 10-foot centers. Estimated depth would be approximately 25 feet. Typical stone specification for this application is naturally rounded AASHTO #8 coarse aggregate, or equivalent. Refer to a specialty contractor for site specific design requirements.

6.5.2 Alternative Shallow Foundations

A shallow mat foundation may be advantageous versus the proposed strip footings for the buildings where liquefaction potential is high. A mat foundation would maximize the bearing resistance of the onsite soils and minimize risk of catastrophic failure under an extreme seismic event due to liquefaction.

6.6 Earthwork

6.6.1 Subgrade Preparation

The following recommendations are provided for subgrade preparation at the project site:

- Proof-roll subgrades below shallow foundations, floor slabs, and pavements with a loaded tri-axle dump truck with 72,000 pounds gross vehicle travelling at a maximum speed of 1.5 feet per second (1 mph) with coverage over the entire area that is proof rolled. Satisfactory proof-rolling is determined when no permanent deformation of greater than 1/2 inch occurs. Proof-rolling will

identify soft pockets and areas of excessive yielding. Do not proof-roll wet or saturated subgrades. Proof-rolling should be conducted as follows:

- Proof-roll entire subgrade in one direction;
- Repeat proof-roll of subgrade in a direction perpendicular to initial direction. Limit vehicle speed to one mile per hour;
- Excavate soft spots, unsuitable soils (organics, bricks and/or concrete fragments), and areas of excessive pumping or rutting to a maximum depth of 3 feet and replace with properly compacted backfill;
- If the base of the overexcavation is soft or loose, then work rock aggregate into the loose soil to stiffen the base of the excavation.

6.6.2 Fill Placement

The following recommendations are provided for fill placement at the project site:

- Suitable granular fill material, meeting AASHTO Soil Material Group Classification A-1 or A-2 criteria (35% or less passing the 0.075 mm sieve) should be placed in controlled, well-compacted lifts not exceeding 8-inches compacted thickness. A minimum of 6 passes shall be provided for each compaction.
- Each layer of soils should be compacted to at least 98 percent of its maximum dry density and within plus-or-minus 2% of the optimum moisture content as estimated by the Modified Proctor test (ASTM D1557). Adjustments to the soil moisture through wetting, drying, or mixing with drier materials should be made as needed. Michael Baker has conducted modified proctor tests for use in this geotechnical report, but these reports are only to serve as estimations of the expected field conditions, actual site fill material must be tested to determine the optimum moisture content and maximum dry density.
  - Maximum dry density ranged from 105.9 pcf to 131.0 pcf.
  - Optimum moisture content of the site soils ranged from 8.7% to 16.3%. Based on the laboratory tested in-situ moisture contents, minimal wetting/drying is expected to be necessary
- Use an earthen material shrink/swell factor of -14 percent (i.e., shrink) to represent combined shrink for placement of excavated site soil materials. This shrink factor is an adjusted interpretation from Excavation Handbook by Horace K. Church for a soil consisting of sand and silt.

6.6.3 General

The following recommendations are provided for general earthwork activities at the project site:

- All proof-rolling and compaction operations should be monitored by an on-site representative that is under the direct supervision of a registered Geotechnical Engineer.
- Due to the elevated fines content in the site soils, do not use vibratory rollers to proof roll or compact site soils.

- The groundwater table was encountered below the base of the anticipated footing excavations and is not expected to be encountered during earthwork operations. If groundwater is encountered, positive drainage should be provided away from the site and towards a controlled BMP or other water conveyance structure.
- The soils at the site appear to have low potential for soil collapse.

6.7 Floor System

For design of slab on grade floor systems, a modulus of subgrade reaction (k) of 150 pci (41,700 kN/m^3) is recommended. Subgrade preparation for slabs-on-grade should be done in accordance with the earthwork recommendations provided in Section 6.6. Provide a drainage layer beneath slabs-on-grade, consisting of a minimum 4 inches of free-draining, non-expansive aggregate. Slabs-on-grade should be designed as floating slabs (i.e., isolated from spread and column foundations).

6.8 Pavement Design

Prior to construction of new pavement, the exposed subgrade should be prepared in accordance with the earthwork recommendations provided in Section 6.6. Consider 0-inches of frost penetration in accordance with the UFC 3-301-01. Provide adequate drainage within the pavement system to avoid ponding of water and subgrade softening.

Based on the available data, consider the following:

- Use a CBR value of 5 for subgrade soils compacted to at least 98 percent of the modified Proctor maximum dry density; and
- Consider a modulus of subgrade reaction (k) of 150 pci (41,700 kN/m^3) for fill that is compacted in accordance with the subgrade preparation recommendations presented in Section 6.6.

6.9 Sewage Lines

Michael Baker was informed by Camp Santiago Representative that utilities such as sewer lines are limited to a depth at or less than 4 feet below ground surface. Refer to Section 6.6 earthwork recommendations.

7.0 LIMITATIONS

The recommendations presented herein are based upon the site observation, the results of the field investigation (test borings and test pits) and other available geotechnical information at the time of the preparation of this document. The test borings and test pits may only depict the soil, groundwater, and rock conditions at the specific locations and at the time at which they were made. The soil, groundwater, and rock conditions at other locations and at other time on the site may differ significantly from those occurring at the test boring locations. Surface conditions may change over a relatively short period of time. If deviations from the noted geotechnical conditions are encountered during construction, they should be brought to the attention of Michael Baker International., Inc.

The professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. Michael Baker International., Inc. is not responsible for the conclusions made by others based upon the data included herein.

The recommendations are prepared for the exclusive use by the USACE for the design and construction of the facility restoration at Camp Santiago. No other use of this document is authorized.

8.0 REFERENCES

NOTE: Sources for Figures are referenced in the title block and contain web links, where applicable.

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TABLES

Table 1: Test Boring & Test Pit Summary Table											
					Fill Soils		Native Soils		Weathered Rock		
Test Boring & Test Pit ID	Northing	Easting	Approx. Ground Surface Elevation (m-msl)	Approx. Thickness of Topsoil (m)	Approx. Thickness (m)	Average N-Value (bpf)	Approx. Thickness (m)	Average N-Value (bpf)	Approx. Thickness (m)	Average N-Value (bpf)	Total Depth of Boring (m)
300B1	1993174.2	786475.6	50.4	N/A	1.53	16	4.42	51	N/A	N/A	5.94
302B1	1993254.2	786556.2	52.4	N/A	1.83	28	4.12	36	N/A	N/A	5.94
304B1	1993133.7	786491.4	48.6	N/A	0.61	9	5.34	46	N/A	N/A	5.94
304B2	1993107.4	786521.6	47.7	N/A	0.61	16	5.34	58	N/A	N/A	5.94
304B3	1993081.6	786543.2	47.5	N/A	N/A	N/A	5.88	53	N/A	N/A	5.88
306B1	1993189.5	786535.2	50.3	0.46	N/A	N/A	17.56	50	N/A	N/A	18.01
308B1	1993237.5	786584.6	52.2	0.4	0.82	26	4.73	59	N/A	N/A	5.94
308B2	1993206.6	786621.2	51.4	N/A	0.61	14	5.15	46	N/A	N/A	5.76
308B3	1993184.6	786642.2	50.9	N/A	0.91	14	5.02	42	N/A	N/A	5.94
310B1	1993102.0	786475.9	47.3	0.15	1.07	13	2.14	>50	N/A	N/A	3.35
310B2	1993075.1	786500.1	46.5	0.15	1.07	15	4.58	>50	N/A	N/A	5.79
310B3	1993049.5	786527.4	46.5	0.06	1.16	39	N/A	N/A	3.38	>50	4.60
312B1	1993123.5	786545.8	48.7	N/A	0.46	10	5.49	49	N/A	N/A	5.94
314B1	1993159.1	786572.0	49.7	N/A	0.91	16	5.03	38	N/A	N/A	5.94
316B1	1993191.5	786606.3	50.7	N/A	0.61	12	5.34	40	N/A	N/A	5.94
318B1	1993260.4	786630.6	53.3	N/A	N/A	N/A	5.79	33	N/A	N/A	5.79
318B2	1993233.1	786655.6	52.5	N/A	0.46	10	5.48	49	N/A	N/A	5.94
318B3	1993197.4	786682.2	51.8	0.2	0.41	20	5.34	38	N/A	N/A	5.94
320B1	1993052.7	786620.8	47.6	N/A	N/A	N/A	5.61	46	N/A	N/A	5.61
322B1	1993018.7	786650.7	47.7	N/A	N/A	N/A	5.88	42	N/A	N/A	5.88
324B1	1993103.5	786637.4	48.9	N/A	0.46	11	5.48	52	N/A	N/A	5.94
326B1	1993161.3	786734.4	50.2	N/A	N/A	N/A	5.64	39	N/A	N/A	5.64
328B1	1993132.5	786764.9	49.6	N/A	N/A	N/A	5.64	39	N/A	N/A	5.64
330B1	1993148.1	786683.1	50.2	N/A	0.46	22	5.48	26	N/A	N/A	5.94
332B1	1993066.5	786686.9	48.0	N/A	1.22	14	4.72	55	N/A	N/A	5.94
334B1	1993092.6	786719.2	47.7	N/A	1.37	19	4.57	62	N/A	N/A	5.94
440B1	1993339.8	786210.2	52.7	N/A	0.61	11	5.15	28	N/A	N/A	5.76
442B1	1993270.3	786234.9	51.7	N/A	0.91	17	5.03	20	N/A	N/A	5.94
444B1	1993246.8	786201.8	51.0	N/A	1.83	15	4.11	17	N/A	N/A	5.94
446B1	1993233.8	786164.5	50.2	N/A	N/A	N/A	5.94	26	N/A	N/A	5.94
448B1	1993292.1	786187.0	51.5	N/A	N/A	N/A	6.25	26	N/A	N/A	6.25
450B1	1993233.3	786347.1	50.6	0.15	N/A	N/A	5.80	33	N/A	N/A	5.94
450B2	1993208.4	786376.1	49.9	N/A	0.49	13	5.34	40	N/A	N/A	5.94
450B3	1993181.9	786403.2	49.1	N/A	N/A	N/A	5.94	43	N/A	N/A	5.94
452B1	1993259.8	786365.4	51.5	N/A	0.46	11	5.49	43	N/A	N/A	5.94
452B2	1993234.6	786402.4	51.1	N/A	0.49	14	5.18	42	N/A	N/A	5.79
452B3	1993209.1	786426.5	50.3	0.06	N/A	N/A	5.88	33	N/A	N/A	5.94
454B1	1993305.5	786413.9	53.4	N/A	1.07	18	4.72	61	N/A	N/A	5.79
454B2	1993260.4	786428.3	52.1	N/A	0.49	22	5.34	53	N/A	N/A	5.94
454B3	1993237.1	786451.3	51.1	N/A	2.74	37	3.20	44	N/A	N/A	5.94
456B1	1993330.2	786438.9	54.6	N/A	0.34	16	5.60	62	N/A	N/A	5.94
456B2	1993301.7	786469.8	53.5	N/A	1.10	21	4.72	47	N/A	N/A	5.94
456B3	1993274.9	786497.2	53.2	N/A	N/A	N/A	5.94	35	N/A	N/A	5.94
458B1	1993359.9	786454.0	55.6	N/A	N/A	N/A	5.94	45	N/A	N/A	5.94
458B2	1993327.3	786497.0	54.7	N/A	0.49	28	5.34	42	N/A	N/A	5.94
458B3	1993301.0	786523.7	54.5	N/A	1.22	14	4.72	25	N/A	N/A	5.94
460B1	1993379.5	786497.7	56.3	0.3	N/A	N/A	5.34	35	N/A	N/A	5.64
460B2	1993352.5	786523.3	56.1	N/A	1.22	15	4.72	42	N/A	N/A	5.94
460B3	1993352.5	786545.9	55.2	0.61	N/A	N/A	5.34	39	N/A	N/A	5.94
TP-1683	1993351.1	786411.2	54.8	N/A	1.22	N/A	N/A	N/A	N/A	N/A	1.22
TP-1684	1993174.7	786457.5	49.9	N/A	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-1685	1993270.3	786559.5	53.7	N/A	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-1686	1993283.4	786198.9	51.6	N/A	1.22	N/A	N/A	N/A	N/A	N/A	1.22
TP-1687	1993165.0	786581.2	50.0	N/A	1.22	N/A	N/A	N/A	N/A	N/A	1.22
TP-9049	1993270.9	786170.6	50.9	0.15*	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-9050	1993167.6	786437.9	49.5	N/A	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-9051	1993296.8	786560.8	54.2	N/A	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-9052	1993124.2	786593.0	49.1	N/A	1.37	N/A	N/A	N/A	N/A	N/A	1.37
TP-9053	1993117.2	786696.0	48.5	N/A	1.22	N/A	N/A	N/A	N/A	N/A	1.22
TP-9054	1993280.8	786450.5	52.7	0.15*	N/A	N/A	N/A	N/A	N/A	N/A	0.76

Notes

1. N/A, Not Applicable
2. N-Value is the number of blows required for 12 inches (0.3048 m) penetratioon resistance of the soil
3. * Asphalt thickness

Table 2: Groundwater Summary Table													
Boring No.	0-Hr				24-Hr				48-Hr				
	Depth (m)	Caved/Dry	Elevation (m)	Date & Time	Depth (m)	Caved/Dry	Elevation (m)	Date & Time	Depth (m)	Caved/Dry	Elevation (m)	Date & Time	
300B1	4.94	-	45.43	2:15:00 PM 3/4/2020	5.03	-	45.34	8:00:00 AM 3/5/2020	-	-	-	-	-
302B1	5.49	-	46.93	9:10:00 AM 3/5/2020	5.24	-	47.18	9:10:00 AM 3/6/2020	-	-	-	-	-
304B1	5.39	-	43.21	3:35:00 PM 3/13/2020	-	-	-	- -	-	-	-	-	-
304B2*	0.94	-	46.77	3:32:00 PM 3/12/2020	0.94	-	46.77	8:00:00 AM 3/13/2020	-	-	-	-	-
304B3*	0.70	-	46.81	10:22:00 AM 3/9/2020	0.27	-	47.24	8:22:00 AM 3/10/2020	1.1	-	46.41	11:40:00 AM	3/11/2020
306B1	4.88	-	45.45	2:30:00 PM 5/20/2020	4.57	-	45.76	8:20:00 AM 5/21/2020	-	-	-	-	-
308B1	5.91	-	46.24	3:35:00 PM 3/12/2020	5.82	-	46.33	8:02:00 AM 3/13/2020	-	-	-	-	-
308B2	-	Dry	-	11:50:00 AM 5/18/2020	-	-	-	- -	-	-	-	-	-
308B3	-	Dry	-	1:00:00 PM 5/18/2020	4.85	-	46.06	1:00:00 PM 5/20/2020	-	-	-	-	-
310B1	-	Dry	-	8:24:00 AM 3/6/2020	-	5.36	41.89	7:40:00 AM 3/9/2020	-	-	-	-	-
310B2	-	Dry	-	11:20:00 AM 3/6/2020	-	4.69	41.84	7:52:00 AM 3/9/2020	-	-	-	-	-
310B3	-	Dry	-	9:15:00 AM 3/9/2020	-	4.94	41.55	8:36:00 AM 3/10/2020	-	-	-	-	-
312B1	4.57	-	44.11	1:38:00 PM 5/19/2020	3.51	-	45.17	1:00:00 PM 5/20/2020	-	-	-	-	-
314B1	4.57	-	45.10	12:15:00 PM 2/27/2020	3.66	-	46.01	8:20:00 AM 2/28/2020	-	-	-	-	-
316B1	5.76	-	44.96	3:00:00 PM 3/5/2020	4.39	-	46.33	8:00:00 AM 3/6/2020	-	-	-	-	-
318B1	-	Dry	-	8:44:00 AM 3/5/2020	-	Dry	-	9:02:00 AM 3/6/2020	-	-	-	-	-
318B2	4.57	-	47.88	1:38:00 PM 5/19/2020	3.51	-	48.94	1:00:00 PM 5/20/2020	-	-	-	-	-
318B3	5.36	-	46.42	11:30:00 AM 3/5/2020	-	5.15	-	8:50:00 AM 3/6/2020	-	-	-	-	-
320B1	-	3.99	43.59	1:15:00 AM 3/2/2020	-	-	-	- -	-	-	-	-	-
322B1	-	3.99	43.73	1:15:00 AM 3/2/2020	-	-	-	- -	-	-	-	-	-
324B1	4.54	-	44.31	9:40:00 AM 5/19/2020	4.27	-	44.58	11:00:00 AM 5/20/2020	-	-	-	-	-
326B1	4.91	-	45.32	11:00:00 AM 3/2/2020	4.27	-	45.96	7:45:00 AM 3/3/2020	-	-	-	-	-
328B1	4.57	-	45.05	1:30:00 AM 2/27/2020	-	4.42	45.20	8:35:00 AM 2/28/2020	-	-	-	-	-
330B1	4.57	-	45.60	11:00:00 AM 5/19/2020	4.27	-	45.90	1:00:00 PM 5/20/2020	-	-	-	-	-
332B1	-	Dry	-	8:30:00 AM 5/19/2020	4.85	-	43.12	1:00:00 PM 5/20/2020	-	-	-	-	-
334B1	-	Dry	-	3:00:00 PM 5/19/2020	4.48	-	43.21	8:00:00 AM 5/19/2020	-	-	-	-	-
440B1	-	Dry	-	1:15:00 PM 5/20/2020	-	Dry	-	8:00:00 AM 5/21/2020	-	-	-	-	-
442B1	4.27	-	47.43	3:00:00 PM 5/19/2020	4.94	-	46.76	11:00:00 AM 5/20/2020	-	-	-	-	-
444B1	-	-	-	- -	-	-	-	- -	-	-	-	-	-
446B1	-	Dry	-	3:30:00 AM 2/27/2020	-	4.60	45.64	8:15:00 AM 2/28/2020	-	-	-	-	-
448B1	5.49	-	46.05	12:30:00 PM 2/26/2020	-	Dry	-	7:15:00 AM 2/27/2020	-	-	-	-	-
450B1	-	Dry	-	2:00:00 PM 2/26/2020	4.48	-	46.09	7:15:00 AM 2/27/2020	-	-	-	-	-
450B2	-	Dry	-	1:18:00 PM 3/11/2020	-	-	-	- -	-	-	-	-	-
450B3	5.67	-	43.38	11:22:00 AM 3/9/2020	5.64	-	43.41	8:11:00 AM 3/10/2020	-	-	-	-	-
452B1	-	Dry	-	3:01:00 AM 3/12/2020	-	Dry	-	8:00:00 AM 3/13/2020	-	-	-	-	-
452B2	-	Dry	-	1:20:00 AM 3/11/2020	-	-	-	- -	-	-	-	-	-
452B3	-	5.03	45.25	3:00:00 PM 2/26/2020	4.82	-	45.46	7:30:00 AM 2/27/2020	-	-	-	-	-
454B1	-	4.69	48.73	12:05:00 AM 3/3/2020	-	-	-	- -	-	-	-	-	-
454B2	-	Dry	-	9:48:00 AM 3/11/2020	-	-	-	- -	-	-	-	-	-
454B3	5.46	-	45.64	8:57:00 AM 3/10/2020	5.12	-	45.98	8:45:00 AM 3/11/2020	-	-	-	-	-
456B1	-	Dry	-	3:32:00 PM 3/12/2013	-	Dry	-	8:15:00 AM 3/13/2020	-	-	-	-	-
456B2	5.88	-	47.62	10:58:00 AM 3/11/2020	5.30	-	48.20	8:17:00 AM 3/12/2020	-	-	-	-	-
456B3	-	5.49	47.67	11:30:00 AM 3/4/2020	-	-	-	- -	-	-	-	-	-
458B1	-	Dry	-	2:05:00 PM 3/3/2020	-	-	-	- -	-	-	-	-	-
458B2	-	Dry	-	3:18:00 PM 3/11/2020	-	-	-	- -	-	-	-	-	-
458B3	5.88	-	48.64	10:11:00 AM 3/10/2020	5.73	-	48.79	8:32:00 AM 3/11/2020	-	-	-	-	-
460B1	-	Dry	-	3:30:00 AM 3/3/2020	-	-	-	- -	-	-	-	-	-
460B2	-	Dry	-	12:32:00 PM 3/10/2020	-	-	-	- -	-	-	-	-	-
460B3	-	5.30	49.88	9:45:00 AM 3/4/2020	-	-	-	- -	-	-	-	-	-
TP-1683	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-1684	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-1685	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-1686	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-1687	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9049	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9050	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9051	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9052	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9053	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-
TP-9054	-	Dry	-	- 5/21/2020	-	-	-	- -	-	-	-	-	-

Notes

* A water line leak was reported in the general vicinity of the boring during reading events

Created By: DJS 8/6/20
Checked By: BD 8/6/20

Table 3 - Field Soil Resistivity Test Results				
Test ID	**Pin Spacing (ft)**	**Pin Spacing (m)**	**Resistance (ohm)**	**Resistivity (ohm*cm)**
FR-1	2.0	0.61	93	35,603
	4.0	1.22	30	22,970
	8.0	2.44	11	16,844
	16.0	4.88	9	27,564
FR-2	2.0	0.61	90	34,455
	4.0	1.22	38	29,095
	8.0	2.44	20	30,626
	16.0	4.88	8	24,501
FR-3	2.0	0.61	110	42,111
	4.0	1.22	35	26,798
	8.0	2.44	13	19,907
	16.0	4.88	6	18,376
FR-4	2.0	0.61	160	61,253
	4.0	1.22	56	42,877
	8.0	2.44	12	18,376
	16.0	4.88	9	27,564

Table 4 - USCS Soil Classification Test Results									
Test Boring	Depth (ft)	Depth (m)	USCS Description	USCS Group	Minus No. 200 Sieve (%)	LL	PL	PI	As-Received Moisture Content (%)
300B1	6.0-10.5	1.83-3.20	Silty Sand	SM	18.2	NP	NP	NP	10
300B1	12.0-16.5	3.66-5.03	Silty Sand	SM	19.1	NP	NP	NP	15
302B1	2.0-5.5	0.61-1.68	Silty Sand with Gravel	SM	17.3	NP	NP	NP	8
302B1	9.0-13.5	2.74-4.11	Silty Sand	SM	17.3	NP	NP	NP	12
304B1	0.0-1.5	0.00-0.46	Clayey Sand with Gravel	SC	48.7	46	21	25	12
304B1	2.0-5.5	0.61-1.68	Silty Sand	SM	14.5	NP	NP	NP	4
304B2	4.0-7.5	1.22-2.29	Silty Sand	SM	21.7	NP	NP	NP	12
304B2	12.0-16.5	3.66-5.03	Silty Sand	SM	26.7	NP	NP	NP	9
304B3	2.0-5.5	0.61-1.68	Silty Sand	SM	26.1	NP	NP	NP	12
304B3	9.0-13.5	2.74-4.11	Silty Sand	SM	34.2	NP	NP	NP	10
306B1	3.0-6.0	0.91-1.83	Silty Sand	SM	20.6	NP	NP	NP	6
306B1	6.0-9.0	1.83-2.74	Silty Sand	SM	18.7	NP	NP	NP	7
308B1	2.0-3.5	0.61-1.07	Silty Sand	SM	34.6	33	25	8	5
308B1	4.0-7.5	1.22-2.29	Silty Sand	SM	18.8	NP	NP	NP	5
308B2	2.0-6.0	0.61-1.83	Silty Sand	SM	23.5	NP	NP	NP	6
308B2	6.0-10.0	1.83-3.05	Silty Sand	SM	22.4	NP	NP	NP	5
308B3	4.5-7.5	1.37-2.29	Silty Sand	SM	21.4	NP	NP	NP	4
308B3	9.0-12.0	2.74-3.66	Silty Sand	SM	20.7	NP	NP	NP	8
310B1	0.0-3.5	0.00-1.07	Clayey Sand with Gravel	SC	36.2	37	18	19	8
310B1	4.0-7.5	1.22-2.29	Silty Sand with Gravel	SM	23.8	NP	NP	NP	4
310B2	4.0-7.5	1.22-2.29	Silty, Clayey Sand	SC-SM	24	26	20	6	5
310B2	9.0-16.5	2.74-5.03	Silty, Clayey Sand with Gravel	SC-SM	14.2	24	17	7	2
310B3	0.0-3.5	0.00-1.07	Clayey Sand with Gravel	SC	36.3	28	19	9	7
312B1	4.5-7.5	1.22-2.29	Silty Sand	SM	23.3	NP	NP	NP	13
314B1	4.0-7.5	1.22-2.29	Silty Sand	SM	17.1	NP	NP	NP	11
314B1	12.0-16.5	3.66-5.03	Silty Sand	SM	19.4	NP	NP	NP	15
316B1	4.0-7.5	1.22-2.29	Silty Sand	SM	17.9	NP	NP	NP	5
316B1	9.0-13.5	2.74-4.11	Silty Sand	SM	19.7	NP	NP	NP	7
318B1	2.0-5.5	0.61-1.68	Silty Sand	SM	43.6	35	29	6	14
318B1	9.0-13.5	2.74-4.11	Silty Sand	SM	18.4	NP	NP	NP	5
318B2	1.5-4.5	0.46-1.37	Silty Sand	SM	33.5	NP	NP	NP	7
318B2	6.0-9.0	1.83-2.74	Silty Sand	SM	26.3	NP	NP	NP	6
318B3	4.0-7.5	1.22-2.29	Silty Sand	SM	33.6	NP	NP	NP	8

Notes
LL=Liquid Limit of soil
PL=Plastic Limit of soil
PI=Plastic Index of soil (LL-PL=PI)
NP= Non Plastic soil

Table 4 - USCS Soil Classification Testing (cont.)									
Test Boring	Depth (ft)	Depth (m)	USCS Description	USCS Group	Minus No. 200 Sieve (%)	LL	PL	PI	As-Received Moisture Content (%)
318B3	12.0-16.5	3.66-5.03	Silty Sand	SM	12.7	NP	NP	NP	7
320B1	4.0-7.5	1.22-2.29	Silty Sand	SM	19.5	NP	NP	NP	9
322B1	2.0-5.5	0.61-1.68	Silty Clayey Sand	SC-SM	32.5	28	21	7	8
322B1	12.0-16.5	3.66-5.03	Silty Sand	SM	23.6	NP	NP	NP	10
324B1	3.0-6.0	0.91-1.83	Silty Sand	SM	33.1	31	25	6	13
324B1	7.5-10.5	2.29-3.20	Silty Sand	SM	12.7	NP	NP	NP	6
326B1	0.0-3.5	0.00-1.07	Silty Sand	SM	46.5	37	28	9	11
326B1	6.0-7.5	1.83-2.29	Silty Sand with Gravel	SM	14.8	NP	NP	NP	16
328B1	2.0-5.5	0.61-1.68	--	--	--	--	--	--	6
328B1	15.0-19.5	4.57-5.94	Silty Sand	SM	26.3	NP	NP	NP	8
330B1	3.0-6.0	0.91-1.83	Silty Sand	SM	49.6	NP	NP	NP	19
330B1	10.5-13.5	3.20-4.11	Silty Sand	SM	23.1	NP	NP	NP	11
332B1	6.0-9.0	1.83-2.74	Silty Sand	SM	22.9	NP	NP	NP	8
334B1	1.5-4.5	0.46-1.37	Silty Sand	SM	30.8	30	24	6	5
334B1	6.0-9.0	1.83-2.74	Silty Sand	SM	17.5	NP	NP	NP	2
440B1	3.0-6.0	0.91-1.83	Sandy Lean Clay	CL	50.7	35	24	11	13
440B1	7.5-10.5	2.29-3.20	Silty Sand with Gravel	SM	18.4	NP	NP	NP	6
442B1	4.5-7.5	1.37-2.29	Silty Sand with Gravel	SM	15.7	NP	NP	NP	7
442B1	9.0-12.0	2.74-3.66	Silty Sand with Gravel	SM	13.9	NP	NP	NP	6
444B1	2.0-5.5	0.61-1.68	Silty Sand with Gravel	--	16.1	--	--	--	7
444B1	6.0-10.5	1.83-3.20	Silty Clayey Sand	--	49.5	--	--	--	12
446B1	0.0-3.5	0.00-1.07	Silty Clayey Sand	--	48.8	--	--	--	10
446B1	9.0-13.5	2.74-4.11	Silty Clayey Sand	--	40.4	--	--	--	11
448B1	2.0-5.5	0.61-1.68	Silty Sand with Gravel	--	21.9	--	--	--	6
448B1	9.0-10.5	2.74-3.20	Silty Clayey Sand	--	48.7	--	--	--	18
450B1	4.0-7.5	1.22-2.29	Silty Clayey Sand	--	25.8	--	--	--	13
450B2	4.0-7.5	1.22-2.29	Silty Sand	SM	26.3	NP	NP	NP	10
450B2	9.0-13.5	2.74-4.11	Silty Sand	SM	31.3	31	25	6	11
450B3	0.0-3.5	0.00-1.07	Clayey Sand	SC	49.5	42	23	19	8
450B3	15.0-19.5	4.57-5.94	Silty Sand	SM	29.9	NP	NP	NP	21
452B1	2.0-5.5	0.61-1.68	Silty Sand	SM	21.5	NP	NP	NP	9
452B1	9.0-13.5	2.74-4.11	Silty Sand	SM	23	NP	NP	NP	10
452B2	4.0-7.5	1.22-2.29	Silty Sand	SM	18.5	NP	NP	NP	7
452B2	12.0-16.5	3.66-5.03	Silty Sand	SM	14.9	NP	NP	NP	7
452B3	9.0-13.5	2.74-4.11	Silty Clayey Sand	--	39.4	--	--	--	18

Notes
LL=Liquid Limit of soil
PL=Plastic Limit of soil
PI=Plastic Index of soil (LL-PL=PI)
NP= Non Plastic soil

Table 4 - USCS Soil Classification Testing (cont.)									
Test Boring	Depth (ft)	Depth (m)	USCS Description	USCS Group	Minus No. 200 Sieve (%)	LL	PL	PI	As-Received Moisture Content (%)
452B3	15.0-19.5	4.57-5.94	Silty Sand	--	18.8	--	--	--	13
454B1	0.0-3.5	0.00-1.07	Silty Sand with Gravel	SM	26.8	42	30	12	9
454B1	4.0-7.5	1.22-2.29	Silty Sand	SM	17.8	NP	NP	NP	6
454B2	2.0-5.5	0.61-1.68	Silty Sand	SM	26.5	NP	NP	NP	9
454B2	6.0-7.5	1.83-2.29	Silty Sand	SM	20.8	NP	NP	NP	7
454B3	4.0-7.5	1.83-2.29	Silty Sand	SM	20.5	NP	NP	NP	11
454B3	9.0-13.5	2.74-4.11	Silty Sand	SM	41.3	31	25	6	17
456B1	2.0-5.5	0.61-1.68	Silty Sand	SM	19.6	NP	NP	NP	6
456B1	9.0-13.5	2.74-4.11	Silty Sand	SM	18.8	NP	NP	NP	10
456B2	6.0-10.5	1.83-3.20	Silty Sand	SM	16.3	NP	NP	NP	7
456B2	15.0-19.5	4.57-5.94	Silty Sand	SM	19.9	NP	NP	NP	10
456B3	4.0-7.5	1.22-2.29	Silty Sand	SM	22.9	NP	NP	NP	10
456B3	9.0-13.5	2.74-4.11	Silty Sand	SM	18	NP	NP	NP	9
458B1	4.0-7.5	1.22-2.29	Silty Sand	SM	16.4	31	25	6	9
458B1	15.0-19.5	4.57-5.94	Silty Sand	SM	22.9	NP	NP	NP	9
458B2	2.0-5.5	0.61-1.68	Silty Sand	SM	22.3	NP	NP	NP	10
458B2	9.0-13.5	2.74-4.11	Silty Sand	SM	16.1	NP	NP	NP	6
458B3	0.0-3.5	0.00-1.07	Clayey Sand with Gravel	SC	48.8	35	21	14	12
458B3	6.0-10.5	1.83-3.20	Silty Sand	SM	19.3	NP	NP	NP	9
460B1	4.0-7.5	1.22-2.29	Silty Sand	--	17.3	--	--	--	9
460B1	9.0-10.5	2.74-3.20	Silty Sand	--	15.4	--	--	--	8
460B2	4.0-7.5	1.22-2.29	--	--	--	--	--	--	10
460B2	9.0-13.5	2.74-4.11	--	--	--	--	--	--	12
460B3	2.0-5.5	0.61-1.68	Silty Sand	SM	39.6	NP	NP	NP	11
460B3	6.0-7.5	1.83-2.29	Silty Sand	SM	19.3	NP	NP	NP	8
TP-1683	--	--	Silty Sand	SM	32.9	NP	NP	NP	11
TP-1684	--	--	Silty Sand	SM	28.8	NP	NP	NP	11
TP-1685	--	--	Sandy Lean Clay	CL	50.2	32	19	13	11
TP-1686	--	--	Clayey Sand with Gravel	SC	18.3	28	19	9	12
TP-1687	--	--	Silty Sand with Gravel	SM	18.7	NP	NP	NP	11
TP-9049	--	--	Clayey Sand with Gravel	SC	27.8	30	19	11	10
TP-9050	--	--	Silty Sand	SM	27.4	NP	NP	NP	11
TP-9051	--	--	Silty Sand	SM	37.4	NP	NP	NP	11
TP-9052	--	--	Silty Sand	SM	40.6	38	32	6	12
TP-9053	--	--	Sandy Silt with Gravel	ML	58.9	44	28	16	11

Notes
LL=Liquid Limit of soil
PL=Plastic Limit of soil
PI=Plastic Index of soil (LL-PL=PI)
NP= Non Plastic soil

Table 5 - Modified Proctor Test Results (Moisture - Density Relationship for Compaction)							
Test Pit	Sample Depth (ft)	Sample Depth (m)	Sample Type	Visual Description	Lab Optimum Moisture Content (%)	Lab Maximum Dry Density (pcf)	Lab Maximum Dry Density (kg/m^3)
TP-1683	1.0-4.0	0.30-1.22	Bag Sample	Silty Sand	11.5	127.1	2036.0
TP-1684	1.0-4.5	0.30-1.37	Bag Sample	Silty Sand	11.0	131.0	2098.4
TP-1685	2.5-4.5	0.76-1.37	Bag Sample	Sandy Lean Clay	13.0	114.3	1830.9
TP-1686	2.5-4.5	0.76-1.37	Bag Sample	Clayey Sand with Gravel	8.7	126.4	2024.7
TP-1687	1.5-4.0	0.46-1.22	Bag Sample	Silty Sand with Gravel	12.9	113.5	1818.1
TP-9049	1.0-4.5	0.30-1.37	Bag Sample	Clayey Sand with Gravel	10.5	124.2	1989.5
TP-9050	1.5-4.5	0.46-1.37	Bag Sample	Silty Sand	13.4	115.7	1853.3
TP-9051	2.0-4.5	0.61-1.37	Bag Sample	Silty Sand	13.3	124.2	1989.5
TP-9052	1.5-4.5	0.46-1.37	Bag Sample	Silty Sand	14.3	120.4	1928.6
TP-9053	1.0-4.0	0.30-1.22	Bag Sample	Sandy Silt with Gravel	16.3	105.9	1696.4

Table 6 - California Bearing Ratio (CBR) Test Results							
Test Pit	**Sample**	**Sample Depth (ft)**	**Sample Depth (m)**	**Compaction Effort**	**Dry Density (pcf)**	**Dry Density (kg/m^3)**	**CBR**
TP-1683	BULK	1.0-4.0	0.31-1.22	95	120.7	1933	2
				100	127.1	2036	7
TP-1684	BULK	1.0-4.5	0.31-1.37	95	124.5	1994	4
				100	131	2098	8
TP-1685	BULK	2.5-4.5	0.76-1.37	95	108.6	1740	2
				100	114.3	1831	4
TP-1686	BULK	2.5-4.5	0.76-1.37	95	120.1	1924	2
				100	126.4	2025	22
TP-1687	BULK	1.5-4.0	0.46-1.22	95	107.8	1727	5
				100	113.5	1818	11
TP-9049	BULK	1.0-4.5	0.31-1.37	95	118	1890	8
				100	124.2	1989	10
TP-9050	BULK	1.5-4.5	0.46-1.37	95	109.9	1760	18.0
				100	115.7	1853	30.0
TP-9051	BULK	2.0-4.5	0.61-1.37	95	118	1890	7
				100	124.2	1989	12
TP-9052	BULK	1.5-4.5	0.46-1.37	95	114.4	1833	3
				100	120.4	1929	4
TP-9053	BULK	1.0-4.0	0.31-1.22	95	100.6	1611	3
				100	105.9	1696	3

Table 7 - Soil Chemistry Test Results										
Lab Test	**Test Pit (TP-1683)**	**Test Pit (TP-1684)**	**Test Pit (TP-1685)**	**Test Pit (TP-1686)**	**Test Pit (TP-1687)**	**Test Pit (TP-9049)**	**Test Pit (TP-9050)**	**Test Pit (TP-9051)**	**Test Pit (TP-9052)**	**Test Pit (TP-9053)**
Sample	BULK	BULK	BULK	BULK	BULK	BULK	BULK	BULK	BULK	BULK
Depth (ft)	1.0-4.0	1.0-4.5	2.5-4.5	2.5-4.5	1.5-4.0	1.0-4.5	1.5-4.5	2.0-4.5	1.5-4.5	1.0-4.0
Depth (m)	0.31-1.22	0.31-1.37	0.76-1.37	0.76-1.37	0.46-1.22	0.31-1.37	0.46-1.37	0.61-1.37	0.46-1.37	0.31-1.22
Total Solids (%)	93.1	--	87.6	--	--	90.2	91.1	--	--	88
Total Phosphorus (%)	59.6	--	204	--	--	314.0	183	--	--	298
Boron (mg/Kg)	110	--	82.7	--	--	107	83.6	--	--	99
Calcium (mg/Kg)	28995	--	18353	--	--	17418	91902	--	--	32935
Copper (mg/Kg)	109	--	52.8	--	--	68	33.1	--	--	49.9
Iron (mg/Kg)	38505	--	31990	--	--	38218	26317	--	--	33433
Magnesium (mg/Kg)	34976	--	12259	--	--	9168	41829	--	--	20687
Manganese (mg/Kg)	624	--	663	--	--	640	628	--	--	449
Potassium (mg/Kg)	1316	--	1738	--	--	2649	722	--	--	1836
Zinc (mg/Kg)	59.7	--	72.2	--	--	73.7	46.2	--	--	71.4
Humidity (%)	6.9	--	12.4	--	--	9.8	8.9	--	--	12
Chloride (mg/Kg)	102	1300	108	63.2	35.6	63.5	24.6	87.3	600	76.2
Sulfate (mg/Kg)	24.1	502	166	31.9	14.7	34.6	12.3	46.3	581	36.1
pH in Water	7.3	--	7.3	--	--	7.7	7.9	--	--	7.8
pH in Calcium Chloride	7.1	--	7.2	--	--	7.6	7.8	--	--	7.7

Table 8 - Organic Content Test Results				
Test Pit	**Sample**	**Depth (ft)**	**Depth (m)**	**Organic Content (%)**
TP-1683	BULK	1.0-4.0	0.31-1.22	4
TP-1684	BULK	1.0-4.5	0.31-1.37	6.6
TP-1685	BULK	2.5-4.5	0.76-1.37	4.9
TP-1686	BULK	2.5-4.5	0.76-1.37	5.1
TP-1687	BULK	1.5-4.0	0.46-1.22	6.5
TP-9049	BULK	1.0-4.5	0.31-1.37	3.5
TP-9050	BULK	1.5-4.5	0.46-1.37	6.4
TP-9051	BULK	2.0-4.5	0.61-1.37	7
TP-9052	BULK	1.5-4.5	0.46-1.37	7.4
TP-9053	BULK	1.0-4.0	0.31-1.22	8.3

Table 9 - Carbonate Content Test Results				
Test Pit	**Sample**	**Depth (ft)**	**Depth (m)**	**Calcite Equivalent (%)**
TP-1687	BULK	1.5 - 4.0	0.46-1.22	11
TP- 9049	BULK	1.0-4.5	0.31-1.37	1
TP- 9050	BULK	1.5-4.5	0.46-1.37	31
TP- 9051	BULK	2.0-4.5	0.61-1.37	19
TP-9052	BULK	1.5-4.5	0.46-1.37	17
TP- 9053	BULK	1.0-4.0	0.31-1.22	4

Table 10 - Collapsible Potential of Soil Test Results								
Test Pit	Sample	Intial Height (in)	Initial Heoght (cm)	Final Height (in)	Final Height (cm)	Intial Void Ratio	Final Void Ratio	Collapse Potential (%)[1]
TP-1687	BULK	1	2.54	0.95	2.41	0.559	0.481	1.4%
TP-9049	BULK	1	2.54	0.93	2.36	0.542	0.434	2.1%
TP-9050	BULK	1	2.54	0.82	2.08	0.843	0.511	3.3%
TP-9051	BULK	1	2.54	0.91	2.31	0.58	0.438	0.8%
TP-9052	BULK	1	2.54	0.95	2.41	0.658	0.575	0.1%
TP-9053	BULK	1	2.54	0.90	2.29	0.778	0.600	1.8%
(1) Measured at an applied stress of 2 tsf, based on Eqn presented in UFC 3-20-10N Figure 6								

Table 11 - Unit Weight Test Results								
Test Pit	Sample	Depth (ft)	Depth (m)	Bulk Density (pcf)	Bulk Density (kg/m^3)	Moisture Content (%)	Dry Density (pcf)	Dry Density (kg/m^3)
TP-1687	BULK	1.5-4.0	0.46-1.22	91.3	1,462	3.5	88.2	1,413
TP-9049	BULK	1.0-4.5	0.30-1.37	98.3	1,574	3.0	95.5	1,529
TP-9050	BULK	1.5-4.5	0.46-1.37	93.5	1,498	3.8	90.1	1,444
TP-9051	BULK	2.0-4.5	0.61-1.37	99.3	1,590	4.1	95.4	1,528
TP-9052	BULK	1.5-4.5	0.46-1.37	93.3	1,494	4.2	89.5	1,434
TP-9053	BULK	1.0-4.0	0.30-1.22	85.8	1,374	4.2	82.3	1,319

Table 12 - STRUCTURE INFORMATION SUMMARY TABLE										
Structure ID	Structure Description	Number of Proposed Buildings	Loading Information							
			Dead Load (DL)	Live Load (LL)	Roof Live Load (RLL0	Seismic Shear Load	Seismic Moment	Wind Uplift Load	Wind Shear Load	Wind Moment
---			(kips)	(kips)	(kips)	(kips)	(kip-ft)	(kips)	(kips)	(kip-ft)
Barracks	Two Story Barracks Buildings	10	181	23	19.0	23.0	241	--	15.0	148.0
Canopy	Canopy at HQ6	1	2.3	--	1.3	3.8	--	--	3.8	--
DFAC	One-Story Dining Facilities	2	9.2	--	6.3	3.3	--	--	1.3	--
HQ	One-Story Headquarters, Administrative and Supply Buildings	13	9.2	--	6.3	3.4	--	--	2.3	--
HQ5		3	23	--	19.0	Not controlling		37.2	10.8	--

Table 13 - SHALLOW FOUNDATION RECOMMENDATIONS SUMMARY TABLE											
Structure ID	Shallow Spread Footing Embedment Depth below Grade[3]		Minimum Spread Footing Size		Allowable Soil Bearing Capacity[8][9]		Maximum Allowable Foundation Contact Pressure[8][9]		Settlement[10]		Coefficient of Friction for Sliding
---	(ft)	(m)	(ft)	(m)	(ksf)	(kPa)	(ksf)	(kPa)	(in)	(mm)	(--)
Barracks (Buildings 304, 308, 310, 318, 450, 452, 454, 456)	3.0	0.9	8x8[4]	2.5x2.5	5.3	254	6.5	311	0.8	20.3	0.45
Barracks (Buildings 458 & 460)	3.0	0.9	9x9[7]	2.7x2.7	5.6	268	6.8	326	1.0	25.4	0.45
Canopy[1]	3.0	0.9	13.5x37 [5]	4.1x11.3	6.9	330	--	--	<0.1	<2.5	0.45
DFAC[2]	3.0	0.9	4.5 wide[6]	1.4 wide	5.5	263	--	--	0.9	22.9	0.45
HQ[2] (Buildings 306 to 330)	3.0	0.9	5.5 wide[6]	1.7 wide	4.7	225	--	--	0.8	20.3	0.45
HQ[2] (Buildings 440 to 446)	4.0	1.2	9 wide[7]	2.7 wide	5.1	244	--	--	1.0	25.4	0.45
	5.0	1.5	8 wide[7]	2.4 wide	5.6	268	--	--	1.0	25.4	0.45

Notes:

1. Canopy structure foundation consists of a mat
2. HQ and DFAC structure foundations consist of strip footings
3. Minimum footing embedment
4. Governed by bearing capacity
5. Foundation size was given (HQ6 95% Drawings)
6. Governed by sliding resistance
7. Governed by settlement
8. Allowable bearing capacity is based on an equivalent uniform bearing pressure over the effective footing width; where moments are imposed on a footing, it is possible to have foundation contact pressures that exceed the allowable bearing pressure. Therefore, the maximum allowable contact pressure at the toe of the footing was also calculated, where applicable, to provide additional design guidance.
9. Allowable bearing capacity and maximum foundation contact pressure are based on the minimum spread footing sizes provided in this table.
10. Settlement calculated considering the bearing pressure induced on the proposed footing size for the maximum load case
11. Subgrade material at all foundation locations consists of soil, generally ranging from medium-dense to dense granular material (SM - silty sand).

Table 14 - DEEP FOUNDATION RECOMMENDATIONS SUMMARY TABLE													
Structure ID	Foundation Type	Outside Diameter		Wall Thickness		Pile Length[1]		Maximum Allowable Axial Capacity per pile[2]		Maximum Allowable Uplift Resistance per pile[2]		Maximum Allowable Shear Load per pile[3][4][5]	
---	---	(in)	(mm)	(in)	(mm)	(ft)	(m)	(kips)	(metric ton)	(kips)	(metric ton)	(kips)	(metric ton)
HQ5	Pipe Pile	12	304.8	0.375	9.5	15	4.6	29.1	13.2	5.7	2.6	--	--
						20	6.1	39.9	18.1	12	5.4	11.3	5.1
						25	7.6	49.8	22.6	18.1	8.2	--	--

Notes:

1. Pile length is measured from the bottom of the pile cap (El. 50 m)
2. Assuming minimum pile spacing of 3 pile diameters (i.e. no group effects)
3. No P-Multiplier (group reduction factor) was considered - for pile spacing less than 5 pile diameters a P-Multiplier must be applied
4. Pinned pile head condition was assumed in the Lpile analysis
5. Shear load for a single pile resulting in target pile head deflection equal to 0.5 inches
6. Subgrade material at all foundation locations consists of soil, generally ranging from medium-dense to dense granular material (SM - silty sand).

Table 15 - LIQUEFACTION ANALYSES SUMMARY TABLE

Area	Groundwater Table		Boring	Structure Type	Maximum Design Earthquake (M_w=7.7)				Estimated Mean Design Earthquake (M_w=6.5)			
					Liquifiable Layer		Liquefaction Induced Settlement		Liquifiable Layer		Liquefaction Induced Settlement	
	(ft-bgs)	(m-bgs)			(ft-bgs)	(m-bgs)	(in)	(mm)	(ft-bgs)	(m-bgs)	(in)	(mm)
NW Corner	16.0	4.9	448B1	HQ5	--	--	0.0	0.0	--	--	0.0	0.0
			442B1	HQ	--	--	0.0	0.0	--	--	0.0	0.0
			444B1	HQ	13.5-19.5	4.1-5.9	1.3	33.0	13.5-19.5	4.1-5.9	1.3	33.0
			446B1	HQ	--	--	0.0	0.0	--	--	0.0	0.0
			440B1	HQ	--	--	0.0	0.0	--	--	0.0	0.0
Central Area	11.5	3.5	452B1	Barracks	--	--	0.0	0.0	--	--	0.0	0.0
			452B3	Barracks	--	--	0.0	0.0	--	--	0.0	0.0
			454B3	Barracks	13.5-16.5	4.1-5.0	0.5	13.7	--	--	0.0	0.0
			458B3	Barracks	10.5-13.5	3.2-4.1	0.4	9.1	--	--	0.0	0.0
			302B1	DFAC	13.5-19.5	4.1-5.9	1.1	28.4	16.5-19.5	5.0-5.9	0.6	16.0
			306B1	HQ	--	--	0.0	0.0	--	--	0.0	0.0
SE Corner	13.0	4.0	330B1	HQ	--	--	0.0	0.0	--	--	0.0	0.0

Notes:

M_w = Design Earthquake Magnitude

Michael Baker
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ATTACHMENT 1
Client Provided Information

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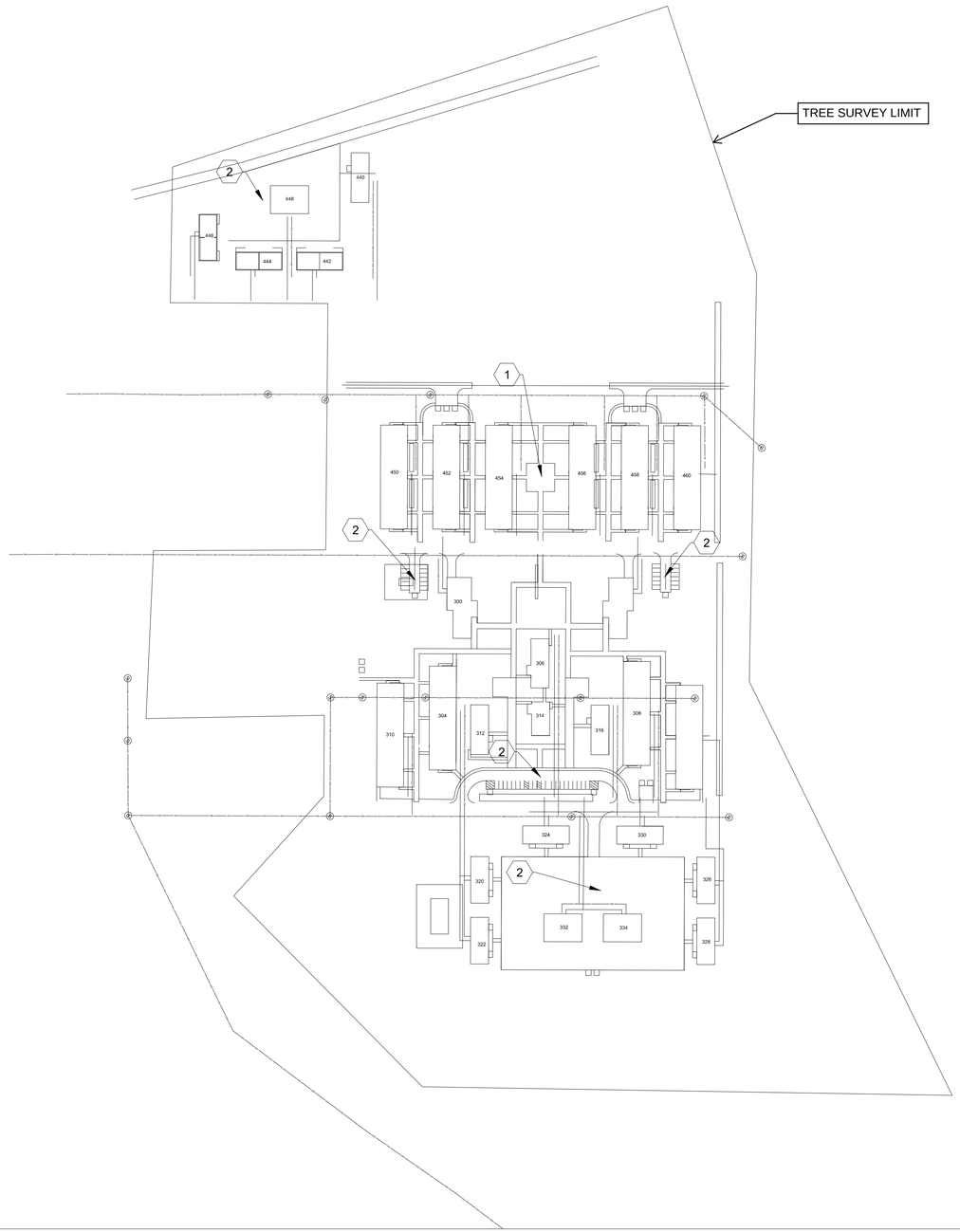
Building Layout



PLAN NORTH

A1 OVERALL SITE AND KEY PLAN
SCALE: 1:2000

POINT TABLE

No.	NORTHING	EASTING	ELEVATION	DESCRIPTIONS
1	1,992,961.74	786,217.72	45.04	CP AM1
2	1,993,011.87	786,176.81	45.86	CP AM2
3	1,993,040.93	786,108.89	46.23	CP AM3
5	1,993,125.52	786,102.02	48.06	CP AM5
6	1,993,140.08	786,116.72	48.39	CP AM6
7	1,993,192.45	786,168.88	49.86	CP AM7
8	1,993,247.20	786,223.70	51.37	CP AM8
9	1,993,262.61	786,263.70	52.00	CP AM9
10	1,993,227.37	786,310.30	50.86	CP AM10
11	1,993,191.07	786,349.81	49.44	CP AM11
12	1,993,137.12	786,383.54	47.80	CP AM12
13	1,993,081.59	786,327.74	47.44	CP AM13
14	1,993,050.70	786,295.95	48.06	CP AM14
15	1,992,982.98	786,226.94	45.71	CP AM15
16	1,993,039.39	786,210.34	46.40	CP AM16
17	1,993,086.41	786,256.32	47.77	CP AM17
18	1,993,103.44	786,273.36	48.09	CP AM18
24	1,993,029.27	786,201.28	46.17	CP AM24
51	1,993,350.81	786,573.23	56.82	BM USACE1
52	1,993,204.72	786,699.06	52.09	BM USACE2
53	1,993,297.45	786,612.38	54.65	BM USACE3
54	1,993,105.80	786,420.66	47.05	BM USACE4
55	1,993,464.52	786,442.50	59.72	BM USACE5
56	1,993,501.43	786,434.19	61.41	BM USACE6
57	1,993,307.69	786,215.70	52.31	BM USACE7
61	1,993,148.35	787,024.51	50.02	CP BB01
62	1,993,148.78	787,024.39	50.04	CP BB02
63	1,993,076.37	786,582.08	47.89	CP BIDOT12972
64	1,993,081.60	786,574.50	47.90	CP724

GENERAL SHEET NOTES

1. SURVEY TO BE REFERENCED TO UTM,WGS84 ZONE 19N DATUM. ELEVATIONS TO BE REFERENCED TO NAVD27
2. SURVEY ALL EXISTING FENCES AND GRADE CHANGE BREAK LINES TO 10 METERS OUTSIDE OF OUTER FENCE.
3. SURVEY ALL FEATURES ON THE NORTH EAST FENCE LINE TO INCLUDE NATURAL DRAIN TO LEFT TOP OF BANK FOR STORM WATER MANAGEMENT, INDIVIDUAL TREES AND SHRUBS DO NOT NEED TO BE LOCATED.
4. SURVEY ALL BUILDING OUTLINES AND FINISHED FLOOR ELEVATIONS.
5. SURVEY ALL ASPHALT OUTLINES AND AND CENTERLINES.
6. SURVEY ALL BREAK LINES FOR EARTH COVERED BUNKERS.
7. LOCATE ALL UTILITIES WITHIN SURVEY LIMITS TO INCLUDE ALL POLES, VALVES, HAND HOLES AND STRUCTURES.

SHEET KEYNOTES

1. PERCOLATION TEST
2. PAVEMENT TEST PITS
3. NEW SEWAGE LINE TEST PITS

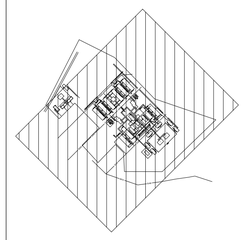
LEGEND

1. NOTE 1
2. NOTE 2
3. NOTE 3

CALLOUTS

1. NOTE 1
2. NOTE 2
3. NOTE 3

KEY PLAN



DIM. NOTE AND NORTH

DIMENSIONS SHOWN ARE IN METERS
UNLESS OTHERWISE NOTED.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. FISCHER
DRAWN BY: J. COON
CHECKED BY: J. CHECKER
SUBMITTED BY: J. SUBMITTER
ISSUE DATE: 11 OCT 19
SOLICITATION NO.: SOL
CONTRACT NO.: CONTR
PLOT DATE: 15 Feb 20 07:50:57
FILE NAME: PR-1901-C-002GN.dwg
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U.S. ARMY CORPS OF ENGINEERS
MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

CAMP SANTIAGO, PUERTO RICO
JOINT TRAINING CENTER
PR-1901

SITE DESIGN
OVERALL SITE AND KEY PLAN

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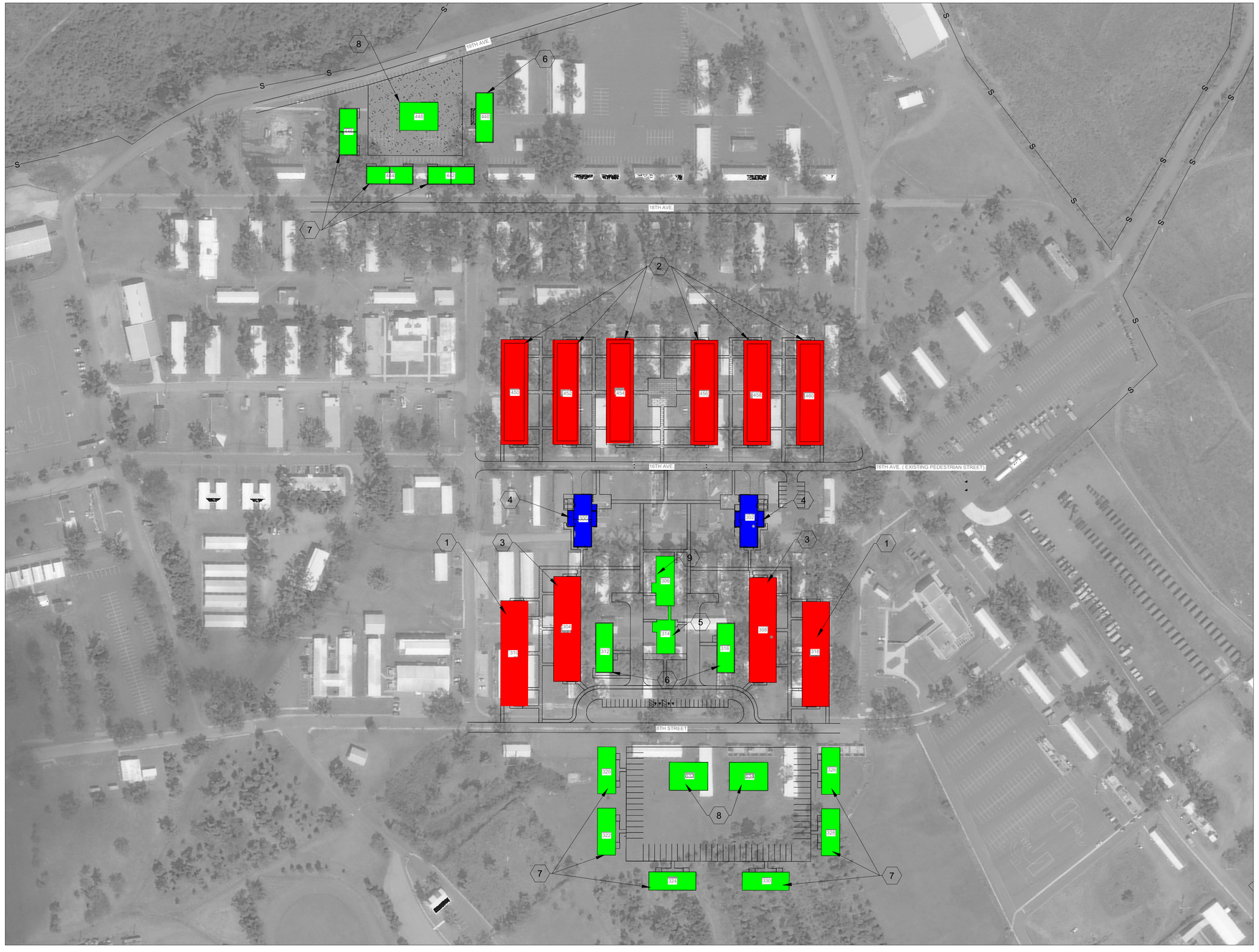
19TH AVE
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16TH AVE
16TH AVE. (EXISTING PEDESTRIAN STREET)
15TH STREET
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Foundation Loads

PR1901 - Maximum Reactions to Foundation

Building	Vetical Loads			Lateral Loads					Remarks
				Seismic loads		Wind Load			
	DL	LL	RLL	Shear	Moment	Uplift	Shear	Moment	
Barracks	181 kip	23 kip	19 kip	23 kip	241 kip*ft	-	15 kip	148 kip*ft	Concrete moment frames
DFAC	9.2 klf	-	6.3 klf	3.3 klf	-	-	1.3 klf	-	Concrete bearing walls
HQs	9.2 klf	-	6.3 klf	3.4 klf	-	-	2.3 klf	-	Concrete bearing walls
HQ5	23.0 kip	-	19.0 kip	Not control		62.0 kip	18.0 kip		Steel PEB frames
Canopy	2.3 kip	-	1.3 kip	3.8 kip	-	-	3.8 kip	-	Steel moment frame

Notes:
- All loads are unfactored.

Dorn, Stacey

From: Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>
Sent: Thursday, August 6, 2020 12:47 PM
To: Muller, Lois
Cc: Miles, Mark; Billings, Mary A CIV USARMY CETAM (USA); Anderson, Tara D CIV USARMY CETAM (USA); Gates, Stephanie C CIV USARMY CETAM (USA); Davis, Brian; Myer, Garrison W CIV USARMY CETAM (US); Fischer, Russell G CIV USARMY CETAM (USA); Burden, Denard M CIV USARMY CETAM (USA); Dorn, Stacey; Aljuboori, Mohammed CIV USARMY CENAP (USA); Delgado-Velez, Nestor J CIV USARMY CENAP (USA)
Subject: EXTERNAL: RE: HQ5 Loading Questions for Foundation Analyses/Design

Lois,

Shear loading is equal to 0.6*18 kips = 10.8 kips at service level.

Please let us know if you have additional questions/concern.

V/r,
Tu

Tu M. Ha, P.E., S.E.
Structural Engineer
USACE - Philadelphia District
Office: 215-656-6486
Cell: 714-657-5760

-----Original Message-----
From: Muller, Lois <Lmuller@mbakerintl.com>
Sent: Thursday, August 6, 2020 12:37 PM
To: Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>
Cc: Miles, Mark <Mark.Miles@mbakerintl.com>; Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>; Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>; Aljuboori, Mohammed CIV USARMY CENAP (USA) <Mohammed.Aljuboori@usace.army.mil>; Delgado-Velez, Nestor J CIV USARMY CENAP (USA) <Nestor.J.Delgado@usace.army.mil>
Subject: [Non-DoD Source] FW: HQ5 Loading Questions for Foundation Analyses/Design

Good Afternoon Tu,

Based on the clarification provided in the response regarding the wind uplift loading at the HQ5 structure, our Engineers have a related follow-up question:

What is the service level wind shear loading at HQ5 - 18 kips, or some lower value?

V/R,
Lois

Lois Muller, P.E., PMP | Vice President | Michael Baker International
100 Airside Drive, Airside Business Park | Moon Township, PA 15108 | [O] 412-269-6115 | [M] 412-302-5767 lmuller@mbakerintl.com |
Blockedhttp://www.mbakerintl.com/

-----Original Message-----
From: Muller, Lois <Lmuller@mbakerintl.com>
Sent: Thursday, August 6, 2020 8:43 AM
To: Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>; Aljuboori, Mohammed CIV USARMY CENAP (USA) <Mohammed.Aljuboori@usace.army.mil>; Delgado-Velez, Nestor J CIV USARMY CENAP (USA) <Nestor.J.Delgado@usace.army.mil>
Subject: RE: HQ5 Loading Questions for Foundation Analyses/Design

Good morning Tu,

Thank you for the detailed response. Hopefully, no more questions from our Engineers, but we'll see as they proceed further with the analyses.

We appreciate your collaboration and consideration as well!
Lois

Lois Muller, P.E., PMP | Vice President | Michael Baker International
100 Airside Drive, Airside Business Park | Moon Township, PA 15108 | [O] 412-269-6115 | [M] 412-302-5767 lmuller@mbakerintl.com |
Blockedhttp://www.mbakerintl.com/

-----Original Message-----
From: Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>

Sent: Thursday, August 06, 2020 8:18 AM
To: Muller, Lois <Lmuller@mbakerintl.com>; Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>; Aljuboori, Mohammed CIV USARMY CENAP (USA) <Mohammed.Aljuboori@usace.army.mil>; Delgado-Velez, Nestor J CIV USARMY CENAP (USA) <Nestor.J.Delgado@usace.army.mil>
Subject: RE: EXTERNAL: RE: HQ5 Loading Questions for Foundation Analyses/Design

Good morning, Lois,

(+ Moe and Nestor)

Thank you for quick response.

1. The high wind uplift (62 kips) at two columns at E1 & E5 is at strength level. The net uplift at these columns is 0.6*DL + 0.6*WL = 0.6*(- 23 kips) + 0.6*(62 kips) = 23.4 kips at service level.

2. Based on the preliminary recommendations, the soil at the site is good, where the allowable soil bearing capacity is equal to 3.4 ksf at 3' below grade.

3. HQ5 is a PEB. Using hairpins to tie the columns to concrete slab has become an acceptable solution to resist lateral load for PEB projects. Of course, there are other ways to design lateral forces for foundation of PEB projects. It is depending the soil condition. Note that the 12" thick slab on grade at HQ5 is a structural slab which is designed to carry 32 kips axle loads.

4. NAP structural team does not concur or reject Geotech recommendations. We will accept Geotech recommendations as the most suitable solution and design the foundation accordingly.

Please keep working to complete the draft soil report on schedule (Aug 14) and let us know if you need any additional information from the design team. We are looking forward to the soil report so that we can update our calculations and drawings.

We appreciate your consideration!

V/R,
Tu

Tu M. Ha, P.E., S.E.
Structural Engineer
USACE - Philadelphia District

Office: 215-656-6486
Cell: 714-657-5760

-----Original Message-----
From: Muller, Lois <Lmuller@mbakerintl.com>
Sent: Wednesday, August 5, 2020 3:53 PM
To: Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>
Subject: [Non-DoD Source] RE: EXTERNAL: RE: HQ5 Loading Questions for Foundation Analyses/Design

Good afternoon Mary & Tara,

Our Geotech engineers have one more question to clarify the information provided this morning: The loadings provided were indicated below as "strength level/unfactored". We are unfamiliar with the two terms used in this fashion. Would it be correct to indicate the loads as SERVICE level/unfactored?

Based on the information provided, our intended course of action at the HQ5 structure is:

1. Recommend driven pipe piles to resist the foundation loadings (tentative diameter 12", pending further analyses)

2. Continue our analyses to design these piles to resist both uplift loading and lateral loading

3. We do NOT recommend a design approach that considers the piling to only resist the uplift loading, with the lateral loading resisted by the footing/pile cap. It is noted in particular that the design loadings involve simultaneous incidence of uplift and lateral load; this would significantly limit the frictional sliding resistance capacity of the footing/pile cap during this loading event.

4. Noting the relatively short lengths of piling anticipated (approximately 25 feet), we do NOT intend to perform a WEAP analysis and/or other driveability evaluations for the piles.

5. Consistent with the above, we will be recommending separate/independent foundations for the columns at this structure (i.e., non-integral floor slab)

If we can receive prompt concurrence that the above proposed course of action is acceptable, we will be able to include the HQ5 building analyses and recommendations in the Aug 14 draft report schedule.

V/R,
Lois

Lois Muller, P.E., PMP | Vice President | Michael Baker International
100 Airside Drive, Airside Business Park | Moon Township, PA 15108 | [O] 412-269-6115 | [M] 412-302-5767 lmuller@mbakerintl.com |
BlockedBlockedhttp://www.mbakerintl.com/

-----Original Message-----
From: Muller, Lois
Sent: Wednesday, August 05, 2020 7:23 AM
To: Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>
Subject: RE: EXTERNAL: RE: HQ5 Loading Questions for Foundation Analyses/Design

Good Morning Mary,

Thank you for the prompt answers to yesterday afternoon's questions on HQ5 loads and foundation design drawings.

Our Geotechnical Engineers will review and let you know if there are any follow-up questions; and a better completion schedule estimate for the deep foundation analyses/design.

V/R,
Lois

Lois Muller, P.E., PMP | Vice President | Michael Baker International
100 Airside Drive, Airside Business Park | Moon Township, PA 15108 | [O] 412-269-6115 | [M] 412-302-5767 lmuller@mbakerintl.com |
BlockedBlockedhttp://www.mbakerintl.com/

-----Original Message-----
From: Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>
Sent: Wednesday, August 05, 2020 6:46 AM
To: Muller, Lois <Lmuller@mbakerintl.com>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>

Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>
Subject: EXTERNAL: RE: HQ5 Loading Questions for Foundation Analyses/Design

Morning, Lois,

Regarding Question #1:

The maximum values of 62 kips for uplift and 18 kips for shear occur simultaneously at columns E1 and E5. The rest of the columns will experience lower magnitudes of uplift and shear:

Columns D1 & D5 = 31.8kip uplift and 14.2kip shear

Columns D2.8 & D3.6 (above and below gridline 3) = 50.9kip uplift and 13.5kip shear

Columns at A1 & A5 = 22kip uplift and 9.3kip shear

Note that all forces are at strength level (unfactored).

Regarding Question #2:

The structural slab on grade with integral thickened slab wasn't designed for uplift since we were waiting for the geotechnical report to make any adjustments/updates based on the recommendations. The slab/foundations will be modified as required to accommodate the recommended pile/spread footings.

v/r,
Mary A. Billings, P.E., PMI-RMP, LEED BD+C Structural Engineer Middle East District U.S. Army Corps of Engineers
Office: (540) 665-2686
Cell: (540) 551-2806
Telework: (540) 250-0004, 0630-1500

-----Original Message-----
From: Muller, Lois <Lmuller@mbakerintl.com>
Sent: Tuesday, August 4, 2020 12:59 PM

To: Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>
Subject: [Non-DoD Source] RE: HQ5 Loading Questions for Foundation Analyses/Design

Good afternoon Mary,

Our Geotechnical Engineers appreciate the 95% drawings received yesterday after our conference call and have reviewed them in support of the foundation analyses for HQ 5:

1. Regarding wind loadings of this structure, please identify what combination of uplift and shear forces acts on which columns simultaneously.

For example:

-Does the full magnitude of both uplift and shear design forces act on each of columns A1, C1, D1 and E1 simultaneously?

-Would there be similar forces in A5, C5, D5 and E5 at the same time?

2. The thickened slab edge with integral floor slab foundation arrangement shown on the details for these 95% drawings does not appear to anticipate significant uplift force imparted by the column (whether or not piling is incorporated). For example, the integral connection of the 12" slab to the thickened edge slab would likely be susceptible to cracking. Has this type of foundation/slab arrangement been used successfully for this type of structure, with its associated loadings, on other sites?

If these can be answered as soon as possible it will help keep our foundation analyses moving along in the right direction.

V/R,

Lois

Lois Muller, P.E., PMP | Vice President | Michael Baker International
100 Airside Drive, Airside Business Park | Moon Township, PA 15108 | [O] 412-269-6115 | [M] 412-302-5767 lmuller@mbakerintl.com
<mailto:lmuller@mbakerintl.com> | BlockedBlockedBlockedhttp://www.mbakerintl.com/ <BlockedBlockedBlockedhttp://www.mbakerintl.com/>

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<BlockedBlockedBlockedhttp://projects.mbakercorp.com/sigimg/MBI-email-sig-Base_72dpi.png>

-----Original Message-----
From: Billings, Mary A CIV USARMY CETAM (USA) <Mary.A.Billings@usace.army.mil>
Sent: Monday, August 03, 2020 3:39 PM
To: Muller, Lois <Lmuller@mbakerintl.com>; Anderson, Tara D CIV USARMY CETAM (USA) <tara.d.anderson@usace.army.mil>
Cc: Gates, Stephanie C CIV USARMY CETAM (USA) <Stephanie.C.Gates@usace.army.mil>; Ha, Tu M CIV USARMY CENAP (USA) <Tu.M.Ha@usace.army.mil>; Miles, Mark <Mark.Miles@mbakerintl.com>; Davis, Brian <BDavis@mbakerintl.com>; Myer, Garrison W CIV USARMY CETAM (US) <Garrison.W.Myer@usace.army.mil>; Fischer, Russell G CIV USARMY CETAM (USA) <Russell.G.Fischer@usace.army.mil>; Burden, Denard M CIV USARMY CETAM (USA) <Denard.M.Burden@usace.army.mil>; Dorn, Stacey <Stacey.Dorn@mbakerintl.com>
Subject: RE: EXTERNAL: RE: Responses to Questions: PRARNG-JTC Preliminary Geotech Report

Lois,

Draft 95% drawings for HQ5 and HQ6 are attached for your use.

v/r,

Mary A. Billings, P.E., PMI-RMP, LEED BD+C Structural Engineer Middle East District U.S. Army Corps of Engineers

Office: (540) 665-2686

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Design Drawings

STRUCTURAL ABBREVIATIONS

#	NUMBER
&	AND
=	EQUAL, EQUALS
@	AT
A/C	AIR CONDITIONING
AB	ANCHOR BOLT
ACI	AMERICAN CONCRETE INSTITUTE
ADDL	ADDITIONAL
ADJ	ADJACENT
AFF	ABOVE FINISEHD FLOOR
AH, AHU	AIR HANDLING UNIT
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
ALT	ALTERNATE
APA	AMERICAN PLYWOOD ASSOCIATION
APPROX	APPROXIMATELY
ARCH	ARCHITECTURAL
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
AT/FP	ANTI-TERRORISM/ FORCE PROTECTION
AWS	AMERICAN WELDING SOCIETY
BET	BETWEEN
BLW	BELOW
BM	BEAM
BN	BOUNDARY NAIL
BOF	BOTTOM OF FOOTING
BOT	BOTTOM
BRG	BEARING
C	CHANNEL
CE	CARBON EQUIVALENT
CENT	CENTERED
CFMF	COLD-FORMED METAL FRAMING
CFS	COLD-FORMED STEEL
CIP	CAST IN PLACE
CJ	CONTROL JOINT/CEILING JOIST
CJP	COMPLETE JOINT PENETRATION
CL	CENTERLINE
CLR	CLEAR
CMU	CONCRETE MASONRY UNIT
COL	COLUMN
CONC	CONCRETE
COND	CONDITION
CONN	CONNECT, CONNECTION
CONST	CONSTRUCTION
CONT	CONTINUOUS
CONTR	CONTRACTOR
COORD	COORDINATE
COR	CORNER
CWB	CAPILLARY WATERBARRIER
D	DEEP, DEPTH
DEG	DEGREE
DEM	DEMOLISH, DEMOLITION
DEP	DEPRESSED
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DL	DEADLOAD
DO	DITTO
DT	DRAG TRUSS
DWG(S)	DRAWINGS
DWL	DOWEL
EA	EACH
EF	EACHFACE
ELEC	ELECTRICAL
ELEV	ELEVATION
EN	EDGE NAIL
EQN	EQUATION
EQUIP	EQUIPMENT
ES	EACH SIDE
EW	EACH WAY
EXIST	EXISTING
EXT	EXTERNAL, EXTERIOR
FF	FAR FACE
FFE	FINISH FLOOR ELEVATION
FG	FINISH GRADE
FJ	FLOOR JOIST
FMG	FRAMING
FN	FIELD NAIL
FND	FOUNDATION
FOC	FACE OF CONCRETE
FOM	FACE OF MASONRY
FOS	FACE OF STUD
FS	FAR SIDE
FT, '	FOOT
FTG	FOOTING
Fy	YIELD STRESS
GA	GAUGE
GLB	GLUED LAMINATED BEAM
GT	GIRDER TRUSS
GUSS	GUSSET
GYP BD	GYPSUM BOARD
HD	HOLD DOWN
HDR	HEADER
HGR	HANGER
HK	HOOK
HORIZ	HORIZONTAL
HP	HIGH POINT
HSS	HOLLOW STRUCTURAL SECTION
HT	HEIGHT
HVAC	HEATNG/ VENTILATING/ AIR CONDITIONING
I	MOMENT OF INERTIA
IBC	INTERNATIONAL BUILDING CODE
ICF	INSULATED CONCRETE FORM
ID	INSIDE DIAMETER
IN, "	INCH

STRUCTURAL ABBREVIATIONS

INCL	INCLUDE
INFO	INFORMATION
INS	INSULATED, INSULATION
JST	JOIST
K, KIPS	THOUSAND POUNDS
L	LENGTH, ANGLE
LB	POUND
LG	LONG
LL	LIVE LOAD
LLH	LONG LEG HORIZONTAL
LLV	LONG LEG VERTICAL
LOC	LOCATE, LOCATION
LONG	LONGITUDINAL
LP	LOW POINT
LW	LIGHT WEIGHT
MAS	MASONRY
MB	MACHINE BOLT
MBR	MEMBER
MECH	MECHANICAL
MED	MEDIUM
MEZZ	MEZZANINE
MF	MOMENT FRAM
MFG	MANUFACTURING
MIN	MINIMUM
MO	MASONRY OPENING
MOD	MODIFY, MODIFIED
MRF	MANUFACTURER
NF	NEAR FACE
NOM	NOMINAL
NS	NEAR SIDE
OC	ON CENTER
OD	OUTSIDE DIAMETER
OH	OPPOSITE HAND, OVERHEAD
OWSJ	OPEN WEB STEEL JOIST
P/C	PIN CONNECTED
PAR	PARALLEL
PCC	PRECAST CONCRETE
PCF	POUNDS PER CUBIC FOOT
PEN	PENETRATION
PFJ	PERIMETER FELT JOINT
PL	PLATE
PLYWD	PLYWOOD
PNL	PANEL
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PT	PRESSURE TREATED, POINT, PRETENSIONED
REINF	REINFORCING, REINFORCED
REQ	REQUIRED
RET	RETURN, RETAINING
REV	REVISION, REVISED
RF	ROOF
RFT	RAFTERS
RPM	REVOLUTIONS PR MINUTE
RS	ROUGH SAWN
RT	ROOF TRUSS
S	SECTION MODULUS
SC	SLIP CRITICAL
SCBRW	SEGMENTAL CONCRETE BLOCK RETAINING WALL
SCHED	SCHEDULE
SDI	STEEL DECK INSTITUTE
SECT	SECTION
SEIS	SEISMIC
SEP	SEPARATION
SHT	SHEET
SIM	SIMILAR
SJI	STEEL JOIST INSTITUTE
SMS	SHEET METAL SCREW
SPEC(S)	SPECIFICATION(S)
SPRT	SUPPORT
SQ	SQUARE
SS	STAINLESS STEEL
ST	SNUG TIGHT
STD	STANDARD
STIF/STIFF	STIFFENER
STL	STEEL
STRUCT	STRUCTURAL, STRUCTURE
SUSP	SUSPENDED
SYM	SYMMETRICAL
T&B	TOP AND BOTTOM
T&G	TONGUE AND GROOVE
TGB	TOP OF GRADE BEAM
THK	THICK, THICKNESS
TL	TOTAL LOAD
TN	TOE NAIL
TOB	TOP OF BEAM
TOC	TOP OF CONCRETE
TOF	TOP OF FOOTING
TOS	TOP OF STEEL
TOW	TOP OF WALL
TYP	TYPICAL
UFC	UNITED FACILITES CRITERIA
UNO	UNLESS NOTED OTHERWISE
UON	UNLESS OTHERWISE NOTED
VB	VAPOR BARRIER
VERT	VERTICAL
W	WIDTH, WEST, WIDE FLANGE
w/	WITH
WF	WIDE FLANGE
WPT	WORKING POINT
WWF	WELDED WIRE FABRIC
WWM	WELDED WIRE MESH
x	BY, TIMES

SHEET INDEX - STRUCTURAL

Sheet Number	Sheet Name
S-001	GENERAL INFORMATION
S-002	GENERAL INFORMATION
S-101	FOUNDATION PLAN
S-501	FOUNDATION DETAILS

GENERAL NOTES:

1. THESE PLANS ARE FOR THE FOUNDATION OF A PRE-ENGINEERED METAL BUILDING. DRAWINGS AND DESIGN OF THE METAL BUILDING SHALL BE CERTIFIED BY A PROFESSIONAL ENGINEER REGISTERED IN THE JURISDICTION OF THE PROJECT.
2. USE STRUCTURAL DRAWINGS IN CONJUNCTION WITH ALL OTHER DRAWINGS. COORDINATE THE WORK OF OTHER TRADES INCLUDING, BUT NOT LIMITED TO, THE REQUIREMENTS FOR SLEEVES, INSERTS, HOLES, HANGERS AND ANCHORS.
3. ELEVATIONS ON THE STRUCTURAL DRAWINGS ARE DENOTED AS [±XXXXX]. REFERENCED TO THE FINISHED FIRST FLOOR ELEVATION DATUM. COORDINATE THE ACTUAL DATUM ELEVATION WITH THE FINAL CIVIL CONSTRUCTION DRAWINGS FOR THE ACTUAL SITE.
4. REPORT DISCREPANCIES IN DIMENSIONS BETWEEN DIFFERENT DRAWINGS TO THE CONTRACTING OFFICER PRIOR TO BEGINNING WORK IN AREAS THAT WILL BE AFFECTED.
5. DETAILS ENTITLED OR NOTED AS "TYPICAL" APPLY NOT ONLY WHERE SPECIFICALLY INDICATED OR REFERENCED, BUT ALSO IN ALL OTHER CASES WHERE THE NATURE OF THE CONSTRUCTION REQUIRES THEIR USE. DETERMINE APPLICABILITY OF TYPICAL DETAILS FROM DESCRIPTIVE TITLES OR FROM THE SIMILARITY OF A CONSTRUCTION CONDITION TO ANOTHER CONDITION WHERE THE DETAIL IS SPECIFICALLY INDICATED OR REFERENCED.
6. THE STRUCTURAL DRAWINGS CONTAINED HEREIN REPRESENT THE FINISHED STRUCTURE. PROVIDE ALL TEMPORARY GUYING AND BRACING REQUIRED TO ERECT AND HOLD THE STRUCTURE IN PROPER ALIGNMENT UNTIL ALL STRUCTURAL WORK, INCLUDING CONNECTIONS, IS COMPLETE. THE ANALYSIS, DESIGN, SAFETY, ADEQUACY AND INSPECTION OF ERECTION BRACING, SHORING, FORMWORK AND OTHER TEMPORARY SUPPORTS ARE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
7. CONSTRUCTION MEANS, METHODS, TECHNIQUES, AND SEQUENCES AND SUPERVISION OF THE WORK ARE THE SOLE RESPONSIBILITY OF THE CONTRACTOR.
8. REPRODUCTION OF CONTRACT DRAWINGS SHALL NOT BE USED AS SHOP DRAWINGS UNDER ANY CIRCUMSTANCE.
9. ALL BUILDINGS WALL DIMENSION AND LOCATIONS SHALL BE COORDINATED WITH ARCHITECTURAL DRAWINGS.
10. IN CASE OF CONFLICT BETWEEN THE NOTES, DETAILS, AND SPECIFICATIONS, THE STRICTEST PROVISION SHALL GOVERN.
11. DO NOT SCALE PLANS.

FOUNDATION NOTES:

1. ANY DEVIATION FROM THE ASSUMED BUILDING CONFIGURATION MUST REQUIRE A REEVALUATION OF THE FOUNDATION DESIGN PRESENTED HEREIN.
2. FOUNDATIONS HAVE BEEN DESIGNED BASED ON A PRESUMPTIVE BEARING CAPACITY EQUAL TO 1500 psf. IF THE ACTUAL BEARING CAPACITY IS LESS THAN PRESUMED, CONTACT THE CONTRACTING OFFICER.
3. DO NOT PLACE FOUNDATION CONCRETE ON SATURATED SUBGRADES.
4. DO NOT INSTALL FOUNDATIONS UNTIL FOUNDATION WORK HAS BEEN COORDINATED WITH ADJACENT UNDERGROUND UTILITIES AND STRUCTURES. FOOTINGS SHALL BE LOWERED IN 1:2 (VERTICAL:HORIZONTAL) AS REQUIRED TO PASS UNDER UTILITY LINES.
5. BACKFILLING SHALL BE DONE SIMULTANEOUSLY ON BOTH SIDES OF FOUNDATION WALLS.
6. FOOTING EXCAVATIONS MUST EXTEND TO COMPETENT BEARING MATERIAL. CONTRACTOR SHALL HIRE A SOILS ENGINEER TO FIELD VERIFY NET ALLOWABLE SOIL BEARING CAPACITY STATED ON THESE CONSTRUCTION DOCUMENTS AND IN GEOTECHNICAL REPORT FOR THIS PROJECT. IF SUITABLE BEARING STRATUM DOES NOT EXIST AT FOOTING ELEVATIONS STATED ON CONSTRUCTION DOCUMENTS, EXCAVATIONS SHALL BE EXTENDED UNTIL SOIL WITH STATED BEARING CAPACITY IS REACHED. PLACE COMPACTED FILL BELOW FOOTINGS OR EXTEND FOOTINGS DOWN TO SUITABLE BEARING STRATUM. ENGINEERED FILL BELOW SLABS ON GRADE AND FOOTINGS SHALL BE FREE DRAINING GRANULAR MATERIAL COMPACTED TO DRY DENSITY DETERMINED BY ASTM D1557 TEST PROCEDURE AND PLACED PER THE SOIL ENGINEERS RECOMMENDATIONS. ALL FIELD CONDITIONS THAT WILL AFFECT DESIGN AS PRESENTED MUST BE COORDINATED WITH STRUCTURAL ENGINEER.

CONCRETE NOTES:

1. REFERENCE STANDARDS:
   EXCEPT AS INDICATED, ALL CONCRETE WORK AND DETAILING, FABRICATION AND PLACING OF REINF SHALL BE GOVERNED BY:
   - ACI 318, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE, 2014
   - ACI 301, SPECIFICATIONS FOR STRUCTURAL CONCRETE FOR BUILDINGS, 2010
   - ACI 305.1, HOT WEATHER CONCRETING, 2014
   - ACI 306, COLD WEATHER CONCRETING, 2010
   - ACI 315R, GUIDE TO PRESENTING REINFORCING STEEL DESIGN DETAILS, 2018
2. CAST-IN-PLACE CONCRETE SHALL BE NORMAL WEIGHT WITH A MINIMUM COMPRESSIVE STRENGTH (f'c) OF 4000 psi AT 28-DAYS
3. CONCRETE REINFORCING STEEL SHALL BE DEFORMED BARS CONFORMING TO ASTM A615, GRADE 60.
4. NO CONCRETE SHALL BE PLACED UNTIL THE CONTRACTING OFFICER OR THE CONTRACTING OFFICER'S DESIGNATED REPRESENTATIVE HAS INSPECTED ALL EMBEDDED WORK, INCLUDING REINFORCEMENT.
5. ALL EXPOSED CONCRETE EDGES SHALL BE CHAMFERED 3/4" OR AS INDICATED.
6. ALL HOOKS IN STEEL REINFORCING SHALL BE ACI STANDARD HOOKS, UNLESS NOTED OTHERWISE IN CONSTRUCTION DOCUMENTS.
7. ALL CONCRETE SURFACES SHALL BE FORMED, UNLESS OTHERWISE NOTED.
8. ALL REINF SHALL BE HELD SECURELY IN POSITION WITH STANDARD ACCESSORIES DURING CONCRETE PLACEMENT. REINF SHALL NOT BE SUPPORTED ON BOOSTERS MADE OF CMU OR CONCRETE NOT SPECIFICALLY DESIGNED TO SUPPORT REINF STEEL.
9. ALL EMBEDDED ITEMS SHALL BE PROPERLY PLACED, ACCURATELY POSITIONED, AND MAINTAINED SECURELY IN PLACE PRIOR TO AND DURING CONCRETE PLACEMENT.
10. REINFORCING STEEL SHALL BE SPREAD AT SLEEVES, TIEBACKS, RECESSES AND OTHER EMBEDDED ITEMS UNLESS OTHERWISE INDICATED. REINFORCEMENT SHALL NOT BE CUT TO FACILITATE PLACEMENT OF EMBEDDED ITEMS.
11. ALUMINUM SHALL NOT BE PLACED IN DIRECT CONTACT WITH CONCRETE UNLESS EFFECTIVELY COATED OR COVERED TO PREVENT ALUMINUM-CONCRETE REACTION AND ELECTROLYTIC ACTION BETWEEN ALUMINUM AND STEEL.
12. PROVIDE CONTINUOUS REINFORCEMENT WHEREVER POSSIBLE. SPLICE ONLY AS SHOWN OR APPROVED. STAGGER SPLICE WHERE POSSIBLE. USE TENSION SPLICE CLASS "B" UNLESS NOTED OTHERWISE. DOWELS SHALL MATCH SIZE AND SPACING OF THE SPECIFIED REINFORCEMENT AND SHALL BE LAPPED WITH TENSION SPLICES. UNLESS NOTED OTHERWISE, LAP LENGTH EXPRESSED IN NUMBER OF BAR DIAMETERS, "D", SHALL BE AS FOLLOWS:

NORMAL WEIGHT CONCRETE, f'c (PSI)

BAR SIZE	CLASS	3,000	4,000	5,000
#6 OR	A	44 D	38 D	34 D
SMALLER	B	57 D	49 D	44 D
#7 OR	A	55 D	47 D	42 D
LARGER	B	71 D	62 D	55 D

NOTES:
a. THE BAR SHALL HAVE CLEAR COVER AT LEAST $1d_b$ AND CC SPACING AT LEAST $2d_b$ FOR BEAMS OR COLUMNS AND $3d_b$ FOR OTHERS.
b. FOR HORIZONTAL REINF WITH MORE THAN 12" OF CONCRETE BELOW, OR FOR VERTICAL REINF, MULTIPLY THE SPLICE LENGTH INDICATED IN THE TABLE BY 1.3

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MARK	DESCRIPTION	DATE

DESIGNED BY: N. DELGADO
DRAWN BY: N.DELGADO
CHECKED BY: D. NELSON & T. HA
SUBMITTED BY:
PROJECT CHIEF:
SIZE: F
ANSI ID: FILE NAME: PR-201901HQ5-S-001
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/26/2020 6:42:58 PM

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

US ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
PHILADELPHIA, PA 19107

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BATTALION MAINTENANCE SHELTER
GENERAL INFORMATION

SHEET ID
HQ5
S-001
SHEET 1 OF 4

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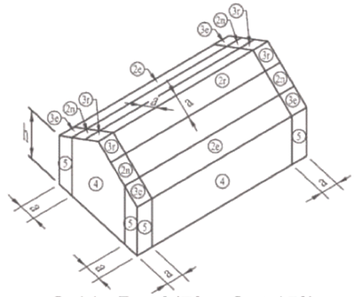
METAL BUILDING NOTES:

1. THE ENTIRE DESIGN OF THE METAL BUILDING SUPERSTRUCTURE SHALL BE THE RESPONSIBILITY OF THE METAL BUILDING SUPPLIER.
2. THE CONTRACTOR SHALL COORDINATE WITH THE METAL BUILDING SUPPLIER ANCHOR BOLT SIZES, TYPE, AND LOCATIONS.
3. METAL BUILDING SHOP DRAWINGS SHALL CONTAIN THE FOLLOWING INFORMATION:
   - A. FRAMING PLANS SPECIFYING ALL MEMBER SIZES AND LOCATIONS
   - B. ANCHOR BOLT SIZES, LENGTHS, AND ELEVATIONS
   - C. ALL COLUMN FRAME VERTICAL AND HORIZONTAL REACTIONS TRANSMITTED TO THE FOUNDATION
   - D. ALL REACTIONS ON FOUNDATIONS
4. CONTRACTOR SHALL REVIEW AND COORDINATE WITH THE METAL BUILDING SUPPLIER ALL BUILDING DIMENSIONS AND ELEVATIONS FOR THE METAL BUILDING TO ENSURE THAT THE METAL BUILDING STRUCTURE WILL SUFFICIENTLY BEAR ON THE FOUNDATION PRIOR TO THE METAL BUILDING FABRICATION.

DESIGN NOTES:

1. STRUCTURAL DESIGN IS IN ACCORDANCE WITH THE FOLLOWING CODES AND SPECIFICATIONS:
   - A. 2018 INTERNATIONAL BUILDING CODE (IBC)
   - B. UFC 3-301-01, STRUCTURAL ENGINEERING
   - C. ASCE 7-16, MINIMUM DESIGN LOADS AND ASSOCIATED CRITERIA FOR BUILDINGS AND OTHER STRUCTURES
   - D. ACI 318-14, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE
   - E. AISC STEEL CONSTRUCTION MANUAL, 15TH EDITION
   - F. 2018 PUERTO RICO BUILDING CODE
2. DESIGN LOAD CRITERIA:
   - A. LIVE LOADS (UNIFORM):
     - ROOF: 20 psf
     - FLOOR (SLAB-ON-GRADE): 300 psf
   - B. RAIN LOAD: 26 psf
   - C. SEISMIC LOAD:
     - RISK CATEGORY: II
     - SEISMIC IMPORTANCE FACTOR: 1.0
     - SPECTRAL RESPONSE ACCELERATION, S_s: 0.936
     - SPECTRAL RESPONSE ACCELERATION, S_1: 0.353
     - SEISMIC DESIGN CATEGORY: D
     - SEISMIC FORCE RESISTING SYSTEM: TO BE DETERMINED BY METAL BUILDING SUPPLIER
     - RESPONSE MODIFICATION FACTOR, R: TO BE DETERMINED BY METAL BUILDING SUPPLIER
   - D. WIND LOAD:
     - BASIC WIND SPEED: 175 mph
     - RISK CATEGORY: II
     - WIND EXPOSURE CATEGORY: C



Gable Roof (7° < Θ ≤ 45°)

NOTES:

1. ALL ELEMENTS AND COMPONENTS ATTACHED TO THE BUILDING SHALL BE DESIGNED FOR THE COMPONENTS AND CLADDING (C&C) WIND PRESSURES AS SHOWN BY ZONE.
2. ALL EXTERIOR WINDOWS, DOORS, MECH. LOUVERS, AND ALL OTHER ASSEMBLIES OR OPENINGS SHALL WITHSTAND IMPACT OF WIND-BORNE DEBRIS IN ACCORDANCE WITH THE IMPACT AND LOADING CRITERIA OF SECTION 26.12.3 OF ASCE 7-16.
3. LOCATION OF ZONES IS PROVIDED PER ASCE7-16, FIG. 30.4-1
4. DESIGN WIND PRESSURES ARE AT STRENGTH LEVEL (UNFACTORED LOADS) AND REPRESENT THE NET PRESSURE (SUM OF INTERNAL AND EXTERNAL PRESSURES) APPLIED NORMAL TO ALL SURFACES.
5. LINEAR INTERPOLATION BETWEEN VALUES OF TRIBUTARY AREA IS PERMISSIBLE.
6. PLUS AND MINUS SIGNS SIGNIFY PRESSURE TOWARD AND AWAY FROM THE EXTERIOR SURFACE, RESPECTIVELY.
7. DISTANCE (a) = 4'-6"

C&C WALL WIND PRESSURE (PSF)				
ZONE	EFFECTIVE WIDTH, FT²	POSITIVE PRESSURE	NEGATIVE PRESSURE	NOTES
4	10	77.2	-83.7	
4	20	73.7	-80.3	
4	50	69.2	-75.7	
4	100	65.7	-72.2	
5	10	77.2	-103.3	
5	20	73.7	-96.4	
5	50	69.2	-87.2	
5	100	65.7	-80.3	

C&C ROOF WIND PRESSURE (PSF)				
ZONE	EFFECTIVE WIDTH, FT²	POSITIVE PRESSURE	NEGATIVE PRESSURE	NOTES
1	10	46.8	-109.9	
1	20	42.1	-109.9	
1	50	36.1	-93.2	
1	100	31.4	-80.7	
2e	10	46.8	-109.9	
2e	20	42.1	-109.9	
2e	50	36.1	-93.2	
2e	50	31.4	-80.7	
2n	10	46.8	-175.4	
2n	20	42.1	-153.5	
2n	50	36.1	-124.7	
2n	100	31.4	-103.0	
2r	10	46.8	-175.4	
2r	20	42.1	-153.5	
2r	50	36.1	-124.7	
2r	100	31.4	-103.0	
3e	10	46.8	-175.4	
3e	20	42.1	-153.5	
3e	50	36.1	-124.7	
3e	100	31.4	-103.3	
3r	10	46.8	-226.0	
3r	20	42.1	-184.4	
3r	50	36.1	-129.5	
3r	100	31.4	-129.5	

C&C ROOF OVERHANG WIND PRESSURE (PSF)			
ZONE	EFFECTIVE WIDTH, FT²	PRESSURE (NEGATIVE)	NOTES
1	10	-130.8	
1	20	-130.8	
1	50	-126.4	
1	100	-123.1	
2e	10	-130.8	
2e	20	-130.8	
2e	50	-125.8	
2e	50	-122.1	
2n	10	-196.3	
2n	20	-182.9	
2n	50	-165.1	
2n	100	-151.8	
2r	10	-196.3	
2r	20	-182.9	
2r	50	-165.1	
2r	100	-151.8	
3e	10	-235.5	
3e	20	-198.1	
3e	50	-148.6	
3e	100	-111.2	
3r	10	-272.8	
3r	20	-225.7	
3r	50	-163.5	
3r	100	-163.5	

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MARK	DESCRIPTION	DATE

ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE : 7/26/2020 6:43:02 PM
FILE NAME: PR-20190\1HQ5-S-002

DESIGNED BY: N. DELGADO
DRAWN BY: N. DELGADO
CHECKED BY: D. NELSON & T. HA

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

SUBMITTED BY:
J. KNEE - CHIEF

US ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
PHILADELPHIA, PA 19107

SIZE: ANSI 'D'

CAMP SANTIAGO, SALINAS, PUERTO RICO
PUERTO RICO ARMY NATIONAL GUARD
JOINT TRAINING CENTER
PR-201901

HEADQUARTERS
BATTALION MAINTENANCE SHELTER
GENERAL INFORMATION

SHEET ID
HQ5
S-002
SHEET 2 OF 4

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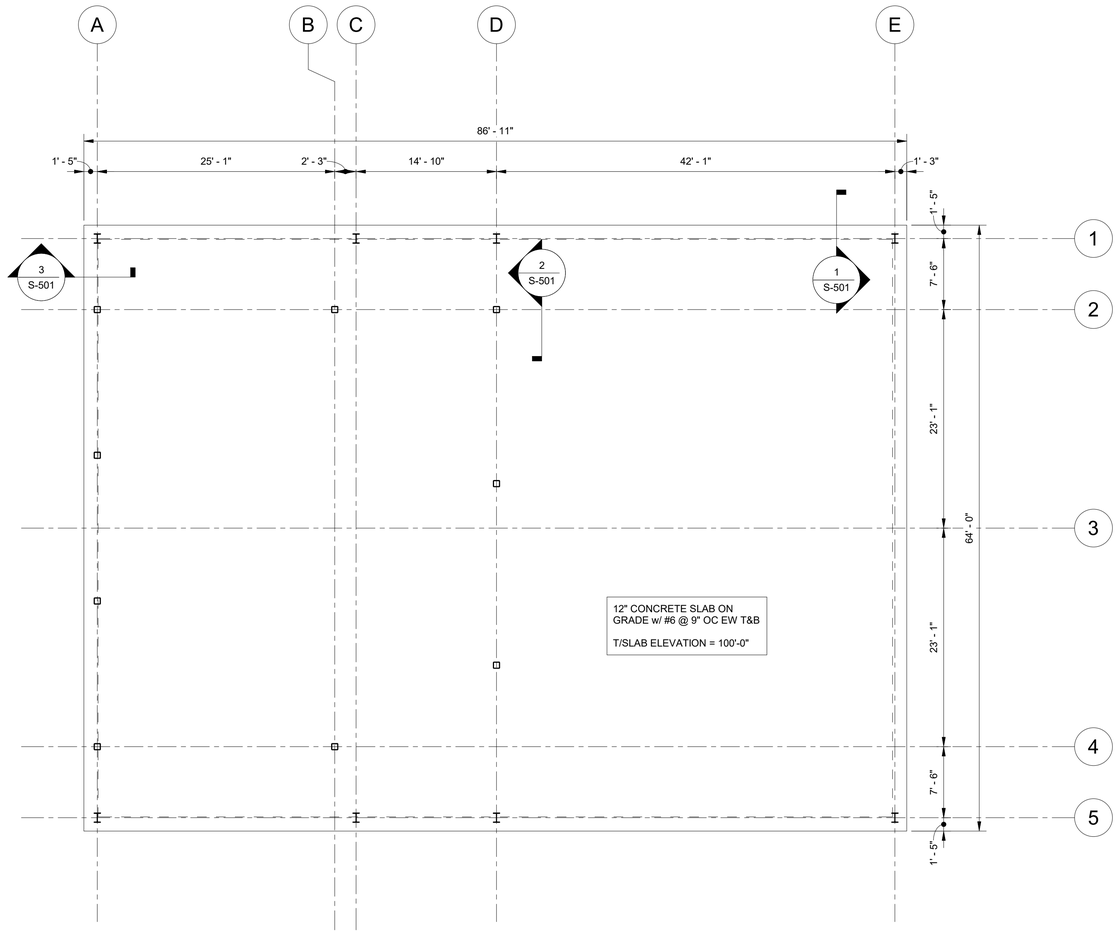
FOUNDATION PLAN NOTES

1. REFER TO GENERAL NOTES SHEET S-001 FOR ADDITIONAL STRUCTURAL NOTES AND FOUNDATION REQUIREMENTS.
2. ELEVATION 100'-0" ON STRUCTURAL DRAWINGS CORRESPONDS TO FINISH FLOOR ELEVATION SHOWN ON SITE PLAN, TYPICAL.
3. BOTTOM OF THICKENED SLAB EDGE ELEVATION = 97'-0" U.O.N, TYP.
4. MAXIMUM CONTROL JOINT SPACING OF SLAB ON GRADE IS 12'-0".
5. THIS FOUNDATION DESIGN IS BASED ON THE BUILDING LAYOUT PROVIDED ON THE ARCHITECTURAL DRAWINGS AND THE APPLICABLE LOADS STATED ON SHEETS S-001 AND S-002. ANY DEVIATION FROM THE LAYOUT AND/OR APPLIED LOADS MUST REQUIRE A REDESIGN OF THE FOUNDATION.



1 FOUNDATION PLAN
1/8" = 1'-0"

PLAN NORTH

8' 0 8' 16'
SCALE: 1/8" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: N. DELGADO	ISSUE DATE: 27 MAR 2020
DRAWN BY: N. DELGADO	SOLICITATION NO.:
CHECKED BY: D. NELSON & T. HA	CONTRACT NO.:
SUBMITTED BY: J. KAMEL, CHIEF	PLOT DATE: 7/26/2020 9:43:14 PM
PROJECT ENGINEER	SIZE: ANSI D
	FILE NAME: PR-201901HQs-S-101

US ARMY CORPS OF ENGINEERS
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201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

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PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
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FOUNDATION PLAN

SHEET ID
HQ5

S-101
SHEET 3 OF 4

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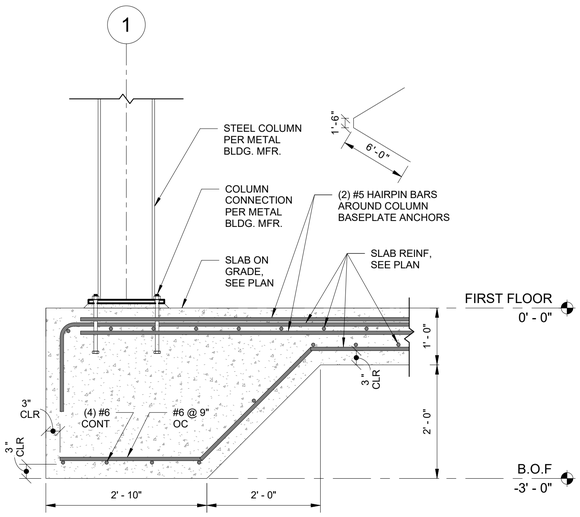
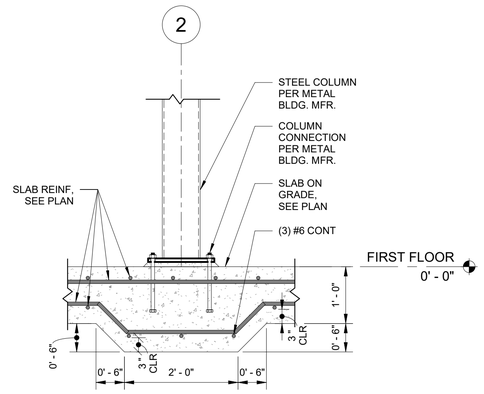


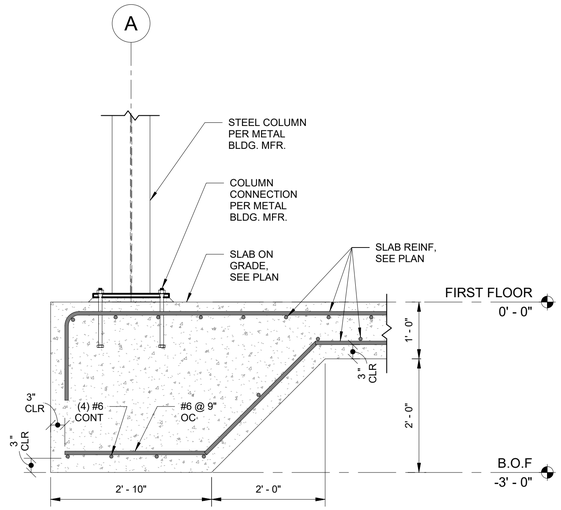
1 THICKENED SLAB EDGE GRIDLINES 1 & 5

3/4" = 1'-0"



2 THICKENED SLAB AT INT. COLUMN

3/4" = 1'-0"



3 THICKENED SLAB EDGE GRIDLINES A & E

3/4" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: N. DELGADO
DRAWN BY: N. DELGADO
CHECKED BY: D. NELSON & T. HA
SUBMITTED BY: PROJECT CHIEF
SIZE: ANSI D
FILE NAME: PR-201901HQ5-S-501
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/26/2020 6:43:14 PM

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
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HEADQUARTERS
BATTALION MAINTENANCE SHELTER
FOUNDATION DETAILS

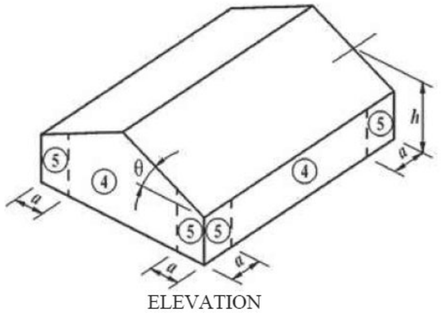
SHEET ID
HQ5

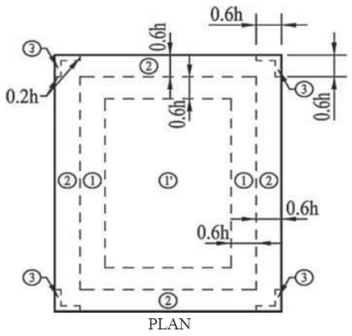
S-501
SHEET 4 OF 4

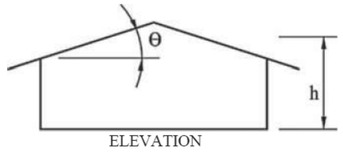
95%

DESIGN LOAD CRITERIA FOR COMPONENT AND CLADDING

C&C WIND LOAD:	
BASIC WIND SPEED	200 mph
RISK CATEGORY	IV
WIND EXPOSURE CATEGORY	C







BUILDING NOTES:

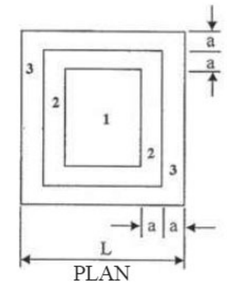
1. ALL EXTERIOR WALLS, WINDOWS, DOORS, MECH. LOUVERS, ROOFING COMPONENTS, AND ALL OTHER ASSEMBLIES OR OPENINGS WITHIN THE BUILDING ENVELOPE SHALL BE DESIGNED FOR THE C&C DESIGN WIND PRESSURES AS SHOWN BY ZONE. IN ADDITION, THESE COMPONENTS SHALL WITHSTAND IMPACT OF WIND-BORNE DEBRIS IN ACCORDANCE WITH THE MISSILE CRITERIA FOR HURRICANE SHELTERS AND THE TEST REQUIREMENTS OF ICC 500-2014 SECTIONS 305.1.2 AND 306, RESPECTIVELY.
2. LOCATION OF ZONES IS PROVIDED PER ASCE7-16, FIG. 30.3-1 & 30.3-1A
3. DISTANCE (a) = 5'-7"
4. DESIGN WIND PRESSURES ARE AT STRENGTH LEVEL (UNFACTORED LOADS) AND REPRESENT THE NET PRESSURE (SUM OF INTERNAL AND EXTERNAL PRESSURE) APPLIED NORMAL TO ALL SURFACES.
5. LINEAR INTERPOLATION BETWEEN VALUES OF TRIBUTARY AREA IS PERMISSIBLE.

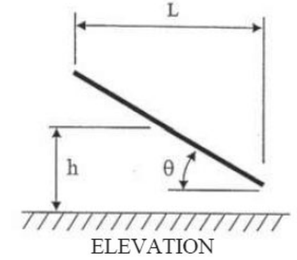
C&C WALL WIND PRESSURE (PSF)				
ZONE	EFFECTIVE WIDTH, FT²	POSITIVE PRESSURE	NEGATIVE PRESSURE	NOTES
4	10	94.0	-101.8	
4	20	91.7	-97.7	
4	50	86.2	-93.2	
4	100	82.3	-87.7	
5	10	94.0	-125.3	
5	20	91.7	-117.5	
5	50	86.2	-105.8	
5	100	82.3	-101.8	

C&C PARAPET WIND PRESSURE (PSF)			
ZONE	EFFECTIVE WIDTH, FT²	PRESSURE	NOTES
2	10	285.0	
2	20	263.0	
2	50	241.4	
2	100	224.0	
3	10	365.1	
3	20	336.0	
3	50	285.9	
3	100	262.3	

C&C ROOF WIND PRESSURE (PSF)				
ZONE	EFFECTIVE WIDTH, FT²	POSITIVE PRESSURE	NEGATIVE PRESSURE	NOTES
1	10	41.8	-163.6	
1	20	39.2	-152.8	
1	50	35.7	-138.6	
1	100	33.1	-127.8	
1'	10	41.8	-94.0	
1'	20	39.2	-94.0	
1'	50	35.7	-94.0	
1'	50	33.1	-94.0	
2	10	41.8	-215.9	
2	20	39.2	-202.0	
2	50	35.7	-183.6	
2	100	33.1	-169.8	
3	10	41.8	-294.2	
3	20	39.2	-266.4	
3	50	35.7	-229.7	
3	100	33.1	-202.0	

SHEET INDEX - STRUCTURAL	
Sheet Number	Sheet Name
S-001	GENERAL INFORMATION
S-101	FOUNDATION PLAN
S-102	ROOF FRAMING PLAN
S-103	SHEARWALL DISTRIBUTION PLAN
S-201	STRUCTURAL ELEVATIONS
S-202	BRACING ELEVATIONS
S-203	BRACING ELEVATIONS
S-501	FOUNDATION DETAILS
S-502	STRUCTURAL DETAILS
S-503	STRUCTURAL DETAILS
S-504	STRUCTURAL DETAILS
S-505	STRUCTURAL DETAILS
S-601	SHEARWALL ELEVATIONS





CANOPY NOTES:

1. ALL EXTERIOR WALLS, WINDOWS, DOORS, MECH. LOUVERS, ROOFING COMPONENTS, AND ALL OTHER ASSEMBLIES OR OPENINGS WITHIN THE BUILDING ENVELOPE SHALL BE DESIGNED FOR THE C&C DESIGN WIND PRESSURES AS SHOWN BY ZONE. IN ADDITION, THESE COMPONENTS SHALL WITHSTAND IMPACT OF WIND-BORNE DEBRIS IN ACCORDANCE WITH THE MISSILE CRITERIA FOR HURRICANE SHELTERS AND THE TEST REQUIREMENTS OF ICC 500-2014 SECTIONS 305.1.2 AND 306, RESPECTIVELY.
2. LOCATION OF ZONES IS PROVIDED PER ASCE7-16, FIG. 30.3-1 & 30.3-1A
3. DISTANCE (a) = 5'-7"
4. THE CONTRACTOR SHALL USE COMPONENT AND CLADDING WIND PRESSURE TO DESIGN ALL ELEMENTS ATTACHED TO THE BUILDING.

C&C ROOF WIND PRESSURE (PSF)				
ZONE	EFFECTIVE AREA, FT²	POSITIVE PRESSURE	NEGATIVE PRESSURE	NOTES
1	≤ a²	95.0	-87.1	
2	≤ a²	142.6	-134.7	
3	≤ a²	190.1	-261.4	
1	> a², ≤ 4.0a²	95.0	-87.1	
2	> a², ≤ 4.0a²	142.6	-134.7	
3	> a², ≤ 4.0a²	142.6	-134.7	
1	> 4.0a²	95.0	-87.1	
2	> 4.0a²	95.0	-87.1	
3	> 4.0a²	95.0	-87.1	

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF, E.M.
ANSI ID: PR-20190HQ6-S-001
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:22 AM
SIZE: E1

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201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

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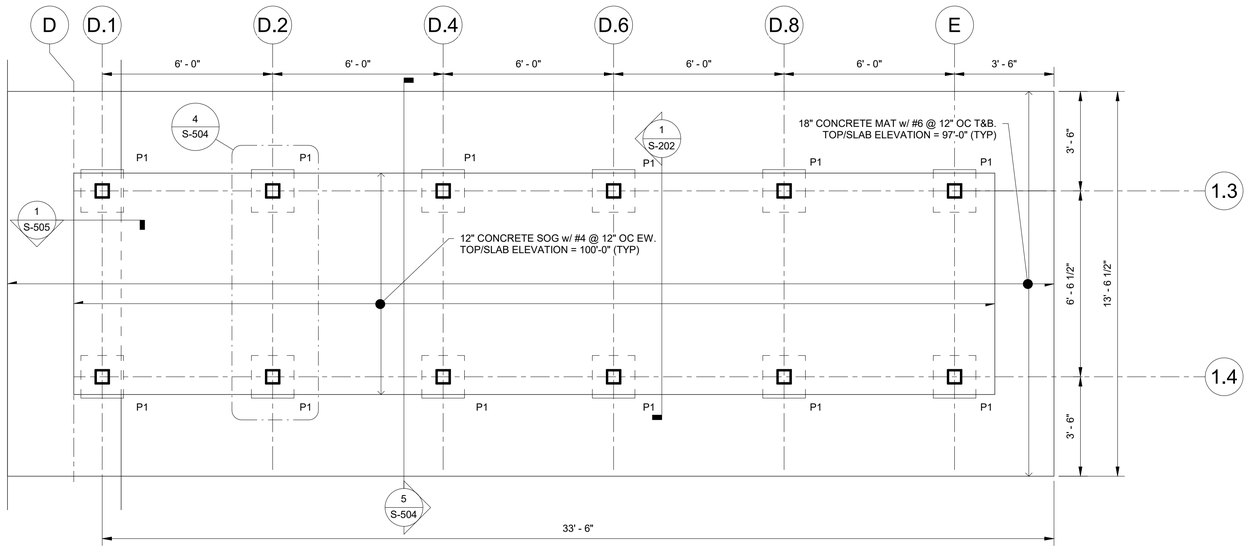
HEADQUARTERS
BRIGADE HEADQUARTERS
GENERAL INFORMATION

SHEET ID
HQ6

S-001
SHEET 1 OF 13

95%



2 CANOPY FOUNDATION PLAN

3/8" = 1'-0"

FOUNDATION PLAN NOTES

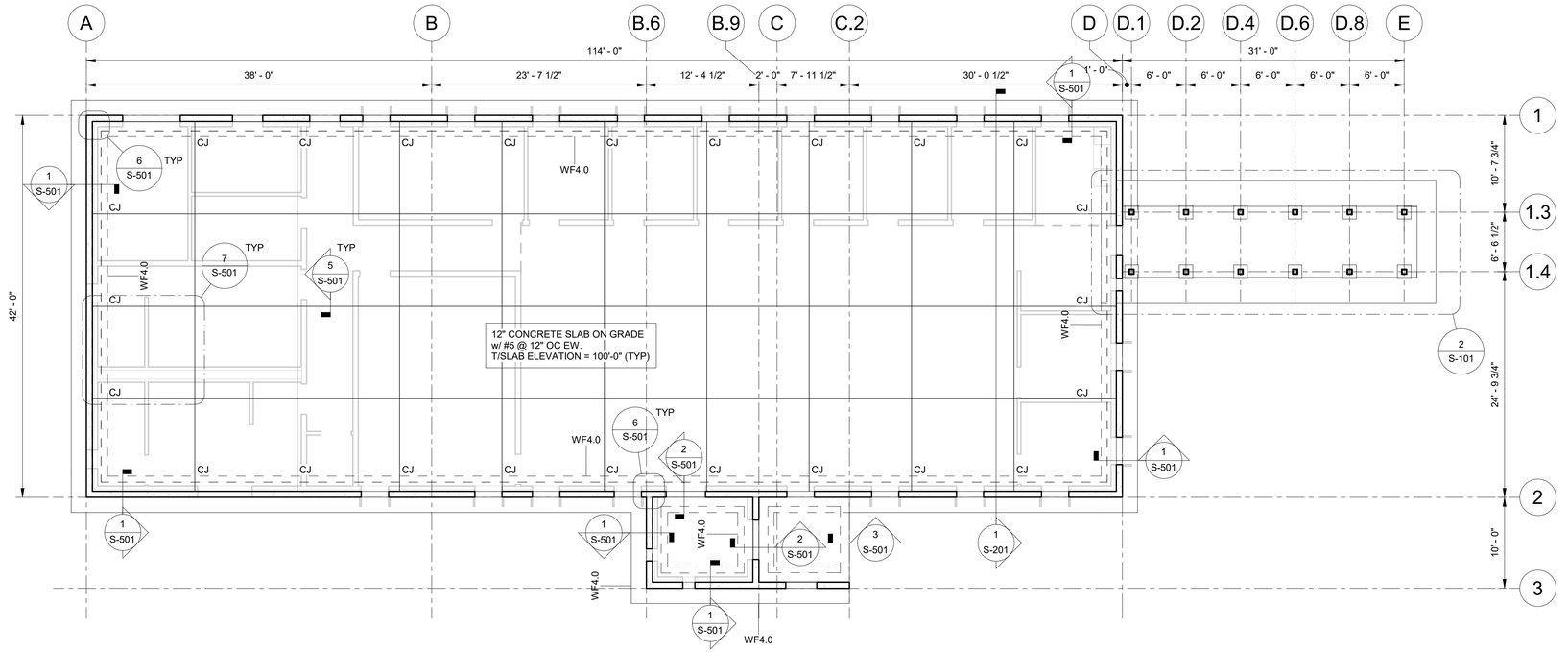
1. REFER TO GENERAL NOTES SHEET S-001 FOR ADDITIONAL STRUCTURAL NOTES AND FOUNDATION REQUIREMENTS.
2. ELEVATION 100'-0" ON STRUCTURAL DRAWINGS CORRESPONDS TO FINISH FLOOR ELEVATION SHOWN ON SITE PLAN, TYPICAL.
3. BOTTOM OF FOOTING ELEVATION = 97'-0" U.O.N, TYP.
4. SLAB DEPRESSIONS: VERIFY ALL SLAB DEPRESSIONS (SIZE, DEPTH, LOCATION) w/ ARCHITECTURAL DRAWINGS.
5. CONCRETE WALL THICKNESS = 8" U.O.N, TYP.
6. MAXIMUM CONTROL JOINT SPACING OF SLAB ON GRADE = 12'-0"

WALL FOOTING SCHEDULE

MARK	DIMENSIONS		REINFORCEMENT				NOTES
			LONGITUDINAL		TRANSVERSE		
	WIDTH	DEPTH	QUANTITY	SIZE	SIZE	SPACING	
WF4.0	4' - 0"	1' - 6"	4	#6	#6	1' - 2"	

CONCRETE PIER SCHEDULE

MARK	DIMENSIONS		REINFORCEMENT				REMARKS
			LONGITUDINAL		TIES		
	WIDTH	DEPTH	QUANTITY	SIZE	SIZE	SPACING	
P1	1' - 6"	1' - 6"	12	#6	#4	1' - 0"	



1 FOUNDATION PLAN

1/8" = 1'-0"

PLAN NORTH

4' 0 4' 8' 12'

SCALE: 3/16" = 1' - 0"

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MARK	DESCRIPTION	DATE

ISSUE DATE: 27 MAR 2020
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PLOT DATE: 7/27/2020 9:39:23 AM
FILE NAME: P:\2019\19011HQ6-S-101

DESIGNED BY: M. ALIJUBOORI
DRAWN BY: M. ALIJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RANEY, CHIEF
SIZE: ANSI 'D'

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WINCHESTER, VA 22602

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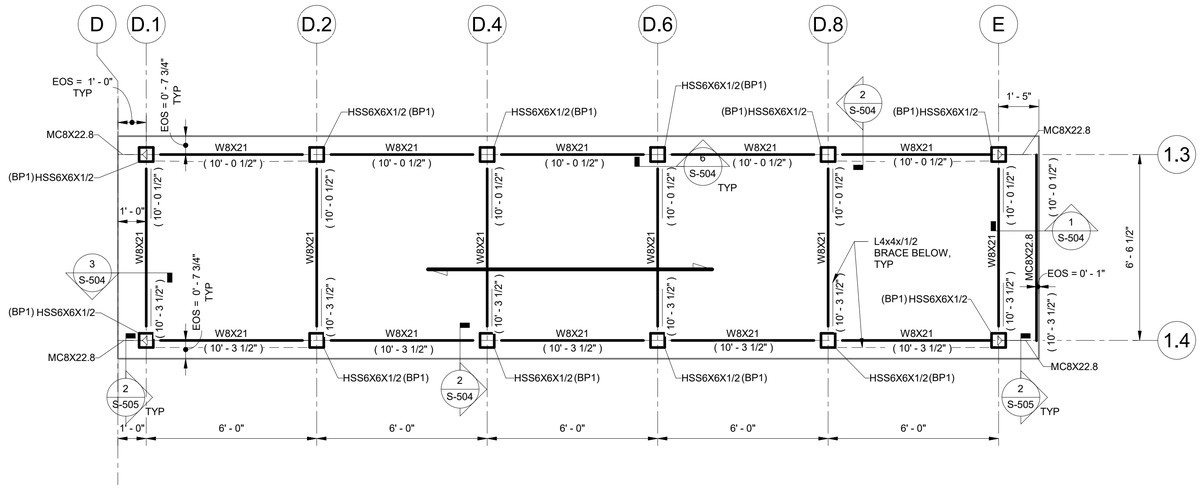
HEADQUARTERS
BRIGADE HEADQUARTERS
FOUNDATION PLAN

SHEET ID
HQ6

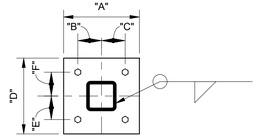
S-101
SHEET 2 OF 13

95%



2 CANOPY FRAMING PLAN

3/8" = 1'-0"



4 BASEPLATE - HSS

3/4" = 1'-0"

FRAMING PLAN NOTES

1. ELEVATION OF STEEL OPEN WEB JOIST BEARING IS 113'-1", UNO.
2. (XXX'-XX") INDICATES THE TOP OF CONCRETE BEAM OR STEEL JOIST ELEVATION.
3. PROVIDE 2.5" CONCRETE OVER 1.5", 18 GA GALVANIZED COMPOSITE METAL DECK (4" TOTAL SLAB THICKNESS) IN A MINIMUM 3-SPAN LAYOUT. ATTACH TO FLOOR STRUCTURE WITH 5/8" DIA PUDDLE WELDS AND 36/5 PATTERN WITH 4 WELDED SIDELAPS (OR #12 TEK SCREWS) PER SPAN. PROVIDE 4x4-W2.9xW2.9 WELDED WIRE FABRIC (FLAT SHEET STOCK) LOCATED 3/4" FROM THE TOP OF THE SLAB.
4. REFER TO DETAIL 1/S-503 FOR FRAMING AROUND DRAIN OPENINGS AND OTHER ROOF OPENINGS. COORDINATE SIZE, LOCATION, & QUANTITY OF STEEL FRAMES w/ MECHANICAL CONTRACTOR ON PROJECT.
5. VERIFY ALL MECHANICAL EQUIPMENT WEIGHTS, SIZES, & LOCATIONS PRIOR TO PREPARING SHOP DRAWNIGS & FABRICATING MATERIALS. CONTRACTOR TO COORDINATE ANY CHANGES w/ JOIST SUPPLIER AND STRCUTURAL ENGINEER.
6. PROVIDE JOIST BRIDGING PER SJI REQUIREMENTS
7. SPLICE OF ANGLE DECK SHALL PROVIDE FULL AREA SPLICE. CONTRACTOR SHALL SUBMIT SPLICE DETAIL TO ENGINEER OF RECORD FOR REVIEW.
8. ROLL-OVER CAPACITY OF JOIST SEAT SHALL BE 1.0 KIP-FT

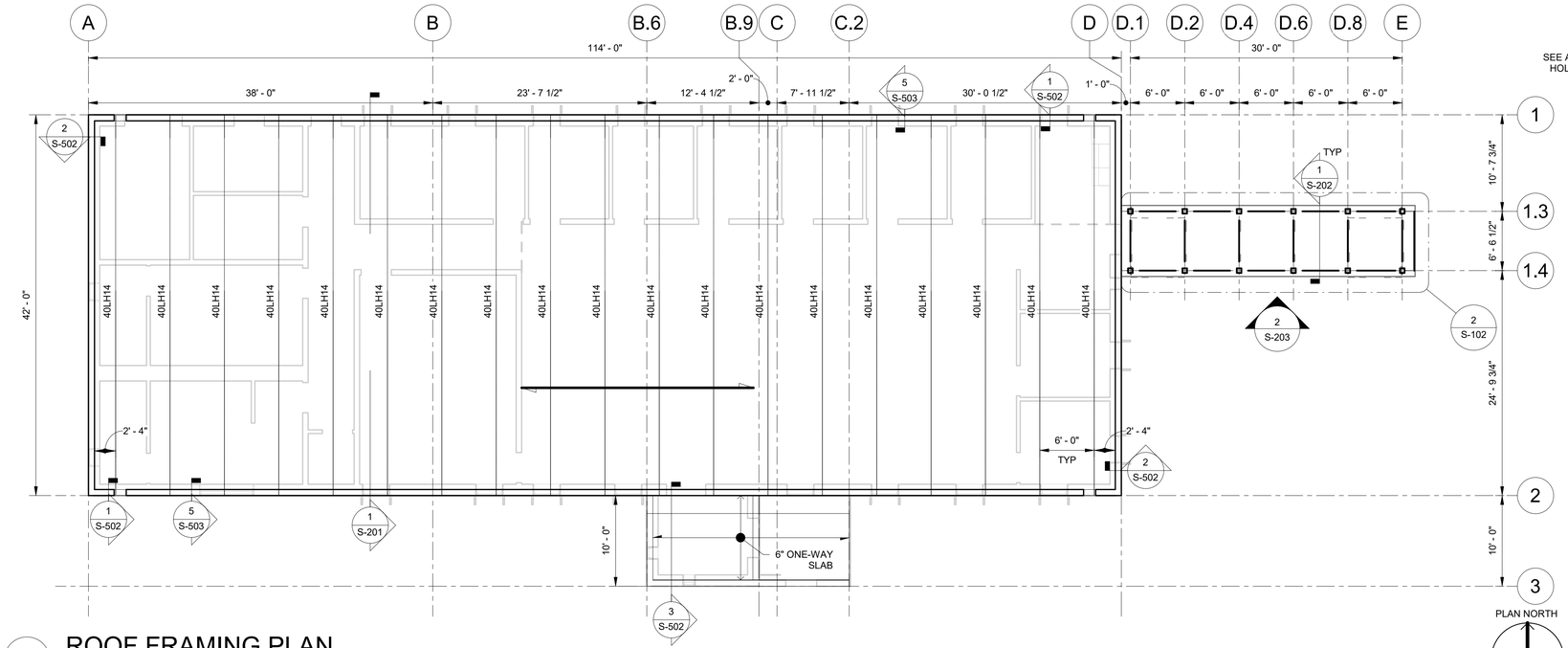
ROOF FRAMING KEYNOTES:

1. TOP CHORD DOUBLE PITCHED UNDERSLANG STEEL OPEN WEB JOIST. REFER TO 1/S-201 FOR DETAILS

BASE PLATE SCHEDULE

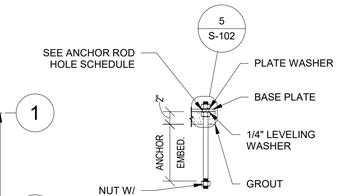
KEY NAME	THICKNESS (t)	ANCHOR DIA	ANCHOR EMBED	DETAIL	"A"	"B"	"C"	"D"	"E"	"F"	COMMENTS
BP1	1"	3/4"	12"	4	12"	4 1/2"	4 1/2"	12"	4 1/2"	4 1/2"	

ANCHOR ROD HOLE SCHEDULE	
ROD SIZE	HOLE SIZE
1/2" AB	1 1/16" DIA
5/8" AB	1 3/16" DIA
3/4" AB	1 5/16" DIA
1" AB	1 7/8" DIA
1 1/4" AB	2 1/8" DIA
1 1/2" AB	2 3/8" DIA
1 3/4" AB	2 7/8" DIA
>2" AB	db + 1 1/4"



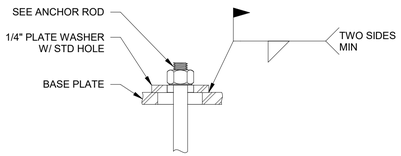
1 ROOF FRAMING PLAN

1/8" = 1'-0"



6 STANDARD ANCHOR BOLT

1" = 1'-0"



5 ANCHOR BOLT w/ WELDED WASHER

3" = 1'-0"

4' 0 4' 8' 12'

SCALE: 3/16" = 1' - 0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALUBOORI
DRAWN BY: M. ALUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RANEY, CHIEF
QC'D BY: R. SCHMIDT
ANSI 'D'

ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:25 AM
FILE NAME: P:\2019\01HQ6-S-102

US ARMY CORPS OF ENGINEERS
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HEADQUARTERS
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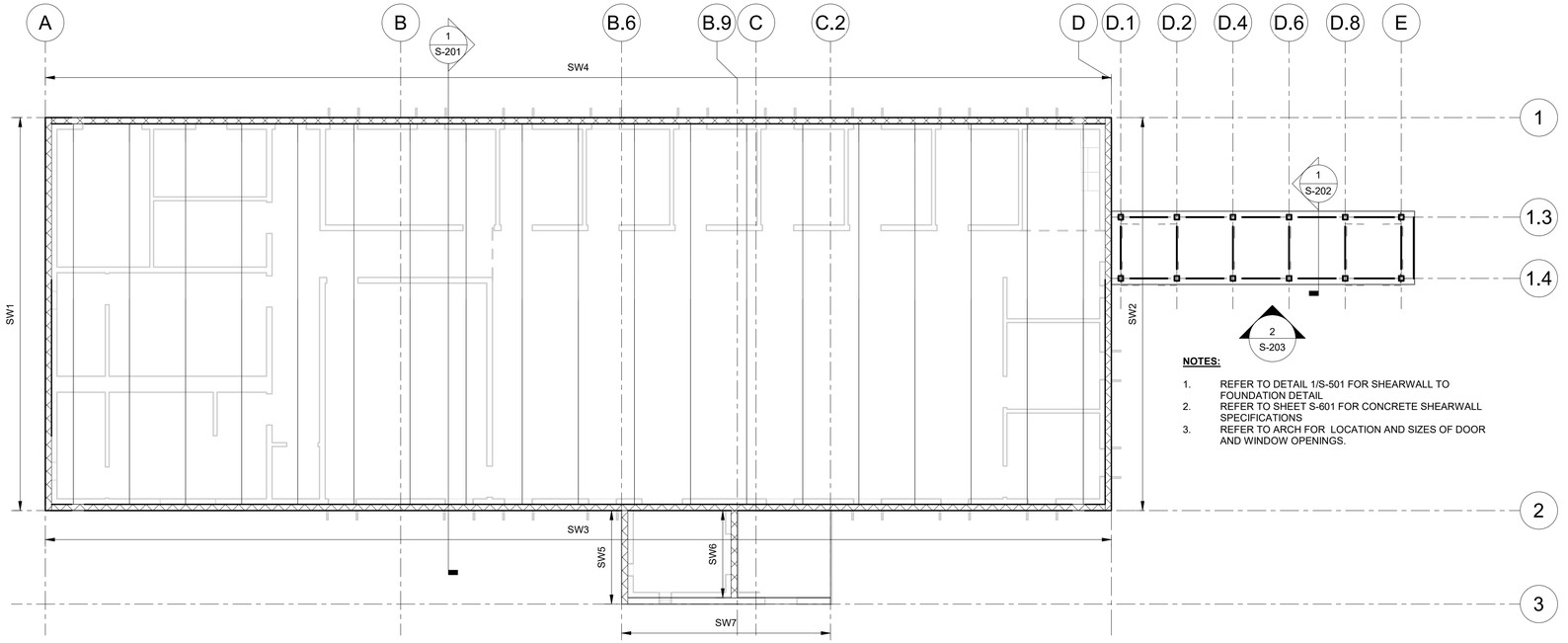
ROOF FRAMING PLAN

SHEET ID
HQ6

S-102
SHEET 3 OF 13

95%



NOTES:

1. REFER TO DETAIL 1/S-501 FOR SHEARWALL TO FOUNDATION DETAIL
2. REFER TO SHEET S-601 FOR CONCRETE SHEARWALL SPECIFICATIONS
3. REFER TO ARCH FOR LOCATION AND SIZES OF DOOR AND WINDOW OPENINGS.

PLAN NORTH

1 SHEARWALL DISTRIBUTION PLAN
1/8" = 1'-0"

4' 0 4' 8' 12'
SCALE: 3/16" = 1' - 0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALIJUBOORI
DRAWN BY: M. ALIJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RANEY, CHIEF
SIZE: ANSI 'D'
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:26 AM
FILE NAME: PR-20190THQ6-S-103

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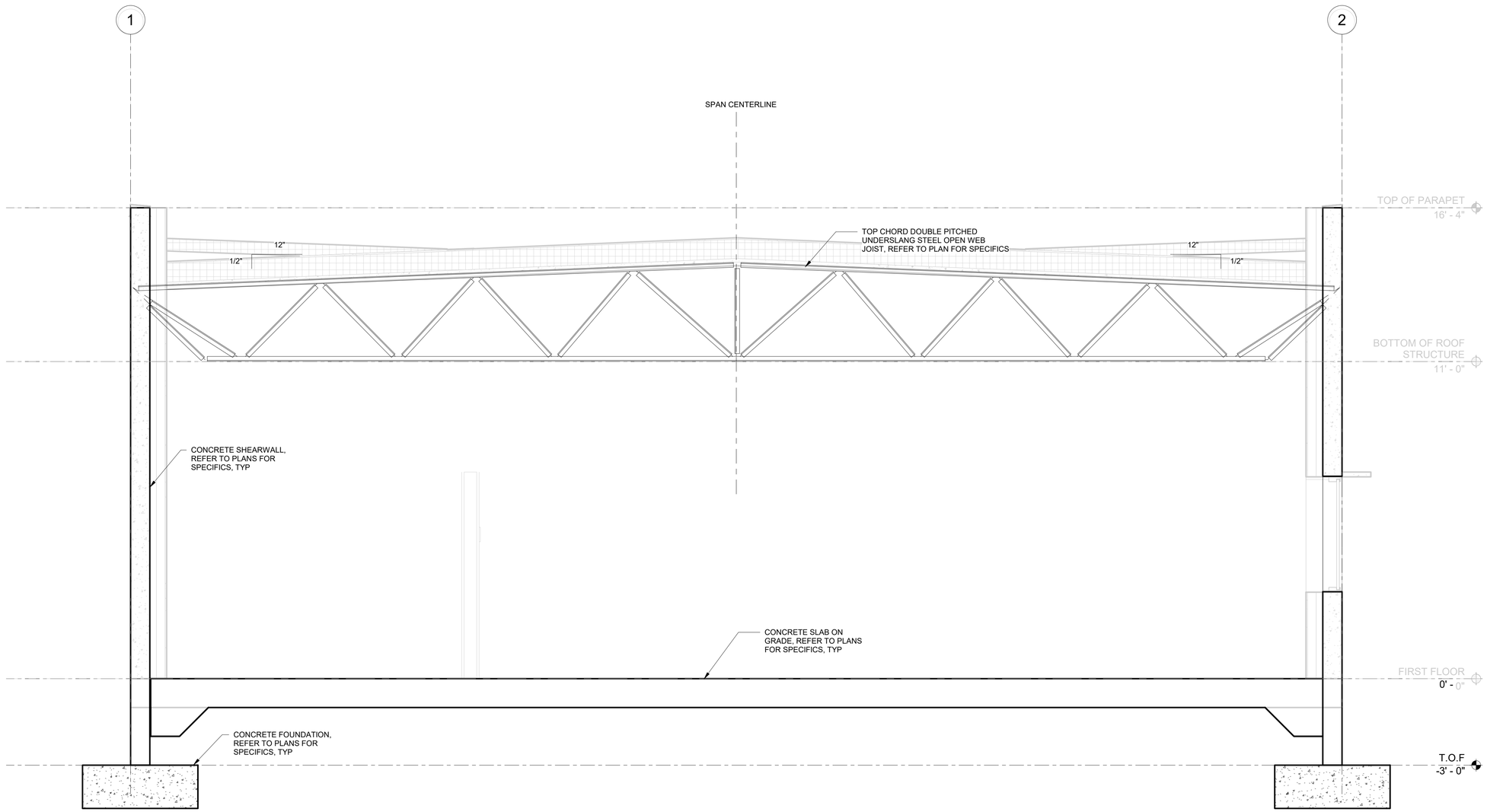
HEADQUARTERS
BRIGADE HEADQUARTERS
SHEARWALL DISTRIBUTION PLAN

SHEET ID
HQ6

S-103
SHEET 4 OF 13

95%



1 TOP CHORD DOUBLE PITHCED JOIST - ELEVATION

1/2" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALUBOORI
DRAWN BY: M. ALUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. PANET, CHIEF
SIZE: ANSI D

ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
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FILE NAME: PR-20190THQ6-S-201

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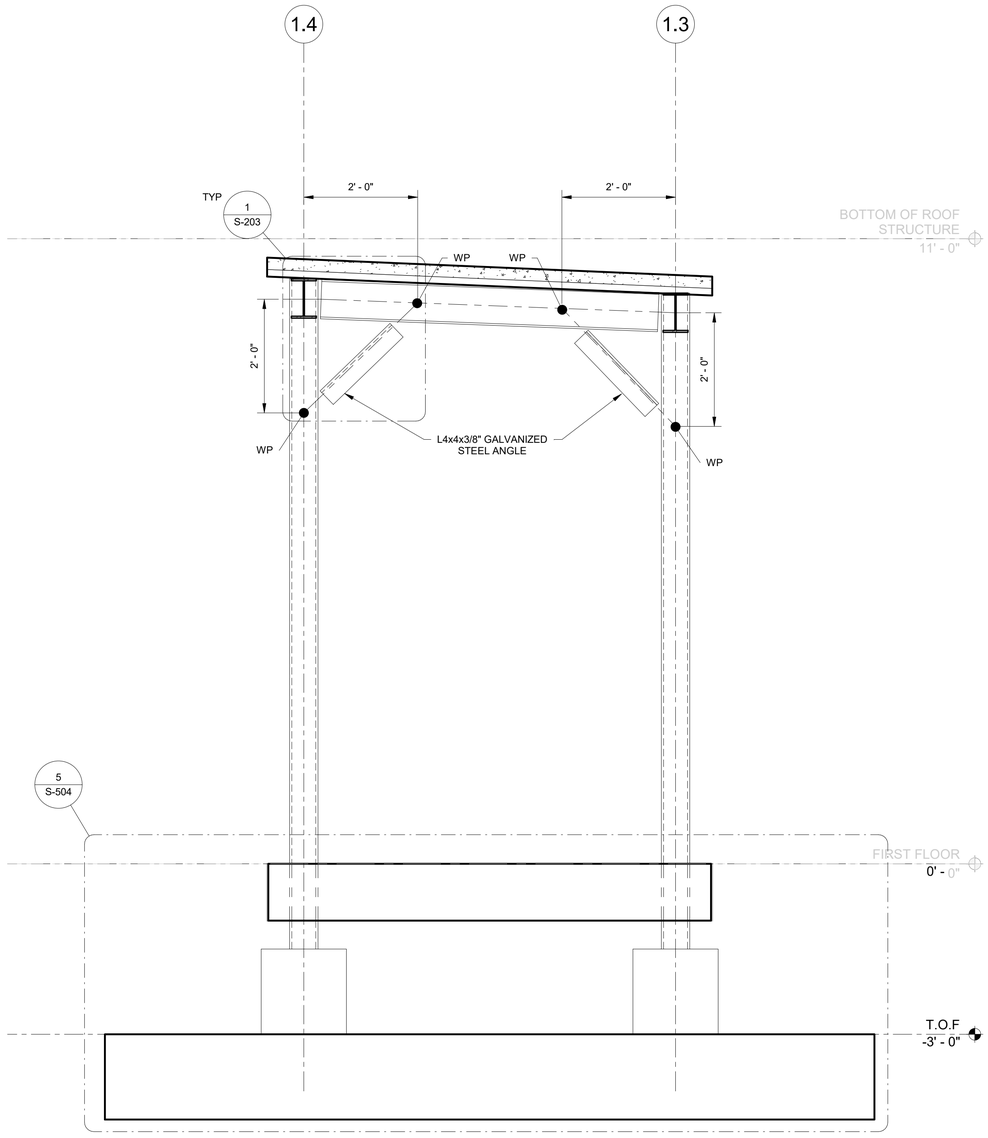
HEADQUARTERS
BRIGADE HEADQUARTERS
STRUCTURAL ELEVATIONS

SHEET ID
HQ6

S-201
SHEET 5 OF 13

95%



1 TRANSVERSE BRACING
3/4" = 1'-0"

1' 0 1' 2' 3'
SCALE: 3/4" = 1' - 0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF, E.T.S.M.E.
ANSI/D: PR-20190THQ6-S-202
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
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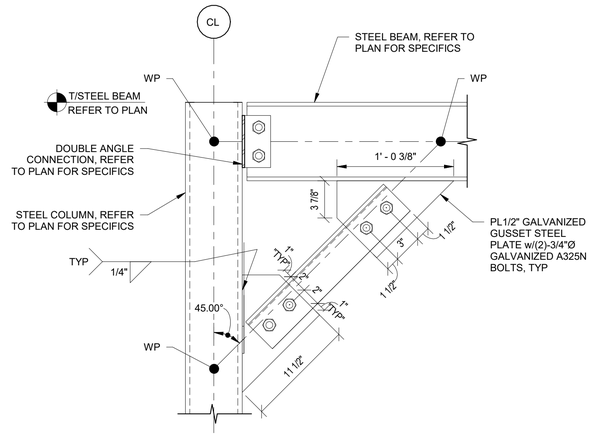
PR-201901

HEADQUARTERS
BRIGADE HEADQUARTERS
BRACING ELEVATIONS

SHEET ID
HQ6

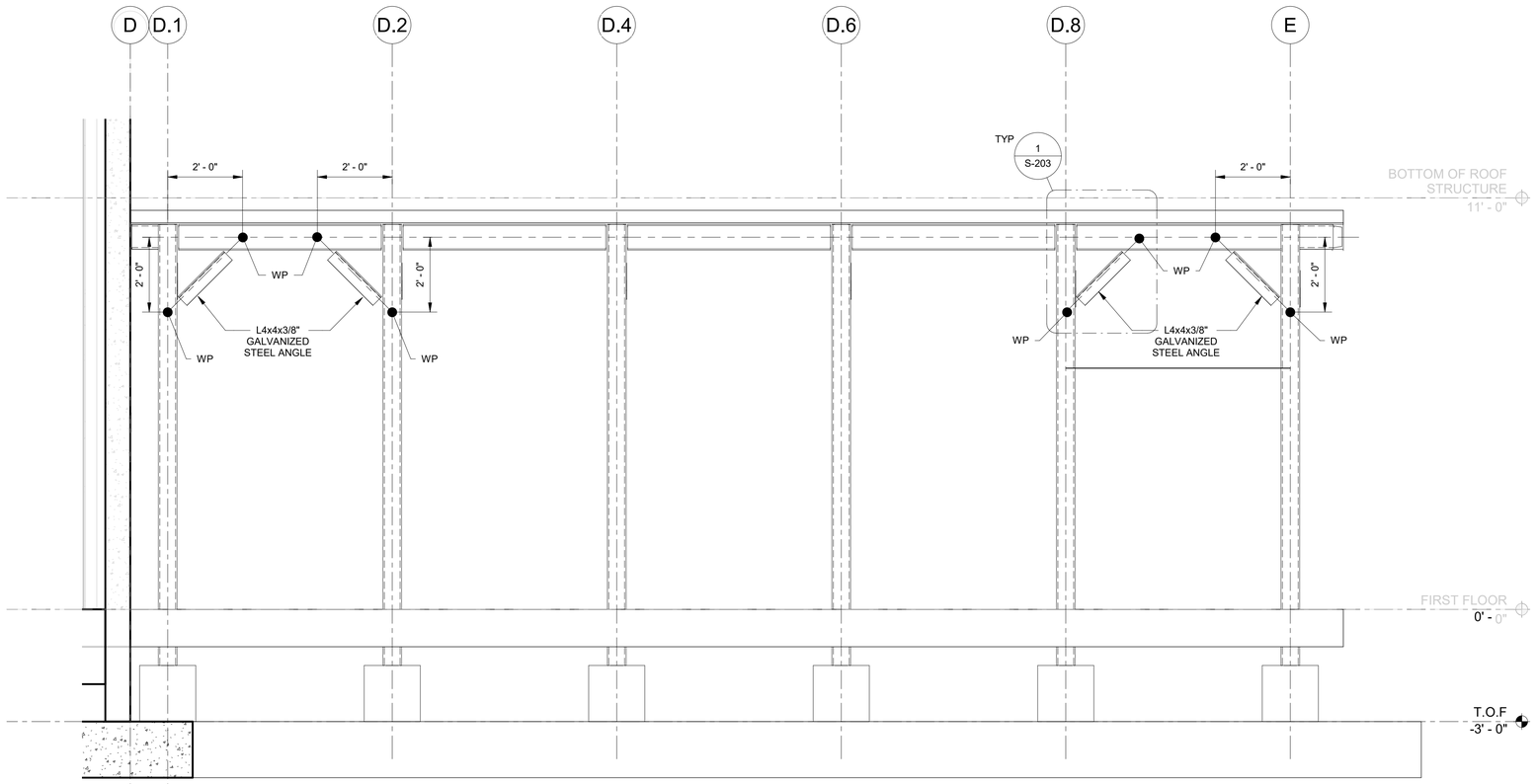
S-202
SHEET 6 OF 13

95%



1 TYPICAL BRACING CONNECTION

1 1/2" = 1'-0"



2 Elevation 1.4 & 1.3

1/2" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALIJUBOORI
DRAWN BY: M. ALIJUBOORI
CHECKED BY: D. NELSON

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SOLICITATION NO.:
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FILE NAME: R20190THQ6-S-203

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
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PHILADELPHIA, PA 19107

SUBMITTED BY:
J. RANEY, CHIEF
SIZE: ANSI 'D'

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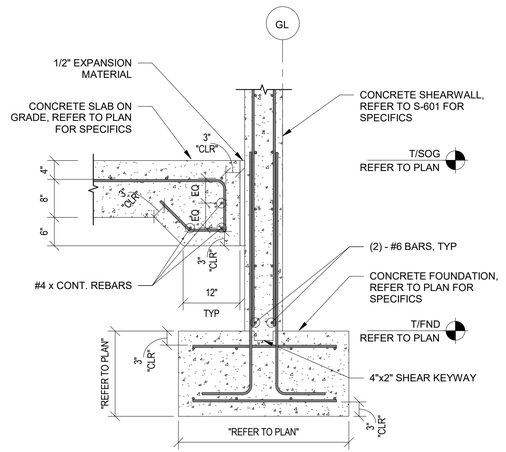
PR-201901

HEADQUARTERS
BRIGADE HEADQUARTERS
BRACING ELEVATIONS

SHEET ID
HQ6

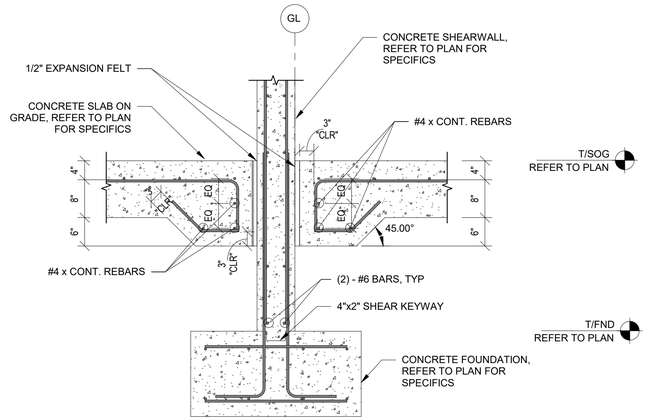
S-203
SHEET 7 OF 13

95%



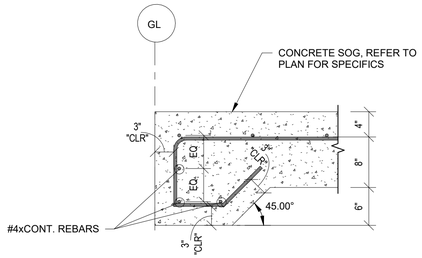
1 TYPICAL WALL FOUNDATION DETAIL

3/4" = 1'-0"



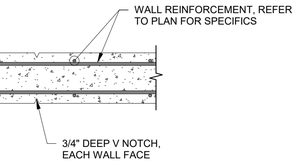
2 TYPICAL THICKENED SLABS AND WALL FOUNDATION DETAIL

3/4" = 1'-0"



3 TYPICAL THICKENED SLAB

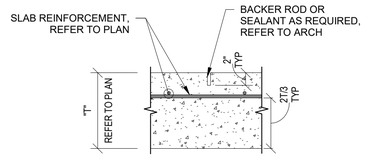
1" = 1'-0"



NOTE:
1- TOP AND BOTTOM WALL BARS ARE TO EXTEND THROUGH JOINT.
2- CONTROL JOINT SPACING TO BE 25'-0" MAXIMUM.

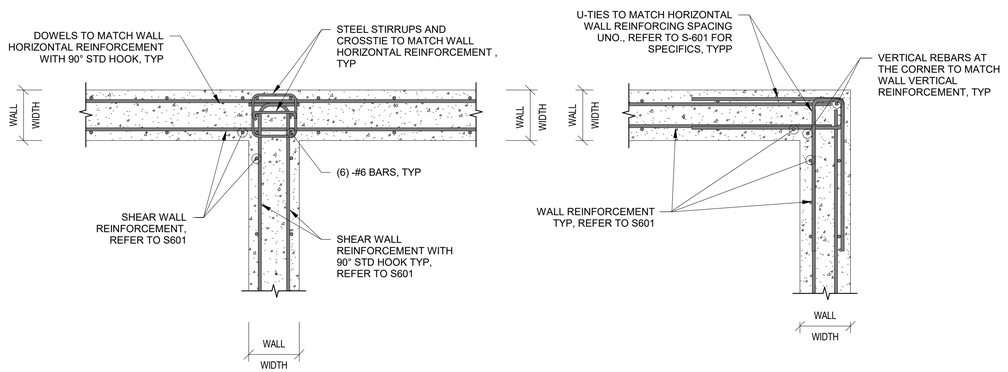
4 TYPICAL WALL CONTROL JOINT

1" = 1'-0"



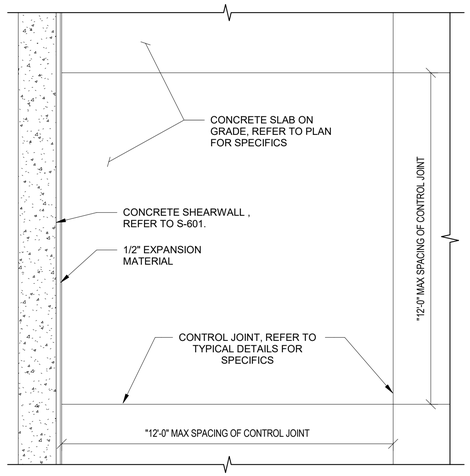
5 TYPICAL SOG CONTROL JOINT

1" = 1'-0"



6 WALL CORNER AND INTERSECTION DETAILS

1" = 1'-0"



7 TYPICAL PLAN VIEW OF CONTROL JOINT

3/4" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF
SIZE: ANSI D
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:29 AM
FILE NAME: PR-20190THQ6-S-501

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201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

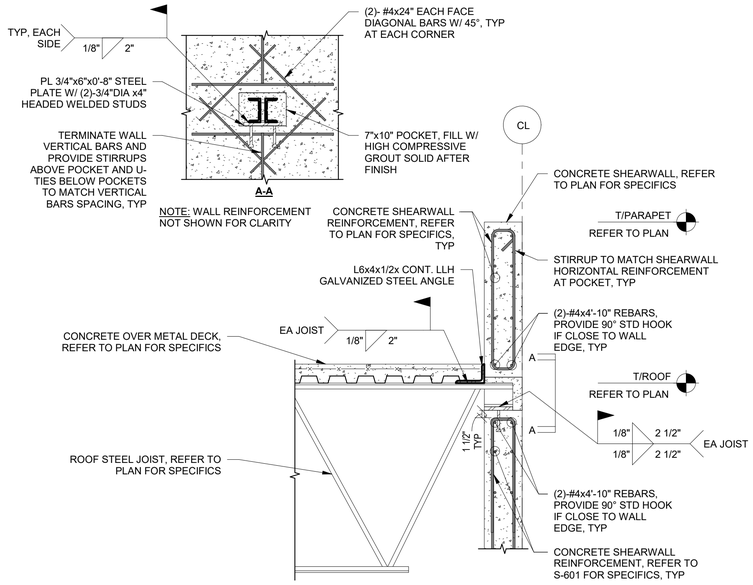
US ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
PHILADELPHIA, PA 19107

CAMP SANTIAGO, SALINAS, PUERTO RICO
PUERTO RICO ARMY NATIONAL GUARD
JOINT TRAINING CENTER
PR-20190T

HEADQUARTERS
BRIGADE HEADQUARTERS
FOUNDATION DETAILS

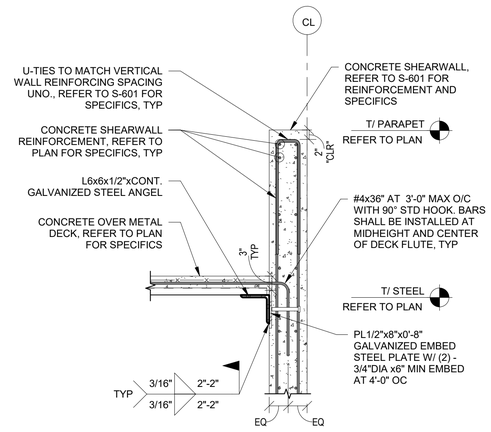
SHEET ID
HQ6
S-501
SHEET 8 OF 13

95%



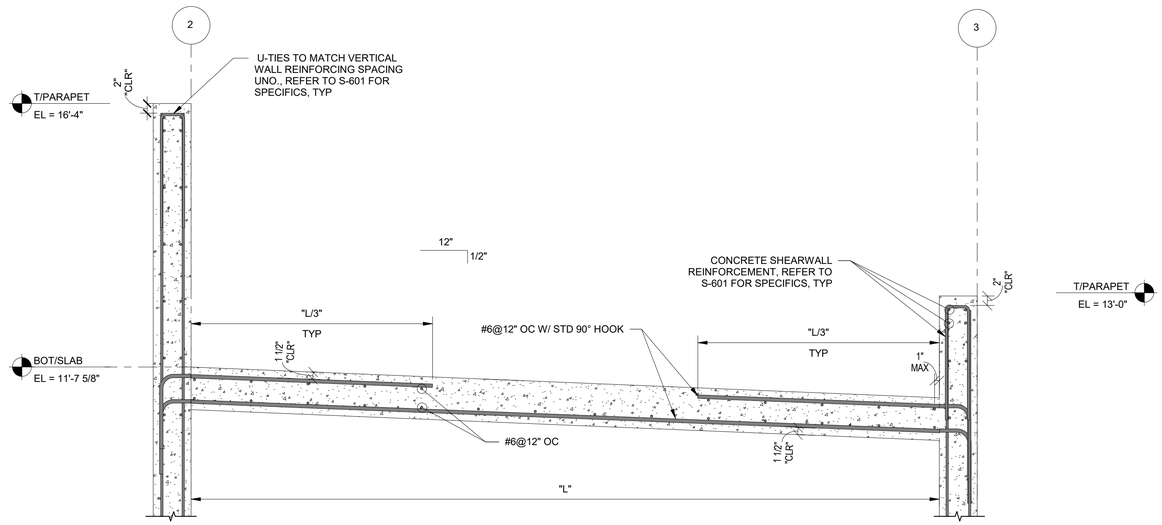
1 TYPICAL STEEL JOIST BEARING

3/4" = 1'-0"



2 TYPICAL DECK BEARING ON ANGLE

3/4" = 1'-0"



3 TYPICAL ONE-WAY SLAB BEARING

3/4" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF, E.T.L.M.E.
SIZE: ANSI D
FILE NAME: PR-20190THQ6-S-502
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:30 AM

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TRANSATLANTIC MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

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PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
PHILADELPHIA, PA 19107

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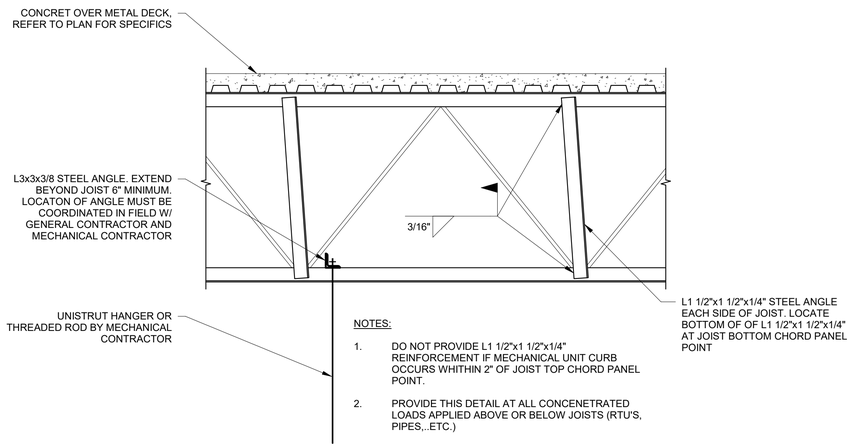
JOINT TRAINING CENTER
PR-201901

HEADQUARTERS
BRIGADE HEADQUARTERS
STRUCTURAL DETAILS

SHEET ID
HQ6

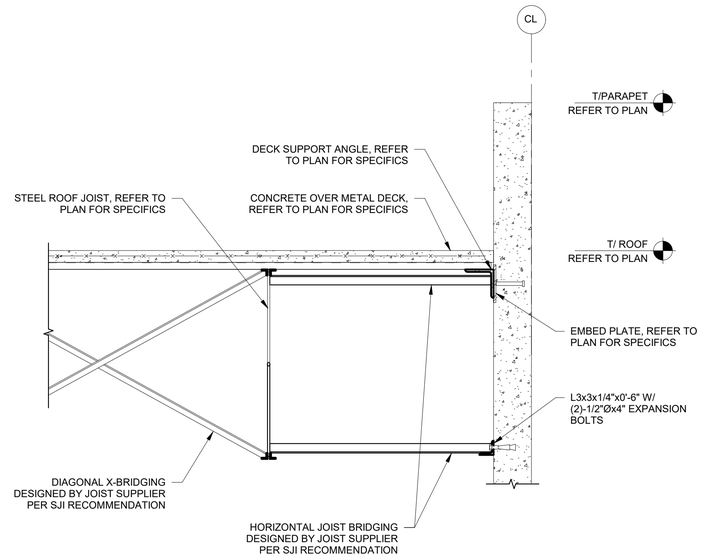
S-502
SHEET 9 OF 13

95%



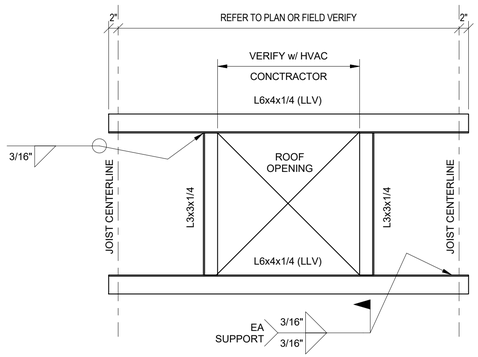
1 JOIST REINFORCEMENT - LOAD NOT AT PANEL POINT

3/4" = 1'-0"



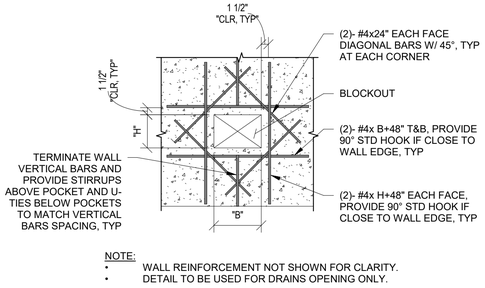
2 TYPICAL JOIST BRIDGING ATTACHMENT TO CONCRETE WALL

3/4" = 1'-0"



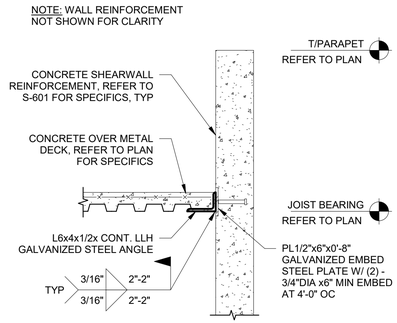
3 STEEL FRAME AT ROOF OPENING

3/4" = 1'-0"



4 TYPICAL WALL BLOCKOUT - ELEVATION

3/4" = 1'-0"



5 DECK ANGLE DETAIL

3/4" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF
SIZE: FE_FAME
ANSI D
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:31 AM
FILE NAME: PR-20190THQ6-S-503

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
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WINCHESTER, VA 22602

US ARMY CORPS OF ENGINEERS
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100 EAST PENN SQUARE
PHILADELPHIA, PA 19107

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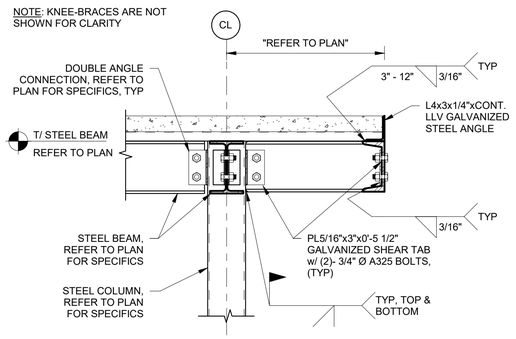
STRUCTURAL DETAILS

SHEET ID
HQ6

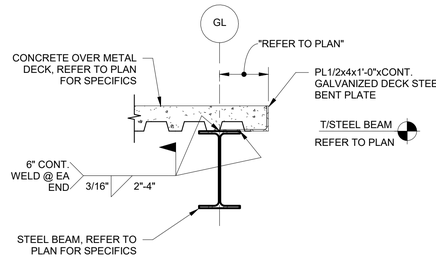
S-503
SHEET 10 OF 13

95%



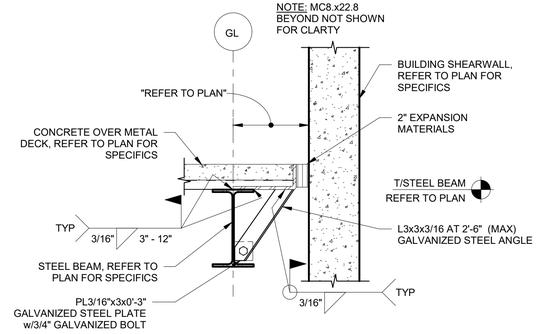
1 CANTILEVER FRAMING AT CANOPY

1" = 1'-0"



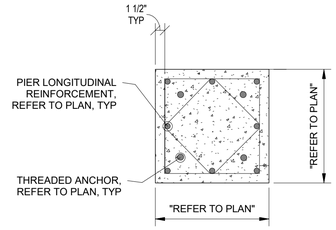
2 TYPICAL SLAB EDGE AT CANOPY

1" = 1'-0"

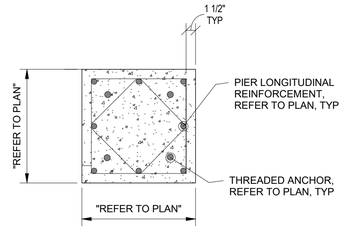


3 EXPANSION JOINT DETAIL AT CANOPY

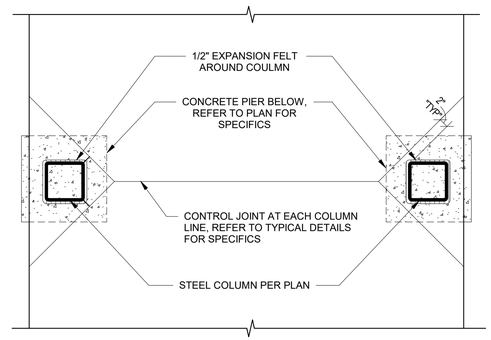
1" = 1'-0"



PIER CROSS-SECTION

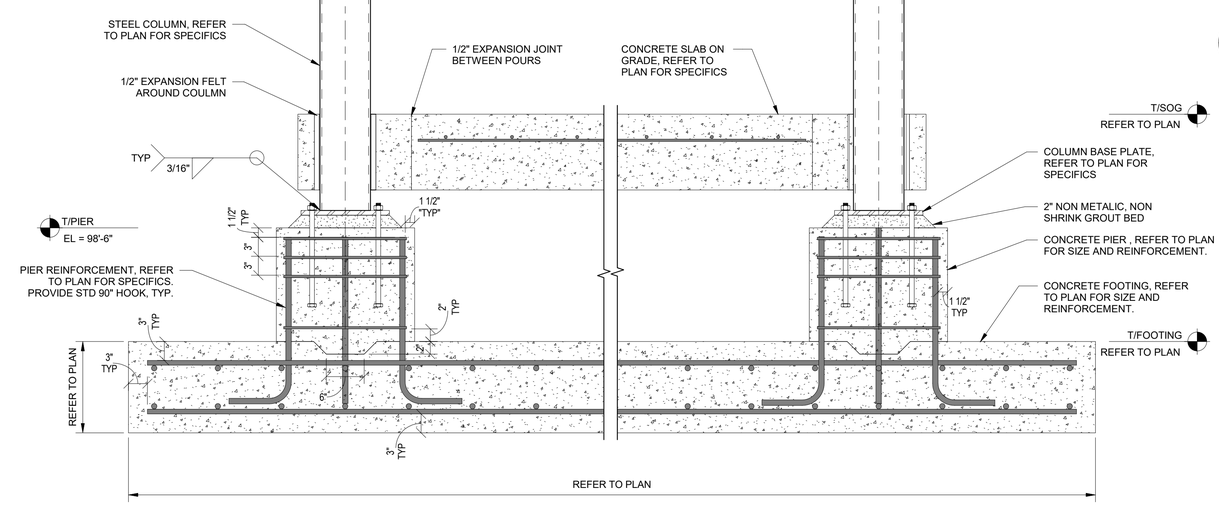


PIER CROSS-SECTION



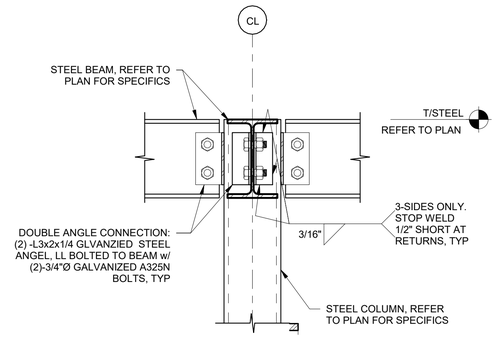
4 PLAN VIEW AT CANOPY COLUMN

3/4" = 1'-0"



5 STEEL COLUMN BEARING ON CONCRETE PIER

1" = 1'-0"



6 TYPICAL STEEL CONNECTION

1 1/2" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

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MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF
SIZE: F.F. NAME: ANSI D
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:33 AM
FILE: PR-20190THQ6-S-504

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

US ARMY CORPS OF ENGINEERS
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100 EAST PENN SQUARE
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PR-201901

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STRUCTURAL DETAILS

SHEET ID
HQ6

S-504
SHEET 11 OF 13

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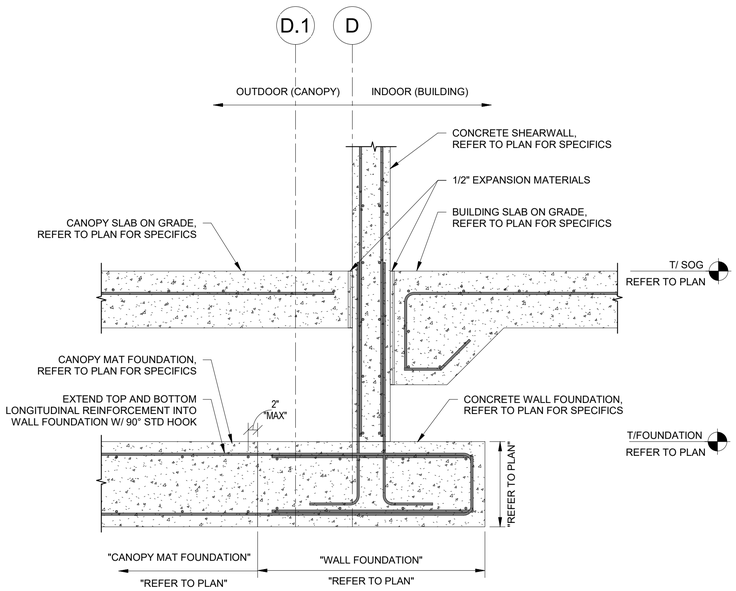
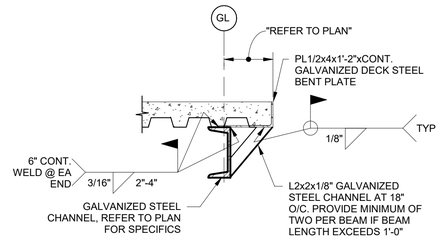


1 DETAIL AT MAT AND WALL FOUNDATION

3/4" = 1'-0"



2 CANOPY CANTILEVER FRAMING

1" = 1'-0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALJUBOORI
DRAWN BY: M. ALJUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY, CHIEF
SIZE: FE, FF, ME
ANSI D
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:34 AM
FILE NAME: PR-20190THQ6-S-505

US ARMY CORPS OF ENGINEERS
TRANSATLANTIC MIDDLE EAST DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

US ARMY CORPS OF ENGINEERS
PHILADELPHIA DISTRICT
100 EAST PENN SQUARE
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PR-201901

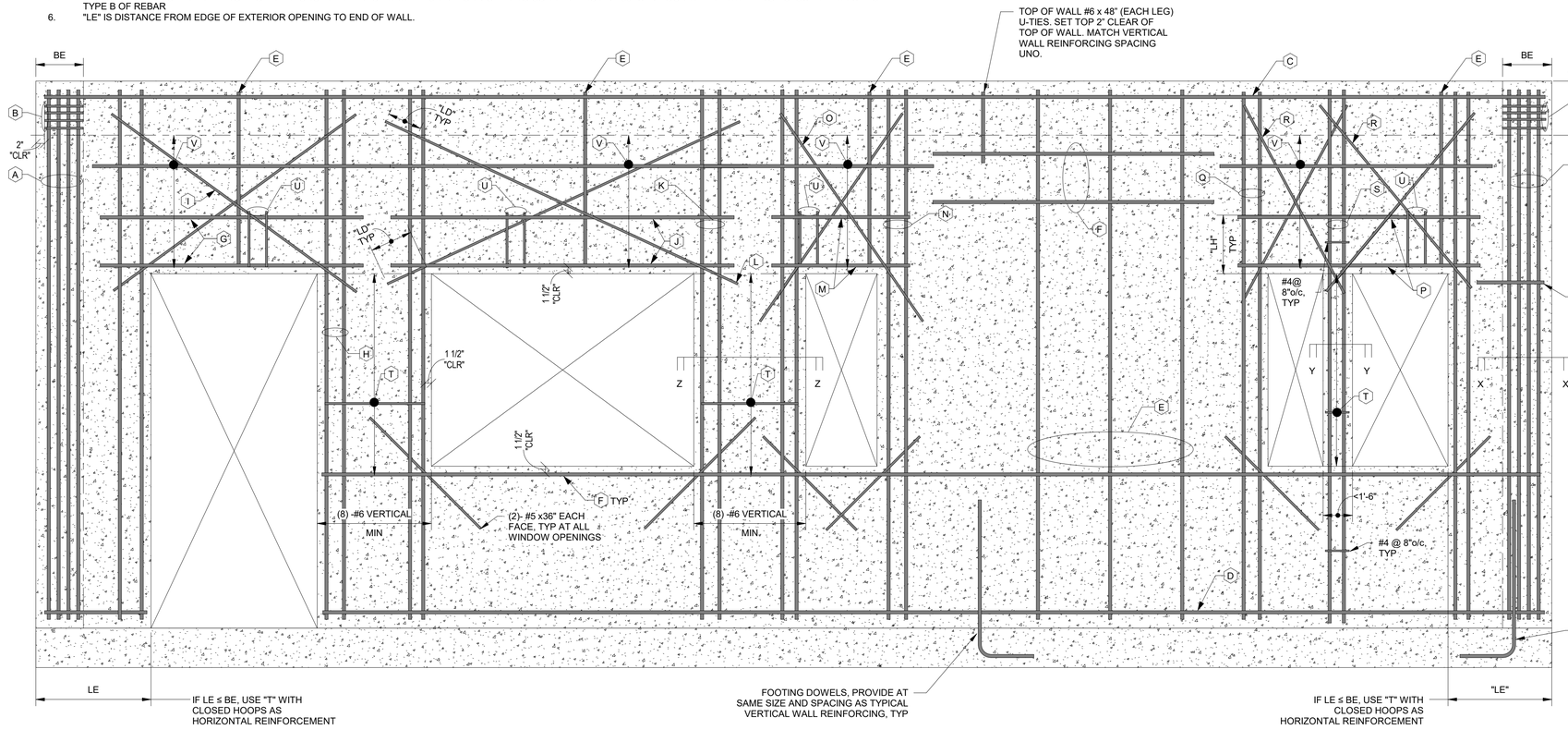
HEADQUARTERS
BRIGADE HEADQUARTERS
STRUCTURAL DETAILS

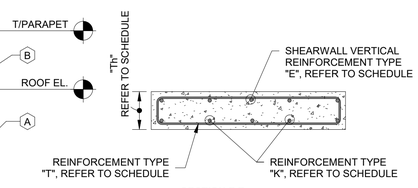
SHEET ID
HQ6
S-505
SHEET 12 OF 13

95%

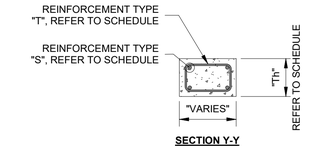
NOTES:

1. REFER TO DETAIL 1/S-501 FOR SHEARWALL TO FOUNDATION DETAIL
2. FOR LINTEL REINFORCEMENT TYPES; "G", "J", "M" & "P", PROVIDE 90° STD HOOK WHERE WALL EDGE DISTANCE TO EDGE OF OPENING IS CLOSER THAN 48"
3. PROVIDE SPLICE TYPE B AT ALL LOCATIONS. PROVIDE 90° STD HOOK WHERE WALL EDGE CLOSER THAN SPLICE TYPE B OF REBAR
4. REFER TO ARCH FOR OPENINGS LOCAION AND SIZE.
5. "LD" IS THE DEVELOPEMENT LENGTH OF REINFORCEMENT INTO PARAPET OR BEYOND OPENING CORNER. PROVIDE 90° STD HOOK WHERE WALL EDGE CLOSER THAN SPLICE TYPE B OF REBAR
6. "LE" IS DISTANCE FROM EDGE OF EXTERIOR OPENING TO END OF WALL.





SECTION Z-Z



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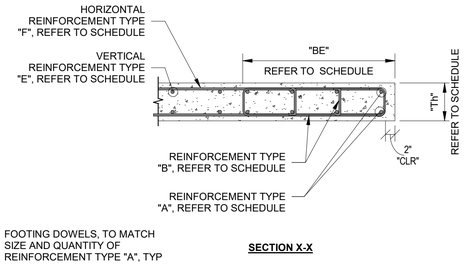

SECTION X-X

SHEARWALL	WALL THICKNESS "Th"	SHEARWALL REINFORCEMENT																							REMARKS
		LH	BE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	
SW1	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	-	-	-	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	#4 AT 4" OC	#6 AT 6" OC	
SW2	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	#4 AT 3" OC	#4 AT 4" OC	#6 AT 6" OC	
SW3	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	#4 AT 4" OC	#4 AT 8" OC	#6 AT 6" OC	
SW4	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	#4 AT 6" OC	#6 AT 6" OC	
SW5	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	-	-	-	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	#4 AT 4" OC	#6 AT 6" OC	
SW6	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	-	-	-	-	-	-	#4 AT 8" OC	#6 AT 6" OC	
SW7	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	-	-	-	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	#4 AT 8" OC	#6 AT 6" OC	
SW8	8"	18"	2'-6"	(8) - #6	#4 @ 8"	(2) - #6	(2) - #6	#6@ 14" OC EF	#6@ 14" OC EF	(2) - #6 T&B	(4) - #6	(2) -#5 EA FACE	-	-	-	(2) - #6	(4) - #6	(2) -#5 EA FACE	-	-	-	-	-	#4 AT 4" OC	#6 AT 6" OC	

1 SHEARWALL - ELEVATION

3/4" = 1'-0"

1' 0 1' 2' 3'

SCALE: 3/4" = 1' - 0"

US Army Corps of Engineers ®

MARK	DESCRIPTION	DATE

DESIGNED BY: M. ALIUBOORI
DRAWN BY: M. ALIUBOORI
CHECKED BY: D. NELSON
SUBMITTED BY: J. RAMEY / CHIEF, ME
ANSI ID: PR-20190THQ6-S-601
ISSUE DATE: 27 MAR 2020
SOLICITATION NO.:
CONTRACT NO.:
PLOT DATE: 7/27/2020 9:39:35 AM
FILE NAME: PR-20190THQ6-S-601

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HEADQUARTERS
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SHEARWALL ELEVATIONS

SHEET ID
HQ6
S-601
SHEET 13 OF 13

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ATTACHMENT 2
Geologic Background Information

FIGURES

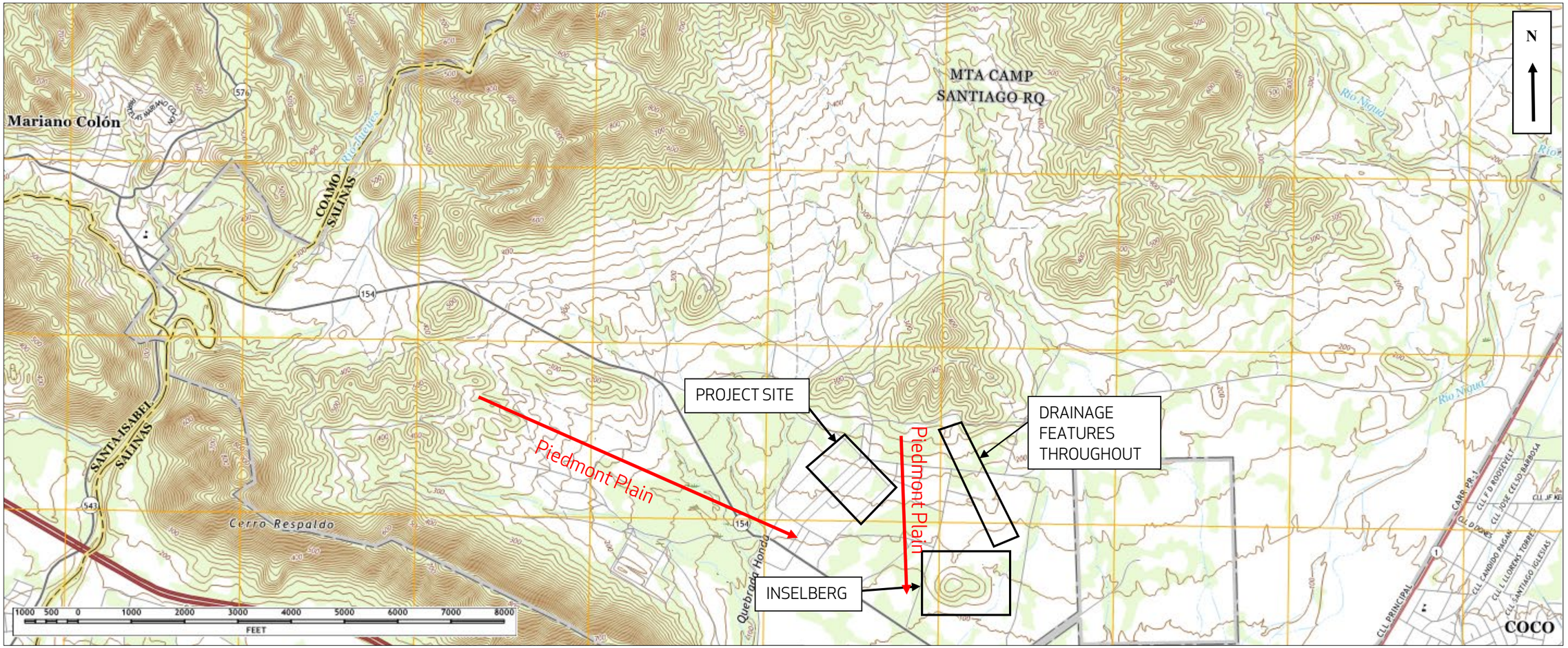


FIGURE 1
PROJECT LOCATION MAP

CAMP SANTIAGO, SALINAS COUNTY, PUERTO RICO

Michael Baker INTERNATIONAL

USGS US Topo 7.5 Minute Map for Coamo Quadrangle, Puerto Rico. 2018.	Created by: Dylan Brown Checked by: Brian Davis	

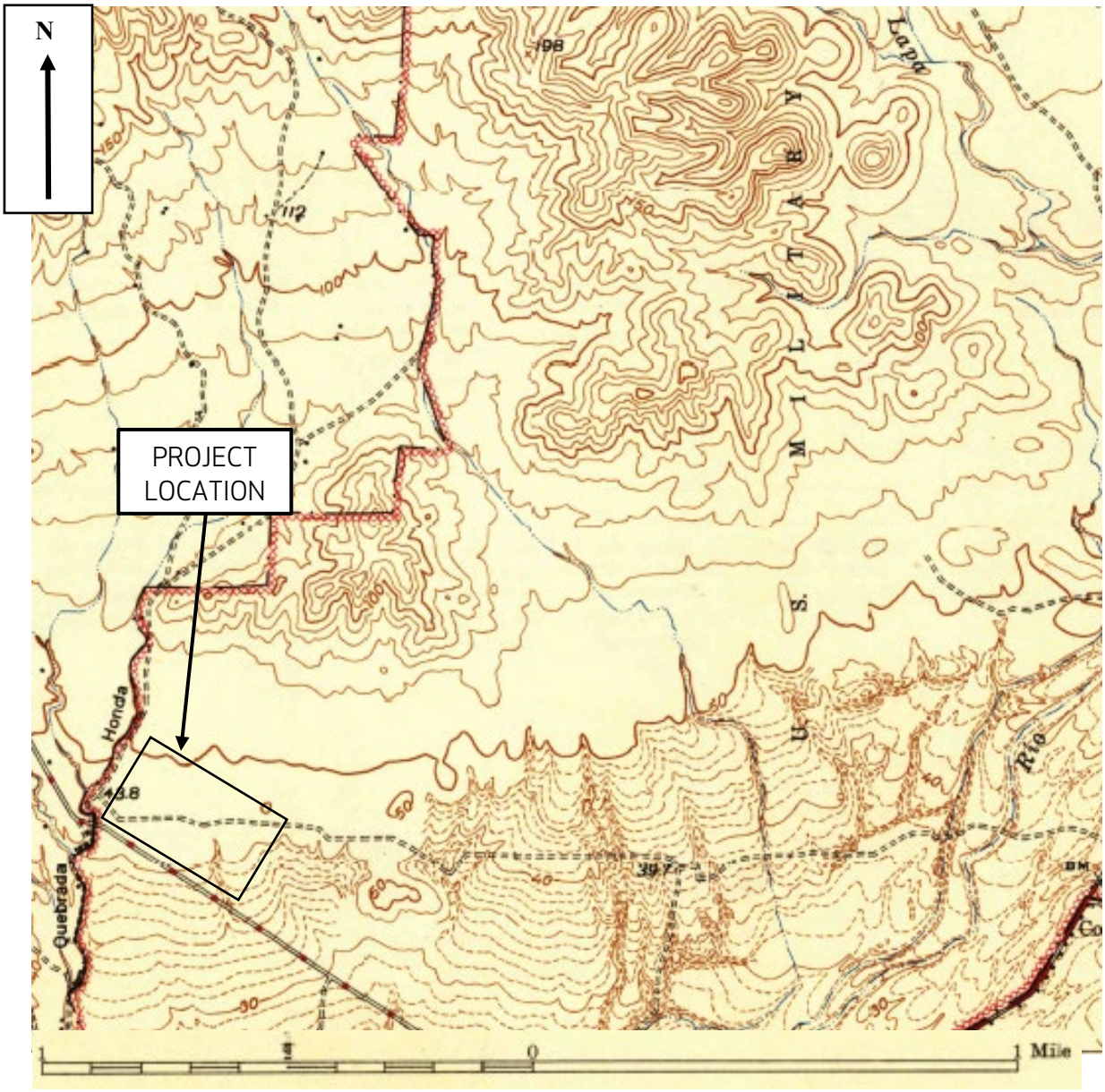


FIGURE 2
HISTORIC TOPOGRAPHIC MAP (1946)

Michael Baker INTERNATIONAL

Created by: Anna Ablak
Checked by: Dustin Soller

Camp Santiago
Salinas County, Puerto Rico

Approximate Scale in Miles – Contour Interval 10 meters
Source: USGS US Topo 7.5 Minute Map for Coamo Quadrangle, Puerto Rico. 1946.

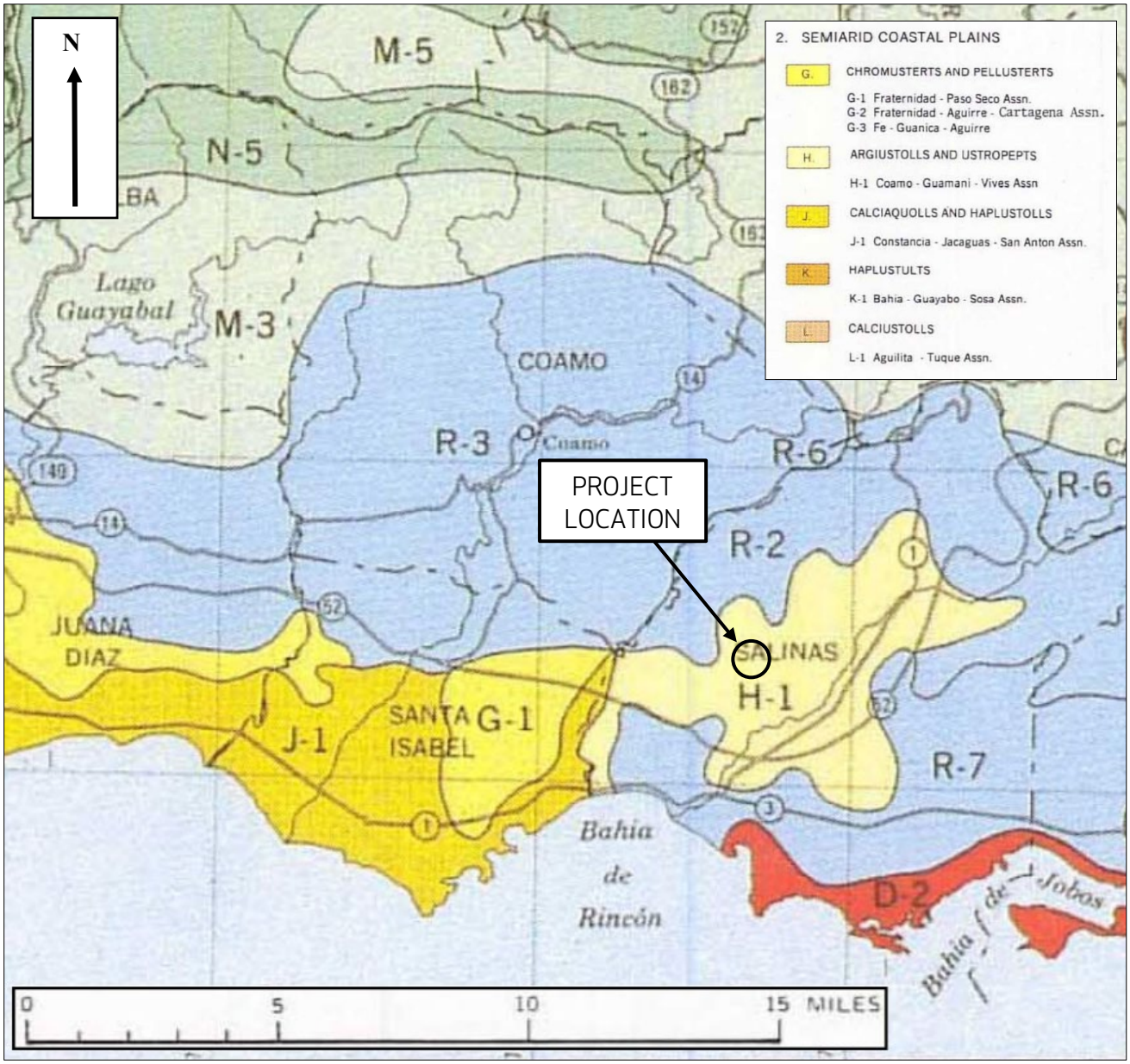
FIGURE 3
AERIAL PHOTO

Michael Baker INTERNATIONAL

Created by: Anna Ablak
Checked by: Dustin Soller

Camp Santiago
Salinas County, Puerto Rico

Source: Google Earth.



Created by: Dylan Brown
Checked by: Brian Davis

FIGURE 4
GENERAL SOILS MAP

Michael Baker INTERNATIONAL

Camp Santiago
Salinas County, Puerto Rico

Source: United States Geological Survey; *General Soil Map Puerto Rico*, 1984.

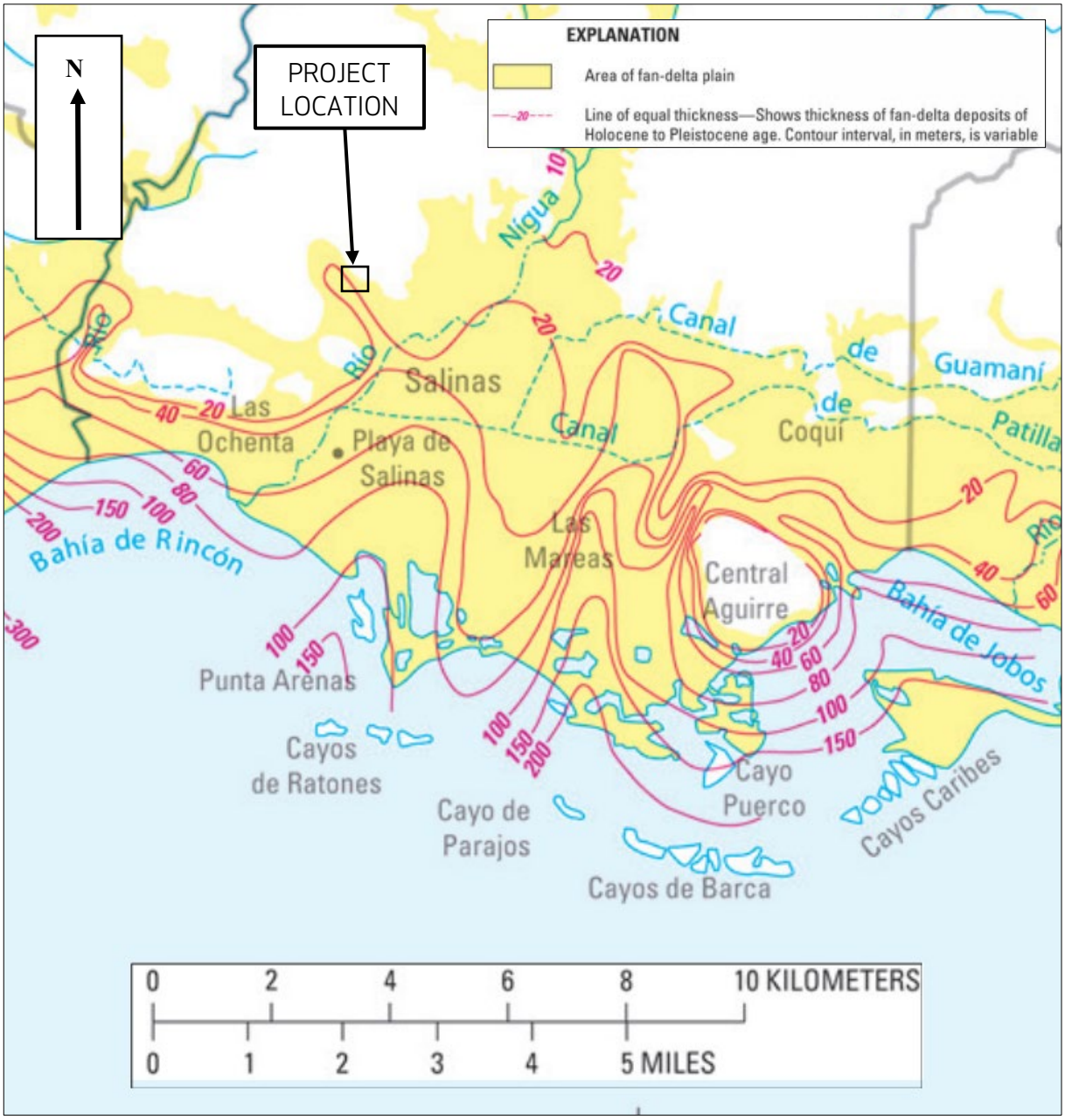


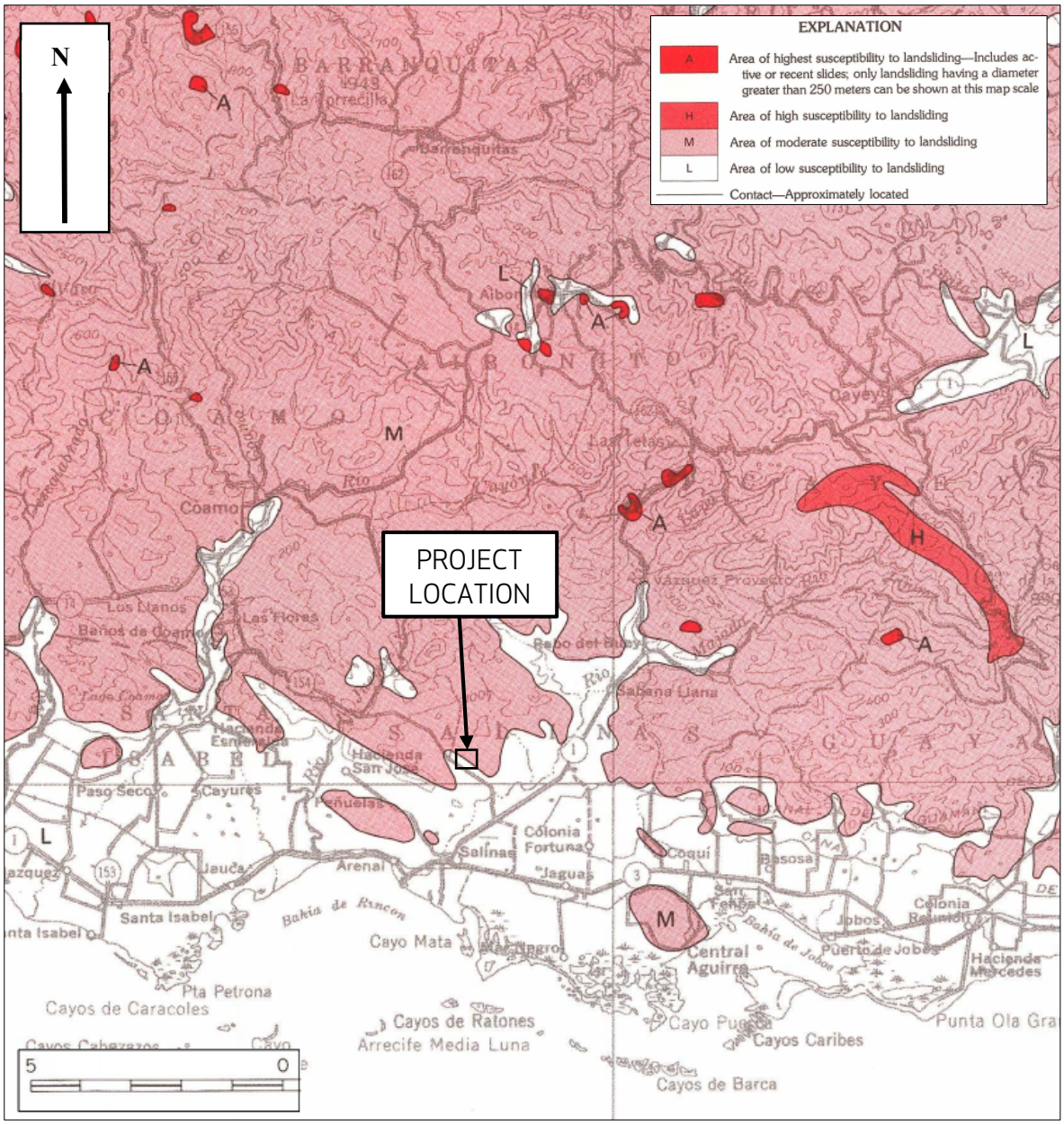
FIGURE 5
ALLUVIUM THICKNESSES IN SOUTHERN PUERTO RICO

Created by: Dylan Brown
Checked by: Brian Davis

Michael Baker INTERNATIONAL

Camp Santiago
Salinas County, Puerto Rico

Approximate Scale in Miles – Contour Interval 10 meters
Source: Rodriguez-Martinez, Jesus. *Stratigraphy, Structure, and Geologic and Coastal Hazards in the Penuelas to Salinas Area, Southern Puerto Rico: A Compendium of Published Literature*. Open-File Report 2007-1259. Reston, Virginia: U.S. Goelogical Survey, 2007.



Created by; Dylan Brown
Checked by: Brian Davis

FIGURE 6
LANDSLIDE SUSCEPTIBILITY MAP

Michael Baker
INTERNATIONAL

Camp Santiago
Salinas County, Puerto Rico

Approximate Scale in Miles – Contour Interval 100 meters
Source: Monroe, Watson H. *Map Showing Landslides and Areas of Susceptibility to Landsliding in Puerto Rico.* Miscellaneous Investigations Series Map I-1148. Arlington, Virginia: U.S. Geological Survey, 1979.

Michael Baker
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ATTACHMENT 3
Site Reconnaissance Photographs

Date: 2/27/2020

Photo #1: View looking northeast at buildings 409-412.

Date: 2/27/2020

Photo #2: View looking south at buildings 501 and 502.

Date: 2/27/2020

Photo #3: View looking north at buildings 721-724.

Date: 2/27/2020

Photo #4: View of building 724 and existing drainage infrastructure.

Date: 2/27/2020

Photo #5: View looking west at building 416.

Date: 2/27/2020

Photo #6: View looking north at Test Boring 448B1.

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ATTACHMENT 4
Field Investigation Results

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As-Drilled Geotechnical Test Boring and Test Pits Plan

Camp Santiago Facility Restoration

MBAKERINTL.COM

0 500

FEET

PLAN NORTH

A1 OVERALL SITE AND KEY PLAN

POINT TABLE

No.	NORTHING	EASTING	ELEVATION	DESCRIPTIONS
1	1,992,961.74	786,217.72	45.04	CP AM1
2	1,993,011.87	786,176.81	45.86	CP AM2
3	1,993,040.93	786,108.89	46.23	CP AM3
5	1,993,125.52	786,102.02	48.06	CP AM5
6	1,993,140.08	786,116.72	48.39	CP AM6
7	1,993,192.45	786,168.88	49.86	CP AM7
8	1,993,247.20	786,223.70	51.37	CP AM8
9	1,993,262.61	786,263.70	52.00	CP AM9
10	1,993,227.37	786,310.30	50.86	CP AM10
11	1,993,191.07	786,349.81	49.44	CP AM11
12	1,993,137.12	786,383.54	47.80	CP AM12
13	1,993,081.59	786,327.74	47.44	CP AM13
14	1,993,050.70	786,295.95	48.06	CP AM14
15	1,992,982.98	786,226.94	45.71	CP AM15
16	1,993,039.39	786,210.34	46.40	CP AM16
17	1,993,086.41	786,256.32	47.77	CP AM17
18	1,993,103.44	786,273.36	48.09	CP AM18
24	1,993,029.27	786,201.28	46.17	CP AM24
51	1,993,350.81	786,573.23	56.82	BM USACE1
52	1,993,204.72	786,699.06	52.09	BM USACE2
53	1,993,297.45	786,612.38	54.65	BM USACE3
54	1,993,105.80	786,420.66	47.05	BM USACE4
55	1,993,464.52	786,442.50	59.72	BM USACE5
56	1,993,501.43	786,434.19	61.41	BM USACE6
57	1,993,307.69	786,215.70	52.31	BM USACE7
61	1,993,148.35	787,024.51	50.02	CP BB01
62	1,993,148.78	787,024.39	50.04	CP BB02
63	1,993,076.37	786,582.08	47.89	CP BIDOT12972
64	1,993,081.60	786,574.50	47.90	CP724

Borehole Completion Table

Borehole Identification	Depth (ft)	Intended Structure
300B1	19.5	D1 DFAC
302B1	19.5	D1 DFAC
304B1	19.5	B3 Private Barracks
304B2	19.5	B3 Private Barracks
304B3	19.3	B3 Private Barracks
306B1	59.4	HQ6 - Headquarters
308B1	19.5	B3 Private Barracks
308B2	19.5	B3 Private Barracks
308B3	19.5	B3 Private Barracks
310B1	11	B1 1+1 Barracks
310B2	19	B1 1+1 Barracks
310B3	15.1	B1 1+1 Barracks
312B1	19.5	HQ2 - Headquarders
314B1	19.5	HQ1 - Headquarters
316B1	19.5	HQ2 - Headquarders
318B1	19	B1 1+1 Barracks
318B2	19.5	B1 1+1 Barracks
318B3	19.5	B1 1+1 Barracks
320B1	18.4	HQ4 - Headquarters
322B1	19.3	HQ4 - Headquarters
324B1	19.5	HQ4 - Headquarters
326B1	18.5	HQ4 - Headquarters
328B1	18.5	HQ4 - Headquarters
330B1	19.5	HQ4 - Headquarters
332B1	19.5	HQ5 - Headquarters
334B1	19.5	HQ5 - Headquarters
440B1	19.5	HQ2 - Headquarders
442B1	19.5	HQ7 - Headquarters
444B1	19.5	HQ7 - Headquarters
446B1	19.5	HQ7 - Headquarters
448B1	20.5	HQ5 - Headquarters
450B1	19.5	B2 OB Barracks
450B2	19.5	B2 OB Barracks
450B3	19.5	B2 OB Barracks
452B1	19.5	B2 OB Barracks
452B2	19	B2 OB Barracks
452B3	19.5	B2 OB Barracks
454B1	19	B2 OB Barracks
454B2	19.5	B2 OB Barracks
454B3	19.5	B2 OB Barracks
456B1	19.5	B2 OB Barracks
456B2	19.5	B2 OB Barracks
456B3	19.5	B2 OB Barracks
458B1	19.5	B2 OB Barracks
458B2	19.5	B2 OB Barracks
458B3	19.5	B2 OB Barracks
460B1	18.5	B2 OB Barracks
460B2	19.5	B2 OB Barracks
460B3	19.5	B2 OB Barracks

GENERAL SHEET NOTES

1. SURVEY TO BE REFERENCED TO UTM,WGS84 ZONE 19N DATUM. ELEVATIONS TO BE REFERENCED TO NAVD27
2. SURVEY ALL EXISTING FENCES AND GRADE CHANGE BREAK LINES TO 10 METERS OUTSIDE OF OUTER FENCE.
3. SURVEY ALL FEATURES ON THE NORTH EAST FENCE LINE TO INCLUDE NATURAL DRAIN TO LEFT TOP OF BANK FOR STORM WATER MANAGEMENT, INDIVIDUAL TREES AND SHRUBS DO NOT NEED TO BE LOCATED.
4. SURVEY ALL BUILDING OUTLINES AND FINISHED FLOOR ELEVATIONS.
5. SURVEY ALL ASPHALT OUTLINES AND AND CENTERLINES.
6. SURVEY ALL BREAK LINES FOR EARTH COVERED BUNKERS.
7. LOCATE ALL UTILITIES WITHIN SURVEY LIMITS TO INCLUDE ALL POLES, VALVES, HAND HOLES AND STRUCTURES.

SHEET KEYNOTES

1. PERCOLATION TEST
2. PAVEMENT TEST PITS
3. NEW SEWAGE LINE TEST PITS

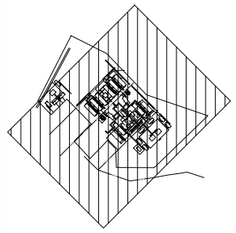
LEGEND

- Drilled Boreholes (as of 3/13/2020)
- Drilled Boreholes (as of 5/20/2020)
- Test Pits & Percolation Test (TP=Test pit; PTP=Pavement test pit)
- Headquarters
- Barracks
- DFAC
- HQ5 - Headquarters
- Canopy

BORING LOCATION MAP NOTES

1. THIS MAP HAS BEEN MODIFIED FOR DISPLAY ON A GOOGLE EARTH PROJECTION.
2. BORING LOCATIONS ARE APPROXIMATE.

KEY PLAN



DIM. NOTE AND NORTH

DIMENSIONS SHOWN ARE IN METERS UNLESS OTHERWISE NOTED.

US Army Corps of Engineers®

MARK	DESCRIPTION	DATE

DESIGNED BY: R. FISCHER
DRAWN BY: J. COON
CHECKED BY: J. CHECKER
SUBMITTED BY: J. SUBMITTER
ANSI D
ISSUE DATE: 11 OCT 19
SOLICITATION NO.: SOL
CONTRACT NO.: CONTR
PLOT DATE: 15 Feb 20 07:50:57
FILE NAME: PR-1901-C-002GN.dwg

U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT
201 PRINCE FREDERICK DRIVE
WINCHESTER, VA 22602

CAMP SANTIAGO, PUERTO RICO
JOINT TRAINING CENTER
PR-1901

SITE DESIGN
OVERALL SITE AND KEY PLAN

SHEET ID
-
C-002

35%

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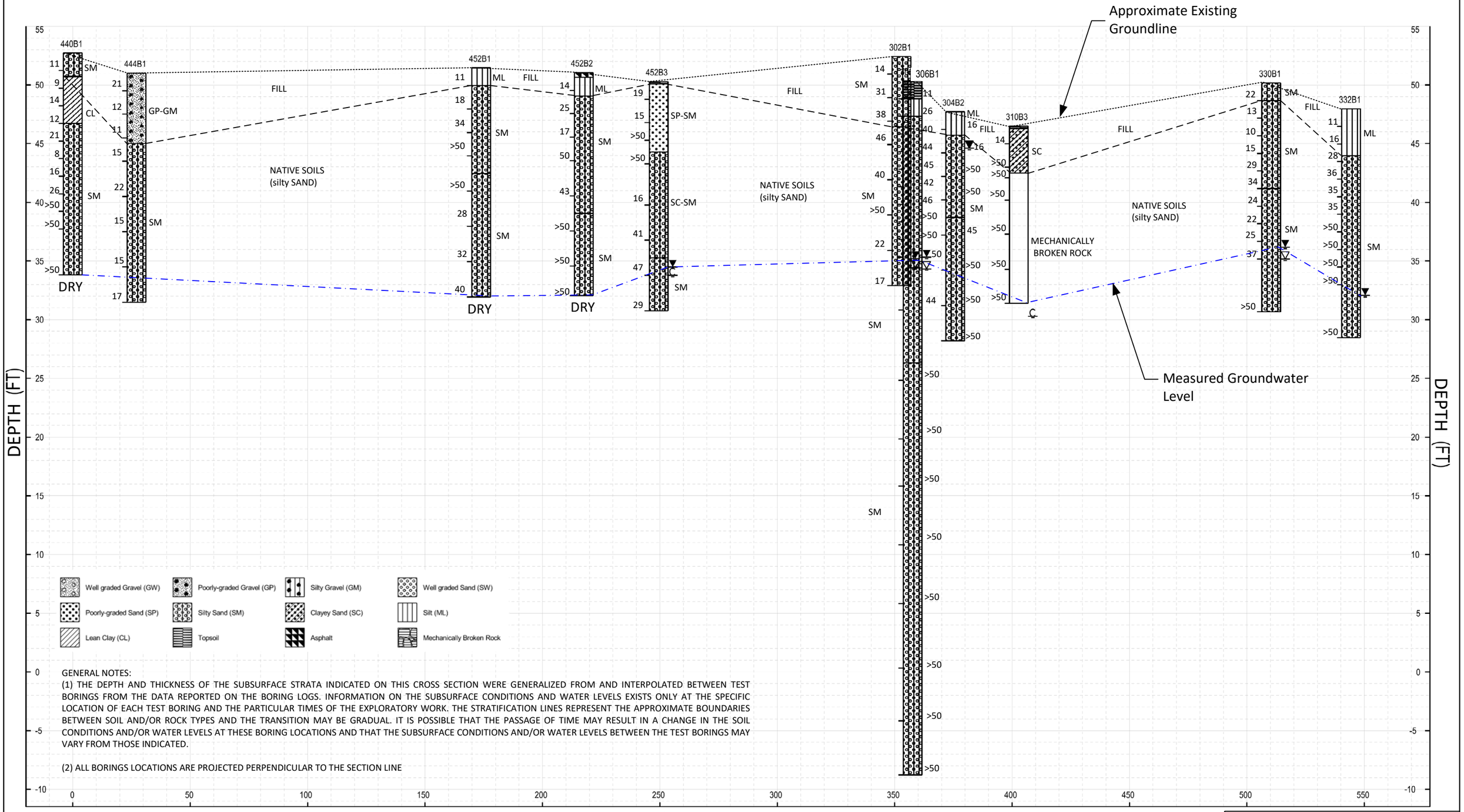
Subsurface Cross Section



GENERAL NOTES:
(1) THE DEPTH AND THICKNESS OF THE SUBSURFACE STRATA INDICATED ON THIS CROSS SECTION WERE GENERALIZED FROM AND INTERPOLATED BETWEEN TEST BORINGS FROM THE DATA REPORTED ON THE BORING LOGS. INFORMATION ON THE SUBSURFACE CONDITIONS AND WATER LEVELS EXISTS ONLY AT THE SPECIFIC LOCATION OF EACH TEST BORING AND THE PARTICULAR TIMES OF THE EXPLORATORY WORK. THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN SOIL AND/OR ROCK TYPES AND THE TRANSITION MAY BE GRADUAL. IT IS POSSIBLE THAT THE PASSAGE OF TIME MAY RESULT IN A CHANGE IN THE SOIL CONDITIONS AND/OR WATER LEVELS AT THESE BORING LOCATIONS AND THAT THE SUBSURFACE CONDITIONS AND/OR WATER LEVELS BETWEEN THE TEST BORINGS MAY VARY FROM THOSE INDICATED.

(2) ALL BORINGS LOCATIONS ARE PROJECTED PERPENDICULAR TO THE SECTION LINE

SCALE

HORIZONTAL 0 25 50 FEET

VERTICAL 0 5 10 FEET

— — — Approximate Material Boundaries

..... Approximate Existing Ground

Water Level Reading 1

Water Level Reading 2

Water Level Reading 3

Boring Caved

SPT N (Blows/Ft)

Sample Recovery (%)

Sample RQD (%)

50/0.5 13

100(67)

CAMP SANTIAGO

SUBSURFACE PROFILE
GENERAL SECTION – NORTH TO SOUTH

Completed by: AMA
Checked by: SED

08/11/2020

$$ DESIGN FILE NAME $$ $$ DATE TIME $$

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Test Boring Logs

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STRATIGRAPHIC SYMBOLS

Well graded Gravel (GW)

Poorly-graded Gravel (GP)

Silty Gravel (GM)

Well graded Sand (SW)

Poorly-graded Sand (SP)

Silty Sand (SM)

Clayey Sand (SC)

Silt (ML)

Lean Clay (CL)

Topsoil

Asphalt

Mechanically Broken Rock

Miscellaneous Symbols

TEMPLATE=10GD_PROJECT_STRATA_SYMBOLS PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

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DEFINITION OF SOIL TERMS (Page 1 of 3)

Soil Description (ASTM D2488)

Criteria			Group Symbol	Primary Group Name
< 50% Passing #200 sieve	% gravel > % sand	< 5% passing #200 sieve	GP	Poorly graded gravel
			GW	Well-graded gravel
		> 15% passing #200 sieve	GM	Silty gravel
			GC	Clayey gravel
		5-15% passing #200 sieve	GW-GM	Well-graded gravel with silt
			GW-GC	Well-graded gravel with clay
			GP-GM	Poorly graded gravel with silt
			GP-GC	Poorly graded gravel with clay
	% gravel < % sand	< 5% passing #200 sieve	SP	Poorly graded sand
			SW	Well-graded sand
		> 15% passing #200 sieve	SM	Silty sand
			SC	Clayey sand
		5-15% passing #200 sieve	SW-SM	Well-graded sand with silt
			SW-SC	Well-graded sand with clay
			SP-SM	Poorly graded sand with silt
			SP-SC	Poorly graded sand with clay
> 50% passing #200 sieve			ML	Silt
			MH	Elastic Silt
			OL	Organic Silt
			CL	Lean Clay
			CH	Fat Clay
			OH	Organic Clay

Grain Size (ASTM D2488)

Material	Size (mm)	Size (in)	US sieve
Boulder	> 300	> 12	
Cobble	75 to 300	3 to 12	
Gravel			
Coarse	19 to 75	0.75 to 3	¾ to 3
Fine	4.75 to 19	0.187 to 0.75	#4 to ¾
Sand			
Coarse	2.0 to 4.75		#10 to #4
Medium	0.425 to 2.0		#40 to #10
Fine	0.075 to 0.425		#200 to #40
Silt and Clay	<0.075		#200

Angularity (ASTM D2488)

Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces
Subangular	Particles are similar to angular description but have rounded edges
Subrounded	Particles have nearly plane sides but have well rounded corners and edges
Rounded	Particles have smoothly curved sides and no edges

Particle Shape (ASTM D2488)

Flat	Particles with width/thickness >3.
Elongated	Particles with length/width >3.
Flat and elongated	Particles meet criteria for both flat and elongated

Particle Hardness (ASTM D2488)

particles are hard (particles do not fracture under considerable hammer blow)
(particles fracture under considerable hammer blow)
(particles crush under hammer blow)
(particles crush under hand pressure)

NOTES: (ASTM D2488) "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ", American Society of Testing and Materials, Standard D-2488, 2017

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DEFINITION OF SOIL TERMS (Page 2 of 3)

Continued from previous page

Plasticity of Fines (ASTM D2488)

Non Plastic	A 1/8 inch (3 mm) thread cannot be rolled at any water content.
low plasticity	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
medium plasticity	The thread is easy to roll, and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
high plasticity	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Dry Strength (ASTM D2488)

no dry strength	The dry specimen crumbles with mere pressure of handling.
low dry strength	The dry specimen crumbles with some finger pressure.
medium dry strength	The dry specimen breaks into pieces or crumbles with considerable finger pressure.
high dry strength	The dry specimen cannot be broken with finger pressure. Specimen will break into pieces between thumb and a hard surface.
very high dry strength	The dry specimen cannot be broken between thumb and a hard surface.

Dilatancy (ASTM D2488)

no dilatancy	No visible change in the specimen.
slow dilatancy	Water slowly appears on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
rapid dilatancy	Water quickly appears on the surface of the specimen during shaking and disappears upon squeezing.

Toughness (ASTM D2488)

low toughness	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
medium toughness	Medium pressure is required to roll the thread to near the plastic limit. The thread and the lump have medium stiffness.
high toughness	Considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump have very high stiffness.

Reaction to HCL (ASTM D2488)

no reaction to HCl	No visible reaction.
weak reaction to HCl	Some reaction, with bubbles forming slowly.
strong reaction to HCl	Violent reaction, with bubbles forming immediately.

Moisture Condition (ASTM D2488)

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually the soil is below the water table

Relative Moisture

NP	A 1/8 inch (3 mm) thread cannot be rolled at any water content
-PL	Breaks up at larger than a 1/8 inch (3 mm) diameter roll of soil
+PL	Cohesive to a 1/8 inch (3 mm) diameter roll of soil
+LL	Conforms to container when shaken

NOTES: (ASTM D2488) "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ", American Society of Testing and Materials, Standard D-2488, 2017

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DEFINITION OF SOIL TERMS (Page 3 of 3)

In-place conditions

Apparent Density of Granular Soils (FHWA NHI-06-088)

Term	SPT N60 (BPF or B/0.3 m)	Response to ½" (6 mm) rod driven with 5lb (2.3 kgf) hammer**	Relative Density (%)
Very Loose	0 - 4		
Loose	5 - 10	Easily penetrated by hand	0-40
Medium Dense	11 - 30	Easily penetrated with hammer	40-70
Dense	31 - 50	Penetrates 1 foot (0.3 m)	70-85
Very Dense	> 50	Penetrates 1 inch (2.5 cm)	85-100

Consistency of Cohesive Soils (FHWA NHI-06-088)

Term	SPT N60 (BPF or B/0.3 m)	Unconf. comp. strength (TSF or Kg/cm^2)	Results of Manual Manipulation
Very soft	< 2	< 0.25	Specimen (height = twice diameter) sags under its own weight, extrudes between fingers when squeezed
Soft	2 – 4	0.25 – 0.5	Specimen can be pinched in two between thumb and forefinger, remolded by light finger pressure
Medium stiff	4 – 8	0.5 - 1	Imprinted easily with fingers, remolded by strong finger pressure
Stiff	8 – 15	1 - 2	Imprinted by considerable finger pressure or indented by thumbnail
Very stiff	15 – 30	2 - 4	Barely imprinted by finger or indented by thumbnail
Hard	> 30	> 4	Cannot be imprinted by finger, difficult to indent by thumbnail

Fabric/Structure (ASTM D2488)

Stratified	Alternating layers of varying material or color with layers at least ¼ inch (6 mm) thick.
Laminated	Alternating layers of varying material or color with the layers less than ¼ inch (6 mm) thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Homogeneous	Same color and appearance throughout
Heterogeneous*	Contains many distinctly different materials randomly arranged (as in an embankment fill)

Cementation (ASTM D2488)

weak cementation	Crumbles or breaks with handling or little finger pressure.
moderate cementation	Crumbles or breaks with considerable finger pressure.
strong cementation	Will not crumble or break with finger pressure.

NOTES: (ASTM D2488) "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) ", American Society of Testing and Materials, Standard D-2488, 2017

(FHWA NHI-06-088) "Soils and Foundation Workshop – Reference Manual", U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI-06-088, December 2006

* Not part of ASTM standard D2488, added for completeness.

** Rod test behavior added from NHI Publication FHWA HI-97-021 "Subsurface Investigations", November 1997.

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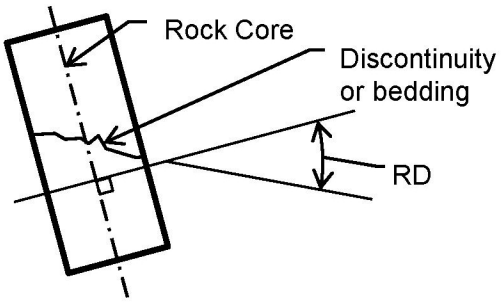
DEFINITION OF ROCK TERMS (Page 1 of 2)

Bedding Spacing (FHWA NHI-06-088)

Term	Spacing
Very Thickly bedded	>3.3 ft (> 1 m)
Thickly bedded	1.6 ft - 3.3 ft (0.5 to 1.0 m)
Thinly bedded	2 in - 1.5 ft (50 mm to 500 mm)
Very Thinly bedded	3/8 in - 2 in (10 mm to 50 mm)
Laminated	3/32 in - 3/8 in (2.5 mm to 10 mm)
Thinly Laminated	< 3/32 in (< 2.5 mm)

RD (Relative Dip)

Relative Dip (RD) is the angle of discontinuities or bedding observed in the core with respect to a plane perpendicular to the axis of the core.



Discontinuity Spacing (FHWA NHI-06-088) & (ISRM, 1981)*

Term	Spacing
Extremely Wide	>20 ft (> 6m)
Very Wide	6.5 ft - 20 ft (2m – 6m)
Wide	2 ft - 6.5 ft (0.6m – 2m)
Moderate	8 in - 2 ft (0.2m – 0.6m)
Close	2.5 in - 8 in (0.06m – 0.2m)
Very Close	3/4 in - 2.5 in (0.02m – 0.06m)
Extremely Close	<3/4 in (<0.06m)

Unit RQD

Unit RQD is calculated per lithologic unit and represents the average RQD of that unit. RQD is as defined in ASTM D6032 and is calculated as follows.

$$100\% \text{ X } \frac{\text{(Length of sound core pieces >4 in. long)}}{\text{(Total length of lithologic unit)}}$$

NOTES:

(FHWA NHI-06-088) "Soils and Foundation Workshop – Reference Manual", U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI-06-088, December 2006

(ISRM, 1981) Brown, E.T.; "Suggested Methods for the Quantitative Description of Discontinuities"; International Society of Rock Mechanics (ISRM); Pergamon Press; Oxford, New York; 1981.

* Criteria is consistent between both references.

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DEFINITION OF ROCK TERMS (Page 2 of 2)

Continued

Weathering (FHWA NHI-06-088) & (ISRM, 1981)*

Weathering Term		Description
I	Fresh	Rock shows no discoloration, loss of strength, or other effects of weathering/alteration
II	Slightly weathered	Rock is slightly discolored, but not noticeably lower in strength than fresh rock
II	Moderately weathered	Rock is discolored and noticeably weakened, but less than half is decomposed; a minimum 2 in (50 mm) diameter sample cannot be broken readily by hand across the rock fabric
IV	Highly weathered	More than half of the rock is decomposed; rock is weathered so that a minimum 2 in (50 mm) diameter sample can be broken readily by hand across the rock fabric
V	Completely weathered	Original minerals of rock have been almost entirely decomposed to secondary minerals even though the original fabric may be intact; material can be granulated by hand
VI	Residual soil	Original minerals of rock have been entirely decomposed to secondary minerals, and original rock fabric is not apparent; material can be easily broke by hand

Rock Strength (FHWA NHI-06-088) & (ISRM, 1981)*

Strength Term		Description	Approximate Unconfined Compressive Strength PSI (mPa)
R6	Extremely Strong Rock	Can only be chipped with blows of geologist's hammer	>36000 (>250)
R5	Very Strong Rock	Requires many blows of geologist's hammer to fracture	15000 – 36000 (100-250)
R4	Strong Rock	Requires one blow of geologist's hammer to fracture	7000 – 15000 (50-100)
R3	Medium Strong Rock	Can be indented 3/16 in (5 mm) with sharp end of pick	3500 – 7000 (25-50)
R2	Weak Rock	Can be peeled with difficulty by pocket knife	725 – 3500 (5-25)
R1	Very Weak Rock	Can be peeled by pocket knife	150 – 725 (1-5)
R0	Extremely Weak Rock	Can be indented by thumbnail	35 – 150 (0.25-1)

NOTES: (FHWA NHI-06-088) "Soils and Foundation Workshop – Reference Manual", U.S. Department of Transportation, Federal Highway Administration, Publication No. FHWA NHI-06-088, December 2006

(ISRM, 1981) Brown, E.T.; "Suggested Methods for the Quantitative Description of Discontinuities"; International Society of Rock Mechanics (ISRM); Pergamon Press; Oxford, New York; 1981.

* Criteria is consistent between both references.

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LOG OF BORING NO.: 300B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/4/2020** END: **3/4/2020**

NORTH: **1993174.178** EAST: **786475.554** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **4.94** ℄ CAVED @ TIME: **14:15** DATE: **3/4/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.03** ℄ CAVED @ TIME: **08:00** DATE: **3/5/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.37**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	11 11 10			0	Well-graded SAND with silt and gravel (sw-sm); sand is fine; gravel is fine to coarse; nonplastic; brown, grayish; dry; NP; HCL test not performed; loose to medium dense.	FILL.
0.46	A-N							
0.61	S-2	67%	7 6 4			1		
1.07	A-N							
1.22	S-3	100%	11 12 15				1.52m - EL 48.85	
1.68	A-N						Silty SAND (SM); sand is fine to medium; nonplastic; brown; dry to wet; NP; HCL test not performed; medium dense to dense.	
1.83	S-4	100%	18 24 25	**(1.83-3.20)** PL=NP MC=10 % USCS=SM AASHTO=A-1-b		2		
2.29	A-N							
2.74	S-5	100%	11 20 27			3		
3.20	A-N							
3.66	S-6	100%	11 20 27	**(3.66-5.03)** PL=NP MC=15 % USCS=SM AASHTO=A-1-b		4		
4.11	A-N							
4.57	S-7	100%	11 22 32		▽▼	5		
5.03	A-N							
5.49	S-8	80%	20 24 32				5.94m - EL 44.43	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 302B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/5/2020** END: **3/6/2020**

NORTH: **1993254.223** EAST: **786556.188** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.49** ⌭ CAVED @ TIME: **09:10** DATE: **3/5/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.24** ⌭ CAVED @ TIME: **09:10** DATE: **3/6/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.42**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	43%	5 6 8			0	Silty SAND with gravel (SM); sand is fine to medium; gravel is fine to coarse; nonplastic; brown; dry; NP; HCL test not performed; medium dense to dense.	FILL.
0.46	A-N							
0.61	S-2	33%	9 15 16	**(0.61-1.68)** PL=NP MC=8 % USCS=SM AASHTO=A-1-b		1		
1.07	A-N							
1.22	S-3	100%	10 21 17					
1.68	A-N						1.83m - EL 50.59	
1.83	S-4	67%	17 18 28			2	Silty SAND (SM); sand is fine; gravel is fine; nonplastic; brown; dry; NP; HCL test not performed; medium dense to very dense.	
2.29	A-N							
2.74	S-5	100%	20 18 22	**(2.74-4.11)** PL=NP MC=12 % USCS=SM AASHTO=A-1-b		3		
3.20	A-N							
3.66	S-6	100%	21 28 26			4		
4.11	A-N							
4.57	S-7	100%	15 6 16			5		
5.03	A-N							
5.49	S-8	100%	9 7 10				5.94m - EL 46.48	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 304B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/13/2020** END: **3/13/2020**

NORTH: **1993133.659** EAST: **786491.447** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.39** ▽ CAVED @ TIME: **15:35** DATE: **3/13/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▽ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▽ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **48.6**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	37%	3 4 5	**S-1(0.00-0.46)** PPen=>4.5 tsf PL=21 % LL=46 % MC=12 % USCS=SC AASHTO=A-7-6		0	Clayey SAND with gravel (SC); sand is fine to medium; gravel is fine to coarse, angular; dark brown, grayish; moist; weak reaction to HCl; medium dense.	FILL.
0.46	A-N						0.61m - EL 47.99	
0.61	S-2	100%	7 8 10	**(0.61-1.68)** PL=NP MC=4 % USCS=SM AASHTO=A-1-b		1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; moist; NP; strong reaction to HCl; medium dense to dense.	
1.07	A-N							
1.22	S-3	67%	18 20 25					
1.68	A-N					2		
1.83	S-4	67%	20 21 22					
2.29	A-N						2.74m - EL 45.86	
2.74	S-5	100%	19 23 33			3	Poorly graded SAND with silt (sp-sm); sand is fine to coarse, angular; nonplastic; dark brown; moist; NP; strong reaction to HCl; dense to very dense.	
3.20	A-N							
3.66	S-6	87%	24 31 45			4		
4.11	A-N							
4.57	S-7	100%	27 50/0.15					
4.88	A-N					5		
5.49	S-8	100%	18 19 16					
5.94							5.94m - EL 42.66	
						6	End of Boring at 5.94m	

Boring backfilled with cuttings. 24-hour water level reading not taken as a result of complications from COVID-19.

CHECKED BY: EHB
TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 304B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/12/2020** END: **3/12/2020**

NORTH: **1993107.357** EAST: **786521.574** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **0.94** ⊆ CAVED @ TIME: **15:32** DATE: **3/12/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **0.94** ⊆ CAVED @ TIME: **08:00** DATE: **3/13/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.71**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	5 10 6	**S-1(0.00-0.46)** PPen=>4.5 tsf	0	Gravelly SILT with sand (ml); sand is fine to medium; gravel is fine to coarse, angular; low plasticity; dark brown, grayish; moist; -PL; weak reaction to HCl; very stiff.	FILL.
0.46	A-N					0.61m - EL 47.10	
0.61	S-2	100%	6 8 8		1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; moist; NP; strong reaction to HCl; medium dense to very dense.	
1.07	A-N						
1.22	S-3	100%	14 34 50	**(1.22-2.29)** PL=NP MC=12 % USCS=SM AASHTO=A-2-4	2		
1.68	A-N						
1.83	S-4	100%	14 20 40				
2.29	A-N					2.74m - EL 44.97	
2.74	S-5	100%	17 20 25		3	Silty SAND (SM); sand is fine to coarse, angular; nonplastic; dark brown; moist; NP; strong reaction to HCl; dense to very dense.	
3.20	A-N						
3.66	S-6	87%	15 25 40	**(3.66-5.03)** PL=NP MC=9 % USCS=SM AASHTO=A-2-4	4		
4.11	A-N						
4.57	S-7	93%	17 25 38		5		
5.03	A-N						
5.49	S-8	87%	16 25 45			5.94m - EL 41.77	
5.94					6	End of Boring at 5.94m	

Boring backfilled with cuttings. Suspected broken utility in the vicinity of the borehole resulting in water pooling up on the ground surface nearby, likely raising the groundwater level in the borehole.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 304B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/9/2020** END: **3/9/2020**

NORTH: **1993081.612** EAST: **786543.215** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **0.70** ▽ CAVED @ TIME: **10:22** DATE: **3/9/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **0.27** ▽ CAVED @ TIME: **08:22** DATE: **3/10/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ **0.34** ▽ CAVED @ TIME: **11:40** DATE: **3/11/2020** DESC.: **48 Hr.** GROUND ELEV.: **47.51**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	1 1 1	**S-1(0.00-0.46)** PPen=>4.5 tsf		0	Sandy SILT (ml); sand is fine to medium; low plasticity; dark brown; moist; +PL; weak reaction to HCl; soft.	
0.46	A-N						0.61m - EL 46.90	
0.61	S-2	100%	10 14 21	**(0.61-1.68)** PL=NP MC=12 % USCS=SM AASHTO=A-2-4		1	Silty SAND (SM); sand is fine to medium, subangular; nonplastic; light brown; moist; NP; strong reaction to HCl; dense to very dense.	
1.07	A-N							
1.22	S-3	100%	13 27 36					
1.68	A-N							
1.83	S-4	100%	30 50/0.15			2		
2.13	A-N							
2.74	S-5	73%	17 23 32	**(2.74-4.11)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4		3		
3.20	A-N							
3.66	S-6	80%	20 23 34			4		
4.11	A-N							
4.57	S-7	73%	16 30 34			5		
5.03	A-N							
5.49	S-8	92%	20 46 50/0.09				5.88m - EL 41.63	
5.88						6	End of Boring at 5.88m	

Boring backfilled with cuttings. Suspected broken utility in the vicinity of the borehole resulting in water pooling up on the ground surface nearby, likely raising the groundwater level in the borehole.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 306B1

PROJECT: **Camp Santiago** SHEET: **1** OF **3**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/20/2020** END: **5/20/2020**

NORTH: **1993189.537** EAST: **786535.178** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.88** ℄ CAVED @ TIME: **14:30** DATE: **5/20/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.57** ℄ CAVED @ TIME: **08:20** DATE: **5/21/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.33**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	17%	3 4 7			0	TOPSOIL. 0.46m - EL 49.87	
0.46	S-2	87%	10 11 15				Sandy SILT with gravel (ml); sand is fine to medium; gravel is fine to coarse; low plasticity; brown and gray; dry; -PL; hard. 0.91m - EL 49.42	
0.91	S-3	100%	18 22 18	**(0.91-1.83)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b		1	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; dense to very dense.	
1.37	S-4	100%	18 25 19					
1.83	S-5	93%	14 26 19	**(1.83-2.74)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4		2		
2.29	S-6	100%	16 18 24					
2.74	S-7	100%	14 21 25			3		
3.20	S-8	100%	33 37 37					
3.66	S-9	100%	19 27 32			4		
4.11	S-10	100%	20 25 25					
4.57	A-N					5		
5.49	S-11	100%	13 21 23					
5.94						6		

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 306B1

PROJECT: **Camp Santiago** SHEET: **2** OF **3**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/20/2020** END: **5/20/2020**

NORTH: **1993189.537** EAST: **786535.178** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.88** ▷ CAVED @ TIME: **14:30** DATE: **5/20/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.57** ▷ CAVED @ TIME: **08:20** DATE: **5/21/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.33**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
	A-N					7	7.32m - EL 43.01	
7.32	S-12	100%	15 24 40				Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine; nonplastic; brown and black; wet; NP; very dense. Wet at 7.3m.	
7.77	A-N					8		
8.84	S-13	100%	17 34 34			9		
9.30	A-N					10		
10.36	S-14	100%	50/0.15					
10.52	A-N					11		
11.89	S-15	100%	50/0.15			12		
12.04								

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 306B1

PROJECT: **Camp Santiago** SHEET: **3** OF **3**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/20/2020** END: **5/20/2020**

NORTH: **1993189.537** EAST: **786535.178** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.88** ▷ CAVED @ TIME: **14:30** DATE: **5/20/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.57** ▷ CAVED @ TIME: **08:20** DATE: **5/21/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.33**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
	A-N					13		
13.41	S-16	100%	50/0.15					
13.56	A-N					14		
14.94	S-17	100%	19 50/0.15			15		
15.24	A-N					16		
16.46	S-18	100%	50/0.15					
16.61	A-N					17		
17.98	S-19	100%	50/0.03			18	18.01m - EL 32.32	
18.01							End of Boring at 18.01m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 308B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/12/2020** END: **3/12/2020**

NORTH: **1993237.531** EAST: **786584.607** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.91** ▽ CAVED @ TIME: **15:35** DATE: **3/12/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.82** ▽ CAVED @ TIME: **08:02** DATE: **3/13/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.15**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	3 3 7			0	TOPSOIL. 0.40m - EL 51.75	
0.46	A-N						Silty SAND (SM); sand is fine to medium; gravel is fine to coarse, angular; nonplastic; dark brown, grayish; dry; weak reaction to HCl; medium dense to dense.	FILL.
0.61	S-2	90%	10 10 16	**S-2(0.61-1.07)** PPen=>4.5 tsf PL=25 % LL=33 % MC=5 % USCS=SM AASHTO=A-2-4		1		
1.07	A-N						1.22m - EL 50.93	
1.22	S-3	100%	15 18 26	**(1.22-2.29)** PL=NP MC=5 % USCS=SM AASHTO=A-2-4			Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; dense to very dense.	
1.68	A-N					2		
1.83	S-4	100%	25 37 44					
2.29	A-N							
2.74	S-5	93%	19 21 25			3	3.17m - EL 48.98	
3.20	A-N						Poorly graded SAND with silt (sp-sm); sand is fine to coarse, angular; nonplastic; dark brown; moist; NP; strong reaction to HCl; dense to very dense.	
3.66	S-6	87%	20 30 45			4		
4.11	A-N							
4.57	S-7	100%	17 17 18			5		
5.03	A-N							
5.49	S-8	100%	25 35 41				5.94m - EL 46.21	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 308B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/18/2020** END: **5/18/2020**

NORTH: **1993206.583** EAST: **786621.162** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **11:50** DATE: **5/18/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.35**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	7 7 7 9			0	Silty GRAVEL with sand (gm); sand is fine; gravel is fine to coarse, angular (particles are hard); nonplastic; brown; dry; NP; medium dense.	FILL.
							0.61m - EL 50.74	
0.61	S-2	90%	15 14 16 21	**(0.61-1.83)** PL=NP MC=6 % USCS=SM AASHTO=A-2-4		1	Silty SAND (SM); sand is fine to medium; nonplastic; brown; dry; dense to very dense.	
1.22	S-3	75%	15 17 20 22				1.83m - EL 49.52	
1.83	S-4	100%	15 22 26 29	**(1.83-3.05)** PL=NP MC=5 % USCS=SM AASHTO=A-2-4		2	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; very dense.	
2.44	S-5	100%	20 50/0.15					
2.74	A-N					3		
3.05	S-6	100%	16 20 16 12					
3.66	S-7	100%	14 19 19 26			4		
4.27	S-8	100%	11 34 34 36					
4.88	A-N					5		
5.49	S-9	100%	27 50/0.12				5.76m - EL 45.59	
5.76						6	End of Boring at 5.76m	

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: DRB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 308B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/18/2020** END: **5/18/2020**

NORTH: **1993184.582** EAST: **786642.194** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **13:00** DATE: **5/18/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.85** ⌭ CAVED @ TIME: **13:00** DATE: **5/20/2020** DESC.: **48 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.91**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	3 4 4			0	Silty GRAVEL with sand (gm); sand is fine; gravel is fine; nonplastic; brown; moist; NP; medium dense.	FILL.
0.46	S-2	53%	9 10 9				0.91m - EL 50.00	
0.91	S-3	87%	7 6 6			1	SILT (ml); low plasticity; brown; dry; -PL; very stiff.	
1.37	S-4	87%	10 11 14	**(1.37-2.29)** PL=NP MC=4 % USCS=SM AASHTO=A-2-4			1.37m - EL 49.54	
1.83	S-5	93%	15 14 9			2	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; medium dense to very dense.	
2.29	S-6	100%	12 18 22					
2.74	S-7	100%	11 17 18	**(2.74-3.66)** PL=NP MC=8 % USCS=SM AASHTO=A-2-4		3		
3.20	S-8	100%	18 21 27					
3.66	S-9	100%	15 18 24			4		
4.11	S-10	100%	23 37 50/0.15					
4.57	A-N					5		
5.49	S-11	100%	31 25 40				5.94m - EL 44.97	
5.94						6	End of Boring at 5.94m	

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: DRB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 310B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/6/2020** END: **3/6/2020**

NORTH: **1993102.017** EAST: **786475.906** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **08:24** DATE: **3/6/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ⌭ CAVED @ **5.36** TIME: **07:40** DATE: **3/9/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.25**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	33%	9 6 6	**(0.00-1.07)** PL=18 % LL=37 % MC=8 % USCS=SC AASHTO=A-6(2)		0	TOPSOIL.	
							0.15m - EL 47.10	FILL.
0.46	A-N						Clayey SAND with gravel (SC); sand is fine to coarse; gravel is fine, subangular; brown; dry; no reaction to HCl; medium dense.	
0.61	S-2	67%	5 6 8	**S-2(0.61-1.07)** PPen=>4.5 tsf		1		
1.07	A-N							
1.22	S-3	100%	15 38 50/0.09	**(1.22-2.29)** PL=NP MC=4 % USCS=SM AASHTO=A-1-b			1.22m - EL 46.03	
1.62	A-N						Silty SAND with gravel (SM); sand is fine to coarse; gravel is fine, subangular; nonplastic; brown; dry; NP; strong reaction to HCl; dense to dense.	
1.83	S-4	90%	50/0.15			2		
1.98	A-N							
2.74	S-5	70%	50/0.15			3		
2.90	A-N							
3.35							3.35m - EL 43.90	
							End of Boring at 3.35m	Auger refusal at 3.35m.
						4		
						5		
						6		

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 310B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/6/2020** END: **3/6/2020**

NORTH: **1993075.101** EAST: **786500.14** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **11:20** DATE: **3/6/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ **4.69** TIME: **07:52** DATE: **3/9/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **46.53**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	33%	5 5 5			0	TOPSOIL.	
							0.15m - EL 46.38	FILL.
0.46	A-N						Sandy SILT (ml); sand is fine to coarse, subangular; low plasticity; brown; dry; -PL; weak reaction to HCl; stiff to very stiff.	
0.61	S-2	67%	9 10 10	**S-2(0.61-1.07)** PPen=>4.5 tsf		1		
1.07	A-N						1.22m - EL 45.31	
1.22	S-3	87%	12 18 19	**(1.22-2.29)** PL=20 % LL=26 % MC=5 % USCS=SC-SM AASHTO=A-2-4(0)			Silty, clayey SAND (SC-SM); sand is fine to coarse, subangular; brown; dry; strong reaction to HCl; dense.	
1.68	A-N							
1.83	S-4	30%	19 20 22			2		
2.29	A-N							
							2.74m - EL 43.79	
2.74	S-5	70%	50/0.15	**(2.74-5.03)** PL=17 % LL=24 % MC=2 % USCS=SC-SM AASHTO=A-2-4(0)			Silty, clayey SAND with gravel (SC-SM); sand is fine to coarse; gravel is fine to coarse, angular; low plasticity; brown; dry; -PL; no reaction to HCl; very dense.	
2.90	A-N					3		
3.66	S-6	100%	50/0.12					
3.78	A-N							
4.57	S-7	100%	38 50/0.15			4		
4.88	A-N							
5.49	S-8	100%	40 50/0.15			5		
5.79							5.79m - EL 40.74	
							End of Boring at 5.79m	
						6		

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 310B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/9/2020** END: **3/9/2020**

NORTH: **1993049.539** EAST: **786527.389** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **09:15** DATE: **3/9/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ **4.94** TIME: **08:36** DATE: **3/10/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **46.49**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	44%	4 7 7	**(0.00-1.07)** PL=19 % LL=28 % MC=7 % USCS=SC AASHTO=A-4		0	TOPSOIL.	
							0.06m - EL 46.43	FILL.
0.46	A-N						Clayey SAND with gravel (SC); sand is fine to coarse; gravel is fine to coarse, angular; brown; dry; no reaction to HCl; dense to very dense.	
0.61	S-2	100%	13 25 38					
1.07	A-N					1		
							1.22m - EL 45.27	
1.22	S-3	100%	50/0.12				MECHANICALY BROKEN ROCK; "poorly graded gravel with silt (gp-gm)"; gravel is fine to coarse, angular, breccia; nonplastic; brown; dry; NP; no reaction to HCl; very dense; strong cementation.	WEATHERED BRECCIA.
1.34	A-N							
1.83	S-4	100%	50/0.09					
1.92	A-N					2		
2.74	S-5	100%	50/0.06					
2.80	A-N					3		
3.66	S-6	100%	50/0.06					
3.72	A-N					4		
							4.60m - EL 41.89	
4.57	S-7	100%	50/0.03				End of Boring at 4.60m	
4.60						5		
						6		

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 312B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/19/2020**

NORTH: **1993123.462** EAST: **786545.792** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.57** ▽ CAVED @ TIME: **13:38** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **3.51** ▽ CAVED @ TIME: **13:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **48.68**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	20%	4 4 6		0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; medium dense.	FILL.
0.46	S-2	60%	10 7 14			0.46m - EL 48.22 Sandy SILT (ml); sand is fine; low plasticity; brown; dry; -PL; very stiff to hard.	
0.91	S-3	100%	14 20 25	**(1.22-2.29)** PL=NP MC=13 % USCS=SM AASHTO=A-2-4	1	1.22m - EL 47.46 Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; very dense.	
1.37	S-4	100%	13 18 28				
1.83	S-5	100%	26 31 38		2		
2.29	S-6	100%	16 18 28				
2.74	S-7	93%	17 32 29		3		
3.20	S-8	100%	30 31 34				
3.66	S-9	100%	17 17 30		4		
4.11	S-10	100%	19 20 23				
4.57	A-N				5		
5.49	S-11	100%	11 24 24				
5.94					6	5.94m - EL 42.74 End of Boring at 5.94m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 314B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/27/2020** END: **2/27/2020**

NORTH: **1993159.137** EAST: **786571.993** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **4.57** ℄ CAVED @ TIME: **12:15** DATE: **2/27/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **3.66** ℄ CAVED @ TIME: **08:20** DATE: **2/28/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.67**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	53%	6 7 9			0	Sandy SILT (ml); sand is fine; low plasticity; brown; dry; -PL; HCL test not performed; stiff.	FILL.
0.46	A-N							
0.61	S-2	60%	10 11 14				0.91m - EL 48.76	
1.07	A-N					1	Silty SAND (SM); sand is fine to medium; nonplastic; brown; dry to wet; NP; HCL test not performed; medium dense to dense.	
1.22	S-3	100%	8 19 11	**(1.22-2.29)** PL=NP MC=11 % USCS=SM AASHTO=A-1-b				
1.68	A-N							
1.83	S-4	100%	14 18 17			2		
2.29	A-N							
2.74	S-5	100%	12 14 16					
3.20	A-N					3		
3.66	S-6	100%	10 17 21	**(3.66-5.03)** PL=NP MC=15 % USCS=SM AASHTO=A-1-b				
4.11	A-N					4		
4.57	S-7	100%	13 20 26					
5.03	A-N					5		
5.49	S-8	100%	17 21 28					
5.94						6	5.94m - EL 43.73 End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

DATE PRINTED= 8/10/20 S.O.#=177050

LIBRARY=BAKER_10-1 (1).GLB

PROJECT=CAMP SANTIAGO.GPJ

TEMPLATE=10L_BORING-US2METRIC

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 316B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/5/2020** END: **3/5/2020**

NORTH: **1993191.459** EAST: **786606.319** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.76** ▽ CAVED @ TIME: **15:00** DATE: **3/5/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.39** ▽ CAVED @ TIME: **08:00** DATE: **3/6/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.72**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	53%	10 6 6		0	Silty GRAVEL with sand (gm); sand is fine to coarse; gravel is fine to coarse, angular (particles are hard); nonplastic; light brown; dry; NP; strong reaction to HCl; medium dense.	FILL.
0.46	A-N					0.61m - EL 50.11	
0.61	S-2	93%	7 6 11	**S-2(0.61-1.07)** PPen=>4.5 tsf		Silty SAND (SM); sand is fine to medium; light brown; dry; strong reaction to HCl; dense to very dense.	
1.07	A-N				1		
1.22	S-3	77%	12 14 16	**(1.22-2.29)** PL=NP MC=5 % USCS=SM AASHTO=A-1-b			
1.68	A-N						
1.83	S-4	100%	12 28 24		2		
2.29	A-N						
2.74	S-5	100%	9 12 15	**(2.74-4.11)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4		2.74m - EL 47.98 Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
3.20	A-N				3		
3.66	S-6	100%	12 22 23				
4.11	A-N				4		
4.57	S-7	100%	17 25 25				
5.03	A-N				5		
5.49	S-8	100%	16 23 33				
5.94					6	5.94m - EL 44.78 End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 318B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/6/2020** END: **3/6/2020**

NORTH: **1993260.407** EAST: **786630.639** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **08:44** DATE: **3/5/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ℄ CAVED @ TIME: **09:02** DATE: **3/6/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **53.3**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	33%	4 5 5		0	Sandy SILT with gravel (ml); sand is fine to medium; gravel is fine, subangular; low plasticity; dark brown; dry; -PL; strong reaction to HCl; stiff.	
0.46	A-N					0.61m - EL 52.69	
0.61	S-2	53%	5 5 5	**(0.61-1.68)** PL=29 % LL=35 % MC=14 % USCS=SM AASHTO=A-4(0)	1	Silty SAND (SM); sand is fine to medium, subangular; light brown; dry; strong reaction to HCl; medium dense to very dense.	
1.07	A-N						
1.22	S-3	80%	6 8 10				
1.68	A-N						
1.83	S-4	100%	15 16 16		2		
2.29	A-N					2.74m - EL 50.56	
2.74	S-5	93%	14 20 22	**(2.74-4.11)** PL=NP MC=5 % USCS=SM AASHTO=A-1-b	3	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; dense to very dense.	
3.20	A-N						
3.66	S-6	100%	14 23 30		4		
4.11	A-N						
4.57	S-7	95%	29 50/0.15				
4.88	A-N				5		
5.49	S-8	100%	35 50/0.15			5.79m - EL 47.51	
5.79					6	End of Boring at 5.79m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 318B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/19/2020**

NORTH: **1993233.046** EAST: **786655.554** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.57** ℄ CAVED @ TIME: **13:38** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **3.51** ℄ CAVED @ TIME: **13:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.45**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	20%	4 4 6			0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; medium dense.	FILL.
0.46	S-2	60%	10 7 14	**(0.46-1.37)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4			0.46m - EL 51.99 Silty SAND (SM); sand is fine; nonplastic; brown; dry; NP; dense to very dense.	
0.91	S-3	100%	14 20 25			1	1.37m - EL 51.08	
1.37	S-4	100%	13 18 28				Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; very dense.	
1.83	S-5	100%	26 31 38	**(1.83-2.74)** PL=NP MC=6 % USCS=SM AASHTO=A-2-4		2		
2.29	S-6	100%	16 18 28					
2.74	S-7	93%	17 32 29			3		
3.20	S-8	100%	30 31 34					
3.66	S-9	100%	17 17 30			4		
4.11	S-10	100%	19 20 23					
4.57	A-N					5		
5.49	S-11	100%	11 24 24				5.94m - EL 46.51	
5.94						6	End of Boring at 5.94m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 318B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/6/2020** END: **3/6/2020**

NORTH: **1993197.362** EAST: **786682.236** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.36** ▽ CAVED @ TIME: **11:30** DATE: **3/5/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ **5.15** TIME: **08:50** DATE: **3/6/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.78**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	43%	7 10 10			0	TOPSOIL.	
							0.20m - EL 51.58	FILL.
0.46	A-N						Sandy LEAN CLAY (cl); sand is fine to coarse, subangular; medium plasticity; dark brown; dry; -PL; weak reaction to HCl; very stiff.	
0.61	S-2	60%	5 5 5	**S-2(0.61-1.07)** PPen=>4.5 tsf			0.61m - EL 51.17	
1.07	A-N					1	Silty SAND (SM); sand is fine to medium; nonplastic; light brown; dry; NP; strong reaction to HCl; medium dense to very dense.	
1.22	S-3	80%	6 8 10	**(1.22-2.29)** PL=NP MC=8 % USCS=SM AASHTO=A-2-4(0)				
1.68	A-N							
1.83	S-4	67%	15 16 16			2		
2.29	A-N							
2.74	S-5	93%	14 20 22				2.74m - EL 49.04	
3.20	A-N					3	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; weak reaction to HCl; dense to very dense.	
3.66	S-6	87%	12 24 37	**(3.66-5.03)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4(0)				
4.11	A-N					4		
4.57	S-7	100%	13 21 30					
5.03	A-N				C ▽	5		
5.49	S-8	100%	14 20 31					
5.94							5.94m - EL 45.84	
						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 320B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/2/2020** END: **3/2/2020**

NORTH: **1993052.739** EAST: **786620.812** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **3.99** TIME: **01:15** DATE: **3/2/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.58**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	7 11 5			0	Sandy SILT (ml); sand is fine; low plasticity; brown; dry; -PL; HCL test not performed; stiff.	
0.46	A-N							
0.61	S-2	67%	5 8 9			1		
1.07	A-N						1.07m - EL 46.51	
1.22	S-3	73%	13 16 22	**(1.22-2.29)** PL=NP MC=9 % USCS=SM AASHTO=A-1-b			Silty SAND (SM); sand is fine to medium; nonplastic; brown; moist to wet; NP; HCL test not performed; medium dense to very dense.	
1.68	A-N							
1.83	S-4	100%	27 50/0.15			2		
2.13	A-N							
2.74	S-5	100%	20 28 30			3		
3.20	A-N							
3.66	S-6	100%	30 35 50/0.12			4		
4.08	A-N							
4.57	S-7	100%	50/0.15					
4.72	A-N					5		
5.49	S-8	100%	50/0.12				5.61m - EL 41.97	
5.61							End of Boring at 5.61m	
						6		

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 322B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/2/2020** END: **3/2/2020**

NORTH: **1993018.708** EAST: **786650.652** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **3.99** TIME: **01:15** DATE: **3/2/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.72**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	87%	4 5 5			0	Silty, clayey SAND (SC-SM); sand is fine; brown; dry; HCL test not performed; medium dense to dense.	
0.46	A-N							
0.61	S-2	83%	8 9 9	**(0.61-1.68)** PL=21 % LL=28 % MC=8 % USCS=SC-SM AASHTO=A-2-4(0)		1		
1.07	A-N							
1.22	S-3	87%	6 6 13					
1.68	A-N							
1.83	S-4	100%	14 12 14			2		
2.29	A-N							
2.74	S-5	87%	9 12 26			3	3.05m - EL 44.67	
3.20	A-N						Silty SAND (SM); sand is fine to medium; nonplastic; brown and black; moist; NP; HCL test not performed; dense to very dense.	
3.66	S-6	100%	26 28 50	**(3.66-5.03)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4(0)		4		
4.08	A-N							
4.57	S-7	100%	28 50/0.15			5		
4.88	A-N							
5.49	S-8	52%	28 44 50/0.09				5.88m - EL 41.84	
5.88						6	End of Boring at 5.88m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 324B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/19/2020**

NORTH: **1993103.474** EAST: **786637.376** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.54** ℄ CAVED @ TIME: **09:40** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.27** ℄ CAVED @ TIME: **11:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **48.85**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	20%	9 6 5			0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown and black; dry; NP; medium dense.	FILL.
0.46	S-2	33%	5 7 7				0.46m - EL 48.39	
0.91	S-3	87%	6 10 18	**(0.91-1.83)** PL=25 % LL=31 % MC=13 % USCS=SM AASHTO=A-2-4		1	Silty SAND (SM); sand is fine to medium; brown and gray; dry; dense to very dense.	
1.37	S-4	67%	10 16 18				1.83m - EL 47.02	
1.83	S-5	87%	20 32 50/0.15			2	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to wet; NP; very dense.	
2.29	S-6	80%	28 50/0.15	**(2.29-3.20)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b				
2.59	A-N							
2.74	S-7	100%	15 32 21			3		
3.20	S-8	100%	23 37 40					
3.66	S-9	90%	21 50/0.15			4		
3.96	A-N							
4.11	S-10	100%	25 50/0.15					
4.42	A-N					5		
5.49	S-11	100%	22 34 50/0.15				5.94m - EL 42.91	
5.94						6	End of Boring at 5.94m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 326B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/2/2020** END: **3/2/2020**

NORTH: **1993161.324** EAST: **786734.381** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **4.91** ℄ CAVED @ TIME: **11:00** DATE: **3/2/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.27** ℄ CAVED @ TIME: **07:45** DATE: **3/3/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.23**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	73%	3 5 7	**(0.00-1.07)** PL=NP MC=11 % USCS=SM AASHTO=A-4(2)		0	Silty SAND (SM); sand is fine; brown; dry; HCL test not performed; medium dense to dense.	
0.46	A-N							
0.61	S-2	87%	7 10 13			1		
1.07	A-N							
1.22	S-3	100%	11 11 20				1.52m - EL 48.71	
1.68	A-N						Silty SAND with gravel (SM); sand is fine to medium; gravel is fine; brown; dry; HCL test not performed; dense to very dense.	
1.83	S-4	100%	23 23 25	**(1.83-2.29)** PL=NP MC=16 % USCS=SM AASHTO=A-1-b		2		
2.29	A-N							
2.74	S-5	100%	18 23 26			3		
3.20	A-N							
3.66	S-6	100%	38 50/0.09				3.66m - EL 46.57	
3.90	A-N					4	Poorly graded SAND (sp); sand is fine to medium; nonplastic; brown; dry to moist; NP; HCL test not performed; very dense.	
4.57	S-7	89%	19 50/0.12					
4.85	A-N					5		
5.49	S-8	100%	50/0.15				5.64m - EL 44.59	
5.64							End of Boring at 5.64m	
						6		

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 328B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/27/2020** END: **2/27/2020**

NORTH: **1993132.46** EAST: **786764.85** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **4.57** ℄ CAVED @ TIME: **01:30** DATE: **2/27/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ **4.42** TIME: **08:35** DATE: **2/28/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.62**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DESCRIPTION	REMARKS
0.00	S-1	33%	3 6 11		SILT with sand (ml); sand is fine; low plasticity; brown; dry; -PL; HCL test not performed; very stiff.	
0.46	A-N					
0.61	S-2	100%	9 9 10		0.61m - EL 49.01 Poorly graded SAND with silt and gravel (sp-sm); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP; HCL test not performed; medium dense to very dense.	
1.07	A-N					
1.22	S-3	100%	11 15 14			
1.68	A-N					
1.83	S-4	53%	18 18 12			
2.29	A-N					
2.74	S-5	100%	18 30 33			
3.20	A-N					
3.66	S-6	60%	24 50/0.15			
3.96	A-N				3.96m - EL 45.66 Silty SAND (SM); sand is fine to medium; nonplastic; brown; moist to wet; NP; HCL test not performed; very dense.	
4.57	S-7	100%	35 50/0.15	**(4.57-5.94)** PL=NP MC=8 % USCS=SM AASHTO=A-2-4(0)		
4.88	A-N					
5.49	S-8	100%	50/0.15		5.64m - EL 43.98 End of Boring at 5.64m	
5.64						

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 330B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/19/2020**

NORTH: **1993148.081** EAST: **786683.127** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.57** ℄ CAVED @ TIME: **11:00** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.27** ℄ CAVED @ TIME: **13:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.17**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	7 11 11		0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; dense.	FILL.
0.46	S-2	73%	6 7 6			0.46m - EL 49.71	
0.91	S-3	100%	4 5 5	**(0.91-1.83)** PL=NP MC=19 % USCS=SM AASHTO=A-4	1	Silty SAND (SM); sand is fine to medium; nonplastic; brown and gray; dry; NP; dense to very dense.	
1.37	S-4	100%	5 6 9				
1.83	S-5	100%	8 12 17		2		
2.29	S-6	100%	17 19 15			2.74m - EL 47.43	
2.74	S-7	100%	7 13 11		3	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; medium dense to very dense.	
3.20	S-8	100%	13 11 11	**(3.20-4.11)** PL=NP MC=11 % USCS=SM AASHTO=A-2-4			
3.66	S-9	100%	10 12 13		4		
4.11	S-10	100%	11 13 24				
4.57	A-N				5		
5.49	S-11	100%	13 22 30			5.94m - EL 44.23	
5.94					6	End of Boring at 5.94m	

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: DRB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 332B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/18/2020** END: **5/19/2020**

NORTH: **1993066.481** EAST: **786686.864** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **08:30** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.85** ⌭ CAVED @ TIME: **13:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.97**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	54%	2 5 6		0	Sandy SILT with gravel (ml); sand is fine to coarse; low plasticity; brown; dry; -PL; very stiff.	FILL.
0.46	S-2	100%	9 6 10				
0.91	S-3	100%	8 12 16		1	1.22m - EL 46.75	
1.37	S-4	100%	15 20 16			Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; dense to very dense.	
1.83	S-5	100%	11 17 18	**(1.83-2.74)** PL=NP MC=8 % USCS=SM AASHTO=A-2-4	2		
2.29	S-6	100%	11 14 21				
2.74	S-7	100%	39 40 40		3		
3.20	S-8	100%	19 22 32				
3.66	S-9	100%	10 23 33		4		
4.11	S-10	100%	30 30 32				
4.57	A-N				5		
5.49	S-11	100%	23 30 50/0.15			5.94m - EL 42.03	
5.94					6	End of Boring at 5.94m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 334B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/18/2020** END: **5/18/2020**

NORTH: **1993092.561** EAST: **786719.234** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **15:00** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.48** ⌭ CAVED @ TIME: **08:00** DATE: **5/19/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **47.69**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	6 7 5			0	Silty SAND (SM); sand is fine to coarse; brown; dry; dense.	FILL.
0.46	S-2	100%	6 7 8	**(0.46-1.37)** PL=24 % LL=30 % MC=5 % USCS=SM AASHTO=A-2-4				
0.91	S-3	100%	6 13 16			1		
1.37	S-4	100%	13 21 18				1.37m - EL 46.32	
1.83	S-5	100%	22 26 25	**(1.83-2.74)** PL=NP MC=2 % USCS=SM AASHTO=A-1-b		2	Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; dense to very dense.	
2.29	S-6	100%	30 50/0.15					
2.59	A-N							
2.74	S-7	100%	39 40 40			3		
3.20	S-8	100%	39 50/0.15					
3.51	A-N							
3.66	S-9	100%	30 50/0.15			4		
3.96	A-N							
4.11	S-10	100%	17 40 50					
4.57	A-N					5		
5.49	S-11	100%	14 47 40					
5.94							5.94m - EL 41.75	
						6	End of Boring at 5.94m	

CHECKED BY: DRB
DATE PRINTED= 8/10/20 S.O.#=177050
LIBRARY=BAKER_10-1 (1).GLB
PROJECT=CAMP SANTIAGO.GPJ
TEMPLATE=10L_BORING-US2METRIC

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 440B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/20/2020**

NORTH: **1993339.846** EAST: **786210.208** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **13:15** DATE: **5/20/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ⌭ CAVED @ TIME: **08:00** DATE: **5/21/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.72**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	61%	17 6 5			0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; medium dense.	FILL.
0.46	S-2	80%	3 4 5				0.61m - EL 52.11	
0.91	S-3	73%	6 6 8	**(0.91-1.83)** PL=24 % LL=35 % MC=13 % USCS=CL AASHTO=A-6(3)		1	Sandy LEAN CLAY (CL); medium plasticity; -PL; medium stiff.	
1.37	S-4	87%	5 7 5				1.83m - EL 50.89	
1.83	S-5	33%	6 10 11			2	Silty SAND (SM); sand is fine to medium; nonplastic; brown; dry; NP; medium dense to very dense.	
2.29	S-6	67%	9 4 4	**(2.29-3.20)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b				
2.74	S-7	67%	5 7 9			3		
3.20	S-8	93%	14 9 17					
3.66	S-9	93%	22 26 25			4		
4.11	S-10	93%	23 24 50					
4.57	A-N					5		
5.49	S-11	100%	30 50/0.12				5.76m - EL 46.96	
5.76						6	End of Boring at 5.76m	

CHECKED BY: DRB

DATE PRINTED= 8/10/20 S.O.#=177050

LIBRARY=BAKER_10-1 (1).GLB

PROJECT=CAMP SANTIAGO.GPJ

TEMPLATE=10L_BORING-US2METRIC

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 442B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/19/2020** END: **5/20/2020**

NORTH: **1993270.299** EAST: **786234.908** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Ed Joel**

EQUIPMENT: **CME 55 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Automatic hammer; 63.5 kg; 76.2 cm fall; ER = 90%.**

▽ H_2O @ **4.27** ⊆ CAVED @ TIME: **15:00** DATE: **5/19/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.94** ⊆ CAVED @ TIME: **11:00** DATE: **5/20/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.7**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	42%	7 9 9			0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; medium dense.	FILL.
0.46	S-2	80%	9 8 7				0.91m - EL 50.79	
0.91	S-3	87%	3 3 4			1	Silty SAND with gravel (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; medium dense to very dense.	
1.37	S-4	28%	3 4 6	**(1.37-2.29)** PL=NP MC=7 % USCS=SM AASHTO=A-1-b				
1.83	S-5	50%	5 5 7			2		
2.29	S-6	100%	7 5 9					
2.74	S-7	60%	4 7 11	**(2.74-3.66)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b		3		
3.20	S-8	47%	10 7 11					
3.66	S-9	100%	8 14 15			4		
4.11	S-10	100%	15 18 17		▽			
4.57	A-N					5		
5.49	S-11	100%	10 14 20		▼			
5.94						6	5.94m - EL 45.76 End of Boring at 5.94m	

CHECKED BY: DRB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 444B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/2/2020** END: **3/3/2020**

NORTH: **1993246.792** EAST: **786201.828** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	7 8 13			0	Poorly graded GRAVEL with silt and sand (gp-gm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; HCL test not performed; medium dense.	FILL.
0.46	A-N							
0.61	S-2	93%	9 6 6	**(0.61-1.68)** MC=7 %		1		
1.07	A-N							
1.22	S-3	100%	4 5 6					
1.68	A-N						1.83m - EL 49.17	
1.83	S-4	87%	10 7 8	**(1.83-3.20)** MC=12 %		2	Silty, clayey SAND (SC-SM); sand is fine to coarse; gravel is fine; nonplastic; brown; moist; NP; HCL test not performed; medium dense.	
2.29	A-N							
2.74	S-5	100%	9 10 12			3		
3.20	A-N							
3.66	S-6	100%	9 8 7			4		
4.11	A-N							
4.57	S-7	87%	6 7 8			5		
5.03	A-N							
5.49	S-8	100%	8 8 9					
5.94						6	5.94m - EL 45.06 End of Boring at 5.94m	

Boring backfilled with cuttings. No water level reading obtained.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 446B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/27/2020** END: **2/28/2020**

NORTH: **1993233.791** EAST: **786164.479** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **03:30** DATE: **2/27/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ **4.60** TIME: **08:15** DATE: **2/28/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.24**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	6 13 13	**(0.00-1.07)** MC=10 %		0	Silty, clayey SAND (SC-SM); sand is fine to medium; gravel is fine; brown; nonplastic; dry; NP; HCL test not performed; medium dense to dense.	
0.46	A-N							
0.61	S-2	67%	10 9 10			1		
1.07	A-N						1.22m - EL 49.02	
1.22	S-3	100%	10 15 16				Silty, clayey SAND (SC-SM); sand is fine; brown; dry; HCL test not performed; dense to very dense.	
1.68	A-N							
1.83	S-4	83%	18 18 16			2		
2.29	A-N							
2.74	S-5	100%	10 8 11	**(2.74-4.11)** MC=11 %		3		
3.20	A-N							
3.66	S-6	100%	12 10 14			4		
4.11	A-N							
4.57	S-7	100%	8 10 18			5		
5.03	A-N						5.49m - EL 44.75	
5.49	S-8	100%	10 18 8				LEAN CLAY (cl); medium plasticity; brown; moist; -PL; HCL test not performed; very stiff.	
5.94							5.94m - EL 44.30	
						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 448B1

PROJECT: **Camp Santiago** SHEET: **1** OF **2**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/26/2020** END: **2/26/2020**

NORTH: **1993292.093** EAST: **786187.038** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betencourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.49** ℄ CAVED @ TIME: **12:30** DATE: **2/26/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ℄ CAVED @ TIME: **07:15** DATE: **2/27/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.54**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	13%	22 13 13			0	ASPHALT. 0.12m - EL 51.42	
0.46	A-N						Silty SAND with gravel (SM); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP; HCL test not performed; medium dense.	
0.61	S-2	33%	5 8 14	**(0.61-1.68)** MC=6 %		1		
1.07	A-N							
1.22	S-3	100%	10 10 9					
1.68	A-N						1.83m - EL 49.71	
1.83	S-4	67%	9 7 7			2	Poorly graded SAND with silt and gravel (sp-sm); sand is fine to medium; gravel is fine; nonplastic; brown; dry; NP; HCL test not performed; medium dense.	
2.29	A-N						2.74m - EL 48.80	
2.74	S-5	100%	4 5 7	**(2.74-3.20)** MC=18 %		3	Silty, clayey SAND (SC-SM); sand is fine; brown; dry to moist; HCL test not performed; medium dense.	
3.20	A-N							
4.27	S-6	100%	10 14 12			4	4.27m - EL 47.27	
4.72	A-N						Poorly graded SAND with silt (sp-sm); sand is fine; nonplastic; brown; dry to moist; NP; HCL test not performed; medium dense to very dense.	
5.79	S-7	100%	8 10			5	5.79m - EL 45.75	
						6	Poorly graded SAND with silt and gravel (sp-sm); sand is fine to medium; gravel is fine; nonplastic; gray and black;	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 448B1

PROJECT: **Camp Santiago** SHEET: **2** OF **2**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/26/2020** END: **2/26/2020**

NORTH: **1993292.093** EAST: **786187.038** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betencourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.49** ⊆ CAVED @ TIME: **12:30** DATE: **2/26/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ⊆ CAVED @ TIME: **07:15** DATE: **2/27/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.54**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
6.25			50/0.15				moist; NP; HCL test not performed; dense to very dense. 6.25m - EL 45.29 End of Boring at 6.25m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 450B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/26/2020** END: **2/26/2020**

NORTH: **1993233.25** EAST: **786347.058** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betencourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ▽ CAVED @ TIME: **14:00** DATE: **2/26/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.48** ▽ CAVED @ TIME: **07:15** DATE: **2/27/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.57**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	6 8 9			0	TOPSOIL.	
0.15m - EL 50.42							Silty, clayey SAND (SC-SM); sand is fine; nonplastic; brown and black; dry to moist; NP; HCL test not performed; medium dense.	
0.46	A-N							
0.61	S-2	40%	8 9 10			1		
1.07	A-N							
1.22	S-3	100%	11 10 10	**(1.22-2.29)** MC=13 %				
1.68	A-N							
1.83	S-4	67%	10 12 13			2		
2.29m - EL 48.28								
2.29	A-N						Poorly graded SAND with silt (sp-sm); sand is fine; nonplastic; brown; dry to moist; NP; HCL test not performed; medium dense to very dense.	
2.74	S-5	100%	7 14 17			3		
3.20	A-N							
3.66	S-6	100%	10 24 27			4		
4.11	A-N							
4.57m - EL 46.00								
4.57	S-7	100%	20 50/0.15				Poorly graded SAND with silt and gravel (sp-sm); sand is fine to medium; gravel is fine; nonplastic; gray and black; moist; NP; HCL test not performed; dense to very dense.	
4.88	A-N					5		
5.49	S-8	100%	18 25 29					
5.94m - EL 44.63								
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB DATE PRINTED= 8/10/20 S.O.#=177050 TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 450B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/11/2020** END: **3/11/2020**

NORTH: **1993208.376** EAST: **786376.109** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ▷ CAVED @ TIME: **13:18** DATE: **3/11/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.89**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	97%	17 6 7	**S-1(0.12-0.46)** PPen=4.5 tsf		0	ASPHALT.	
0.12							0.12m - EL 49.77	FILL.
0.46	A-N						Sandy SILT (ml); sand is fine to coarse, subangular; low plasticity; light brown; dry to moist; -PL; strong reaction to HCl; stiff.	
0.61	S-2	93%	6 7 10				0.61m - EL 49.28	
1.07	A-N					1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry; NP; strong reaction to HCl; medium dense to dense.	
1.22	S-3	100%	9 12 13	**(1.22-2.29)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4(0)				
1.68	A-N							
1.83	S-4	100%	16 20 30			2		
2.29	A-N							
2.74	S-5	87%	10 12 16	**(2.74-4.11)** PL=25 % LL=31 % MC=11 % USCS=SM AASHTO=A-2-4(0)		3		
3.20	A-N							
3.66	S-6	100%	12 13 17			4		
4.11	A-N							
4.57	S-7	100%	15 28 40				4.91m - EL 44.98	
5.03	A-N					5	Poorly graded SAND with silt (sp-sm); sand is fine to coarse, subangular; nonplastic; light brown, olivish; dry to moist; NP; strong reaction to HCl; very dense.	
5.49	S-8	100%	20 25 39				5.94m - EL 43.95	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings. Roadway boring was backfilled immediatley following drilling when no groundwater was encountered.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 450B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/9/2020** END: **3/9/2020**

NORTH: **1993181.944** EAST: **786403.214** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.67** ⌭ CAVED @ TIME: **11:22** DATE: **3/9/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.64** ⌭ CAVED @ TIME: **08:11** DATE: **3/10/2020** DESC.: **24 Hr,** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.05**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	4 7 6	**S-1(0.00-0.46)** PPen=>4.5 tsf **(0.00-1.07)** PL=42 % MC=23 % USCS=8 AASHTO=SC FG=A-7-6(6)		0	Clayey SAND (SC); sand is fine to coarse, subangular; brown; dry to moist; weak reaction to HCl; medium dense.	
0.46	A-N							
0.61	S-2	53%	7 6 7	**S-2(0.61-1.07)** PPen=>4.5 tsf		1	1.07m - EL 47.98	
1.07	A-N						Silty SAND (sm); sand is fine to medium, subangular; nonplastic; light brown; dry; NP; strong reaction to HCl; dense to very dense.	
1.22	S-3	100%	11 21 39					
1.68	A-N							
1.83	S-4	100%	50/0.15			2		
1.98	A-N						2.74m - EL 46.31	
2.74	S-5	100%	17 27 31				Silty SAND (SM); sand is fine to coarse, angular; nonplastic; brown, oliveish; moist; NP; strong reaction to HCl; dense to very dense.	
3.20	A-N					3		
3.66	S-6	100%	15 22 25					
4.11	A-N					4		
4.57	S-7	100%	14 14 21	**(4.57-5.94)** PL=0 % MC=0 % USCS=21 AASHTO=SM FG=A-2-4(0)				
5.03	A-N					5		
5.49	S-8	100%	19 28 40					
5.94						6	5.94m - EL 43.11 End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 452B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/12/2020** END: **3/12/2020**

NORTH: **1993259.804** EAST: **786365.419** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **03:01** DATE: **3/12/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ℄ CAVED @ TIME: **08:00** DATE: **3/13/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.45**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	3 5 6	**S-1(0.00-0.46)** PPen=3.5 tsf		0	Sandy SILT (ml); sand is fine to medium; low plasticity; dark brown, grayish; dry; -PL; no reaction to HCl; stiff.	FILL.
0.46	A-N						0.46m - EL 50.99	
0.61	S-2	100%	7 8 10	**(0.61-1.68)** PL=NP MC=9 % USCS=SM AASHTO=A-1-b		1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
1.07	A-N							
1.22	S-3	53%	14 14 20					
1.68	A-N							
1.83	S-4	100%	35 36 50/0.15			2		
2.29	A-N						2.74m - EL 48.71	
2.74	S-5	100%	21 30 32	**(2.74-4.11)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4		3	Silty SAND (SM); sand is fine to coarse, angular; nonplastic; dark brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
3.20	A-N							
3.66	S-6	80%	8 12 16			4		
4.11	A-N							
4.57	S-7	100%	9 12 20			5		
5.03	A-N							
5.49	S-8	100%	12 14 26				5.94m - EL 45.51	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

DATE PRINTED= 8/10/20 S.O.#=177050

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 452B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/11/2020** END: **3/11/2020**

NORTH: **1993234.565** EAST: **786402.391** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ▷ CAVED @ TIME: **01:20** DATE: **3/11/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.05**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	35 7 7	**S-1(0.12-0.46)** PPen=4.5 tsf		0	ASPHALT.	
0.12							0.12m - EL 50.93	FILL.
0.46	A-N						Gravelly SILT with sand (ml); sand is fine to coarse; gravel is fine to coarse, angular; low plasticity; light brown; moist; -PL; strong reaction to HCl; stiff.	
0.61	S-2	67%	5 10 15				0.61m - EL 50.44	
1.07	A-N					1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to dense.	
1.22	S-3	100%	9 6 11	**(1.22-2.29)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4(0)				
1.68	A-N							
1.83	S-4	100%	16 20 30			2		
2.29	A-N							
2.74	S-5	100%	11 18 25			3		
3.20	A-N							
3.66	S-6	100%	16 23 28	**(3.66-5.03)** PL=NP MC=7 % USCS=SM AASHTO=A-1-b			3.66m - EL 47.39	
4.11	A-N					4	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown, olivish; dry; NP; strong reaction to HCl; very dense.	
4.57	S-7	100%	10 21 40					
5.03	A-N					5		
5.49	S-8	100%	21 50/0.15					
5.79							5.79m - EL 45.26	
						6	End of Boring at 5.79m	

Boring backfilled with cuttings. Roadway boring was backfilled immediatley following drilling when no groundwater was encountered.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 452B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **2/26/2020** END: **2/27/2020**

NORTH: **1993209.133** EAST: **786426.474** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betencourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **5.03** TIME: **15:00** DATE: **2/26/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **4.82** ▽ CAVED @ TIME: **07:30** DATE: **2/27/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.28**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	80%	11 10 9			0	TOPSOIL. 0.06m - EL 50.22	
0.46	A-N						Poorly graded SAND with silt and gravel (sp-sm); sand is fine; gravel is fine; nonplastic; brown and gray; dry; NP; HCL test not performed; medium dense to very dense.	
0.61	S-2	33%	7 7 8			1		
1.07	A-N							
1.22	S-3	100%	25 50/0.15					
1.52	A-N							
1.83	S-4	100%	19 50/0.15			2	1.83m - EL 48.45 Silty, clayey SAND (SC-SM); sand is fine; brown; dry; HCL test not performed; dense to very dense.	
2.13	A-N							
2.74	S-5	100%	9 10 6	**(2.74-4.11)** MC=18 %		3		
3.20	A-N							
3.66	S-6	100%	24 19 22			4		
4.11	A-N							
4.57	S-7	100%	19 28 19	**(4.57-5.94)** MC=13 %		5	4.57m - EL 45.71 Silty SAND (SM); sand is fine to medium; nonplastic; brown and dark gray; moist; NP; HCL test not performed; medium dense to dense.	
5.03	A-N							
5.49	S-8	100%	12 11 18					
5.94						6	5.94m - EL 44.34 End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 454B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/3/2020** END: **3/3/2020**

NORTH: **1993305.45** EAST: **786413.935** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **4.69** TIME: **00:05** DATE: **3/3/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **53.42**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	7 8 8	**(0.00-1.07)** PL=30 % LL=42 % MC=9 % USCS=SM AASHTO=A-2-7(0)		0	Silty SAND with gravel (SM); sand is fine to medium; gravel is fine to coarse; brown; dry; HCL test not performed; medium dense.	FILL.
0.46	A-N							
0.61	S-2	60%	9 9 10					
1.07	A-N					1	1.07m - EL 52.35	
1.22	S-3	100%	9 6 16	**(1.22-2.29)** PL=NP MC=6 % USCS=SM AASHTO=A-2-4(0)			Silty SAND (SM); sand is fine to coarse; nonplastic; brown; dry to moist; NP; HCL test not performed; medium dense to very dense.	
1.68	A-N							
1.83	S-4	83%	33 34 34			2		
2.29	A-N							
2.74	S-5	100%	27 41 46			3		
3.20	A-N							
3.66	S-6	100%	21 32 40			4		
4.11	A-N							
4.57	S-7	100%	18 29 40		▽	5	Moist at 4.72m.	
5.03	A-N							
5.49	S-8	100%	25 50/0.15				5.79m - EL 47.63	
5.79						6	End of Boring at 5.79m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 454B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/11/2020** END: **3/11/2020**

NORTH: **1993260.361** EAST: **786428.317** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **09:48** DATE: **3/11/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.07**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	20 14 8	**S-1(0.12-0.46)** PPen=>4.5 tsf		0	ASPHALT. 0.12m - EL 51.95	FILL.
0.46	A-N						Gravelly SILT with sand (ml); sand is fine to coarse; gravel is fine to coarse, angular; low plasticity; light brown; moist; -PL; strong reaction to HCl; very stiff. 0.61m - EL 51.46	
0.61	S-2	67%	6 7 11	**(0.61-1.68)** PL=NP MC=9 % USCS=SM AASHTO=A-2-4(0)		1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
1.07	A-N							
1.22	S-3	67%	11 24 30				1.83m - EL 50.24	
1.68	A-N							
1.83	S-4	100%	30 50/0.15	**(1.83-2.29)** PL=NP MC=7 % USCS=SM AASHTO=A-2-4(0)		2	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown, oliveish; dry; NP; strong reaction to HCl; dense to very dense.	
2.13	A-N							
2.74	S-5	100%	19 19 25			3		
3.20	A-N							
3.66	S-6	100%	22 34 40			4		
4.11	A-N							
4.57	S-7	100%	21 32 46			5		
5.03	A-N							
5.49	S-8	100%	18 21 34				5.94m - EL 46.13	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings. Roadway boring was backfilled immediatley following drilling when no groundwater was encountered.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 454B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/9/2020** END: **3/10/2020**

NORTH: **1993237.051** EAST: **786451.321** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.46** ⌭ CAVED @ TIME: **08:57** DATE: **3/10/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.12** ⌭ CAVED @ TIME: **08:45** DATE: **3/11/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.1**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	23%	9 8 7			0	Silty SAND (SM); sand is fine to medium; gravel is fine to coarse, subrounded; nonplastic; brown; dry; NP; strong reaction to HCl; medium dense to very dense.	FILL.
0.46	A-N							
0.61	S-2	33%	7 8 9			1		
1.07	A-N							
1.22	S-3	100%	15 20 22	**(1.22-2.29)** PL=NP MC=11 % USCS=SM AASHTO=A-1-b				
1.68	A-N							
1.83	S-4	100%	20 24 50/0.15			2		
2.29	A-N							
2.74	S-5	100%	18 24 26	**(2.74-4.11)** PL=25 % LL=31 % MC=17 % USCS=SM AASHTO=A-4(0)		3	2.74m - EL 48.36 Silty SAND (SM); sand is fine; light brown; dry to moist; strong reaction to HCl; medium dense to dense.	
3.20	A-N							
3.66	S-6	100%	8 11 14			4		
4.11	A-N							
4.57	S-7	100%	7 9 11			5		
5.03	A-N							
5.49	S-8	80%	21 32 50/0.15				5.49m - EL 45.61 Poorly graded SAND with silt (sp-sm); sand is fine to coarse, subangular; nonplastic; dark brown, olivish; moist; NP; strong reaction to HCl; very dense.	
5.94						6	5.94m - EL 45.16 End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 456B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/12/2020** END: **3/12/2020**

NORTH: **1993330.209** EAST: **786438.936** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ℄ CAVED @ TIME: **15:32** DATE: **3/12/2013** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **Dry** ℄ CAVED @ TIME: **08:15** DATE: **3/13/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **54.55**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	63%	7 9 7	**S-1(0.00-0.34)** PPen=>4.5 tsf		0	Sandy SILT with gravel (ml); sand is fine to medium; gravel is fine to coarse, angular; low plasticity; dark brown, grayish; dry; -PL; no reaction to HCl; very stiff.	FILL.
0.46	A-N						0.34m - EL 54.21	
0.61	S-2	73%	5 5 15	**(0.61-1.68)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b		1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense.	
1.07	A-N							
1.22	S-3	87%	12 35 50/0.15				1.68m - EL 52.87	
1.68	A-N						Silty SAND (SM); sand is fine to coarse, angular; nonplastic; dark brown; dry to moist; NP; strong reaction to HCl; dense to very dense.	
1.83	S-4	100%	25 39 39			2		
2.29	A-N							
2.74	S-5	100%	23 33 42	**(2.74-4.11)** PL=NP MC=10 % USCS=SM AASHTO=A-1-b		3		
3.20	A-N							
3.66	S-6	100%	25 35 40			4		
4.11	A-N							
4.57	S-7	100%	28 50/0.15					
4.88	A-N					5		
5.49	S-8	100%	15 21 29				5.94m - EL 48.61	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 456B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/11/2020** END: **3/11/2020**

NORTH: **1993301.714** EAST: **786469.849** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.88** ⌭ CAVED @ TIME: **10:58** DATE: **3/11/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.30** ⌭ CAVED @ TIME: **08:17** DATE: **3/12/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **53.5**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	87%	27 13 13	**S-1(0.12-0.46)** PPen=>4.5 tsf		0	ASPHALT. 0.12m - EL 53.38	FILL.
0.46	A-N						Sandy SILT with gravel (ml); sand is fine to medium; gravel is fine to coarse, subangular; low plasticity; dark brown, grayish; moist; -PL; weak reaction to HCl; very stiff.	
0.61	S-2	67%	8 9 8	**S-2(0.61-1.07)** PPen=4.25 tsf		1		
1.07	A-N						1.22m - EL 52.28	
1.22	S-3	100%	6 5 12				Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
1.68	A-N							
1.83	S-4	67%	18 22 30	**(1.83-3.20)** PL=NP MC=7 % USCS=SM AASHTO=A-1-b		2		
2.29	A-N							
2.74	S-5	100%	16 20 25			3		
3.20	A-N							
3.66	S-6	93%	26 36 45			4		
4.11	A-N						4.57m - EL 48.93	
4.57	S-7	100%	17 28 22	**(4.57-5.94)** PL=NP MC=10 % USCS=SM AASHTO=A-1-b		5	Silty SAND (SM); sand is fine to coarse, angular; nonplastic; brown,olivish; dry to moist; NP; strong reaction to HCl; dense to very dense.	
5.03	A-N							
5.49	S-8	100%	17 18 18				5.94m - EL 47.56	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 456B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/4/2020** END: **3/4/2020**

NORTH: **1993274.858** EAST: **786497.176** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **5.49** TIME: **11:30** DATE: **3/4/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **53.16**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	44%	5 3 4			0	Poorly graded GRAVEL with silt and sand (gp-gm); sand is fine to medium; gravel is fine to coarse; nonplastic; brown; dry; NP; HCL test not performed; loose to medium dense.	
0.46	A-N							
0.61	S-2	60%	4 3 7			1	1.07m - EL 52.09	
1.07	A-N						Silty SAND (SM); sand is fine; nonplastic; brown; dry; -NP; HCL test not performed; medium dense to dense.	
1.22	S-3	100%	10 9 8	**(1.22-2.29)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4(0)				
1.68	A-N							
1.83	S-4	67%	9 9 14			2	2.29m - EL 50.87	
2.29	A-N						Silty SAND (SM); sand is fine to medium; gravel is fine; nonplastic; brown; dry to moist; NP; HCL test not performed; medium dense to very dense.	
2.74	S-5	100%	14 16 20	**(2.74-4.11)** PL=NP MC=9 % USCS=SM AASHTO=A-1-b				
3.20	A-N							
3.66	S-6	100%	20 23 30			3		
4.11	A-N							
4.57	S-7	100%	22 50/0.15			4		
4.88	A-N							
5.49	S-8	100%	17 32 50/0.15			5		
5.94							5.94m - EL 47.22	
						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 458B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/3/2020** END: **3/3/2020**

NORTH: **1993359.919** EAST: **786453.971** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: **14:05** DATE: **3/3/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **55.62**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	2 4 6			0	Silty SAND (sm); sand is fine; nonplastic; brown; dry; NP; HCL test not performed; medium dense.	
0.46	A-N							
0.61	S-2	67%	8 8 8			1	1.07m - EL 54.55	
1.07	A-N						Silty SAND (SM); sand is fine; gravel is fine; brown; dry; HCL test not performed; medium dense to very dense.	
1.22	S-3	87%	14 13 21	**(1.22-2.29)** PL=25 % LL=31 % MC=9 % USCS=SM AASHTO=A-1-b				
1.68	A-N							
1.83	S-4	100%	28 50/0.15			2		
2.13	A-N							
2.74	S-5	100%	22 25 50			3		
3.20	A-N						3.66m - EL 51.96	
3.66	S-6	100%	40 50/0.12				Silty SAND (SM); sand is fine to medium; gravel is fine; nonplastic; brown; moist; NP; HCL test not performed; dense to very dense.	
3.93	A-N					4		
4.57	S-7	100%	18 28 30	**(4.57-5.94)** PL=NP MC=9 % USCS=SM AASHTO=A-2-4(0)				
4.88	A-N					5		
5.49	S-8	100%	21 32 33				5.94m - EL 49.68	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 458B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/10/2020** END: **3/10/2020**

NORTH: **1993327.299** EAST: **786497.049** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: **15:18** DATE: **3/11/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **54.73**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	35 14 14			0	ASPHALT.	
0.12m - EL 54.61								FILL.
0.46	A-N						Gravelly SILT with sand (ml); sand is fine to coarse; gravel is fine to coarse, angular; low plasticity; light brown; moist; -PL; strong reaction to HCl; very stiff.	
0.61	S-2	67%	9 7 6	**(0.61-1.68)** PL=NP MC=10 % USCS=SM AASHTO=A-2-4(0)			0.61m - EL 54.12	
1.07	A-N					1	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; medium dense to very dense.	
1.22	S-3	100%	5 8 12					
1.68	A-N							
1.83	S-4	80%	18 25 35			2		
2.29	A-N							
2.74m - EL 51.99								
2.74	S-5	100%	28 21 24	**(2.74-4.11)** PL=NP MC=6 % USCS=SM AASHTO=A-1-b		3	Silty SAND (SM); sand is fine to coarse, subangular; nonplastic; light brown, olivish; dry; NP; strong reaction to HCl; dense to very dense.	
3.20	A-N							
3.66	S-6	100%	12 21 25			4		
4.11	A-N							
4.57	S-7	100%	50/0.15					
4.72	A-N					5		
5.49	S-8	100%	22 30 32					
5.94m - EL 48.79								
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings. Roadway boring was backfilled immediatley following drilling when no groundwater was encountered.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 458B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/10/2020** END: **3/10/2020**

NORTH: **1993301.032** EAST: **786523.705** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **5.88** ℄ CAVED @ TIME: **10:11** DATE: **3/10/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ **5.73** ℄ CAVED @ TIME: **08:32** DATE: **3/11/2020** DESC.: **24 Hr.** ELEV. DATUM: **PRVD2002**

▼ H_2O @ ℄ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **54.52**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	5 7 4	**S-1(0.00-0.46)** PPen=>4.5 tsf **(0.00-1.07)** PL=21 % LL=35 % MC=12 % USCS=SC AASHTO=A-6(4)		0	Clayey SAND with gravel (SC); sand is fine to medium; gravel is fine to coarse, angular (particles are hard); dark brown; dry to moist; weak reaction to HCl; medium dense to dense.	FILL.
0.46	A-N							
0.61	S-2	67%	5 7 10	**S-2(0.61-1.07)** PPen=>4.5 tsf		1		
1.07	A-N						1.22m - EL 53.30	
1.22	S-3	100%	3 4 5				Silty SAND (SM); sand is fine to medium, subangular; nonplastic; light brown; dry to moist; NP; strong reaction to HCl; loose to dense.	
1.68	A-N							
1.83	S-4	87%	7 10 10	**(1.83-3.20)** PL=NP MC=9 % USCS=SM AASHTO=A-1-b		2		
2.29	A-N							
2.74	S-5	93%	11 12 12			3		
3.20	A-N							
3.66	S-6	77%	10 11 14			4		
4.11	A-N							
4.57	S-7	100%	11 15 17			5		
5.03	A-N							
5.49	S-8	100%	14 18 20					
5.94						6	5.94m - EL 48.58 End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 460B1

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/3/2020** END: **3/3/2020**

NORTH: **1993379.543** EAST: **786497.676** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ▽ CAVED @ TIME: **03:30** DATE: **3/3/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **56.34**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	4 5 6			0	TOPSOIL. 0.30m - EL 56.04	
0.46	A-N						Silty SAND (SM); sand is fine to medium; gravel is fine; nonplastic; brown; dry to moist; NP; HCL test not performed; loose to very dense.	
0.61	S-2	67%	8 6 5			1		
1.07	A-N							
1.22	S-3	100%	4 4 2	**(1.22-2.29)** MC=9 %				
1.68	A-N							
1.83	S-4	100%	9 10 18			2		
2.29	A-N							
2.74	S-5	100%	20 22 26	**(2.74-3.20)** MC=8 %		3		
3.20	A-N							
3.66	S-6	83%	40 50/0.12			4		
3.93	A-N							
4.57	S-7	83%	39 50/0.15			5		
4.88	A-N							
5.49	S-8	100%	50/0.15				5.64m - EL 50.70	
5.64						6	End of Boring at 5.64m	

Boring backfilled with cuttings.

CHECKED BY: EHB

DATE PRINTED= 8/10/20 S.O.#=177050

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 460B2

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/10/2020** END: **3/10/2020**

NORTH: **1993352.475** EAST: **786523.311** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Dylan Brown**

STATION: OFFSET: BASELINE: DRILLER: **Jose Betancourt**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ **Dry** ▷ CAVED @ TIME: **12:32** DATE: **3/10/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▷ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **56.1**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	100%	17 7 7	**S-1(0.18-0.46)** PPen=3.5 tsf		0	ASPHALT.	
							0.18m - EL 55.92	
0.46	A-N						SILT (ml); low plasticity; gray; moist; -PL; no reaction to HCl; stiff.	FILL.
							0.61m - EL 55.49	
0.61	S-2	67%	6 7 8	**S-2(0.61-1.07)** PPen=>4.5 tsf		1	Sandy SILT (ml); sand is fine to medium, subangular; low plasticity; brown; moist; -PL; no reaction to HCl; very stiff.	FILL.
1.07	A-N						1.22m - EL 54.88	
1.22	S-3	100%	5 6 6	**(1.22-2.29)** MC=10 %			Silty SAND (sm); sand is fine to coarse, subangular; nonplastic; light brown; dry; NP; strong reaction to HCl; medium dense.	
1.68	A-N							
1.83	S-4	100%	6 7 6			2		
2.29	A-N							
2.74	S-5	100%	12 11 18	**(2.74-4.11)** MC=12 %		3		
3.20	A-N							
3.66	S-6	73%	11 14 16			4		
4.11	A-N							
4.57	S-7	100%	10 17 50/0.15				4.57m - EL 51.53	
							Poorly graded SAND with silt (sp-sm); sand is fine to coarse, angular; nonplastic; dark brown; dry to moist; NP; strong reaction to HCl; very dense.	
5.03	A-N					5		
5.49	S-8	67%	27 50 50/0.15				5.94m - EL 50.16	
5.94						6	End of Boring at 5.94m	

Boring backfilled with cuttings. Roadway boring was backfilled immediatley following drilling when no groundwater was encountered.

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050 CHECKED BY: EHB

Michael Baker INTERNATIONAL

LOG OF BORING NO.: 460B3

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **3/4/2020** END: **3/4/2020**

NORTH: **1993352.475** EAST: **786545.912** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Eduardo Santiago**

EQUIPMENT: **CME 45 Trailer Rig** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS: **5.715 cm ID HSA. 3.493 cm ID spoon. Safety hammer; 63.5 kg; 76.2 cm fall; ER = 60%.**

▽ H_2O @ ▽ CAVED @ **5.30** TIME: **09:45** DATE: **3/4/2020** DESC.: **0 Hr.** PLUNGE: **-90**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ▽ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **55.18**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	RECOVERY %	SPT BLOWS/0.15m or (RQD)	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
0.00	S-1	67%	4 6 6			0	TOPSOIL.	
0.46	A-N						0.61m - EL 54.57	
0.61	S-2	80%	6 10 10	**(0.61-1.68)** PL=NP MC=11 % USCS=SM AASHTO=A-4(0)		1	Silty SAND (SM); sand is fine to medium; gravel is fine; nonplastic; brown; dry to moist; NP; HCL test not performed; medium dense to very dense.	
1.07	A-N							
1.22	S-3	100%	7 6 6					
1.68	A-N							
1.83	S-4	100%	18 50/0.15	**(1.83-2.29)** PL=NP MC=8 % USCS=SM AASHTO=A-1-b		2		
2.13	A-N							
2.74	S-5	100%	15 25 12			3		
3.20	A-N							
3.66	S-8	100%	14 19 28				3.66m - EL 51.52 SILT with sand (ml); sand is fine; low plasticity; brown; dry; -PL; HCL test not performed; stiff.	
3.96						4	3.96m - EL 51.22 Poorly graded SAND with silt and gravel (sp-sm); sand is fine to medium; gravel is fine; nonplastic; brown; moist; NP; HCL test not performed; dense to very dense.	
4.11	A-N							
4.57	S-7	100%	13 13 18					
5.03	A-N					5		
5.49	S-8	100%	15 24 50/0.15					
5.94							5.94m - EL 49.24	
						6	End of Boring at 5.94m	

Boring backfilled with cuttings.

CHECKED BY: EHB

TEMPLATE=10L_BORING-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker
INTERNATIONAL

We Make a Difference

Test Pit Logs

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-1683

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993351.056** EAST: **786411.239** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.22**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **54.79**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
		(0.30-1.22) PL=NP MC=11 % USCS=SM AASHTO=A-2-4 OLI=4 MD=127.1 OMC=11.5		0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP. Roots throughout.	FILL.
					0.30m - EL 54.49	
				1	Silty SAND (SM); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP.	
					1.22m - EL 53.57	Sample collected at 1.22 m.
					End of Pit at 1.22m	
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-1684

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993174.673** EAST: **786457.51** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.91**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
		(0.30-1.37) PL=NP MC=11 % USCS=SM AASHTO=A-2-4 OLI=6.6 MD=131 OMC=11		0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP. Roots throughout.	FILL.
					0.30m - EL 49.61	
				1	Silty SAND (SM); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP.	
					1.37m - EL 48.54	
					End of Pit at 1.37m	Sample collected at 1.37 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-1685

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993270.285** EAST: **786559.497** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **53.65**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP. Concrete debris throughout.	FILL.
					0.76m - EL 52.89	
		(0.76-1.37) PL=19 % LL=32 % MC=11 % USCS=CL AASHTO=A-6(3) OLI=4.9 MD=114.3 OMC=13		1	Sandy LEAN CLAY (CL); sand is fine to coarse; low plasticity; gravel is fine; brown; dry; -PL.	
					1.37m - EL 52.28	
					End of Pit at 1.37m	Sample collected at 1.37 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-1686

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993283.353** EAST: **786198.93** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.22**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **51.56**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	ASPHALT.	
					0.15m - EL 51.41	FILL.
					Well-graded GRAVEL with silt and sand (gw-gm); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP.	
		(0.76-1.22) PL=19 % LL=28 % MC=12 % USCS=SC AASHTO=A-2-4 OLI=5.1 MD=126.4 OMC=8.7			0.76m - EL 50.80	
				1	Clayey SAND with gravel (SC); sand is fine to coarse; gravel is fine to coarse; brown; dry.	
					1.22m - EL 50.34	
					End of Pit at 1.22m	Sample collected at 1.22 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-1687

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993164.995** EAST: **786581.249** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.22**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.98**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP. Roots throughout.	FILL.
					0.46m - EL 49.52	
		(0.46-1.22) PL=NP MC=11 % USCS=SM AASHTO=A-1-b OLI=6.5 MD=113.5 OMC=12.9			Silty SAND with gravel (SM); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP.	
				1	1.22m - EL 48.76	
					End of Pit at 1.22m	Sample collected at 1.22 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-9049

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993270.85** EAST: **786170.587** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **50.87**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
		(0.30-1.37) PL=19 % LL=30 % MC=10 % USCS=SC AASHTO=A-2-6 OLI=3.5 MD=124.2 OMC=10.5		0	ASPHALT. 0.15m - EL 50.72 Silty GRAVEL with sand (gm); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP. 0.30m - EL 50.57 Clayey SAND with gravel (SC); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP. 1.37m - EL 49.50 End of Pit at 1.37m	FILL. Sample collected at 1.37 m.
				1		
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-9050

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993167.606** EAST: **786437.898** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.5**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is coarse, concrete; nonplastic; brown; dry; NP.	FILL.
					0.46m - EL 49.04	
		(0.46-1.37) PL=NP MC=11 % USCS=SM AASHTO=A-2-4 OLI=6.4 MD=115.7 OMC=13.4		1	Silty SAND (SM); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP.	
					1.37m - EL 48.13	
					End of Pit at 1.37m	Sample collected at 1.37 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

Michael Baker INTERNATIONAL

LOG OF TEST PIT NO.: TP-9051

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993296.84** EAST: **786560.772** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⌭ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⌭ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **54.22**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is coarse; nonplastic; brown; dry; NP.	FILL.
					0.61m - EL 53.61	
		(0.61-1.37) PL=NP MC=11 % USCS=SM AASHTO=A-4 OLI=7 MD=124.2 OMC=13.3		1	Silty SAND (SM); sand is fine to coarse; gravel is fine; nonplastic; brown; dry; NP.	
					1.37m - EL 52.85	
					End of Pit at 1.37m	Sample collected at 1.37 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

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LOG OF TEST PIT NO.: TP-9052

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993124.231** EAST: **786592.951** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.37**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **49.12**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	Silty SAND with gravel (sm); sand is fine to coarse; gravel is coarse; nonplastic; brown; dry; NP.	FILL.
					0.46m - EL 48.66	
		(0.46-1.37) PL=32 % LL=38 % MC=12 % USCS=SM AASHTO=A-4 OLI=7.4 MD=120.4 OMC=14.3		1	Silty SAND (SM); sand is fine to coarse; gravel is fine; brown; dry.	
					1.37m - EL 47.75	
					End of Pit at 1.37m	Sample collected at 1.37 m.
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

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LOG OF TEST PIT NO.: TP-9053

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993117.226** EAST: **786695.982** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.91** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **1.22**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **48.53**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
		(0.30-1.22) PL=28 % LL=44 % MC=11 % USCS=ML AASHTO=A-7-6(8) OLI=8.3 MD=120.4 OMC=14.3		0	Well-graded GRAVEL with sand (gw); sand is fine to coarse; gravel is fine to coarse; nonplastic; brown; dry; NP. 0.30m - EL 48.23 Sandy SILT with gravel (ML); sand is fine to coarse; low plasticity; brown; dry; -PL. 1.22m - EL 47.31 End of Pit at 1.22m	FILL. Sample collected at 1.22 m.
				1		
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

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LOG OF TEST PIT NO.: TP-9054

PROJECT: **Camp Santiago** SHEET: **1** OF **1**

LATITUDE: LONGITUDE: GEO. DATUM: START: **5/21/2020** END: **5/21/2020**

NORTH: **1993280.752** EAST: **786450.479** COORD. DATUM: **WGS84 Zone 19N** LOGGER: **Brian Davis**

STATION: OFFSET: BASELINE: DRILLER: **Rommel Cintron**

EQUIPMENT: **Bobcat 1257 Excavator** DRILL CO.: **Jaca & Sierra Engineering**

METHOD DETAILS:

TEST PIT LENGTH: **0.61** TEST PIT WIDTH: **0.61** TEST PIT DEPTH: **0.76**

▽ H_2O @ **Dry** ⊆ CAVED @ TIME: DATE: **5/21/2020** DESC.: **0 Hr.** PLUNGE:

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: ELEV. DATUM: **PRVD2002**

▼ H_2O @ ⊆ CAVED @ TIME: DATE: DESC.: GROUND ELEV.: **52.67**

SAMPLE DEPTH (m)	SAMPLE TYPE - NUMBER	TEST RESULTS	STRATA	DEPTH (m)	DESCRIPTION	REMARKS
				0	ASPHALT; nonplastic; brown; dry; NP.	
					0.15m - EL 52.52	
					Silty SAND (sm); sand is fine to coarse; nonplastic; brown; dry; NP.	
					0.76m - EL 51.91	
					End of Pit at 0.76m	
				1		
				2		
				3		
				4		
				5		
				6		

CHECKED BY: DRB

TEMPLATE=10L_PIT-US2METRIC PROJECT=CAMP SANTIAGO.GPJ LIBRARY=BAKER_10-1 (1).GLB DATE PRINTED= 8/10/20 S.O.#=177050

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Field Soil Resistivity Test Results

Camp Santiago Facility Restoration

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Testing Laboratories
Geotechnical Engineers

Field Test Results

Soil Resistivity using Wenner Four-Electrode Method (ASTM G57)

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Tests: 4
Date: May 21, 2020
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Test ID	Pin Spacing (ft)	Resistance (ohm)	Resistivity (ohm*cm)
FR-1	2	93	35603
	4	30	22970
	8	11	16844
	16	9	27564
FR-2	2	90	34455
	4	38	29095
	8	20	30626
	16	8	24501
FR-3	2	110	42111
	4	35	26798
	8	13	19907
	16	6	18376
FR-4	2	160	61253
	4	56	42877
	8	12	18376
	16	9	27564

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TEST LOCATIONS

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Field Soil Percolation Tests Results

Camp Santiago Facility Restoration

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JACA & SIERRA
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Field Test Results

Soil Percolation

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Tests: 1
Date: May 22, 2020
Engineer: Rommel Cintrón Aponte, MSCE, PE

METHOD

The percolation test was performed in accordance with Regulations for the Control of Underground Injection, Appendix A, Section E, Puerto Rico Environmental Quality Board ("Reglamento para el Control de la Inyección Subterránea, Apéndice A, Sección E, Junta de Calidad Ambiental de Puerto Rico" in Spanish), September 14, 1983. The procedure requires an excavation of 1 foot wide by 1 foot long by 2 feet depth. Testing is started by filling the excavation with water. After allowing for the soil to saturate, the test is made by refilling the hole with a column of water of 1 foot depth. The rate of drop of water level is measured by keeping a record of elapsed time and the corresponding relative water level from fixed reference for the last 6 inches of water in the test hole. The result of the percolation test is presented as the average time of the column of water to drop 1 inch (average of the last 6 inches).

RESULTS

Test ID	Average Time (min/in)
FP-1	60

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TEST LOCATIONS

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ATTACHMENT 5
Laboratory Testing Results

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Soil Classification and Moisture Content Test Results

Camp Santiago Facility Restoration

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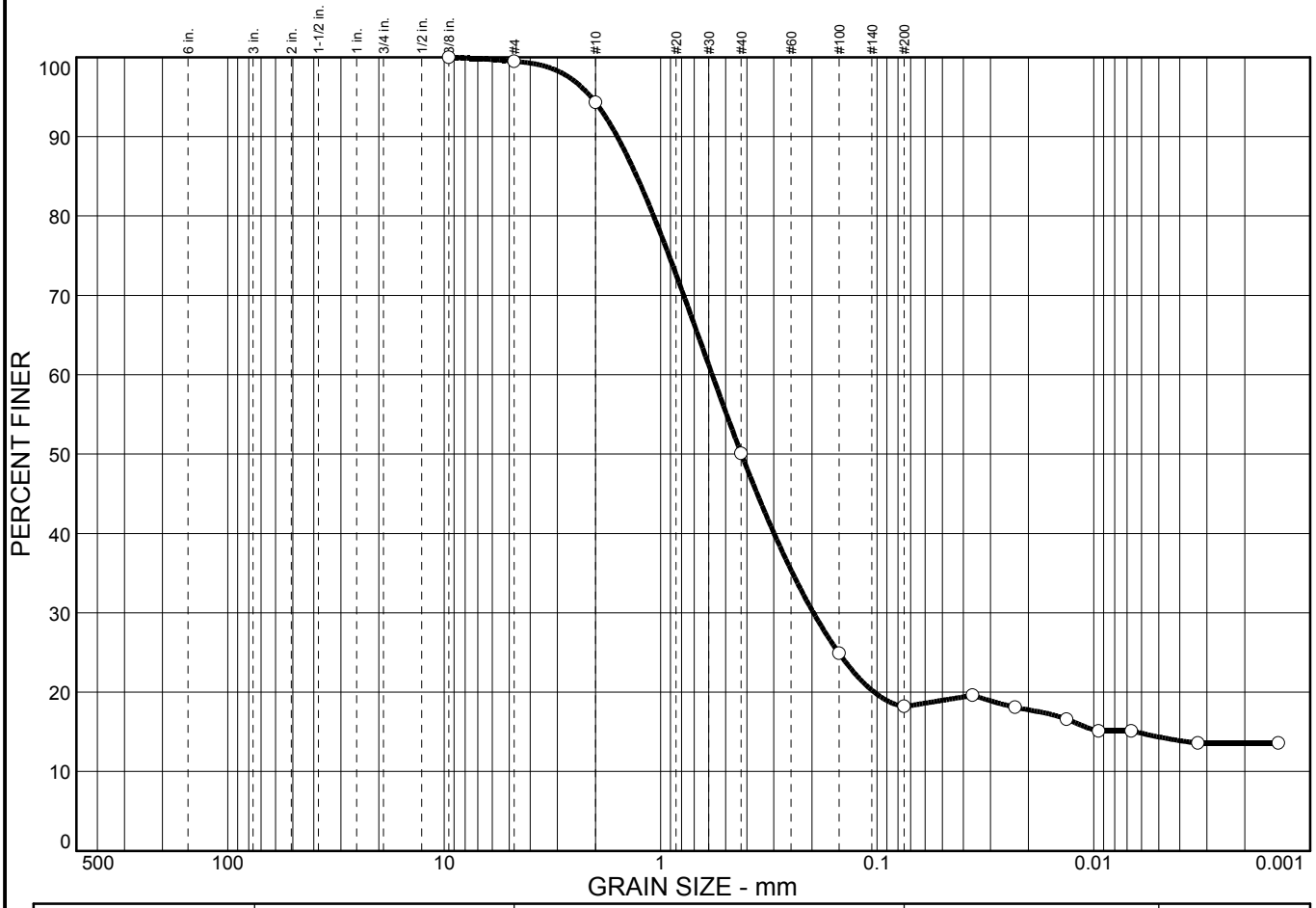
Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	81.3	3.8	14.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.5		
#10	94.3		
#40	50.1		
#100	24.9		
#200	18.2		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.29 D_{60}= 0.578 D_{50}= 0.424
D_{30}= 0.197 D_{15}= 0.0064 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

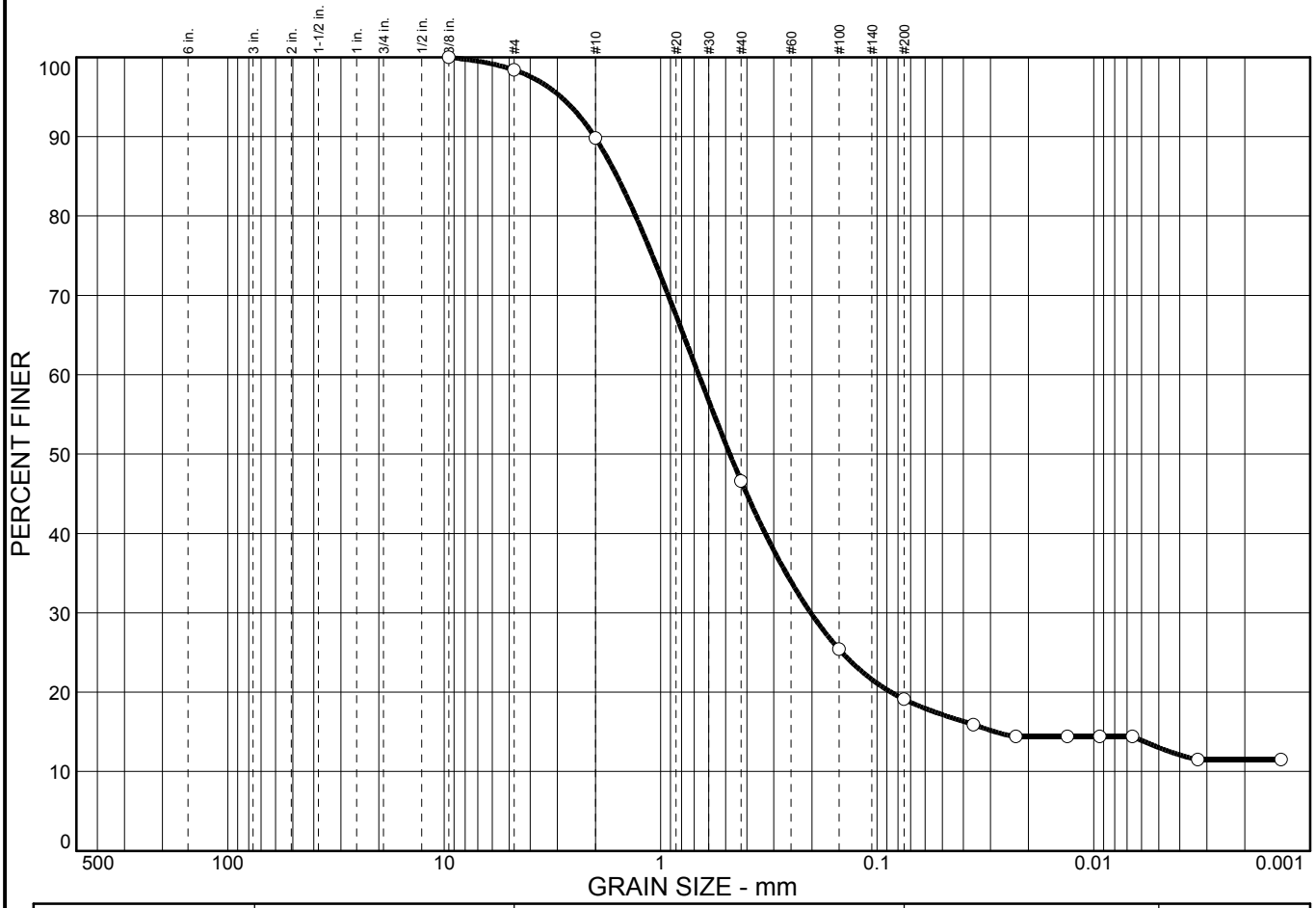
Sample No.: 300B1 **Source of Sample:** Project Site **Date:** 5/12/20
Location: Salinas, PR **Elev./Depth:** 6-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	79.3	6.1	13.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.4		
#10	89.8		
#40	46.6		
#100	25.4		
#200	19.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.59 D_{60}= 0.668 D_{50}= 0.479
D_{30}= 0.203 D_{15}= 0.0284 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

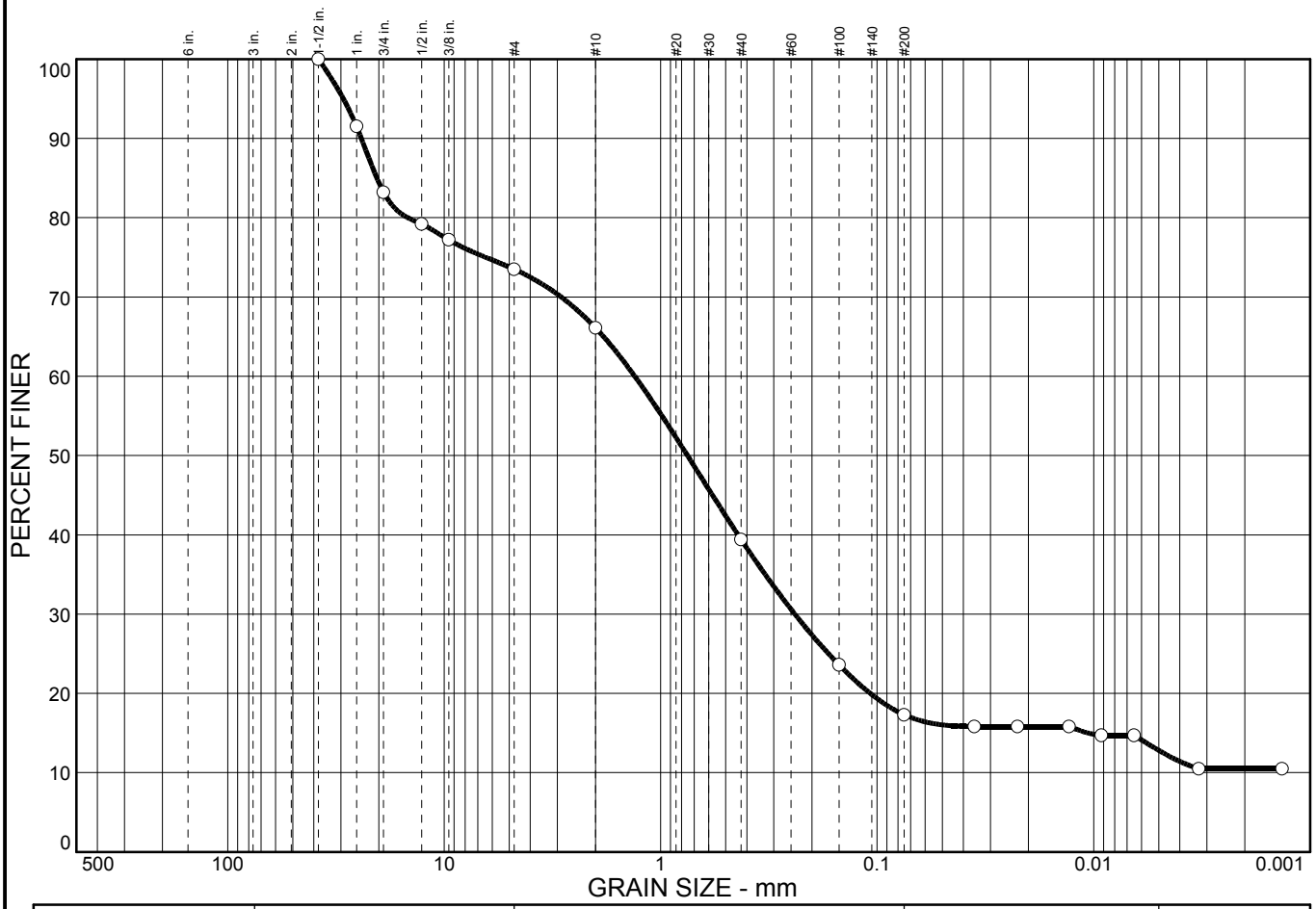
Sample No.: 300B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	26.5	56.2	4.5	12.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	91.5		
.75 in.	83.2		
.5 in.	79.2		
.375 in.	77.2		
#4	73.5		
#10	66.1		
#40	39.4		
#100	23.6		
#200	17.3		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 20.5 D_{60}= 1.32 D_{50}= 0.752
D_{30}= 0.240 D_{15}= 0.0106 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

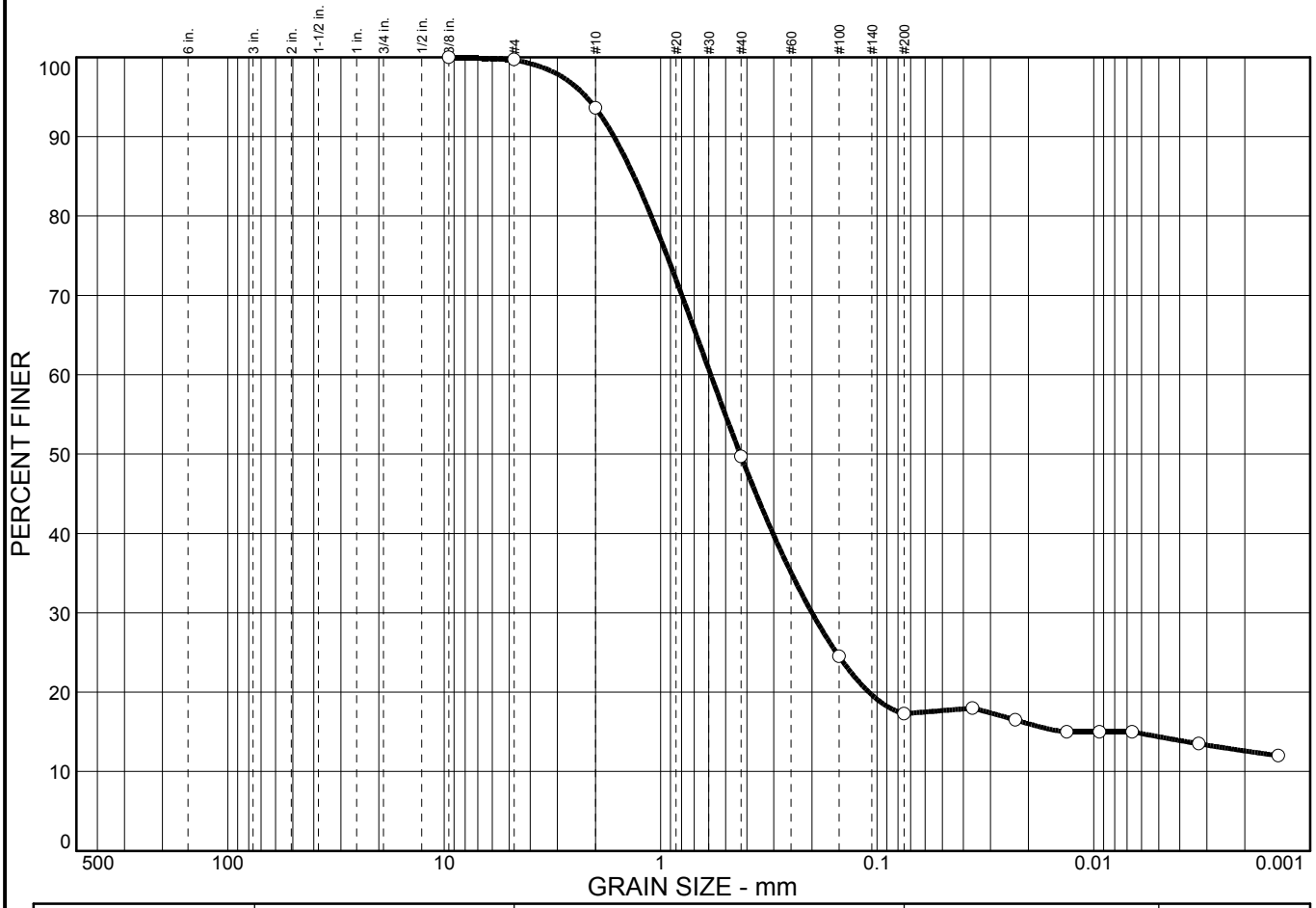
Sample No.: 302B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	82.4	2.9	14.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	93.6		
#40	49.7		
#100	24.5		
#200	17.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.33 D_{60}= 0.587 D_{50}= 0.429
D_{30}= 0.200 D_{15}= 0.0066 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

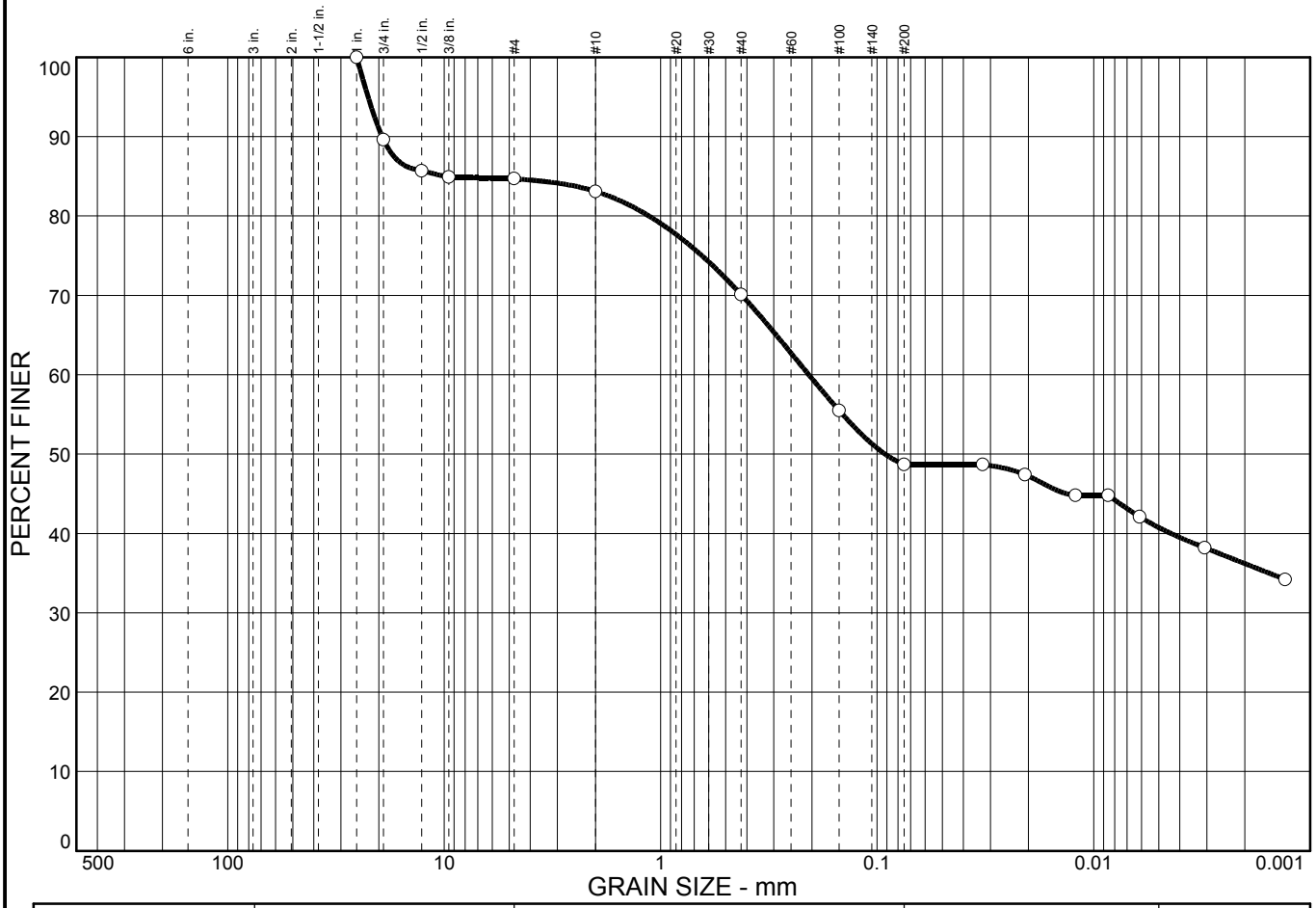
Sample No.: 302B1 **Source of Sample:** Project Site **Date:** 5/15/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	15.3	36.0	8.0	40.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	89.6		
.5 in.	85.7		
.375 in.	84.9		
#4	84.7		
#10	83.1		
#40	70.1		
#100	55.5		
#200	48.7		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 21 LL= 46 PI= 25

Coefficients

D_{85}= 9.94 D_{60}= 0.207 D_{50}= 0.0920
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(8)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

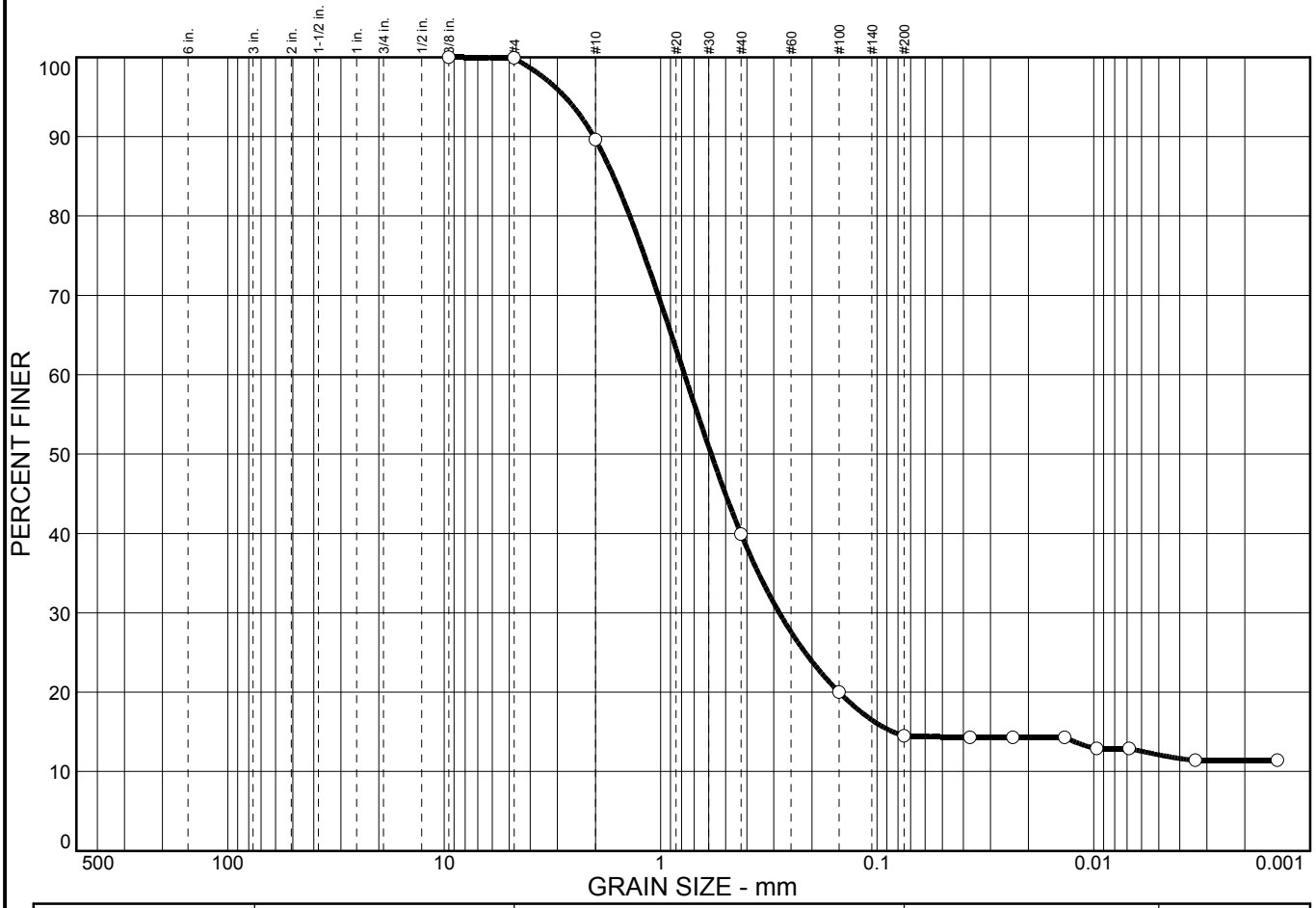
Sample No.: 304B1 **Source of Sample:** Project Site **Date:** 6/3/20
Location: Salinas, PR **Elev./Depth:** 0-1.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	85.4	2.4	12.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	89.6		
#40	39.9		
#100	20.0		
#200	14.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.65 D_{60}= 0.776 D_{50}= 0.584
D_{30}= 0.283 D_{15}= 0.0845 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

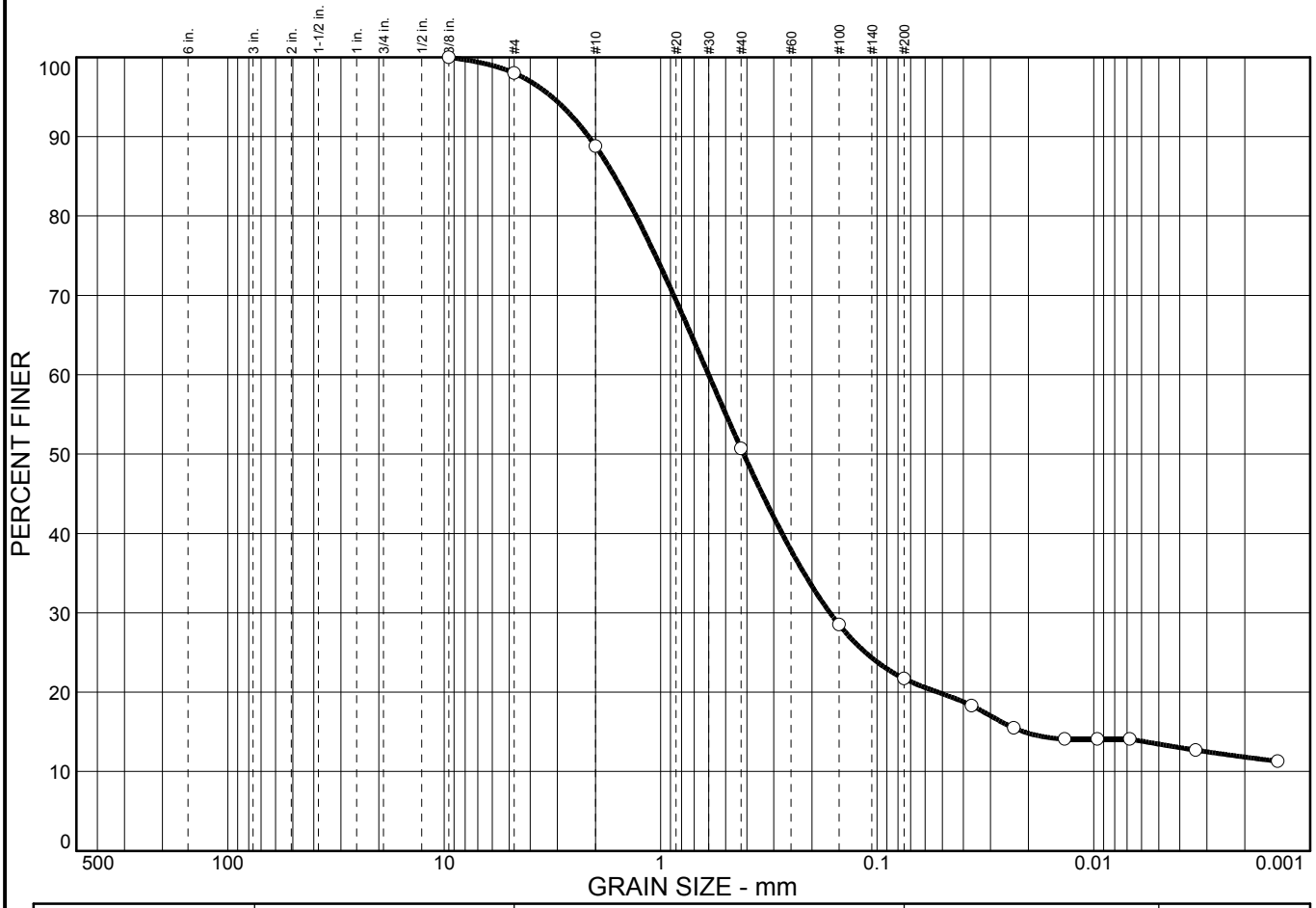
Sample No.: 304B1 **Source of Sample:** Project Site **Date:** 6/2/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.0	76.3	8.2	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.0		
#10	88.8		
#40	50.7		
#100	28.5		
#200	21.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.63 D_{60}= 0.601 D_{50}= 0.414
D_{30}= 0.165 D_{15}= 0.0209 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

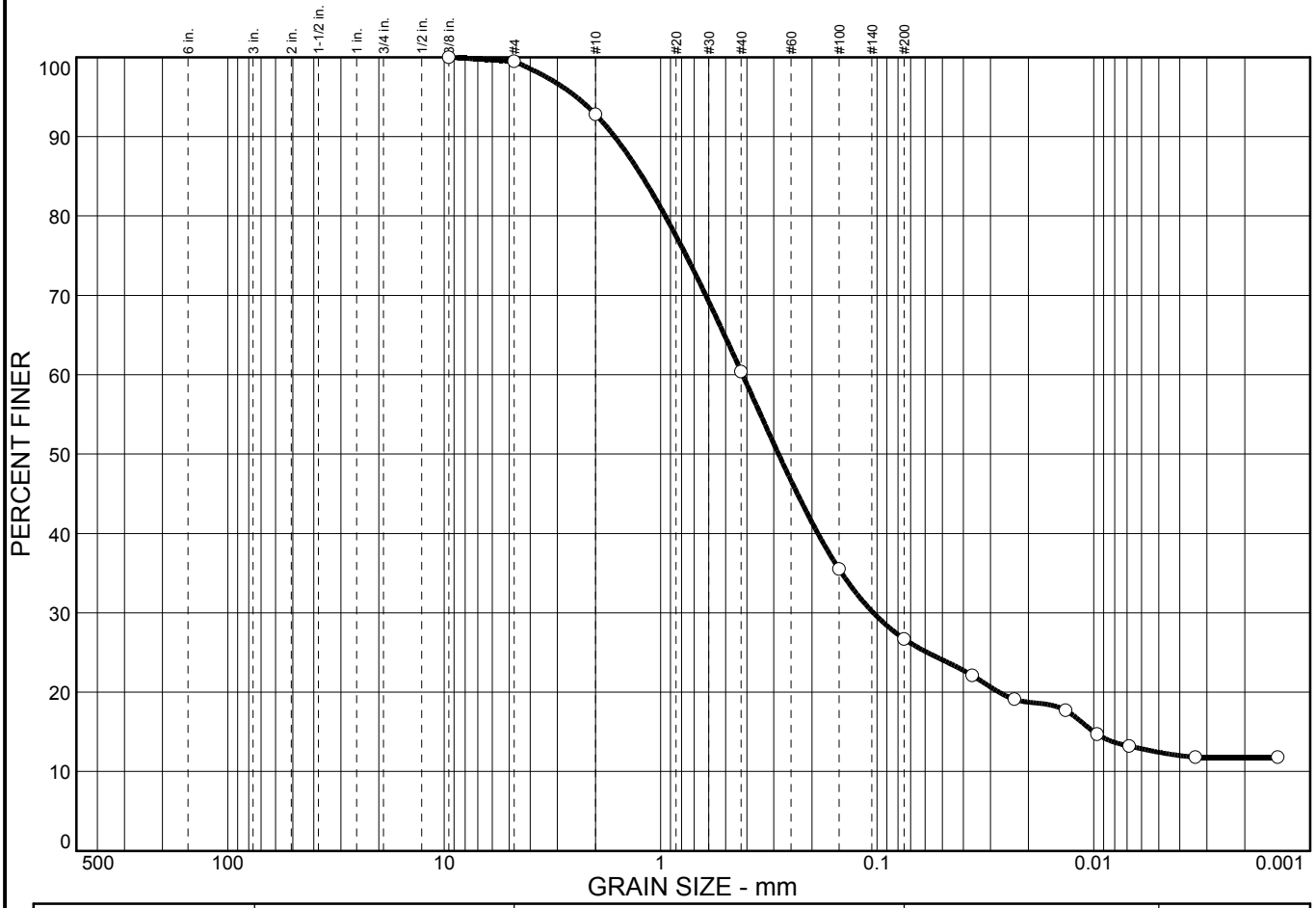
Sample No.: 304B2 **Source of Sample:** Project Site **Date:** 6/2/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	72.8	14.3	12.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.5		
#10	92.8		
#40	60.4		
#100	35.5		
#200	26.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.22 D_{60}= 0.419 D_{50}= 0.285
D_{30}= 0.104 D_{15}= 0.0100 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

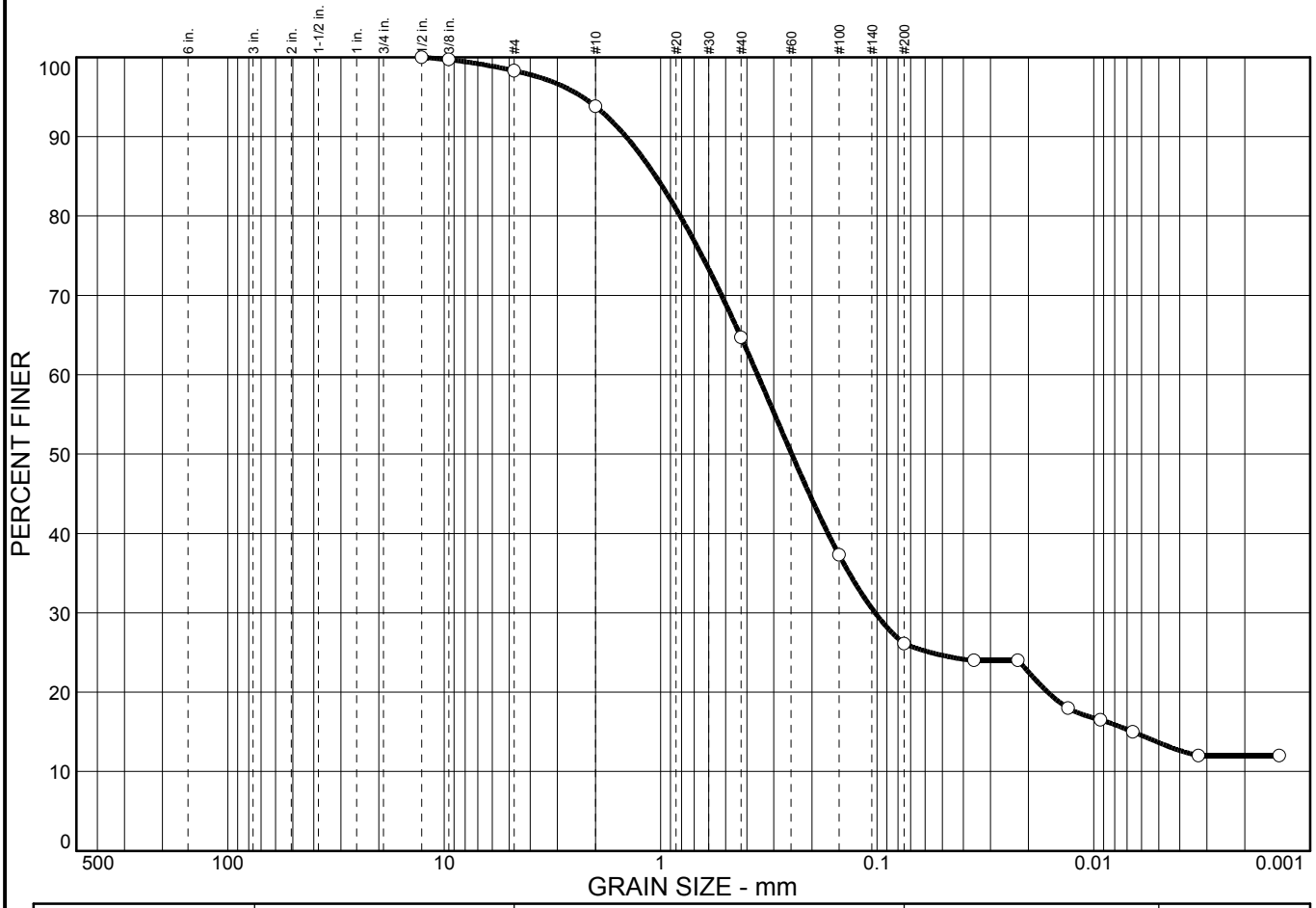
Sample No.: 304B2 **Source of Sample:** Project Site **Date:** 6/2/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.7	72.2	12.5	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.7		
#4	98.3		
#10	93.8		
#40	64.7		
#100	37.3		
#200	26.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.06 D_{60}= 0.357 D_{50}= 0.248
D_{30}= 0.102 D_{15}= 0.0066 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

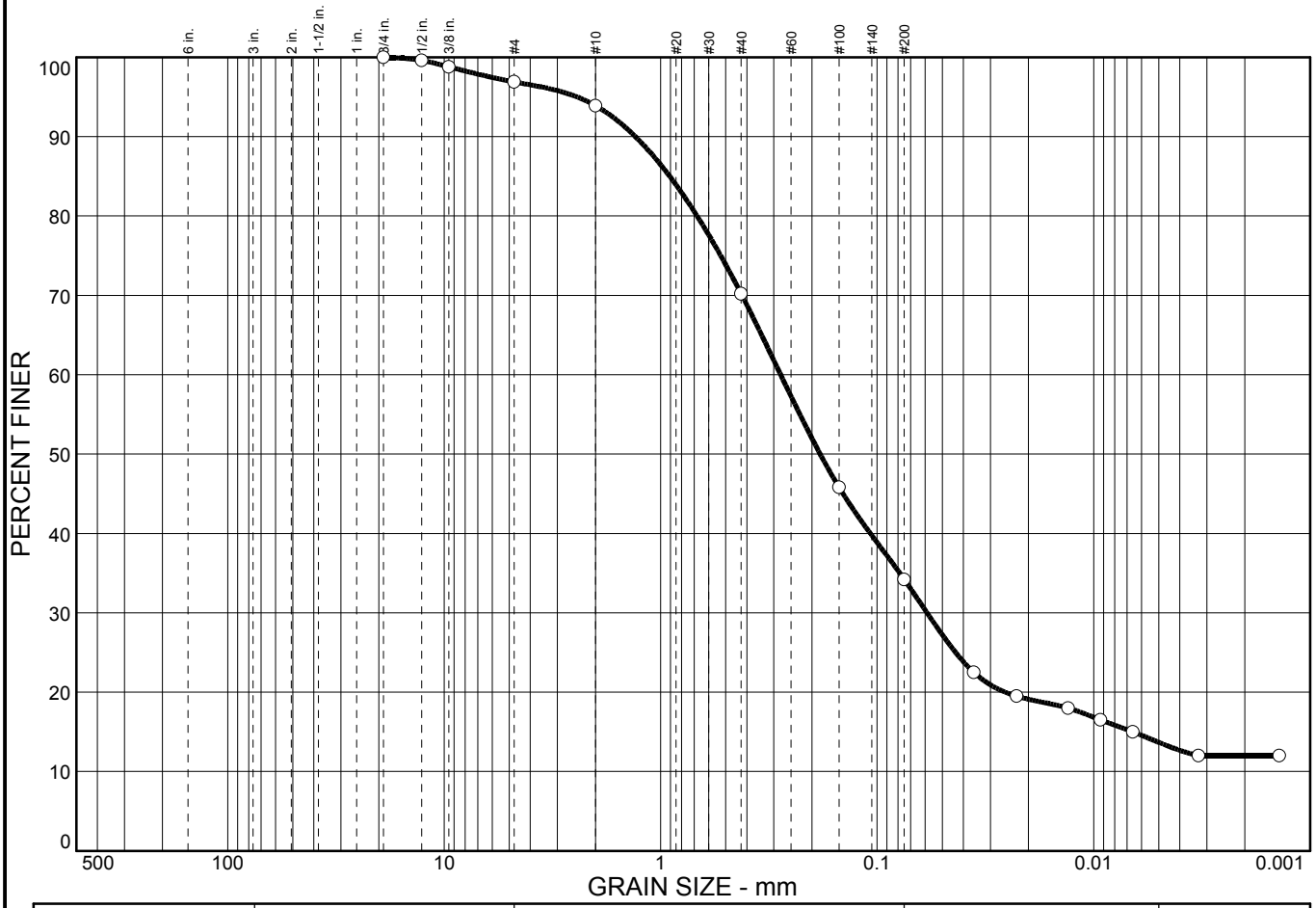
Sample No.: 304B3 **Source of Sample:** Project Site **Date:** 6/25/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.1	62.7	20.5	13.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.6		
.375 in.	98.8		
#4	96.9		
#10	93.9		
#40	70.2		
#100	45.8		
#200	34.2		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.909 D_{60}= 0.279 D_{50}= 0.183
D_{30}= 0.0589 D_{15}= 0.0066 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

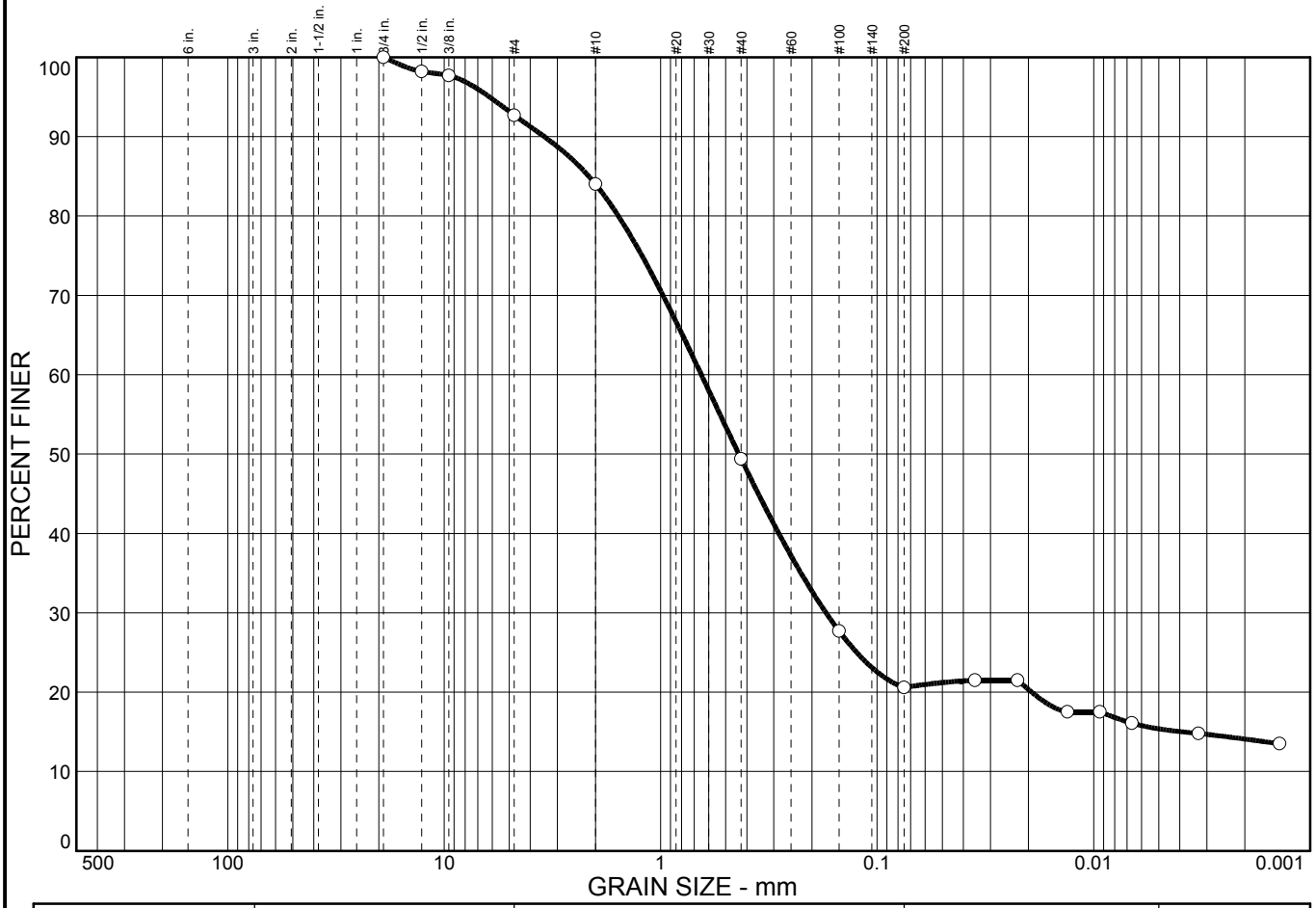
Sample No.: 304B3 **Source of Sample:** Project Site **Date:** 6/25/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.3	72.1	5.2	15.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.2		
.375 in.	97.7		
#4	92.7		
#10	84.0		
#40	49.4		
#100	27.7		
#200	20.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 2.15 D_{60}= 0.649 D_{50}= 0.435
D_{30}= 0.172 D_{15}= 0.0039 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

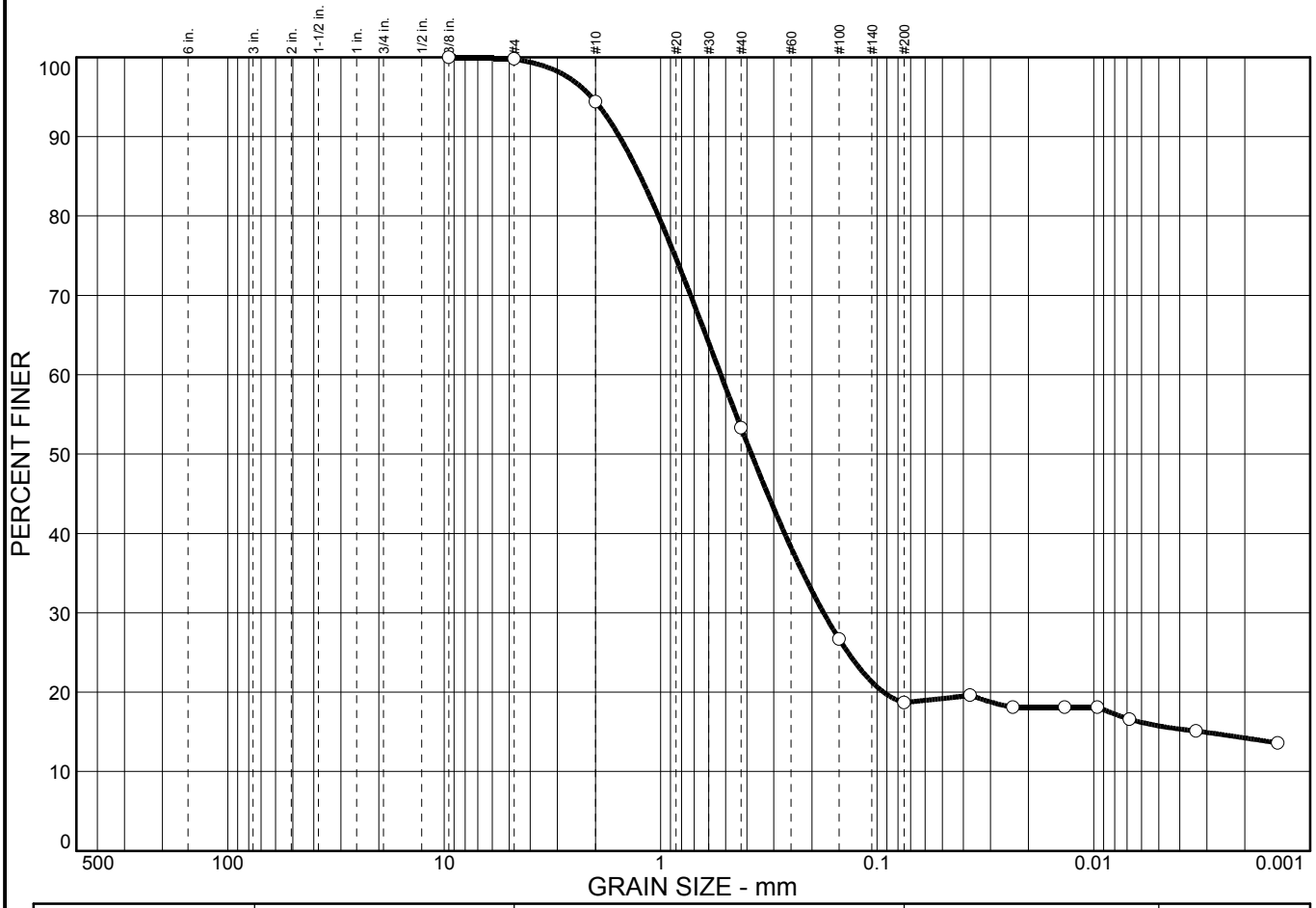
Sample No.: 306B1 **Source of Sample:** Project Site **Date:** 6/10/20
Location: Salinas, PR **Elev./Depth:** 3-6'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	81.1	3.0	15.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	94.4		
#40	53.3		
#100	26.7		
#200	18.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.24 D_{60}= 0.528 D_{50}= 0.381
D_{30}= 0.177 D_{15}= 0.0031 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

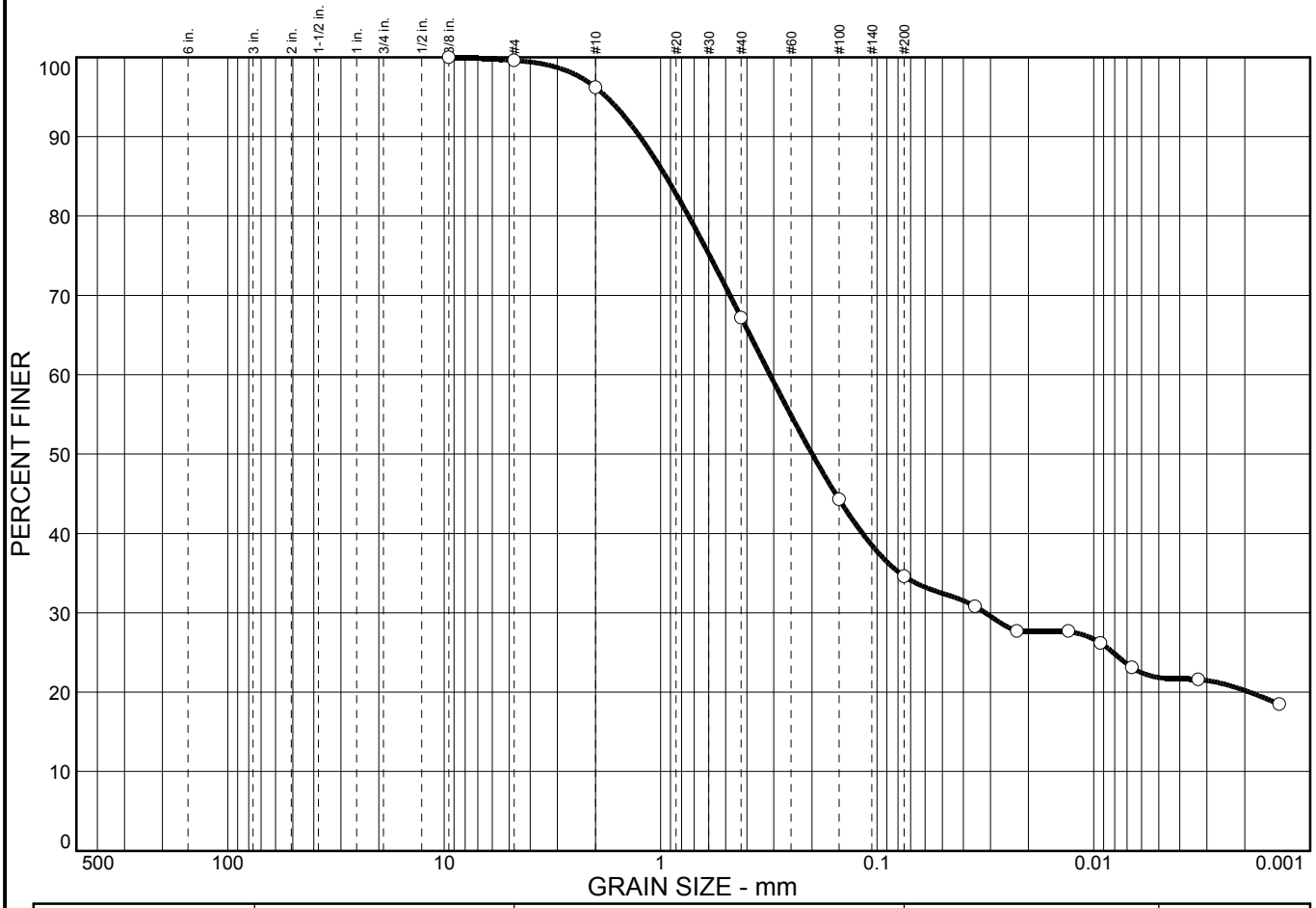
Sample No.: 306B1 **Source of Sample:** Project Site **Date:** 6/11/20
Location: Salinas, PR **Elev./Depth:** 6-9'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.4	65.0	12.8	21.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.6		
#10	96.2		
#40	67.2		
#100	44.3		
#200	34.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 25 LL= 33 PI= 8

Coefficients

D_{85}= 0.948 D_{60}= 0.313 D_{50}= 0.200
D_{30}= 0.0317 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

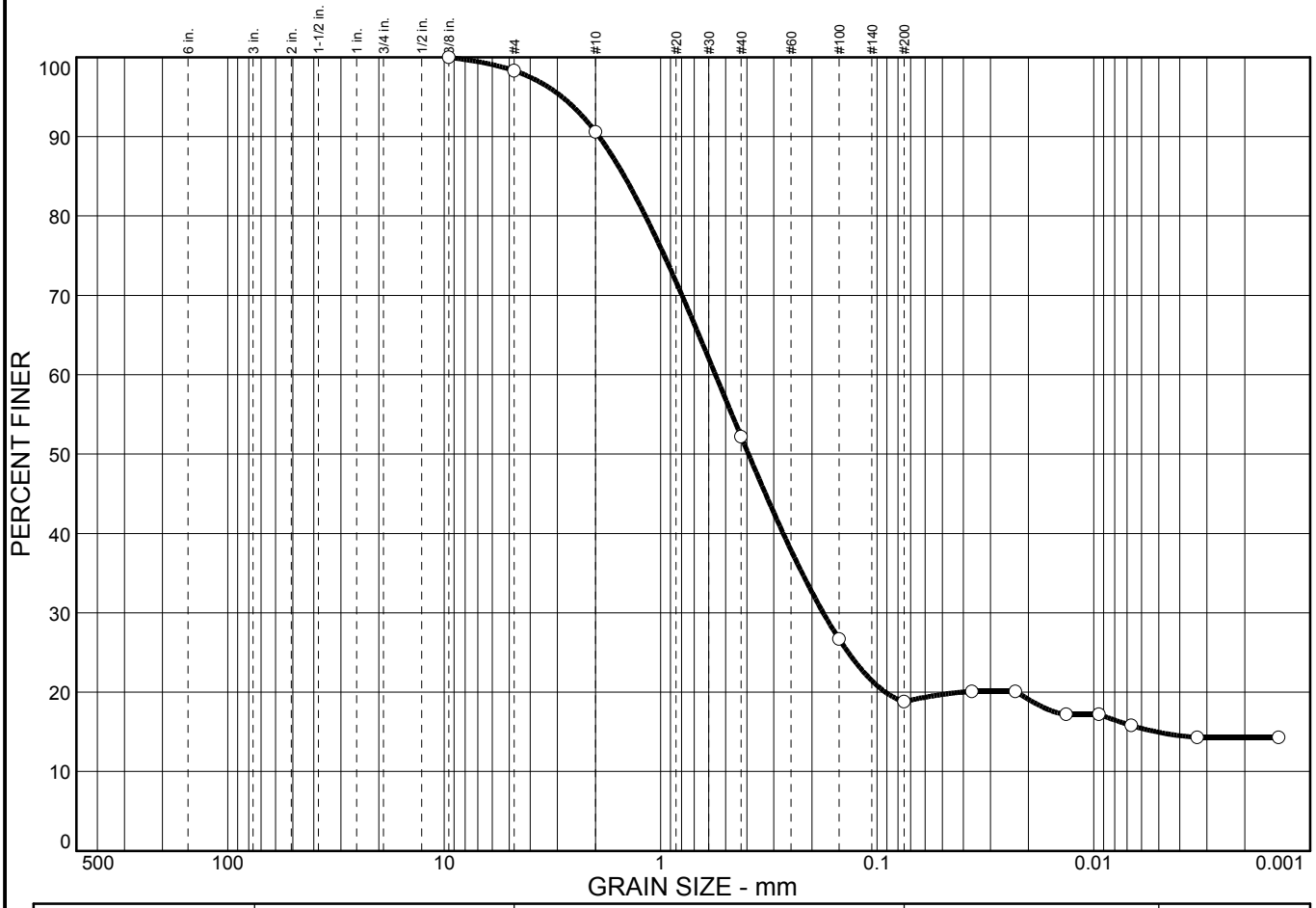
Sample No.: 308B1 **Source of Sample:** Project Site **Date:** 6/2/20
Location: Salinas, PR **Elev./Depth:** 2-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.7	79.5	3.9	14.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.3		
#10	90.6		
#40	52.2		
#100	26.7		
#200	18.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.47 D_{60}= 0.559 D_{50}= 0.393
D_{30}= 0.178 D_{15}= 0.0051 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

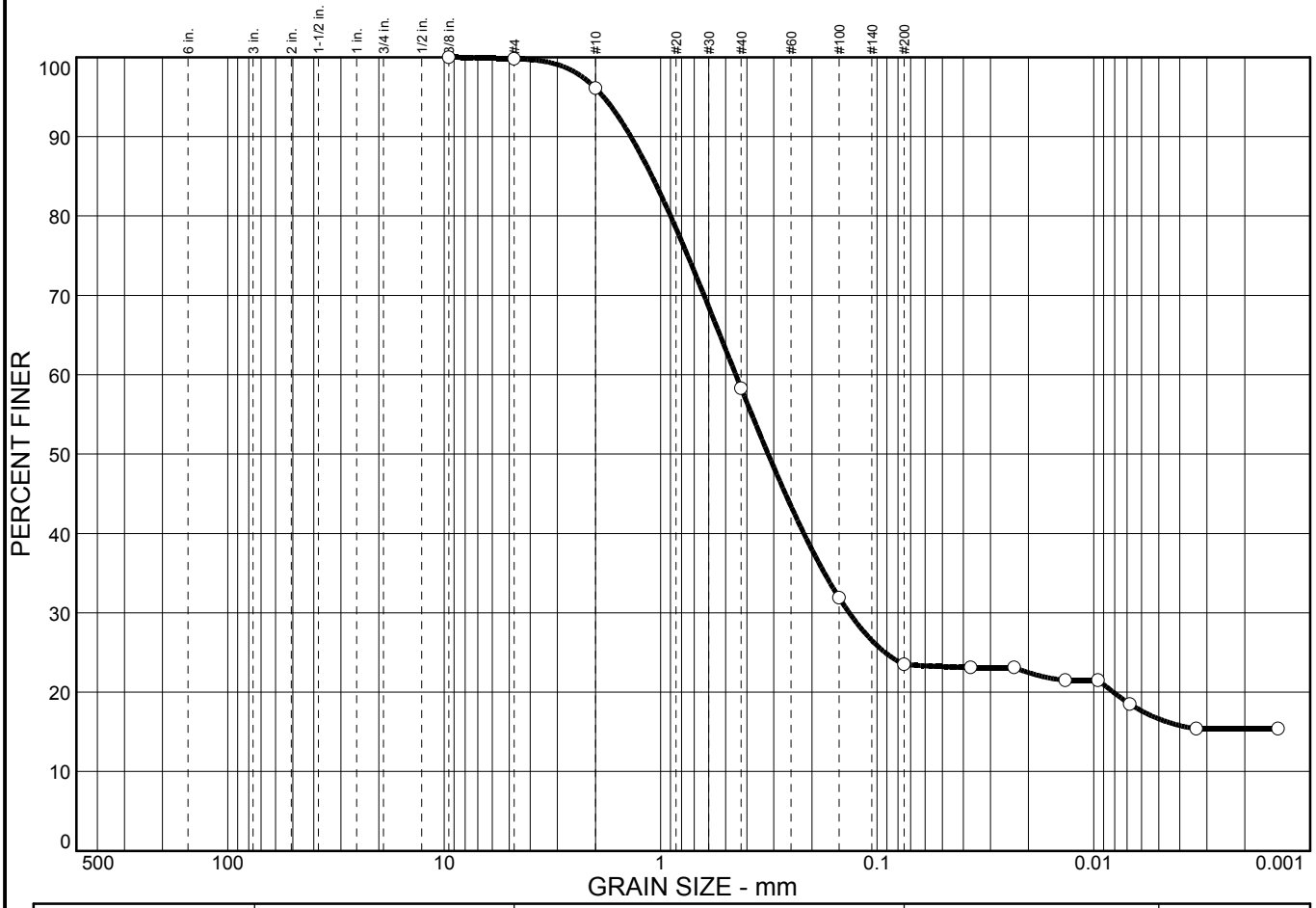
Sample No.: 308B1 **Source of Sample:** Project Site **Date:** 6/2/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	76.3	6.9	16.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	96.1		
#40	58.3		
#100	31.9		
#200	23.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.10 D_{60}= 0.450 D_{50}= 0.319
D_{30}= 0.135 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

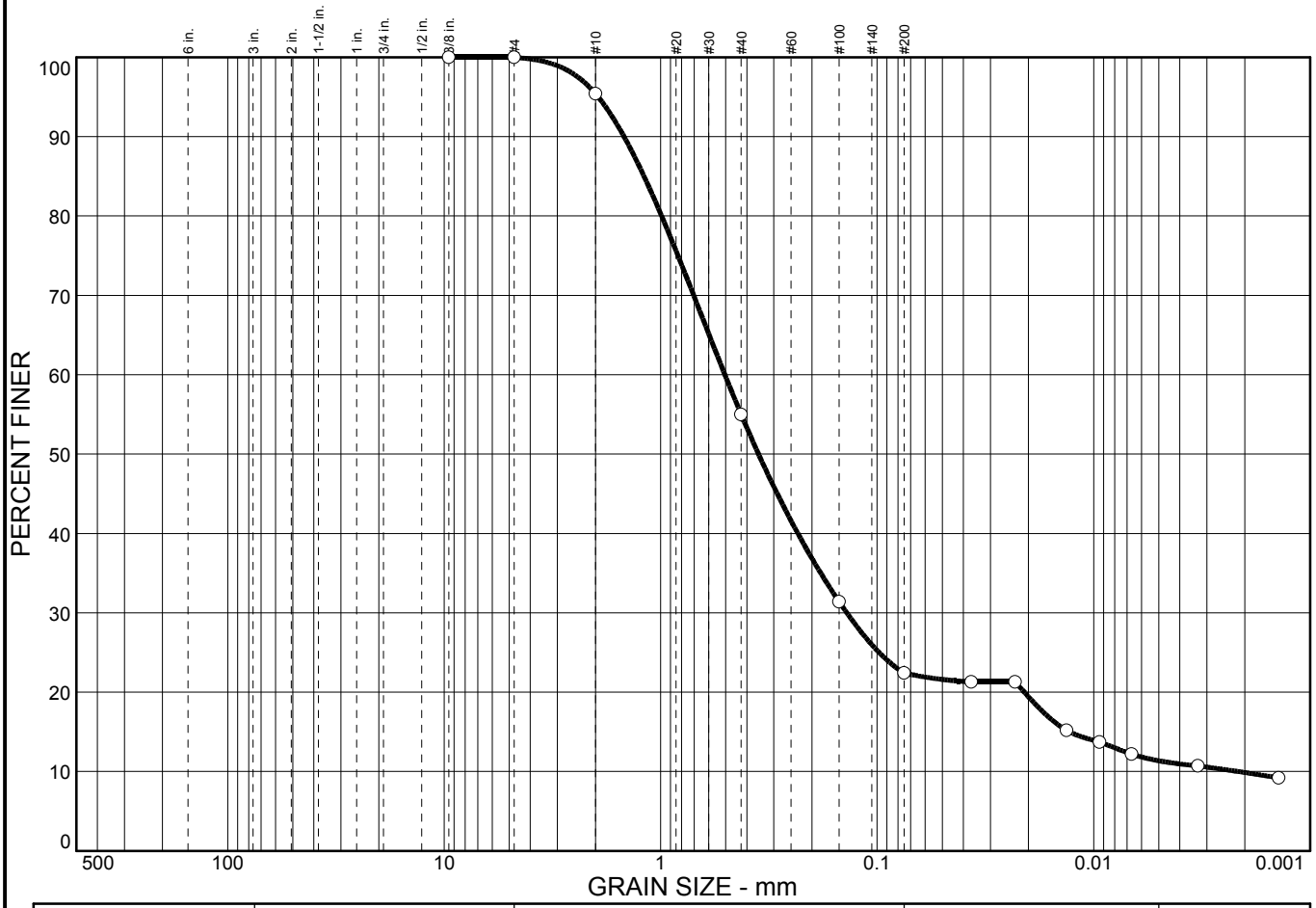
Sample No.: 308B2 **Source of Sample:** Project Site **Date:** 6/11/20
Location: Salinas, PR **Elev./Depth:** 2-6'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	77.6	11.0	11.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	100.0		
#10	95.4		
#40	55.0		
#100	31.4		
#200	22.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.19 D_{60}= 0.505 D_{50}= 0.353
D_{30}= 0.138 D_{15}= 0.0129 D_{10}= 0.0021
C_u= 235.76 C_c= 17.63

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

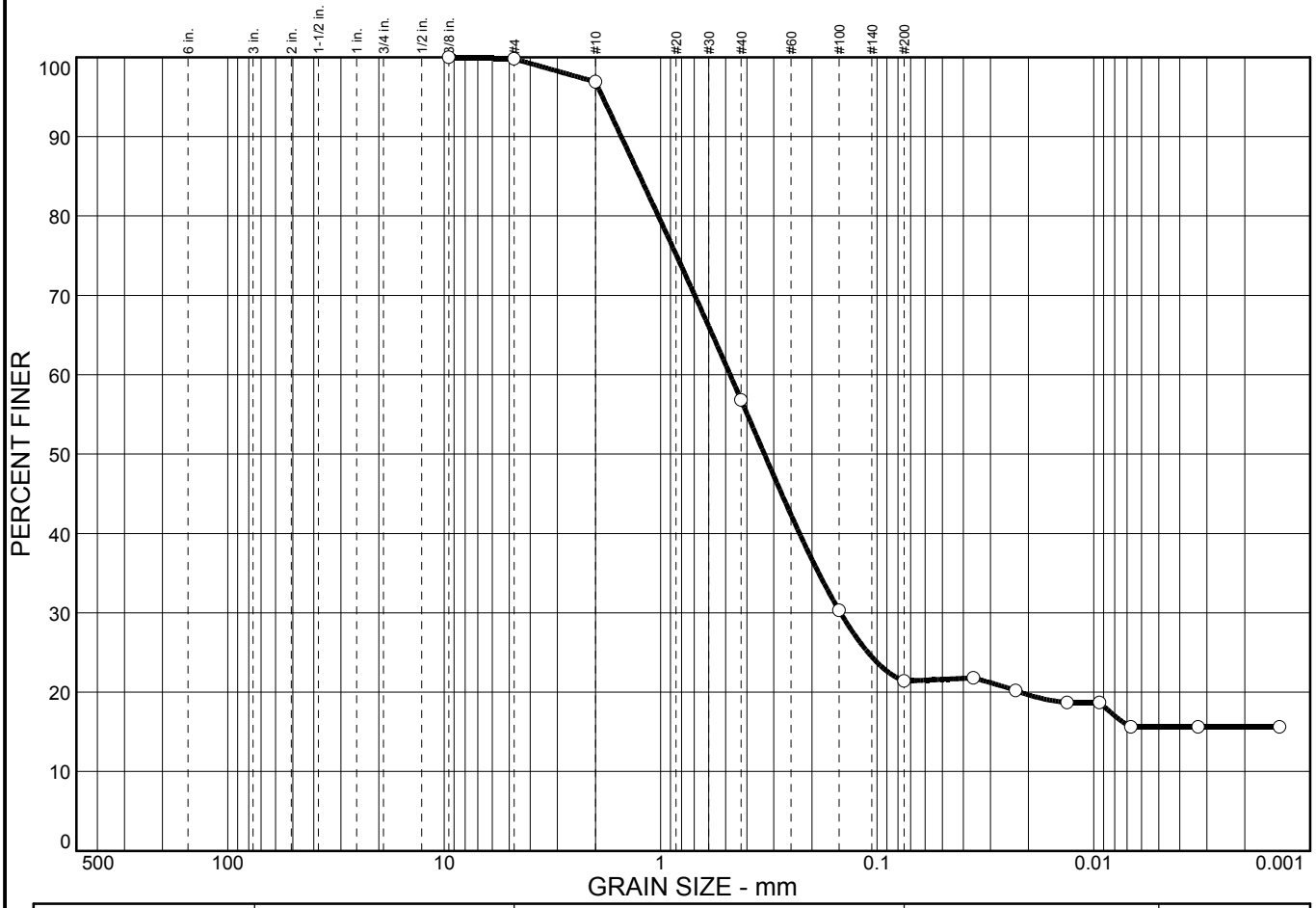
Sample No.: 308B2 **Source of Sample:** Project Site **Date:** 6/11/20
Location: Salinas, PR **Elev./Depth:** 6-10'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	78.4	5.8	15.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	96.9		
#40	56.8		
#100	30.3		
#200	21.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.25 D_{60}= 0.478 D_{50}= 0.332
D_{30}= 0.148 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

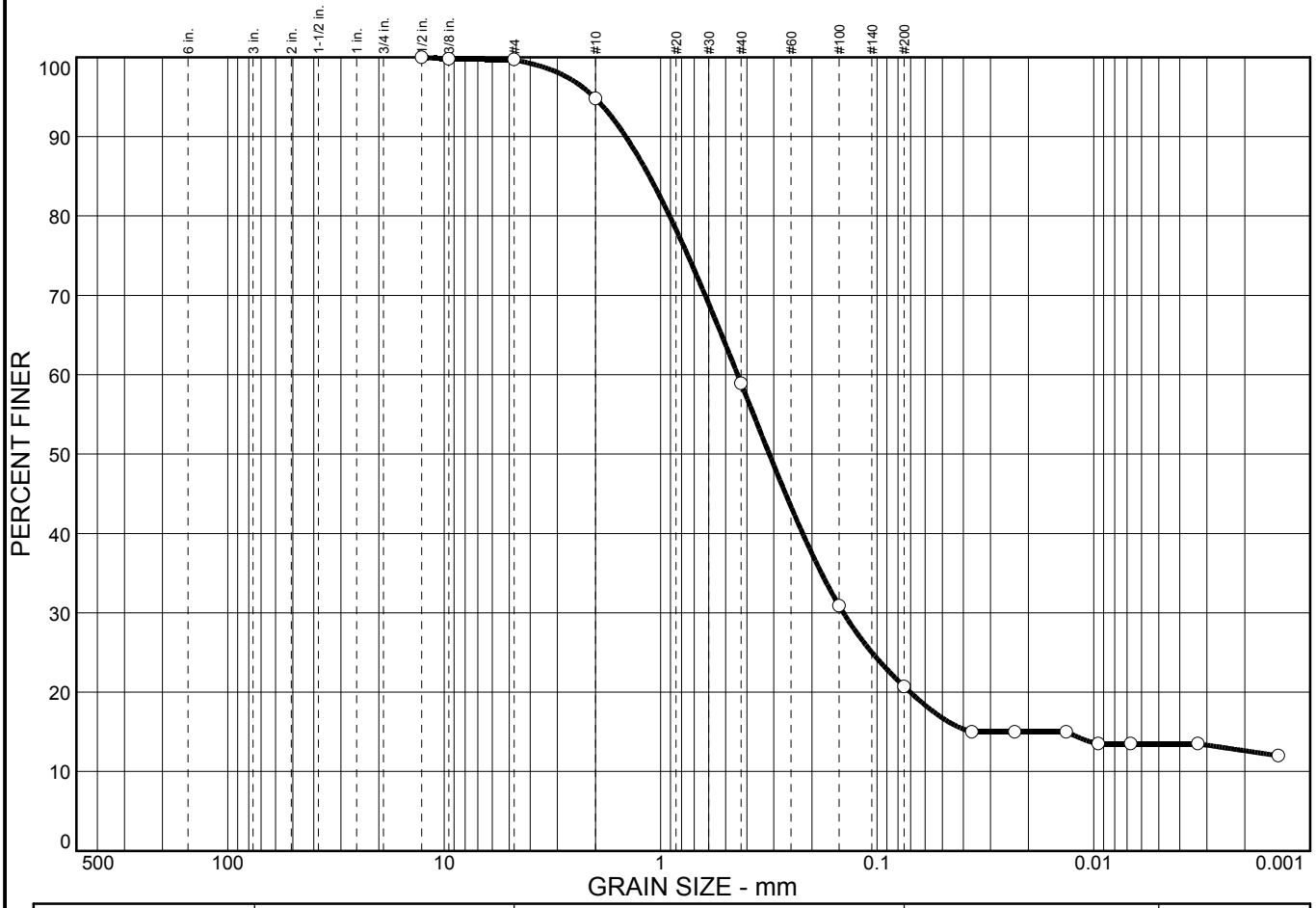
Sample No.: 308B3 **Source of Sample:** Project Site **Date:** 6/11/20
Location: Salinas, PR **Elev./Depth:** 4.5-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	79.0	7.2	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.8		
#4	99.7		
#10	94.8		
#40	58.9		
#100	30.9		
#200	20.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.13 D_{60}= 0.441 D_{50}= 0.315
D_{30}= 0.143 D_{15}= 0.0134 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

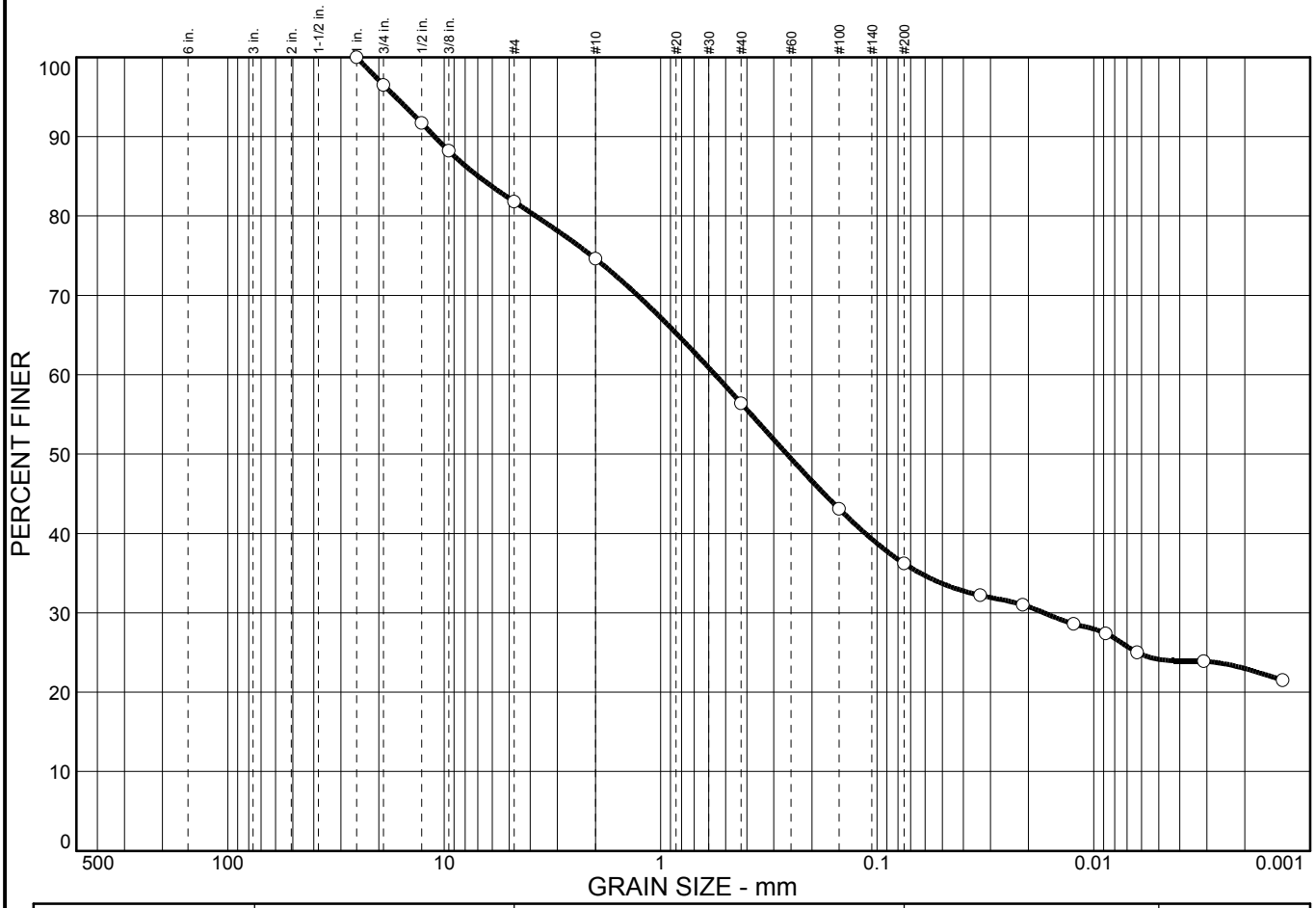
Sample No.: 308B3 **Source of Sample:** Project Site **Date:** 6/12/20
Location: Salinas, PR **Elev./Depth:** 9-12'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	18.2	45.6	12.1	24.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	96.5		
.5 in.	91.7		
.375 in.	88.2		
#4	81.8		
#10	74.6		
#40	56.4		
#100	43.1		
#200	36.2		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 18 LL= 37 PI= 19

Coefficients

D_{85}= 6.96 D_{60}= 0.560 D_{50}= 0.261
D_{30}= 0.0170 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-6(2)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

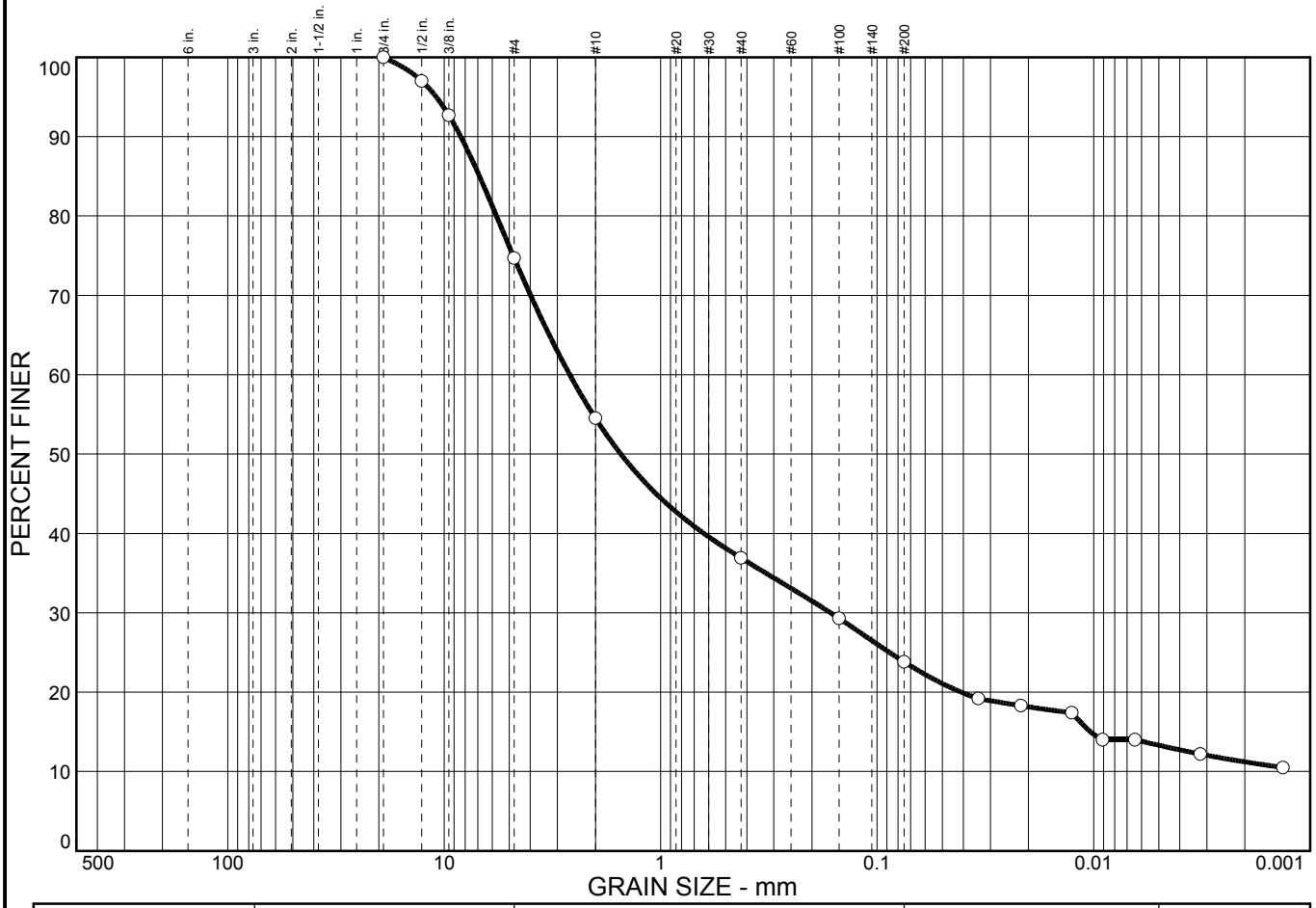
Sample No.: 310B1 **Source of Sample:** Project Site **Date:** 5/18/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	25.3	50.9	10.5	13.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	97.0		
.375 in.	92.7		
#4	74.7		
#10	54.5		
#40	36.9		
#100	29.3		
#200	23.8		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 6.87 D_{60}= 2.63 D_{50}= 1.53
D_{30}= 0.164 D_{15}= 0.0103 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

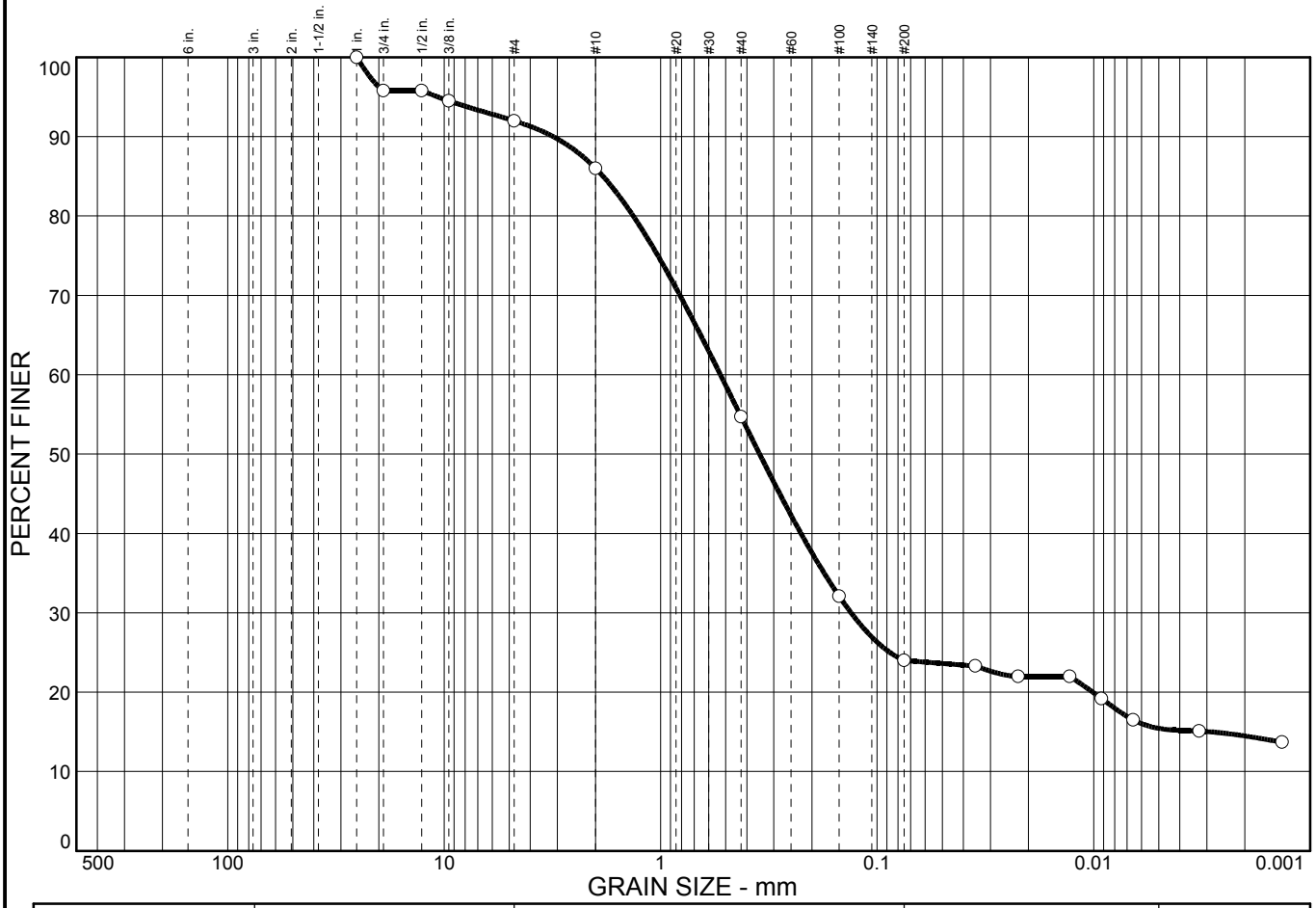
Sample No.: 310B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	8.0	68.0	8.5	15.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	95.8		
.5 in.	95.8		
.375 in.	94.5		
#4	92.0		
#10	86.0		
#40	54.7		
#100	32.1		
#200	24.0		

* (no specification provided)

Material Description

Silty, clayey sand

Atterberg Limits

PL= 20 LL= 26 PI= 6

Coefficients

D_{85}= 1.85 D_{60}= 0.530 D_{50}= 0.349
D_{30}= 0.132 D_{15}= 0.0029 D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
checked by: Rommel Cintron Aponte, MSCE, PE

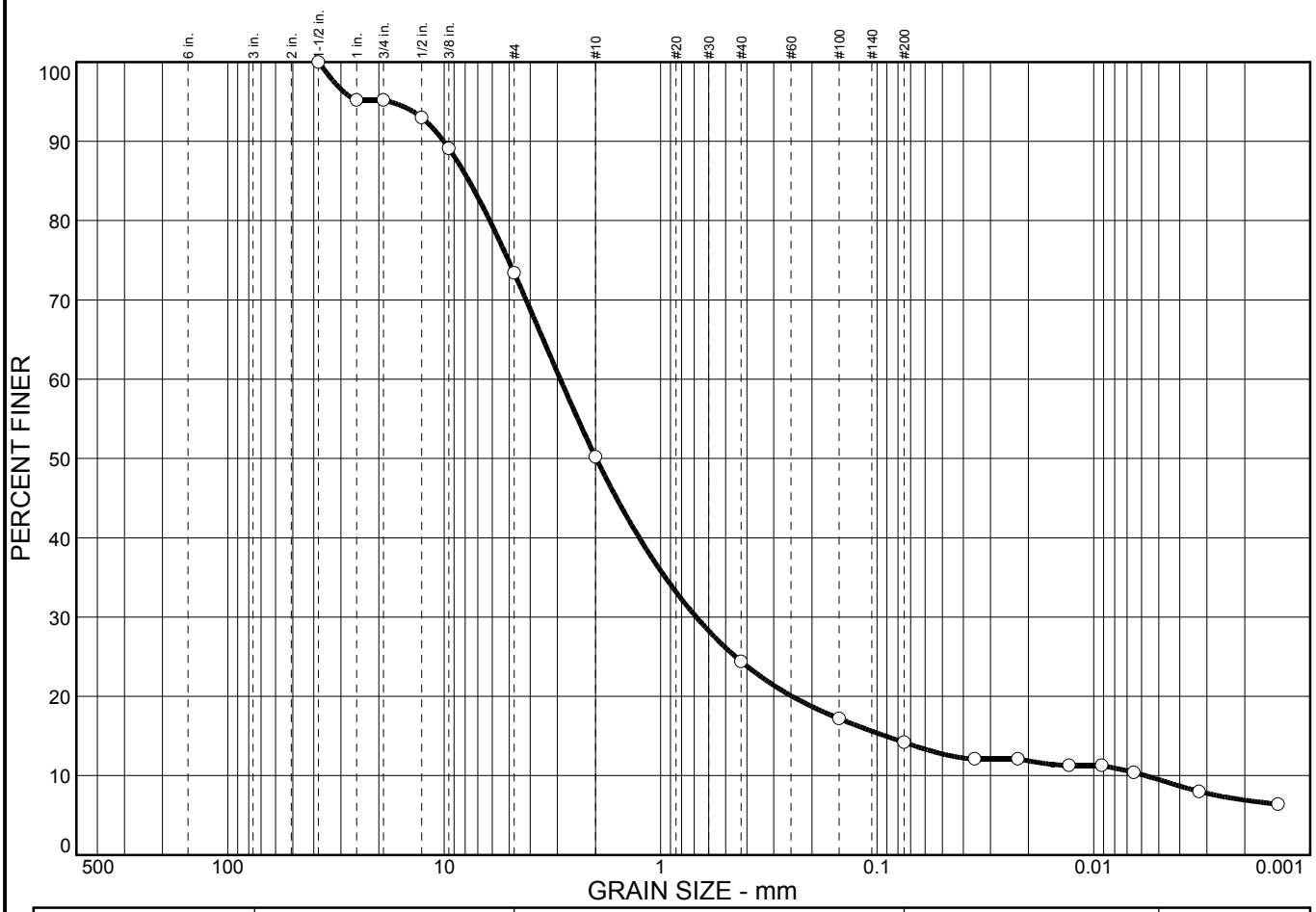
Sample No.: 310B2 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	26.6	59.2	4.7	9.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	95.2		
.75 in.	95.2		
.5 in.	93.0		
.375 in.	89.1		
#4	73.4		
#10	50.2		
#40	24.4		
#100	17.2		
#200	14.2		

* (no specification provided)

Material Description

Silty, clayey sand with gravel

Atterberg Limits

PL= 17 LL= 24 PI= 7

Coefficients

D_{85}= 7.68 D_{60}= 2.91 D_{50}= 1.98
D_{30}= 0.685 D_{15}= 0.0914 D_{10}= 0.0058
C_u= 504.94 C_c= 27.98

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

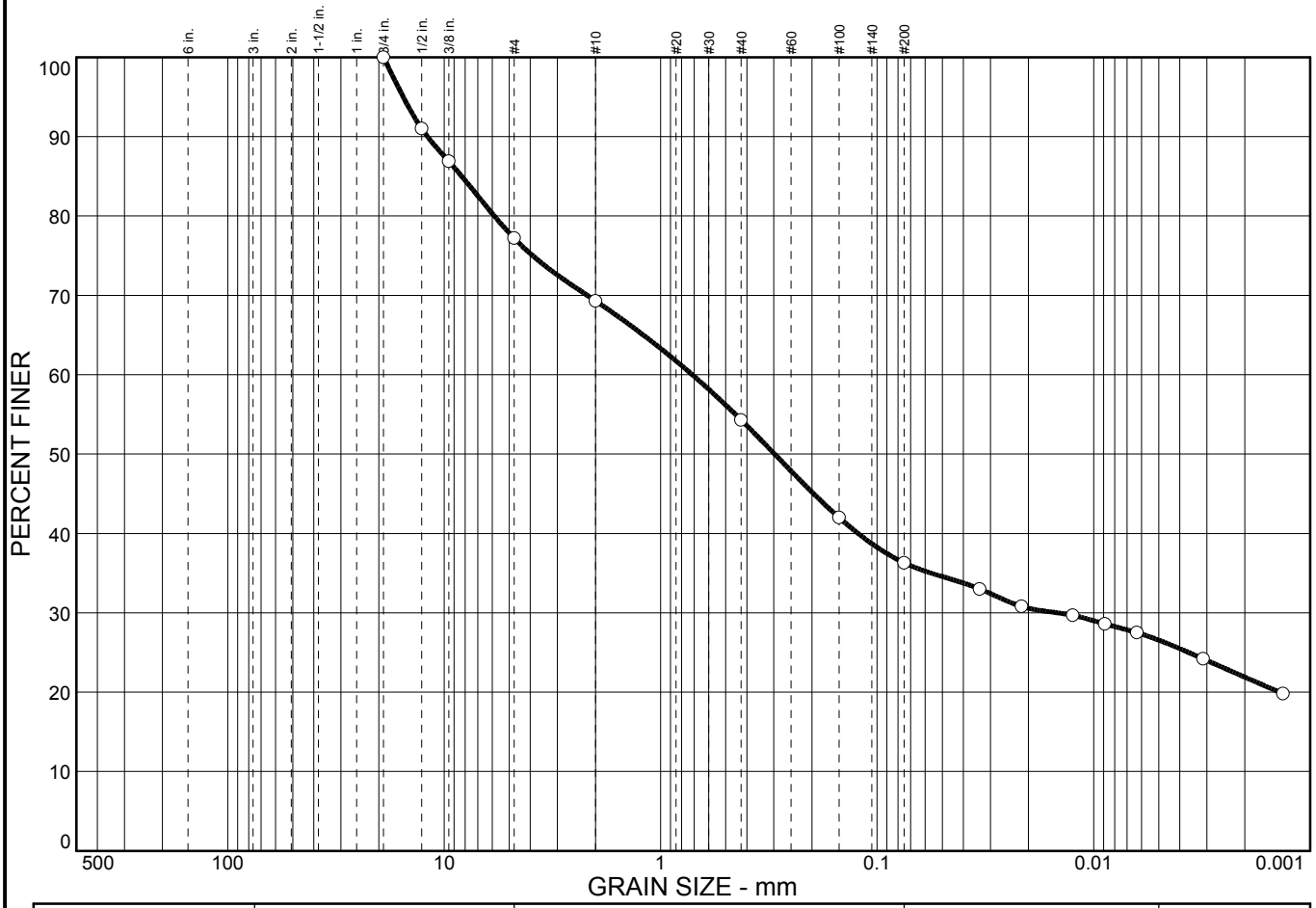
Sample No.: 310B2 **Source of Sample:** Project Site **Date:** 5/18/20
Location: Salinas, PR **Elev./Depth:** 9-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	22.8	40.9	9.7	26.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	91.0		
.375 in.	86.9		
#4	77.2		
#10	69.3		
#40	54.3		
#100	42.0		
#200	36.3		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 19 LL= 28 PI= 9

Coefficients

D_{85}= 8.30 D_{60}= 0.715 D_{50}= 0.298
D_{30}= 0.0146 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

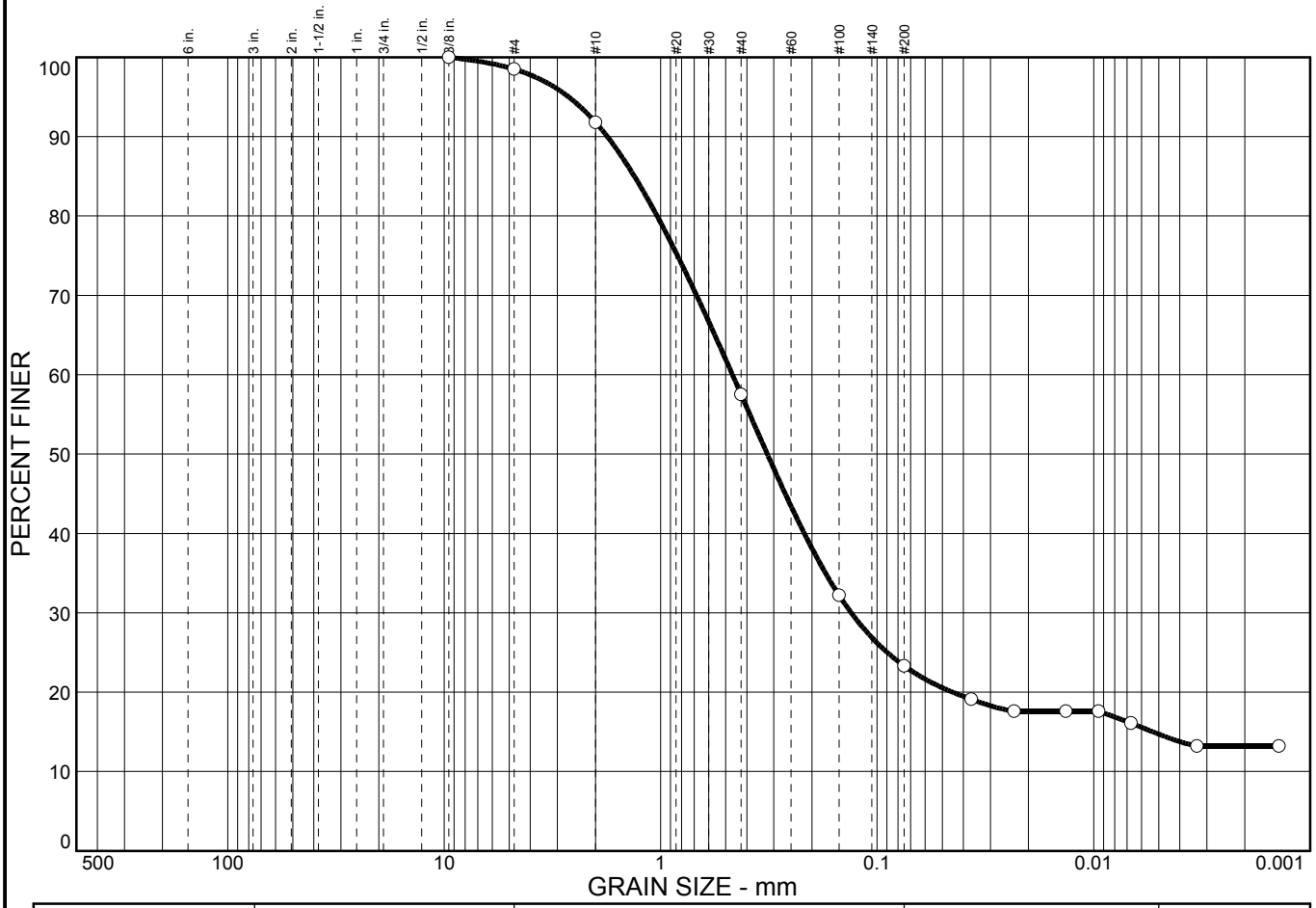
Sample No.: 310B3 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.5	75.2	8.6	14.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.5		
#10	91.8		
#40	57.5		
#100	32.2		
#200	23.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.32 D_{60}= 0.466 D_{50}= 0.322
D_{30}= 0.132 D_{15}= 0.0053 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

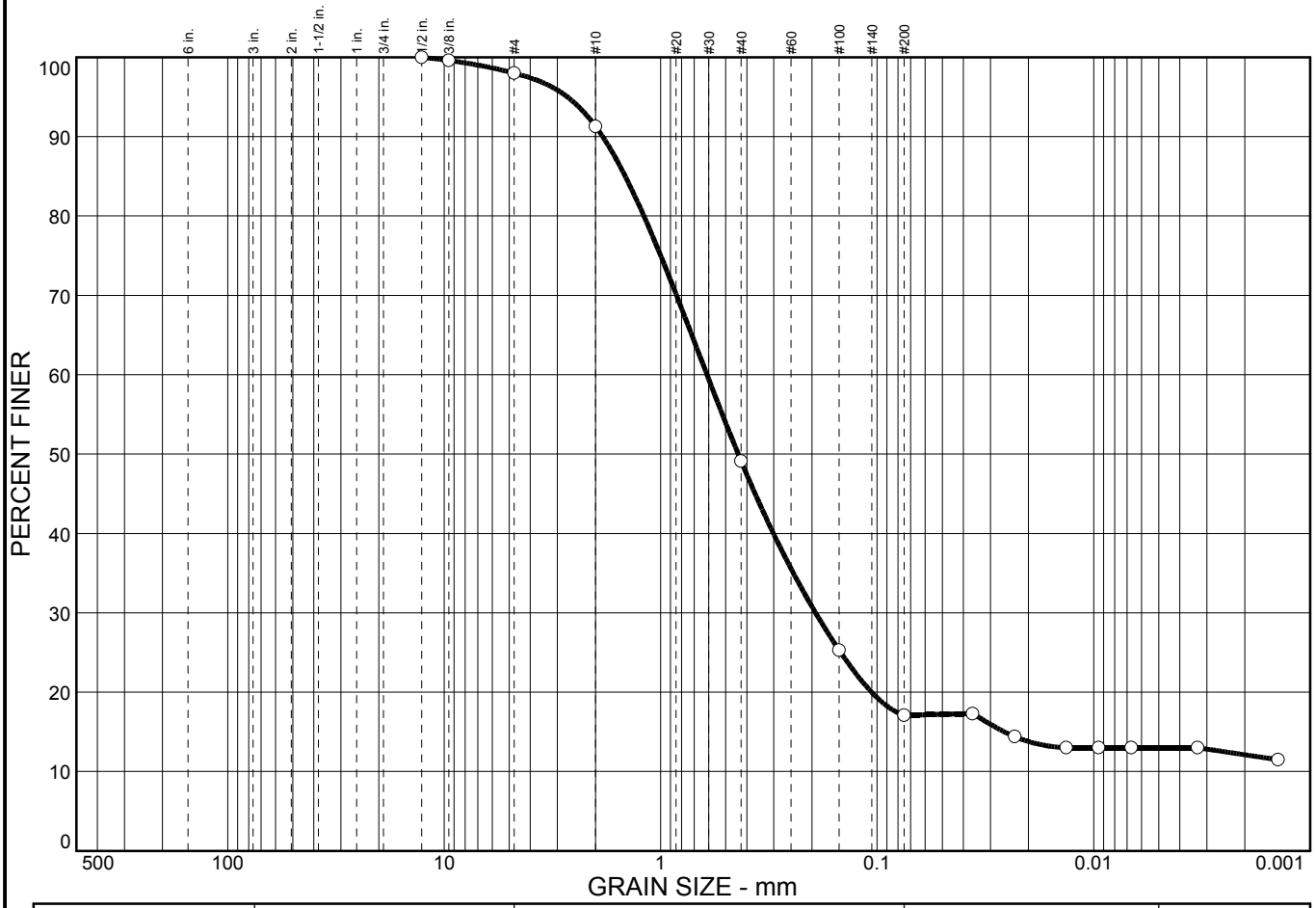
Sample No.: 312B1 **Source of Sample:** Project Site **Date:** 6/25/20
Location: Salinas, PR **Elev./Depth:** 4.5-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.0	80.9	4.1	13.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	98.0		
#10	91.3		
#40	49.1		
#100	25.3		
#200	17.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.46 D_{60}= 0.611 D_{50}= 0.439
D_{30}= 0.193 D_{15}= 0.0258 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

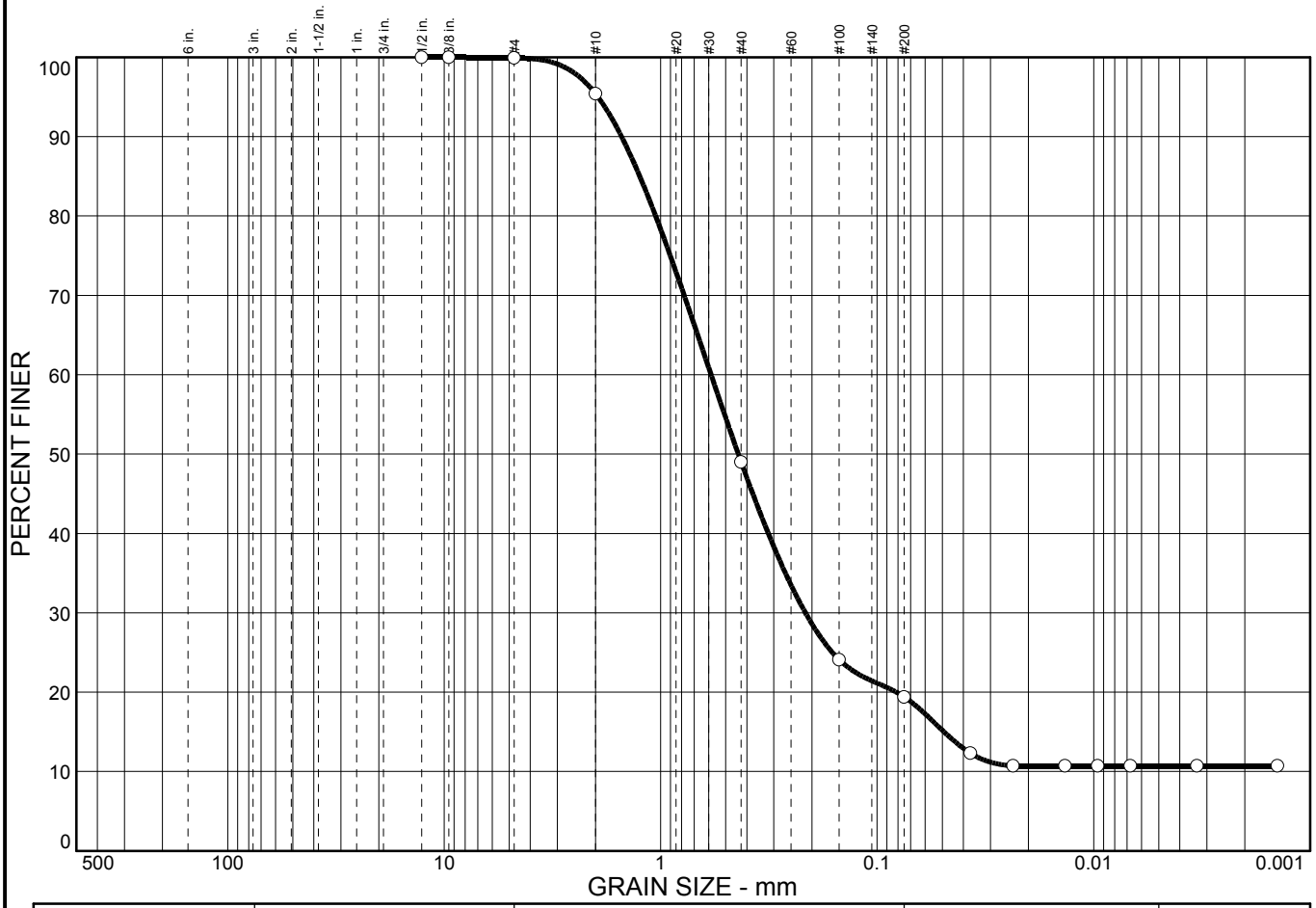
Sample No.: 314B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	80.5	8.7	10.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	100.0		
#4	99.9		
#10	95.4		
#40	49.0		
#100	24.1		
#200	19.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.25 D_{60}= 0.586 D_{50}= 0.438
D_{30}= 0.215 D_{15}= 0.0491 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

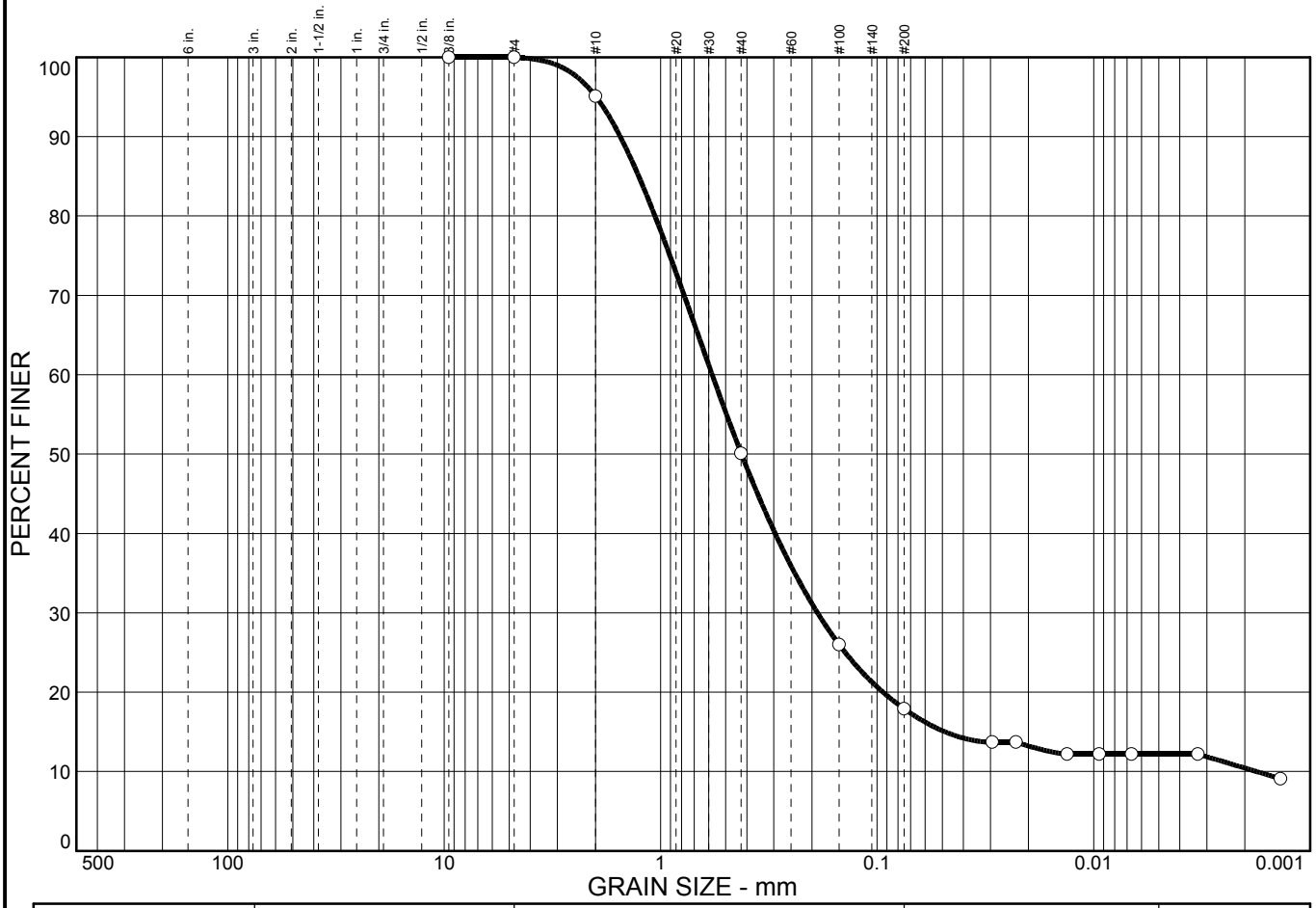
Sample No.: 314B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	82.1	5.7	12.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	100.0		
#10	95.1		
#40	50.1		
#100	26.0		
#200	17.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.26 D_{60}= 0.578 D_{50}= 0.424
D_{30}= 0.189 D_{15}= 0.0486 D_{10}= 0.0018
C_u= 326.99 C_c= 34.83

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

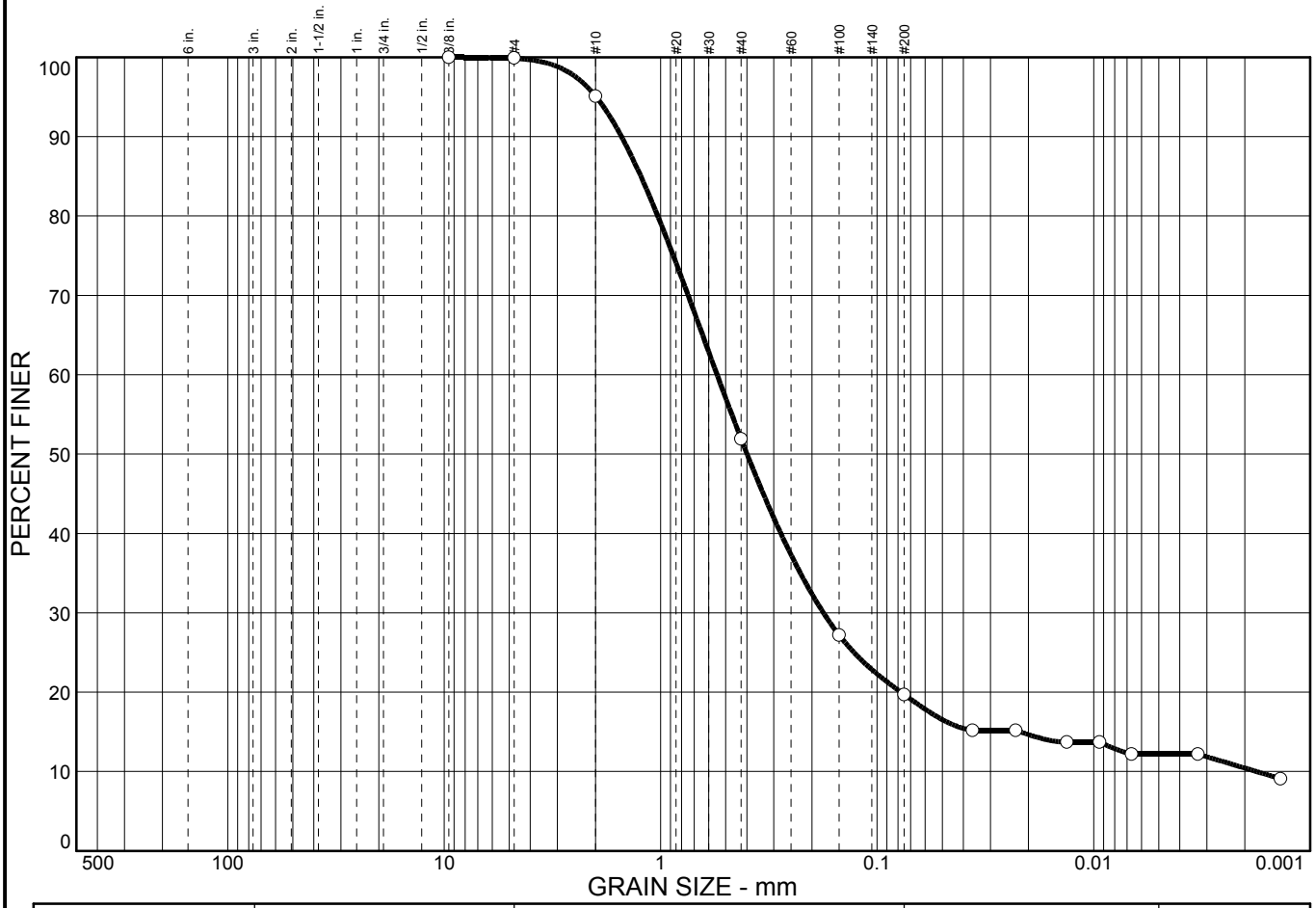
Sample No.: 316B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	80.2	7.5	12.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	95.1		
#40	51.9		
#100	27.2		
#200	19.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.24 D_{60}= 0.549 D_{50}= 0.399
D_{30}= 0.177 D_{15}= 0.0218 D_{10}= 0.0018
C_u= 310.61 C_c= 32.34

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

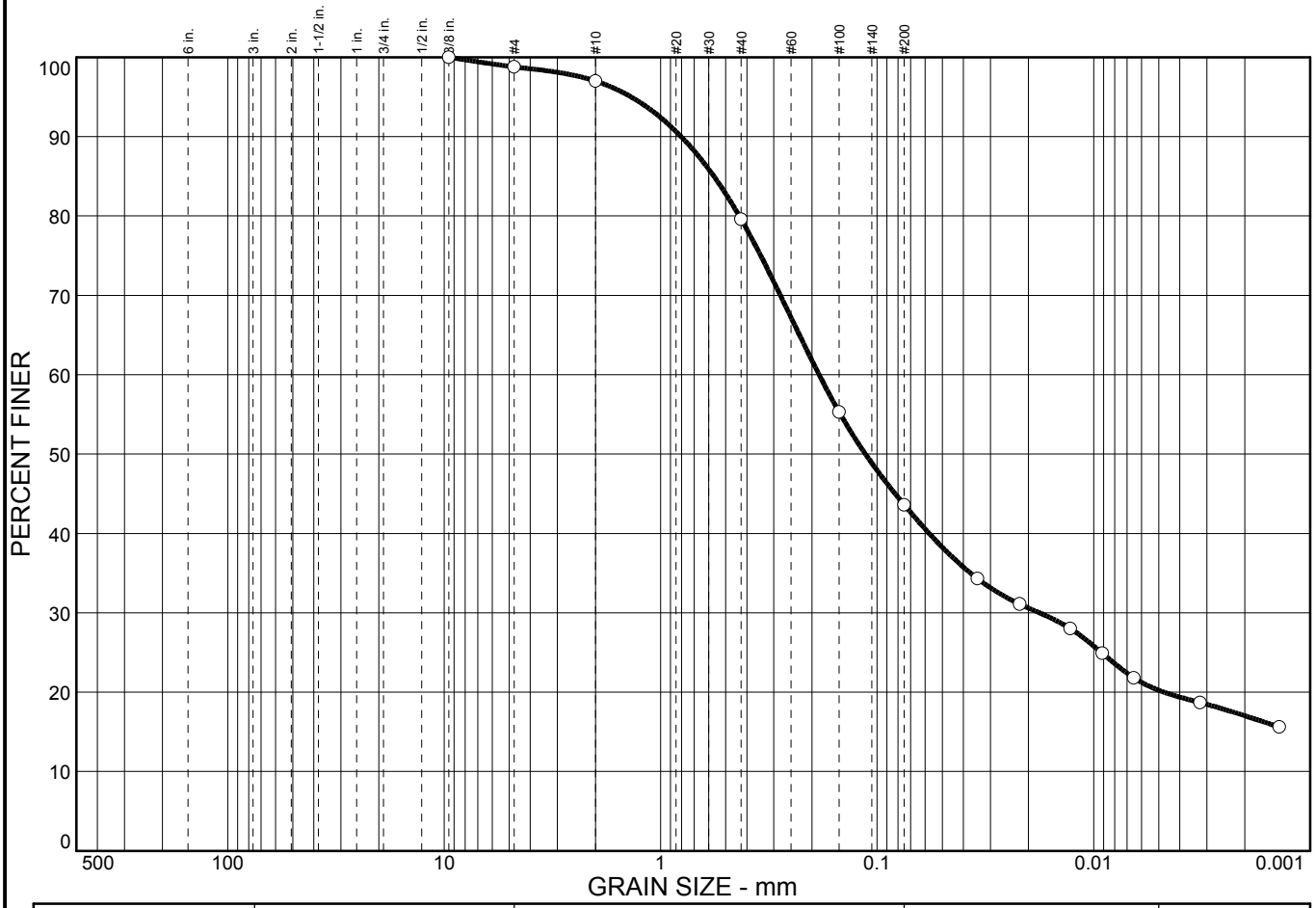
Sample No.: 316B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.2	55.2	23.4	20.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.8		
#10	97.0		
#40	79.6		
#100	55.3		
#200	43.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 29 LL= 35 PI= 6

Coefficients

D_{85}= 0.568 D_{60}= 0.185 D_{50}= 0.113
D_{30}= 0.0178 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

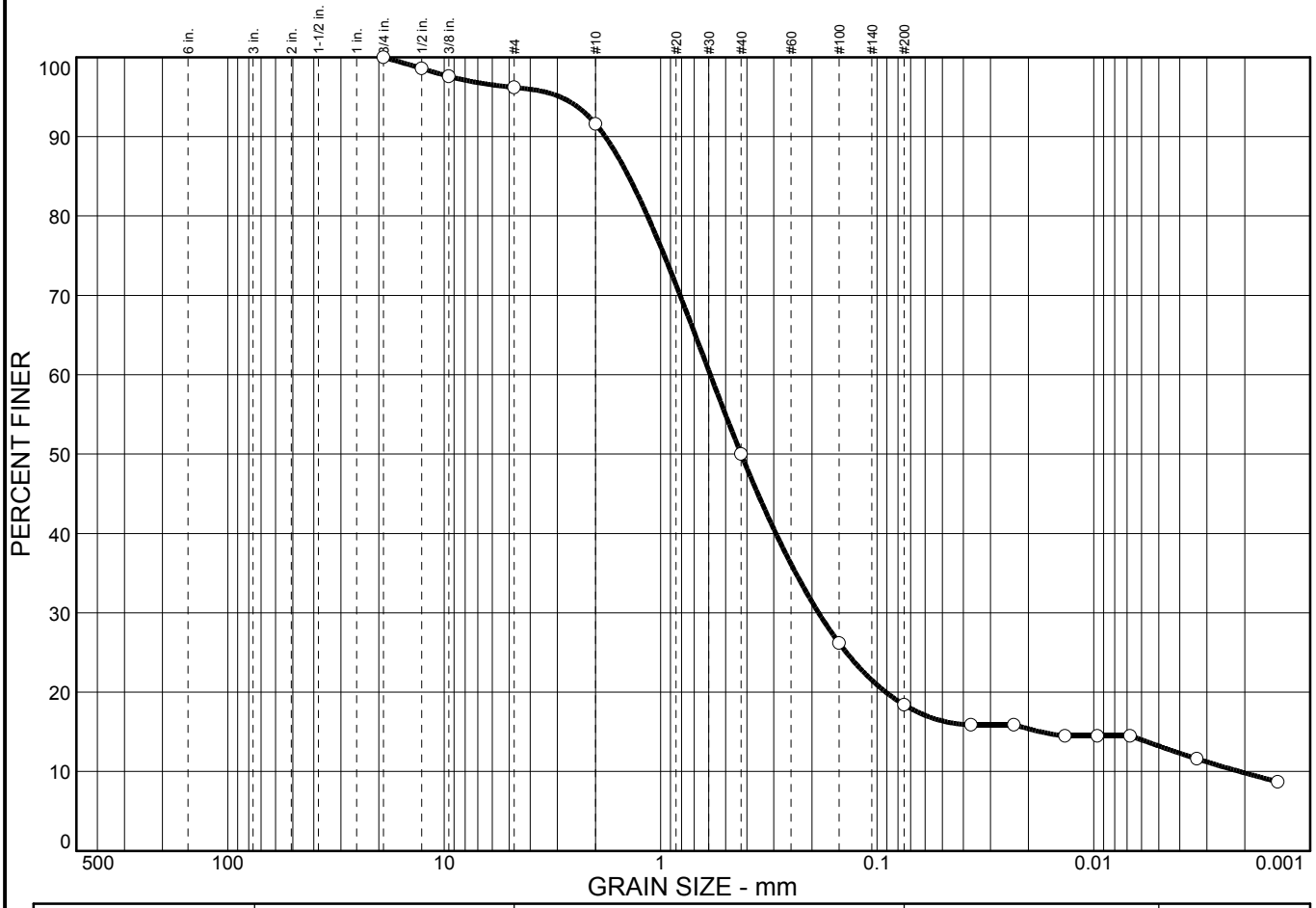
Sample No.: 318B1 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.8	77.8	5.2	13.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.6		
.375 in.	97.6		
#4	96.2		
#10	91.6		
#40	50.0		
#100	26.2		
#200	18.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.41 D_{60}= 0.590 D_{50}= 0.425
D_{30}= 0.186 D_{15}= 0.0175 D_{10}= 0.0021
C_u= 279.44 C_c= 27.89

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

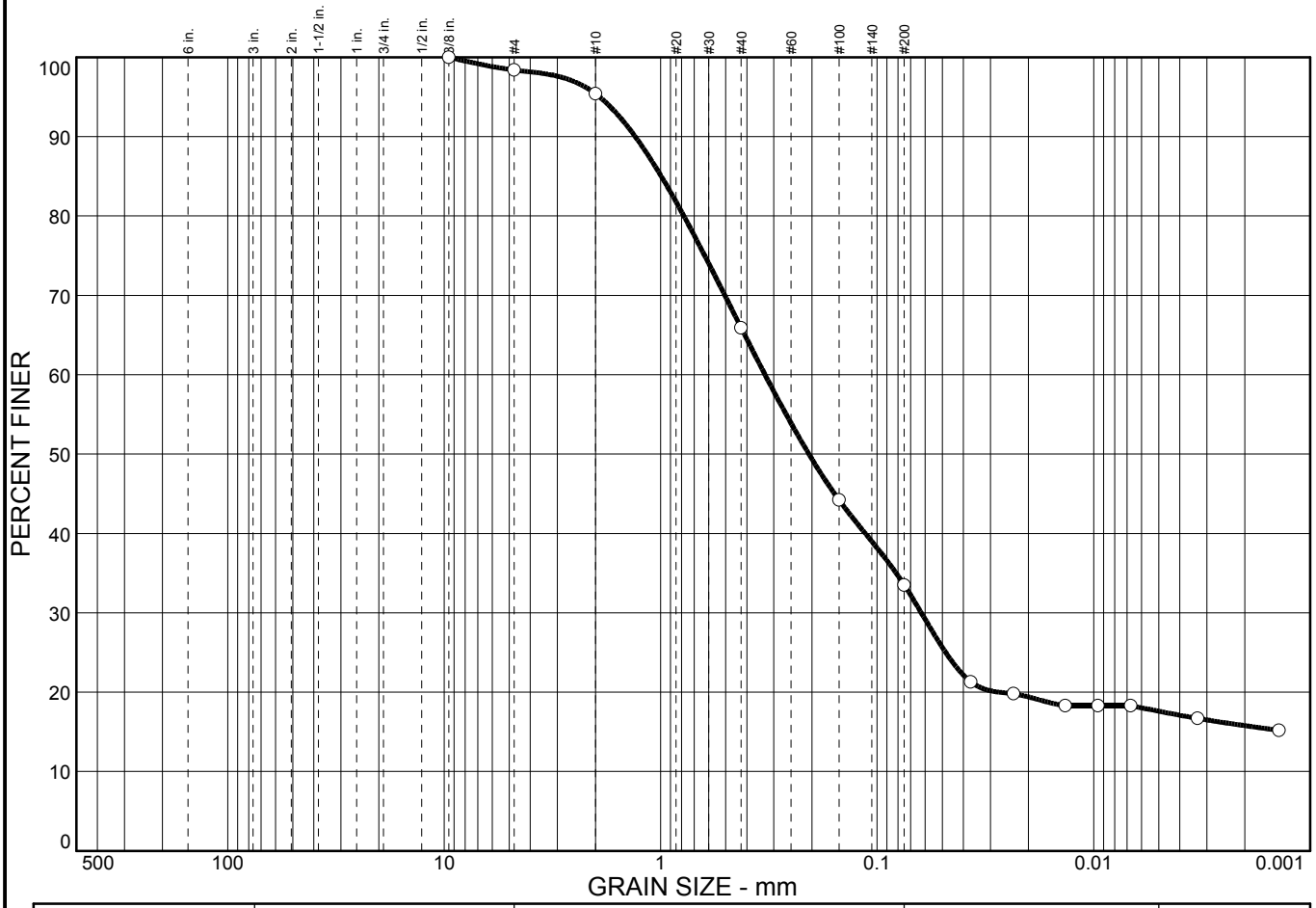
Sample No.: 318B1 **Source of Sample:** Project Site **Date:** 5/13/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	64.9	15.9	17.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.4		
#10	95.4		
#40	65.9		
#100	44.2		
#200	33.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.994 D_{60}= 0.330 D_{50}= 0.207
D_{30}= 0.0626 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE

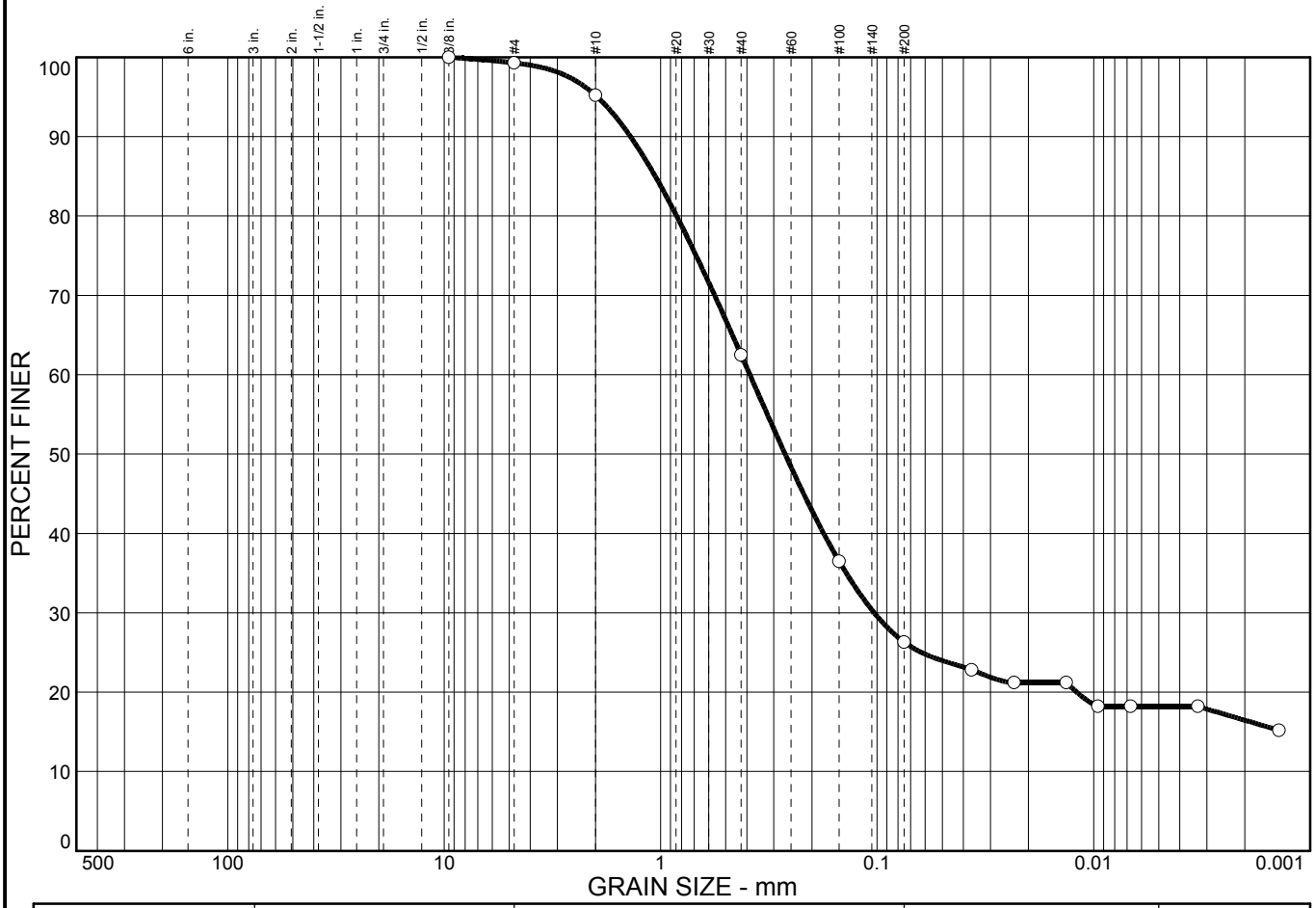
Sample No.: 318B2 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 1.5-4.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	73.0	8.1	18.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.3		
#10	95.2		
#40	62.5		
#100	36.5		
#200	26.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.06 D_{60}= 0.387 D_{50}= 0.266
D_{30}= 0.103 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE

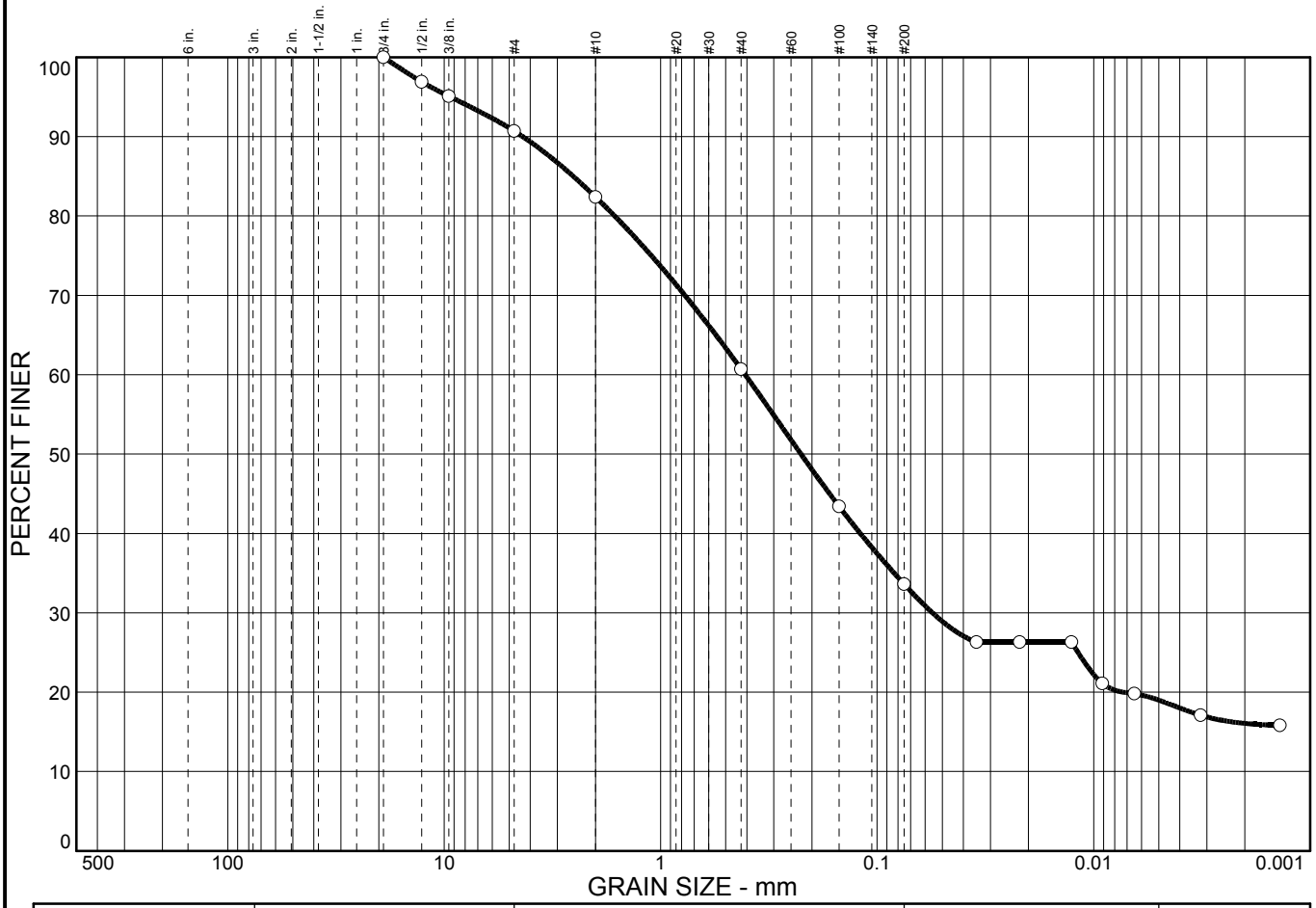
Sample No.: 318B2 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 6-9'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	9.3	57.1	14.6	19.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	96.9		
.375 in.	95.1		
#4	90.7		
#10	82.4		
#40	60.7		
#100	43.4		
#200	33.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 2.53 D_{60}= 0.407 D_{50}= 0.225
D_{30}= 0.0556 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

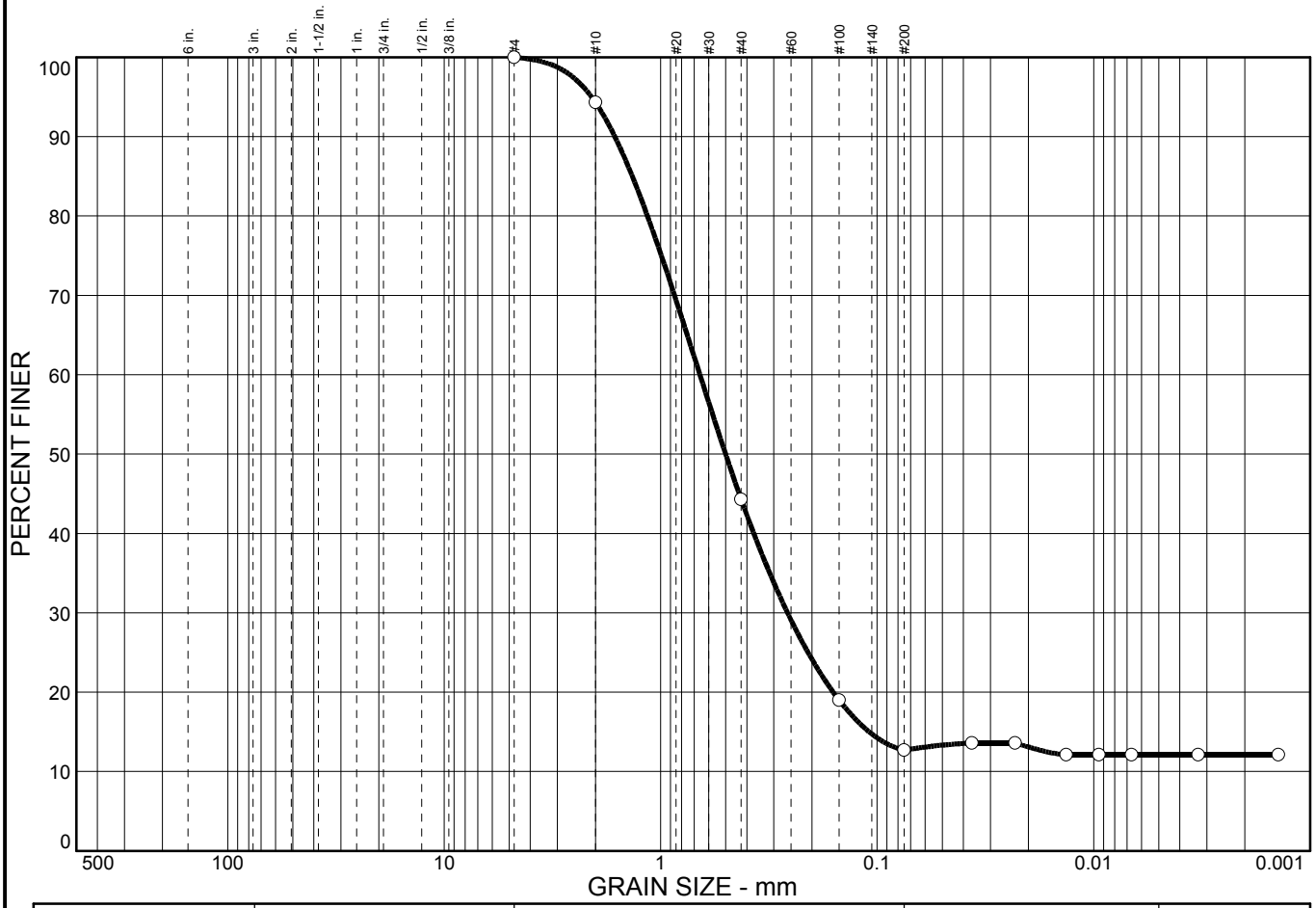
Sample No.: 318B3 **Source of Sample:** Project Site **Date:** 5/13/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	87.3	0.6	12.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	94.3		
#40	44.3		
#100	19.0		
#200	12.7		

* (no specification provided)

Material Description

Sily sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.35 D_{60}= 0.659 D_{50}= 0.502
D_{30}= 0.259 D_{15}= 0.109 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

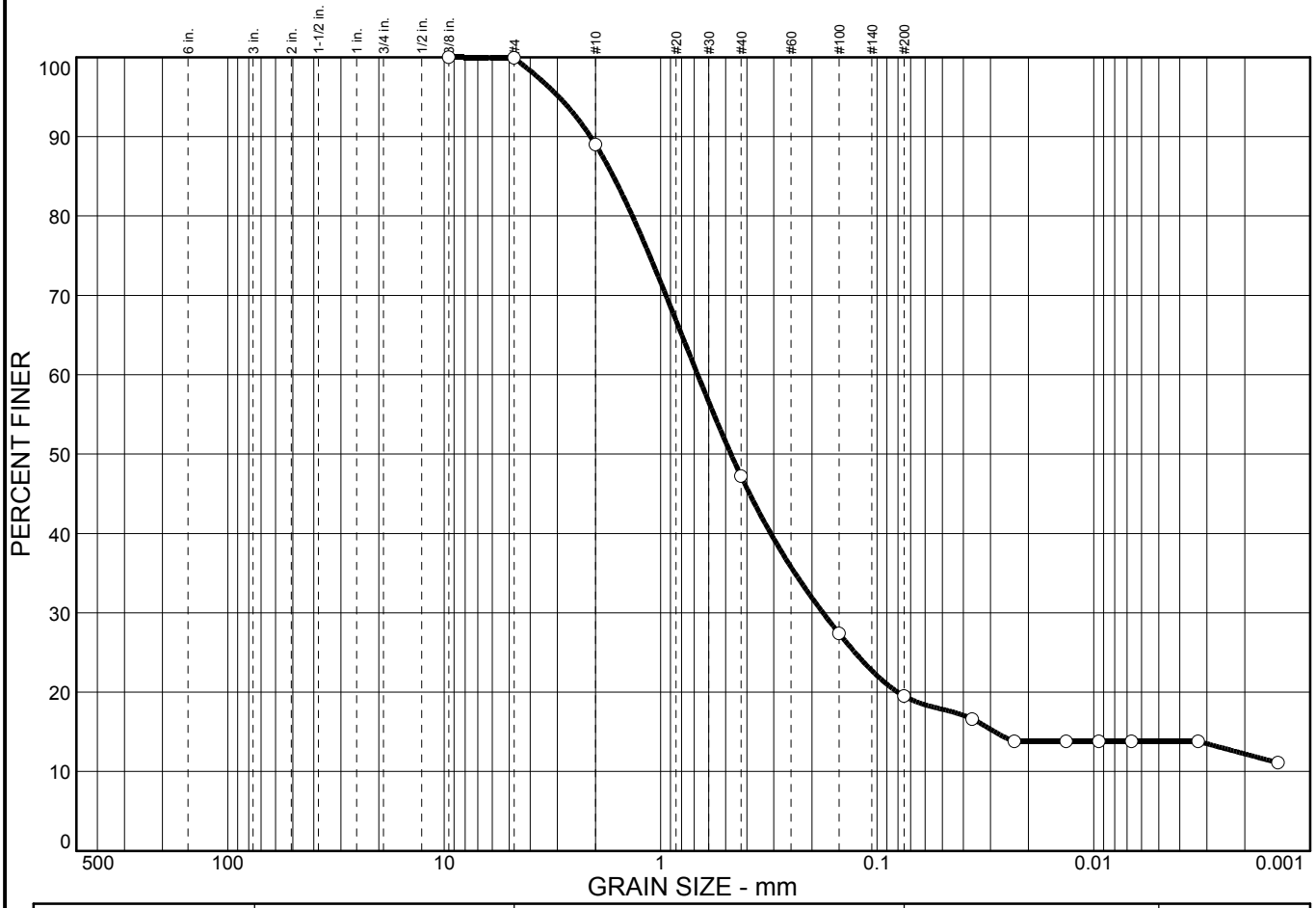
Sample No.: 318B3 **Source of Sample:** Project Site **Date:** 5/14/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	80.4	5.7	13.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	89.0		
#40	47.2		
#100	27.4		
#200	19.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.66 D_{60}= 0.675 D_{50}= 0.474
D_{30}= 0.178 D_{15}= 0.0286 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

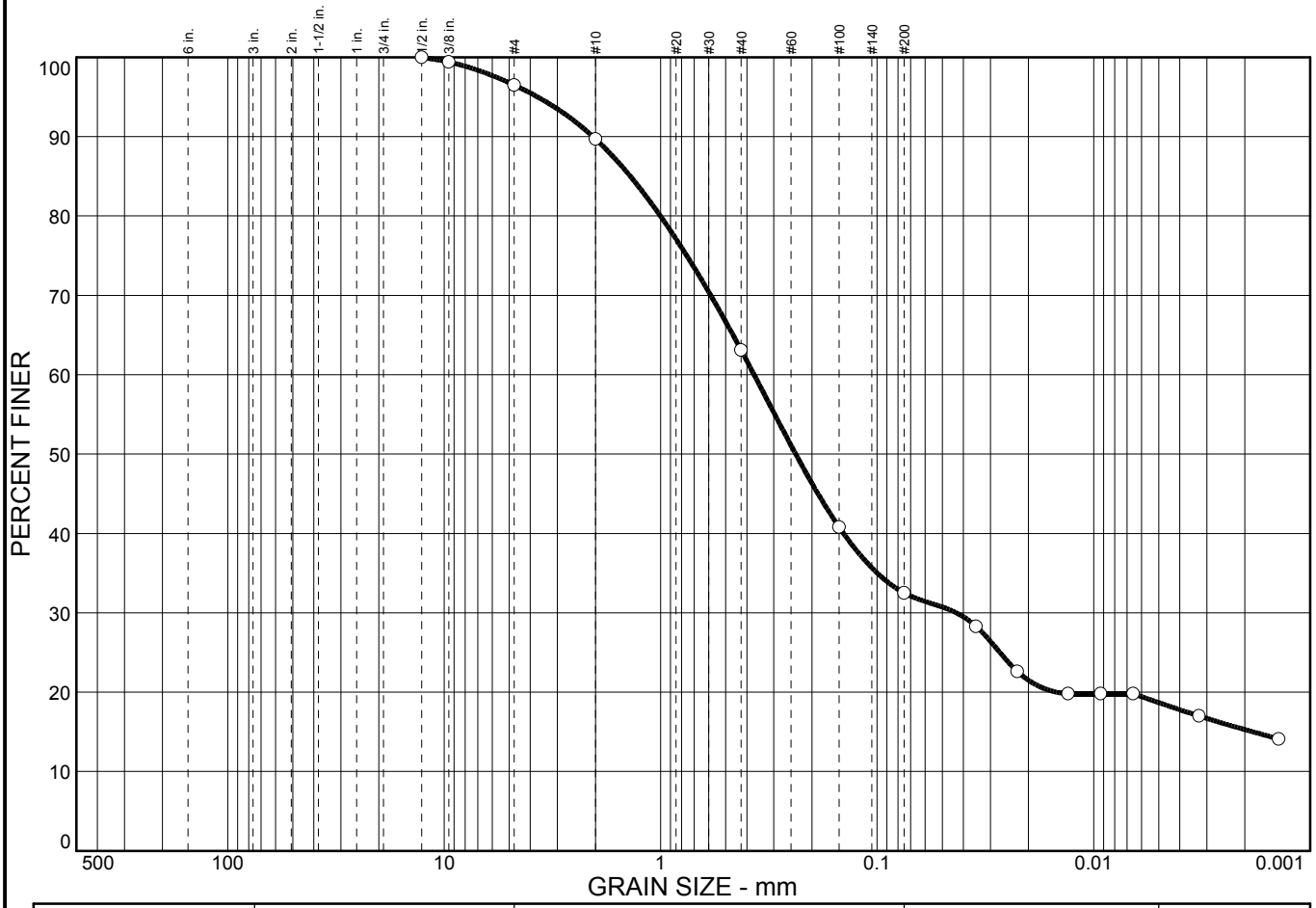
Sample No.: 320B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.5	64.0	13.8	18.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.4		
#4	96.5		
#10	89.7		
#40	63.1		
#100	40.8		
#200	32.5		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= 21 LL= 28 PI= 7

Coefficients

D_{85}= 1.38 D_{60}= 0.370 D_{50}= 0.238
D_{30}= 0.0431 D_{15}= 0.0018 D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

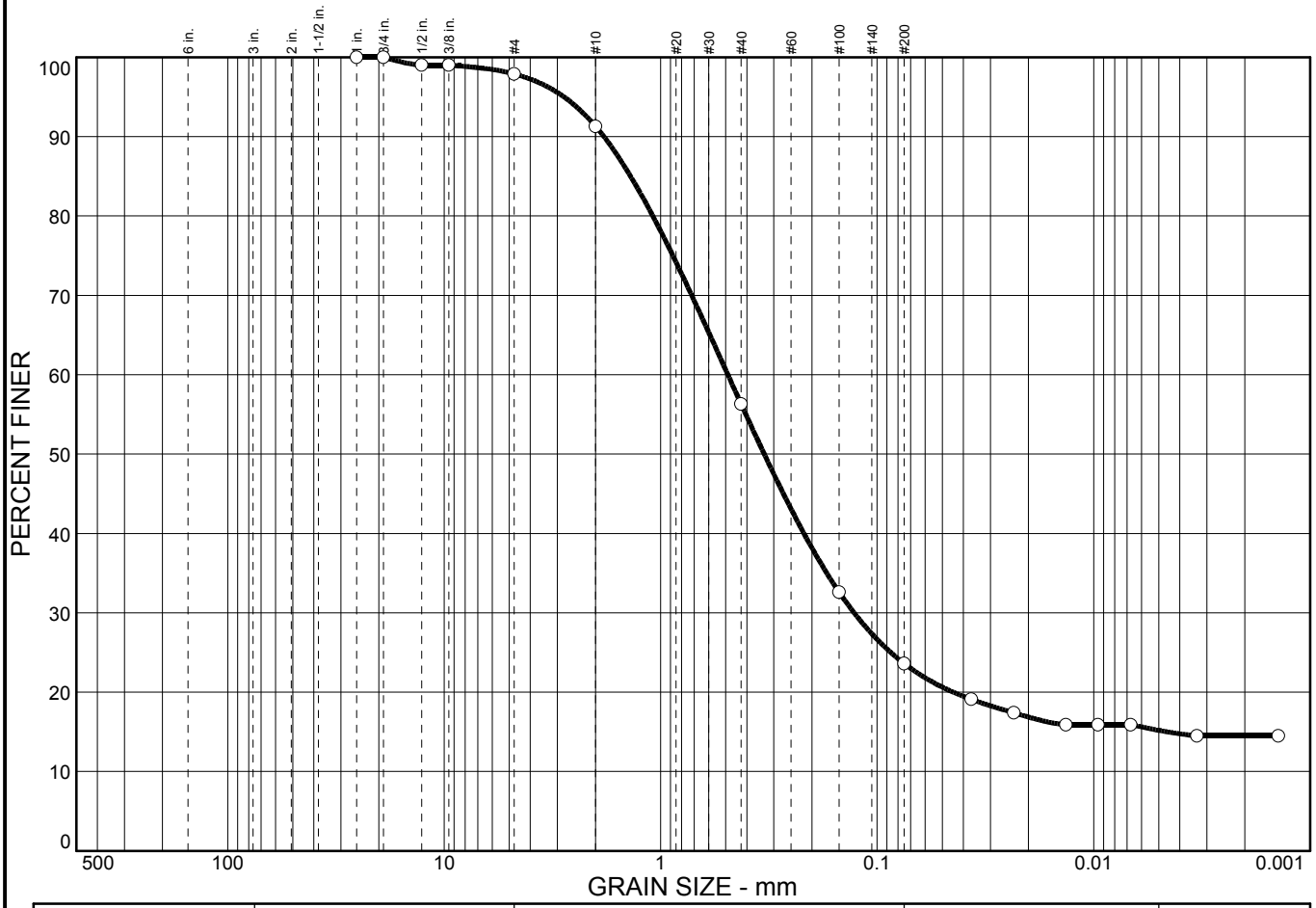
Sample No.: 322B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.1	74.3	8.4	15.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	100.0		
.5 in.	99.0		
.375 in.	99.0		
#4	97.9		
#10	91.3		
#40	56.3		
#100	32.6		
#200	23.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.38 D_{60}= 0.490 D_{50}= 0.332
D_{30}= 0.128 D_{15}= 0.0046 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

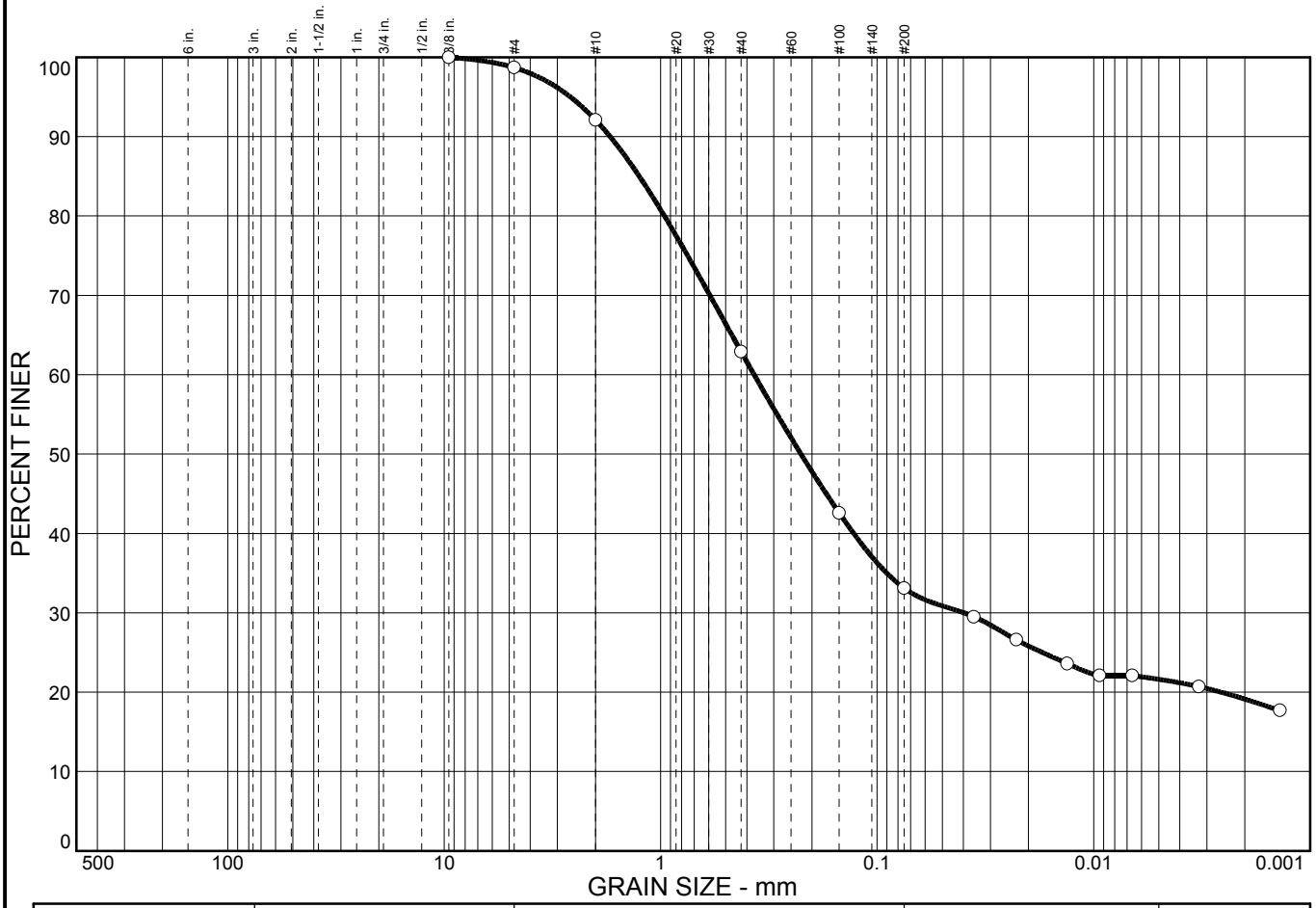
Sample No.: 322B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.3	65.6	11.5	21.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.7		
#10	92.1		
#40	62.9		
#100	42.6		
#200	33.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 25 LL= 31 PI= 6

Coefficients

D_{85}= 1.26 D_{60}= 0.370 D_{50}= 0.225
D_{30}= 0.0398 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE

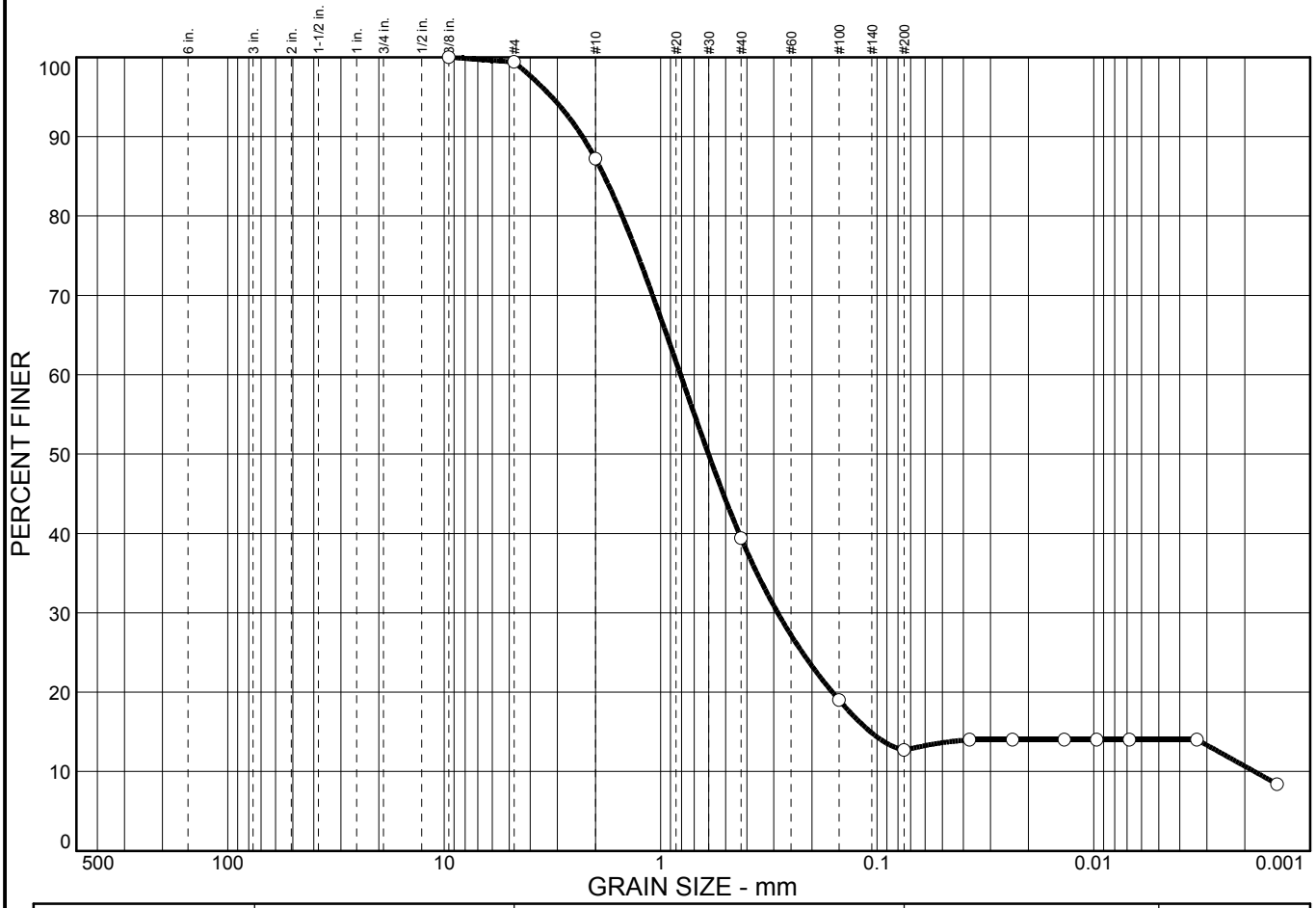
Sample No.: 324B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 3-6'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.6	86.7		14.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.4		
#10	87.2		
#40	39.4		
#100	19.0		
#200	12.7		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.82 D_{60}= 0.810 D_{50}= 0.602
D_{30}= 0.288 D_{15}= 0.107 D_{10}= 0.0018
C_u= 447.70 C_c= 56.61

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

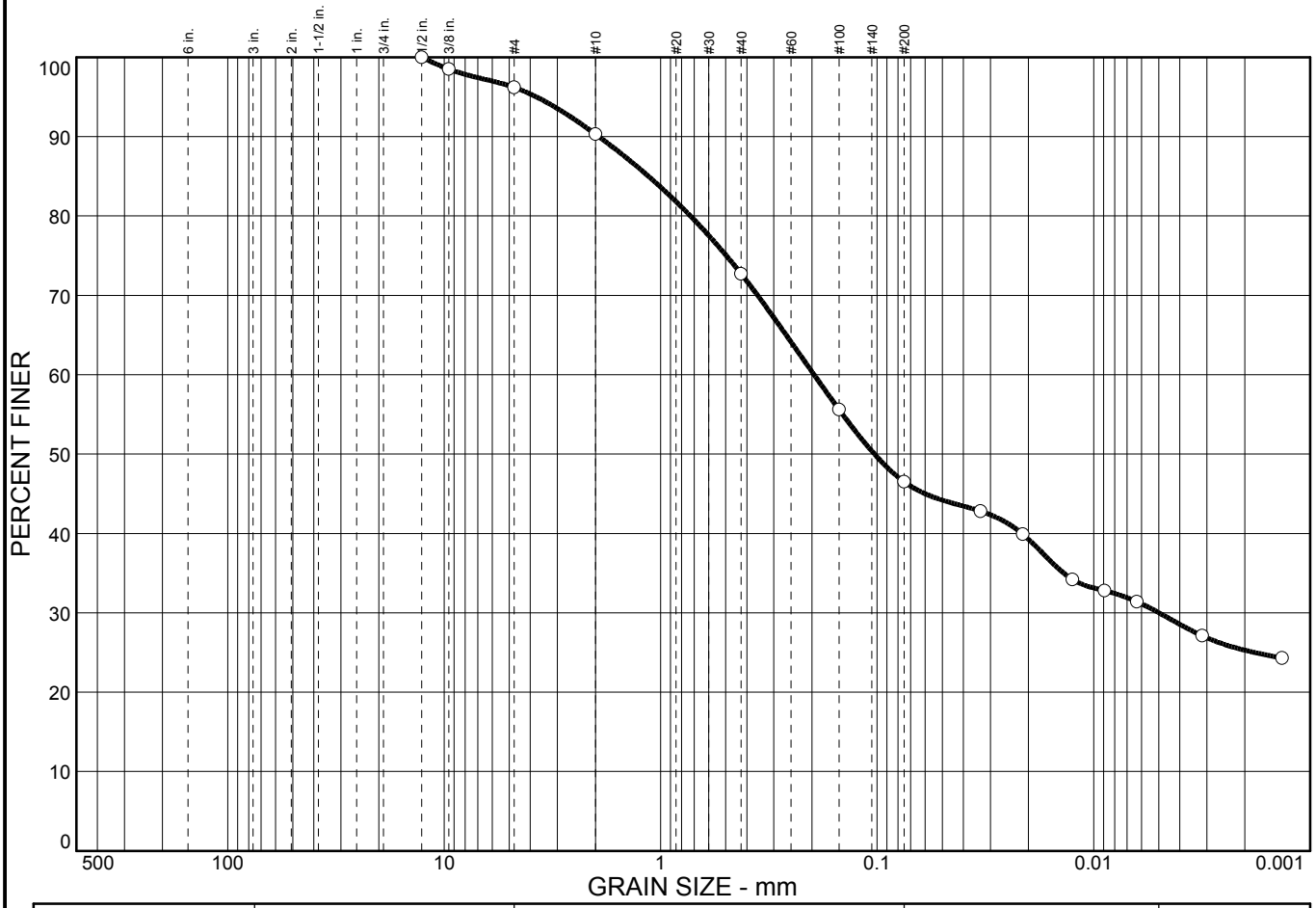
Sample No.: 324B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 7.5-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.8	49.7	16.5	30.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	98.5		
#4	96.2		
#10	90.3		
#40	72.7		
#100	55.6		
#200	46.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 28 LL= 37 PI= 9

Coefficients

D_{85}= 1.14 D_{60}= 0.196 D_{50}= 0.103
D_{30}= 0.0050 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(2)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

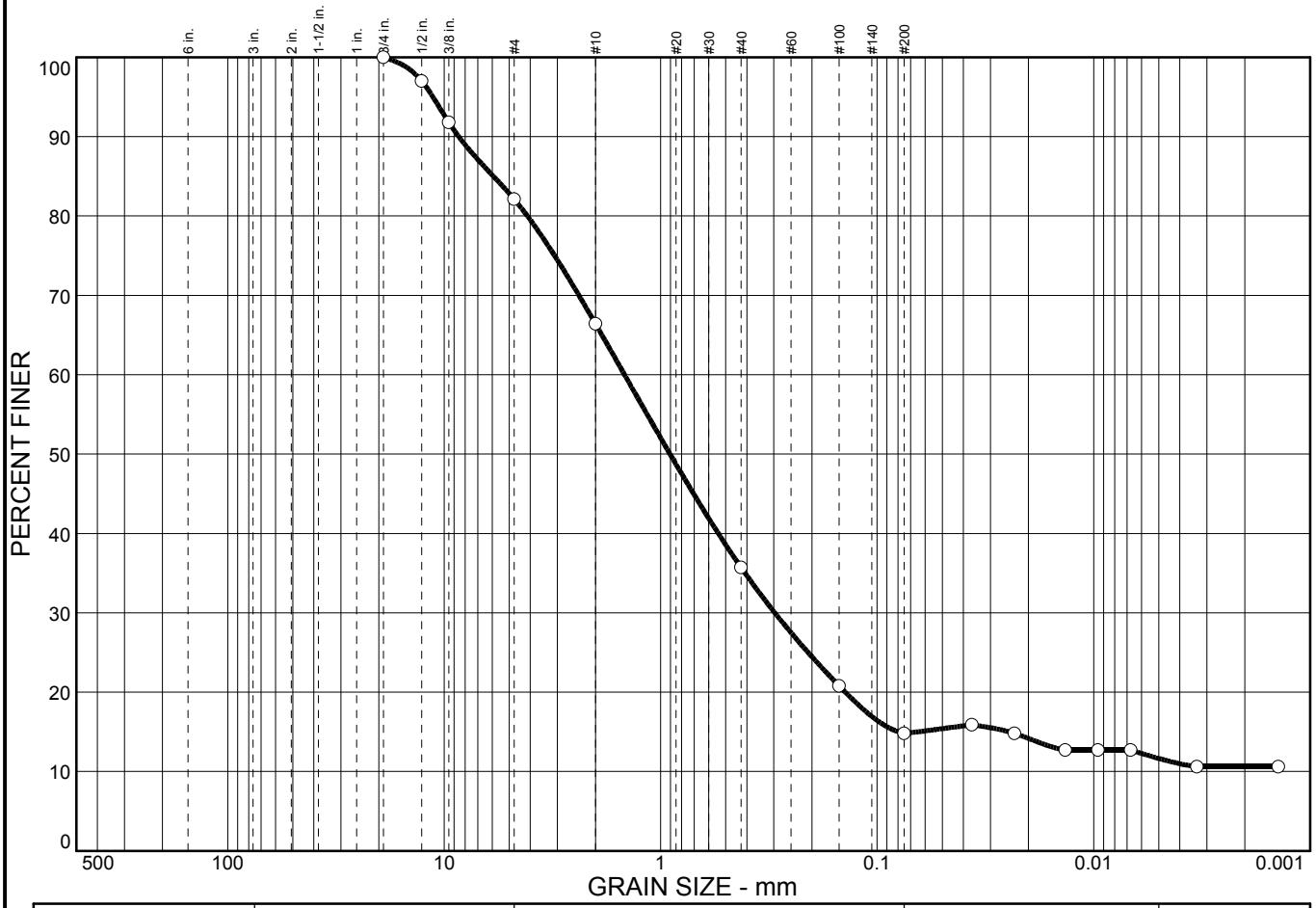
Sample No.: 326B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	17.9	67.3	3.2	11.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	97.0		
.375 in.	91.8		
#4	82.1		
#10	66.4		
#40	35.7		
#100	20.8		
#200	14.8		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 5.93 D_{60}= 1.47 D_{50}= 0.906
D_{30}= 0.297 D_{15}= 0.0246 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

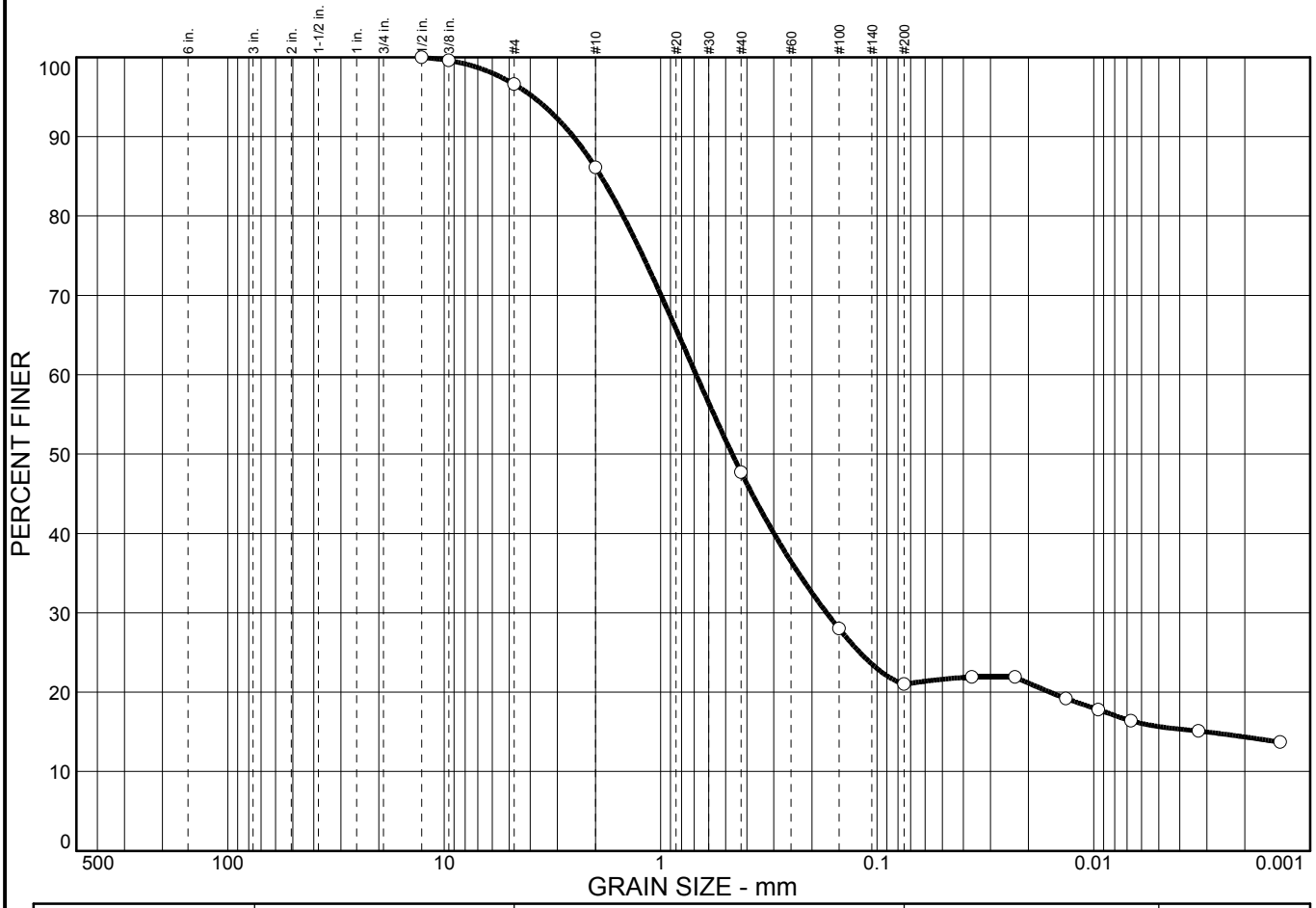
Sample No.: 326B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 6-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.4	75.6	5.3	15.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	96.6		
#10	86.1		
#40	47.7		
#100	28.0		
#200	21.0		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 1.89 D_{60}= 0.686 D_{50}= 0.467
D_{30}= 0.171 D_{15}= 0.0030 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

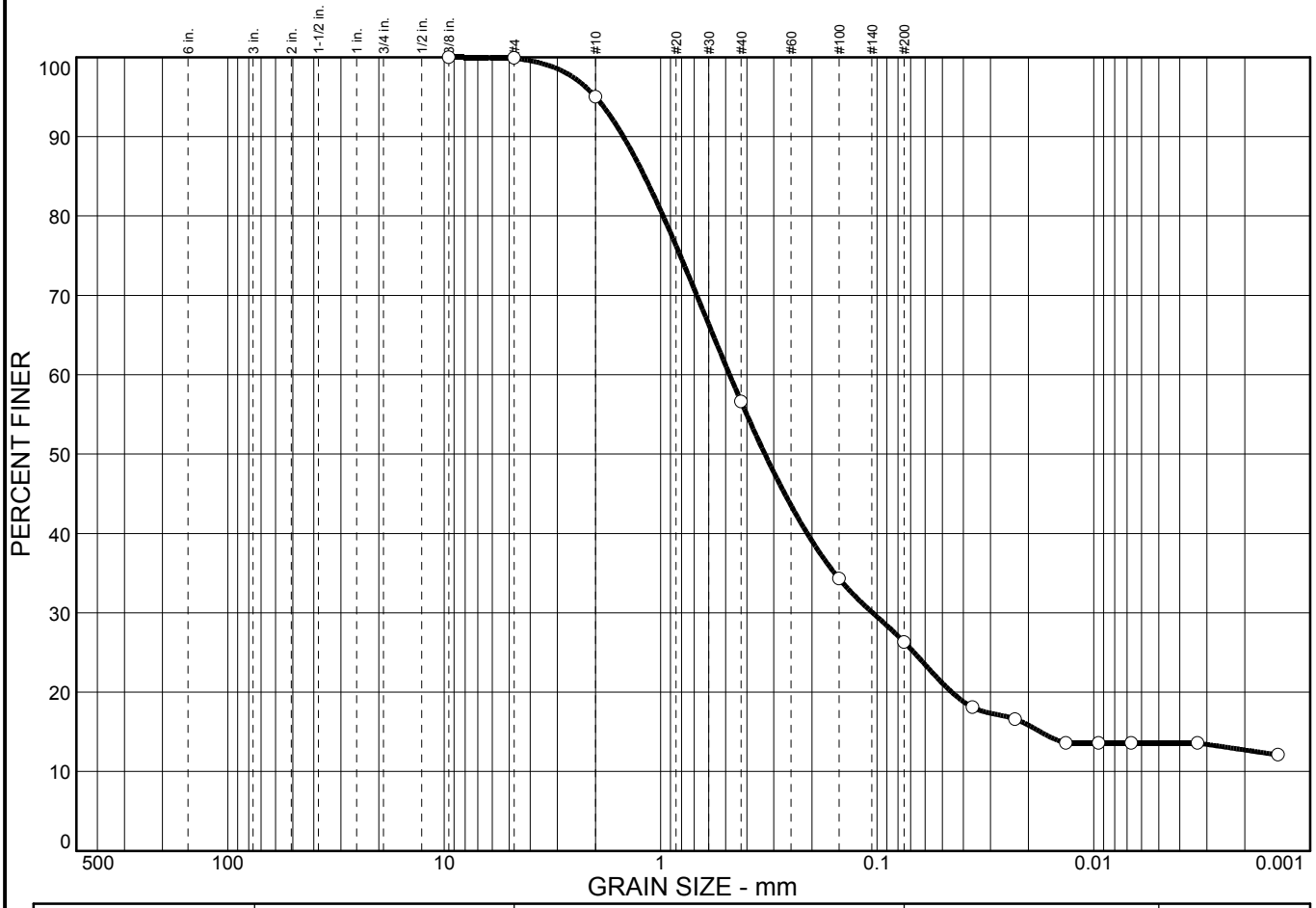
Sample No.: 328B1 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	73.6	12.7	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	95.0		
#40	56.6		
#100	34.3		
#200	26.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.19 D_{60}= 0.480 D_{50}= 0.330
D_{30}= 0.105 D_{15}= 0.0176 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

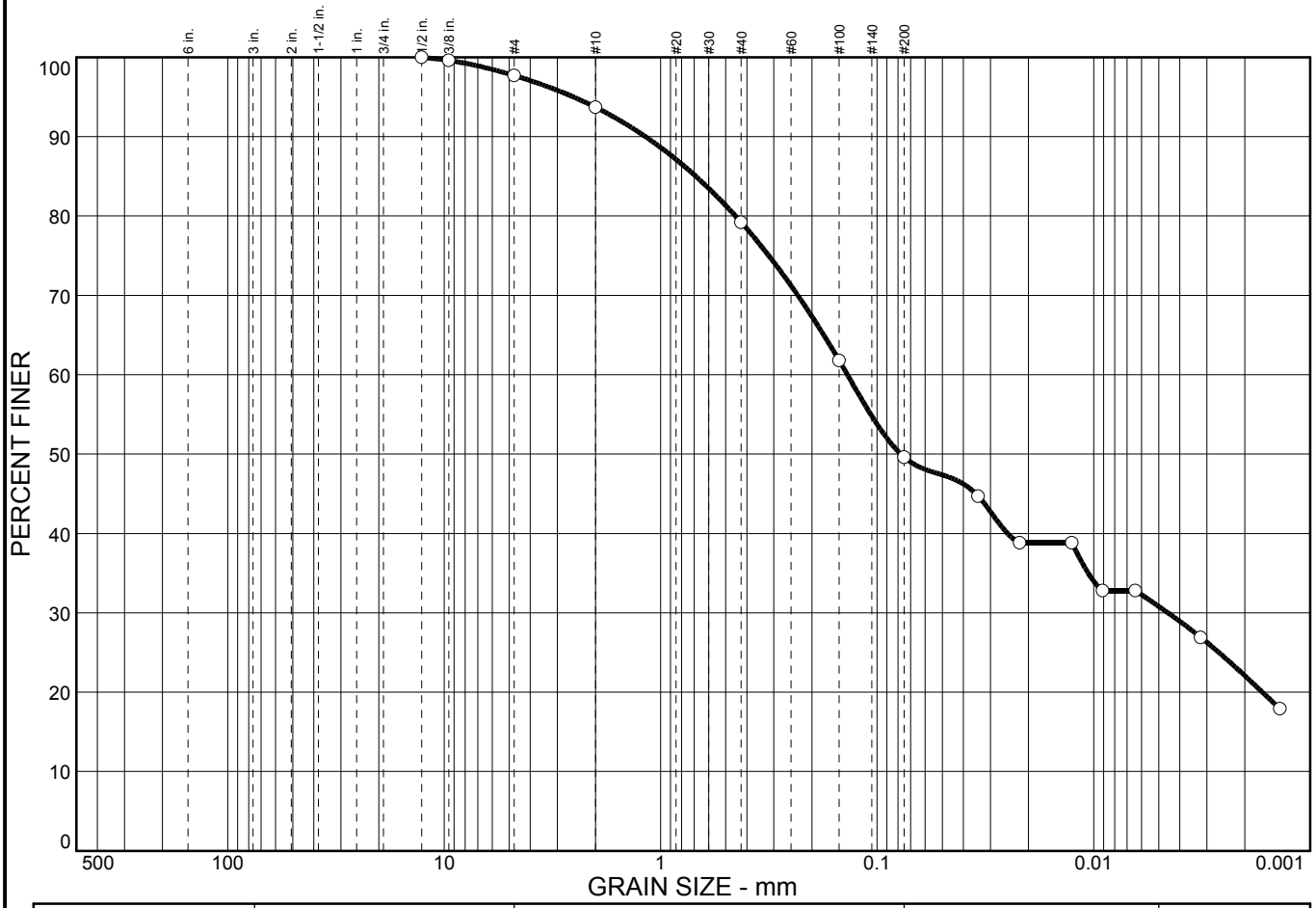
Sample No.: 328B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 15-19.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.3	48.1	18.8	30.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	97.7		
#10	93.7		
#40	79.2		
#100	61.8		
#200	49.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.689 D_{60}= 0.137 D_{50}= 0.0779
D_{30}= 0.0045 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

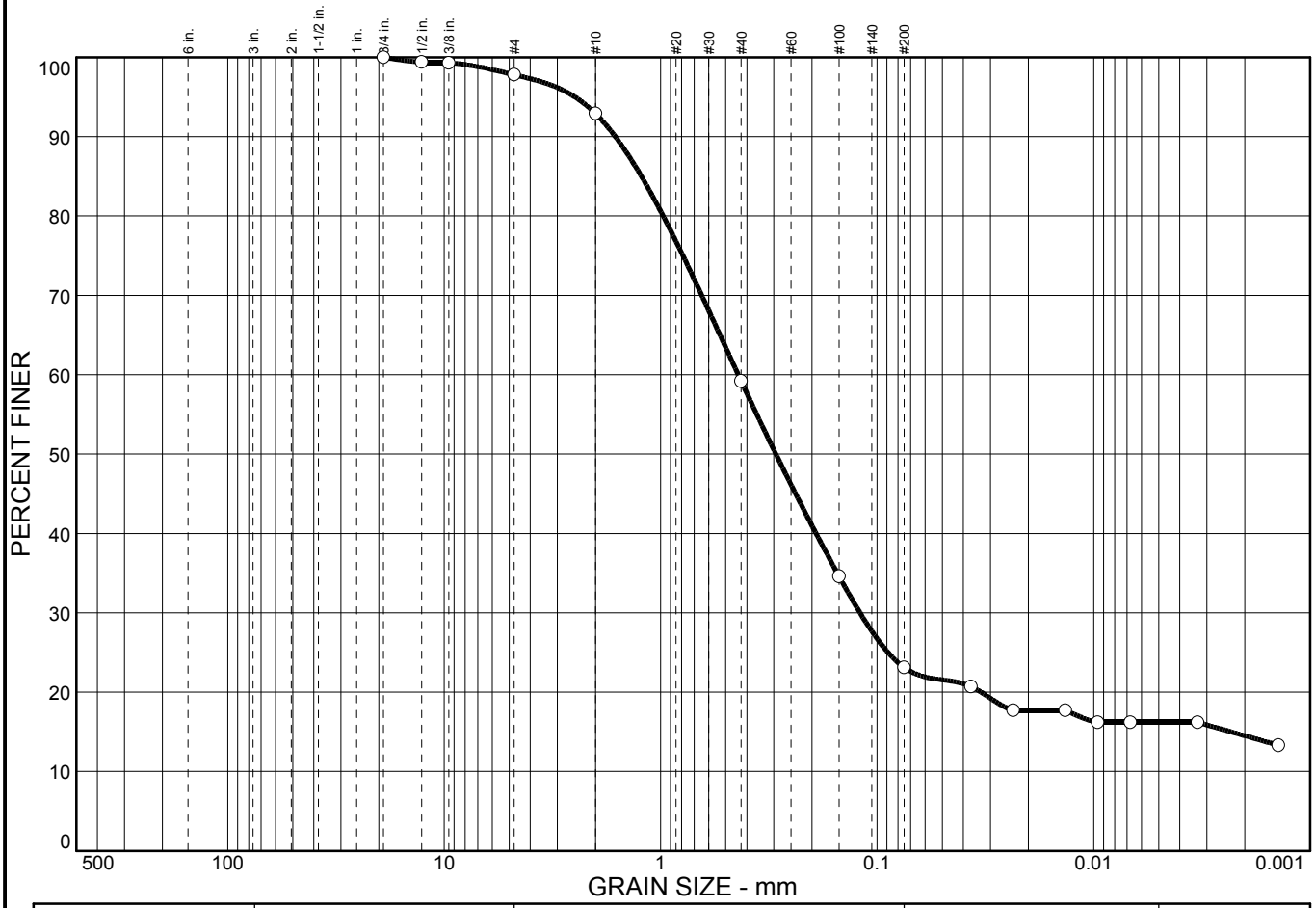
Sample No.: 330B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 3-6'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.2	74.7	6.9	16.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.4		
.375 in.	99.3		
#4	97.8		
#10	92.9		
#40	59.2		
#100	34.6		
#200	23.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.23 D_{60}= 0.439 D_{50}= 0.294
D_{30}= 0.120 D_{15}= 0.0023 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

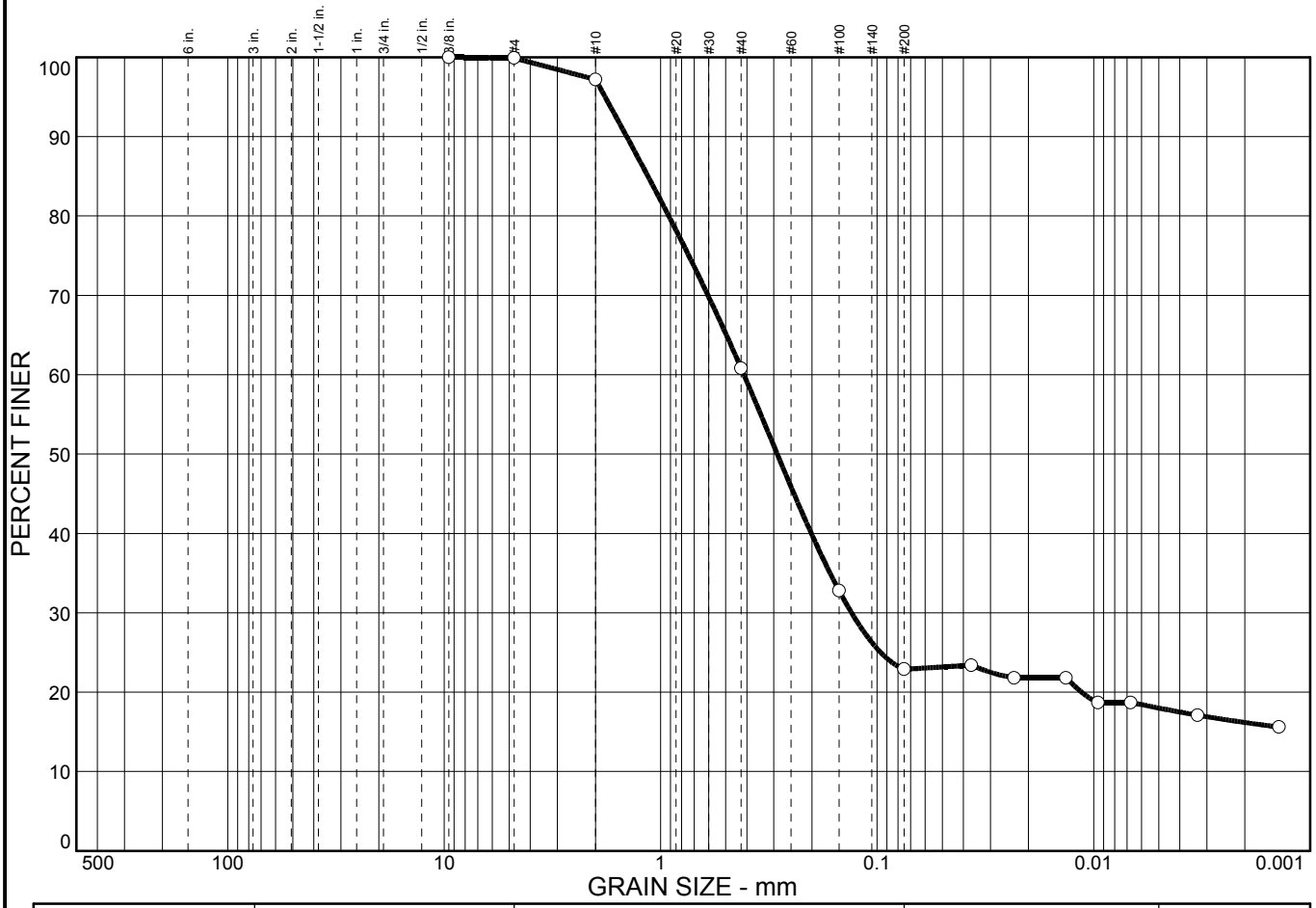
Sample No.: 330B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 10.5-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.1	77.0	4.9	18.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.9		
#10	97.2		
#40	60.8		
#100	32.8		
#200	22.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.14 D_{60}= 0.413 D_{50}= 0.290
D_{30}= 0.131 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

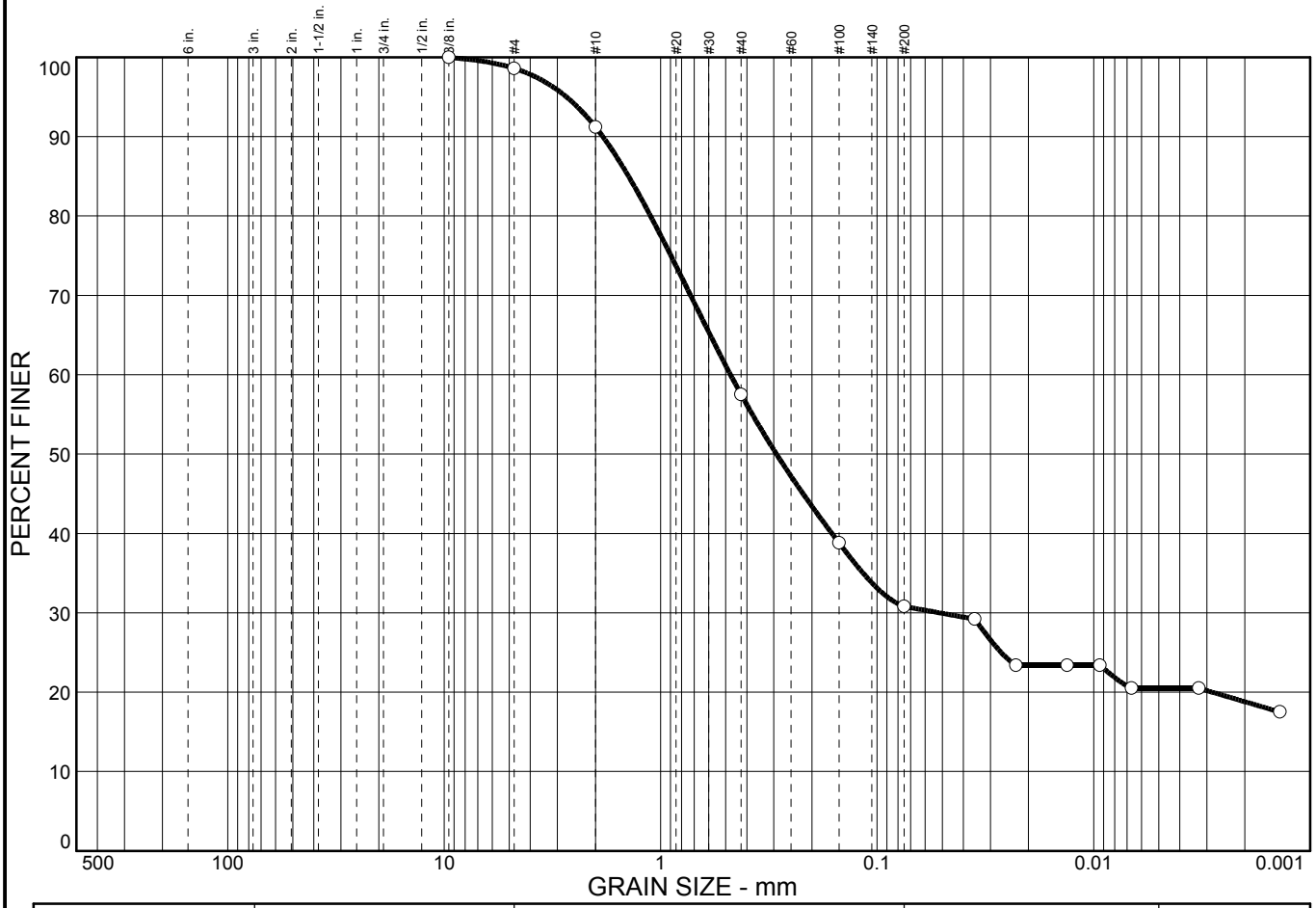
Sample No.: 332B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 6-9'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.4	67.8	10.3	20.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.6		
#10	91.2		
#40	57.5		
#100	38.8		
#200	30.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 24 LL= 30 PI= 6

Coefficients

D_{85}= 1.41 D_{60}= 0.476 D_{50}= 0.292
D_{30}= 0.0515 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

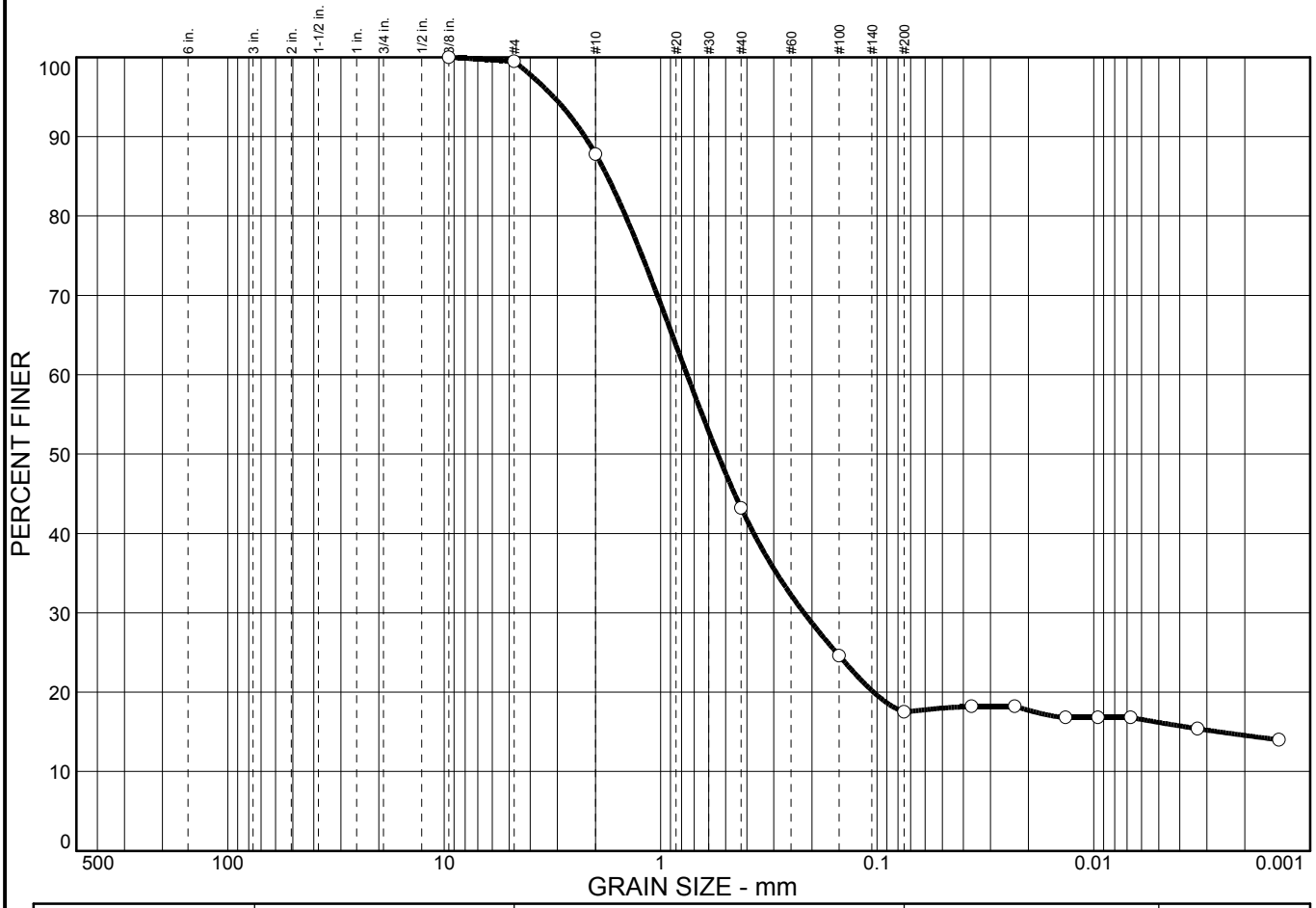
Sample No.: 334B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas. PR **Elev./Depth:** 1.5-4.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	82.0	1.3	16.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.5		
#10	87.8		
#40	43.2		
#100	24.6		
#200	17.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.76 D_{60}= 0.756 D_{50}= 0.545
D_{30}= 0.218 D_{15}= 0.0026 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

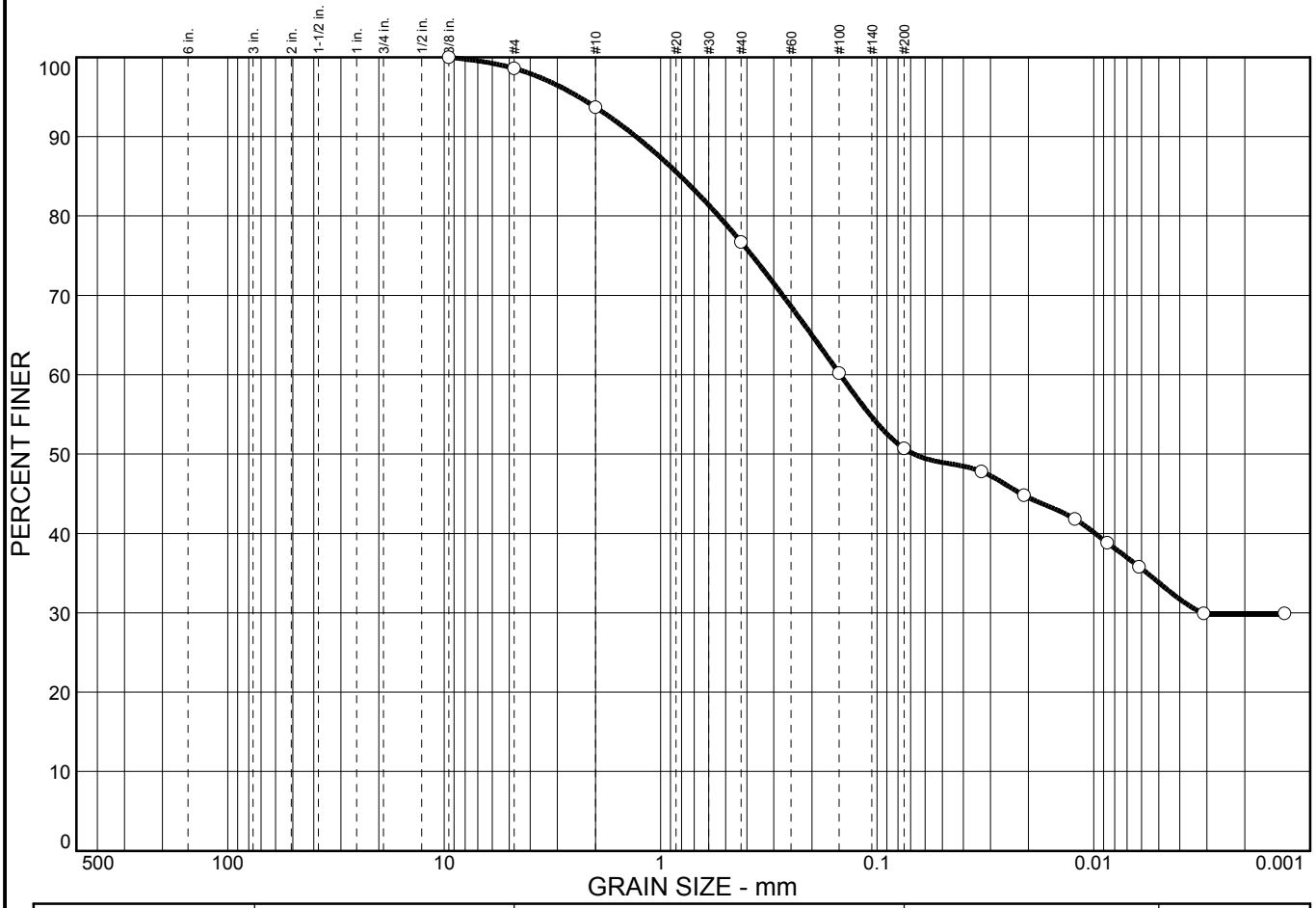
Sample No.: 334B1 **Source of Sample:** Project Site **Date:** 6/17/20
Location: Salinas, PR **Elev./Depth:** 6-9'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.4	47.9	16.9	33.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.6		
#10	93.7		
#40	76.7		
#100	60.2		
#200	50.7		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 24 LL= 35 PI= 11

Coefficients

D_{85}= 0.808 D_{60}= 0.148 D_{50}= 0.0676
D_{30}= 0.0032 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(3)

Remarks

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE

Sample No.: 440B1 **Source of Sample:** Project Site **Date:** 6/19/20
Location: Salinas, PR **Elev./Depth:** 3-6'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report

% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	19.7	61.9	3.1	15.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	97.1		
.5 in.	93.9		
.375 in.	90.0		
#4	80.3		
#10	66.1		
#40	39.5		
#100	24.1		
#200	18.4		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 6.65 D_{60}= 1.41 D_{50}= 0.792
D_{30}= 0.232 D_{15}= 0.0041 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

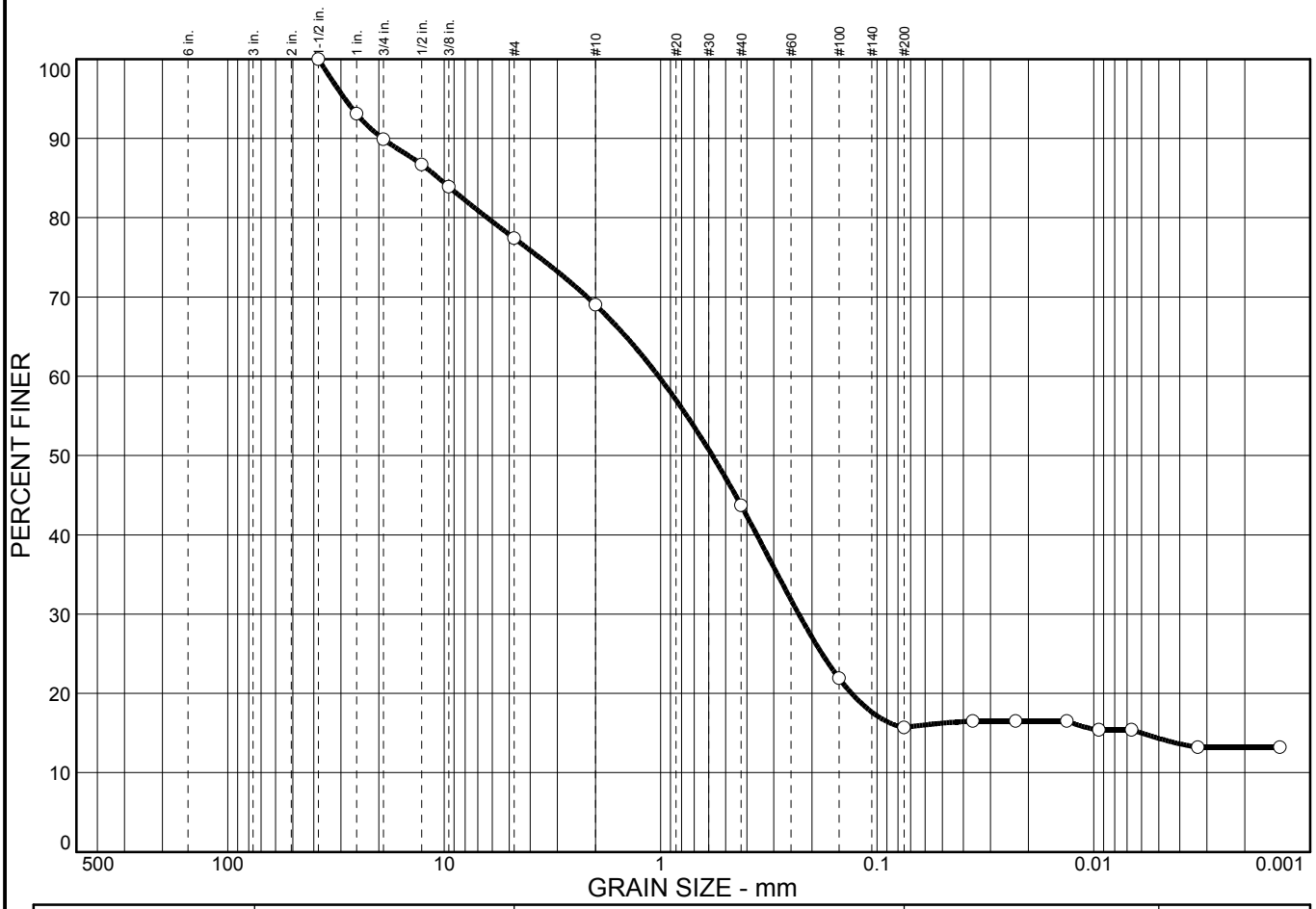
Sample No.: 440B1 **Source of Sample:** Project Site **Date:** 6/19/20
Location: Salinas, PR **Elev./Depth:** 7.5-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	22.6	61.7	1.4	14.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	93.1		
.75 in.	89.9		
.5 in.	86.7		
.375 in.	83.9		
#4	77.4		
#10	69.0		
#40	43.7		
#100	21.9		
#200	15.7		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 10.6 D_{60}= 1.02 D_{50}= 0.577
D_{30}= 0.230 D_{15}= 0.0060 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

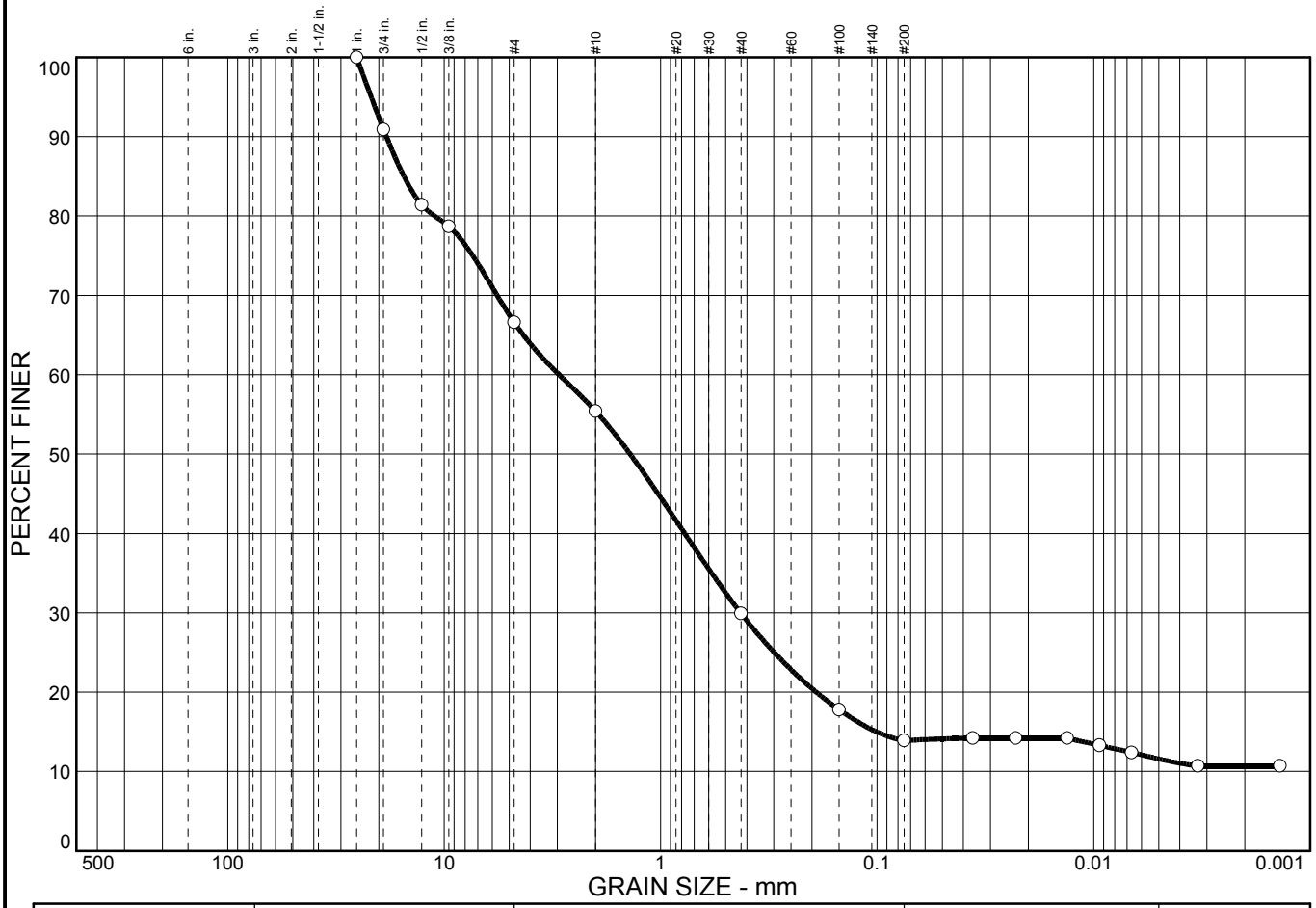
Sample No.: 442B1 **Source of Sample:** Project Site **Date:** 6/26/20
Location: Salinas, PR **Elev./Depth:** 4.5-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	33.4	52.7	2.3	11.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	90.9		
.5 in.	81.4		
.375 in.	78.7		
#4	66.6		
#10	55.4		
#40	29.9		
#100	17.8		
#200	13.9		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 15.4 D_{60}= 2.95 D_{50}= 1.38
D_{30}= 0.428 D_{15}= 0.101 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

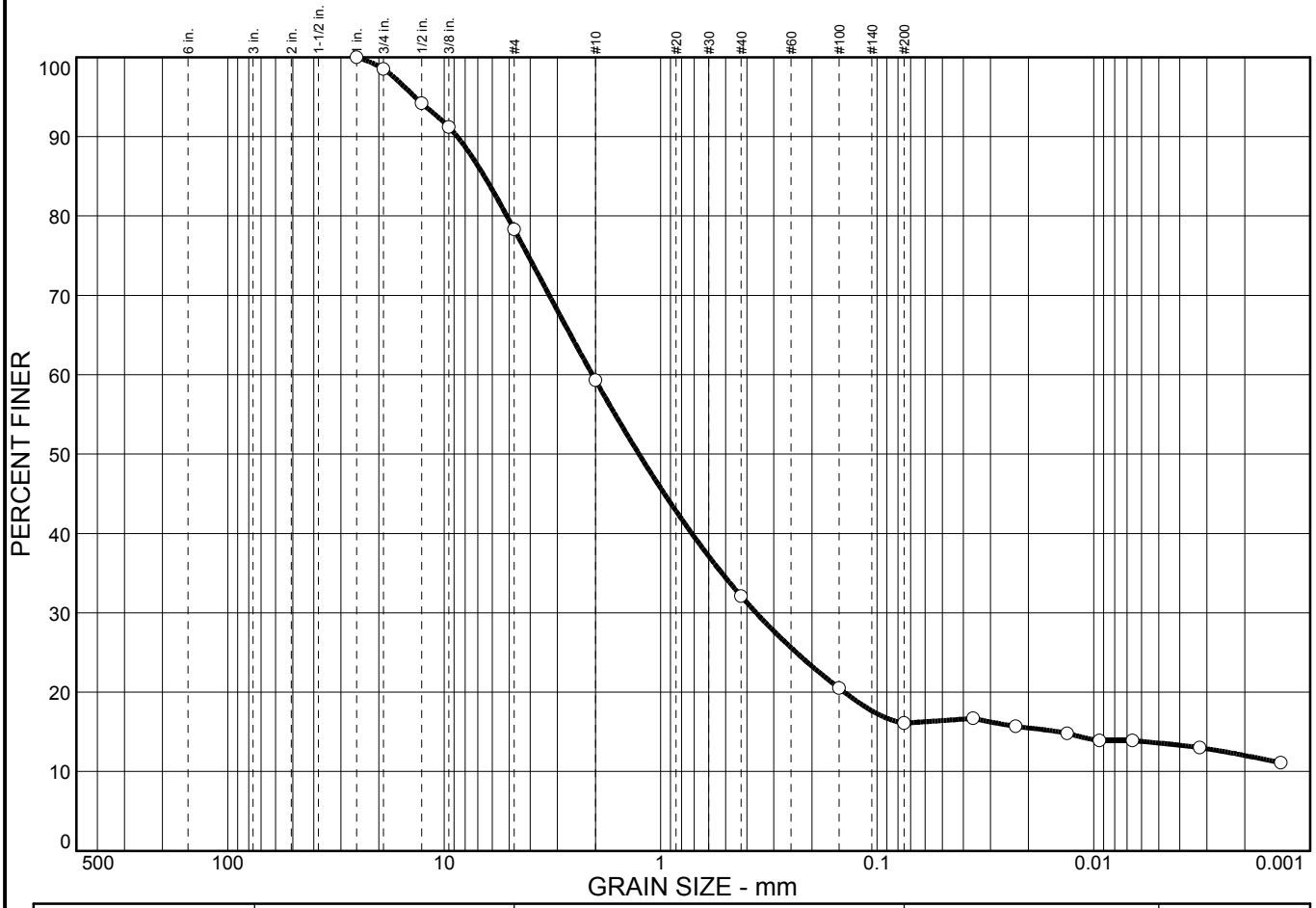
Sample No.: 442B1 **Source of Sample:** Project Site **Date:** 6/19/20
Location: Salinas, PR **Elev./Depth:** 9-12'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	21.7	62.2	2.5	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	98.5		
.5 in.	94.2		
.375 in.	91.2		
#4	78.3		
#10	59.3		
#40	32.1		
#100	20.5		
#200	16.1		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 6.52 D_{60}= 2.07 D_{50}= 1.26
D_{30}= 0.362 D_{15}= 0.0144 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

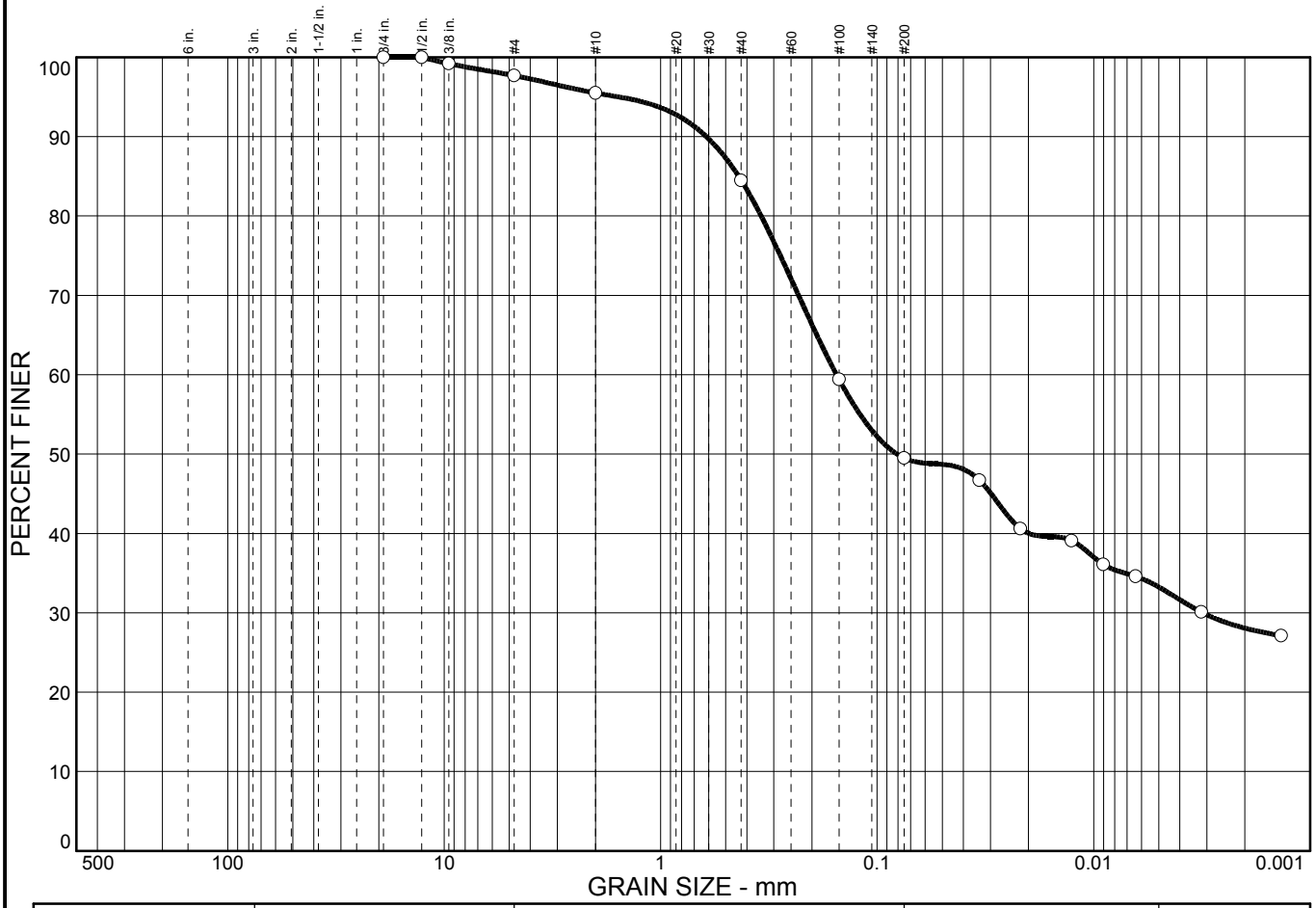
Sample No.: 444B1 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.3	48.2	16.3	33.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	100.0		
.375 in.	99.2		
#4	97.7		
#10	95.5		
#40	84.5		
#100	59.4		
#200	49.5		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 0.437 D_{60}= 0.154 D_{50}= 0.0810
D_{30}= 0.0031 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

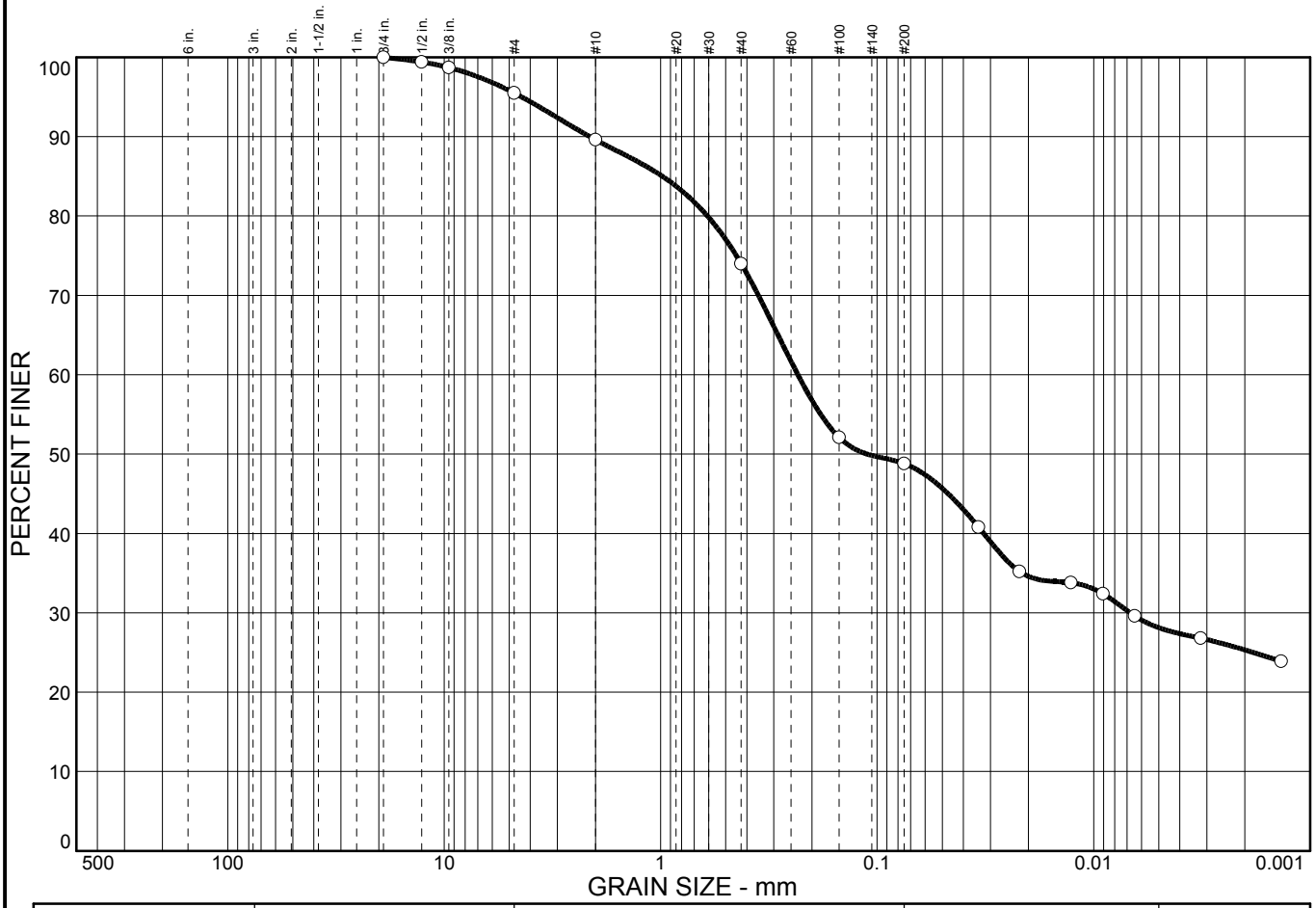
Sample No.: 444B1 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 6-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.5	46.7	20.7	28.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.4		
.375 in.	98.7		
#4	95.5		
#10	89.6		
#40	74.0		
#100	52.1		
#200	48.8		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 0.983 D_{60}= 0.232 D_{50}= 0.111
D_{30}= 0.0068 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

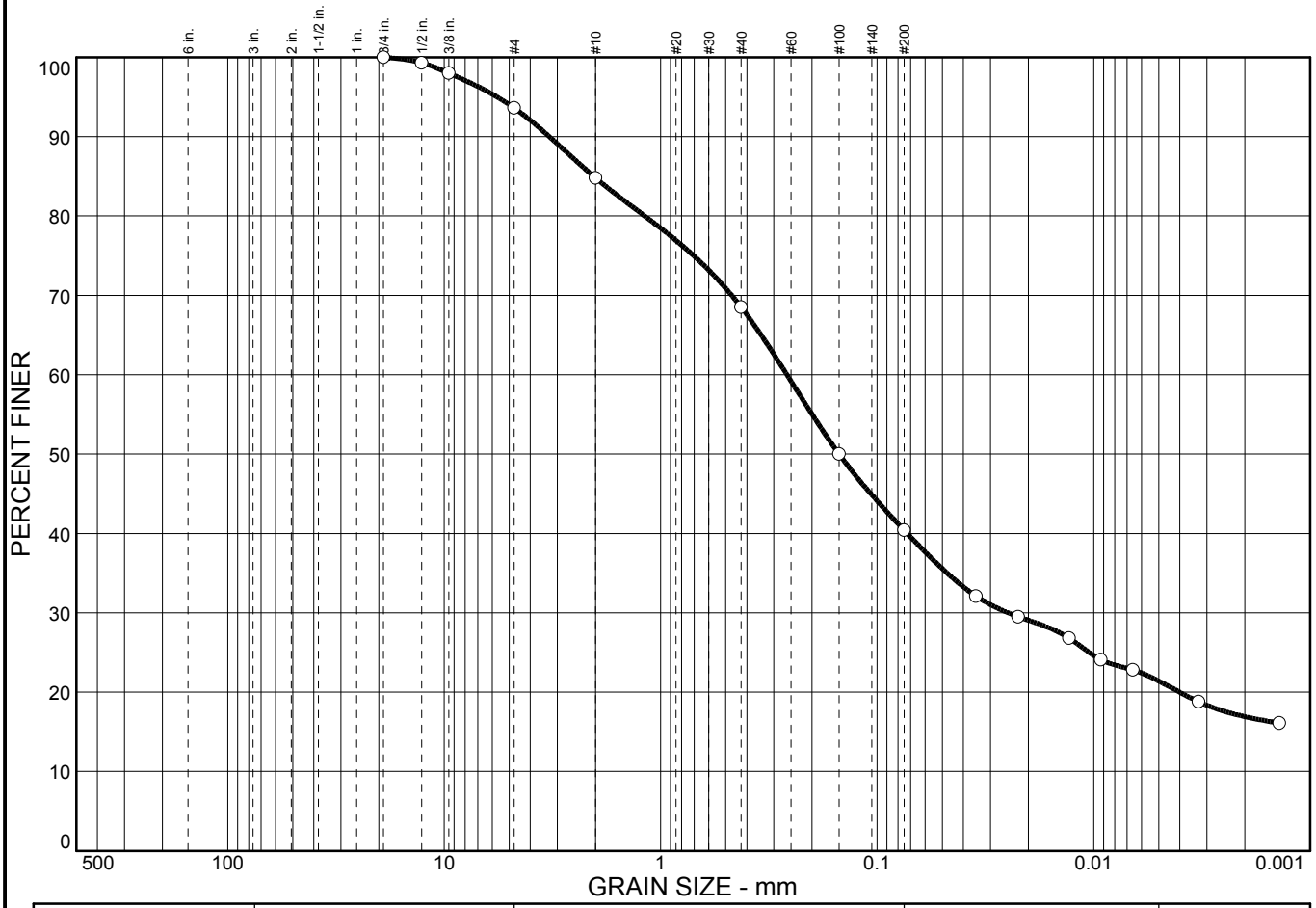
Sample No.: 446B1 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	6.4	53.2	19.0	21.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.3		
.375 in.	98.0		
#4	93.6		
#10	84.8		
#40	68.5		
#100	50.0		
#200	40.4		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 2.04 D_{60}= 0.261 D_{50}= 0.150
D_{30}= 0.0249 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

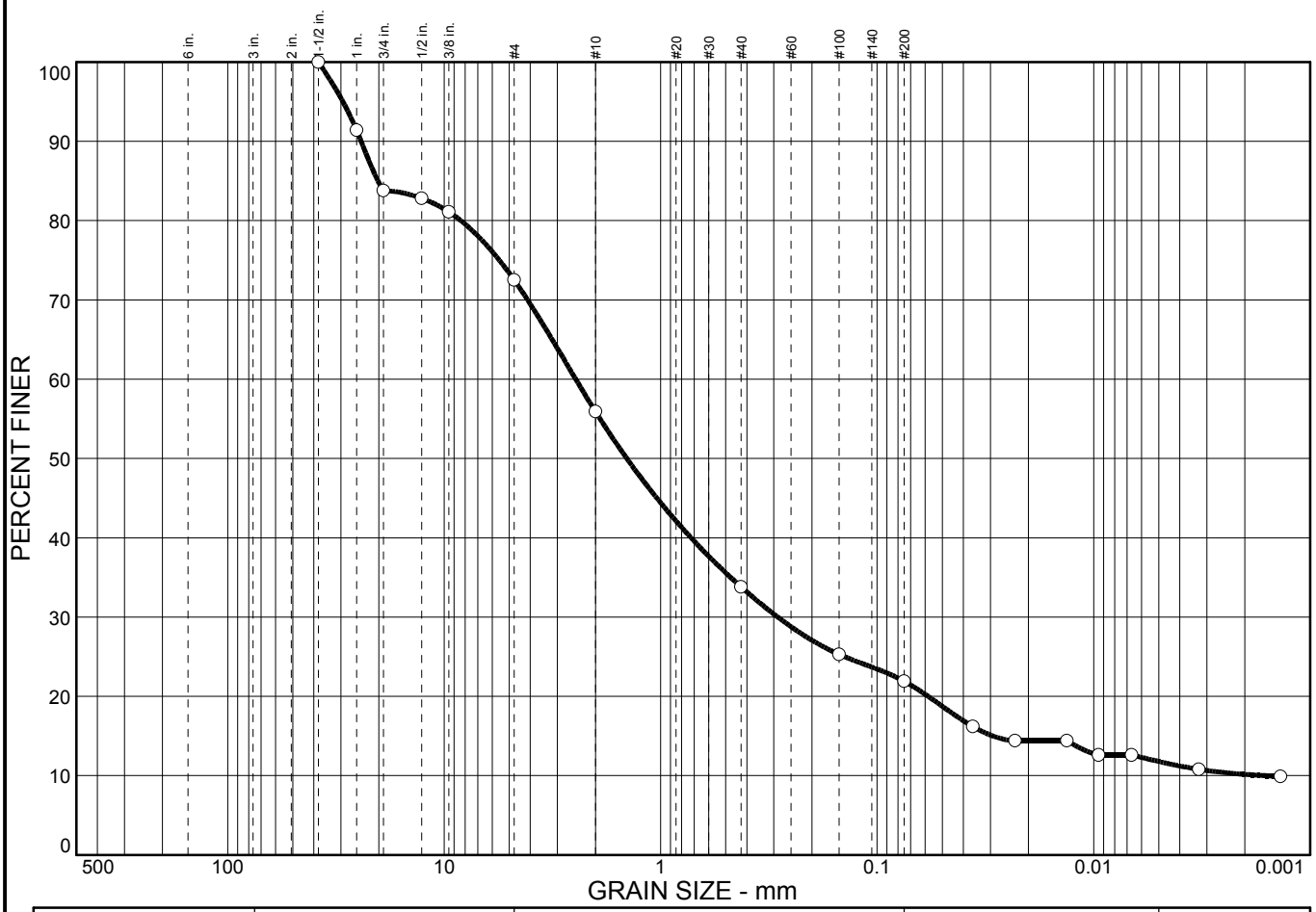
Sample No.: 446B1 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	27.5	50.6	10.1	11.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	91.4		
.75 in.	83.8		
.5 in.	82.8		
.375 in.	81.1		
#4	72.5		
#10	55.9		
#40	33.8		
#100	25.3		
#200	21.9		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 20.2 D_{60}= 2.47 D_{50}= 1.43
D_{30}= 0.288 D_{15}= 0.0292 D_{10}= 0.0016
C_u= 1543.16 C_c= 21.03

Classification

USCS= AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

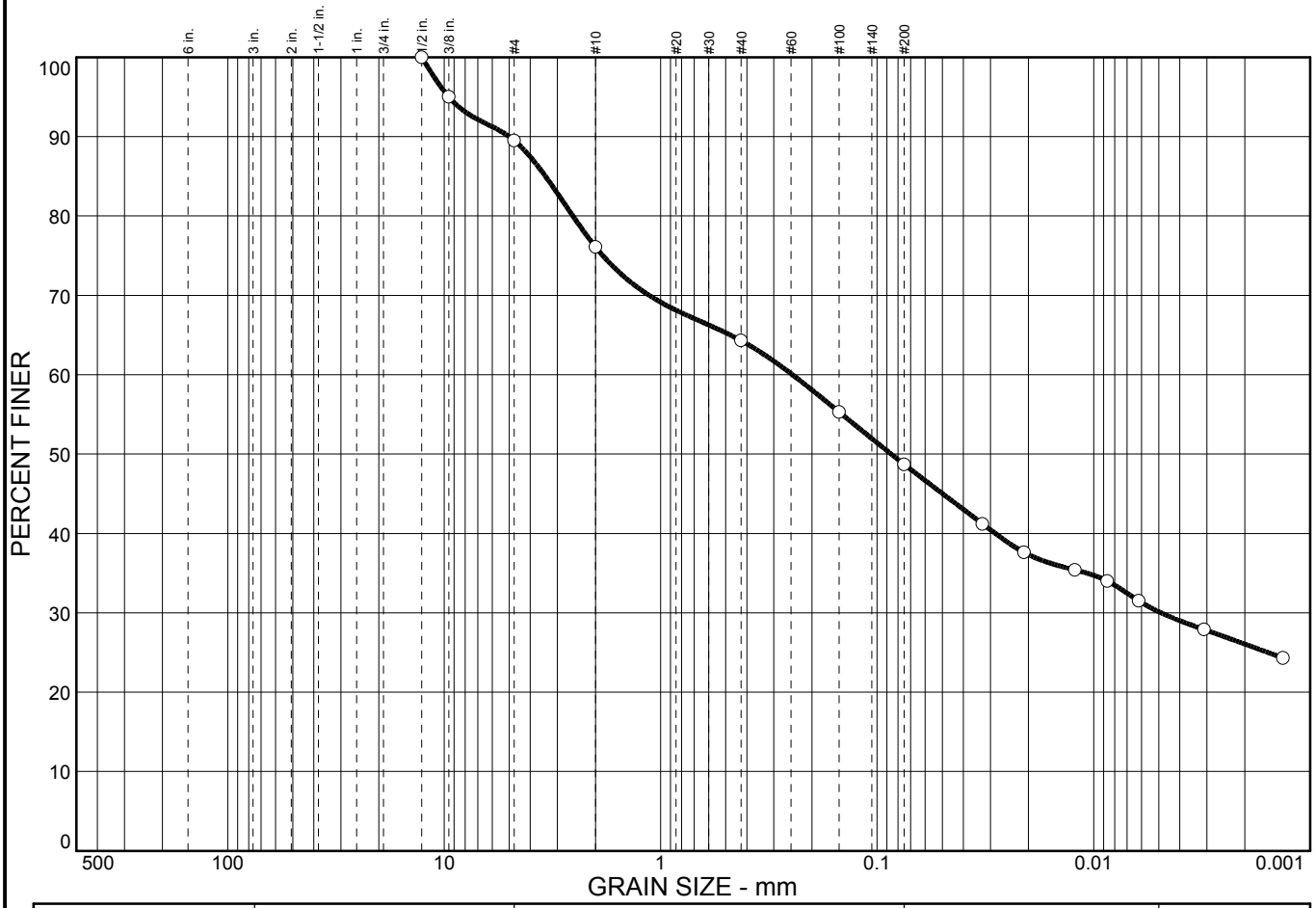
Sample No.: 448B1 **Source of Sample:** Project Site **Date:** 5/21/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	10.5	40.8	18.6	30.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	95.0		
#4	89.5		
#10	76.1		
#40	64.3		
#100	55.3		
#200	48.7		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 3.41 D_{60}= 0.247 D_{50}= 0.0862
D_{30}= 0.0049 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

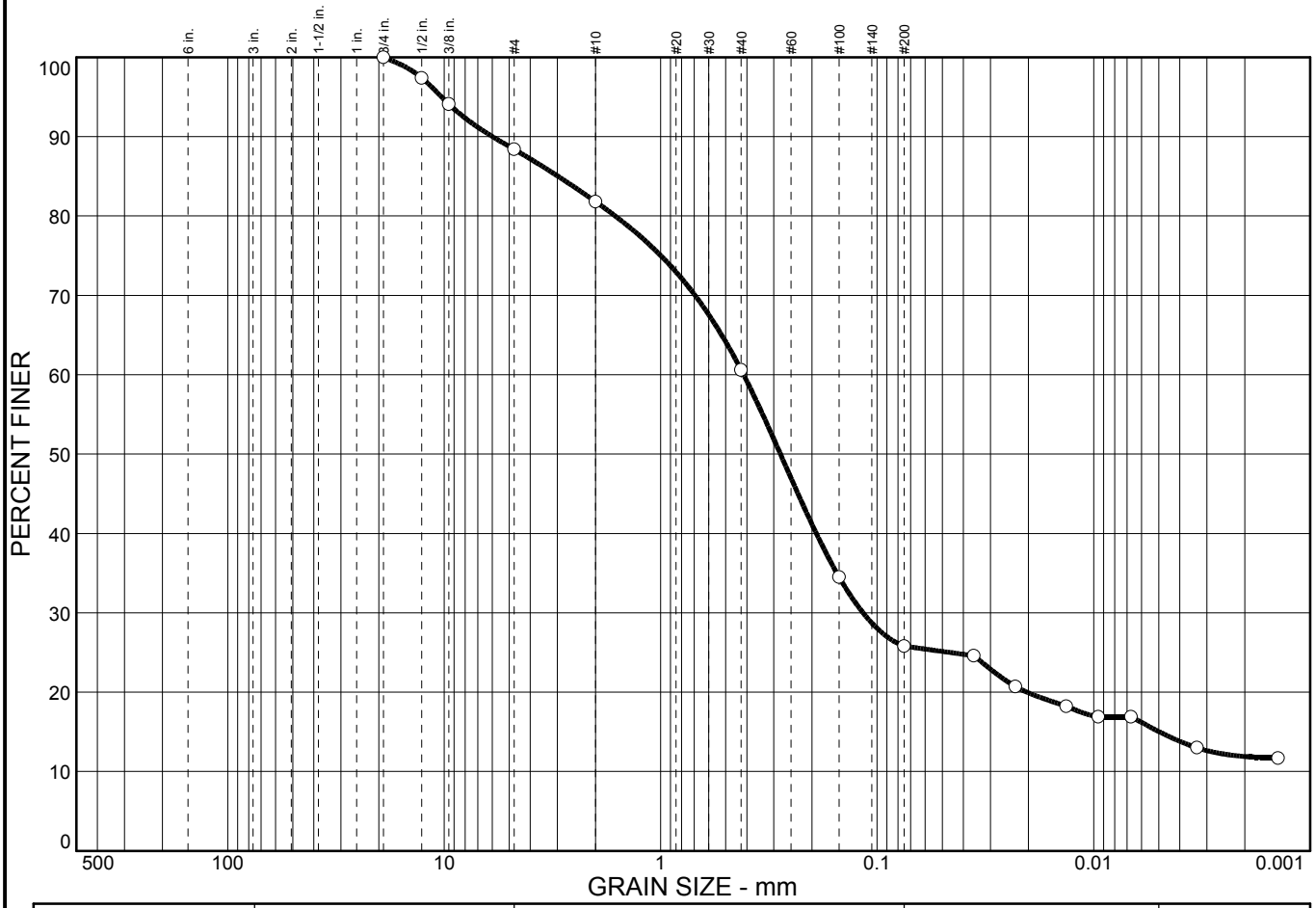
Sample No.: 448B1 **Source of Sample:** Project Site **Date:** 4/15/20
Location: Salinas, PR **Elev./Depth:** 9-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.6	62.6	10.8	15.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	97.4		
.375 in.	94.1		
#4	88.4		
#10	81.8		
#40	60.6		
#100	34.5		
#200	25.8		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 2.98 D_{60}= 0.414 D_{50}= 0.280
D_{30}= 0.116 D_{15}= 0.0050 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

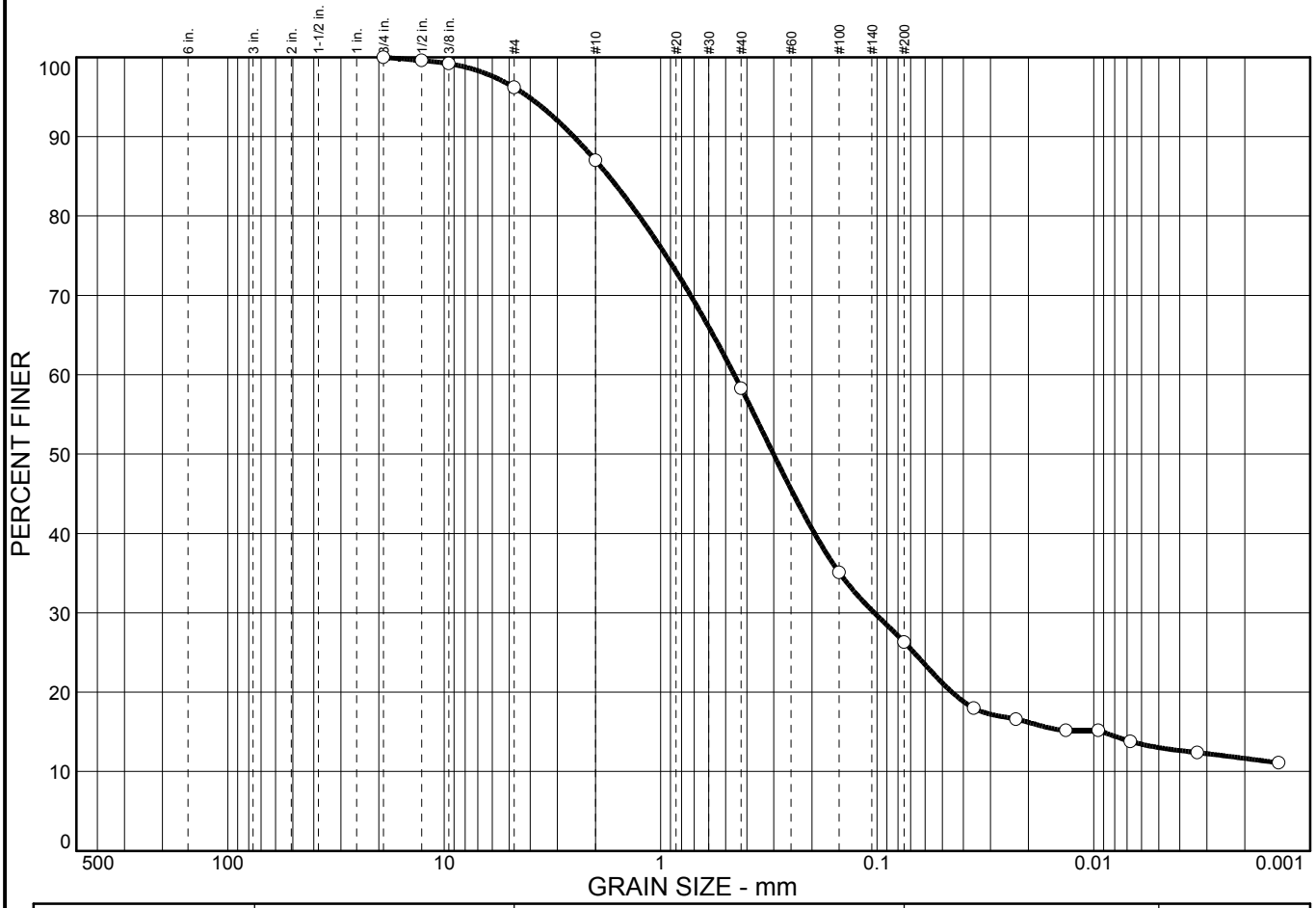
Sample No.: 450B1 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.8	69.9	13.3	13.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.6		
.375 in.	99.2		
#4	96.2		
#10	87.0		
#40	58.3		
#100	35.1		
#200	26.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.74 D_{60}= 0.457 D_{50}= 0.301
D_{30}= 0.103 D_{15}= 0.0091 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

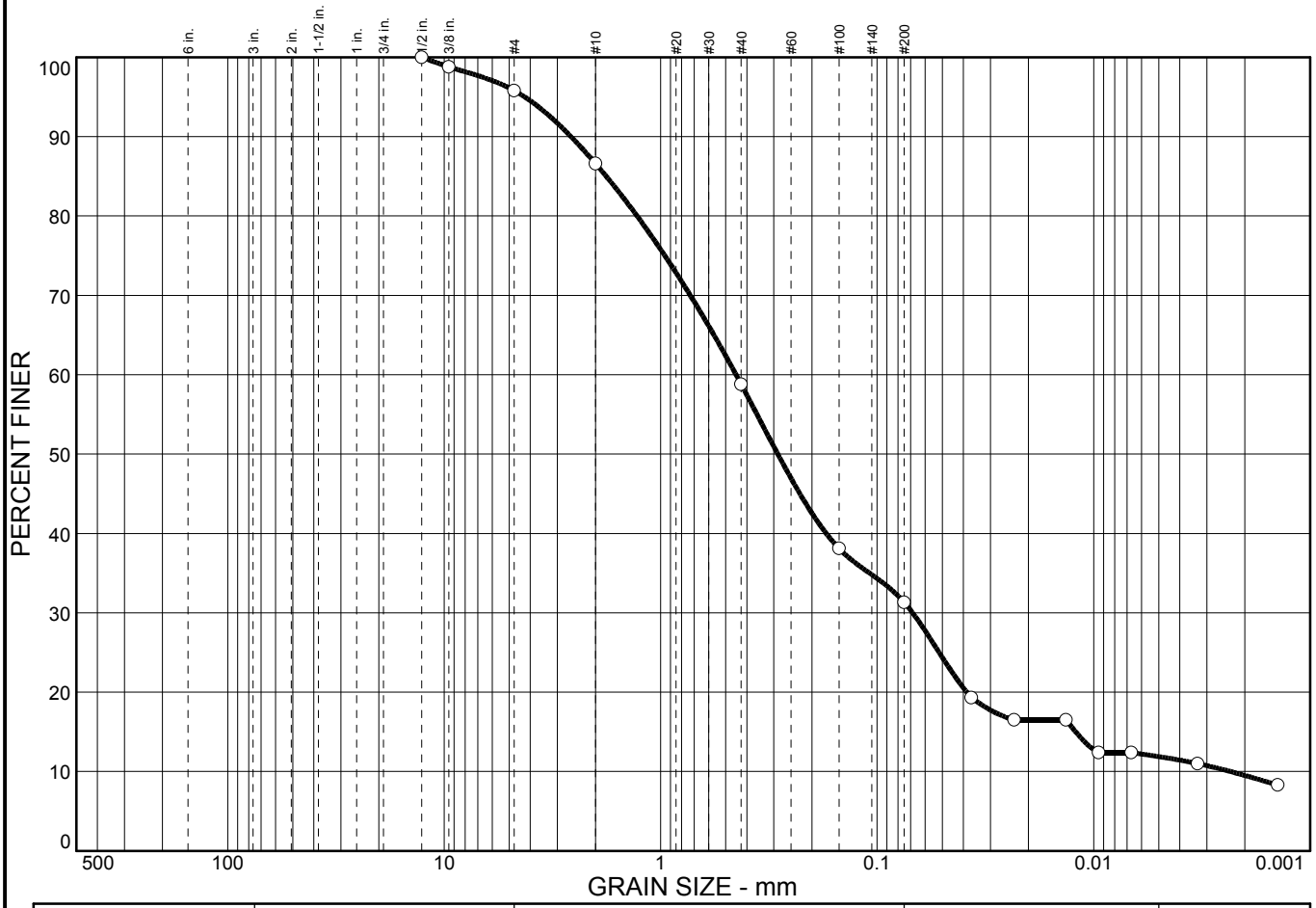
Sample No.: 450B2 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.2	64.5	19.4	11.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	98.8		
#4	95.8		
#10	86.6		
#40	58.8		
#100	38.1		
#200	31.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 25 LL= 31 PI= 6

Coefficients

D_{85}= 1.79 D_{60}= 0.449 D_{50}= 0.288
D_{30}= 0.0687 D_{15}= 0.0121 D_{10}= 0.0023
C_u= 192.51 C_c= 4.51

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

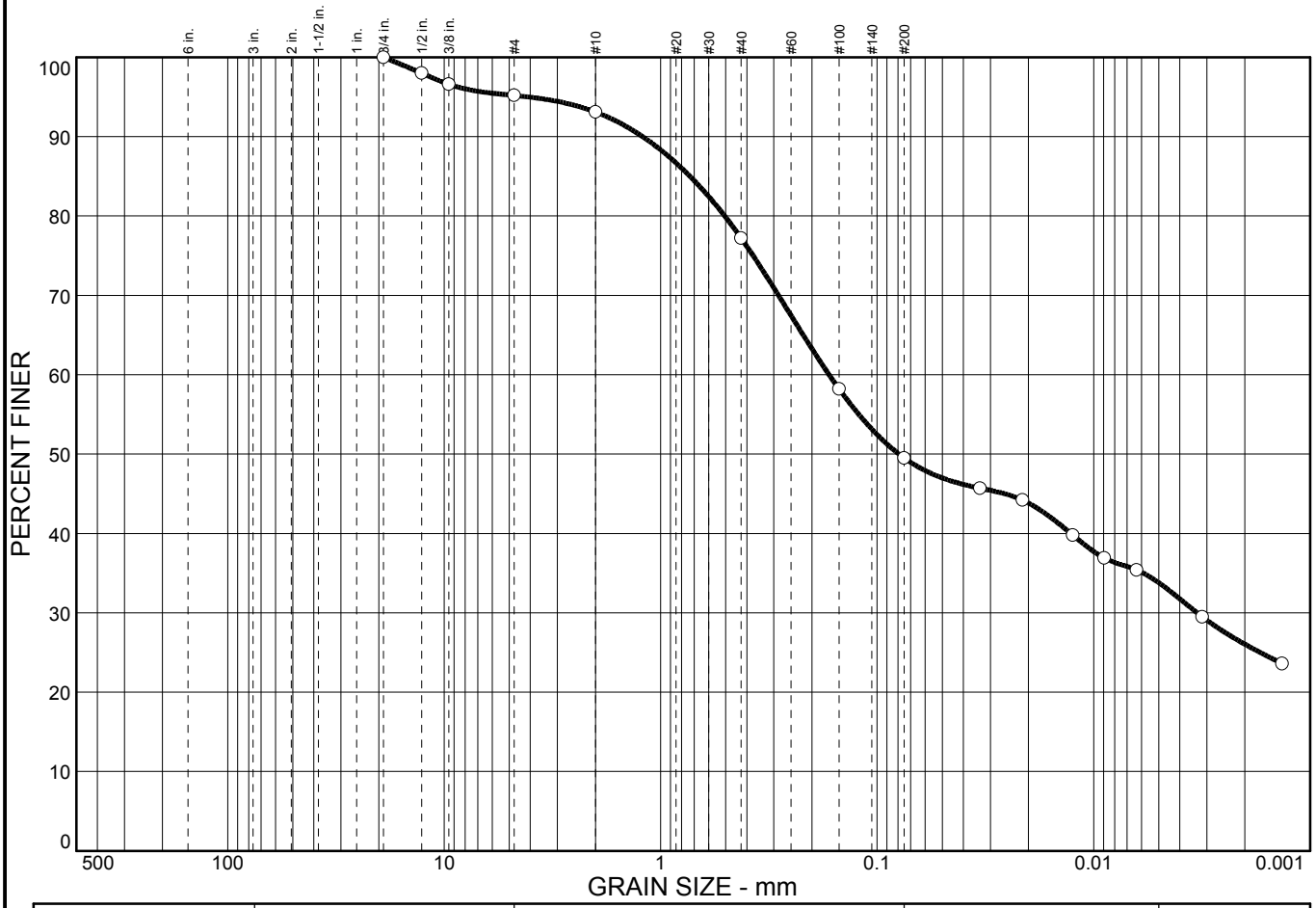
Sample No.: 450B2 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	4.8	45.7	15.7	33.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.0		
.375 in.	96.6		
#4	95.2		
#10	93.1		
#40	77.2		
#100	58.2		
#200	49.5		

* (no specification provided)

Material Description

Clayey sand

Atterberg Limits

PL= 23 LL= 42 PI= 19

Coefficients

D_{85}= 0.733 D_{60}= 0.167 D_{50}= 0.0794
D_{30}= 0.0033 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-7-6(6)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

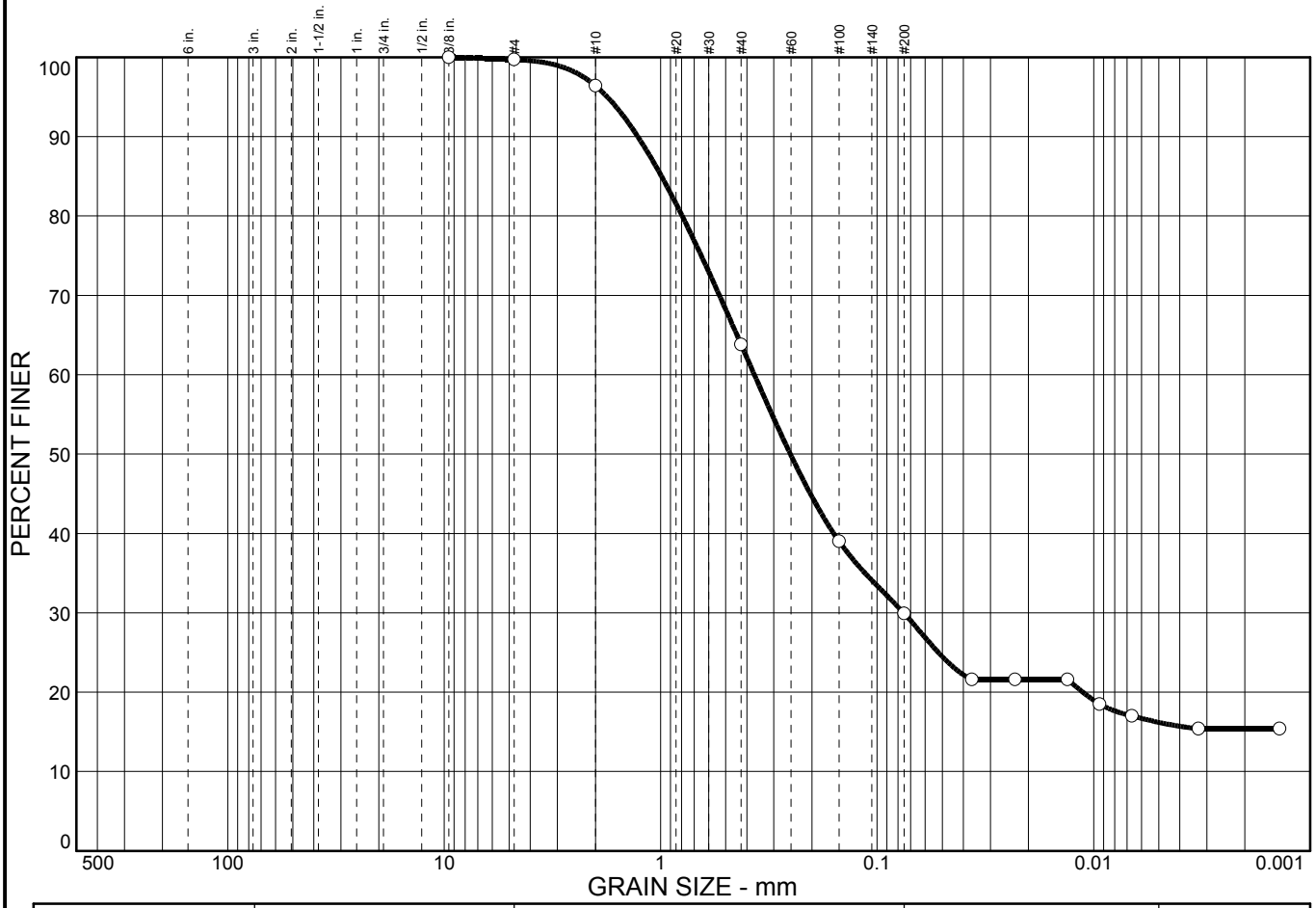
Sample No.: 450B3 **Source of Sample:** Project Site **Date:** 5/19/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	69.8	13.7	16.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	96.4		
#40	63.8		
#100	39.0		
#200	29.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 0.992 D_{60}= 0.369 D_{50}= 0.252
D_{30}= 0.0756 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

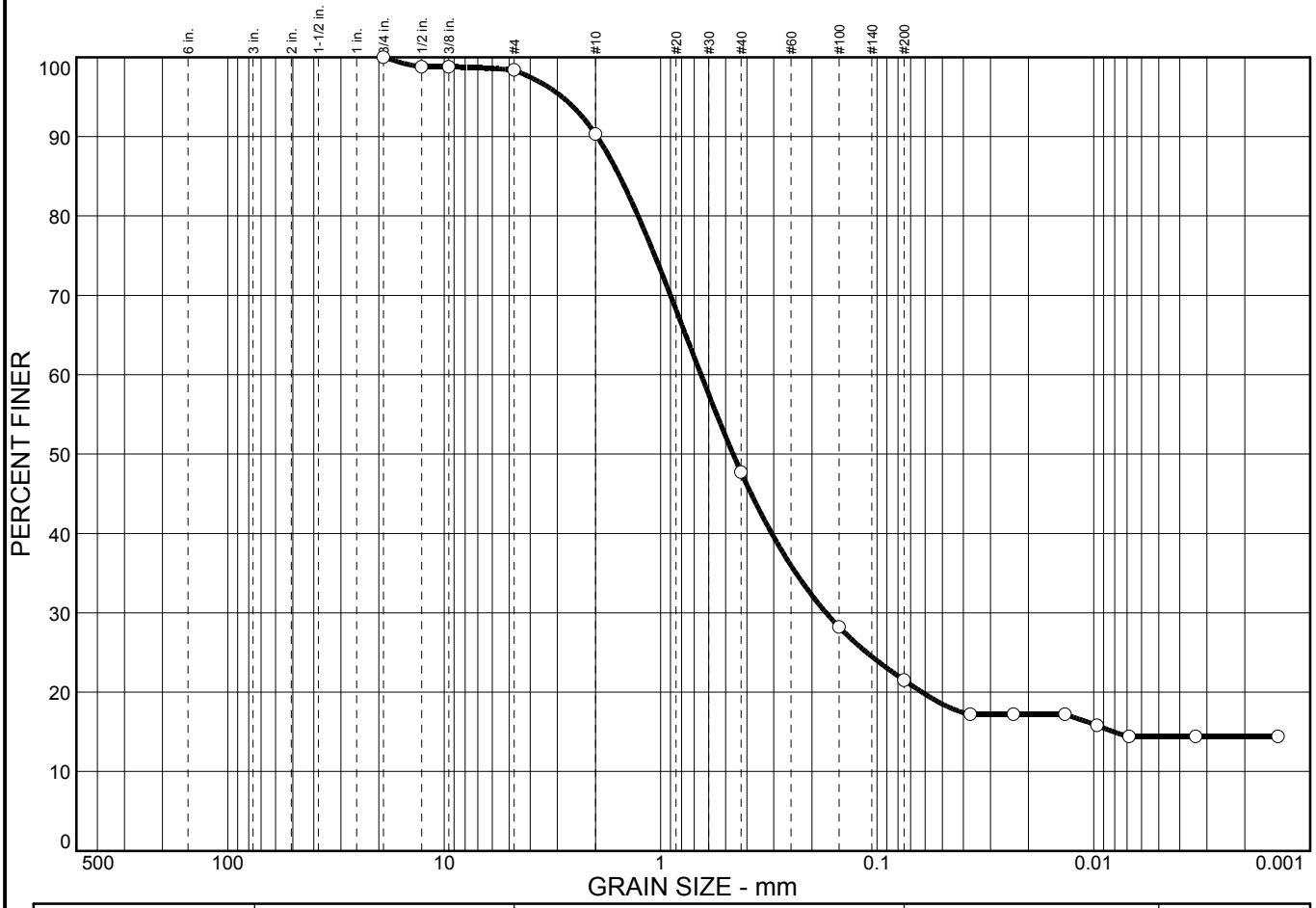
Sample No.: 450B3 **Source of Sample:** Project Site **Date:** 5/21/20
Location: Salinas, PR **Elev./Depth:** 15-19.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.6	76.9	7.1	14.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.8		
.375 in.	98.8		
#4	98.4		
#10	90.3		
#40	47.7		
#100	28.2		
#200	21.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.55 D_{60}= 0.651 D_{50}= 0.463
D_{30}= 0.172 D_{15}= 0.0081 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

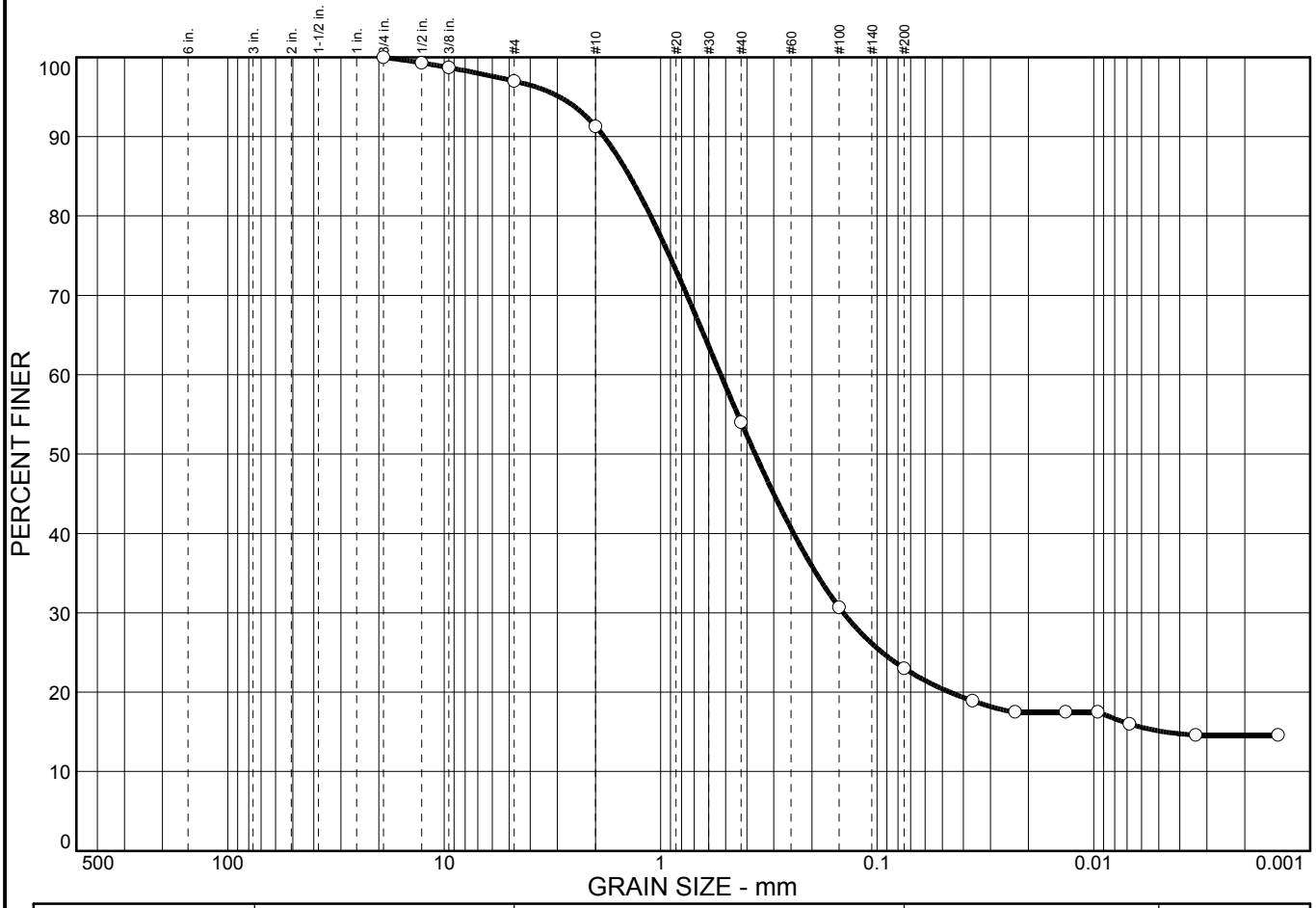
Sample No.: 452B1 **Source of Sample:** Project Site **Date:** 6/3/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.0	74.0	7.9	15.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.3		
.375 in.	98.7		
#4	97.0		
#10	91.3		
#40	54.0		
#100	30.7		
#200	23.0		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.39 D_{60}= 0.528 D_{50}= 0.366
D_{30}= 0.143 D_{15}= 0.0047 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: T. Melendez
Checked by: Rommel Cintron Aponte, MSCE, PE

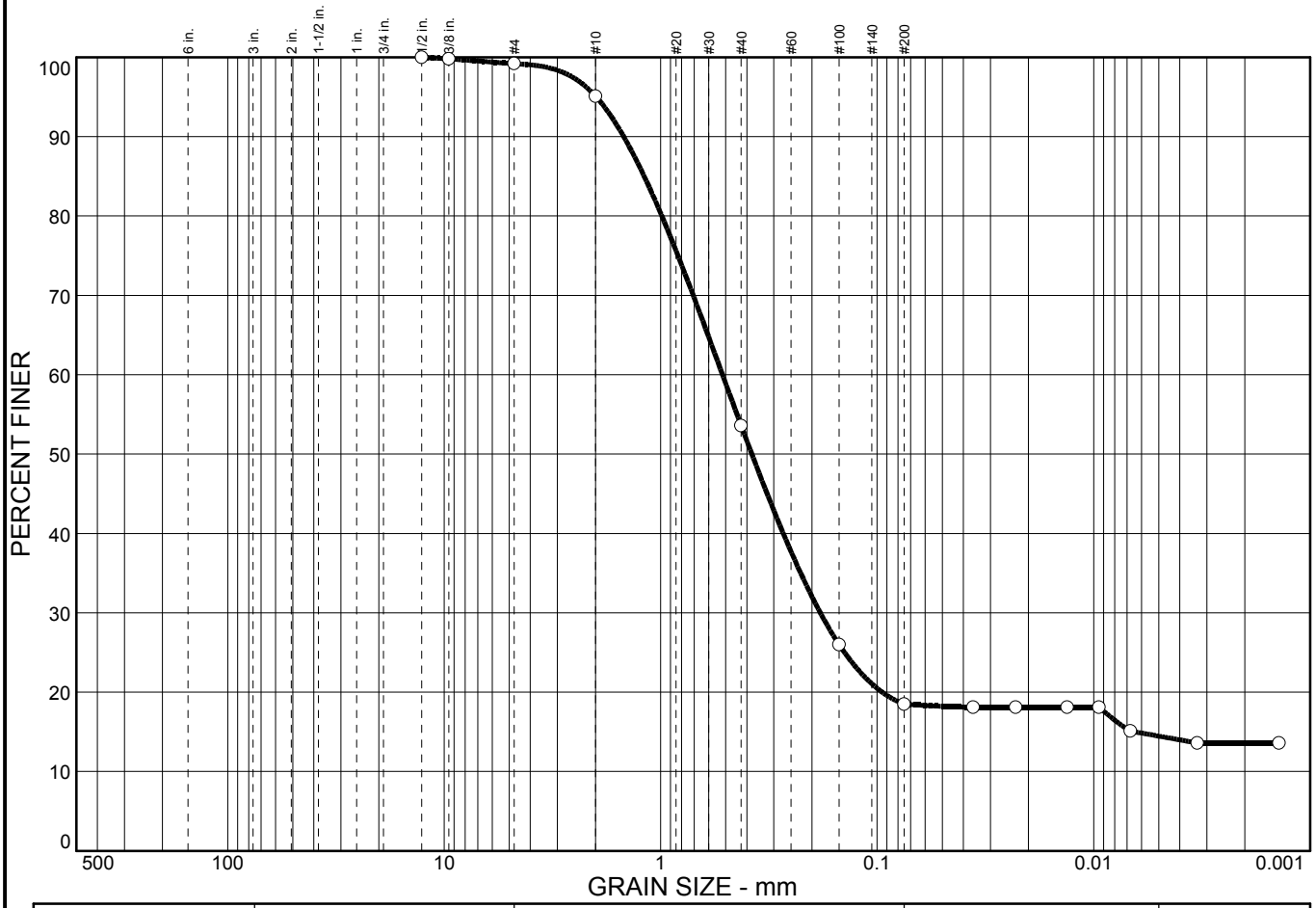
Sample No.: 452B1 **Source of Sample:** Project Site **Date:** 6/3/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.8	80.7	4.0	14.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.8		
#4	99.2		
#10	95.1		
#40	53.6		
#100	26.0		
#200	18.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.19 D_{60}= 0.518 D_{50}= 0.379
D_{30}= 0.183 D_{15}= 0.0064 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

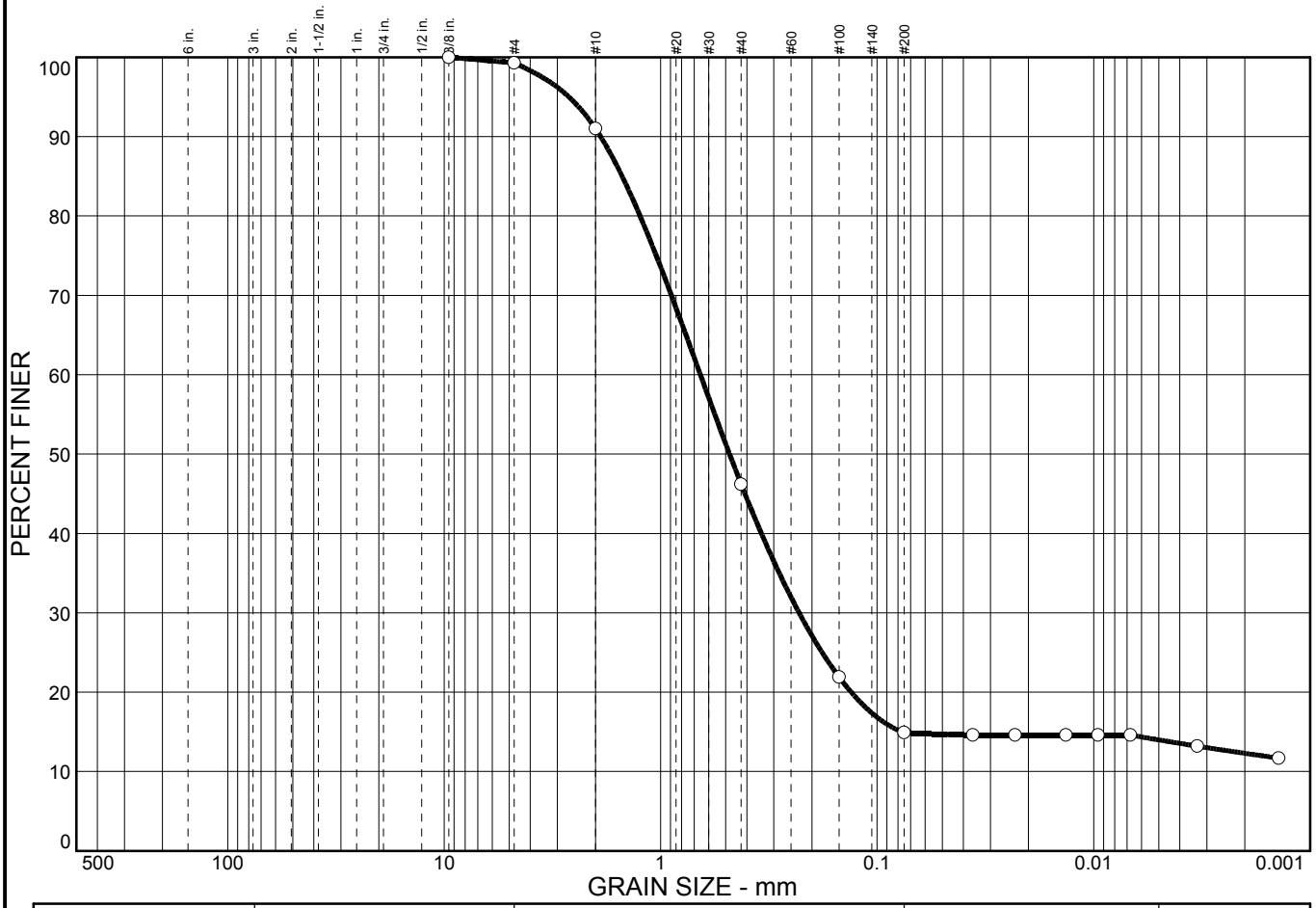
Sample No.: 452B2 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	84.4	0.9	14.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.3		
#10	91.0		
#40	46.2		
#100	21.9		
#200	14.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.51 D_{60}= 0.656 D_{50}= 0.481
D_{30}= 0.229 D_{15}= 0.0767 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

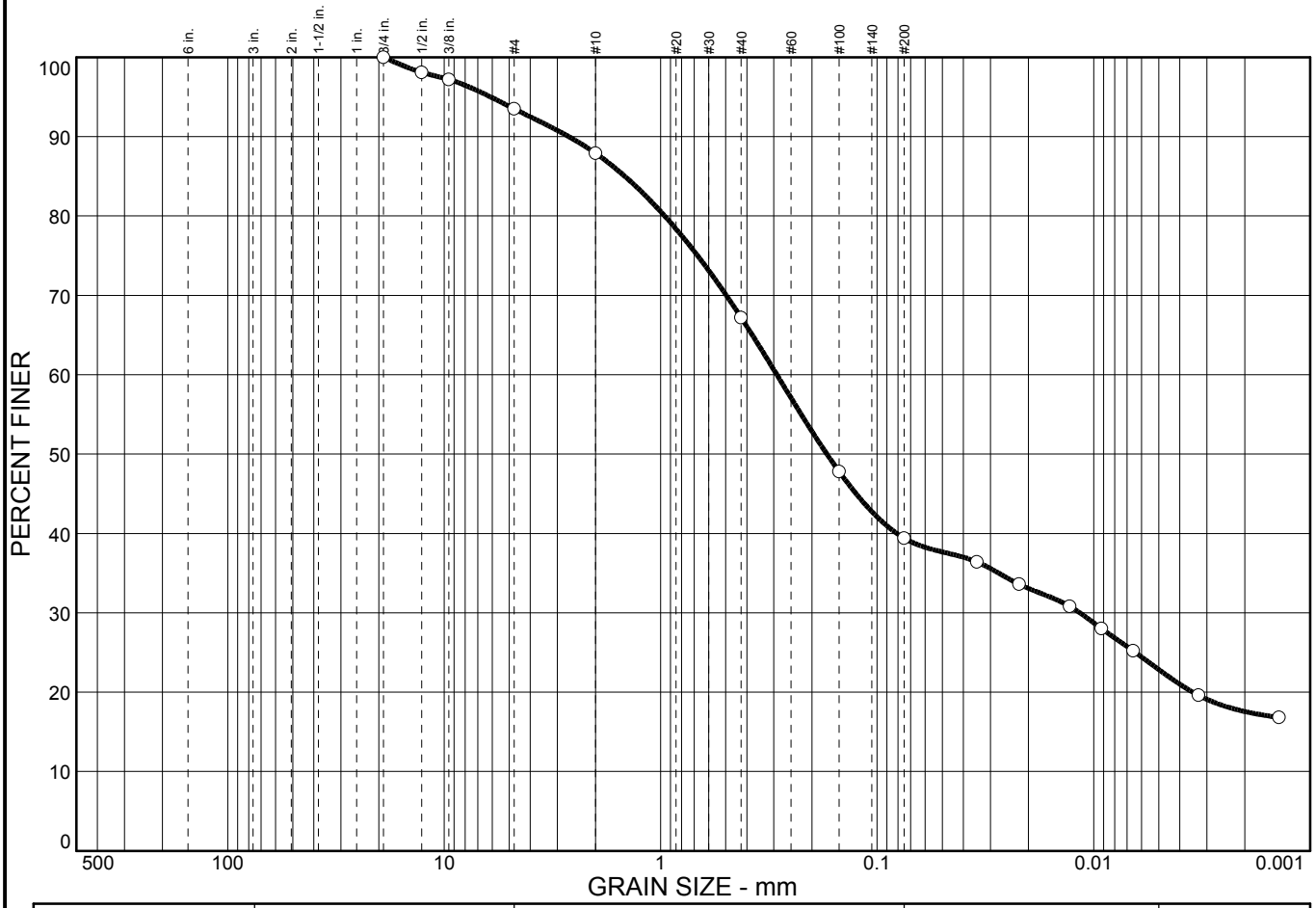
Sample No.: 452B2 **Source of Sample:** Project Site **Date:** 5/20/20
Location: Salinas, PR **Elev./Depth:** 12-16.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	6.5	54.1	16.6	22.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.1		
.375 in.	97.2		
#4	93.5		
#10	87.9		
#40	67.2		
#100	47.8		
#200	39.4		

* (no specification provided)

Material Description

Silty clayey sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 1.47 D_{60}= 0.291 D_{50}= 0.171
D_{30}= 0.0116 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

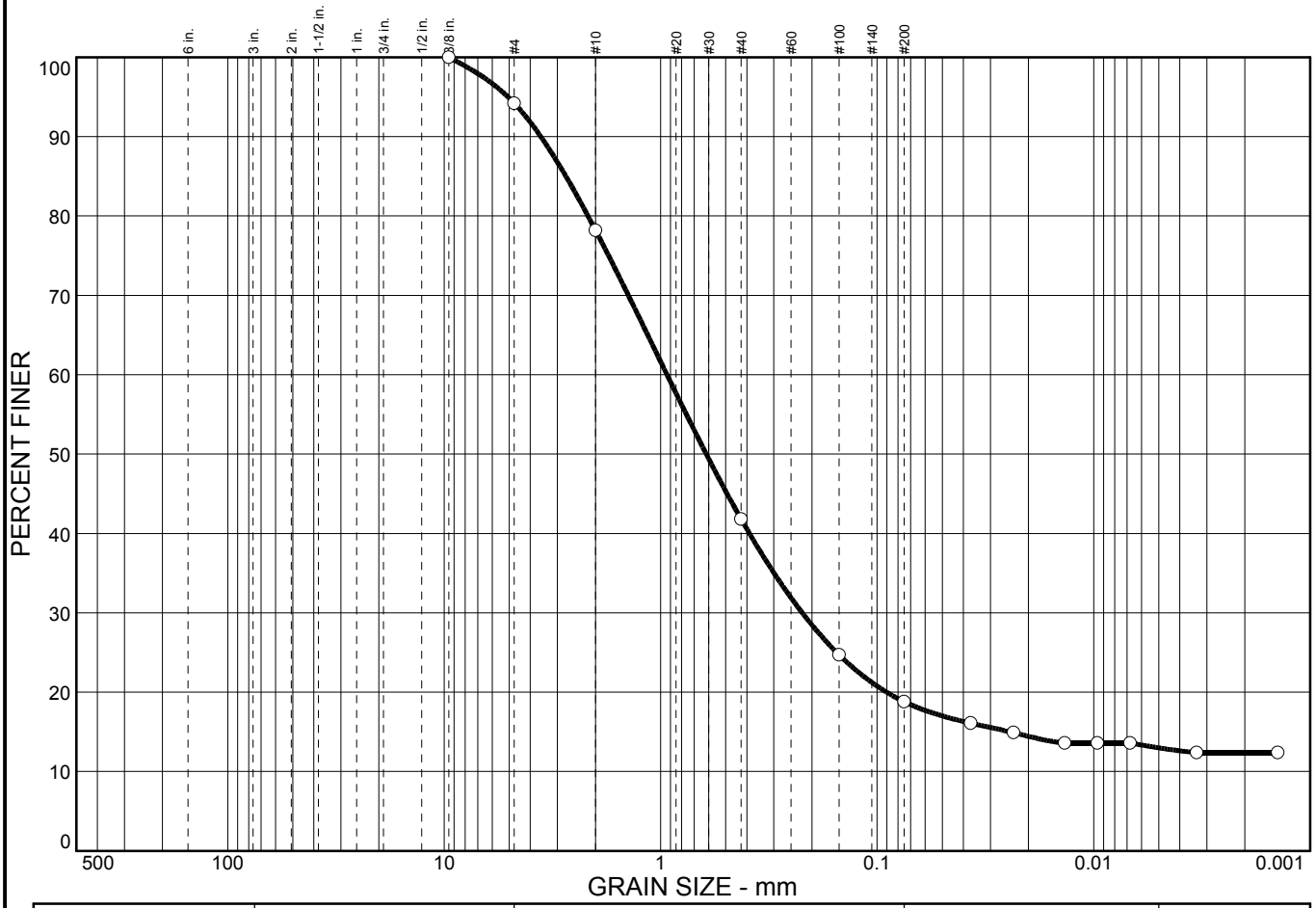
Sample No.: 452B3 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	5.8	75.4	5.8	13.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	94.2		
#10	78.2		
#40	41.8		
#100	24.7		
#200	18.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 2.74 D_{60}= 0.935 D_{50}= 0.616
D_{30}= 0.222 D_{15}= 0.0243 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: F. de los Santos
Checked by: Rommel Cintron Aponte, MSCE, PE

Sample No.: 452B3 **Source of Sample:** Project Site **Date:** 3/12/20
Location: Salinas, PR **Elev./Depth:** 15-19.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report

% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	22.4	50.8	3.7	23.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	94.7		
.5 in.	89.1		
.375 in.	85.0		
#4	77.6		
#10	69.7		
#40	50.5		
#100	35.1		
#200	26.8		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= 30 LL= 42 PI= 12

Coefficients

D_{85}= 9.52 D_{60}= 0.860 D_{50}= 0.410
D_{30}= 0.106 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-7(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

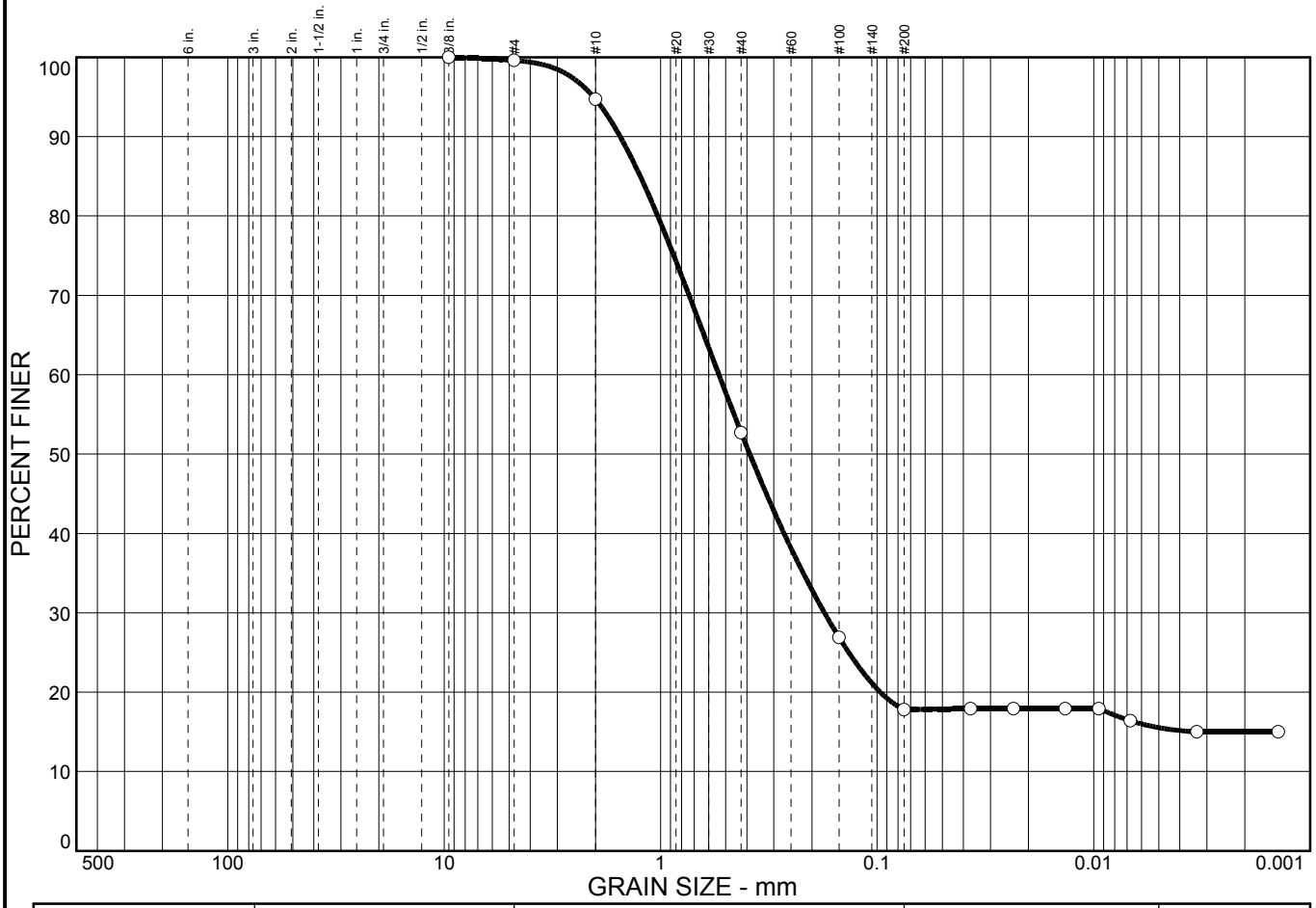
Sample No.: 454B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.4	81.8	2.3	15.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.6		
#10	94.7		
#40	52.7		
#100	26.9		
#200	17.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.24 D_{60}= 0.539 D_{50}= 0.388
D_{30}= 0.175 D_{15}= 0.0033 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

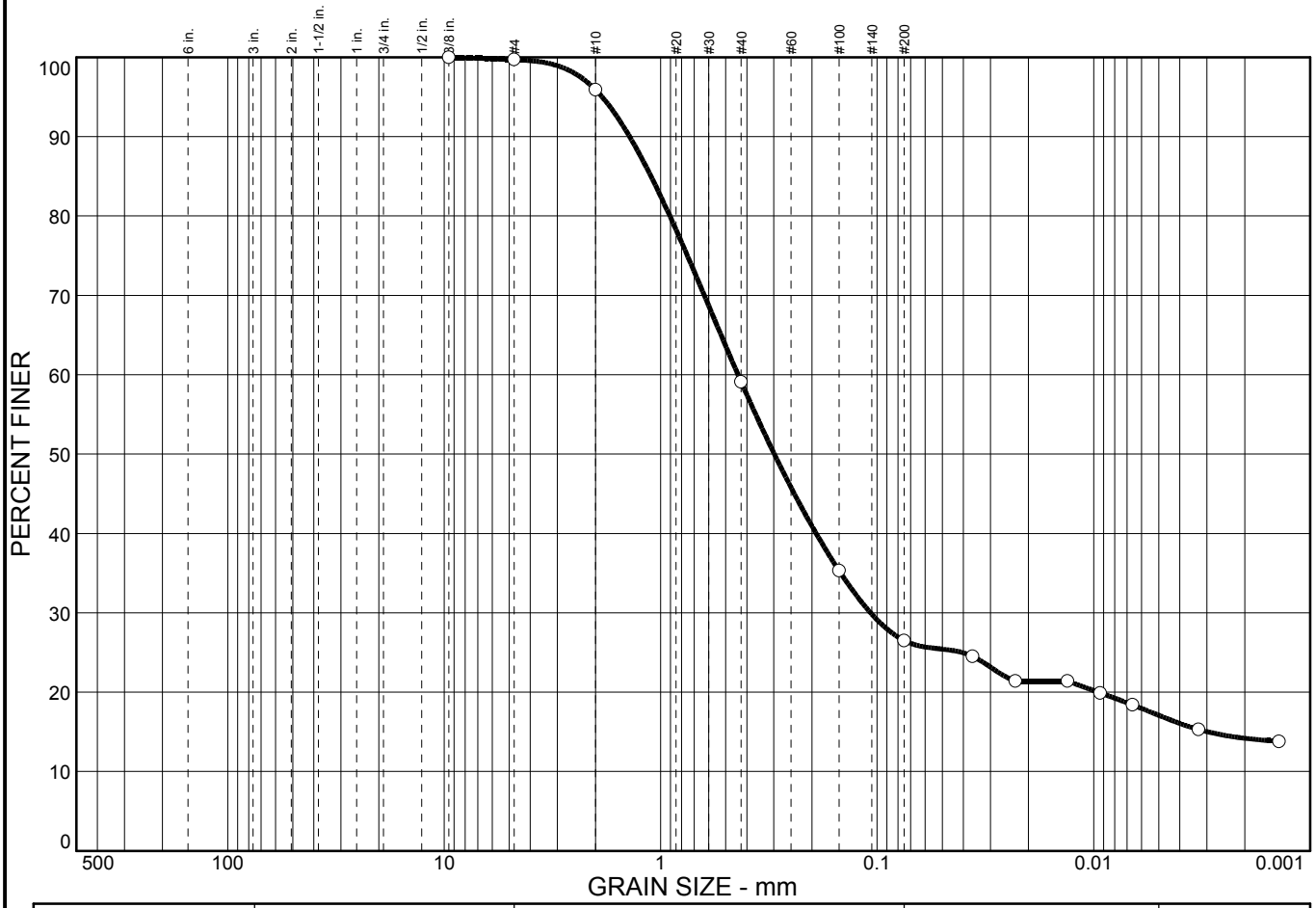
Sample No.: 454B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	73.2	9.4	17.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	95.9		
#40	59.1		
#100	35.3		
#200	26.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.11 D_{60}= 0.439 D_{50}= 0.299
D_{30}= 0.107 D_{15}= 0.0030 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

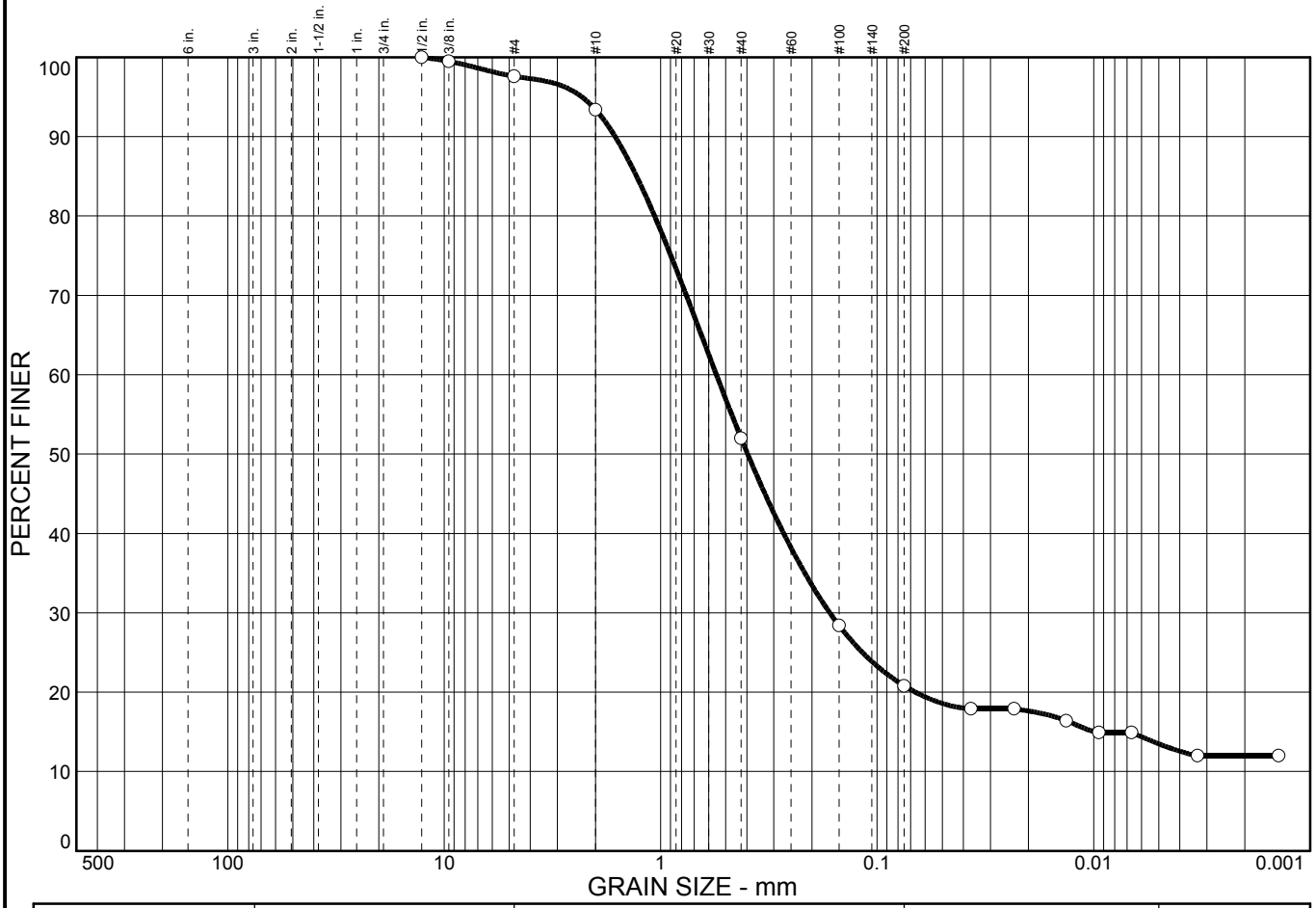
Sample No.: 454B2 **Source of Sample:** Project Site **Date:** 5/25/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.4	76.8	7.3	13.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.5		
#4	97.6		
#10	93.4		
#40	52.0		
#100	28.4		
#200	20.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.29 D_{60}= 0.553 D_{50}= 0.396
D_{30}= 0.166 D_{15}= 0.0098 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

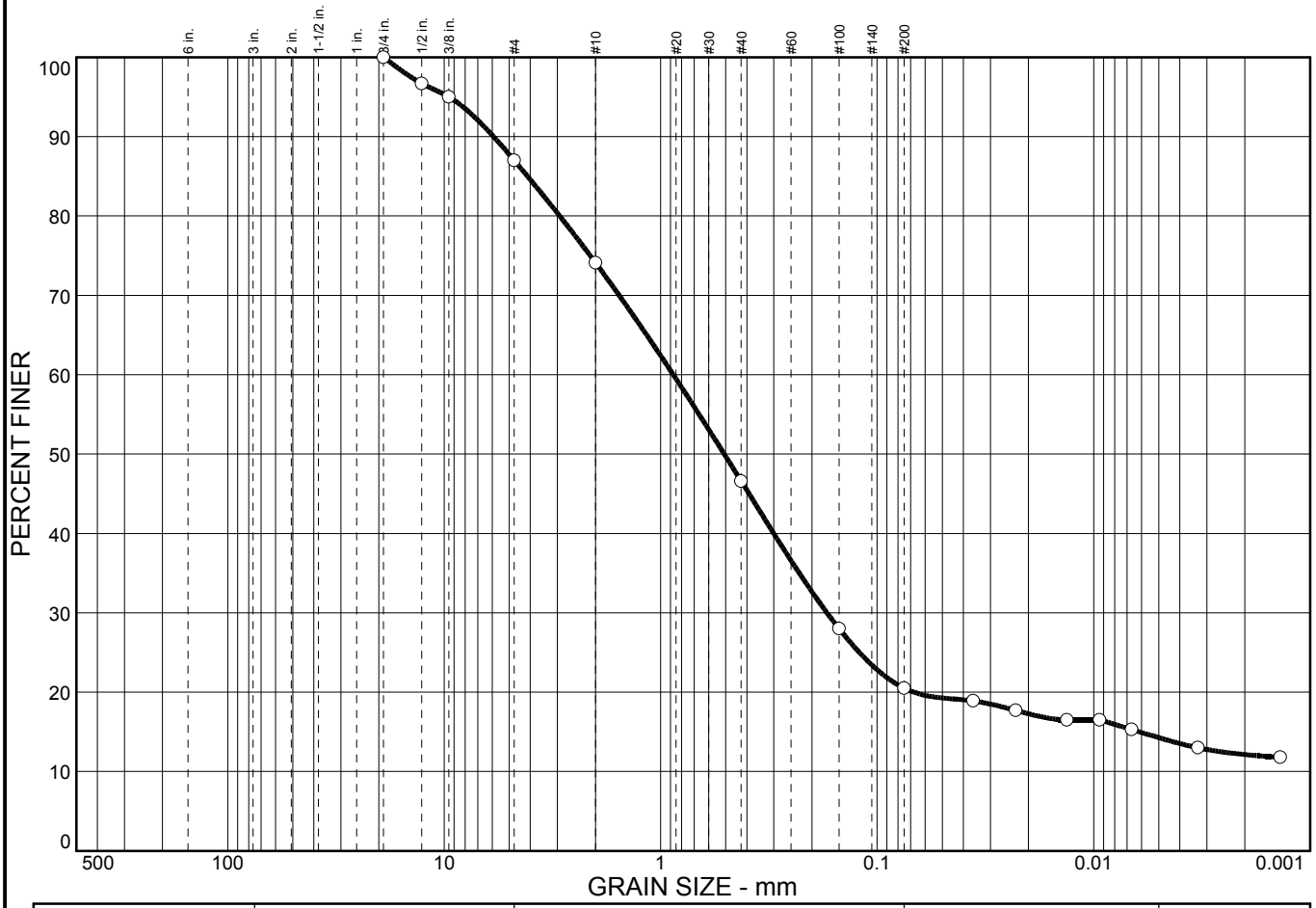
Sample No.: 454B2 **Source of Sample:** Project Site **Date:** 5/22/20
Location: Salinas, PR **Elev./Depth:** 6-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	13.0	66.5	6.2	14.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	96.7		
.375 in.	95.0		
#4	87.0		
#10	74.1		
#40	46.6		
#100	28.0		
#200	20.5		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 4.12 D_{60}= 0.875 D_{50}= 0.509
D_{30}= 0.171 D_{15}= 0.0061 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

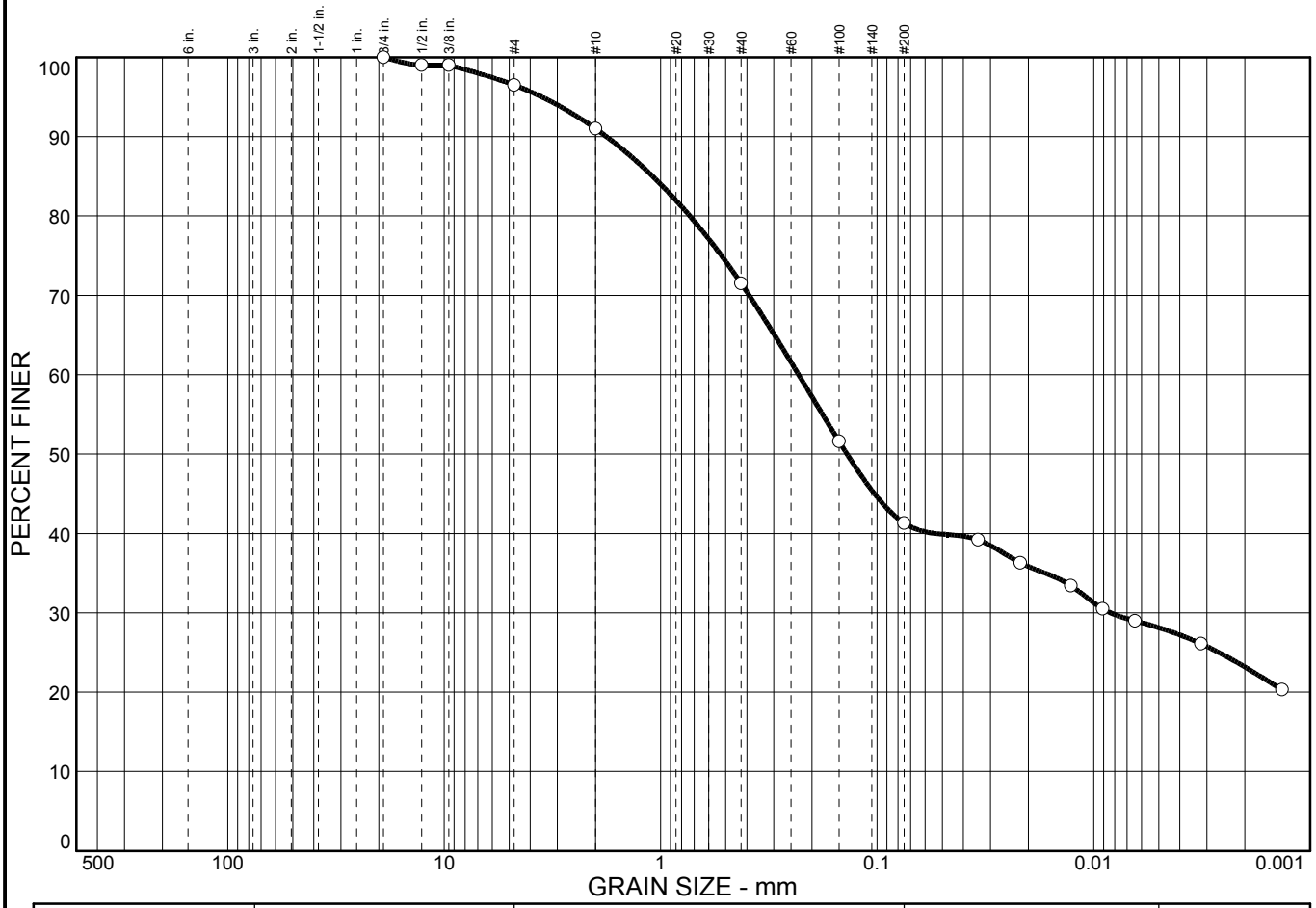
Sample No.: 454B3 **Source of Sample:** Project Site **Date:** 5/26/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	3.5	55.2	13.2	28.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.0		
.375 in.	99.0		
#4	96.5		
#10	91.0		
#40	71.5		
#100	51.6		
#200	41.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 25 LL= 31 PI= 6

Coefficients

D_{85}= 1.09 D_{60}= 0.231 D_{50}= 0.138
D_{30}= 0.0084 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

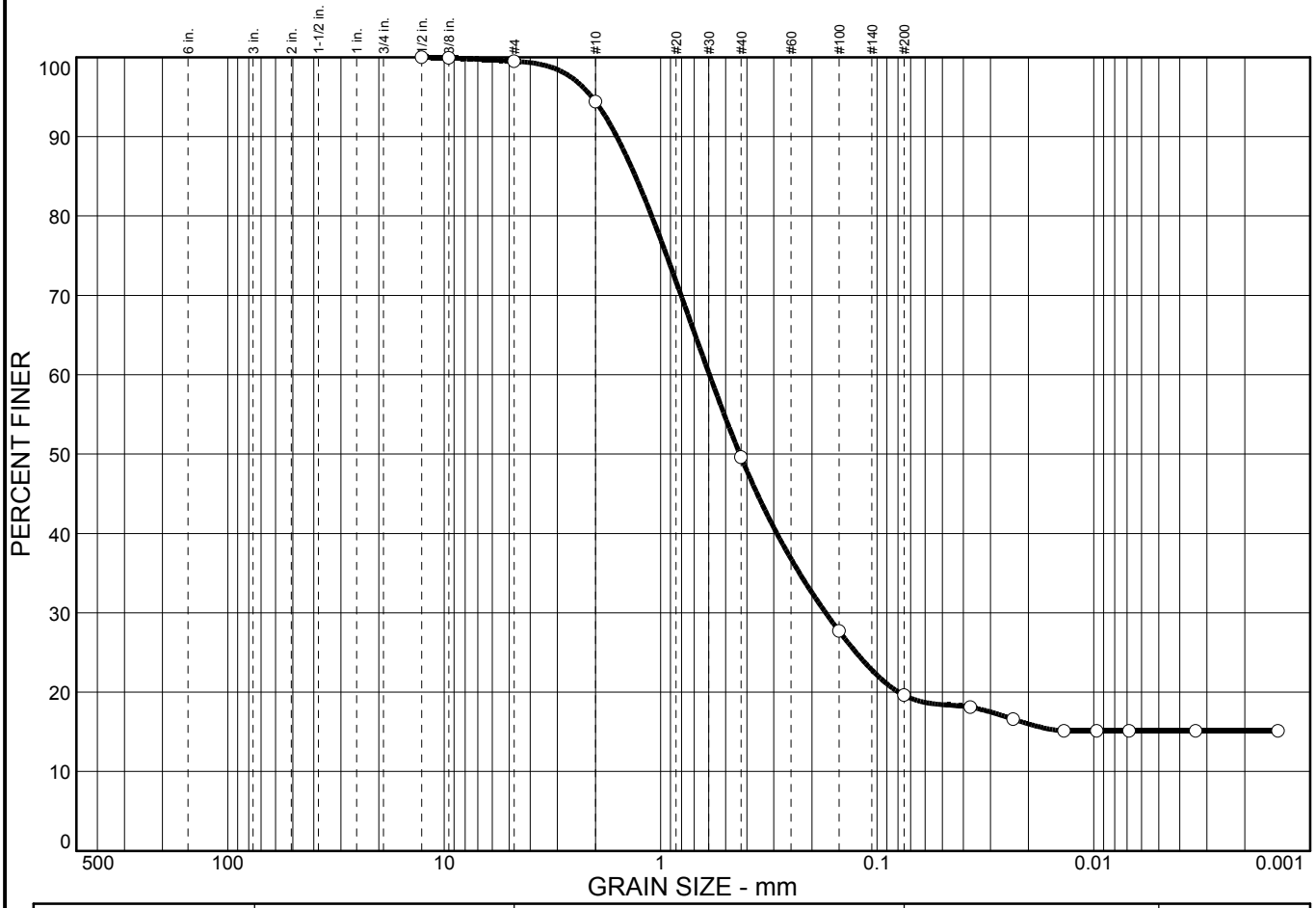
Sample No.: 454B3 **Source of Sample:** Project Site **Date:** 5/27/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.5	79.9	4.5	15.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.9		
#4	99.5		
#10	94.4		
#40	49.6		
#100	27.7		
#200	19.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.31 D_{60}= 0.595 D_{50}= 0.431
D_{30}= 0.173 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

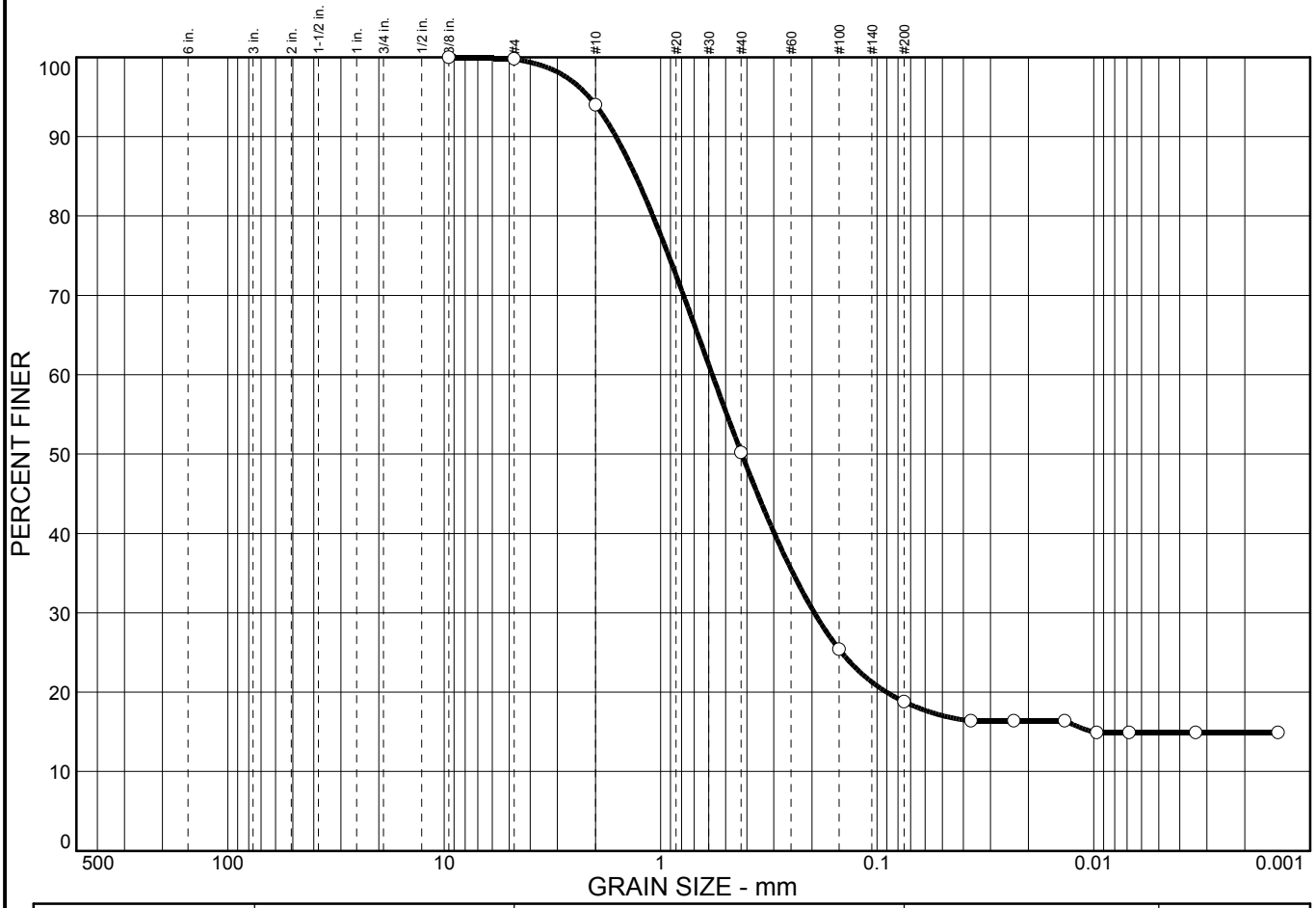
Sample No.: 456B1 **Source of Sample:** Project Site **Date:** 6/3/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.2	81.0	3.9	14.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.8		
#10	94.0		
#40	50.2		
#100	25.4		
#200	18.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.30 D_{60}= 0.577 D_{50}= 0.422
D_{30}= 0.195 D_{15}= 0.0100 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

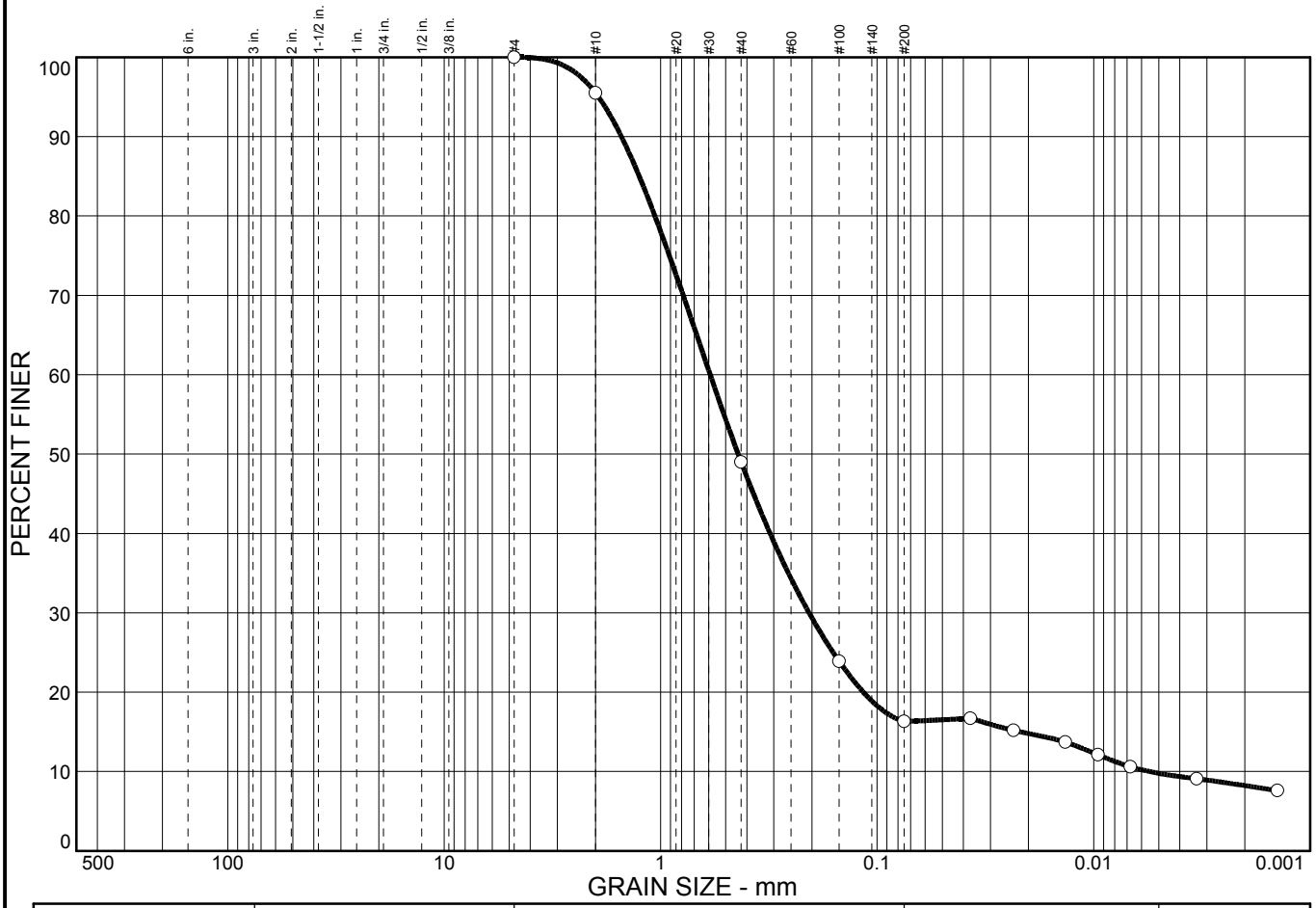
Sample No.: 456B1 **Source of Sample:** Project Site **Date:** 6/3/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	83.7	6.5	9.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	95.5		
#40	49.0		
#100	23.9		
#200	16.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.26 D_{60}= 0.591 D_{50}= 0.439
D_{30}= 0.206 D_{15}= 0.0217 D_{10}= 0.0055
C_u= 106.88 C_c= 13.04

Classification

USCS= SM AASHTO= A-1-b

Remarks

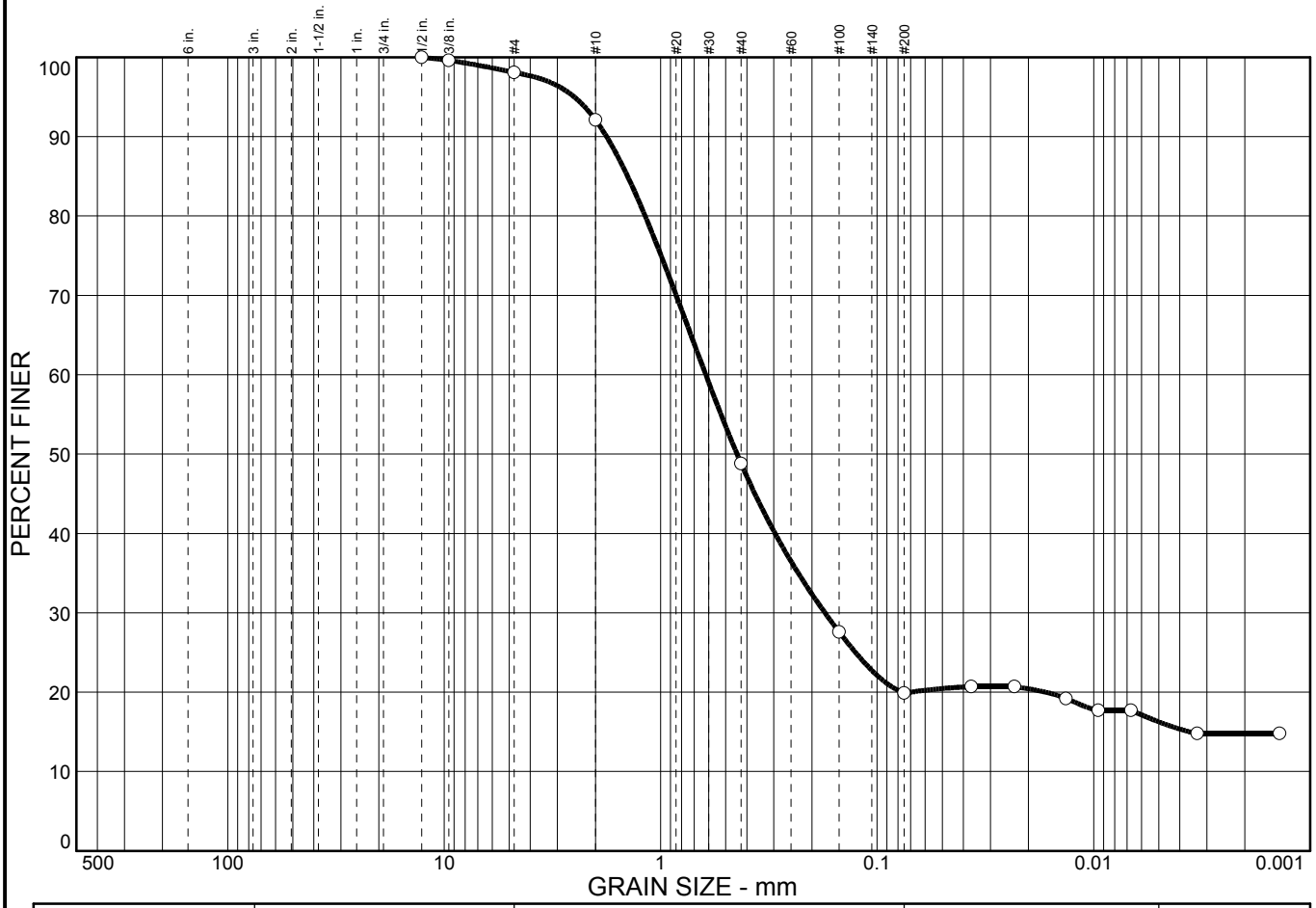
Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

Sample No.: 456B2 **Source of Sample:** Project Site **Date:** 5/25/20
Location: Salinas, PR **Elev./Depth:** 6-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR
Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	78.2	3.6	16.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	98.1		
#10	92.1		
#40	48.8		
#100	27.6		
#200	19.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.42 D_{60}= 0.619 D_{50}= 0.444
D_{30}= 0.174 D_{15}= 0.0036 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

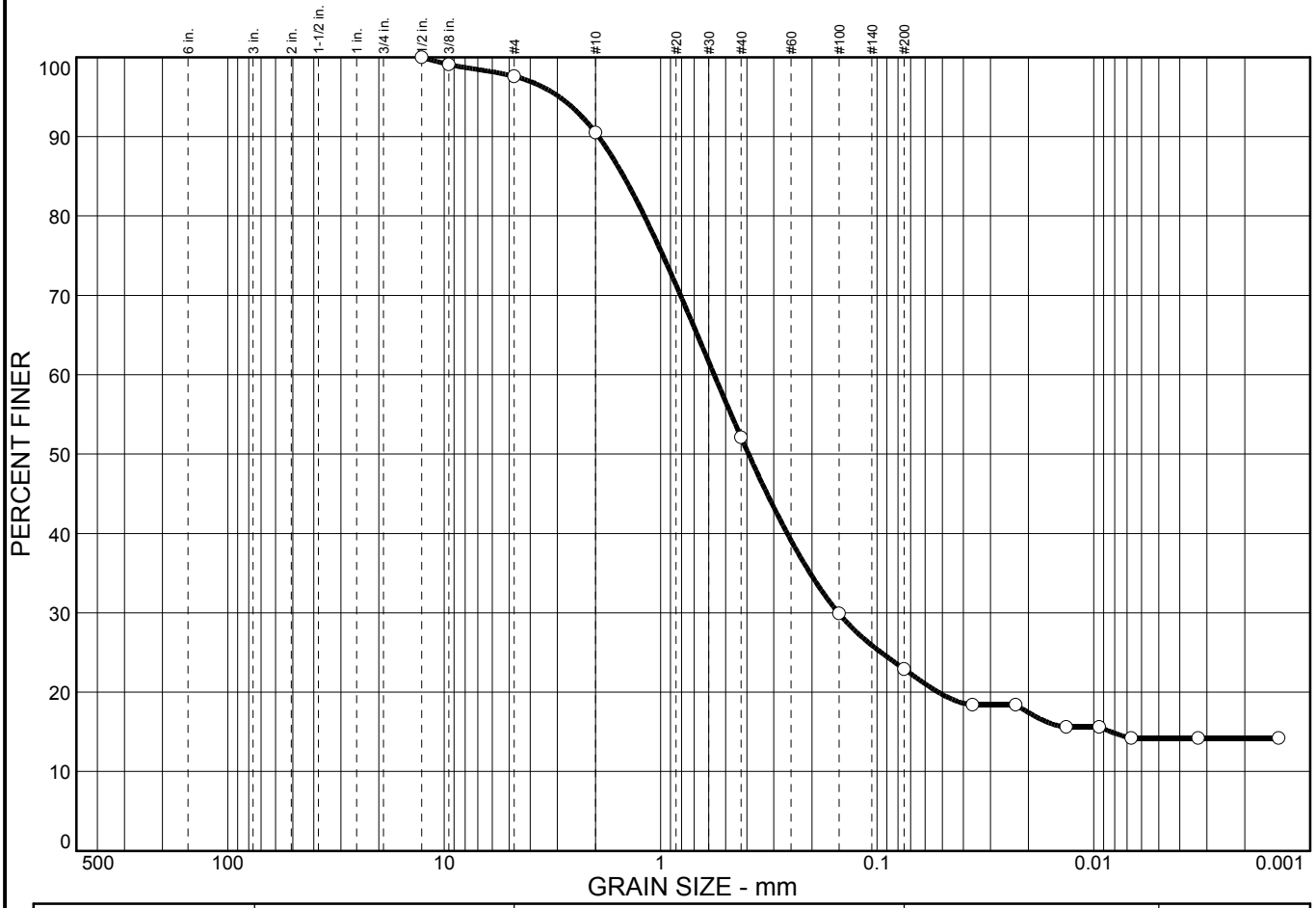
Sample No.: 456B2 **Source of Sample:** Project Site **Date:** 5/26/20
Location: Salinas, PR **Elev./Depth:** 15-19.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.4	74.7	8.7	14.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.1		
#4	97.6		
#10	90.5		
#40	52.1		
#100	29.9		
#200	22.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.48 D_{60}= 0.566 D_{50}= 0.393
D_{30}= 0.151 D_{15}= 0.0083 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

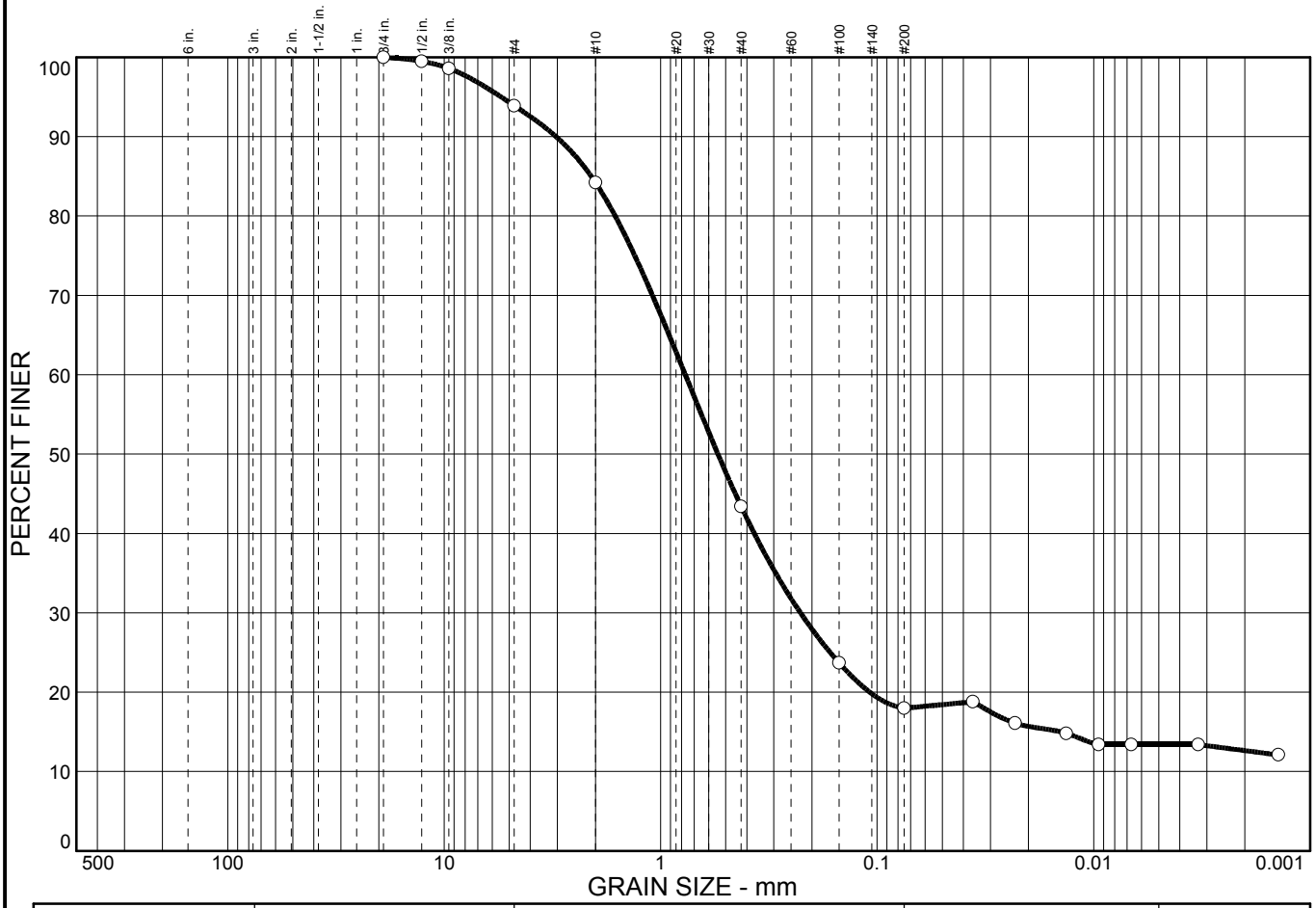
Sample No.: 456B3 **Source of Sample:** Project Site **Date:** 5/11/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	6.1	75.9	4.6	13.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.5		
.375 in.	98.6		
#4	93.9		
#10	84.2		
#40	43.4		
#100	23.7		
#200	18.0		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 2.09 D_{60}= 0.770 D_{50}= 0.544
D_{30}= 0.226 D_{15}= 0.0142 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

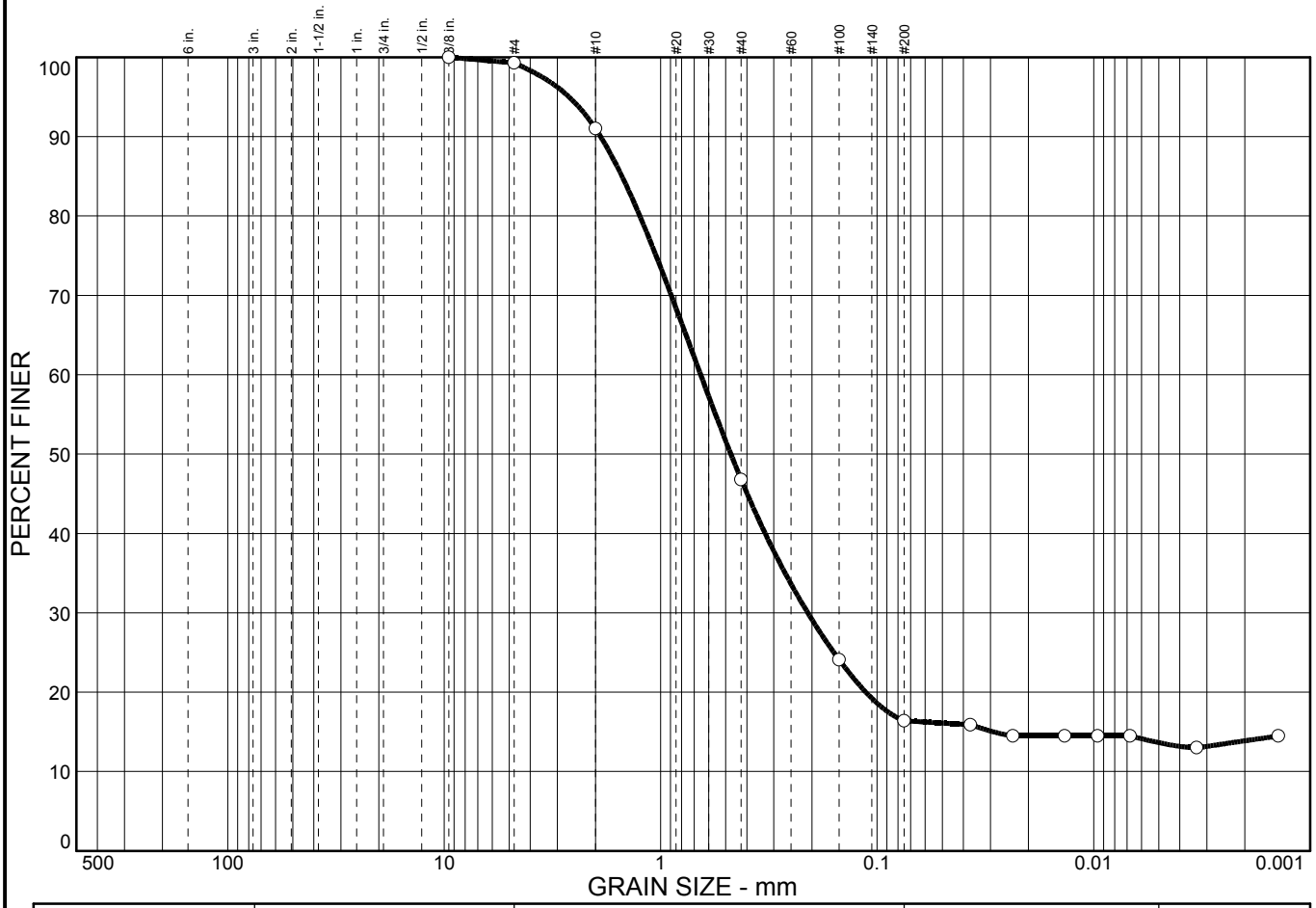
Sample No.: 456B3 **Source of Sample:** Project Site **Date:** 5/11/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	82.9	2.8	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.3		
#10	91.0		
#40	46.8		
#100	24.1		
#200	16.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 25 LL= 31 PI= 6

Coefficients

D_{85}= 1.51 D_{60}= 0.654 D_{50}= 0.474
D_{30}= 0.209 D_{15}= 0.0290 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

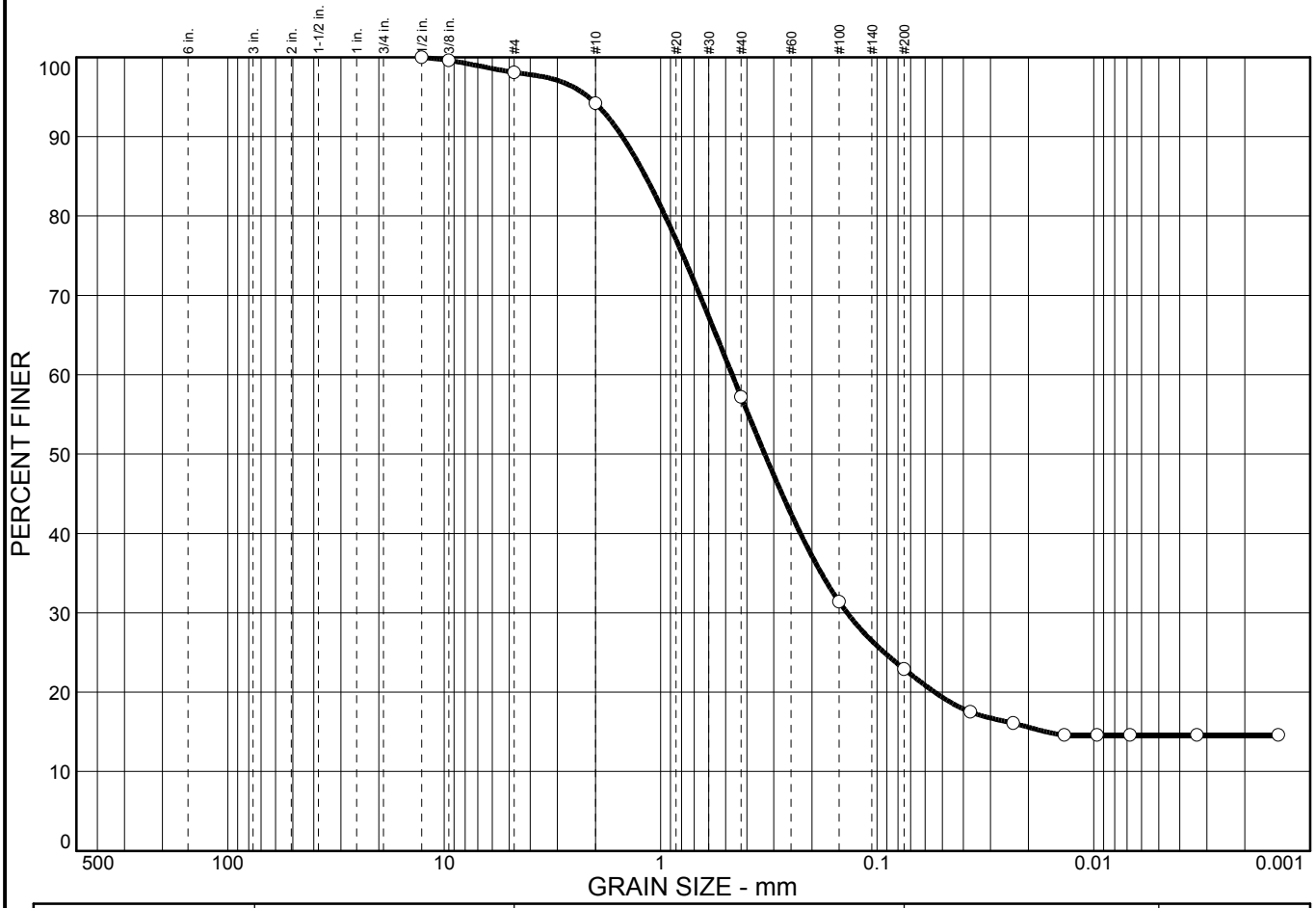
Sample No.: 458B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.9	75.2	8.3	14.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	98.1		
#10	94.2		
#40	57.2		
#100	31.4		
#200	22.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.18 D_{60}= 0.468 D_{50}= 0.331
D_{30}= 0.138 D_{15}= 0.0166 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: M. Alamo
Checked by: Rommel Cintron Aponte, MSCE, PE

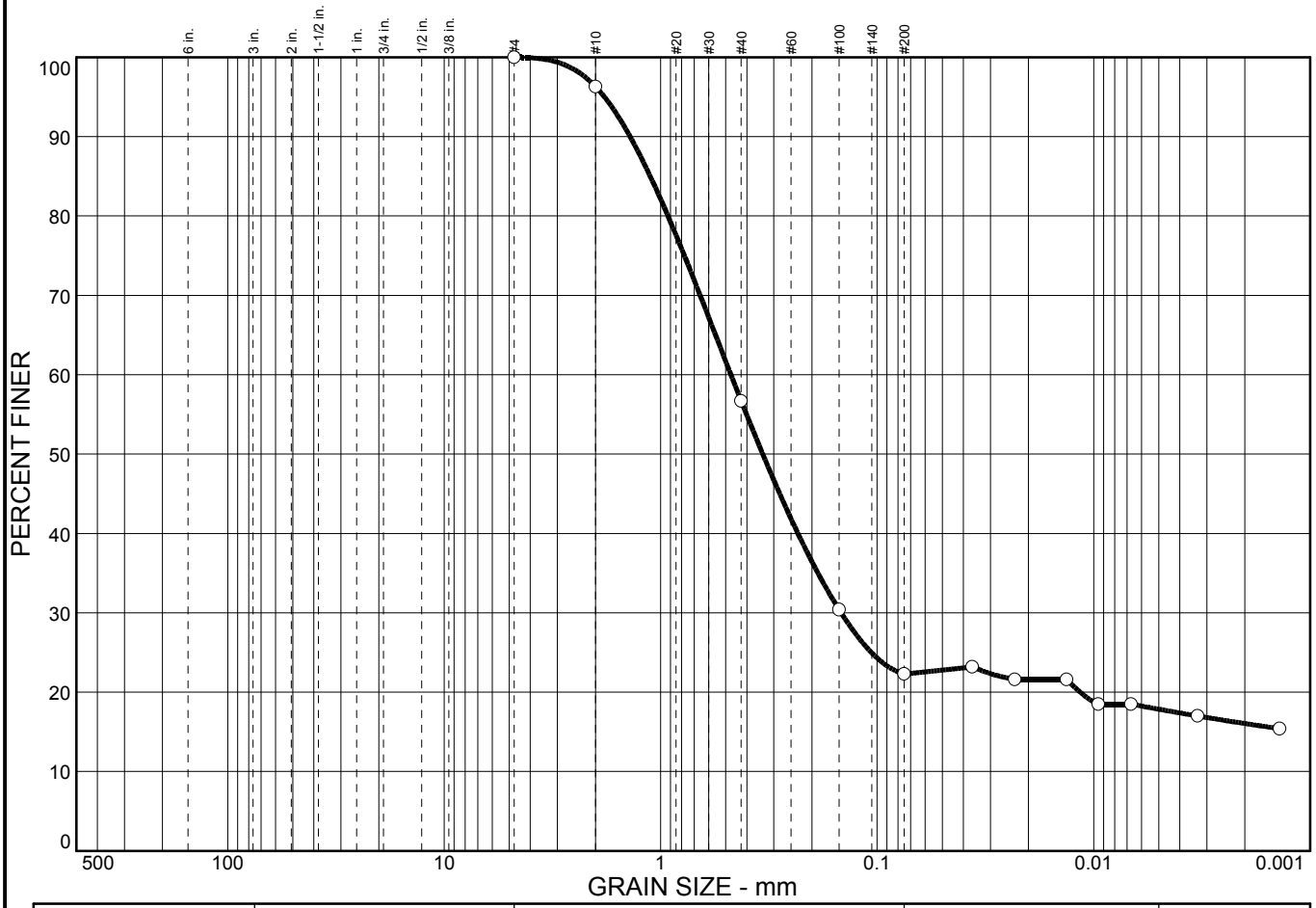
Sample No.: 458B1 **Source of Sample:** Project Site **Date:** 4/27/20
Location: Salinas, PR **Elev./Depth:** 15-19.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	77.7	4.4	17.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.3		
#40	56.7		
#100	30.4		
#200	22.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.12 D_{60}= 0.474 D_{50}= 0.338
D_{30}= 0.147 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

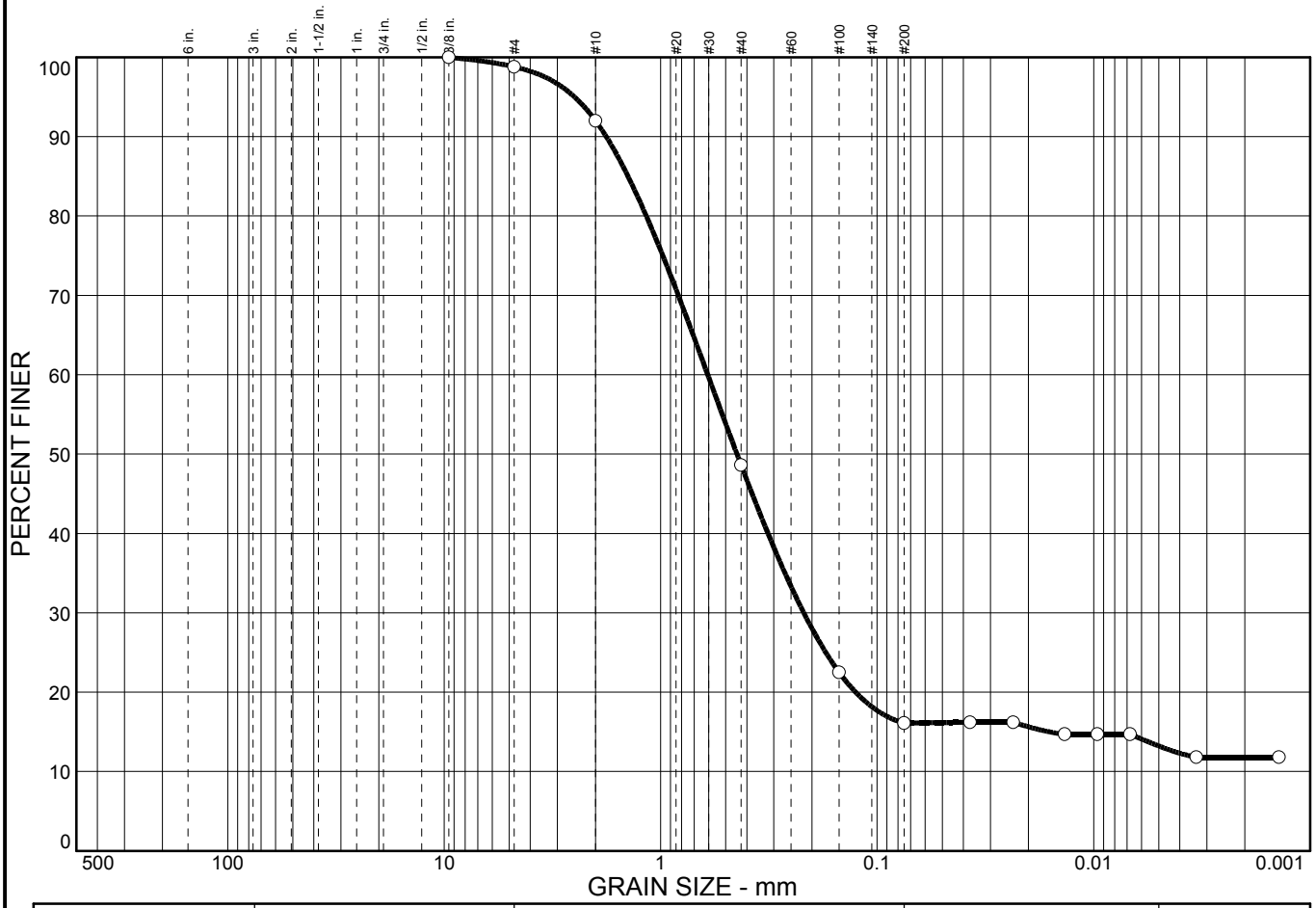
Sample No.: 458B2 **Source of Sample:** Project Site **Date:** 5/26/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.2	82.7	2.9	13.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	98.8		
#10	92.0		
#40	48.6		
#100	22.5		
#200	16.1		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.42 D_{60}= 0.606 D_{50}= 0.444
D_{30}= 0.218 D_{15}= 0.0161 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

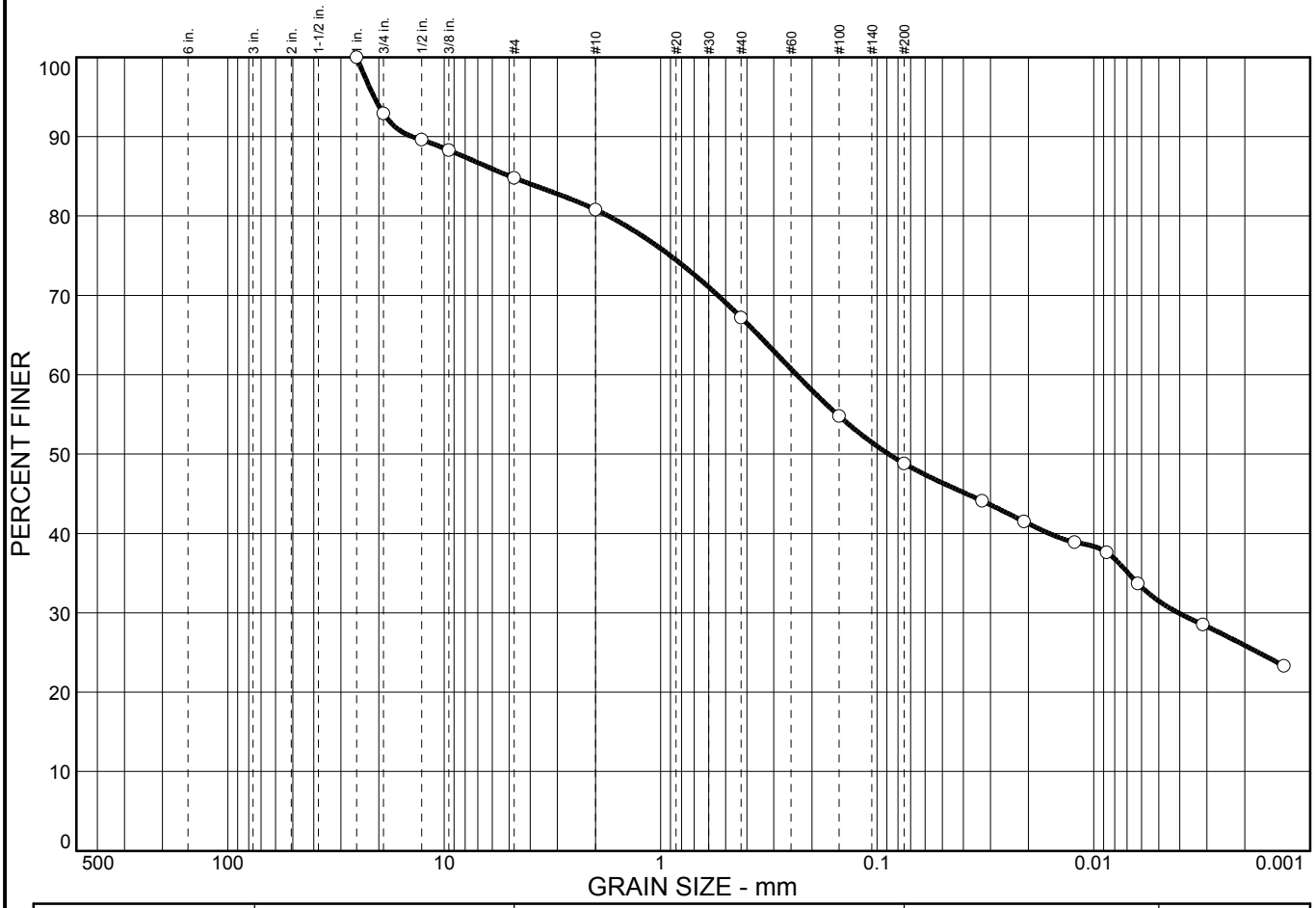
Sample No.: 458B2 **Source of Sample:** Project Site **Date:** 5/26/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	15.2	36.0	17.3	31.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	92.9		
.5 in.	89.6		
.375 in.	88.3		
#4	84.8		
#10	80.8		
#40	67.2		
#100	54.8		
#200	48.8		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 21 LL= 35 PI= 14

Coefficients

D_{85}= 4.96 D_{60}= 0.236 D_{50}= 0.0885
D_{30}= 0.0041 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-6(4)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

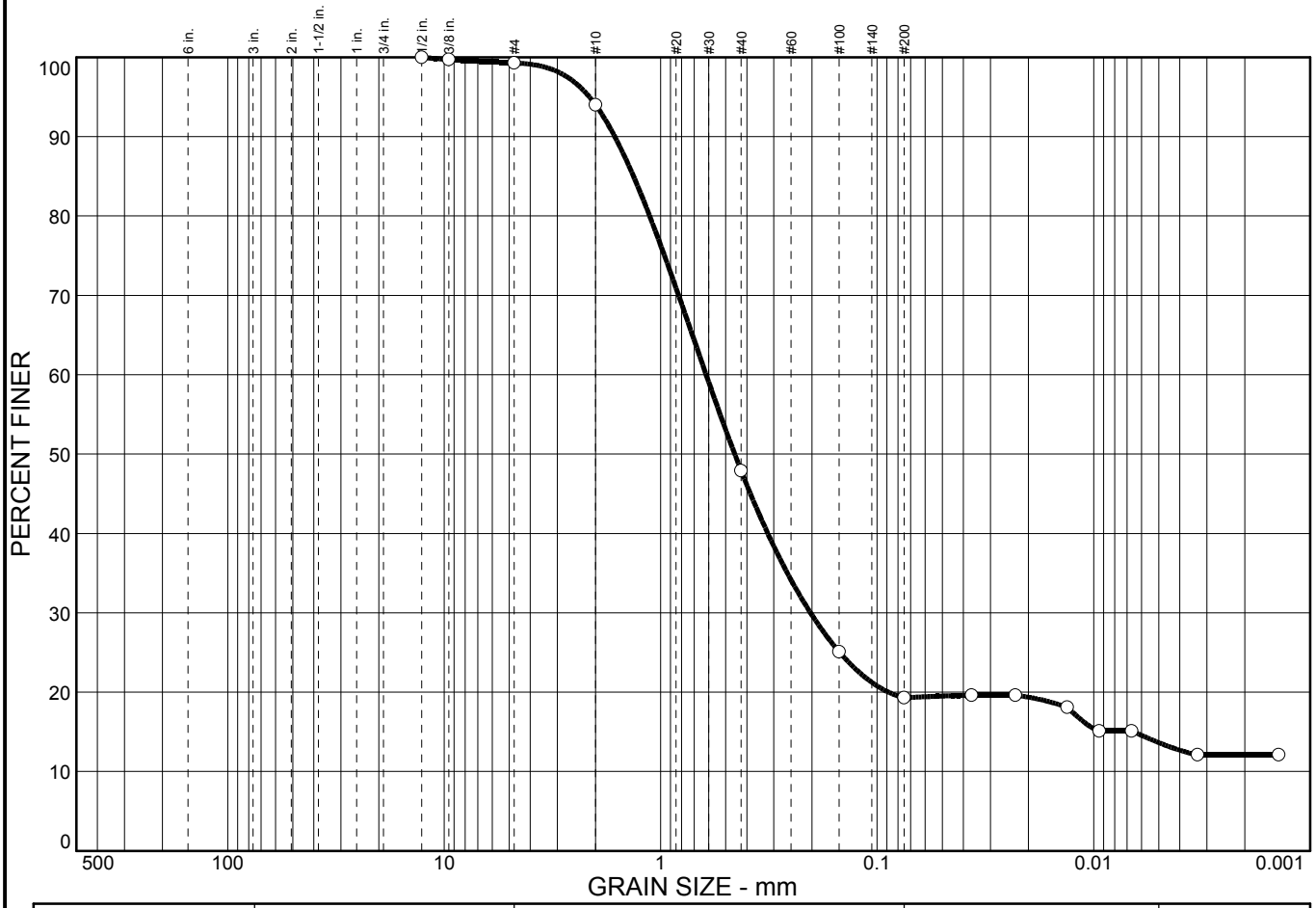
Sample No.: 458B3 **Source of Sample:** Project Site **Date:** 5/27/20
Location: Salinas, PR **Elev./Depth:** 0-3.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.7	80.0	5.7	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.7		
#4	99.3		
#10	94.0		
#40	47.9		
#100	25.1		
#200	19.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.34 D_{60}= 0.617 D_{50}= 0.455
D_{30}= 0.203 D_{15}= 0.0065 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

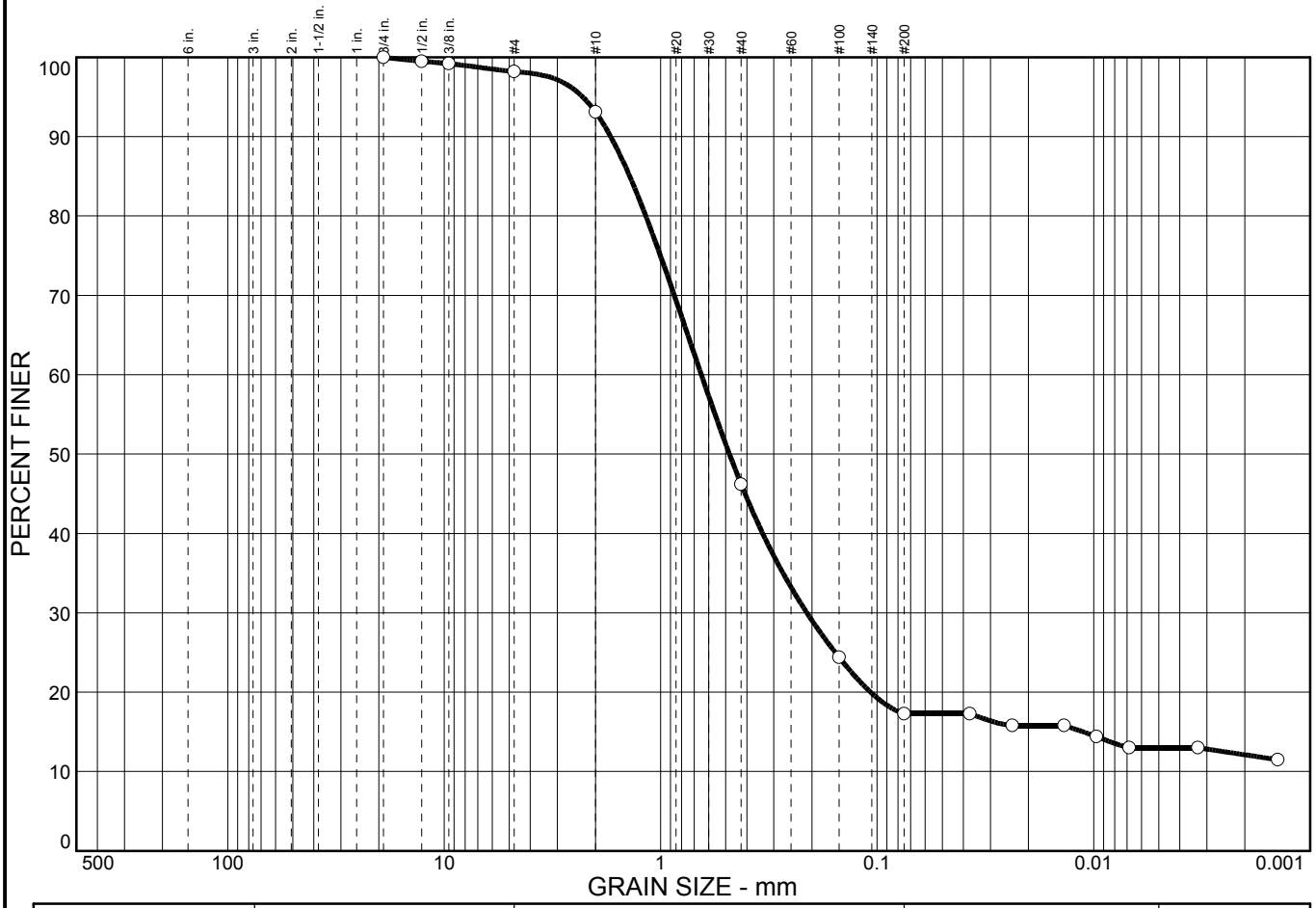
Sample No.: 458B3 **Source of Sample:** Project Site **Date:** 5/25/20
Location: Salinas, PR **Elev./Depth:** 6-10.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.8	80.9	4.3	13.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.5		
.375 in.	99.2		
#4	98.2		
#10	93.1		
#40	46.2		
#100	24.4		
#200	17.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 1.39 D_{60}= 0.649 D_{50}= 0.481
D_{30}= 0.211 D_{15}= 0.0112 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

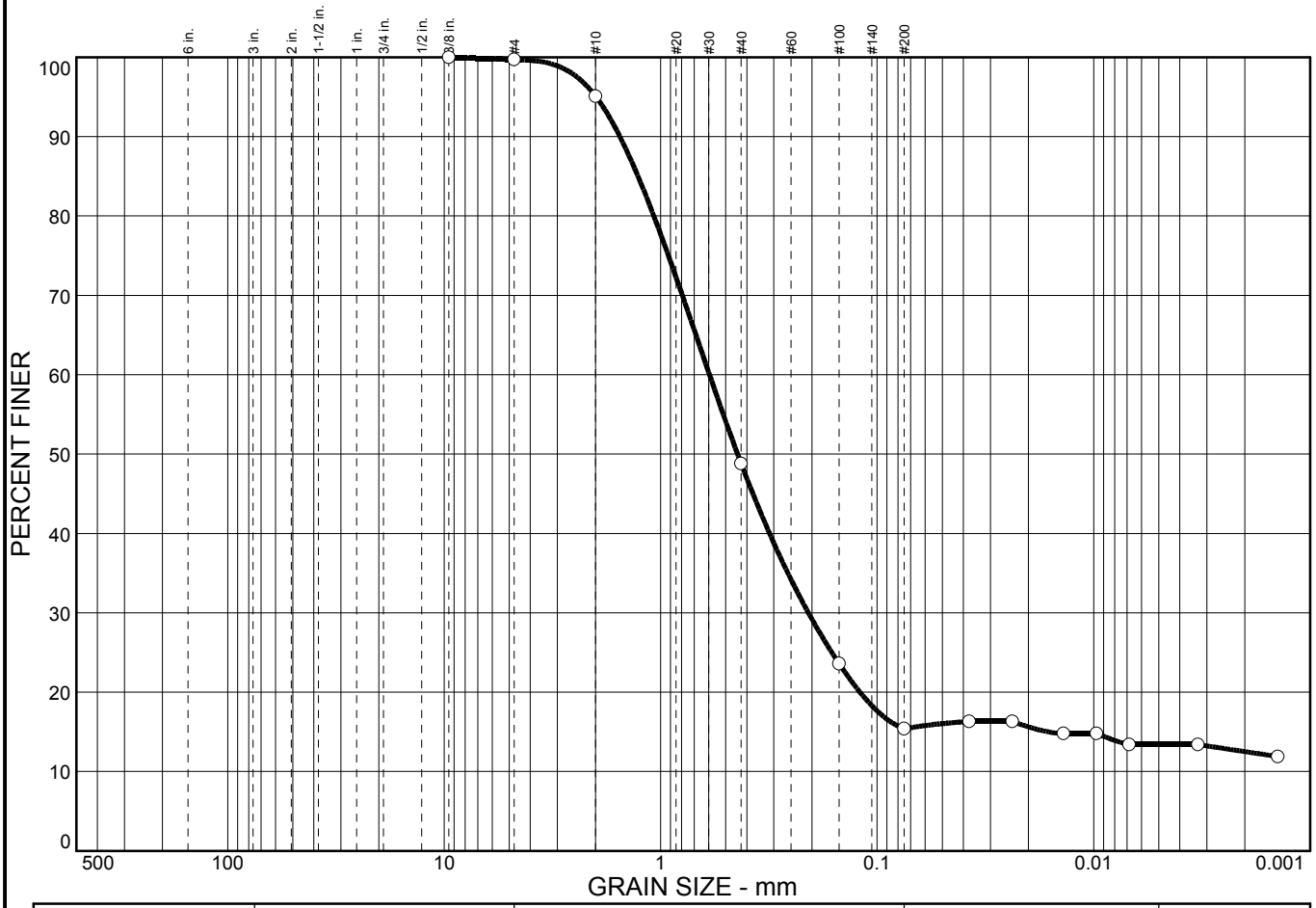
Sample No.: 460B1 **Source of Sample:** Project Site **Date:** 5/15/20
Location: Salina, PR **Elev./Depth:** 4-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.3	84.3	2.0	13.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.375 in.	100.0		
#4	99.7		
#10	95.1		
#40	48.8		
#100	23.6		
#200	15.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= - LL= - PI= -

Coefficients

D_{85}= 1.27 D_{60}= 0.595 D_{50}= 0.441
D_{30}= 0.208 D_{15}= 0.0162 D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

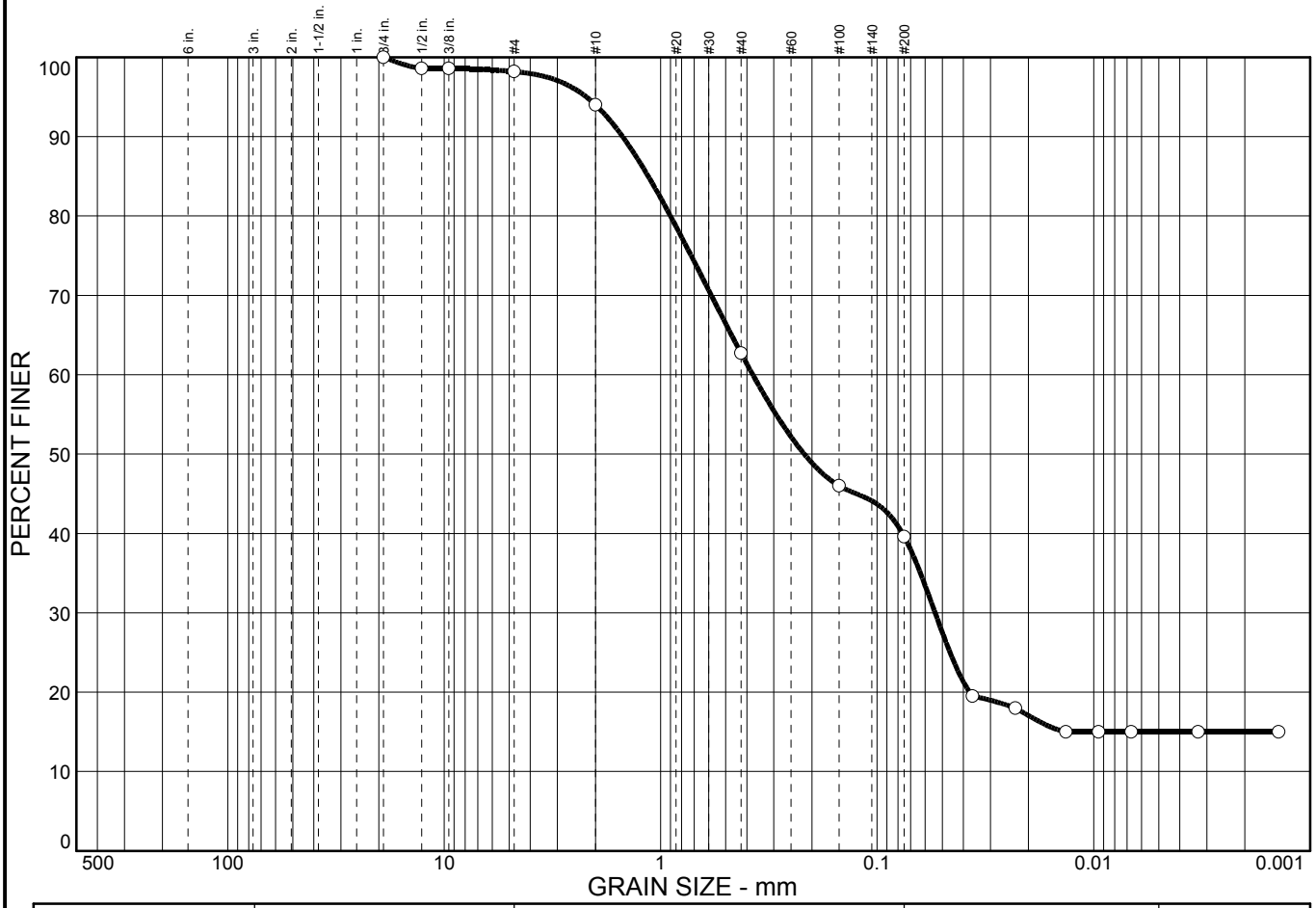
Sample No.: 460B1 **Source of Sample:** Project Site **Date:** 5/15/20
Location: Salinas, PR **Elev./Depth:** 9-13.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.8	58.6	24.6	15.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	98.6		
.375 in.	98.6		
#4	98.2		
#10	94.0		
#40	62.7		
#100	46.0		
#200	39.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.14 D_{60}= 0.376 D_{50}= 0.217
D_{30}= 0.0540 D_{15}= 0.0033 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

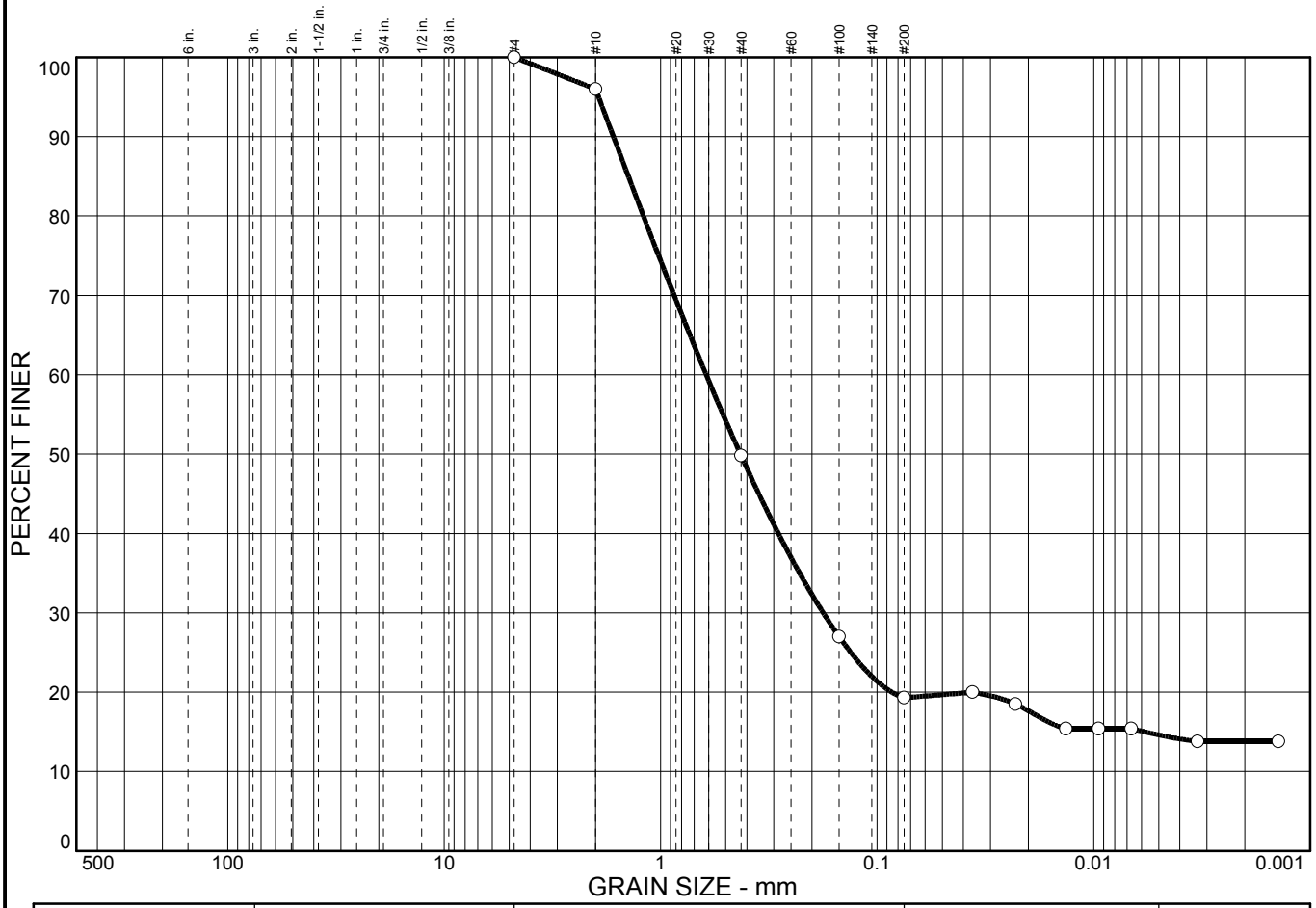
Sample No.: 460B3 **Source of Sample:** Project Site **Date:** 5/12/20
Location: Salinas, PR **Elev./Depth:** 2-5.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	0.0	80.7	4.7	14.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	96.0		
#40	49.8		
#100	27.0		
#200	19.3		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.41 D_{60}= 0.616 D_{50}= 0.428
D_{30}= 0.178 D_{15}= 0.0058 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

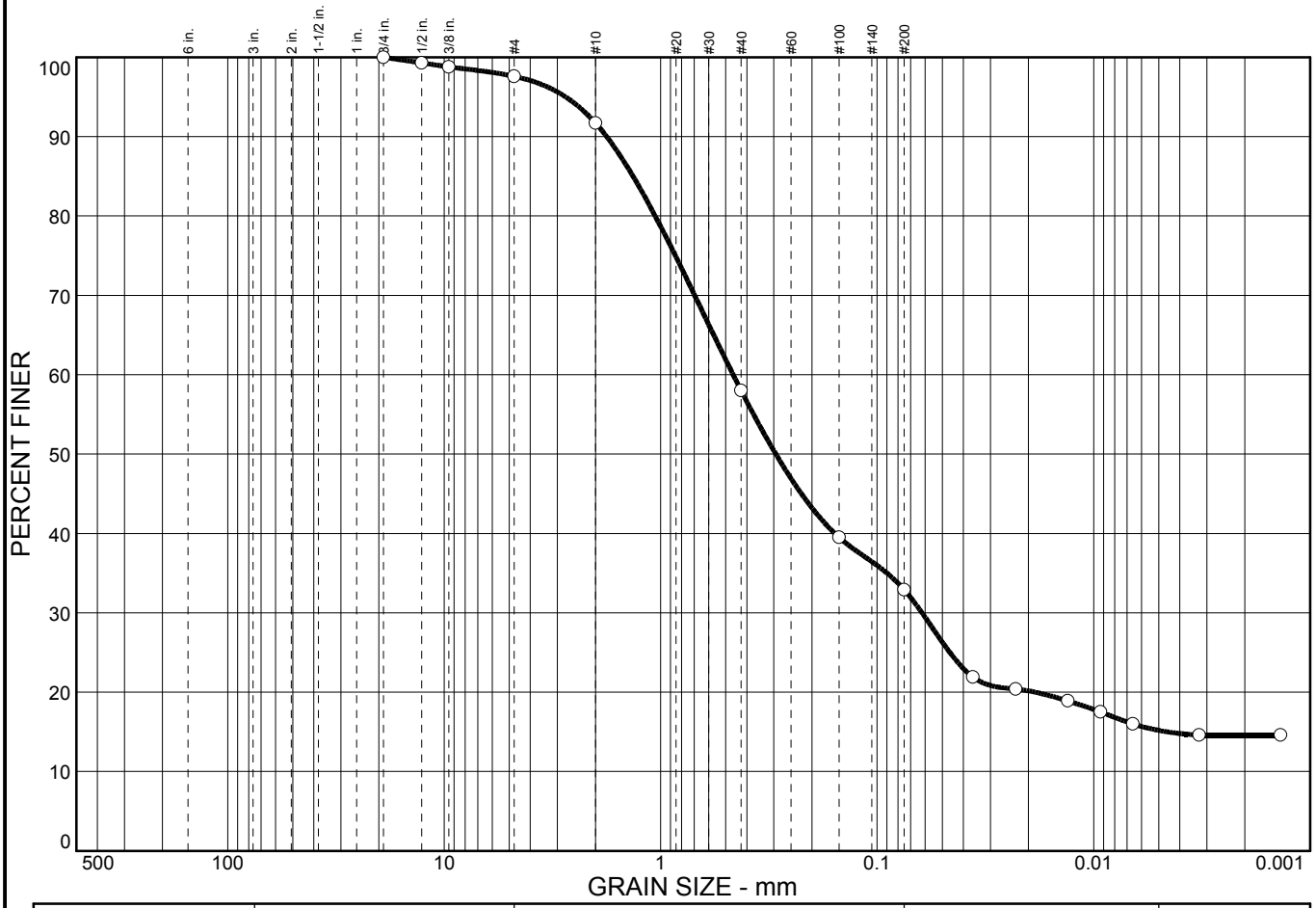
Sample No.: 460B3 **Source of Sample:** Project Site **Date:** 5/12/20
Location: Salinas, PR **Elev./Depth:** 6-7.5'

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	2.4	64.7	17.7	15.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.75 in.	100.0		
.5 in.	99.3		
.375 in.	98.8		
#4	97.6		
#10	91.7		
#40	58.0		
#100	39.5		
#200	32.9		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.34 D_{60}= 0.463 D_{50}= 0.294
D_{30}= 0.0621 D_{15}= 0.0046 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

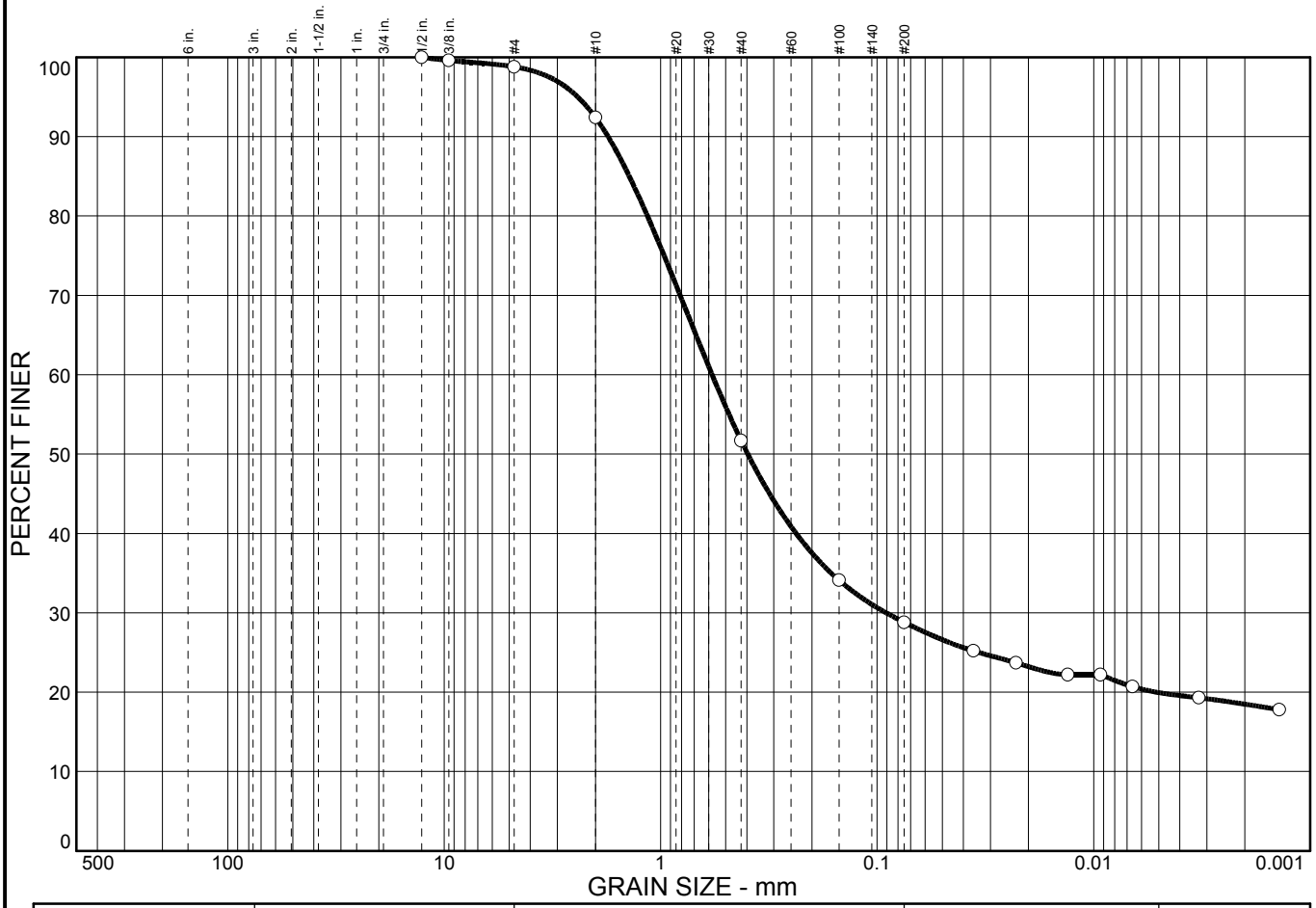
Sample No.: TP-1683 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.2	70.0	8.9	19.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.6		
#4	98.8		
#10	92.4		
#40	51.7		
#100	34.1		
#200	28.8		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.40 D_{60}= 0.579 D_{50}= 0.396
D_{30}= 0.0910 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

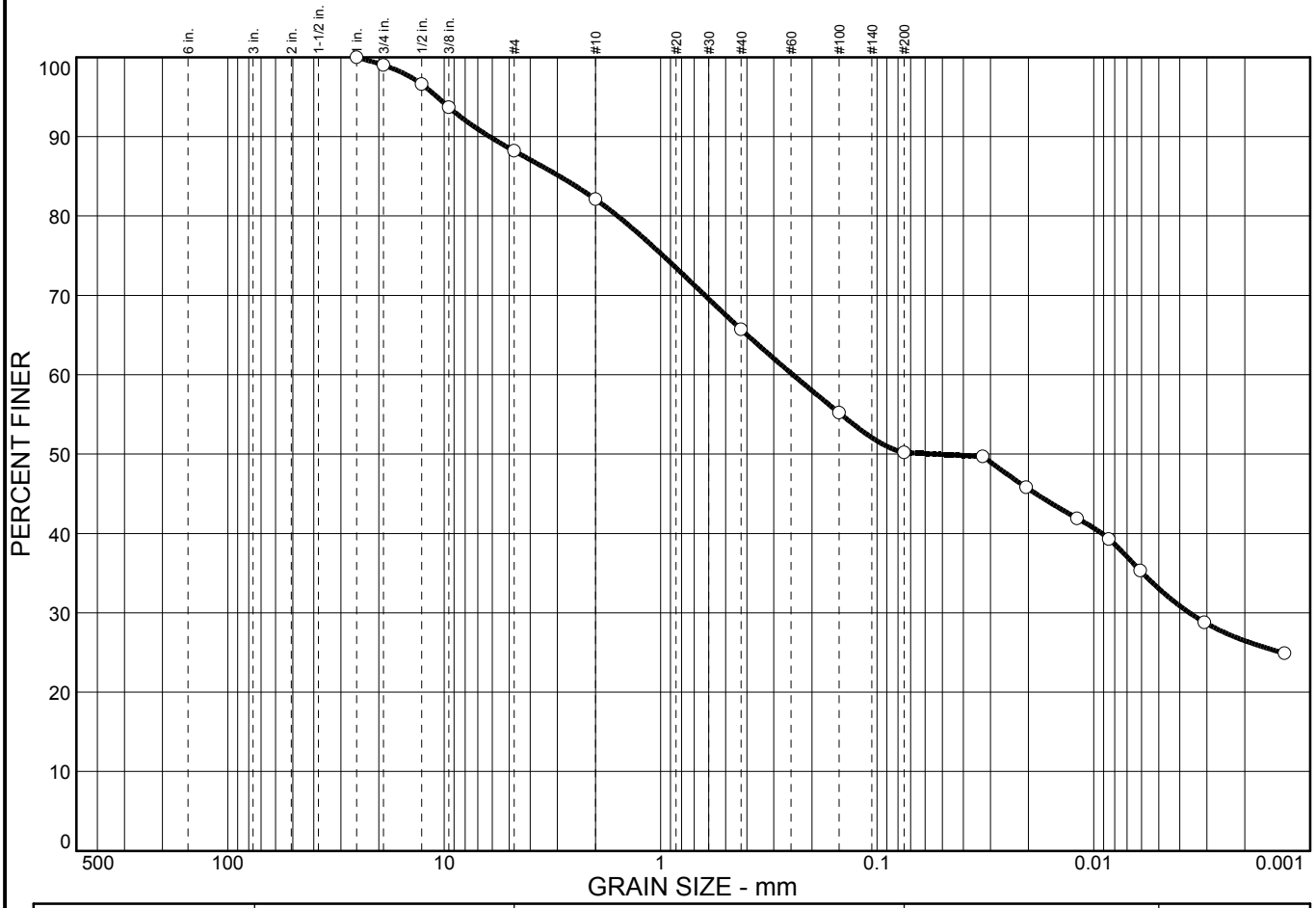
Sample No.: TP-1684 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	11.8	38.0	17.2	33.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1 in.	100.0		
.75 in.	99.0		
.5 in.	96.6		
.375 in.	93.7		
#4	88.2		
#10	82.1		
#40	65.7		
#100	55.2		
#200	50.2		

* (no specification provided)

Material Description

Sandy lean clay

Atterberg Limits

PL= 19 LL= 32 PI= 13

Coefficients

D_{85}= 2.93 D_{60}= 0.245 D_{50}= 0.0537
D_{30}= 0.0036 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(3)

Remarks

Tested by: T. Melendez
Checked by: Rommel Cintron Aponte, MSCE, PE

Sample No.: TP-1685 **Source of Sample:** Project Site **Date:** 6/5/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report

% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	32.6	49.1	3.3	15.0

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100.0		
1.5 in.	96.1		
1 in.	85.2		
.75 in.	84.1		
.5 in.	78.7		
.375 in.	75.4		
#4	67.4		
#10	56.9		
#40	32.7		
#100	21.2		
#200	18.3		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 19 LL= 28 PI= 9

Coefficients

D_{85}= 25.0 D_{60}= 2.53 D_{50}= 1.26
D_{30}= 0.349 D_{15}= 0.0049 D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

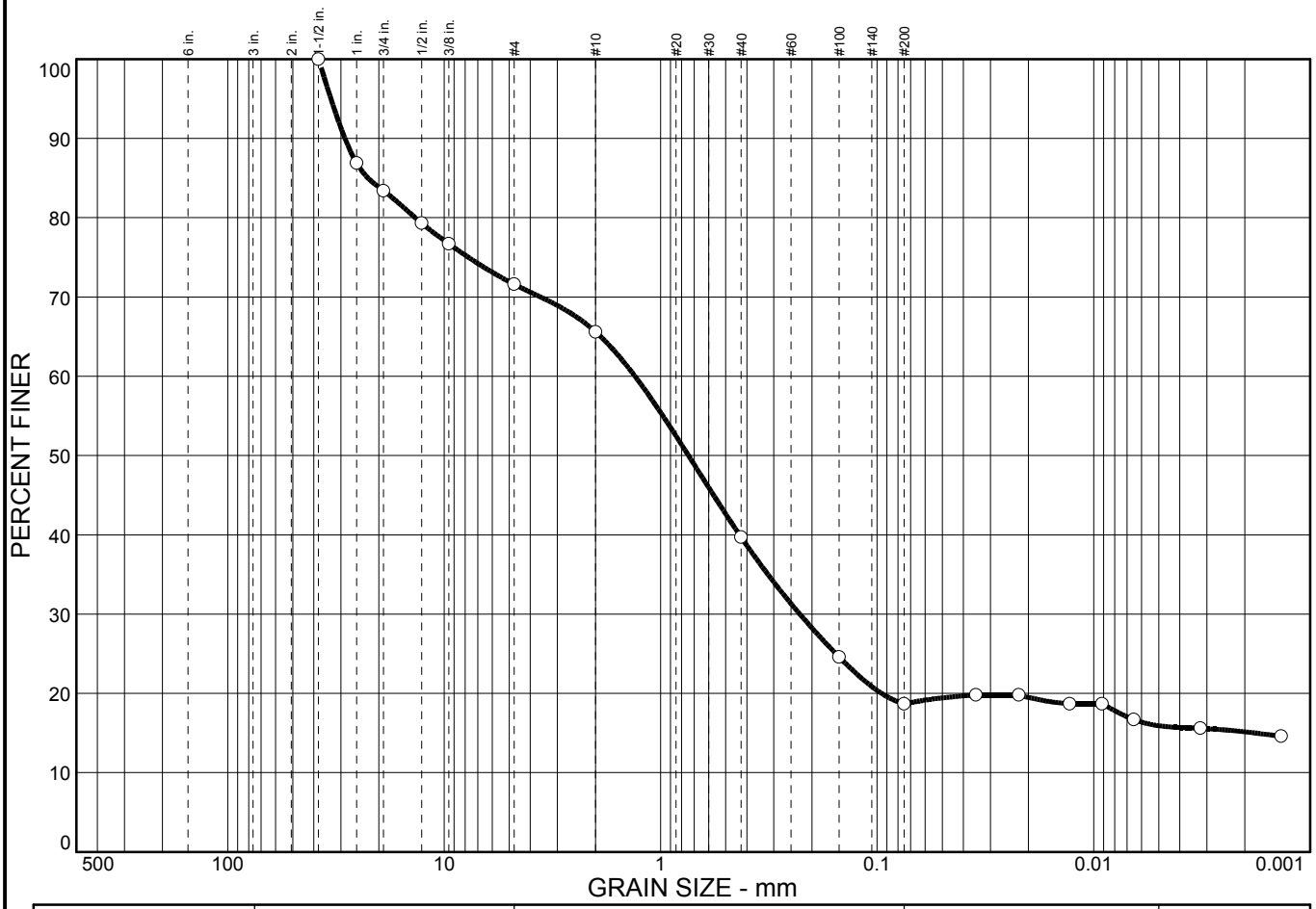
Sample No.: TP-1686 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	28.4	52.9	2.8	15.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	86.9		
.75 in.	83.4		
.5 in.	79.3		
.375 in.	76.7		
#4	71.6		
#10	65.6		
#40	39.7		
#100	24.6		
#200	18.7		

* (no specification provided)

Material Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 22.5 D_{60}= 1.31 D_{50}= 0.744
D_{30}= 0.228 D_{15}= 0.0018 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-1-b

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

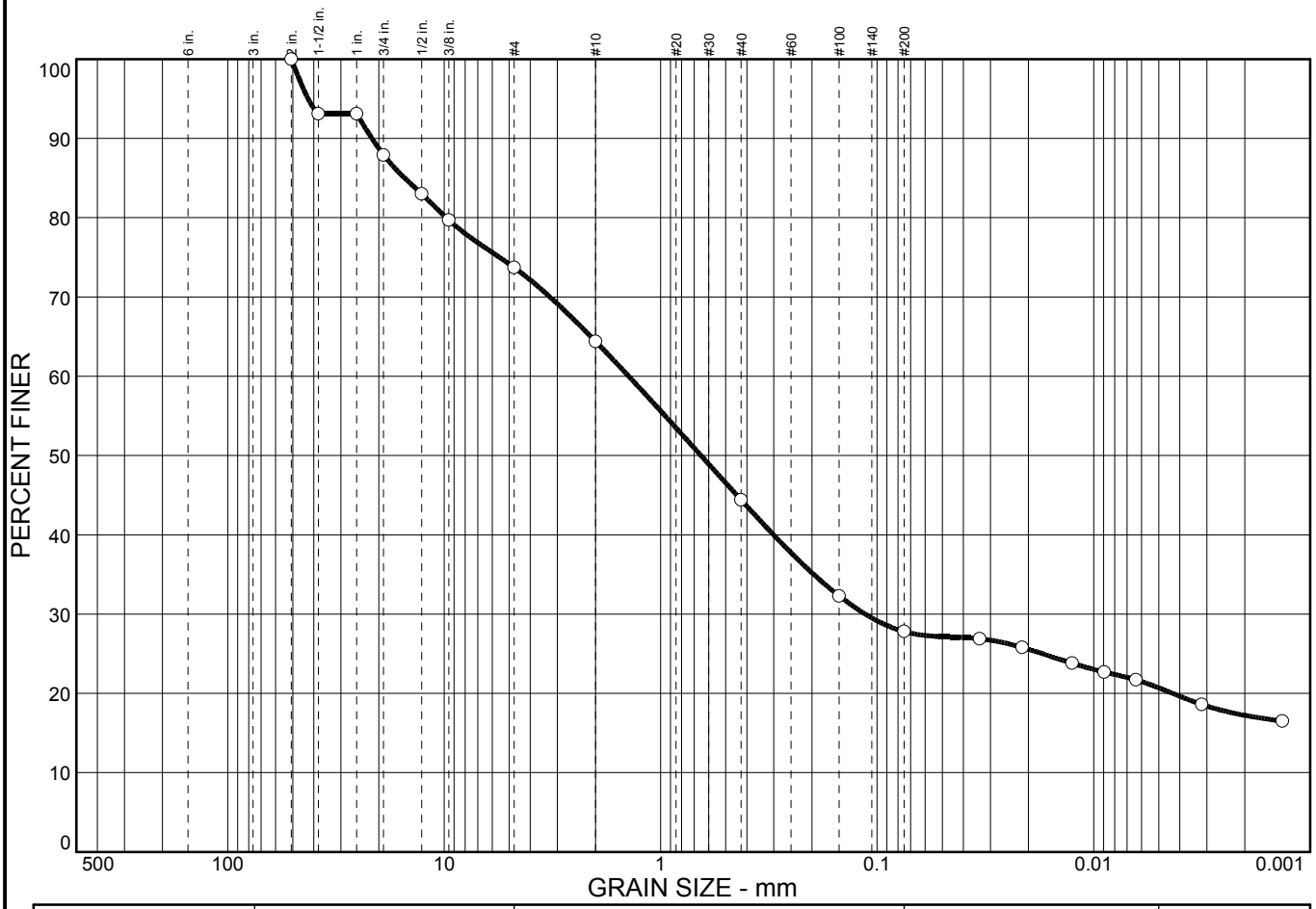
Sample No.: TP-1687 **Source of Sample:** Project Site **Date:** 6/5/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	26.3	45.9	7.1	20.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100.0		
1.5 in.	93.1		
1 in.	93.1		
.75 in.	87.9		
.5 in.	83.0		
.375 in.	79.7		
#4	73.7		
#10	64.4		
#40	44.4		
#100	32.3		
#200	27.8		

* (no specification provided)

Material Description

Clayey sand with gravel

Atterberg Limits

PL= 19 LL= 30 PI= 11

Coefficients

D_{85}= 15.2 D_{60}= 1.40 D_{50}= 0.652
D_{30}= 0.114 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-2-6(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

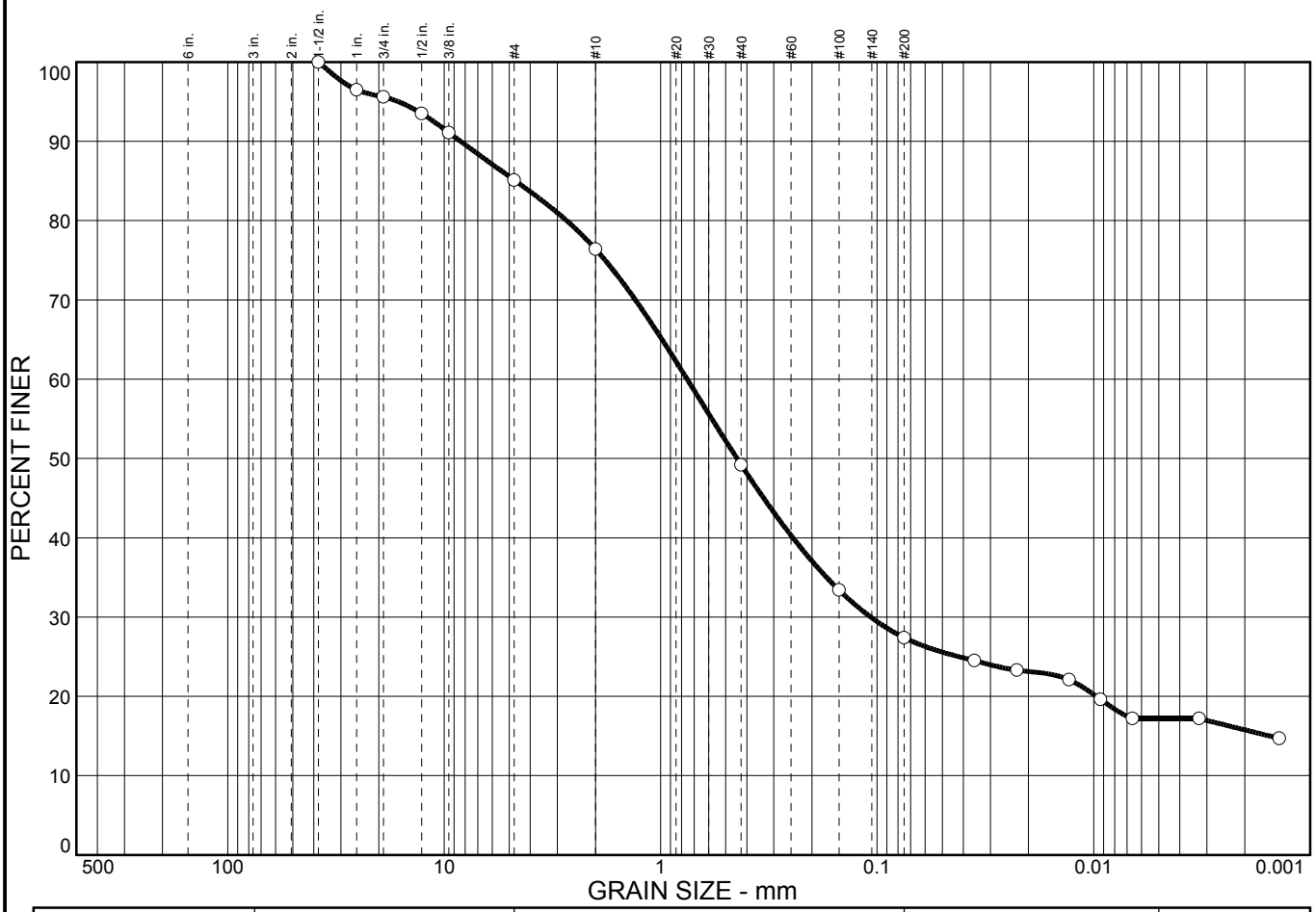
Sample No.: TP-9049 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	14.9	57.7	10.2	17.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	96.5		
.75 in.	95.6		
.5 in.	93.5		
.375 in.	91.1		
#4	85.1		
#10	76.4		
#40	49.2		
#100	33.4		
#200	27.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 4.69 D_{60}= 0.755 D_{50}= 0.444
D_{30}= 0.107 D_{15}= 0.0015 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel cintron Aponte, MSCE, PE

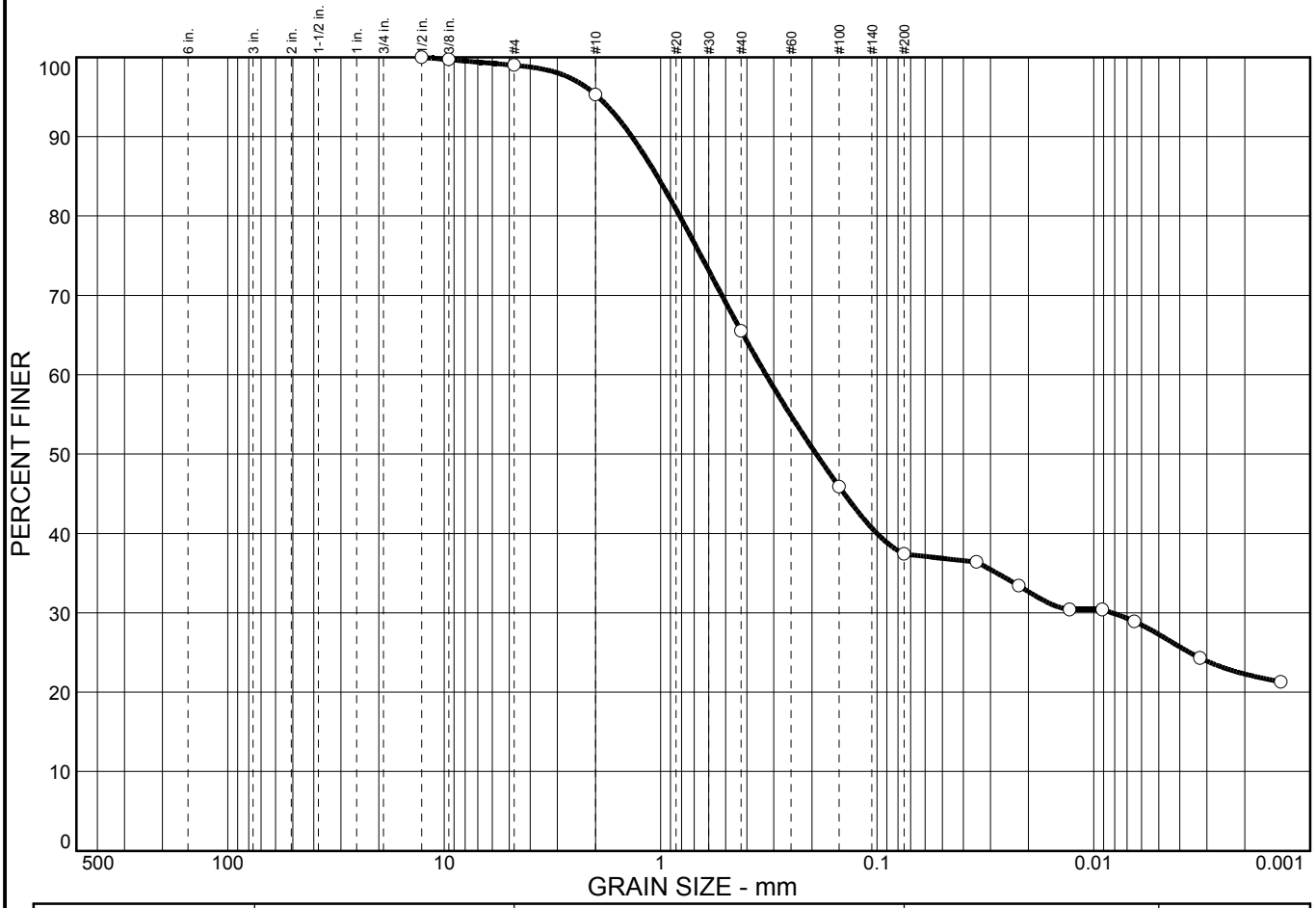
Sample No.: TP-9050 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	1.0	61.6	10.1	27.3

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
.5 in.	100.0		
.375 in.	99.7		
#4	99.0		
#10	95.3		
#40	65.5		
#100	45.9		
#200	37.4		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 1.04 D_{60}= 0.326 D_{50}= 0.191
D_{30}= 0.0082 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

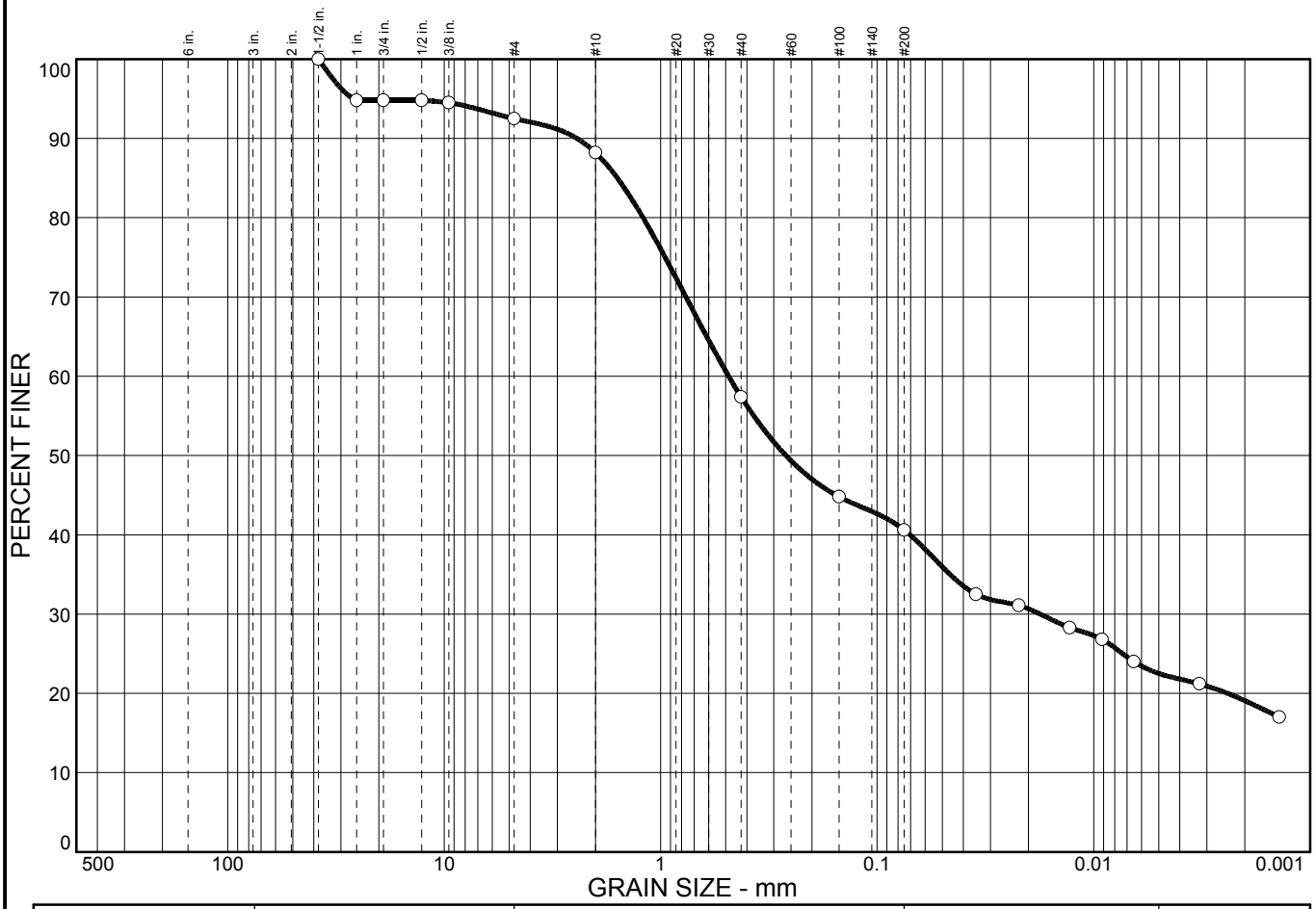
Sample No.: TP-9051 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	7.5	51.9	18.1	22.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	94.8		
.75 in.	94.8		
.5 in.	94.8		
.375 in.	94.5		
#4	92.5		
#10	88.2		
#40	57.4		
#100	44.8		
#200	40.6		

* (no specification provided)

Material Description

Silty sand

Atterberg Limits

PL= 32 LL= 38 PI= 6

Coefficients

D_{85}= 1.59 D_{60}= 0.485 D_{50}= 0.264
D_{30}= 0.0176 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO= A-4(0)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

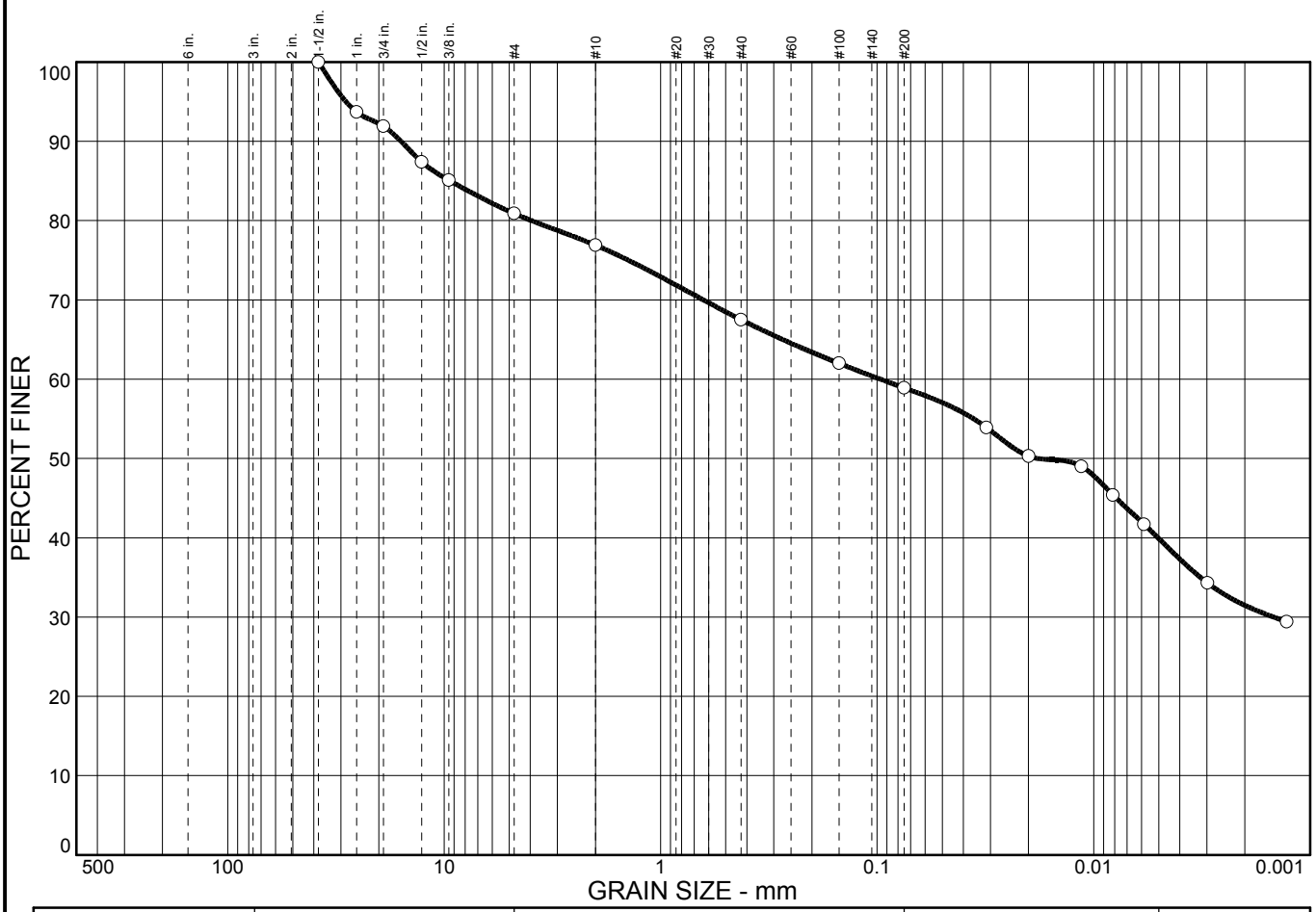
Sample No.: TP-9052 **Source of Sample:** Project Site **Date:** 6/8/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

Particle Size Distribution Report



% +75 MM	% GRAVEL	% SAND	% SILT	% CLAY
0.0	19.1	22.0	19.0	39.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
1.5 in.	100.0		
1 in.	93.7		
.75 in.	91.9		
.5 in.	87.4		
.375 in.	85.1		
#4	80.9		
#10	76.9		
#40	67.5		
#100	62.0		
#200	58.9		

* (no specification provided)

Material Description

Sandy silt with gravel

Atterberg Limits

PL= 28 LL= 44 PI= 16

Coefficients

D_{85}= 9.38 D_{60}= 0.0966 D_{50}= 0.0180
D_{30}= 0.0015 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= ML AASHTO= A-7-6(8)

Remarks

Tested by: J. Cruz
Checked by: Rommel Cintron Aponte, MSCE, PE

Sample No.: TP-9053 **Source of Sample:** Project Site **Date:** 6/5/20
Location: Salinas, PR **Elev./Depth:**

JACA & SIERRA TESTING LABORATORIES
San Juan, Puerto Rico

Client: Michael Baker International
Project: Joint Training Center, Camp Santiago-Salinas, PR

Project No: 8081 **Figure**

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Laboratory Test Results

Moisture Content (ASTM D2216)

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Samples: 103
Date: May 22, 2020
Technician: J. Cruz
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
314B1	S3	4-5.5	12	11
	S4	6-7.5	10	
314B1	S6	12-13.5	14	15
	S7	15-16.5	15	
320B1	S3	4-5.5	11	9
	S4	6-7.5	7	
322B1	S2	2-3.5	8	8
	S3	4-5.5	8	
322B1	S6	12-13.5	12	10
	S7	15-16.5	8	
326B1	S1	0-1.5	13	11
	S2	2-3.5	8	
326B1	S4	6-7.5	16	-
328B1	S2	2-3.5	5	6
	S3	4-5.5	6	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
328B1	S7	15-16.5	7	8
	S8	18-19.5	8	
444B1	S2	2-3.5	6	7
	S3	4-5.5	7	
444B1	S4	6-7.5	11	12
	S5	9-10.5	12	
446B1	S1	0-1.5	10	10
	S2	2-3.5	9	
446B1	S5	9-10.5	8	11
	S6	12-13.5	13	
448B1	S2	2-3.5	6	6
	S3	4-5.5	6	
448B1	S5	9-10.5	18	-
450B1	S3	4-5.5	12	13
	S4	6-7.5	14	
452B3	S5	9-10.5	18	18
	S6	12-13.5	17	
452B3	S7	15-16.5	14	13
	S8	18-19.5	12	
454B1	S1	0-1.5	7	9
	S2	2-3.5	10	
454B1	S3	4-5.5	5	6
	S4	6-7.5	6	
458B1	S3	4-5.5	9	9
	S4	6-7.5	8	
458B1	S7	15-16.5	7	9
	S8	18-19.5	10	
460B1	S3	4-5.5	9	9
	S4	6-7.5	8	
460B1	S5	9-10.5	7	8
	S6	12-13.5	9	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
460B3	S2	2-3.5	12	11
	S3	4-5.5	9	
460B3	S4	6-7.5	8	-
456B3	S3	4-5.5	10	10
	S4	6-7.5	9	
456B3	S5	9-10.5	10	9
	S6	12-13.5	7	
300B1	S4	6-7.5	9	10
	S5	9-10.5	10	
300B1	S6	12-13.5	14	15
	S7	15-16.5	16	
302B1	S2	2-3.5	9	8
	S3	4-5.5	6	
302B1	S5	9-10.5	11	12
	S6	12-13.5	13	
318B1	S2	2-3.5	12	14
	S3	4-5.5	15	
318B1	S5	9-10.5	4	5
	S6	12-13.5	5	
318B3	S3	4-5.5	6	8
	S4	6-7.5	10	
318B3	S6	12-13.5	5	7
	S7	15-16.5	8	
316B1	S3	4-5.5	7	5
	S4	6-7.5	3	
316B1	S5	9-10.5	5	7
	S6	12-13.5	8	
310B1	S1	0-1.5	8	8
	S2	2-3.5	8	
310B1	S3	4-5.5	4	4
	S4	6-7.5	4	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
310B2	S3	4-5.5	5	5
	S4	6-7.5	5	
310B2	S5	9-10.5	2	2
	S6	12-13.5	2	
	S7	15-16.5	2	
304B3	S2	2-3.5	11	12
	S3	4-5.5	13	
304B3	S5	9-10.5	11	10
	S6	12-13.5	9	
310B3	S1	0-1.5	9	7
	S2	2-3.5	5	
450B2	S3	4-5.5	9	10
	S4	6-7.5	10	
450B2	S5	9-10.5	9	11
	S6	12-13.5	12	
450B3	S1	0-1.5	6	8
	S2	2-3.5	10	
450B3	S7	15-16.5	9	21
	S8	18-19.5	33	
452B2	S3	4-5.5	7	7
	S4	6-7.5	6	
452B2	S6	12-13.5	6	7
	S7	15-16.5	8	
454B2	S2	2-3.5	12	9
	S3	4-5.5	6	
454B2	S4	6-7.5	7	-
454B3	S3	4-5.5	6	11
	S4	6-7.5	15	
454B3	S5	9-10.5	16	17
	S6	12-13.5	17	
456B2	S4	6-7.5	6	7
	S5	9-10.5	7	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
456B2	S7	15-16.5	7	10
	S8	18-19.5	13	
458B2	S2	2-3.5	9	10
	S3	4-5.5	11	
458B2	S5	9-10.5	6	6
	S6	12-13.5	6	
458B3	S1	0-1.5	16	12
	S2	2-3.5	8	
458B3	S4	6-7.5	8	9
	S5	9-10.5	10	
460B2	S3	4-5.5	10	10
	S4	6-7.5	9	
460B2	S5	9-10.5	13	12
	S6	12-13.5	10	
304B1	S1	0-1.5	12	-
304B1	S2	2-3.5	4	4
	S3	4-5.5	3	
304B2	S3	4-5.5	13	12
	S4	6-7.5	10	
304B2	S6	12-13.5	9	9
	S7	15-16.5	8	
308B1	S2	2-3.5	5	-
308B1	S3	4-5.5	5	5
	S4	6-7.5	4	
452B1	S2	2-3.5	10	9
	S3	4-5.5	8	
452B1	S5	9-10.5	7	10
	S6	12-13.5	13	
456B1	S2	2-3.5	7	6
	S3	4-5.5	5	
456B1	S5	9-10.5	6	10
	S6	12-13.5	13	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
306B1	S3	3-4.5	4	6
	S4	4.5-6	7	
306B1	S5	6-7.5	7	7
	S6	7.5-9	6	
308B2	S2	2-4	7	6
	S3	4-6	4	
308B2	S4	6-8	4	5
	S5	8-10	5	
308B3	S4	4.5-6	4	4
	S5	6-7.5	4	
308B3	S7	9-10.5	9	8
	S8	10.5-12	6	
312B1	S4	4.5-6	14	13
	S5	6-7.5	12	
318B2	S2	1.5-3	9	7
	S3	3-4.5	5	
318B2	S5	6-7.5	6	6
	S6	7.5-9	6	
324B1	S3	3-4.5	12	13
	S4	4.5-6	14	
324B1	S6	7.5-9	6	6
	S7	9-10.5	5	
330B1	S3	3-4.5	21	19
	S4	4.5-6	17	
330B1	S8	10.5-12	15	11
	S9	12-13.5	7	
332B1	S5	6-7.5	7	8
	S6	7.5-9	8	
334B1	S2	1.5-3	6	5
	S3	3-4.5	4	
334B1	S5	6-7.5	2	2
	S6	7.5-9	2	

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Boring ID	Sample ID	Depth (ft)	Moisture Content (%)	Moisture Content Average (%)
440B1	S3	3-4.5	16	13
	S4	4.5-6	10	
440B1	S6	7.5-9	4	6
	S7	9-10.5	7	
442B1	S4	4.5-6	6	7
	S5	6-7.5	7	
442B1	S7	9-10.5	6	6
	S8	10.5-12	5	

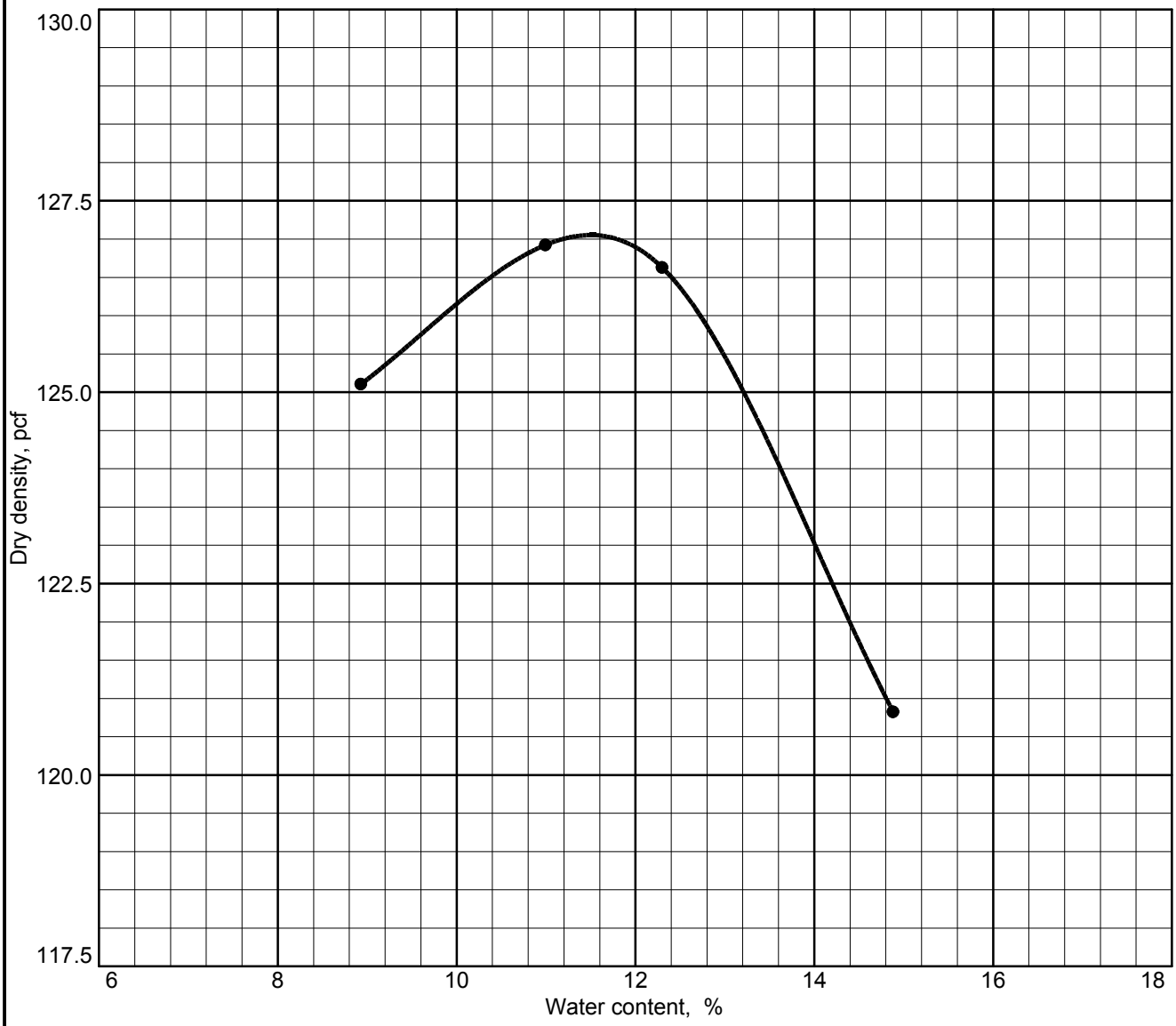
Test Pit ID	Sample ID	Depth (ft)	Moisture Content (%)
TP-1683	S1	1-4	11
TP-1684	S1	1-4.5	11
TP-1685	S1	2.5-4.5	11
TP-1686	S1	2.5-4.5	12
TP-1687	S1	1.5-4	11
TP-9049	S1	1-4.5	10
TP-9050	S1	1.5-4.5	11
TP-9051	S1	2-4.5	11
TP-9052	S1	1.5-4.5	12
TP-9053	S1	1-4	11

Michael Baker
INTERNATIONAL

We Make a Difference

Modified Proctor Test Results

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)			NP	NP	0.0	32.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 127.1 pcf Optimum moisture = 11.5 %	Silty sand

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/8/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

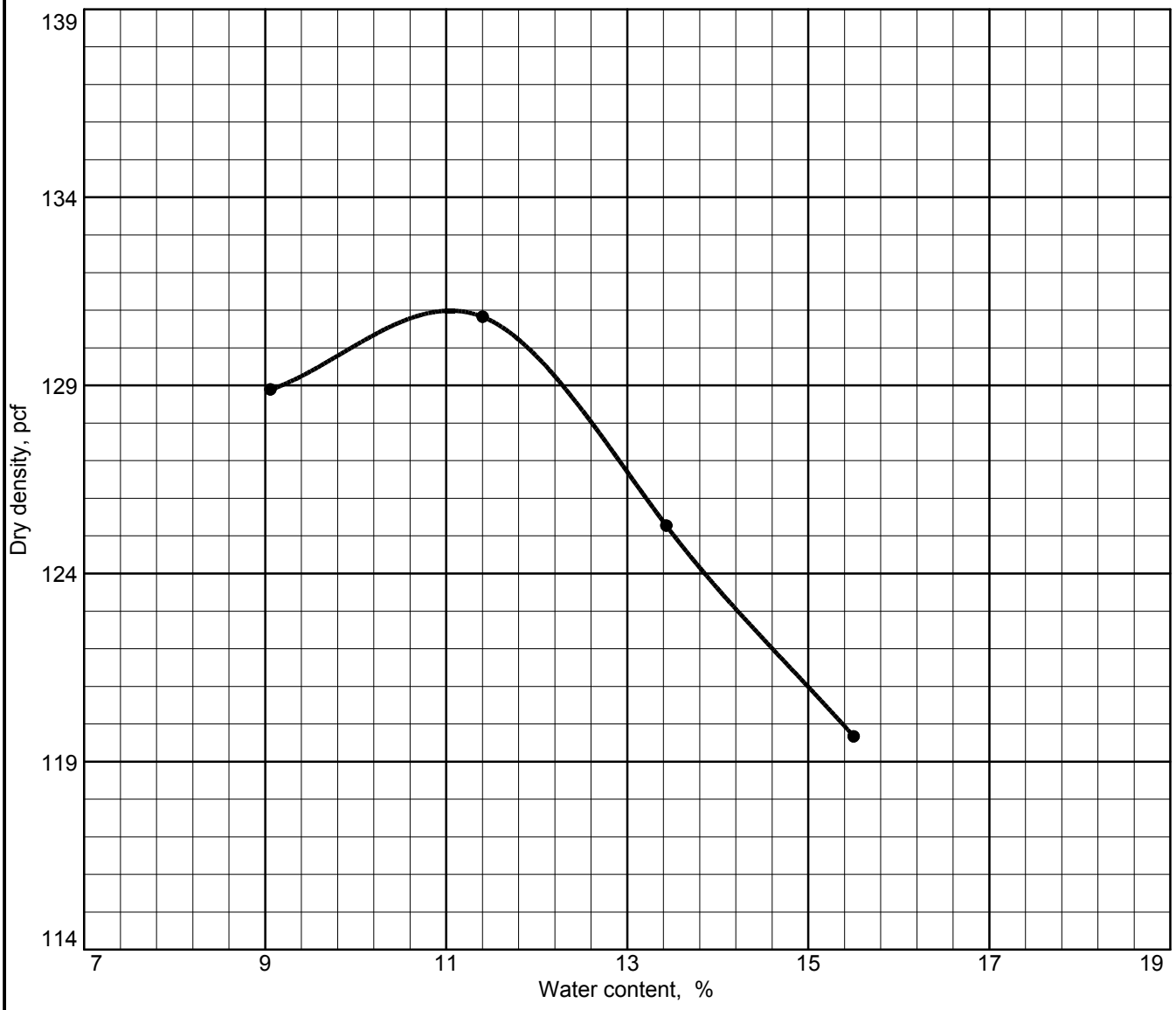
San Juan, Puerto Rico

Remarks:

Tested by: J. Rojas/A. Perez
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-1683

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)			NP	NP		28.8

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 131.0 pcf Optimum moisture = 11.0 %	Silty sand

Project No. 8081 **Client:**

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/1/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

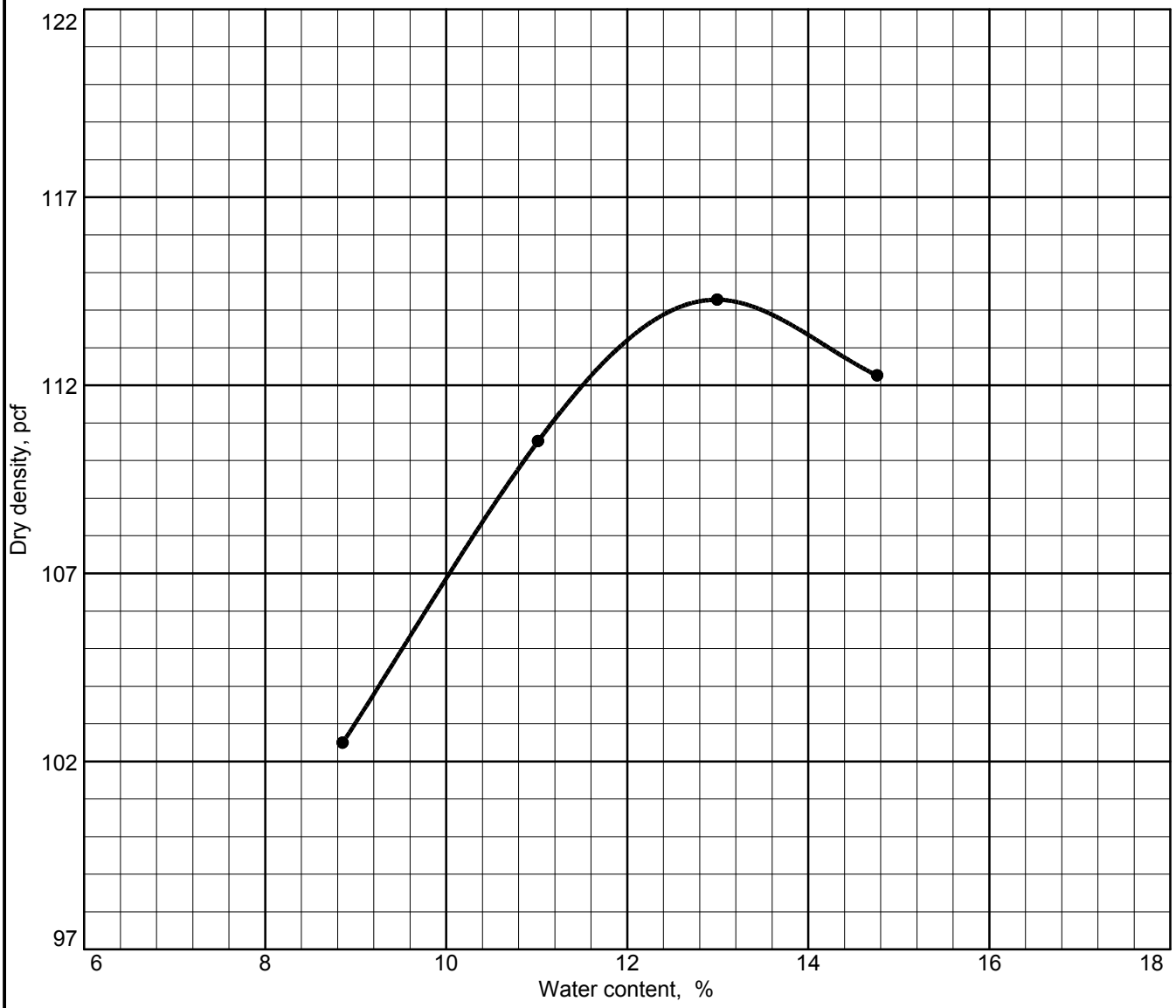
San Juan, Puerto Rico

Remarks:

Tested by: C. Santiago
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-1684

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	CL	A-6(3)			32	13	1.0	50.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 114.3 pcf Optimum moisture = 13.0 %	Sandy lean clay

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 5/27/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

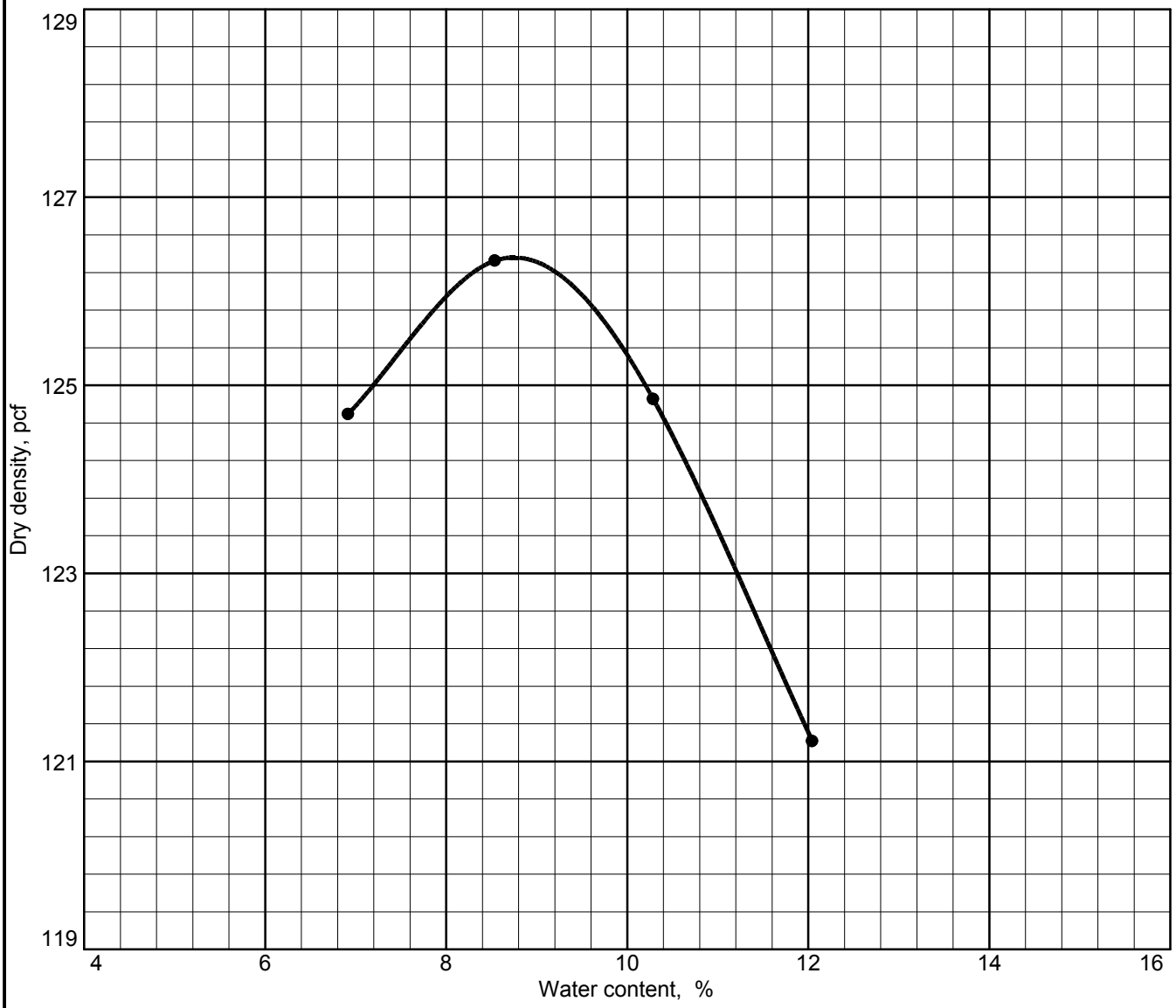
San Juan, Puerto Rico

Remarks:

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-1685

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SC	A-2-4(0)			28	9	15.9	18.3

TEST RESULTS

Maximum dry density = 126.4 pcf

Optimum moisture = 8.7 %

MATERIAL DESCRIPTION

Clayey sand with gravel

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/10/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

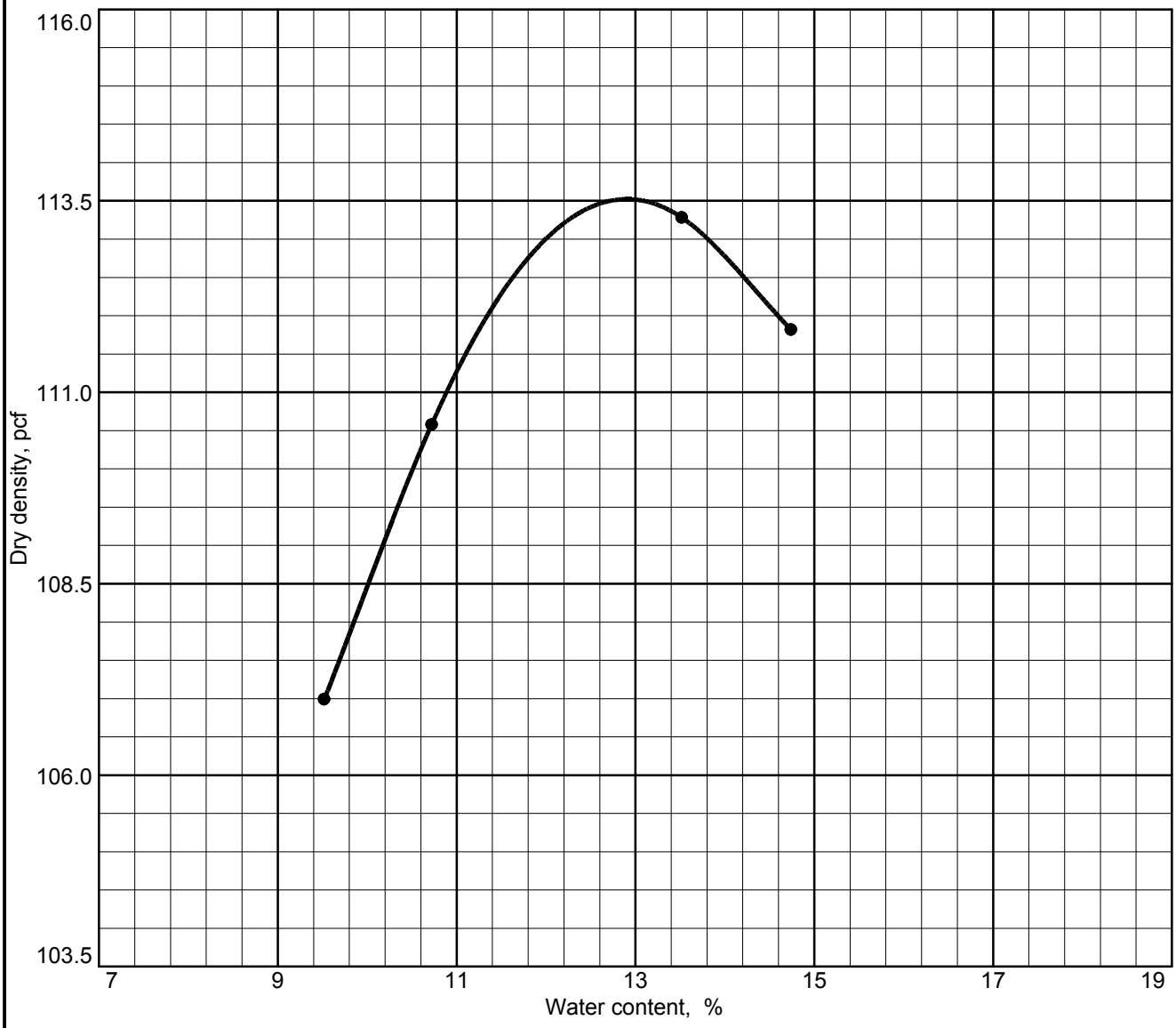
San Juan, Puerto Rico

Remarks:

Tested by: M. Reyes
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-1686

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-1-b			NP	NP		18.7

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 113.5 pcf Optimum moisture = 12.9 %	Silty sand with gravel

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 5/28/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

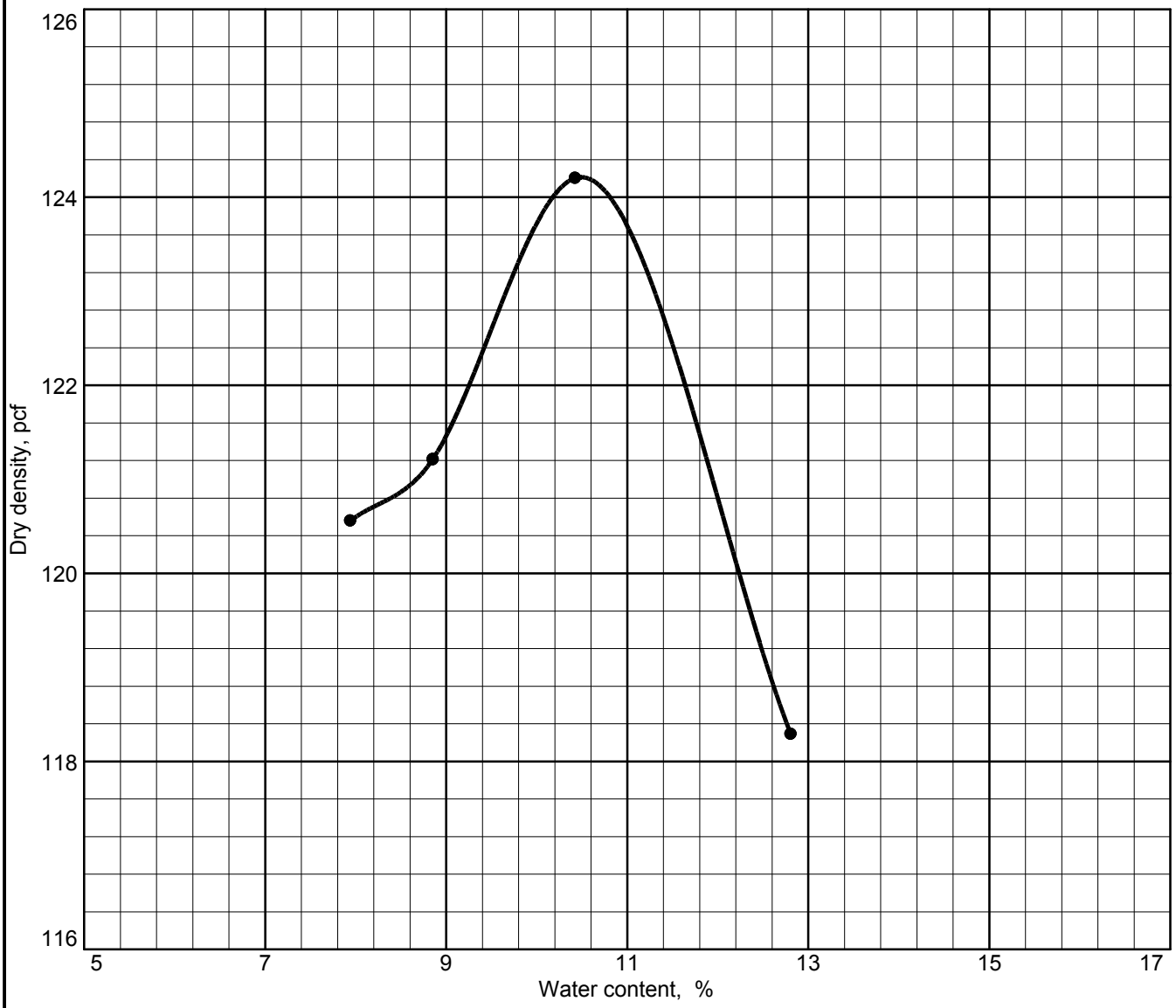
San Juan, Puerto Rico

Remarks:

Tested by: E. Martinez
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-1687

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SC	A-2-6(0)			30	11	12.1	

TEST RESULTS

Maximum dry density = 124.2 pcf

Optimum moisture = 10.5 %

MATERIAL DESCRIPTION

Clayey sand with gravel

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/8/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

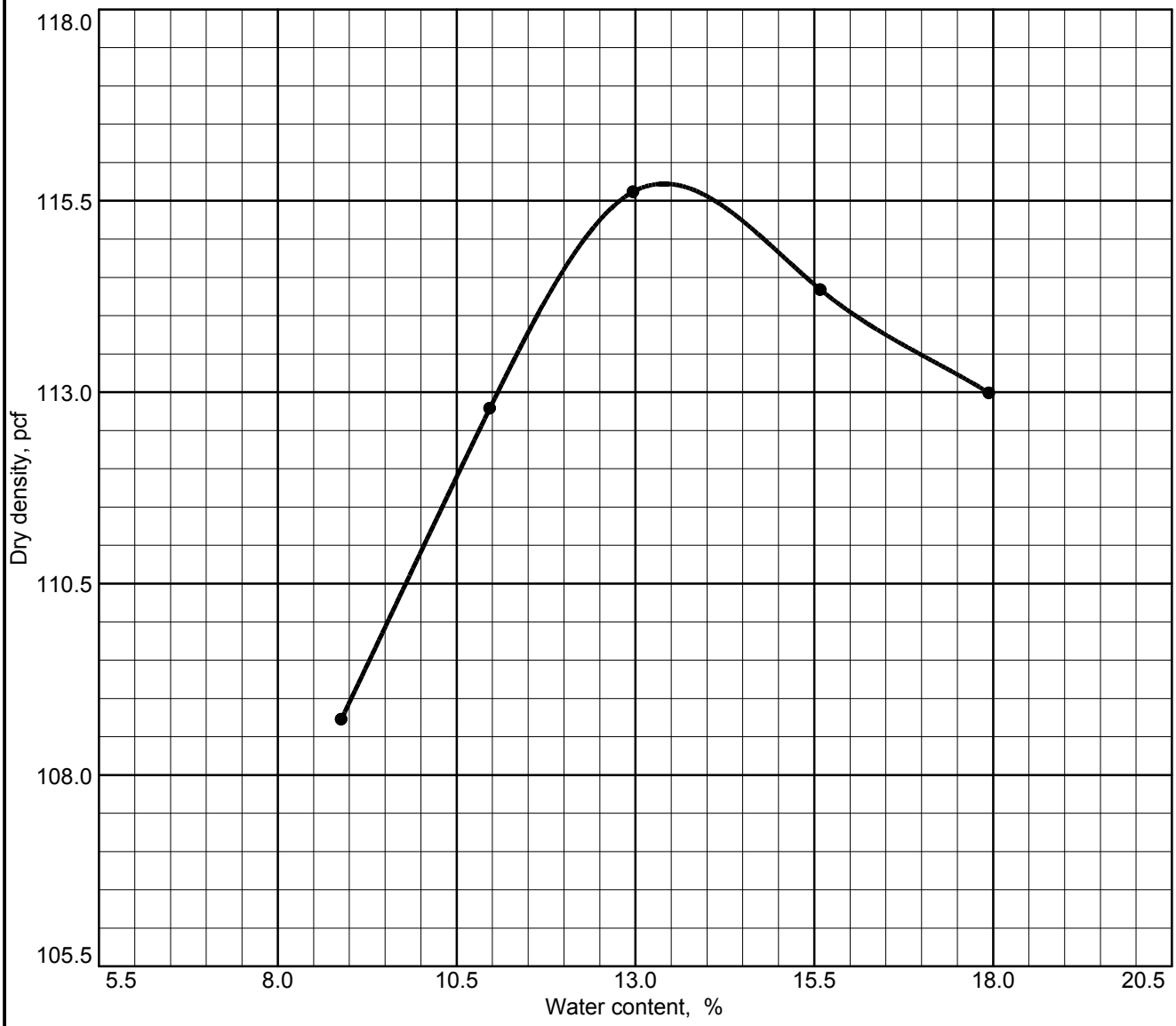
San Juan, Puerto Rico

Remarks:

Tested by: J. Rojas/A. Perez
Checked by: Rommel Cintron aponte, MSCE, PE
Sample: TP-9049

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-2-4(0)			NP	NP	4.4	27.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 115.7 pcf Optimum moisture = 13.4 %	Silty sand

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/8/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

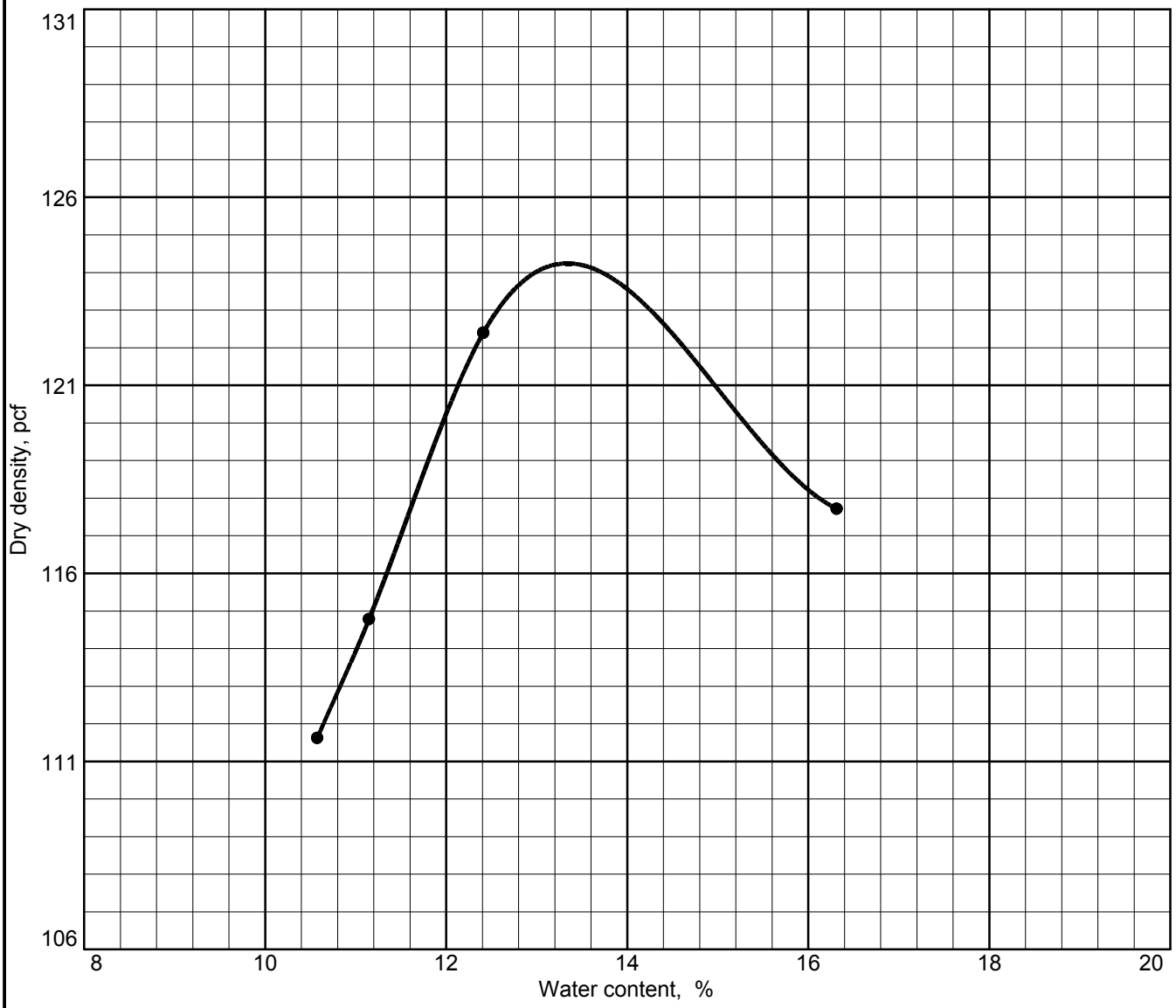
San Juan, Puerto Rico

Remarks:

Tested by: A. Perez Jr.
Checked by: Rommel Cintron Aponte, MSCE,
Sample: TP-9050

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-4(0)			NP	NP	0.0	37.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 124.2 pcf Optimum moisture = 13.3 %	Silty sand

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 5/27/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

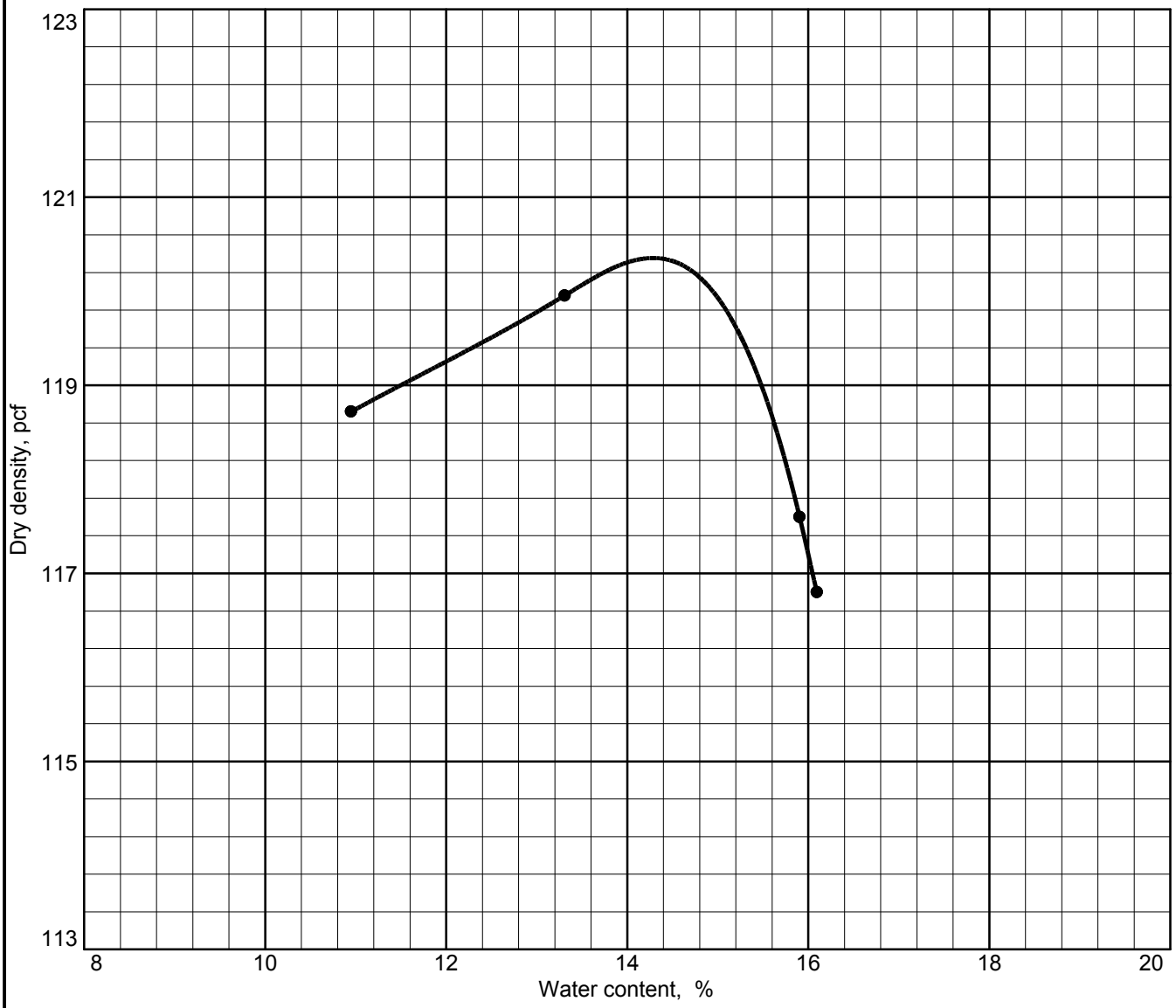
San Juan, Puerto Rico

Remarks:

Tested by: J. Rojas/E. Cordova
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-9051

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	SM	A-4(0)			38	6	5.2	40.6

TEST RESULTS

Maximum dry density = 120.4 pcf

Optimum moisture = 14.3 %

MATERIAL DESCRIPTION

Silty sand

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/3/20

● **Location:** Salinas, PR

Remarks:

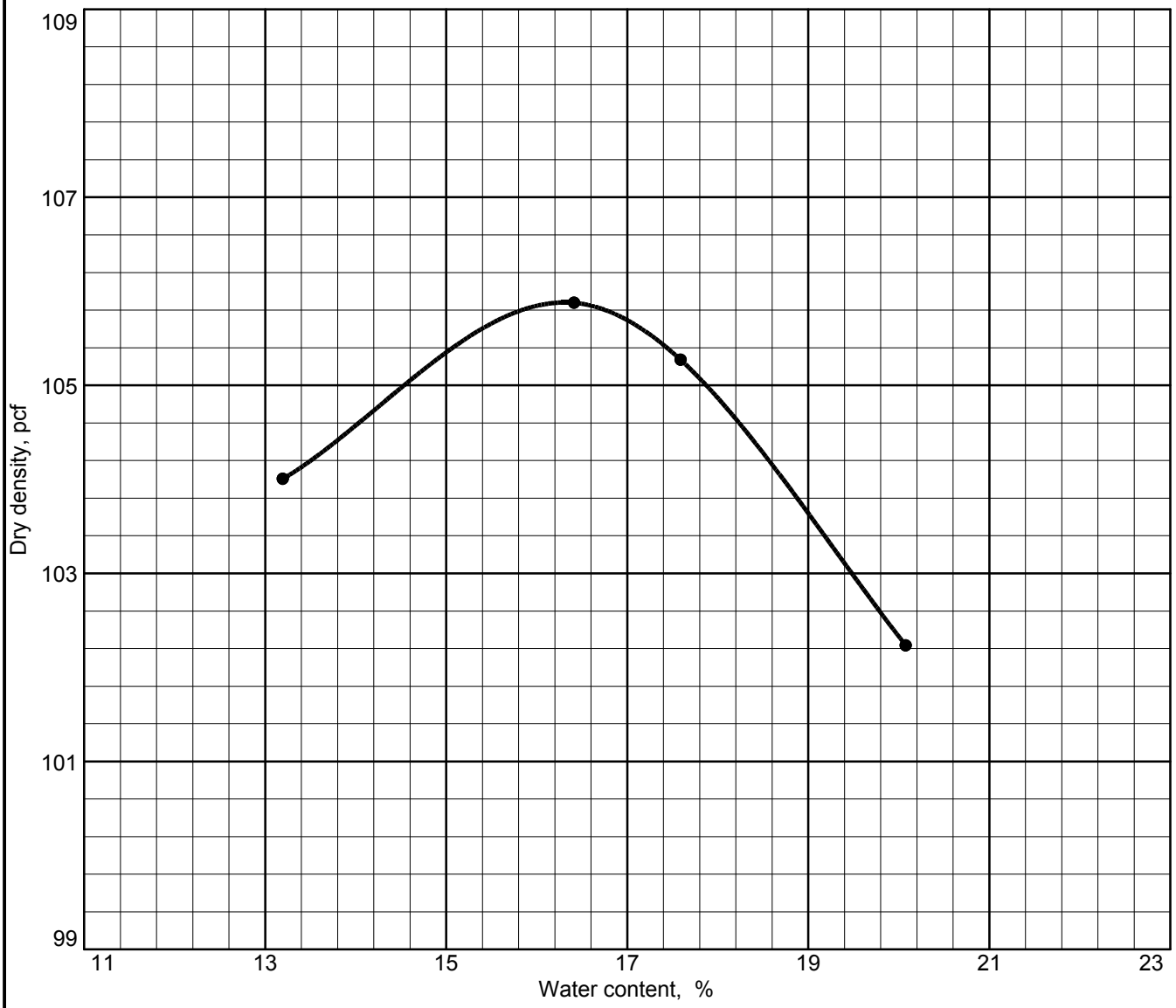
Tested by: C. Santiago
Checked by: Rommel Cintron Aponte, MSCE, PE Sample: TP-9052

JACA & SIERRA TESTING LABORATORIES

San Juan, Puerto Rico

Figure

COMPACTION TEST REPORT



Test specification: ASTM D 1557-91 Procedure C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	ML	A-7-6(8)			44	16		58.9

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 105.9 pcf Optimum moisture = 16.3 %	Sandy silt with gravel

Project No. 8081 **Client:** Michael Baker International

Project: Joint Training Center, Camp Santiago-Salinas, PR

Date: 6/2/20

● **Location:** Salinas, PR

JACA & SIERRA TESTING LABORATORIES

San Juan, Puerto Rico

Remarks:

Tested by: J. Rojas/E. Martinez
Checked by: Rommel Cintron Aponte, MSCE, PE
Sample: TP-9053

Figure

Michael Baker
INTERNATIONAL

We Make a Difference

California Bearing Ratio (CBR) Test Results

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

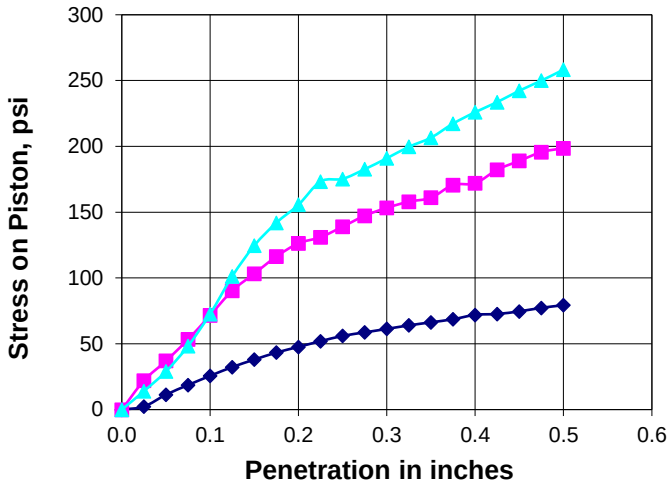
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

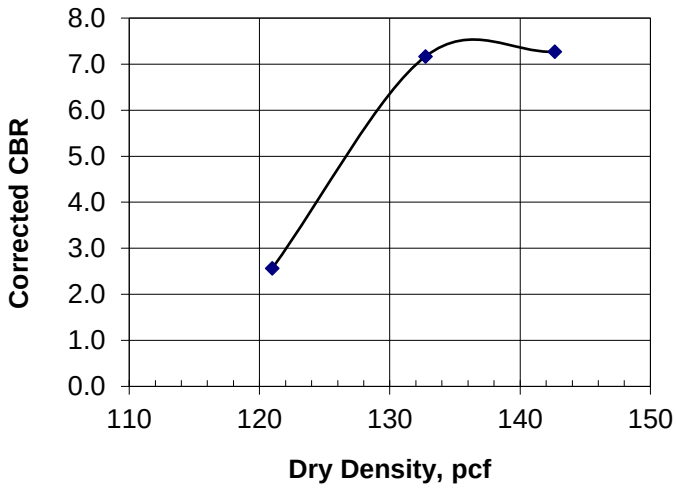
Date	:	6/8/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-1683
Sample Description	:	Silty sand

USCS Class.	:	SM			
AASHTO Class.	:	A-2-4(0)	Max. Dry Density		
Liquid Limit	:	NP	(lb/ft3)	:	127.1
Plastic Limit	:	NP	Optimum Moisture		
Plasticity Index	:	NP	Content (%)	:	11.5
Percent retained on the 3/4 in. sieve	:	0.0			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	121.0	132.7	142.7
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	7.9	8.3	8.1
Average after testing, %	18.9	15.6	16.2
Swell, %	1.90	2.70	2.46
CBR at 0.1-in. penetration	2.6	7.2	7.3
CBR at 0.2-in. penetartion	3.2	8.4	10.4
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**2**
CBR at 100%	**7**

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

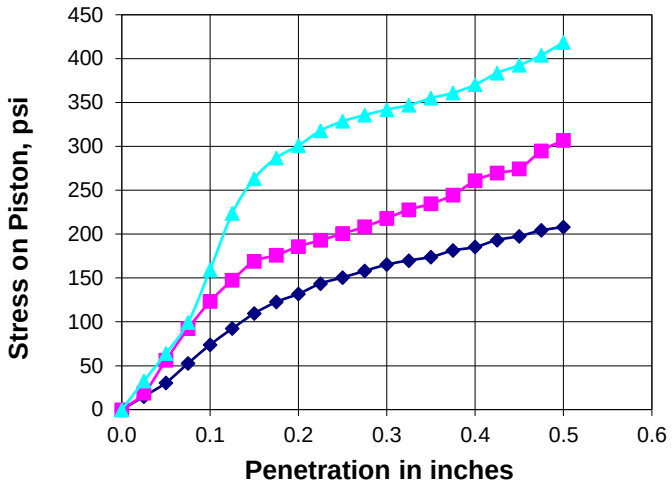
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

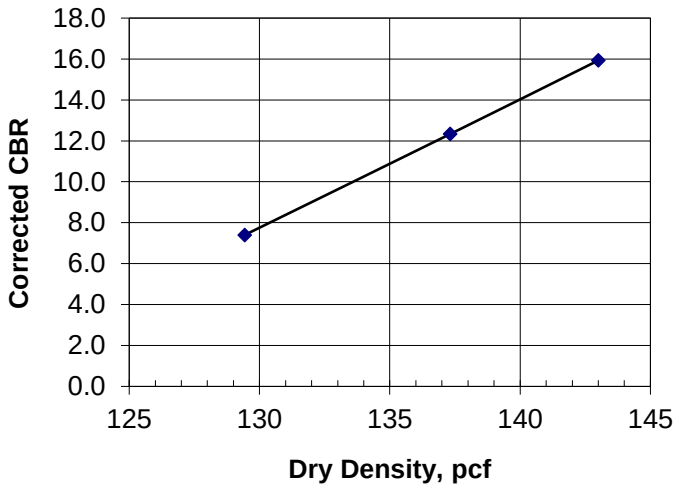
Date	:	6/1/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-1684
Sample Description	:	Silty sand
USCS Class.	:	SM
AASHTO Class.	:	A-2-4(0)
Liquid Limit	:	NP
Plastic Limit	:	NP
Plasticity Index	:	NP
Percent retained on the 3/4 in. sieve	:	0.0
Method used for compaction of specimen	:	ASTM D 1557
Condition of sample	:	Soaked

Max. Dry Density (lb/ft3)	:	131.0
Optimum Moisture Content (%)	:	11.0

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	129.4	137.3	143.0
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	10.1	10.2	10.4
Average after testing, %	17.2	15.9	16.2
Swell, %	1.48	1.04	1.90
CBR at 0.1-in. penetration	7.4	12.3	15.9
CBR at 0.2-in. penetartion	8.8	12.4	20.1
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**4**
CBR at 100%	**8**

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

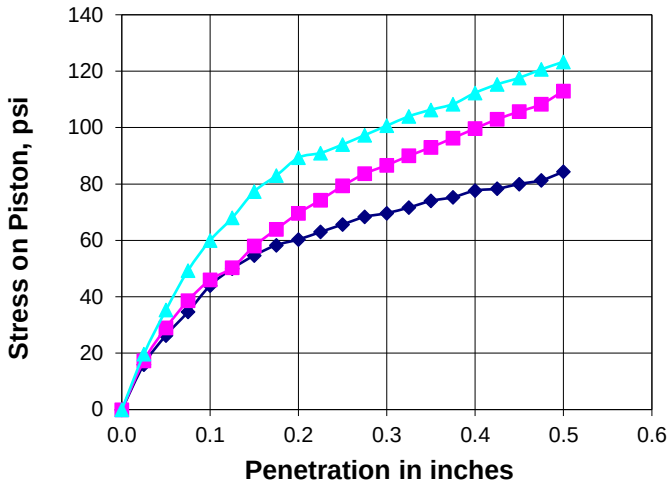
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

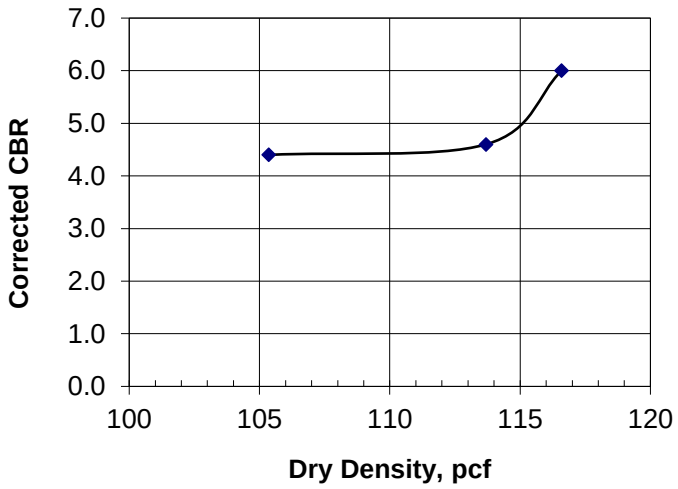
Date	:	5/27/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-1685
Sample Description	:	Sandy lean clay

USCS Class.	:	CL			
AASHTO Class.	:	A-6(3)	Max. Dry Density		
Liquid Limit	:	32	(lb/ft3)	:	114.3
Plastic Limit	:	19	Optimum Moisture		
Plasticity Index	:	13	Content (%)	:	13.0
Percent retained on the 3/4 in. sieve	:	1.0			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	105.4	113.7	116.6
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	14.4	13.5	12.4
Average after testing, %	18.8	19.7	19.9
Swell, %	3.74	3.42	6.04
CBR at 0.1-in. penetration	4.4	4.6	6.0
CBR at 0.2-in. penetartion	4.0	4.6	6.0
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**2**
CBR at 100%	**4**

JACA & SIERRA ENGINEERING, PSC

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

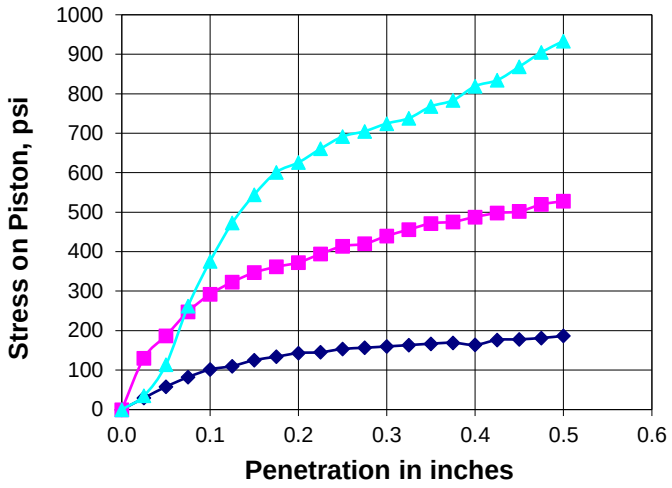
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

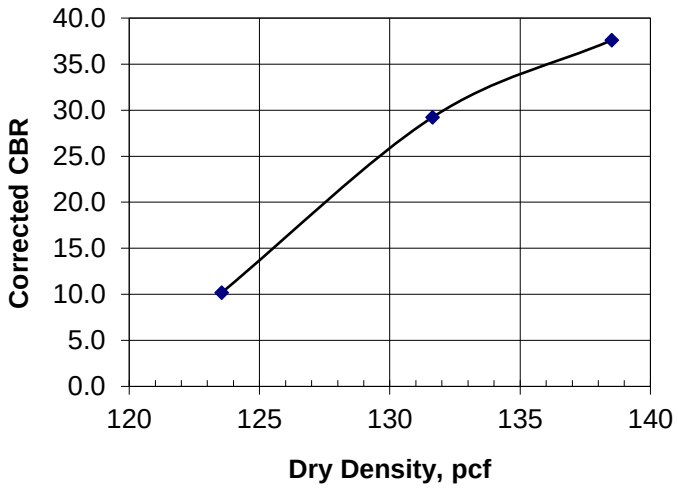
Date	:	6/10/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-1686
Sample Description	:	Clayey sand with gravel

USCS Class.	:	SC			
AASHTO Class.	:	A-2-4(0)	Max. Dry Density		
Liquid Limit	:	28	(lb/ft3)	:	126.4
Plastic Limit	:	19	Optimum Moisture		
Plasticity Index	:	9	Content (%)	:	8.7
Percent retained					
on the 3/4 in. sieve	:	15.9			
Method used for compaction					
of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	123.5	131.6	138.5
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	8.3	9.0	8.4
Average after testing, %	15.2	15.5	13.5
Swell, %	0.34	0.38	0.16
CBR at 0.1-in. penetration	10.2	29.2	37.6
CBR at 0.2-in. penetartion	9.6	24.8	41.7
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**2**
CBR at 100%	**22**

JACA & SIERRA ENGINEERING, PSC

Checked by:

Rommel Cintrón, MSCE, PE

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Testing Laboratories
Geotechnical Engineers

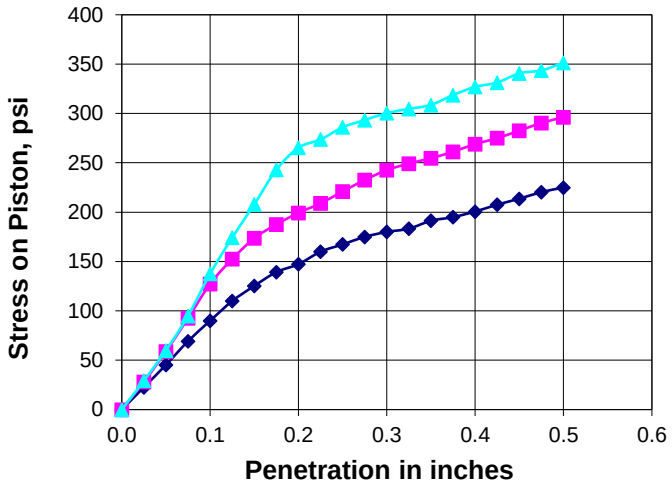
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

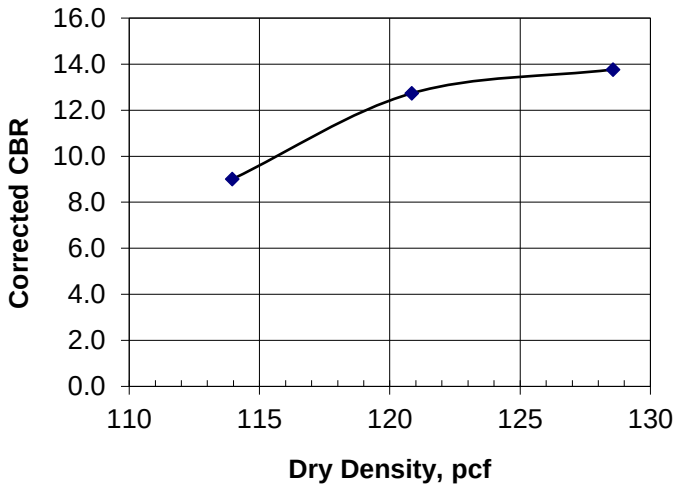
Date	:	5/28/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-1687
Sample Description	:	Silty sand with gravel

USCS Class.	:	SM			
AASHTO Class.	:	A-1-b	Max. Dry Density		
Liquid Limit	:	NP	(lb/ft3)	:	113.5
Plastic Limit	:	NP	Optimum Moisture		
Plasticity Index	:	NP	Content (%)	:	12.9
Percent retained on the 3/4 in. sieve	:	0.0			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	114.0	120.8	128.6
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	8.1	7.3	7.6
Average after testing, %	23.5	22.0	20.8
Swell, %	1.44	1.74	0.00
CBR at 0.1-in. penetration	9.0	12.7	13.8
CBR at 0.2-in. penetartion	9.8	13.3	17.7
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**5**
CBR at 100%	**11**

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

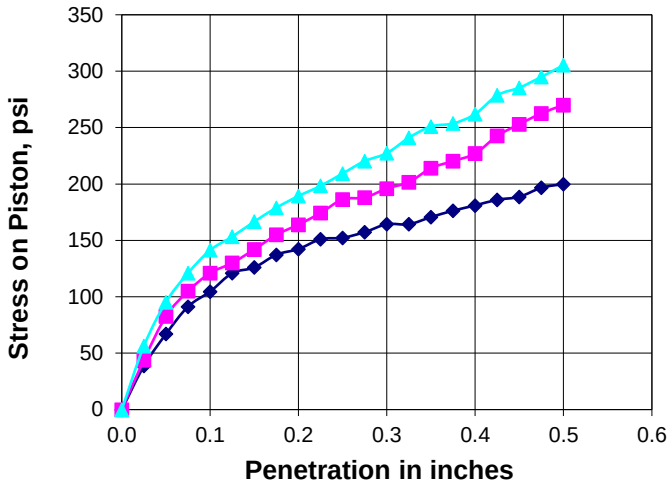
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

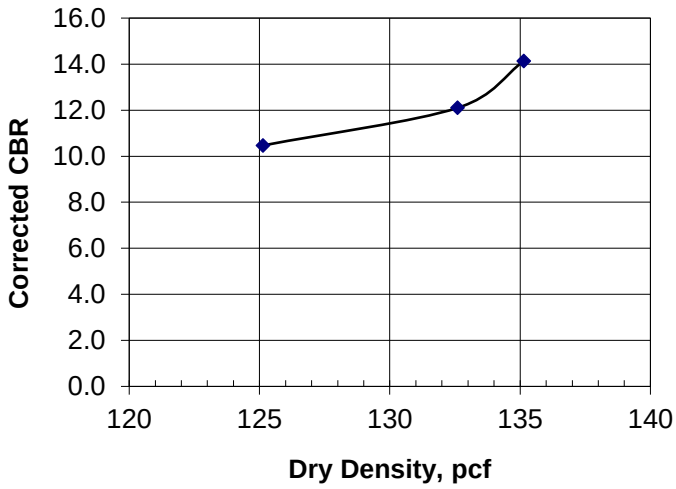
Date	:	6/8/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-9049
Sample Description	:	Clayey sand with gravel

USCS Class.	:	SC			
AASHTO Class.	:	A-2-6(0)	Max. Dry Density		
Liquid Limit	:	30	(lb/ft3)	:	124.2
Plastic Limit	:	19	Optimum Moisture		
Plasticity Index	:	11	Content (%)	:	10.5
Percent retained on the 3/4 in. sieve	:	12.1			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	125.1	132.6	135.1
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	11.8	10.7	10.0
Average after testing, %	15.5	14.7	15.4
Swell, %	0.44	0.10	0.20
CBR at 0.1-in. penetration	10.5	12.1	14.1
CBR at 0.2-in. penetartion	9.5	10.9	12.6
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**8**
CBR at 100%	**10**

JACA & SIERRA ENGINEERING, PSC

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

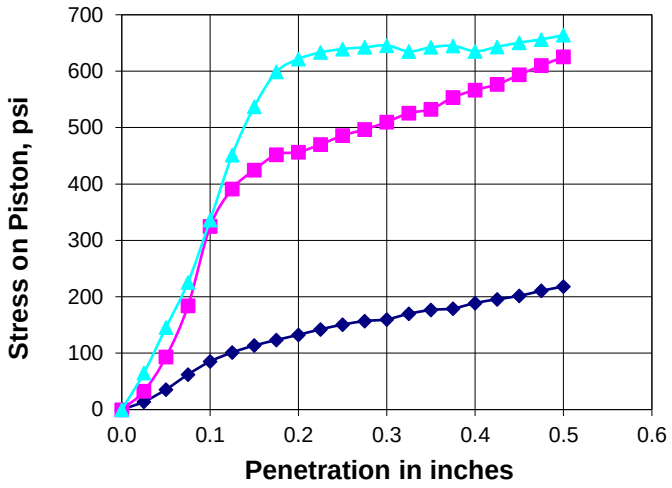
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

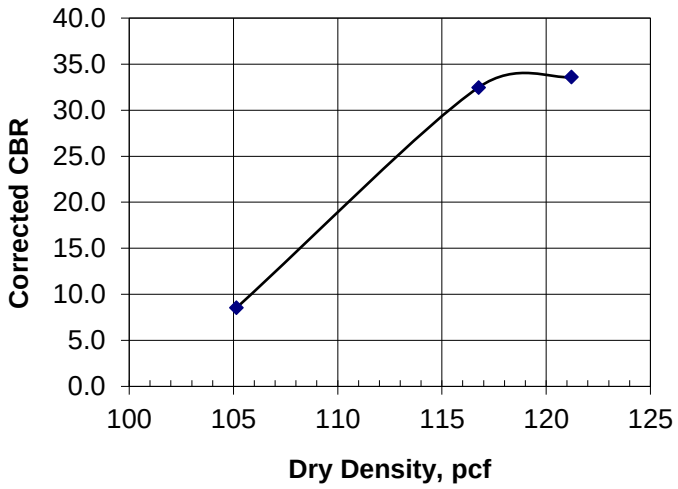
Date	:	6/8/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-9050
Sample Description	:	Silty sand

USCS Class.	:	SM			
AASHTO Class.	:	A-2-4(0)	Max. Dry Density		
Liquid Limit	:	NP	(lb/ft3)	:	115.7
Plastic Limit	:	NP	Optimum Moisture		
Plasticity Index	:	NP	Content (%)	:	13.4
Percent retained on the 3/4 in. sieve	:	4.4			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	105.1	116.8	121.2
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	12.7	11.2	11.1
Average after testing, %	20.1	17.0	16.2
Swell, %	0.96	0.84	1.00
CBR at 0.1-in. penetration	8.5	32.5	33.6
CBR at 0.2-in. penetartion	8.8	30.4	41.4
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**18**
CBR at 100%	**30**

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

JACA & SIERRA ENGINEERING, PSC

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

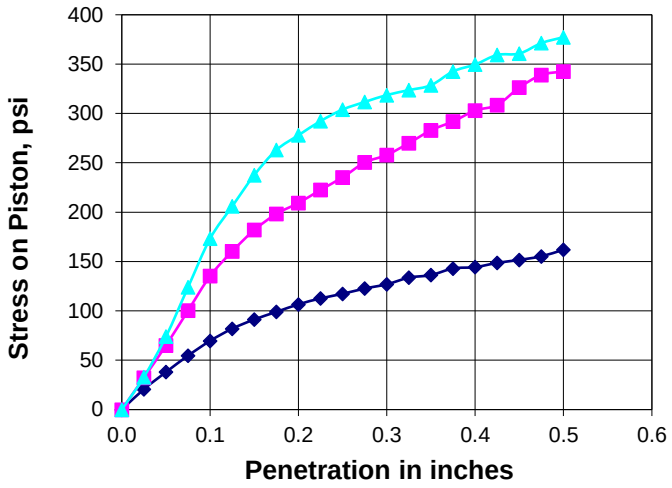
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

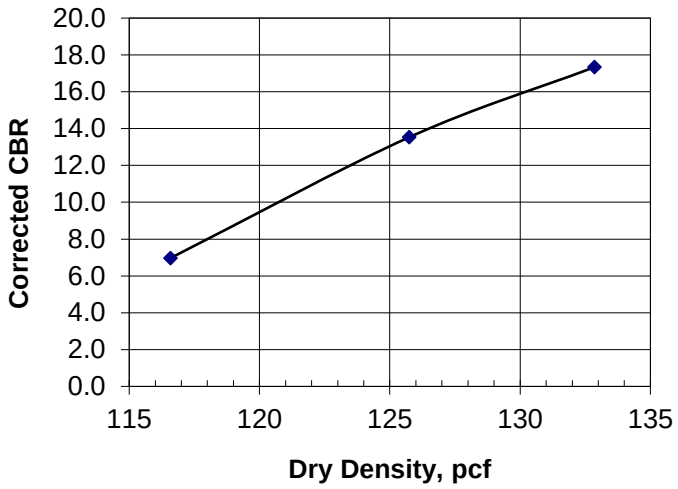
Date	:	5/27/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-9051
Sample Description	:	Silty sand

USCS Class.	:	SM			
AASHTO Class.	:	A-4(0)	Max. Dry Density		
Liquid Limit	:	NP	(lb/ft3)	:	124.2
Plastic Limit	:	NP	Optimum Moisture		
Plasticity Index	:	NP	Content (%)	:	13.3
Percent retained on the 3/4 in. sieve	:	0.0			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	116.6	125.7	132.9
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	12.7	12.6	13.1
Average after testing, %	20.8	17.7	18.0
Swell, %	1.20	0.90	1.30
CBR at 0.1-in. penetration	7.0	13.5	17.3
CBR at 0.2-in. penetartion	7.1	14.0	18.5
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**7**
CBR at 100%	**12**

Checked by:

Rommel Cintrón, MSCE, PE

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

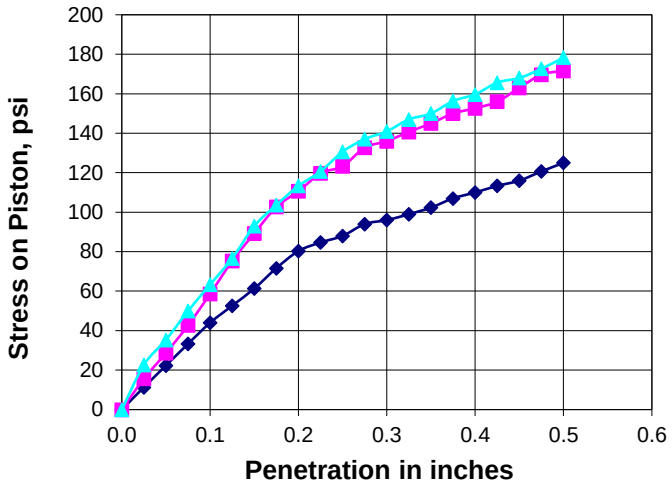
Project No.: 8081

CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

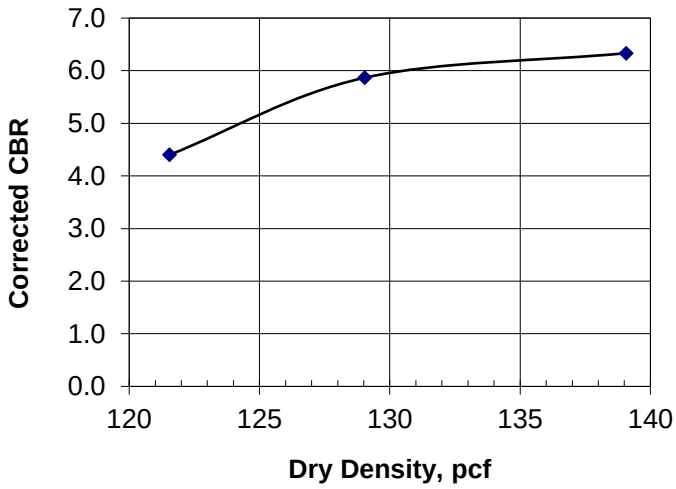
Date	:	6/3/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-9052
Sample Description	:	Silty sand

USCS Class.	:	SM			
AASHTO Class.	:	A-4(0)	Max. Dry Density		
Liquid Limit	:	38	(lb/ft3)	:	120.4
Plastic Limit	:	32	Optimum Moisture		
Plasticity Index	:	6	Content (%)	:	14.3
Percent retained on the 3/4 in. sieve	:	5.2			
Method used for compaction of specimen	:	ASTM D 1557			
Condition of sample	:	Soaked			

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	121.5	129.0	139.1
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	9.1	8.6	5.5
Average after testing, %	22.9	20.5	20.3
Swell, %	3.22	3.38	3.54
CBR at 0.1-in. penetration	4.4	5.9	6.3
CBR at 0.2-in. penetartion	5.4	7.4	7.6
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**3**
CBR at 100%	**4**

JACA & SIERRA ENGINEERING, PSC

Checked by:

Rommel Cintrón, MSCE, PE

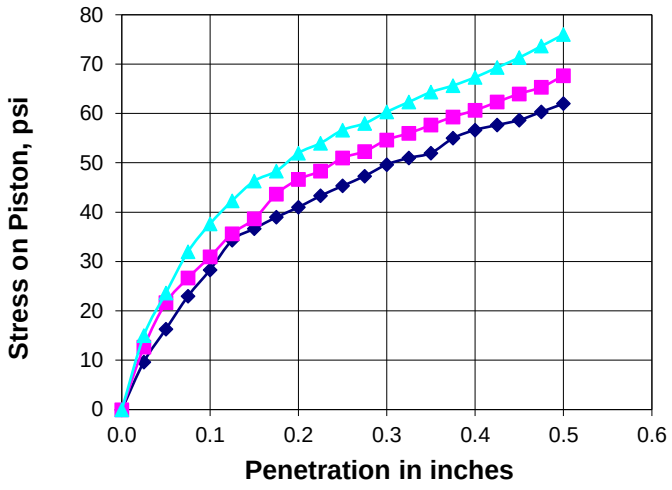
JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Project No.: 8081

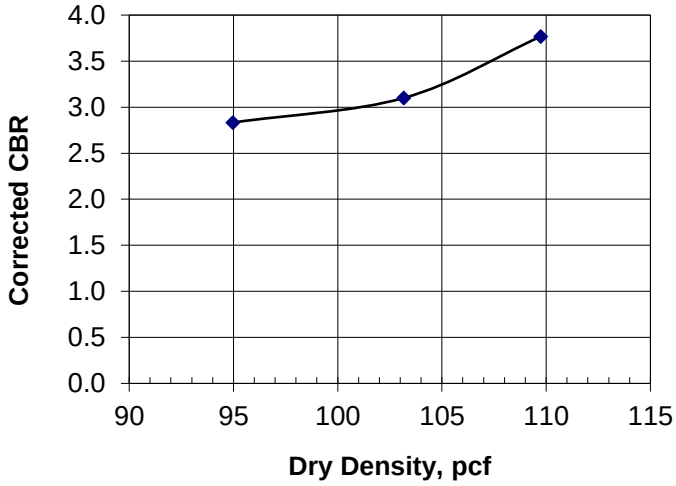
CALIFORNIA BEARING RATIO TEST REPORT (ASTM D 1883)

Date	:	6/2/2020
Client	:	Michael Baker International
Project	:	Joint Training Center, Camp Santiago, Salinas, PR
Source of Sample	:	TP-9053
Sample Description	:	Sandy silt with gravel
USCS Class.	:	ML
AASHTO Class.	:	A-7-6(8)
Liquid Limit	:	44
Plastic Limit	:	28
Plasticity Index	:	16
Percent retained on the 3/4 in. sieve	:	0.0
Method used for compaction of specimen	:	ASTM D 1557
Condition of sample	:	Soaked
Max. Dry Density (lb/ft3)	:	105.9
Optimum Moisture Content (%)	:	16.3

Load-Penetration Curves



Dry Density versus CBR



	10 blows	25 blows	56 blows
Dry Density of sample before soaking, pcf	95.0	103.2	109.7
Dry Density of sample after soaking, pcf	N.D.	N.D.	N.D.
Moisture Content:			
Average before testing, %	15.2	16.2	15.5
Average after testing, %	29.6	27.5	26.3
Swell, %	6.26	6.88	8.42
CBR at 0.1-in. penetration	2.8	3.1	3.8
CBR at 0.2-in. penetartion	2.7	3.1	3.5
Surchage amount, lbs.	10.0	10.0	10.0

RESULTS	
CBR at 95%	**3**
CBR at 100%	**3**

Checked by:

Rommel Cintrón, MSCE, PE

Michael Baker
INTERNATIONAL

We Make a Difference

Unit Weight Test Results

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Laboratory Test Results

Unit Weight (ASTM D7263)

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Samples: 6
Date: July 24, 2020
External Lab: GeoTesting Express, Inc.
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Test Pit ID	Sample ID	Depth (ft)	Bulk Density (pcf)	Moisture Content (%)	Dry Density (pcf)
TP-1687	S1	1.5-4	91.29	3.50	88.20
TP-9049	S1	1-4.5	98.28	2.97	95.45
TP-9050	S1	1.5-4.5	93.53	3.78	90.12
TP-9051	S1	2-4.5	99.27	4.08	95.37
TP-9052	S1	1.5-4.5	93.28	4.20	89.52
TP-9053	S1	1-4	85.80	4.22	82.33

Michael Baker
INTERNATIONAL

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Soil Chemistry Test Results

Camp Santiago Facility Restoration

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Testing Laboratories
Geotechnical Engineers

Laboratory Test Results

Nutrients, Chloride, Sulfate & pH in Soils

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Samples: 10
Date: June 30, 2020
External Lab: Environmental Quality Laboratories, Inc. (EQ Lab)
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Test Pit ID: TP-1683 **Sample ID:** S1 **Depth (ft):** 1-4		
Parameter	**Method**	**Results**
Total Solids (%)	SM 2540G	93.1
Total Phosphorus (mg/Kg)	SM 4500-P A,B,E	59.6
Boron - Total (mg/Kg)	EPA 6010B	110
Calcium - Total (mg/Kg)	EPA 6010B	28995
Copper - Total (mg/Kg)	EPA 6010B	109
Iron - Total (mg/Kg)	EPA 6010B	38505
Magnesium - Total (mg/Kg)	EPA 6010B	34976
Manganese - Total (mg/Kg)	EPA 6010B	624
Potassium - Total (mg/Kg)	EPA 6010B	1316
Zinc - Total (mg/Kg)	EPA 6010B	59.7
Humidity (%)	ASTM D-2974	6.9
Chloride (mg/Kg)	EPA 300.0 A	102
Sulfate (mg/Kg)	EPA 300.0 A	24.1
pH in Water	ASTM D-4972	7.3
pH in Calcium Chloride	ASTM D-4972	7.1

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Test Pit ID: TP-1684 **Sample ID:** S1 **Depth (ft):** 1-4.5		
Parameter	**Method**	**Results**
Chloride (mg/Kg)	EPA 300.0 A	1300
Sulfate (mg/Kg)	EPA 300.0 A	502

Test Pit ID: TP-1685 **Sample ID:** S1 **Depth (ft):** 2.5-4.5		
Parameter	**Method**	**Results**
Total Solids (%)	SM 2540G	87.6
Total Phosphorus (mg/Kg)	SM 4500-P A,B,E	204
Boron - Total (mg/Kg)	EPA 6010B	82.7
Calcium - Total (mg/Kg)	EPA 6010B	18353
Copper - Total (mg/Kg)	EPA 6010B	52.8
Iron - Total (mg/Kg)	EPA 6010B	31990
Magnesium - Total (mg/Kg)	EPA 6010B	12259
Manganese - Total (mg/Kg)	EPA 6010B	663
Potassium - Total (mg/Kg)	EPA 6010B	1738
Zinc - Total (mg/Kg)	EPA 6010B	72.2
Humidity (%)	ASTM D-2974	12.4
Chloride (mg/Kg)	EPA 300.0 A	108
Sulfate (mg/Kg)	EPA 300.0 A	166
pH in Water	ASTM D-4972	7.3
pH in Calcium Chloride	ASTM D-4972	7.2

Test Pit ID: TP-1686 **Sample ID:** S1 **Depth (ft):** 2.5-4.5		
Parameter	**Method**	**Results**
Chloride (mg/Kg)	EPA 300.0 A	63.2
Sulfate (mg/Kg)	EPA 300.0 A	31.9

Test Pit ID: TP-1687 **Sample ID:** S1 **Depth (ft):** 1.5-4		
Parameter	**Method**	**Results**
Chloride (mg/Kg)	EPA 300.0 A	35.6
Sulfate (mg/Kg)	EPA 300.0 A	14.7

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Test Pit ID: TP-9049 **Sample ID:** S1 **Depth (ft):** 1-4.5		
Parameter	**Method**	**Results**
Total Solids (%)	SM 2540G	90.2
Total Phosphorus (mg/Kg)	SM 4500-P A,B,E	314
Boron - Total (mg/Kg)	EPA 6010B	107
Calcium - Total (mg/Kg)	EPA 6010B	17418
Copper - Total (mg/Kg)	EPA 6010B	68.0
Iron - Total (mg/Kg)	EPA 6010B	38218
Magnesium - Total (mg/Kg)	EPA 6010B	9168
Manganese - Total (mg/Kg)	EPA 6010B	640
Potassium - Total (mg/Kg)	EPA 6010B	2649
Zinc - Total (mg/Kg)	EPA 6010B	73.7
Humidity (%)	ASTM D-2974	9.8
Chloride (mg/Kg)	EPA 300.0 A	63.5
Sulfate (mg/Kg)	EPA 300.0 A	34.6
pH in Water	ASTM D-4972	7.7
pH in Calcium Chloride	ASTM D-4972	7.6

Test Pit ID: TP-9050 **Sample ID:** S1 **Depth (ft):** 1.5-4.5		
Parameter	**Method**	**Results**
Total Solids (%)	SM 2540G	91.1
Total Phosphorus (mg/Kg)	SM 4500-P A,B,E	183
Boron - Total (mg/Kg)	EPA 6010B	83.6
Calcium - Total (mg/Kg)	EPA 6010B	91902
Copper - Total (mg/Kg)	EPA 6010B	33.1
Iron - Total (mg/Kg)	EPA 6010B	26317
Magnesium - Total (mg/Kg)	EPA 6010B	41829
Manganese - Total (mg/Kg)	EPA 6010B	628
Potassium - Total (mg/Kg)	EPA 6010B	722
Zinc - Total (mg/Kg)	EPA 6010B	46.2
Humidity (%)	ASTM D-2974	8.9
Chloride (mg/Kg)	EPA 300.0 A	24.6
Sulfate (mg/Kg)	EPA 300.0 A	12.3
pH in Water	ASTM D-4972	7.9
pH in Calcium Chloride	ASTM D-4972	7.8

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Geotechnical Engineers

Test Pit ID: TP-9051 **Sample ID:** S1 **Depth (ft):** 2-4.5		
Parameter	**Method**	**Results**
Chloride (mg/Kg)	EPA 300.0 A	87.3
Sulfate (mg/Kg)	EPA 300.0 A	46.3

Test Pit ID: TP-9052 **Sample ID:** S1 **Depth (ft):** 1.5-4.5		
Parameter	**Method**	**Results**
Chloride (mg/Kg)	EPA 300.0 A	600
Sulfate (mg/Kg)	EPA 300.0 A	581

Test Pit ID: TP-9053 **Sample ID:** S1 **Depth (ft):** 1-4		
Parameter	**Method**	**Results**
Total Solids (%)	SM 2540G	88.0
Total Phosphorus (mg/Kg)	SM 4500-P A,B,E	298
Boron - Total (mg/Kg)	EPA 6010B	99.0
Calcium - Total (mg/Kg)	EPA 6010B	32935
Copper - Total (mg/Kg)	EPA 6010B	49.9
Iron - Total (mg/Kg)	EPA 6010B	33433
Magnesium - Total (mg/Kg)	EPA 6010B	20687
Manganese - Total (mg/Kg)	EPA 6010B	449
Potassium - Total (mg/Kg)	EPA 6010B	1836
Zinc - Total (mg/Kg)	EPA 6010B	71.4
Humidity (%)	ASTM D-2974	12.0
Chloride (mg/Kg)	EPA 300.0 A	76.2
Sulfate (mg/Kg)	EPA 300.0 A	36.1
pH in Water	ASTM D-4972	7.8
pH in Calcium Chloride	ASTM D-4972	7.7

June 30, 2020

Mr. Rommel Cintrón
Jaca & Sierra
PO Box 363116
San Juan, PR 00936-3116

I hereby certify that the results reported for EQ Lab Sample #: 3288351 to 3288360 have been reviewed by me and are correct as presented herein.

Lcda. Sonia Pichardo
Laboratory Director

amps

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 1683**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

eqlab ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288351**	Collected Date & Time:	**06/09/2020** 10:54	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Total Solids	SM 2540G	93.1	%	--	0.01	0.01	--	06/11/2020	13:49	YVV	--	--	N/A
+	Total Phosphorus	SM 4500-P A,B,E	59.6	mg/Kg	D	50.00	250.00	--	06/17/2020	09:57	CMRR	06/16/2020	CMRR	Digestion
	Boron - Total	EPA 6010B	110	mg/Kg	--	1.0	5.0	--	06/19/2020	21:00	YDCV	06/16/2020	CRP	SW846-3050B
	Calcium - Total	EPA 6010B	28995	mg/Kg	D	125.0	1250.0	--	06/20/2020	02:07	YDCV	06/16/2020	CRP	SW846-3050B
	Copper - Total	EPA 6010B	109	mg/Kg	--	0.25	2.50	--	06/19/2020	21:00	YDCV	06/16/2020	CRP	SW846-3050B
	Iron - Total	EPA 6010B	38505	mg/Kg	D	50.0	125.0	--	06/20/2020	05:54	YDCV	06/16/2020	CRP	SW846-3050B
	Magnesium - Total	EPA 6010B	34976	mg/Kg	D	250.0	5000.0	--	06/20/2020	05:54	YDCV	06/16/2020	CRP	SW846-3050B
	Manganese - Total	EPA 6010B	624	mg/Kg	D	1.25	25.00	--	06/20/2020	02:07	YDCV	06/16/2020	CRP	SW846-3050B
	Potassium - Total	EPA 6010B	1316	mg/Kg	D	62.5	250.0	--	06/20/2020	02:07	YDCV	06/16/2020	CRP	SW846-3050B
	Zinc - Total	EPA 6010B	59.7	mg/Kg	--	1.00	12.50	--	06/19/2020	21:00	YDCV	06/16/2020	CRP	SW846-3050B
+	Humidity	ASTM D-2974	6.90	%	--	0.1	0.1	--	06/11/2020	13:49	YVV	--	--	N/A
+	Chloride	EPA 300.0 A	102	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+	Sulfate	EPA 300.0 A	24.1	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM.

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 1684**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288352**	Collected Date & Time:	**06/09/2020** 10:58	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

					Limits			Analysis			Prep Method		
	Parameter	Method	Results	Units	DQ	MDL	MRL	MCL	Date	Time	By	Date	By	Method
+	Chloride	EPA 300.0 A	1300	mg/Kg	D	1.00	10.00	--	06/17/2020	16:58	GVM	--	--	N/A
+	Sulfate	EPA 300.0 A	502	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Asociado de P.R. Estado Libre Asociado LICENCIA NUM.

Certified by Laboratory Director

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ACCREDITED IN ACCORDANCE WITH nelac

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PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
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PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 1685**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288353**	Collected Date & Time:	**06/09/2020** 11:04	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Total Solids	SM 2540G	87.6	%	--	0.01	0.01	--	06/11/2020	13:49	YVV	--	--	N/A
+	Total Phosphorus	SM 4500-P A,B,E	204	mg/Kg	D	100.00	500.00	--	06/17/2020	09:57	CMRR	06/16/2020	CMRR	Digestion
	Boron - Total	EPA 6010B	82.7	mg/Kg	--	1.0	5.0	--	06/19/2020	21:06	YDCV	06/16/2020	CRP	SW846-3050B
	Calcium - Total	EPA 6010B	18353	mg/Kg	D	125.0	1250.0	--	06/20/2020	02:14	YDCV	06/16/2020	CRP	SW846-3050B
	Copper - Total	EPA 6010B	52.8	mg/Kg	--	0.25	2.50	--	06/19/2020	21:06	YDCV	06/16/2020	CRP	SW846-3050B
	Iron - Total	EPA 6010B	31990	mg/Kg	D	50.0	125.0	--	06/20/2020	05:58	YDCV	06/16/2020	CRP	SW846-3050B
	Magnesium - Total	EPA 6010B	12259	mg/Kg	D	250.0	5000.0	--	06/20/2020	05:58	YDCV	06/16/2020	CRP	SW846-3050B
	Manganese - Total	EPA 6010B	663	mg/Kg	D	1.25	25.00	--	06/20/2020	02:14	YDCV	06/16/2020	CRP	SW846-3050B
	Potassium - Total	EPA 6010B	1738	mg/Kg	D	62.5	250.0	--	06/20/2020	02:14	YDCV	06/16/2020	CRP	SW846-3050B
	Zinc - Total	EPA 6010B	72.2	mg/Kg	--	1.00	12.50	--	06/19/2020	21:06	YDCV	06/16/2020	CRP	SW846-3050B
+	Humidity	ASTM D-2974	12.4	%	--	0.1	0.1	--	06/11/2020	13:49	YVV	--	--	N/A
+	Chloride	EPA 300.0 A	108	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+	Sulfate	EPA 300.0 A	166	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Licencia Num. 4

Certified by Laboratory Director

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MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

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PRDOH Certified
EPA ID PR00014

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60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 1686**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

This report shall not be reproduced, except in full, without the written consent of Environmental Quality Laboratories, Inc.

Sample Number:	**3288354**	Collected Date & Time:	**06/09/2020** 11:06	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

					Limits			Analysis			Prep Method		
Parameter	Method	Results	Units	DQ	MDL	MRL	MCL	Date	Time	By	Date	By	Method
+ Chloride	EPA 300.0 A	63.2	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+ Sulfate	EPA 300.0 A	31.9	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Asociado a Puerto Rico LICENCIA NUM. 43

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
+ = Parameter is not accredited under EQLab's NELAP Certification

ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 1687**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

eqlab
ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288355**	Collected Date & Time:	**06/09/2020** 11:07	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Chloride	EPA 300.0 A	35.6	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+	Sulfate	EPA 300.0 A	14.7	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM 458

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
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PRDOH Certified
EPA ID PR00014

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PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 9049**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288356**	Collected Date & Time:	**06/09/2020** 11:09	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Total Solids	SM 2540G	90.2	%	--	0.01	0.01	--	06/11/2020	13:49	YVV	--	--	N/A
+	Total Phosphorus	SM 4500-P A,B,E	314	mg/Kg	D	50.00	250.00	--	06/17/2020	09:57	CMRR	06/16/2020	CMRR	Digestion
	Boron - Total	EPA 6010B	107	mg/Kg	--	1.0	5.0	--	06/19/2020	21:12	YDCV	06/16/2020	CRP	SW846-3050B
	Calcium - Total	EPA 6010B	17418	mg/Kg	D	125.0	1250.0	--	06/20/2020	02:20	YDCV	06/16/2020	CRP	SW846-3050B
	Copper - Total	EPA 6010B	68.0	mg/Kg	--	0.25	2.50	--	06/19/2020	21:12	YDCV	06/16/2020	CRP	SW846-3050B
	Iron - Total	EPA 6010B	38218	mg/Kg	D	50.0	125.0	--	06/20/2020	06:02	YDCV	06/16/2020	CRP	SW846-3050B
	Magnesium - Total	EPA 6010B	9168	mg/Kg	D	50.0	1000.0	--	06/20/2020	05:35	YDCV	06/16/2020	CRP	SW846-3050B
	Manganese - Total	EPA 6010B	640	mg/Kg	D	1.25	25.00	--	06/20/2020	02:20	YDCV	06/16/2020	CRP	SW846-3050B
	Potassium - Total	EPA 6010B	2649	mg/Kg	D	62.5	250.0	--	06/20/2020	02:20	YDCV	06/16/2020	CRP	SW846-3050B
	Zinc - Total	EPA 6010B	73.7	mg/Kg	--	1.00	12.50	--	06/19/2020	21:12	YDCV	06/16/2020	CRP	SW846-3050B
+	Humidity	ASTM D-2974	9.80	%	--	0.1	0.1	--	06/11/2020	13:49	YVV	--	--	N/A
+	Chloride	EPA 300.0 A	63.5	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM			N/A
+	Sulfate	EPA 300.0 A	34.6	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM			N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Licencia Asociado de Laboratorio NUM.

Certified by Laboratory Director

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ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 9050**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

eqlab ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288357**	Collected Date & Time:	**06/09/2020** 11:12	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Total Solids	SM 2540G	91.1	%	--	0.01	0.01	--	06/11/2020	13:49	YVV	--	--	N/A
+	Total Phosphorus	SM 4500-P A,B,E	183	mg/Kg	D	50.00	250.00	--	06/17/2020	09:57	CMRR	06/16/2020	CMRR	Digestion
	Boron - Total	EPA 6010B	83.6	mg/Kg	--	1.0	5.0	--	06/19/2020	21:18	YDCV	06/16/2020	CRP	SW846-3050B
	Calcium - Total	EPA 6010B	91902	mg/Kg	D	1250.0	12500.0	--	06/20/2020	06:07	YDCV	06/16/2020	CRP	SW846-3050B
	Copper - Total	EPA 6010B	33.1	mg/Kg	--	0.25	2.50	--	06/19/2020	21:18	YDCV	06/16/2020	CRP	SW846-3050B
	Iron - Total	EPA 6010B	26317	mg/Kg	D	50.0	125.0	--	06/20/2020	06:07	YDCV	06/16/2020	CRP	SW846-3050B
	Magnesium - Total	EPA 6010B	41829	mg/Kg	D	250.0	5000.0	--	06/20/2020	06:07	YDCV	06/16/2020	CRP	SW846-3050B
	Manganese - Total	EPA 6010B	628	mg/Kg	D	1.25	25.00	--	06/20/2020	02:26	YDCV	06/16/2020	CRP	SW846-3050B
	Potassium - Total	EPA 6010B	722	mg/Kg	--	12.5	50.0	--	06/19/2020	21:18	YDCV	06/16/2020	CRP	SW846-3050B
	Zinc - Total	EPA 6010B	46.2	mg/Kg	--	1.00	12.50	--	06/19/2020	21:18	YDCV	06/16/2020	CRP	SW846-3050B
+	Humidity	ASTM D-2974	8.90	%	--	0.1	0.1	--	06/11/2020	13:49	YVV	--	--	N/A
+	Chloride	EPA 300.0 A	24.6	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM			N/A
+	Sulfate	EPA 300.0 A	12.3	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM			N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Asociado de Puerto Rico LICENCIA NUM. 45

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
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ACCREDITED IN ACCORDANCE WITH nelac

The results presented herein meet all NELAC requirements.
Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 9051**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288358**	Collected Date & Time:	**06/09/2020** 11:15	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

					Limits			Analysis			Prep Method		
Parameter	Method	Results	Units	DQ	MDL	MRL	MCL	Date	Time	By	Date	By	Method
+ Chloride	EPA 300.0 A	87.3	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+ Sulfate	EPA 300.0 A	46.3	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Estado Libre Asociado de Puerto Rico LICENCIA NUM.

Certified by Laboratory Director

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MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
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ACCREDITED IN ACCORDANCE WITH nelac

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Refer to eqlab certification number E87783 at www.eqlab.com.

PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 9052**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

Laboratory Test Report

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Sample Number:	**3288359**	Collected Date & Time:	**06/09/2020** 11:16	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

					Limits			Analysis			Prep Method		
Parameter	Method	Results	Units	DQ	MDL	MRL	MCL	Date	Time	By	Date	By	Method
+ Chloride	EPA 300.0 A	600	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+ Sulfate	EPA 300.0 A	581	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO RODRIGUEZ Químico Licenciado Colegio de Químicos de Puerto Rico Miembro Asociado de P.R. LICENCIA NUM. 453

Certified by Laboratory Director

ND = Not Detected MCL = Maximum Contaminant Level BDL = Below Detection Limit DNI = Does Not Ignite MDL = Minimum Detection Limit N/A = Not Applicable
MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
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ACCREDITED IN ACCORDANCE WITH nelac

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PRDOH Certified
EPA ID PR00014

ENVIRONMENTAL QUALITY LABORATORIES, INC.
60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

To: JACA & SIERRA
PO BOX 363116
SAN JUAN PR 00936-3116

Attn: MR. ROMMEL CINTRON
Source: **TP 9053**
CAMP SANTIAGO, SALINAS PR

Project Name: INTERNAL
Facility: SALINAS - CAMP SANTIAGO
Description: SOIL - Grab
Client Ref. #: N/A

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

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Laboratory Test Report

Sample Number:	**3288360**	Collected Date & Time:	**06/09/2020** 11:17	Date of Report:	06/30/2020
Work Order:	208-01-73	Received Date & Time:	06/10/2020 08:30	Collected By:	CLIENT
Delivery Slip:	2020-06337	Temperature at Arrival:	ROOM TEMPERATURE	Eqlab Rep.:	ELAZARO
Folder Number:	290233			Proposal Number:	24657 - 2

Remarks:

	Parameter	Method	Results	Units	DQ	Limits MDL	Limits MRL	Limits MCL	Analysis Date	Analysis Time	Analysis By	Prep Method Date	Prep Method By	Prep Method Method
+	Total Solids	SM 2540G	88.0	%	--	0.01	0.01	--	06/11/2020	13:49	YVV	--	--	N/A
+	Total Phosphorus	SM 4500-P A,B,E	298	mg/Kg	D	50.00	250.00	--	06/17/2020	09:57	CMRR	06/16/2020	CMRR	Digestion
	Boron - Total	EPA 6010B	99.0	mg/Kg	--	1.0	5.0	--	06/19/2020	21:25	YDCV	06/16/2020	CRP	SW846-3050B
	Calcium - Total	EPA 6010B	32935	mg/Kg	D	125.0	1250.0	--	06/20/2020	02:33	YDCV	06/16/2020	CRP	SW846-3050B
	Copper - Total	EPA 6010B	49.9	mg/Kg	--	0.25	2.50	--	06/19/2020	21:25	YDCV	06/16/2020	CRP	SW846-3050B
	Iron - Total	EPA 6010B	33433	mg/Kg	D	50.0	125.0	--	06/20/2020	06:11	YDCV	06/16/2020	CRP	SW846-3050B
	Magnesium - Total	EPA 6010B	20687	mg/Kg	D	250.0	5000.0	--	06/20/2020	06:11	YDCV	06/16/2020	CRP	SW846-3050B
	Manganese - Total	EPA 6010B	449	mg/Kg	D	1.25	25.00	--	06/20/2020	02:33	YDCV	06/16/2020	CRP	SW846-3050B
	Potassium - Total	EPA 6010B	1836	mg/Kg	D	62.5	250.0	--	06/20/2020	02:33	YDCV	06/16/2020	CRP	SW846-3050B
	Zinc - Total	EPA 6010B	71.4	mg/Kg	--	1.00	12.50	--	06/19/2020	21:25	YDCV	06/16/2020	CRP	SW846-3050B
+	Humidity	ASTM D-2974	12.0	%	--	0.1	0.1	--	06/11/2020	13:49	YVV	--	--	N/A
+	Chloride	EPA 300.0 A	76.2	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A
+	Sulfate	EPA 300.0 A	36.1	mg/Kg	--	0.50	5.00	--	06/16/2020	16:58	GVM	--	--	N/A

SONIA PICHARDO-RODRIGUEZ Químico Licenciado Licencia Núm. 4509 Profesional Asociado de Puerto Rico

Certified by Laboratory Director

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MO = Monitoring Only MRL = Minimum Reporting Level PTRL = Pattern Recognition Level. All results are calculated on a wet weight basis unless otherwise stated. All results relate only to this sample.
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PRDOH Certified
EPA ID PR00014

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60 E STREET, MINILLAS INDUSTRIAL PARK, BAYAMÓN, PR 00959
PO BOX 11458 SANTURCE, PR 00910-1458 TEL. (787) 288-6420 FAX (787) 288-6465 www.eqlab.com

ENVIRONMENTAL QUALITY LABORATORIES, INC.

SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2020-06337

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: JACA & SIERRA | CLIENT ID: 208-01 | W.O. #: 73 | SITE: CAMP SANTIAGO, SALINAS PR | CLIENT REP: MR. ROMMEL CINTRON

P.O. #: WAF | PWSID #: | FOLDER #: 290233 | PROJECT: SOIL SAMPLES | EQLAB REP: ELAZARO

SAMPLE INFORMATION		CONTAINER INFORMATION	FIELD TESTING	ANALYSIS REQUESTED
SAMPLE #: 3288351-1 MATRIX: SOIL SOURCE: TP 1683, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 10:54 TYPE: Grab	TYPE: G/TC COLOR: CLEAR VOLUME: 8 PRESERVATIVE: Cool 4 °C		Total Phosphorus, Total Solids - %
SAMPLE #: 3288351-2 MATRIX: SOIL SOURCE: TP 1683, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 10:54 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 8 PRESERVATIVE: Cool 4 °C		EPA 300.0 A, Humidity
SAMPLE #: 3288351-3 MATRIX: SOIL SOURCE: TP 1683, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 10:54 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 4 PRESERVATIVE: None		ICP Total Metals: Zn, B, Ca, K, Fe, Mg, Mn, Cu,
SAMPLE #: 3288352-1 MATRIX: SOIL SOURCE: TP 1684, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 10:38 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 4 PRESERVATIVE: Cool 4 °C		EPA 300.0 A

CUSTODY RECORD	SIGNATURE	DATE	TIME
Collected in field by:	Client	06/09/20	
Fixed in field by:	Client	06/04/20	10:54
Authorized by:	N/A	N/A	N/A
Received by EQLF:	N/A	N/A	N/A
Released to EQLL by:	Marcelino Pereira	06/10/20	0830
Received by EQLL:		06/10/20	0830

SPECIAL INSTRUCTIONS / COMMENTS:

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: 27 Signature:

Eqlab's general terms and conditions on reverse side of this document.

PVAR

+++

ENVIRONMENTAL QUALITY LABORATORIES, INC.

SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2020-06337

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: JACA & SIERRA | CLIENT ID: 208-01 | W.O. #: 73 | SITE: CAMP SANTIAGO, SALINAS PR. | CLIENT REP: MR. ROMMEL CINTRON

P.O. #: WAF | PWSID #: | FOLDER #: 290233 | PROJECT: SOIL SAMPLES | EQLAB REP: ELAZARO

SAMPLE INFORMATION		CONTAINER INFORMATION	FIELD TESTING	ANALYSIS REQUESTED
SAMPLE #: 3288353-1 MATRIX: SOIL SOURCE: TP 1685, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:04 TYPE: Grab	TYPE: G/TC COLOR: CLEAR VOLUME: 8 PRESERVATIVE: Cool 4 °C		Total Phosphorus, Total Solids - %
SAMPLE #: 3288353-2 MATRIX: SOIL SOURCE: TP 1685, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:04 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 8 PRESERVATIVE: Cool 4 °C		EPA 300.0 A, Humidity
SAMPLE #: 3288353-3 MATRIX: SOIL SOURCE: TP 1685, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:04 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 4 PRESERVATIVE: None		ICP Total Metals: Zn, B, Ca, K, Fe, Mg, Mn, Cu,
SAMPLE #: 3288354-1 MATRIX: SOIL SOURCE: TP 1686, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:06 TYPE: Grab	TYPE: G/PC COLOR: CLEAR VOLUME: 4 PRESERVATIVE: Cool 4 °C		EPA 300.0 A

CUSTODY RECORD	SIGNATURE	DATE	TIME
Collected in field by:	Efrain Efrain	06/09/20	
Fixed in field by:	Efrain Efrain	06/09/20	Varies
Authorized by:			
Received by EQLF:			
Released to EQLL by:	Marcelino Pereira	06/10/20	0830
Received by EQLL:	Diego Cruz	06/10/20	0830

SPECIAL INSTRUCTIONS / COMMENTS:

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: [illegible] Signature: [illegible]

Eqlab's general terms and conditions on reverse side of this document.

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2020-06337

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: JACA & SIERRA | CLIENT ID: 208-01 | W.O. #: 73 | SITE: CAMP SANTIAGO, SALINAS PR | CLIENT REP: MR. ROMMEL CINTRON

P.O. #: WAF | PWSID #: | FOLDER #: 290233 | PROJECT: SOIL SAMPLES | EQLAB REP: ELAZARO

SAMPLE INFORMATION		CONTAINER INFORMATION	FIELD TESTING	ANALYSIS REQUESTED
SAMPLE #: 3288355-1 MATRIX: SOIL SOURCE: TP 1687, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:07 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: Cool 4 °C		EPA 300.0 A
SAMPLE #: 3288356-1 MATRIX: SOIL SOURCE: TP 9049, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:09 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		EPA 300.0 A, Humidity
SAMPLE #: 3288356-2 MATRIX: SOIL SOURCE: TP 9049, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:09 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: None		ICP Total Metals: Zn, B, Ca, K, Fe, Mg, Mn, Cu,
SAMPLE #: 3288356-3 MATRIX: SOIL SOURCE: TP 9049, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:09 TYPE: Grab	TYPE: G/TC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		Total Phosphorus, Total Solids - %

CUSTODY RECORD	SIGNATURE	DATE	TIME
Collected in field by:	[signature]	06/09/20	varias
Fixed in field by:	[signature]	06/09/20	varias
Authorized by:	[signature]	[signature]	[signature]
Received by EQLF:	[signature]	[signature]	[signature]
Released to EQLL by:	Marcelino Pereira	06/10/20	0830
Received by EQLL:	[signature]	06/10/20	0830

SPECIAL INSTRUCTIONS / COMMENTS:

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: [signature] Signature: [signature]

Eqlab's general terms and conditions on reverse side of this document.

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2020-06337

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: JACA & SIERRA | CLIENT ID: 208-01 | W.O. #: 73 | SITE: CAMP SANTIAGO, SALINAS PR | CLIENT REP: MR. ROMMEL CINTRON

P.O. #: WAF | PWSID #: | FOLDER #: 290233 | PROJECT: SOIL SAMPLES | EQLAB REP: ELAZARO

SAMPLE INFORMATION		CONTAINER INFORMATION	FIELD TESTING	ANALYSIS REQUESTED
SAMPLE #: 3288357-1 MATRIX: SOIL SOURCE: TP 9050, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:12 TYPE: Grab	TYPE: G/TC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		Total Phosphorus, Total Solids - %
SAMPLE #: 3288357-2 MATRIX: SOIL SOURCE: TP 9050, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:12 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: None		ICP Total Metals: Zn, B, Ca, K, Fe, Mg, Mn, Cu,
SAMPLE #: 3288357-3 MATRIX: SOIL SOURCE: TP 9050, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:12 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		EPA 300.0 A, Humidity
SAMPLE #: 3288358-1 MATRIX: SOIL SOURCE: TP 9051, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:15 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: Cool 4 °C		EPA 300.0 A

CUSTODY RECORD	SIGNATURE	DATE	TIME
Collected in field by:		06/09/20	
Fixed in field by:		06/09/20	1115
Authorized by:			
Received by EQLF:			
Released to EQLL by:	Marcel Moreira	06/10/20	0830
Received by EQLL:	Diego Cesar	06/10/20	0830

SPECIAL INSTRUCTIONS / COMMENTS:

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: _____ Signature: _____

Eqlab's general terms and conditions on reverse side of this document.

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ENVIRONMENTAL QUALITY LABORATORIES, INC.

SAMPLE DELIVERY SLIP & CHAIN OF CUSTODY

2020-06337

PO BOX 11458, SAN JUAN, PR 00910-1458 • TEL. (787) 288-6420, FAX (787) 288-6465, e-mail: info@eqlab.com

CLIENT NAME: JACA & SIERRA | CLIENT ID: 208-01 | W.O. #: 73 | SITE: CAMP SANTIAGO, SALINAS PR | CLIENT REP: MR. ROMMEL CINTRON

P.O. #: WAF | PWSID #: | FOLDER #: 290233 | PROJECT: SOIL SAMPLES | EQLAB REP: ELAZARO

SAMPLE INFORMATION		CONTAINER INFORMATION	FIELD TESTING	ANALYSIS REQUESTED
SAMPLE #: 3288359-1 MATRIX: SOIL SOURCE: TP 9052, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:16 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: Cool 4 °C		EPA 300.0 A
SAMPLE #: 3288360-1 MATRIX: SOIL SOURCE: TP 9053, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:17 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 4 PRESERVATIVE: None		ICP Total Metals: Zn, B, Ca, K, Fe, Mg, Mn, Cu,
SAMPLE #: 3288360-2 MATRIX: SOIL SOURCE: TP 9053, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:17 TYPE: Grab	TYPE: G/PC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		EPA 300.0 A, Humidity
SAMPLE #: 3288360-3 MATRIX: SOIL SOURCE: TP 9053, CAMP SANTIAGO, SALINAS PR	DATE: 06/09/20 TIME: 11:17 TYPE: Grab	TYPE: G/TC, COLOR: CLEAR, VOLUME: 8 PRESERVATIVE: Cool 4 °C		Total Phosphorus, Total Solids - %

CUSTODY RECORD	SIGNATURE	DATE	TIME
Collected in field by:	Client	06/09/20	
Fixed in field by:		06/09/20	11:45
Authorized by:			
Received by EQLF:			
Released to EQLL by:	Marcelina Oliveira	06/10/20	0830
Received by EQLL:		06/10/20	0830

SPECIAL INSTRUCTIONS / COMMENTS:

*EQLF = Eqlab's Field Personnel.
*EQLL = Eqlab's Log-in Personnel.

Arrival Temperature: 4 Signature:

Eqlab's general terms and conditions on reverse side of this document.

Michael Baker
INTERNATIONAL

We Make a Difference

Organic Content Test Results

Camp Santiago Facility Restoration

MBAKERINTL.COM

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Laboratory Test Results

Organic Content (ASTM D2974)

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Samples: 10
Date: May 22, 2020
Technician: J. Cruz
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Test Pit ID	Sample ID	Depth (ft)	Organic Content (%)
TP-1683	S1	1-4	4.0
TP-1684	S1	1-4.5	6.6
TP-1685	S1	2.5-4.5	4.9
TP-1686	S1	2.5-4.5	5.1
TP-1687	S1	1.5-4	6.5
TP-9049	S1	1-4.5	3.5
TP-9050	S1	1.5-4.5	6.4
TP-9051	S1	2-4.5	7.0
TP-9052	S1	1.5-4.5	7.4
TP-9053	S1	1-4	8.3

Michael Baker
INTERNATIONAL

We Make a Difference

Carbonate Content Tests Results

JACA & SIERRA
Testing Laboratories
Geotechnical Engineers

Laboratory Test Results

Carbonate Content (ASTM D4373)

Client: Michael Baker International
Project: Joint Training Center
Location: Camp Santiago, Salinas, PR
Job No.: 8081
No. of Samples: 6
Date: August 3, 2020
External Lab: GeoTesting Express, Inc.
Engineer: Rommel Cintrón Aponte, MSCE, PE

RESULTS

Test Pit ID	Sample ID	Depth (ft)	CO_2 Pressure (psi)	Weight of Sample Used (g)	Weight of $CaCO_3$ (g)	Calcite Equivalent (%)
TP-1687	S1	1.5-4	0.90	1.00	0.11	11
TP-9049	S1	1-4.5	0.10	2.06	0.01	1
TP-9050	S1	1.5-4.5	2.70	1.03	0.32	31
TP-9051	S1	2-4.5	1.60	1.01	0.19	19
TP-9052	S1	1.5-4.5	1.40	1.03	0.18	17
TP-9053	S1	1-4	0.40	1.06	0.05	4

Michael Baker
INTERNATIONAL

We Make a Difference

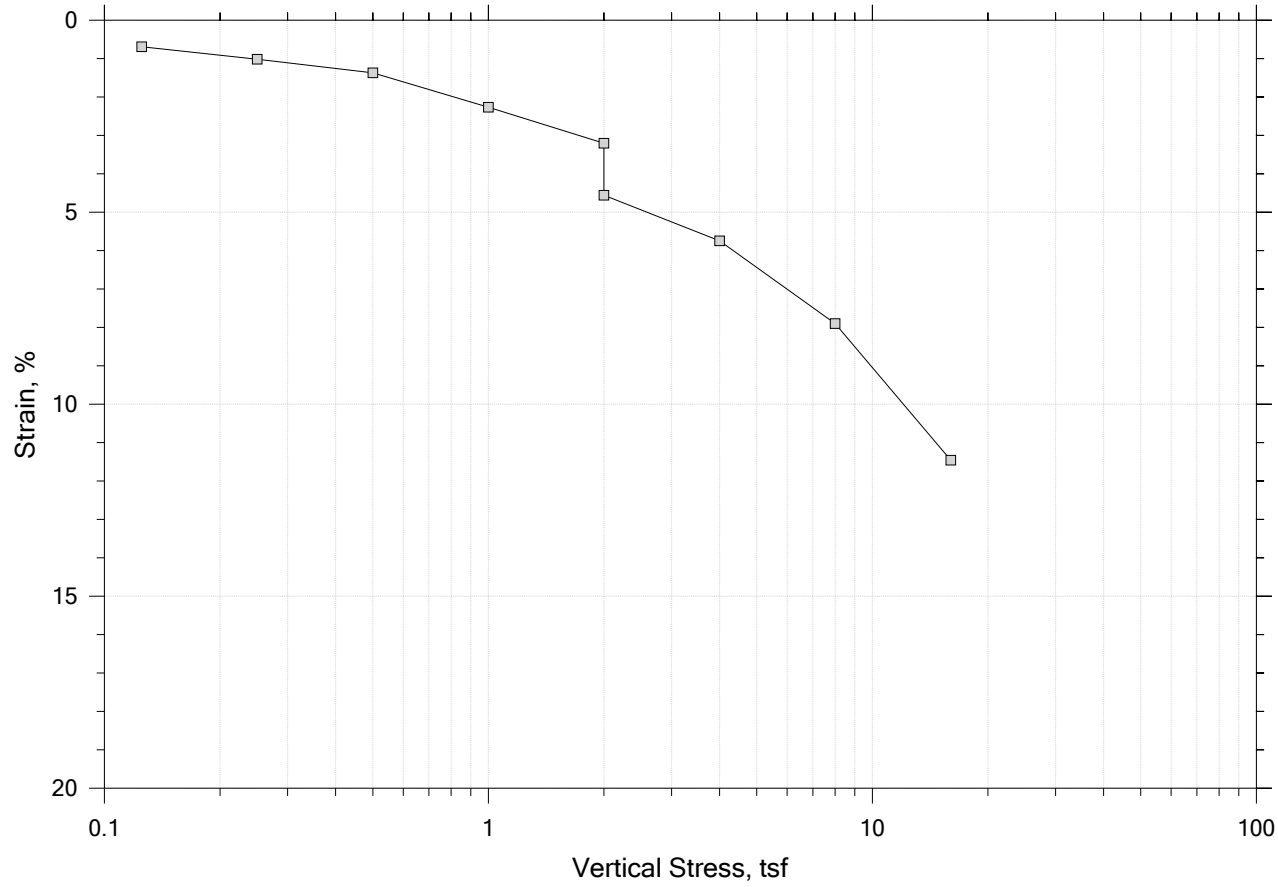
Soil Collapse Potential Tests Results

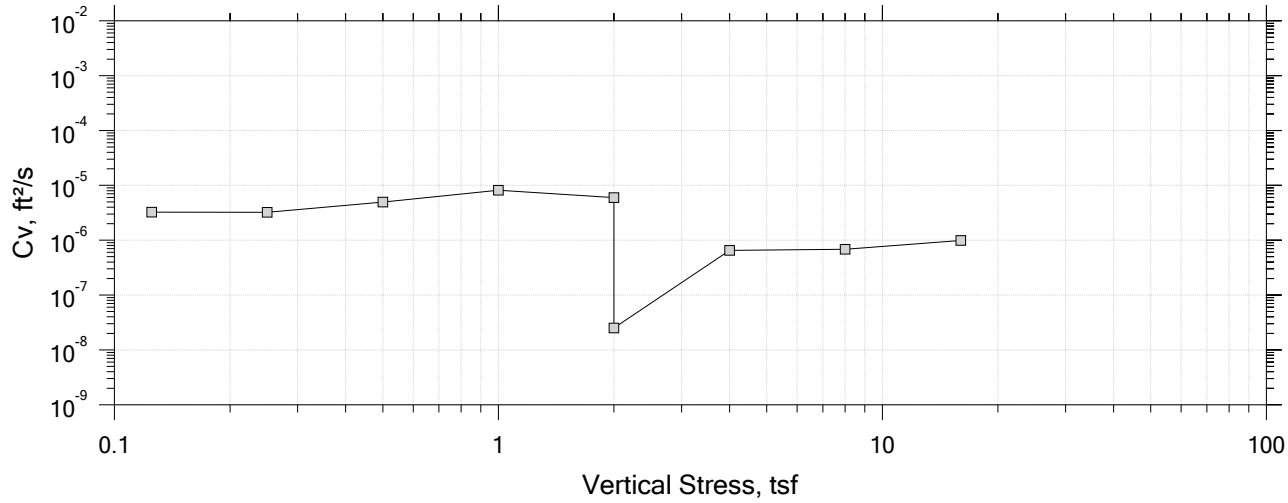
Camp Santiago Facility Restoration

MBAKERINTL.COM

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report





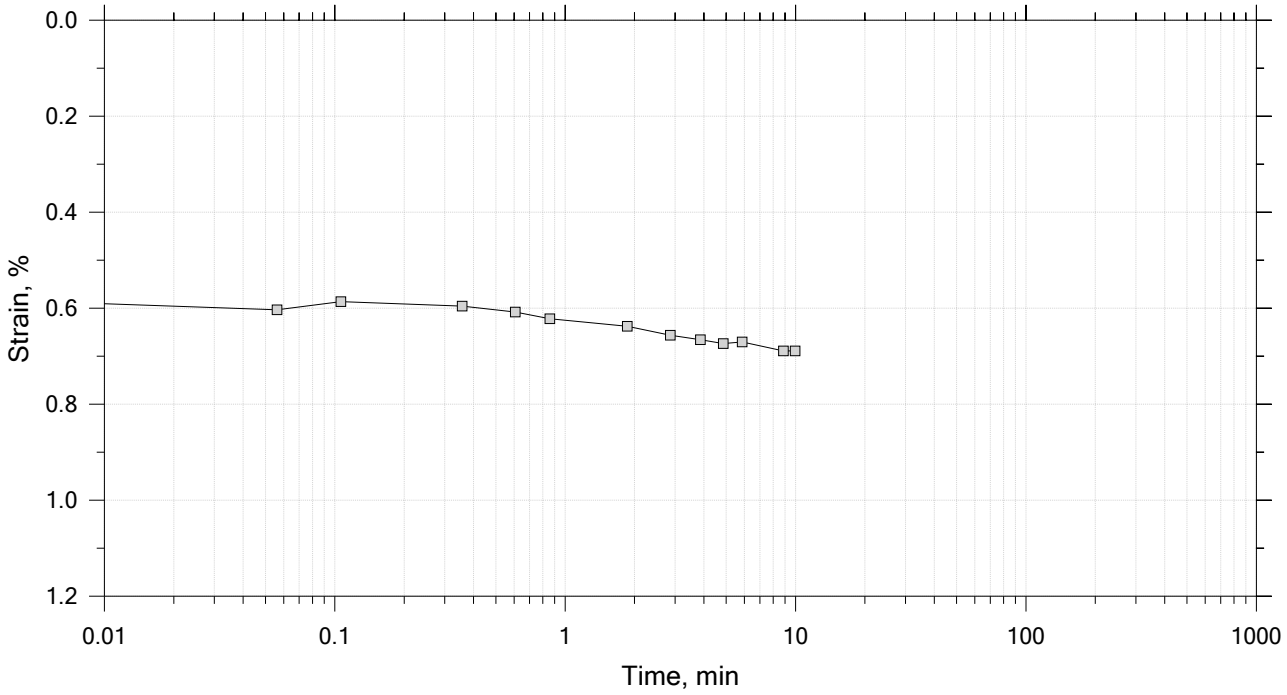
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-3	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		
	Displacement at End of Increment		

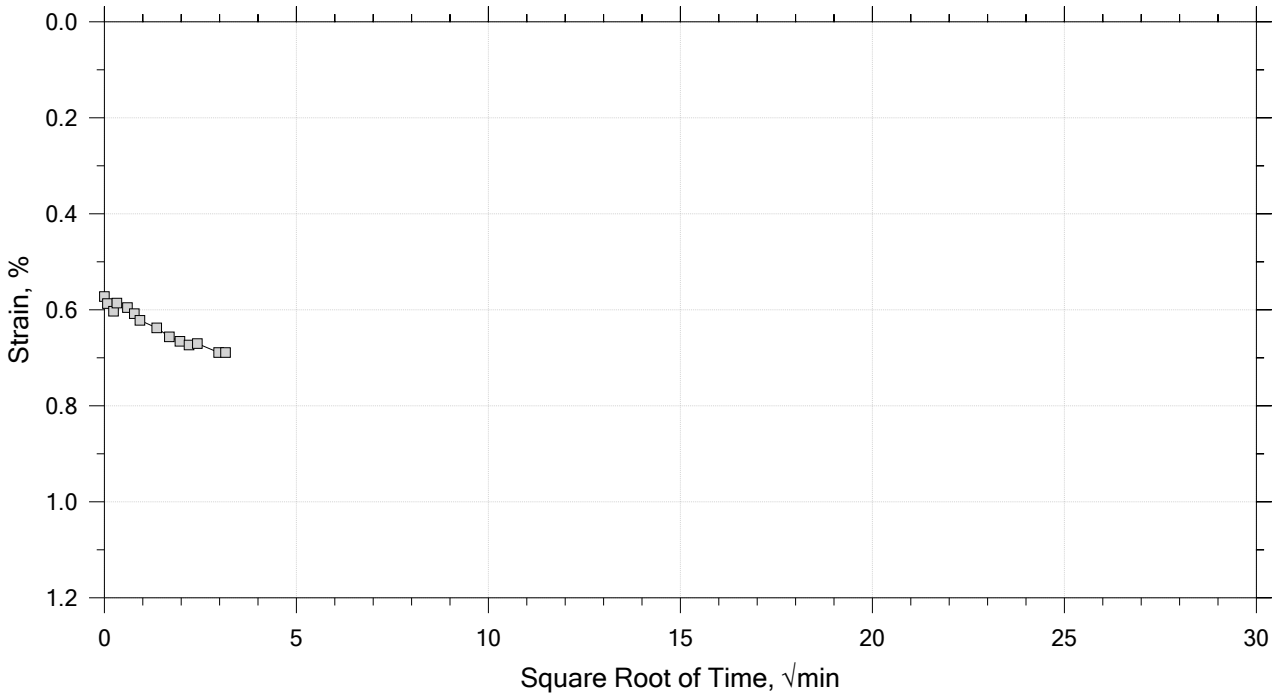
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9

Constant Load Step

Stress: 0.125 tsf

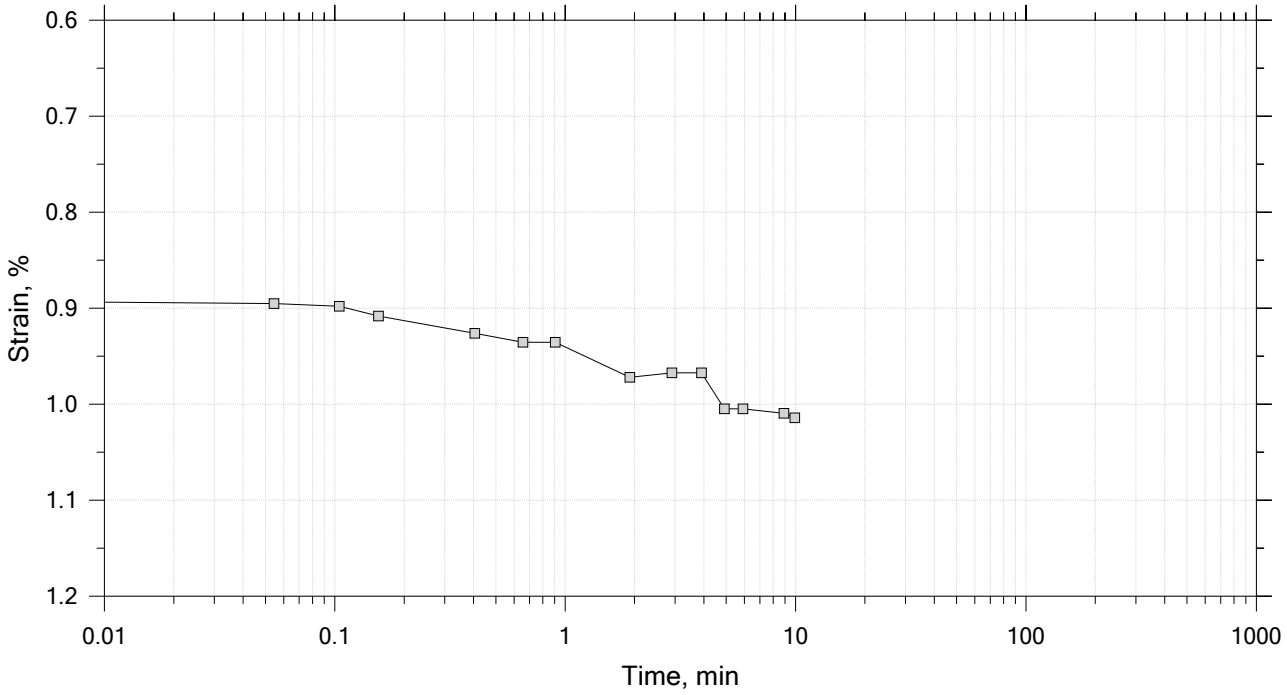


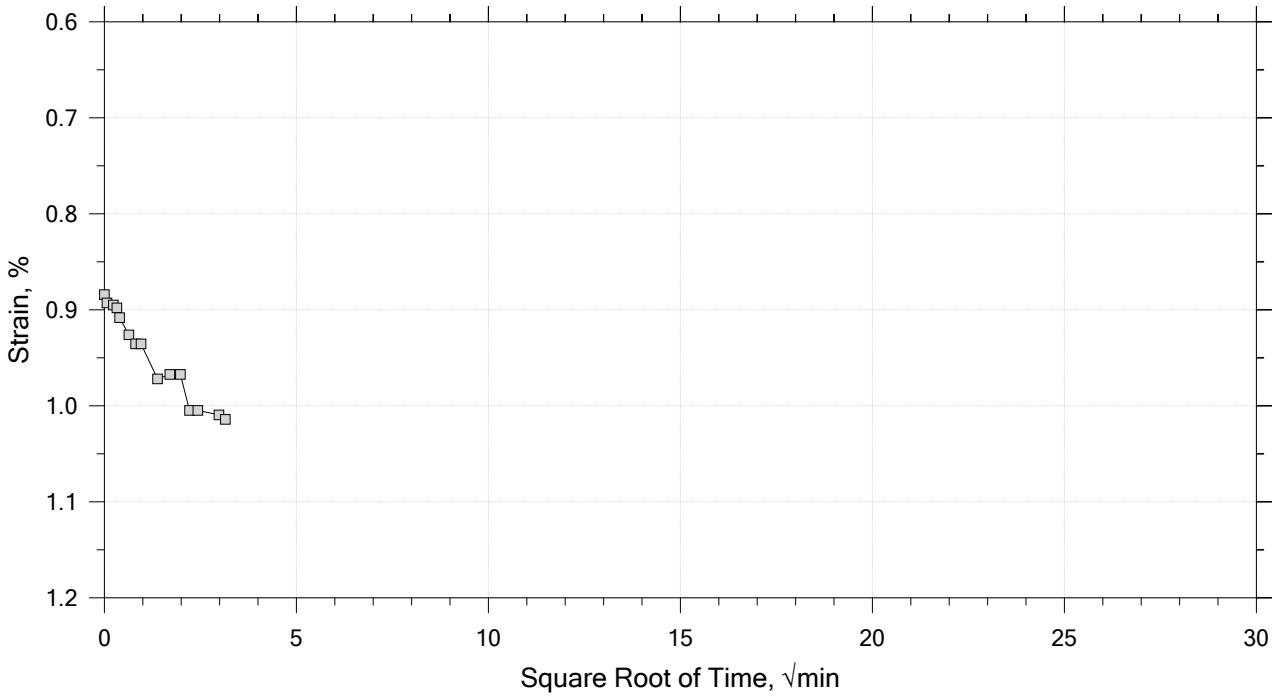


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

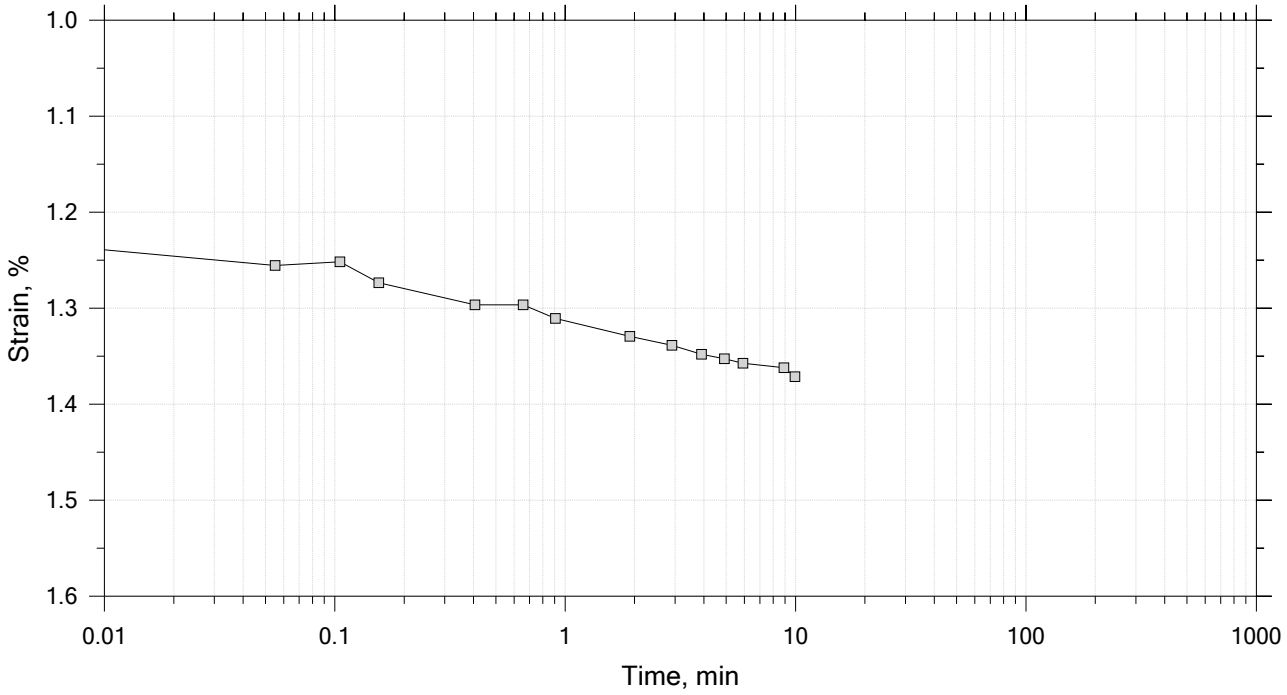


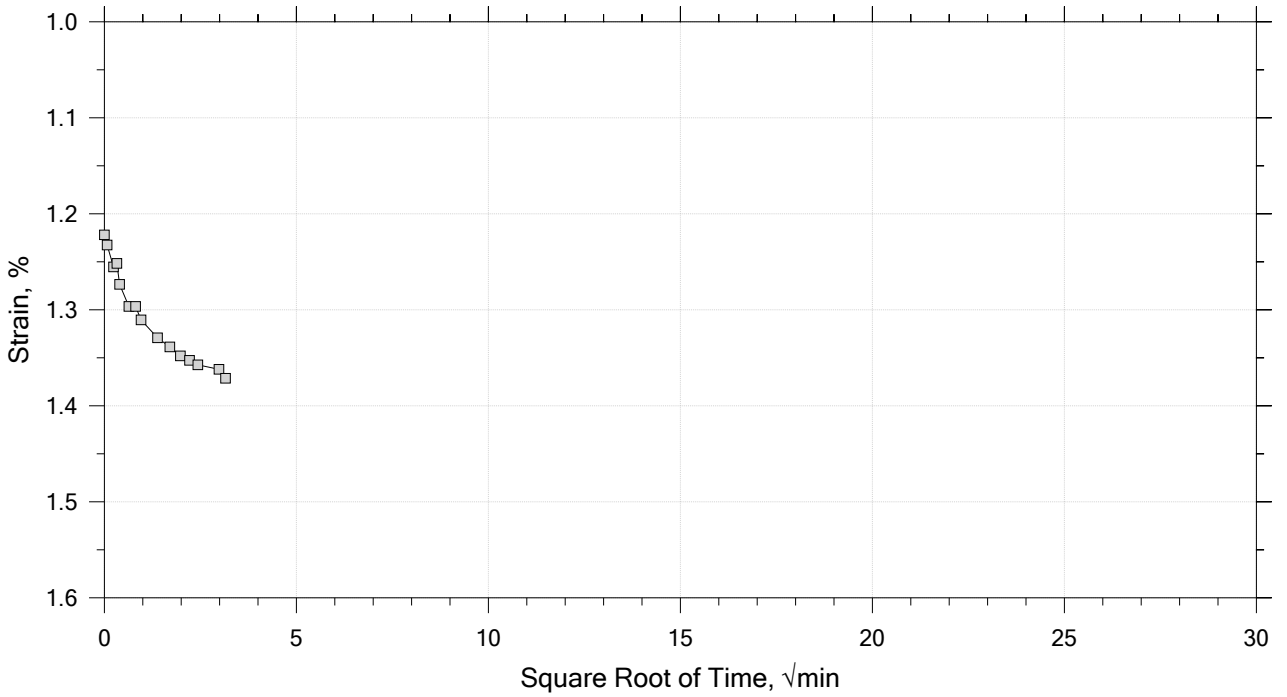


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf

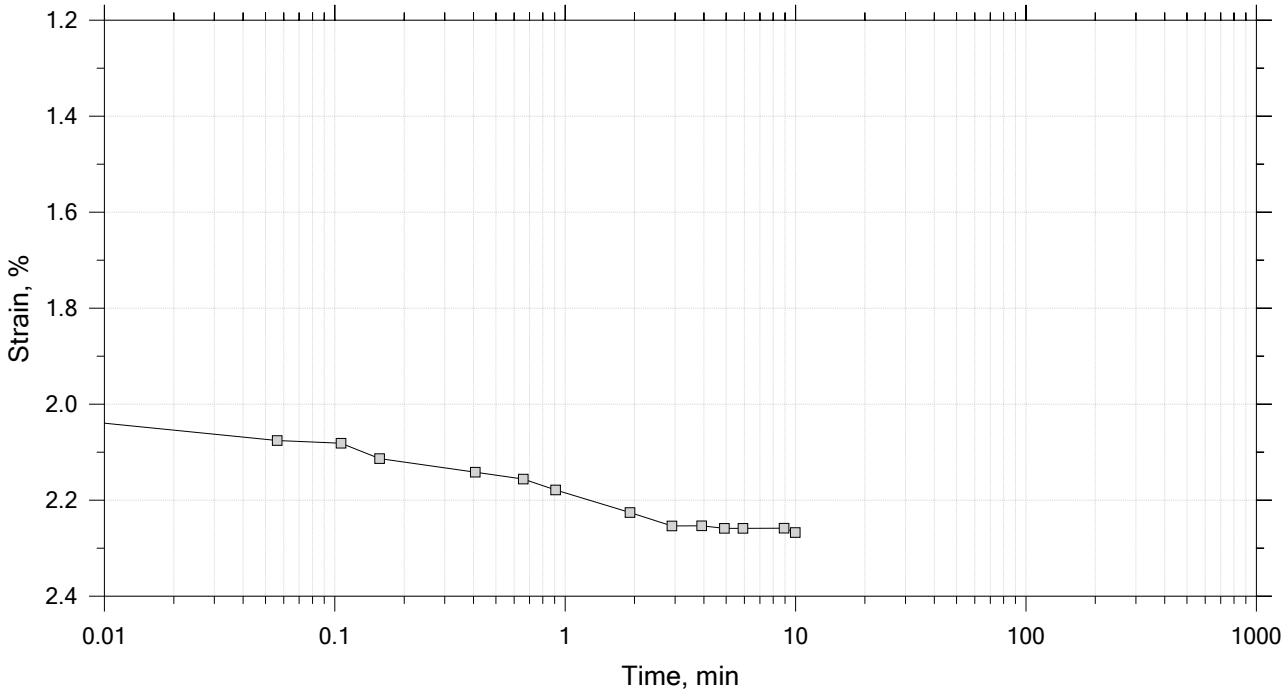


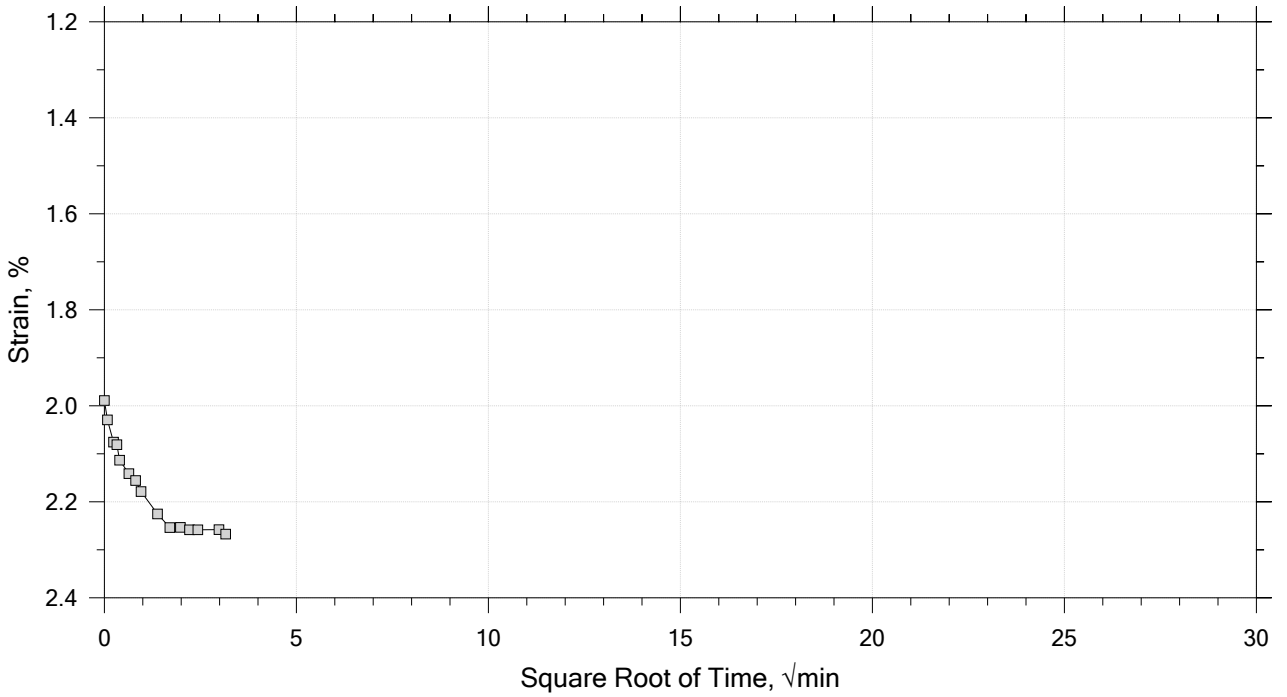


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9
Constant Load Step
Stress: 1 tsf

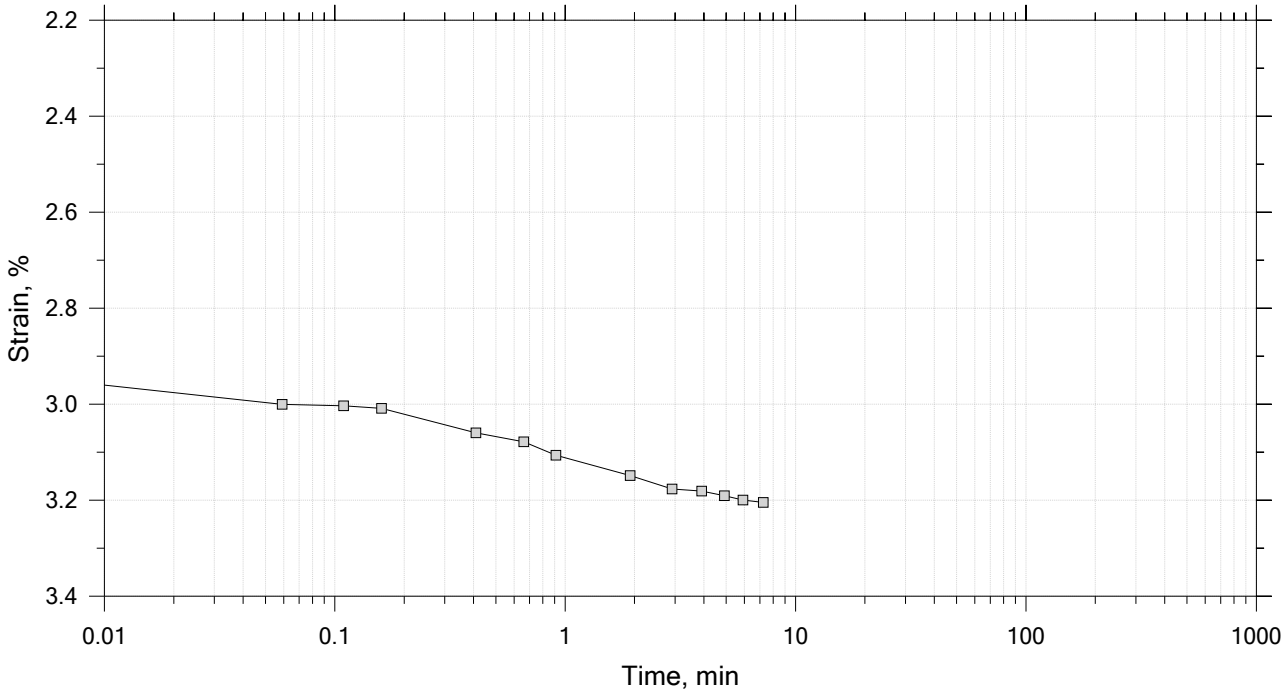


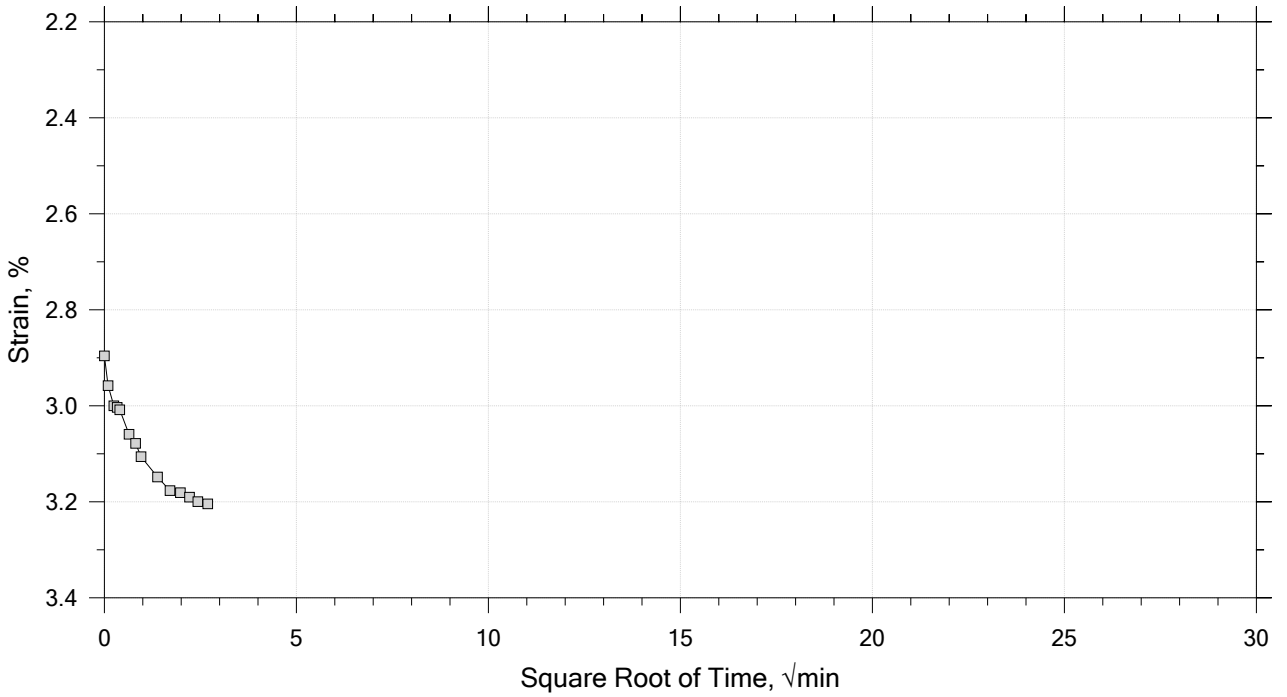


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9
Constant Load Step
Stress: 2 tsf





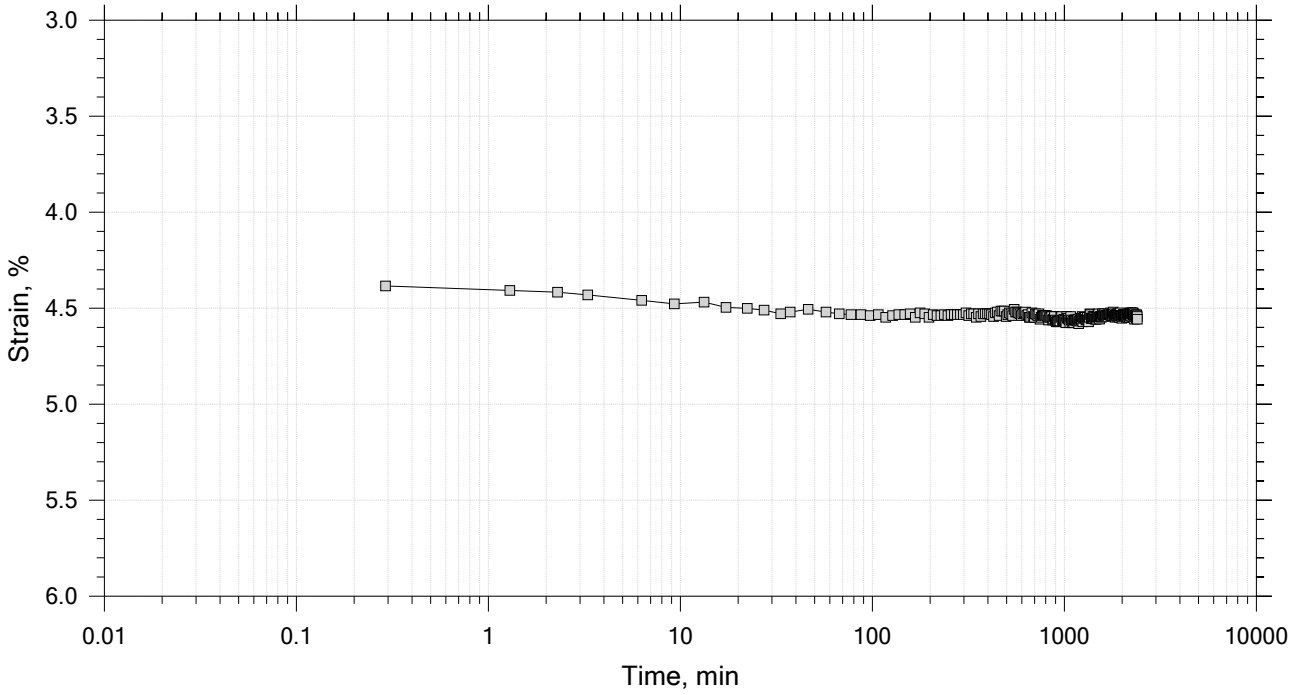
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

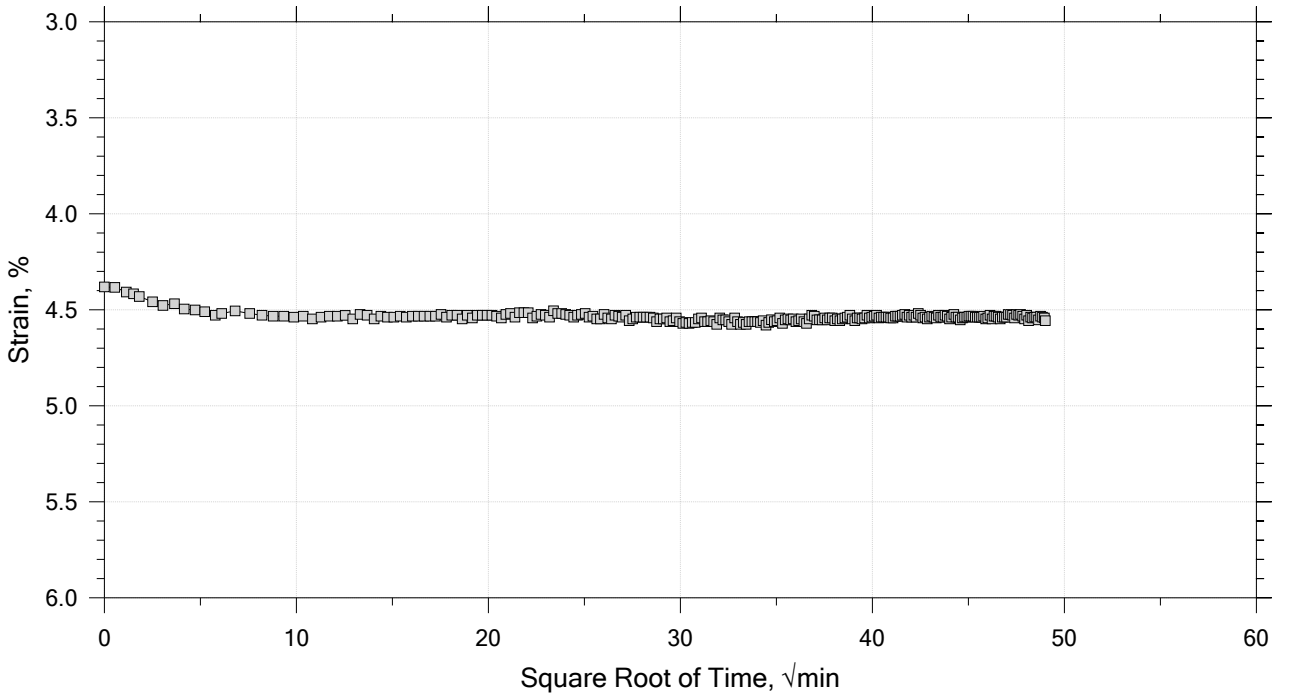
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

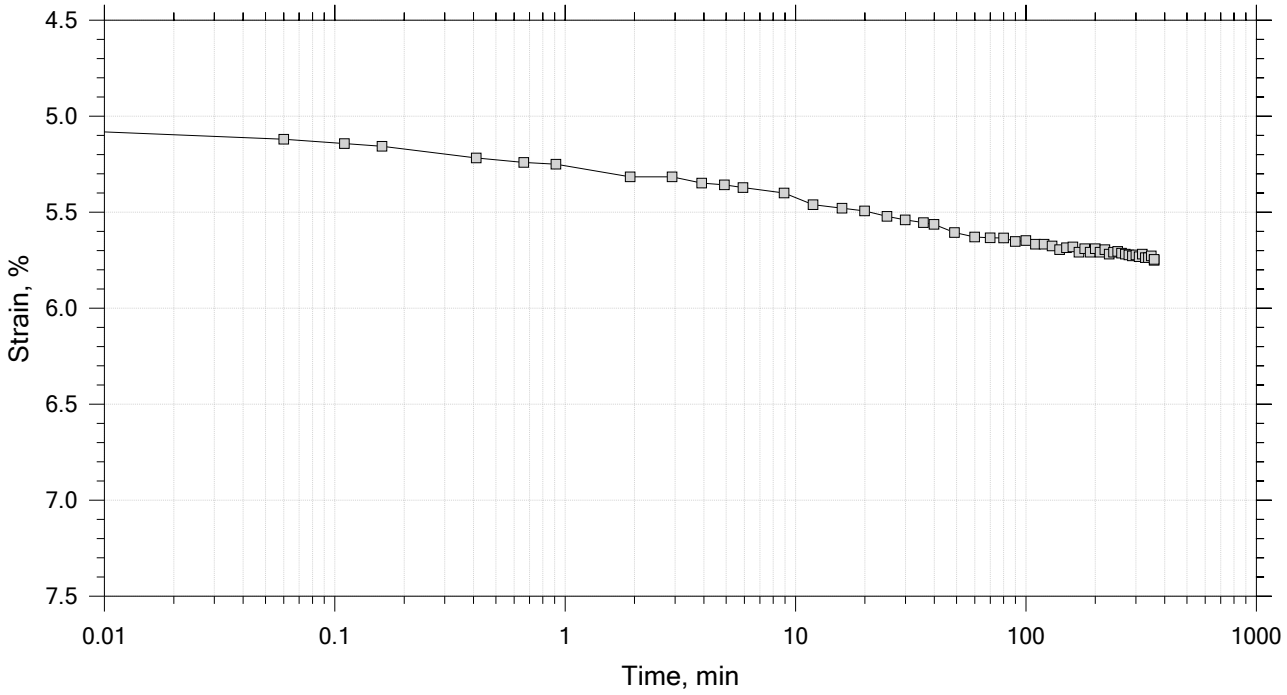


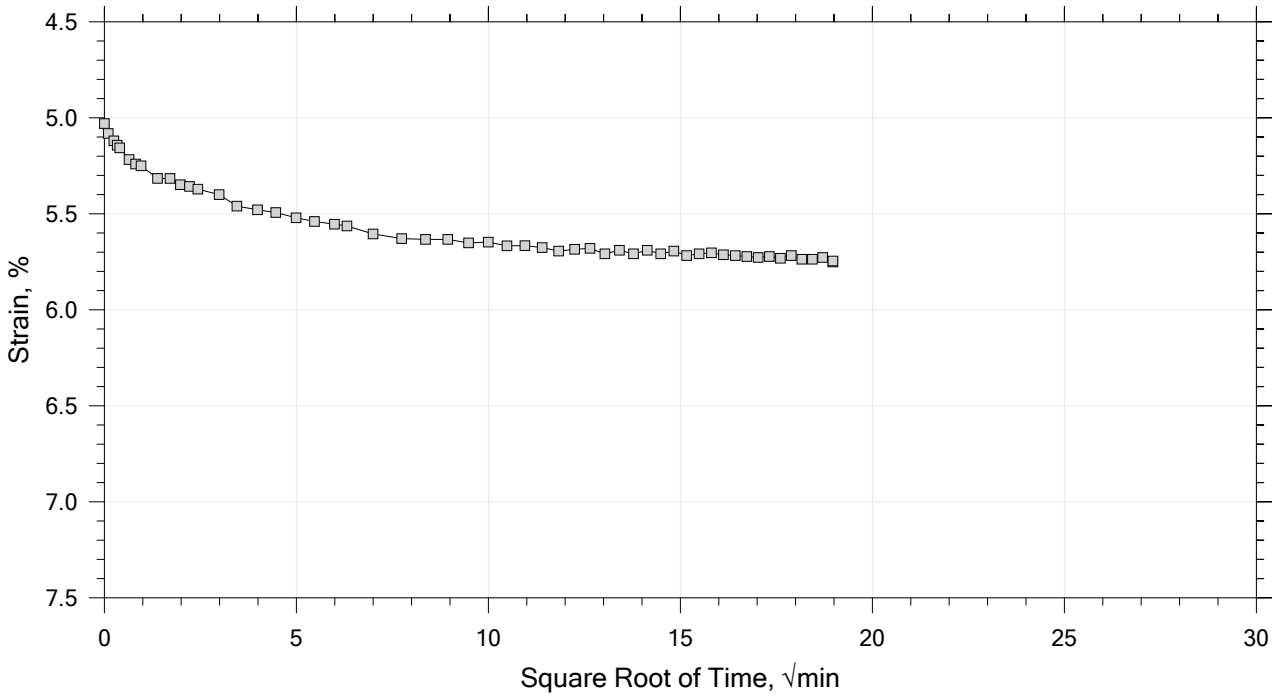


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-3	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9
Constant Load Step
Stress: 4 tsf





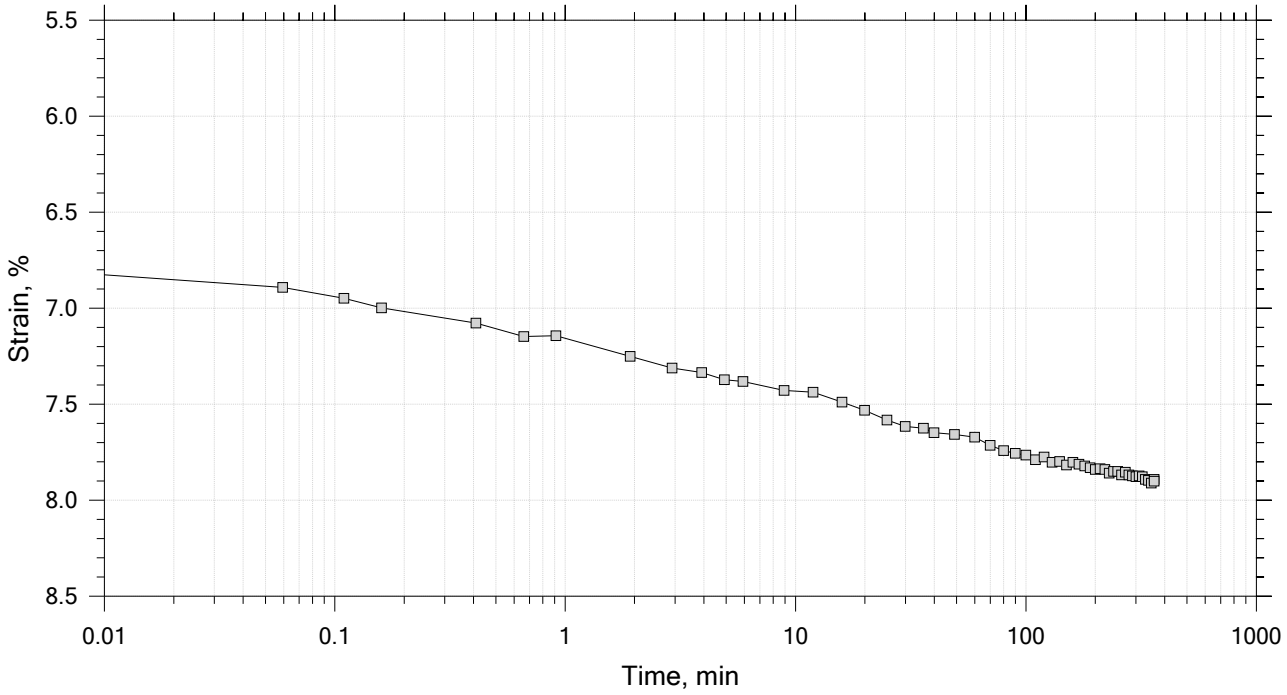
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

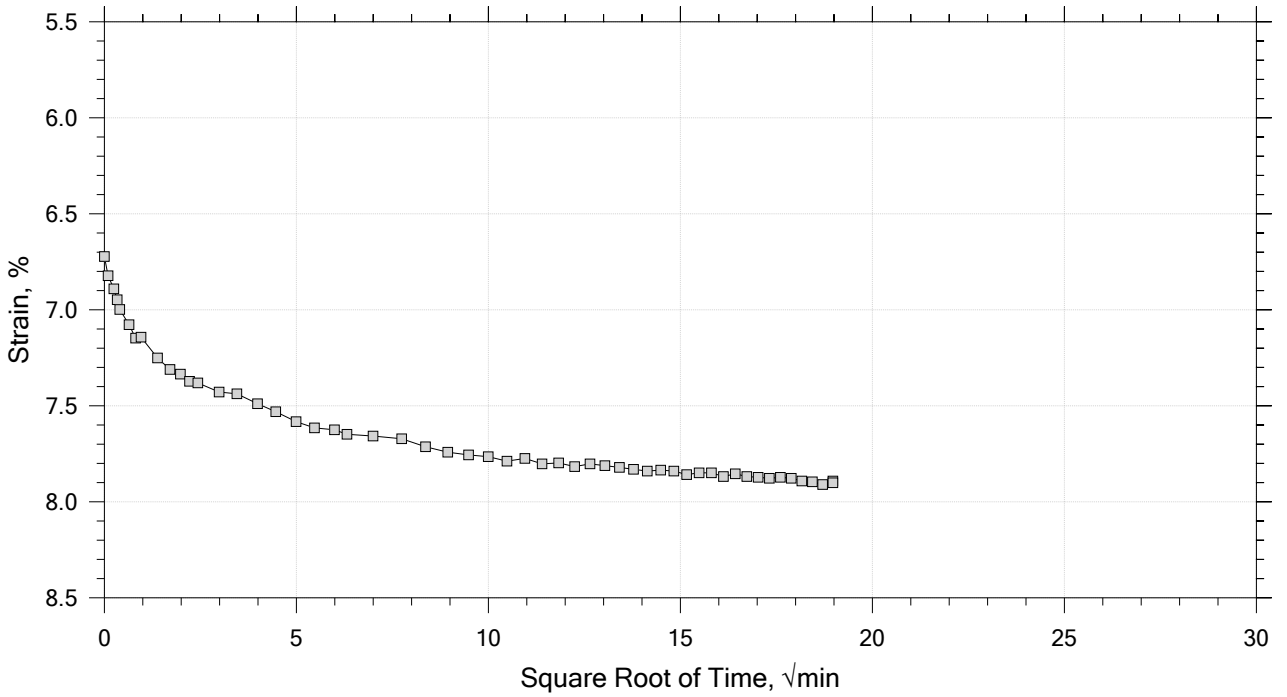
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9

Constant Load Step

Stress: 8 tsf

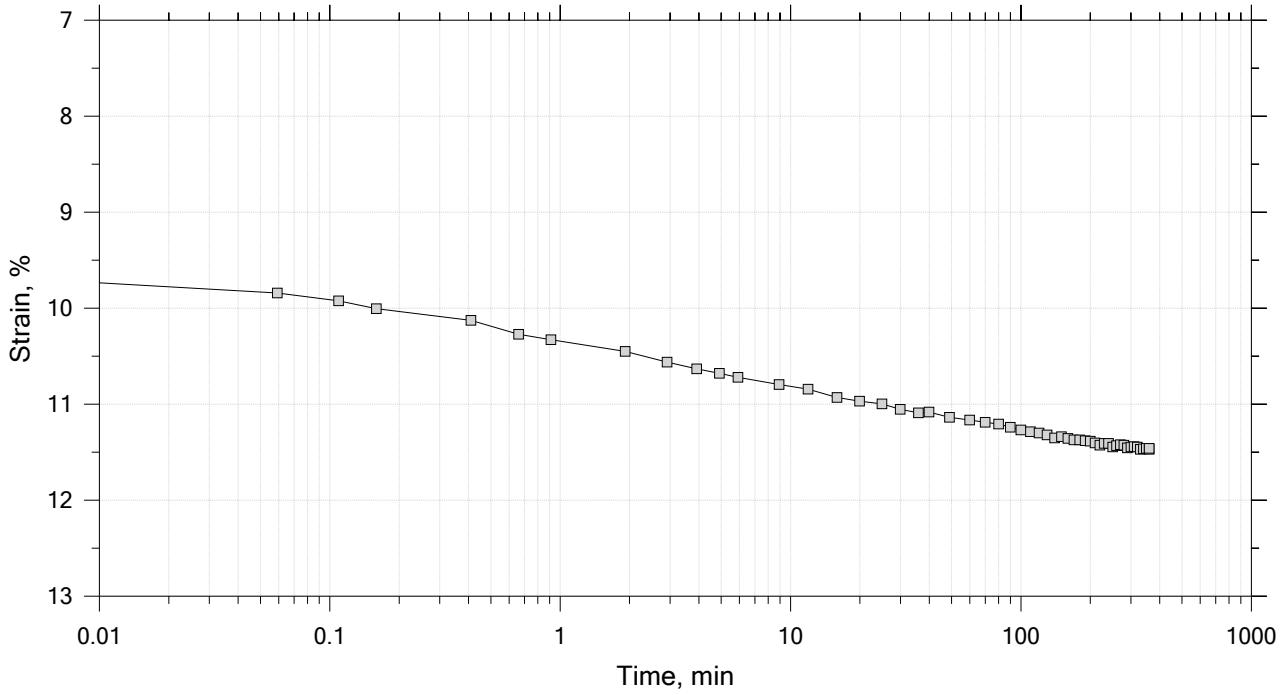


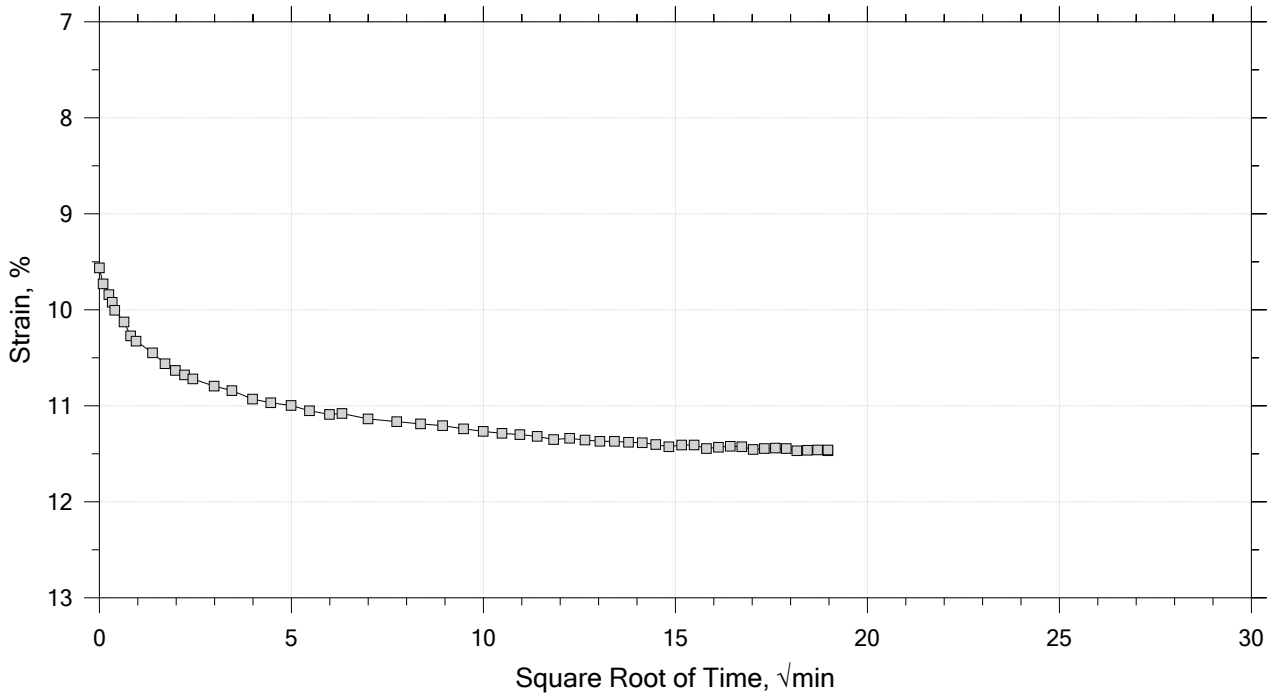


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.64	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.559	Plastic Limit: ---
Final Height: 0.95 in	Final Void Ratio: 0.481	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	D-1833	RING		B2220
Mass Container, gm	8.33	109.06	109.06	8.34
Mass Container + Wet Soil, gm	88.92	259.69	270	168.73
Mass Container + Dry Soil, gm	79.68	245.19	245.19	144
Mass Dry Soil, gm	71.35	136.13	136.13	135.66
Water Content, %	12.95	10.66	18.23	18.23
Void Ratio	---	0.56	0.48	---
Degree of Saturation, %	---	50.30	100.00	---
Dry Unit Weight, pcf	---	105.64	111.2	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-3	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Square Root of Time Coefficients

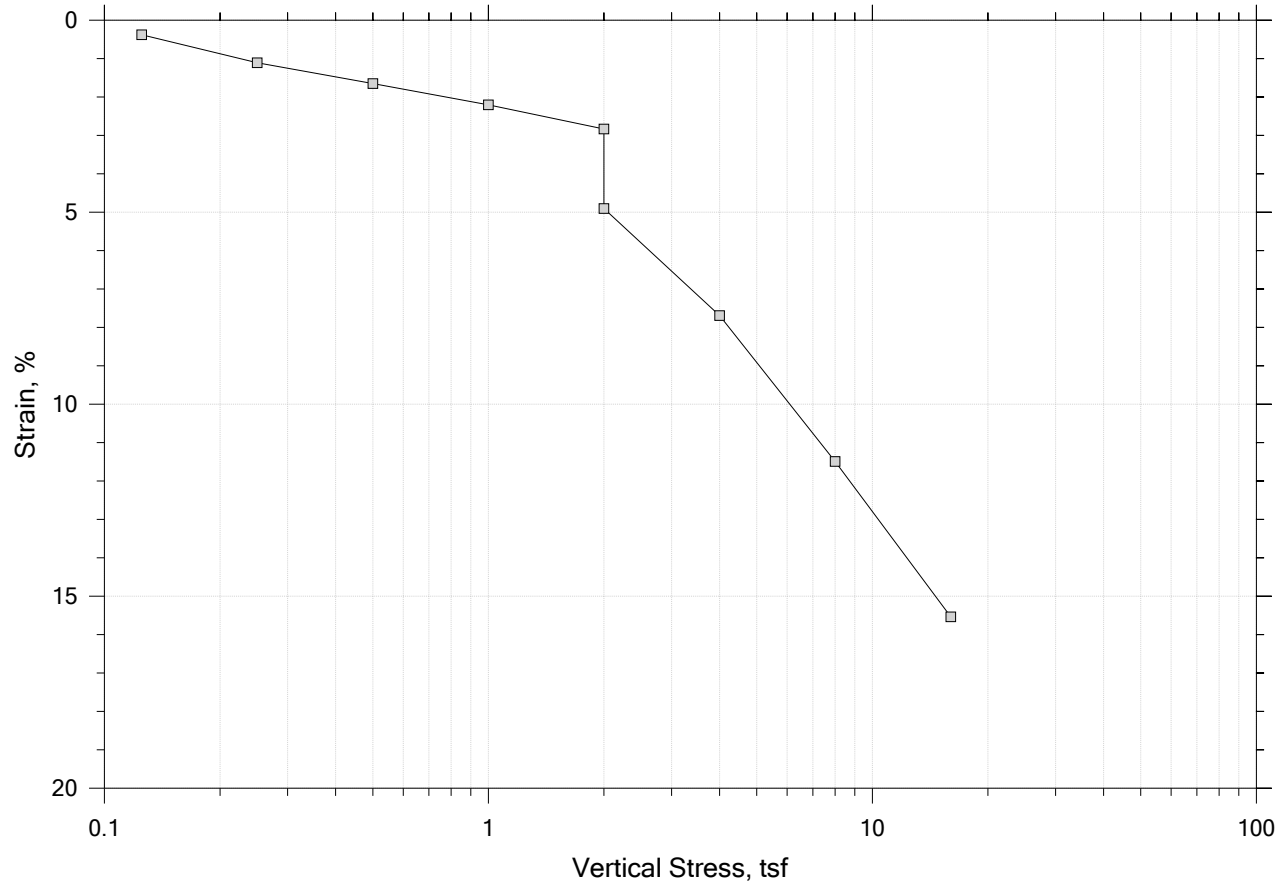
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.125	0.006891	0.548	0.689	7.521	3.24e-06	5.51e-02	4.82e-04
2	0.250	0.01014	0.543	1.01	7.507	3.21e-06	2.60e-02	2.25e-04
3	0.500	0.01371	0.537	1.37	4.823	4.97e-06	1.43e-02	1.91e-04
4	1.00	0.02267	0.523	2.27	2.902	8.15e-06	1.79e-02	3.94e-04
5	2.00	0.03205	0.509	3.20	3.877	5.99e-06	9.37e-03	1.51e-04
6	2.00	0.04557	0.488	4.56	901.346	2.52e-08	---	---
7	4.00	0.05746	0.469	5.75	33.772	6.54e-07	5.94e-03	1.05e-05
8	8.00	0.07901	0.436	7.90	31.130	6.84e-07	5.39e-03	9.94e-06
9	16.0	0.1146	0.380	11.5	20.194	9.91e-07	4.45e-03	1.19e-05

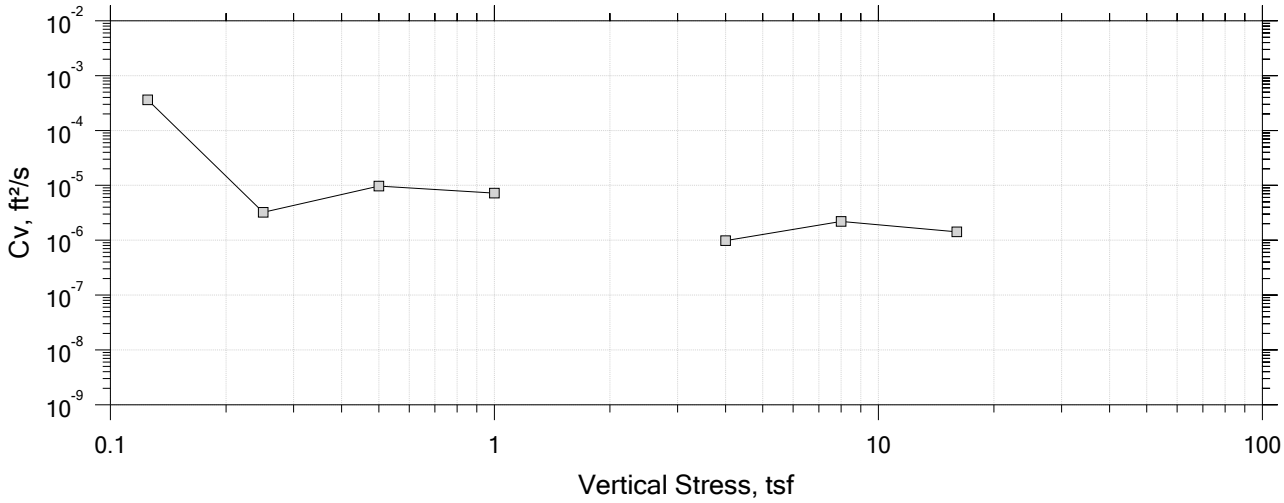
GeoTesting EXPRESS

Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP1687 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-3	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System E, 95% of 113.5 pcf @ 12.9% MC		
Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report

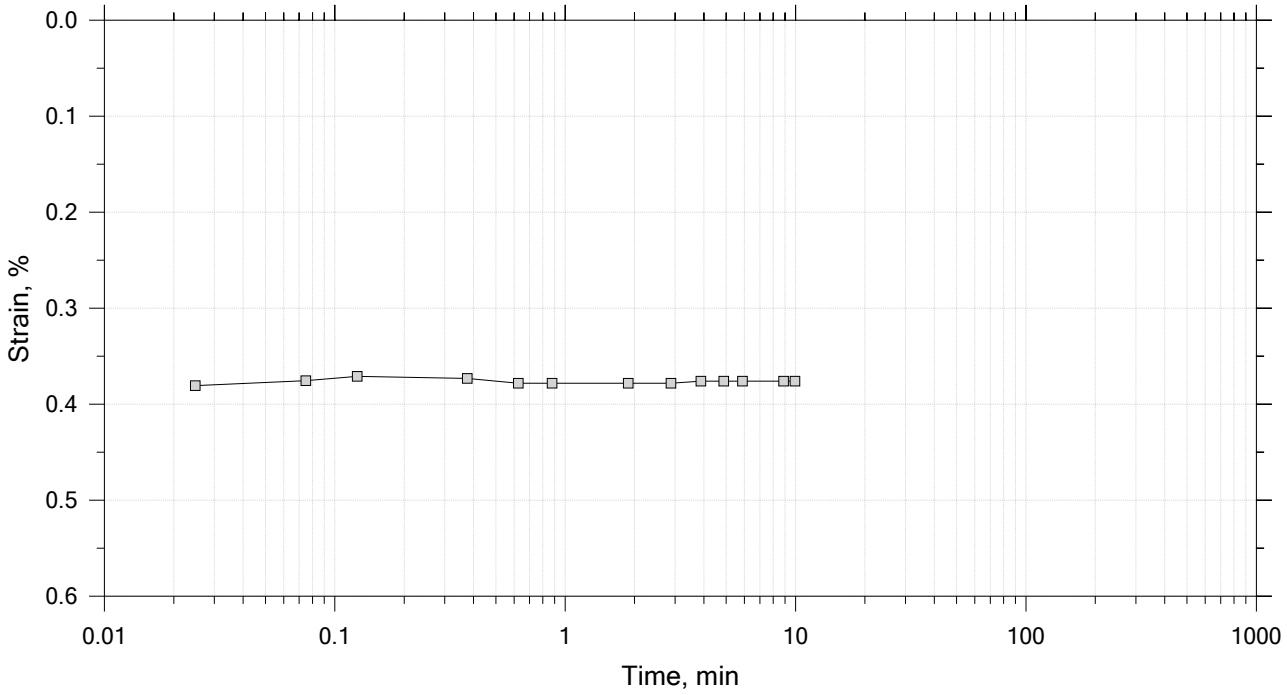


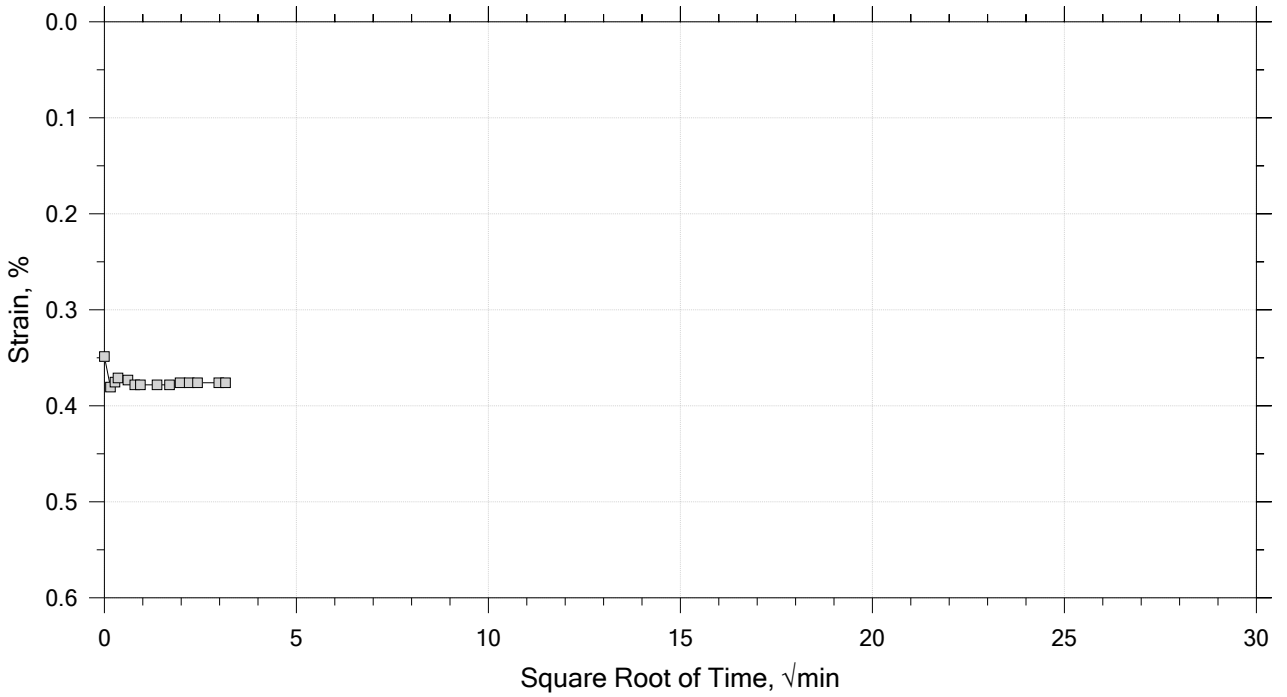


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-6	Sample Type: remolded	Elevation: ---
	Description: Moist, light brown sand, silt and gravel		
	Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9
Constant Load Step
Stress: 0.125 tsf

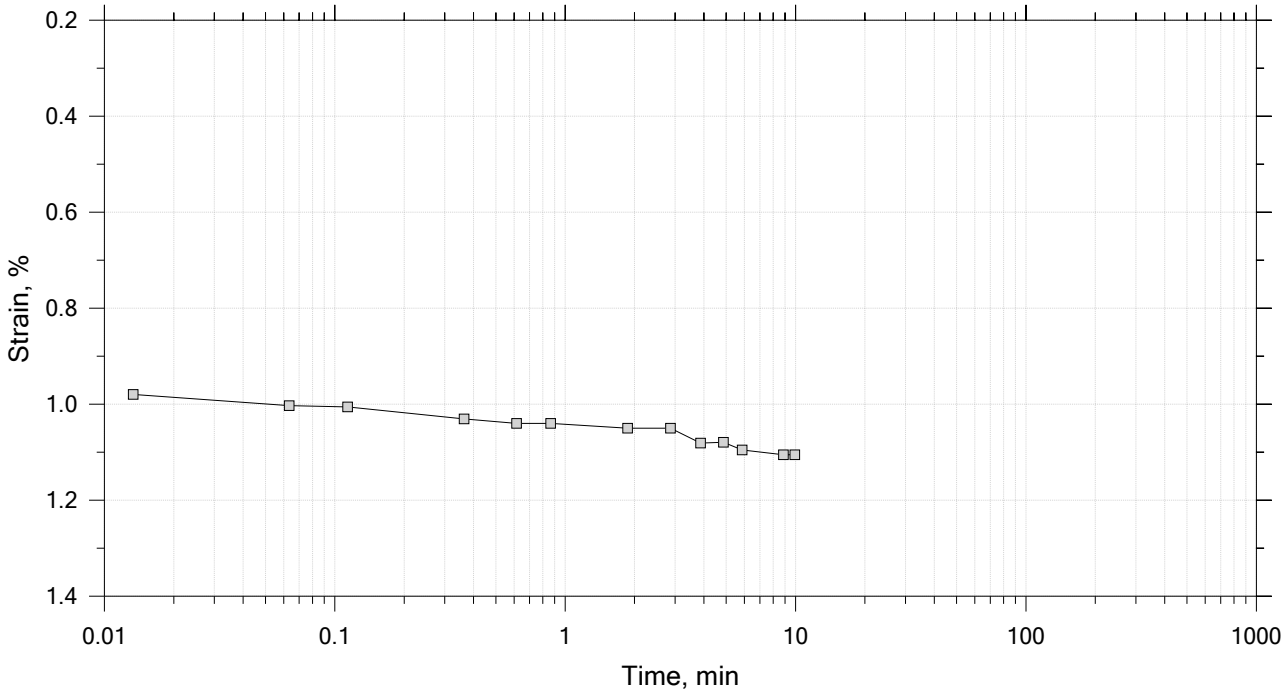


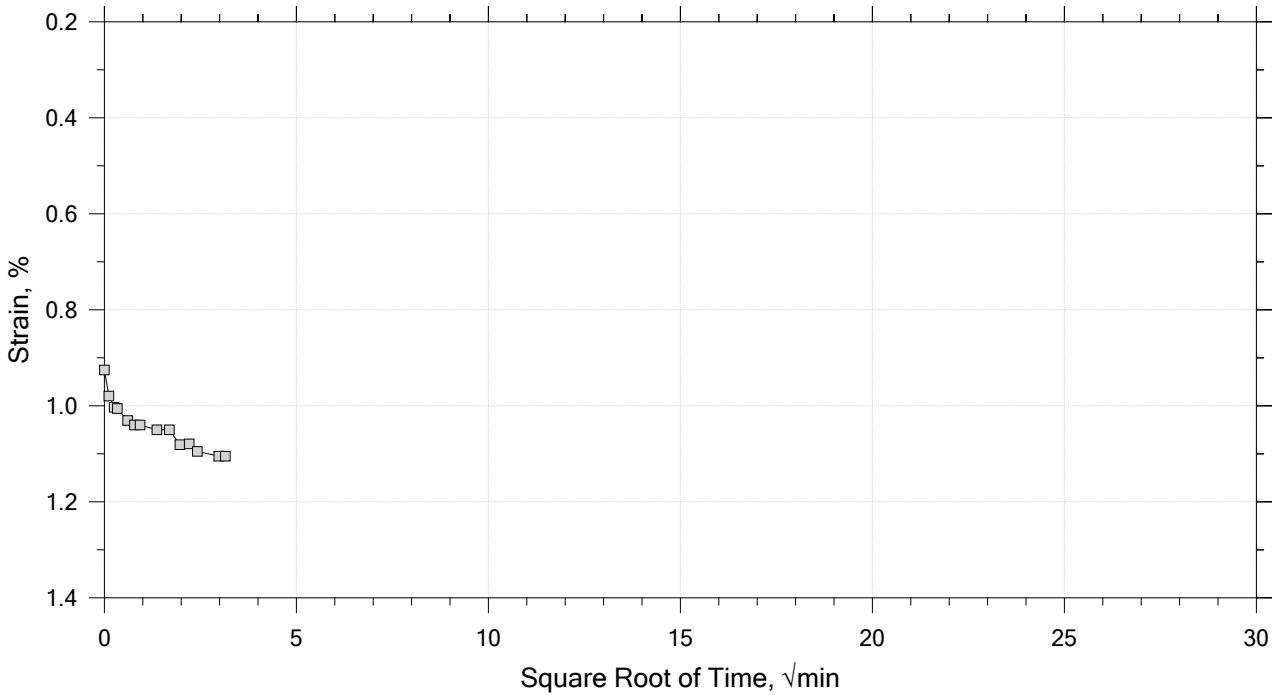


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

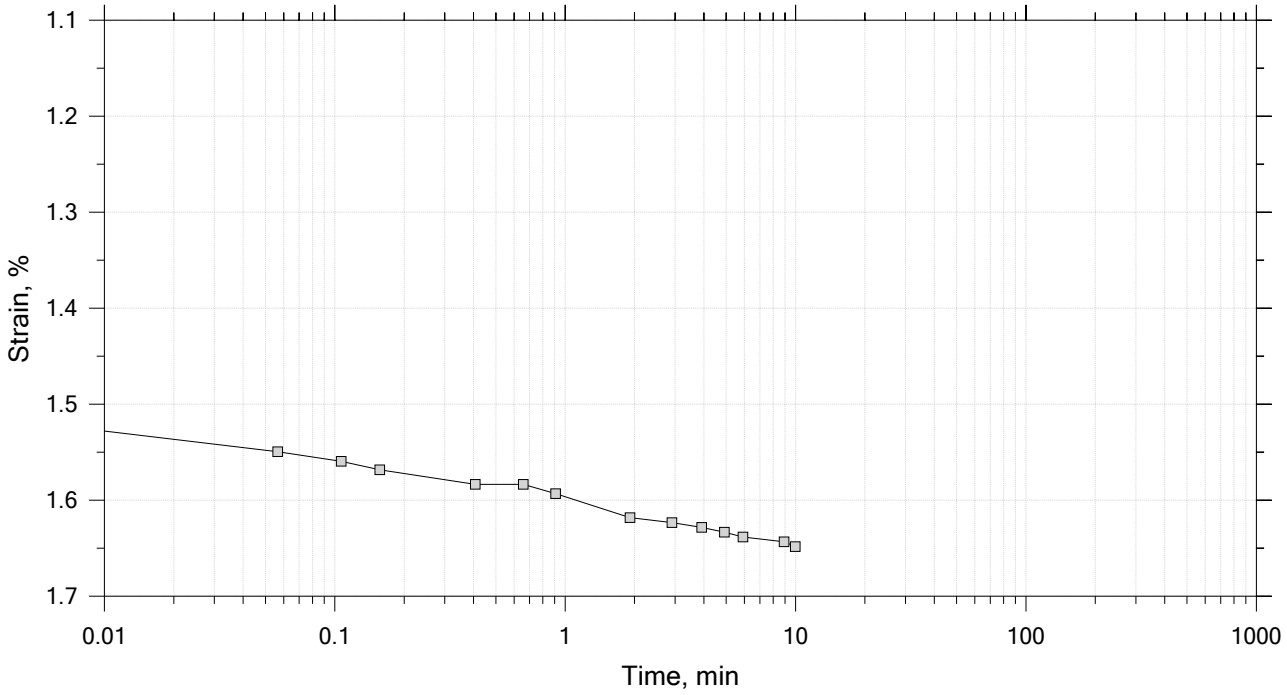


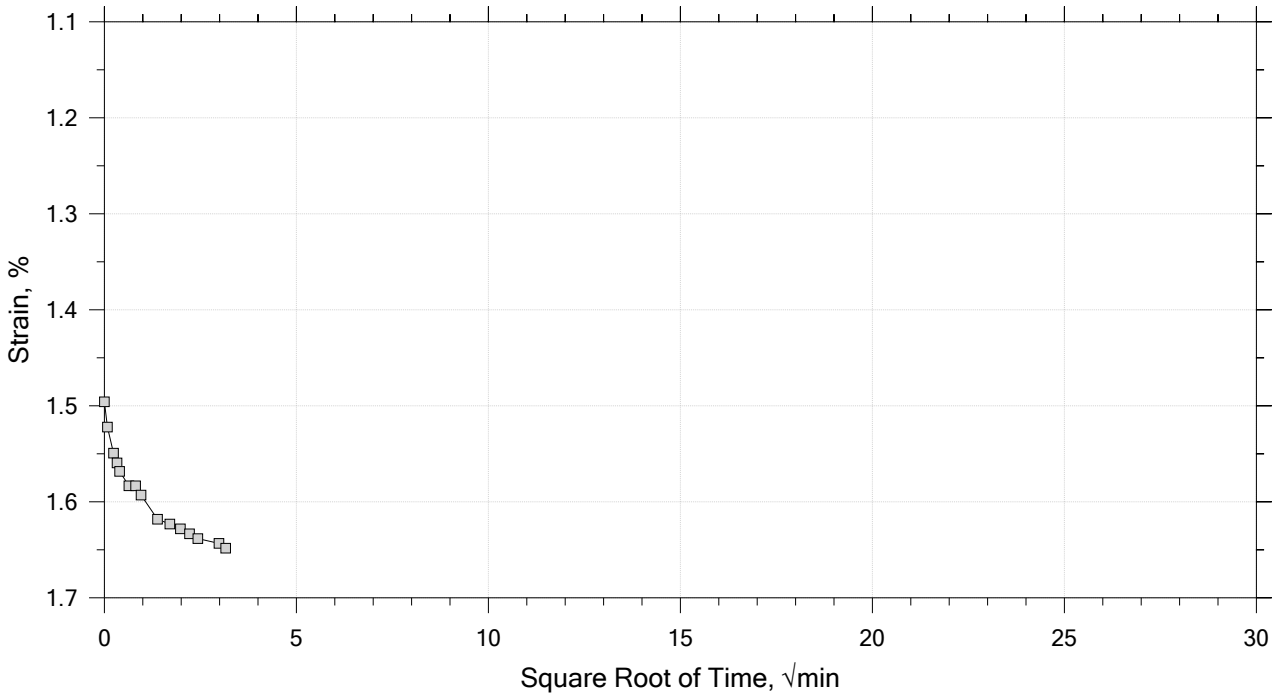


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-6	Sample Type: remolded	Elevation: ---
	Description: Moist, light brown sand, silt and gravel		
	Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf





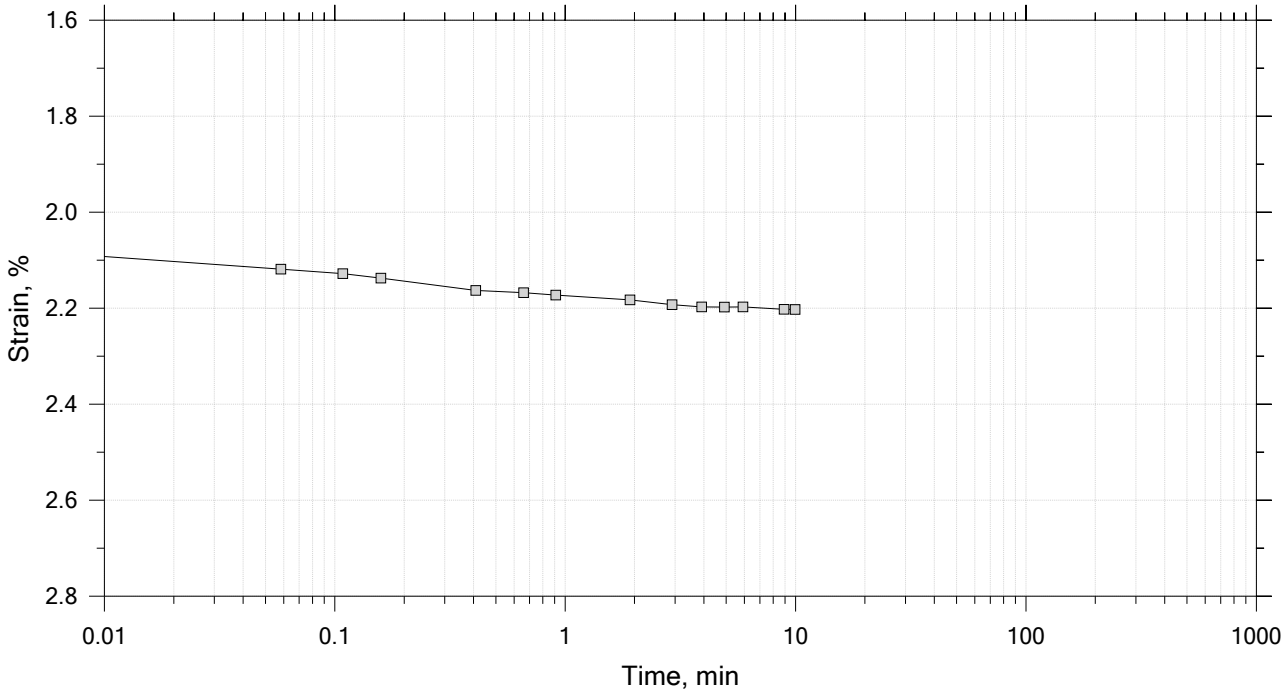
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

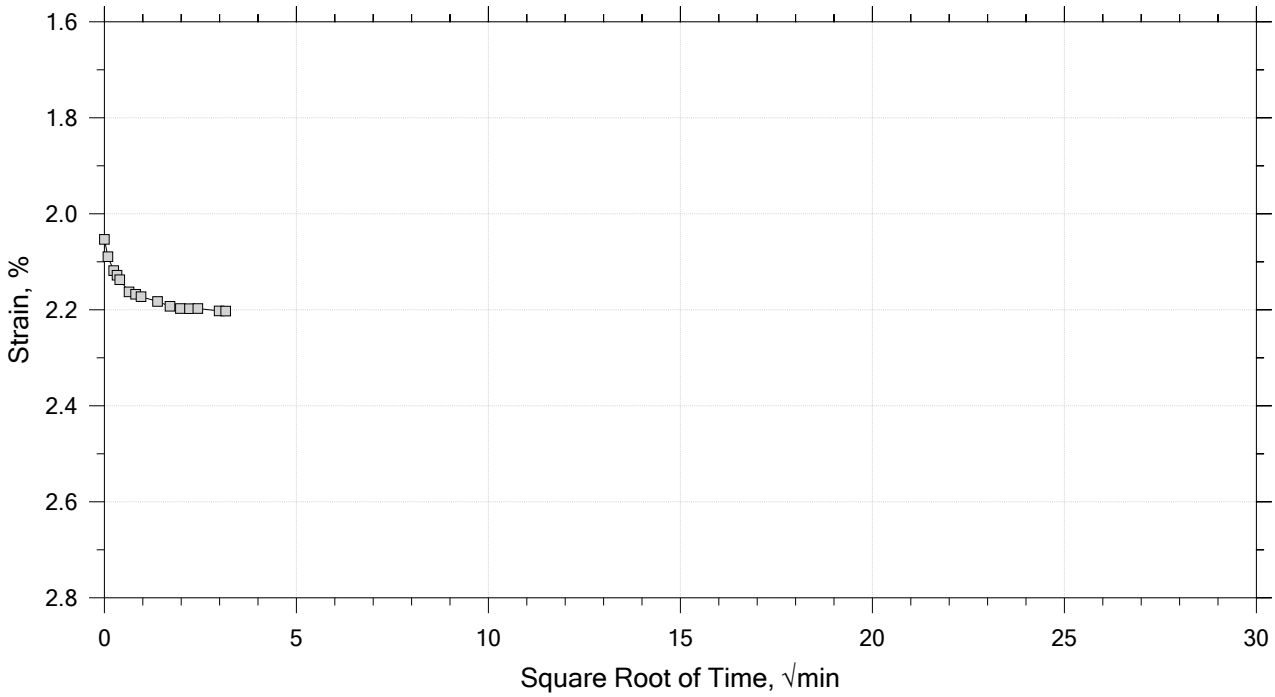
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9

Constant Load Step

Stress: 1 tsf

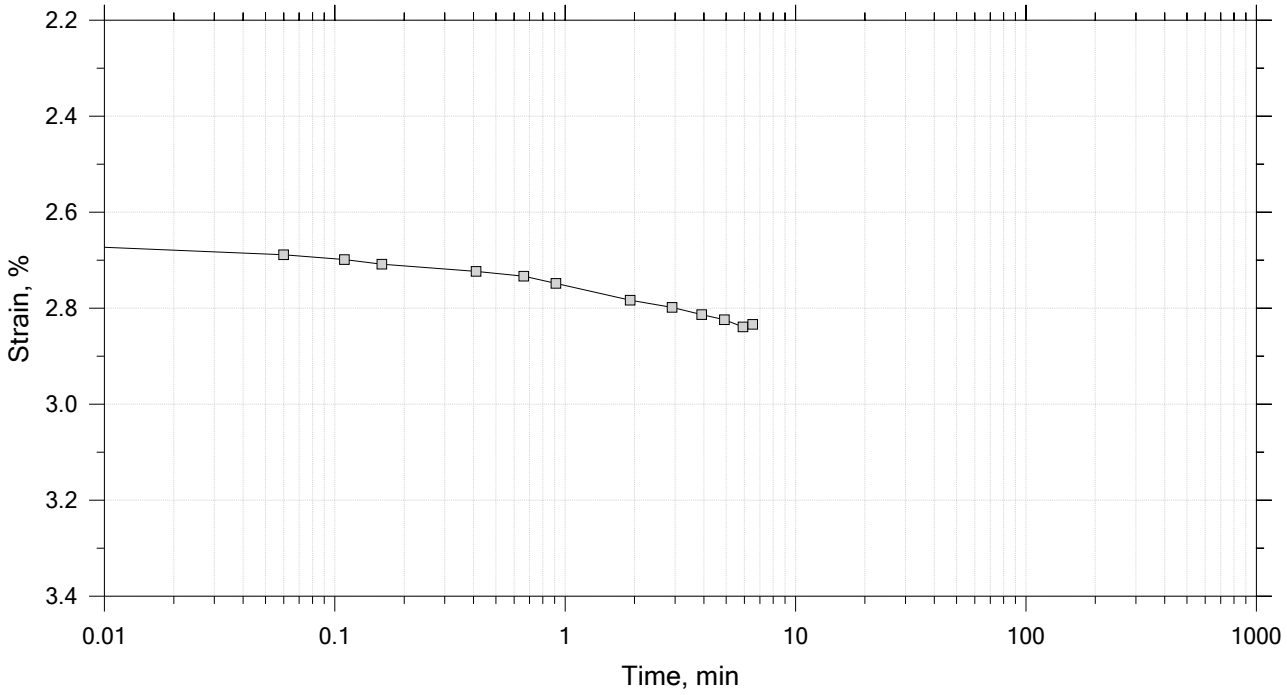


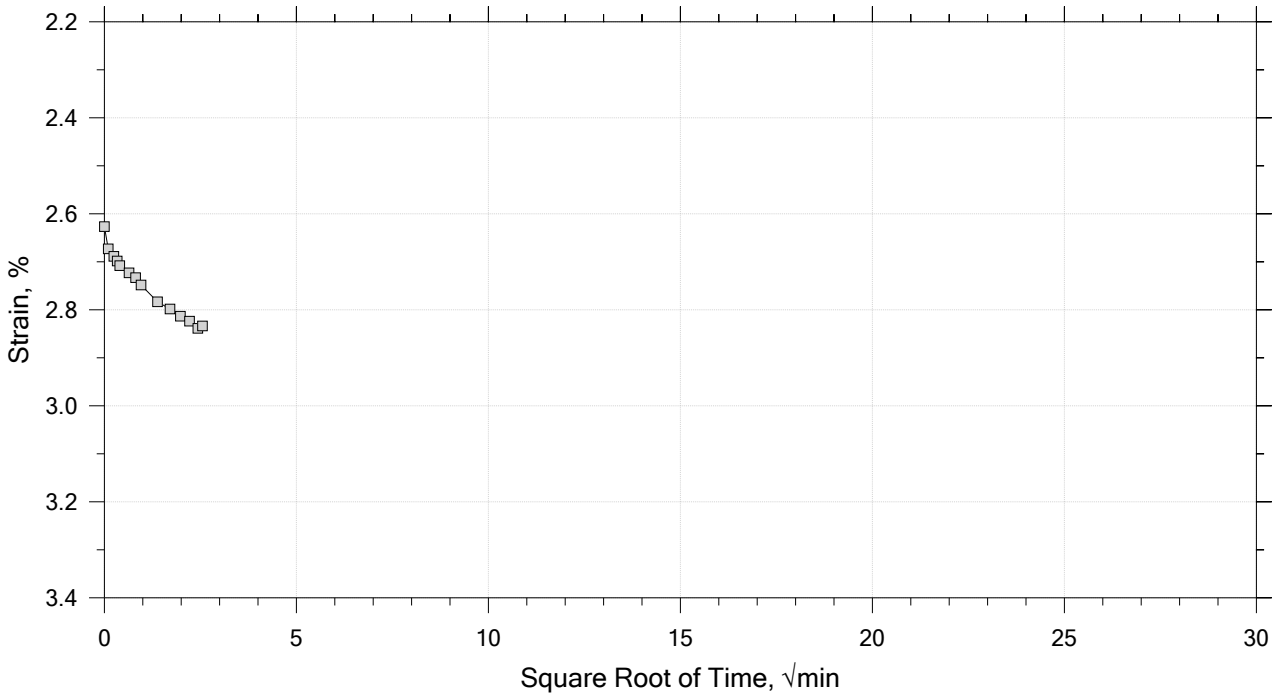


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9
Constant Load Step
Stress: 2 tsf





GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-6	Sample Type: remolded	Elevation: ---
	Description: Moist, light brown sand, silt and gravel		
	Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

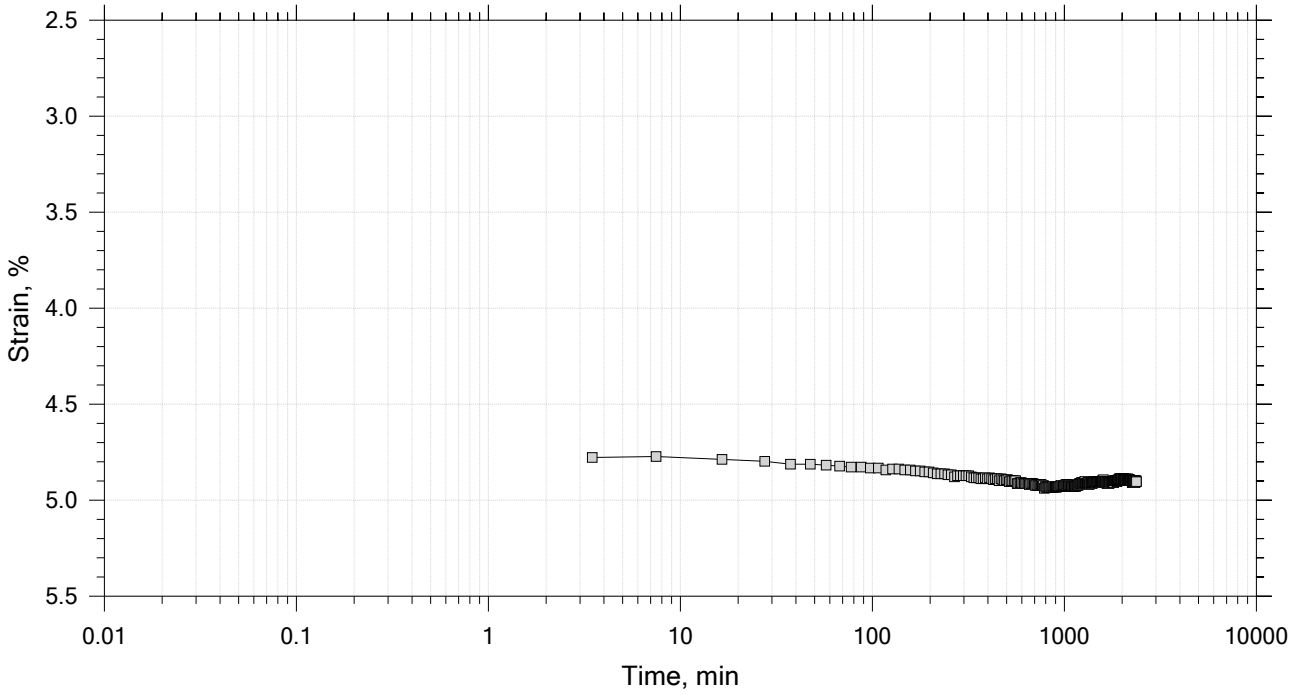
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

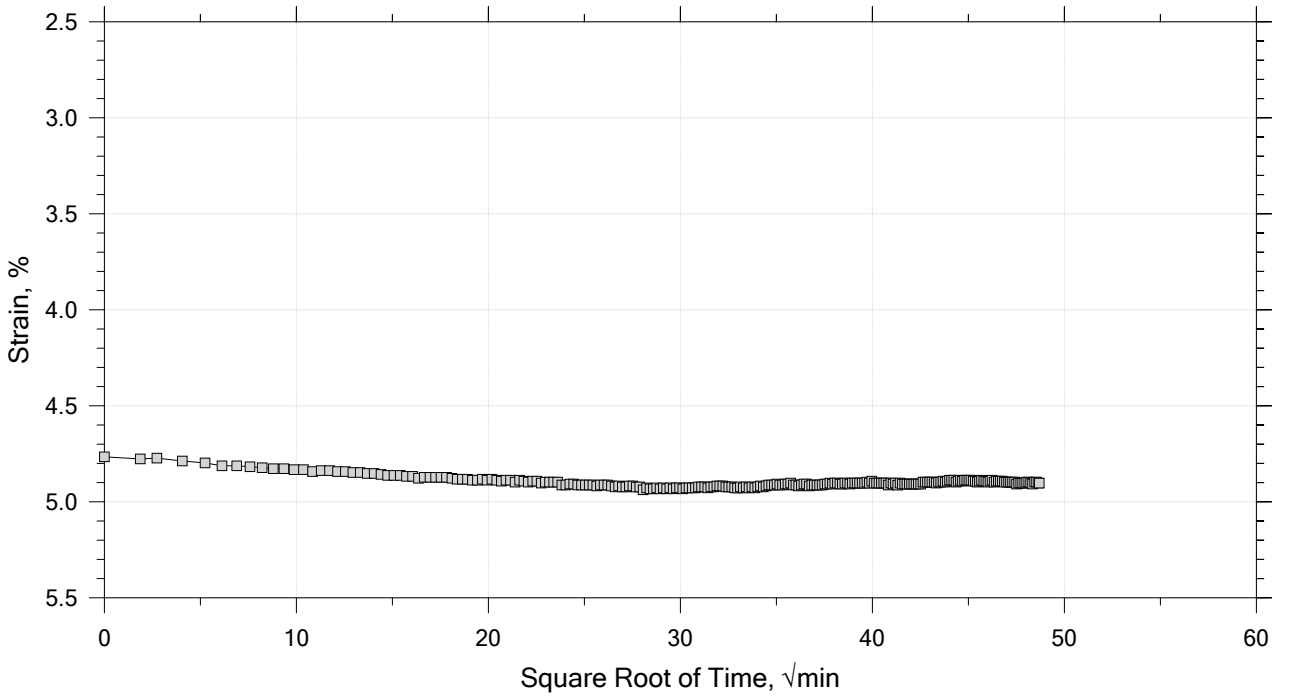
Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

WATER ADDED TO TEST





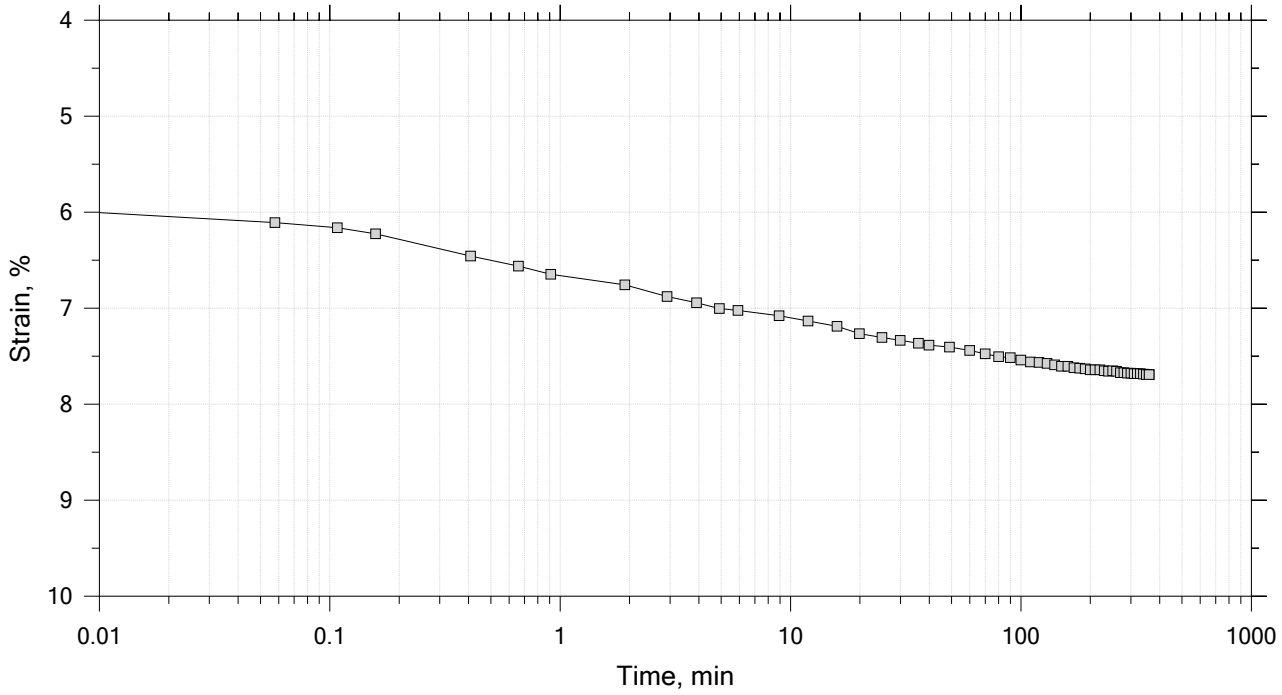
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

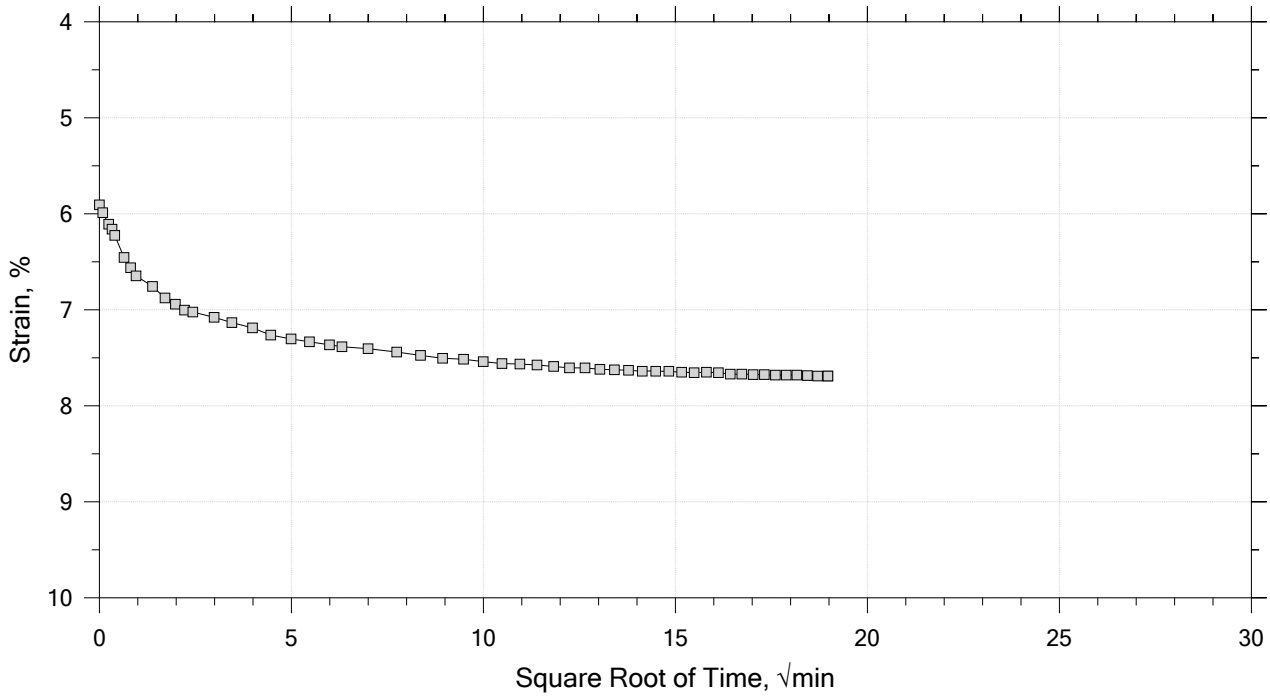
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9

Constant Load Step

Stress: 4 tsf





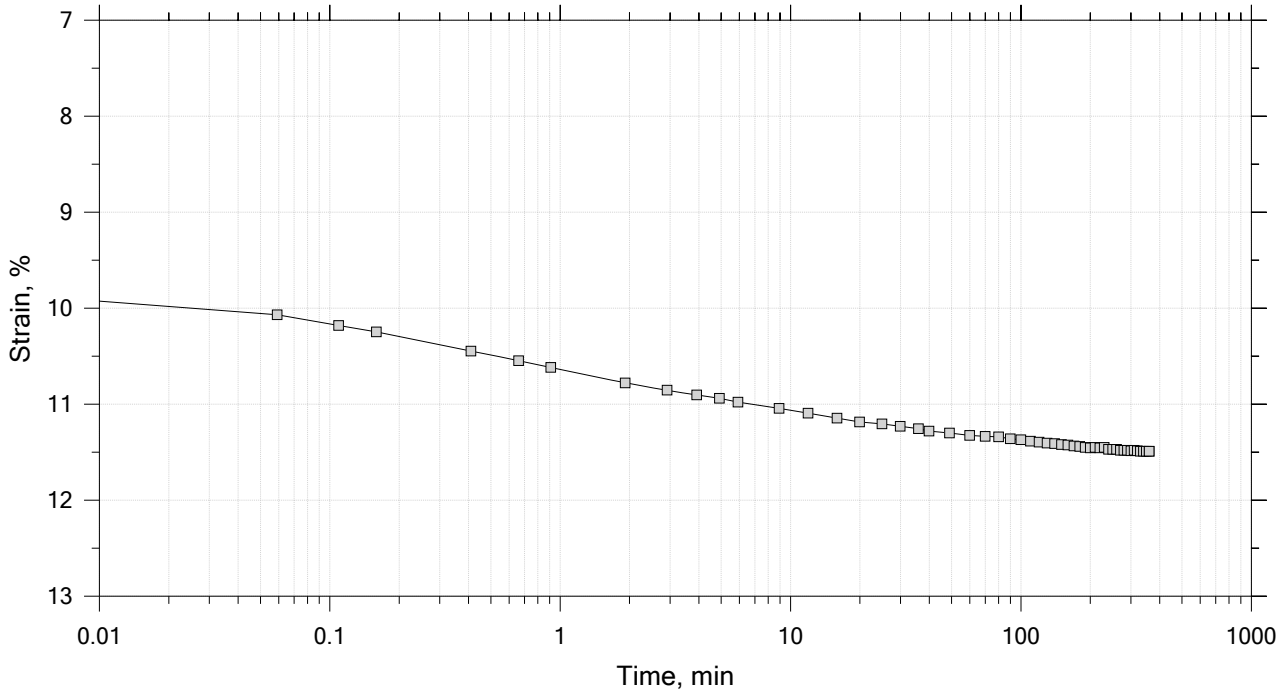
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

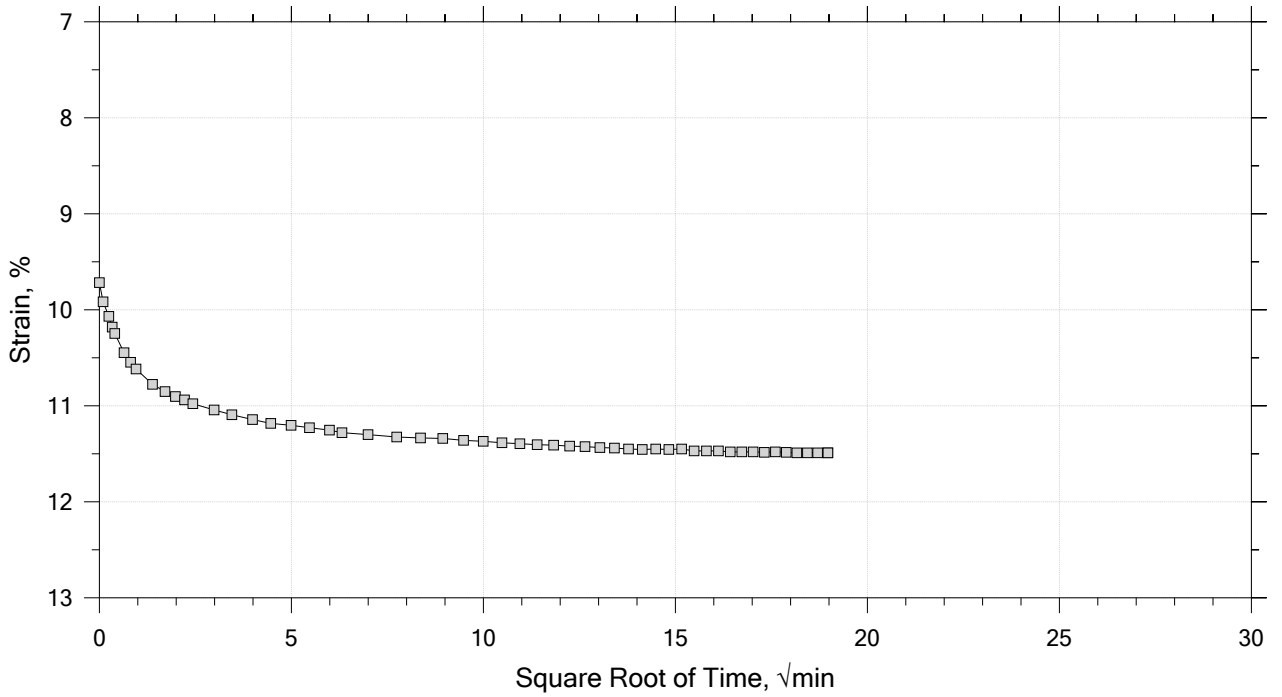
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9

Constant Load Step

Stress: 8 tsf

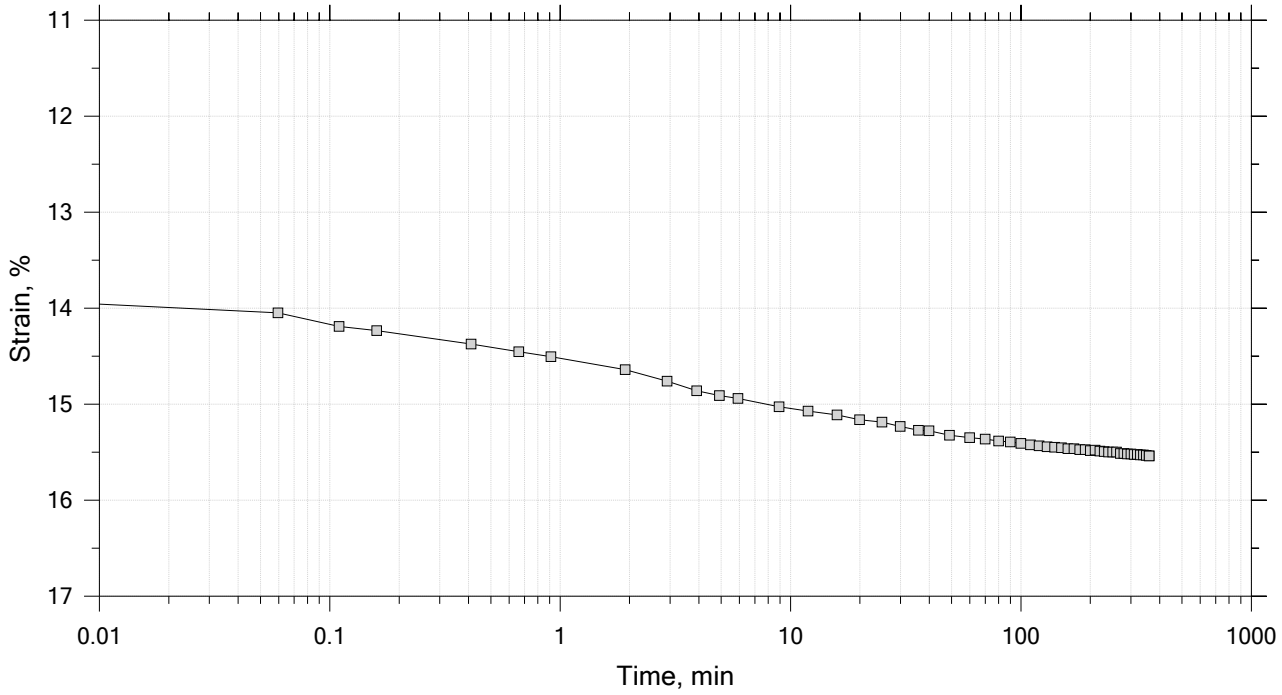


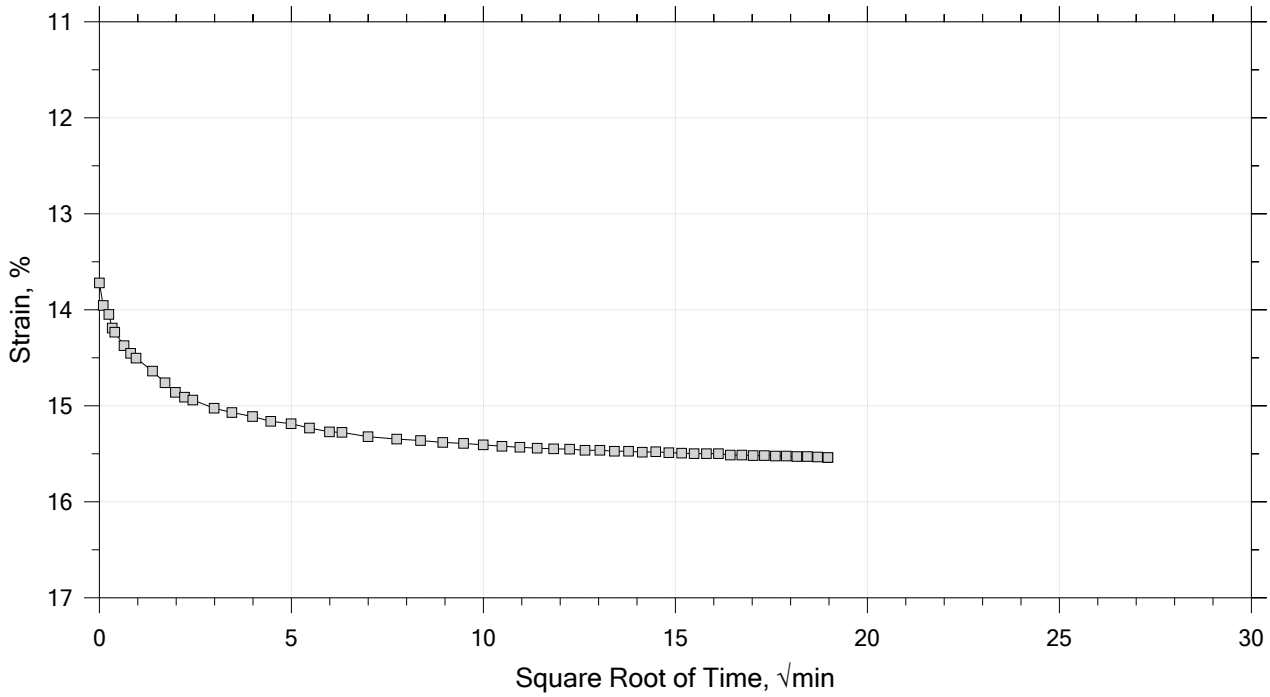


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-6	Sample Type: remolded	Elevation: ---
Description: Moist, light brown sand, silt and gravel		
Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.63	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.542	Plastic Limit: ---
Final Height: 0.93 in	Final Void Ratio: 0.434	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	B--1731	RING		C2205
Mass Container, gm	8.53	109.39	109.39	9.22
Mass Container + Wet Soil, gm	94.65	260.12	269.45	168.66
Mass Container + Dry Soil, gm	87	246.82	246.82	146.12
Mass Dry Soil, gm	78.47	137.43	137.43	136.9
Water Content, %	9.75	9.68	16.46	16.46
Void Ratio	---	0.54	0.43	---
Degree of Saturation, %	---	47.06	100.00	---
Dry Unit Weight, pcf	---	106.66	114.69	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-6	Sample Type: remolded	Elevation: ---
	Description: Moist, light brown sand, silt and gravel		
	Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

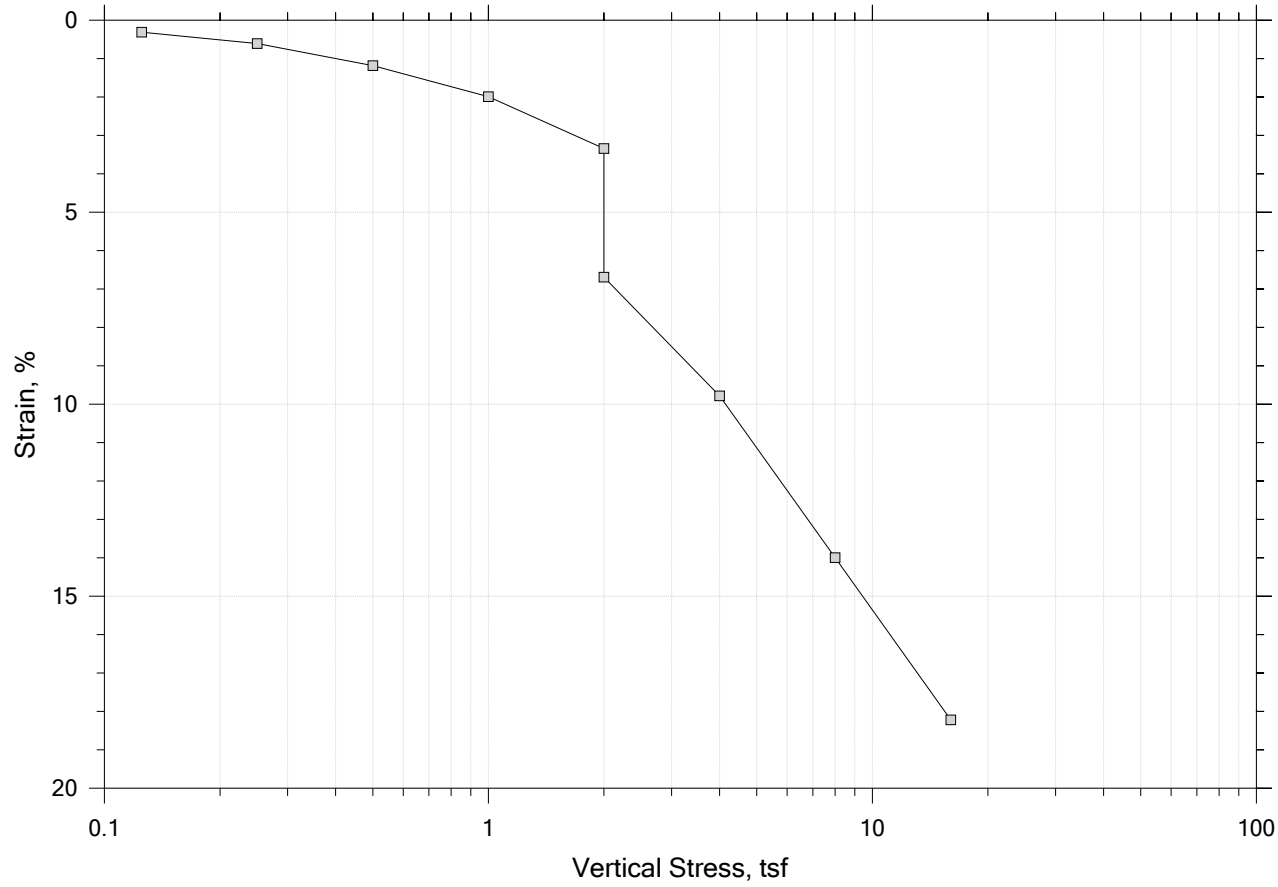
Square Root of Time Coefficients

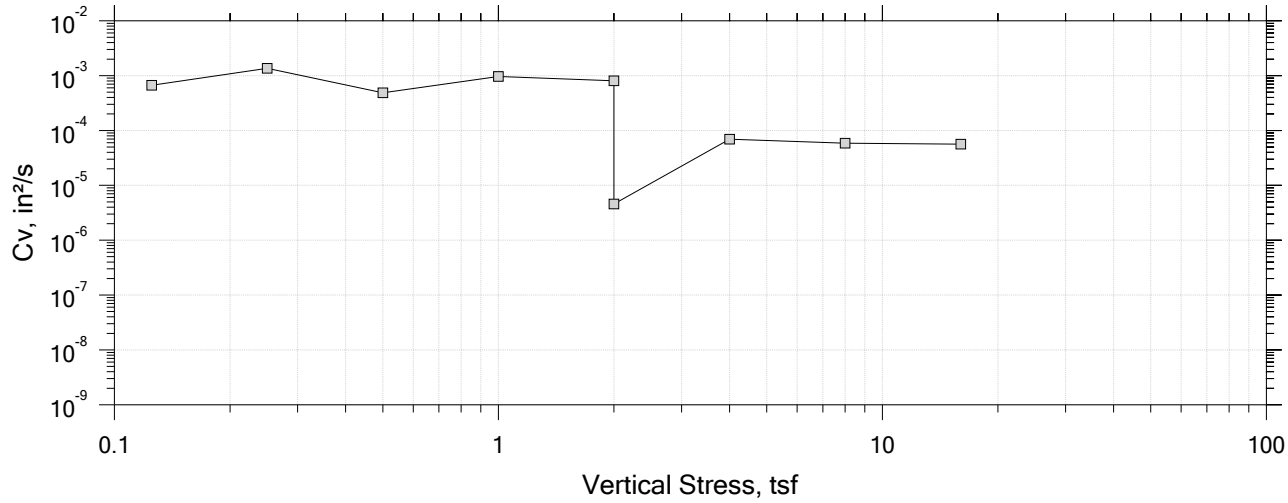
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.125	0.003760	0.536	0.376	0.067	3.63e-04	3.01e-02	2.94e-02
2	0.250	0.01105	0.525	1.11	7.507	3.22e-06	5.83e-02	5.07e-04
3	0.500	0.01648	0.516	1.65	2.458	9.71e-06	2.17e-02	5.69e-04
4	1.00	0.02203	0.508	2.20	3.264	7.23e-06	1.11e-02	2.16e-04
5	2.00	0.02834	0.498	2.83	---	---	6.31e-03	---
6	2.00	0.04903	0.466	4.90	---	0.00e+00	---	---
7	4.00	0.07691	0.423	7.69	21.986	9.80e-07	1.39e-02	3.68e-05
8	8.00	0.1149	0.364	11.5	9.104	2.20e-06	9.50e-03	5.64e-05
9	16.0	0.1554	0.302	15.5	12.936	1.42e-06	5.06e-03	1.94e-05

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9049 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-6	Sample Type: remolded	Elevation: ---
	Description: Moist, light brown sand, silt and gravel		
	Remarks: System E, 95% of 124.2 pcf @ 10.5% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report





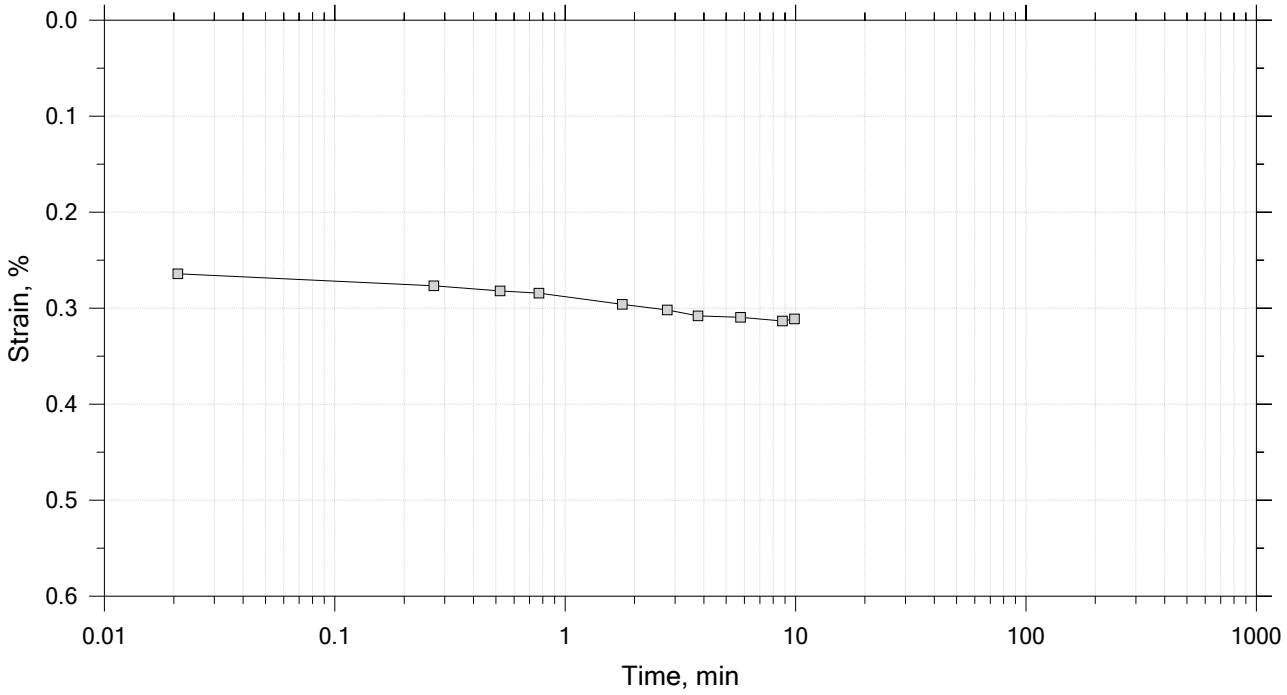
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		
	Displacement at End of Increment		

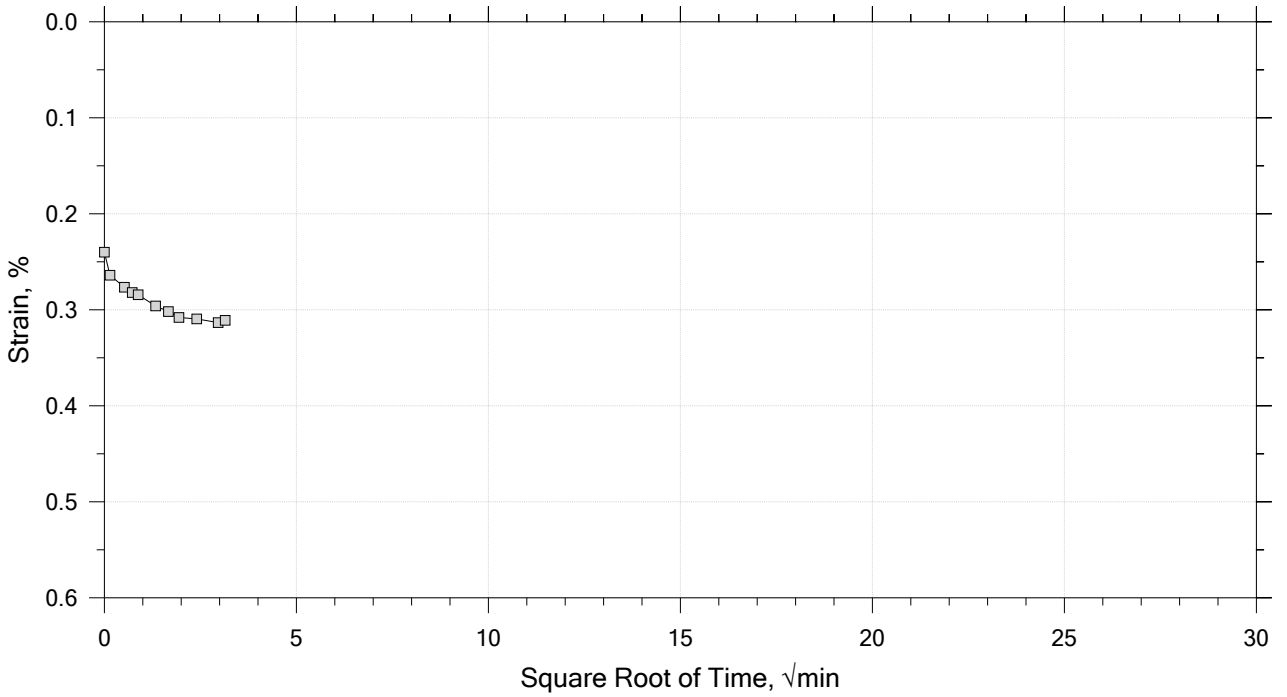
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9

Constant Load Step

Stress: 0.125 tsf

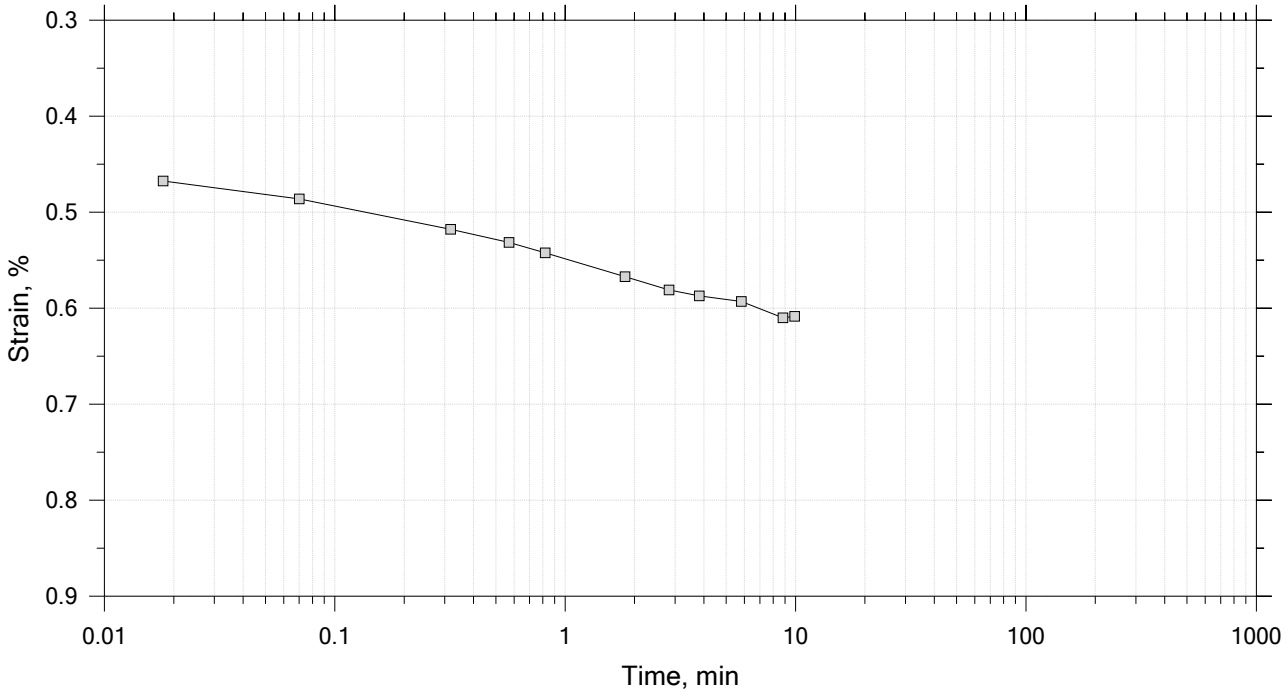


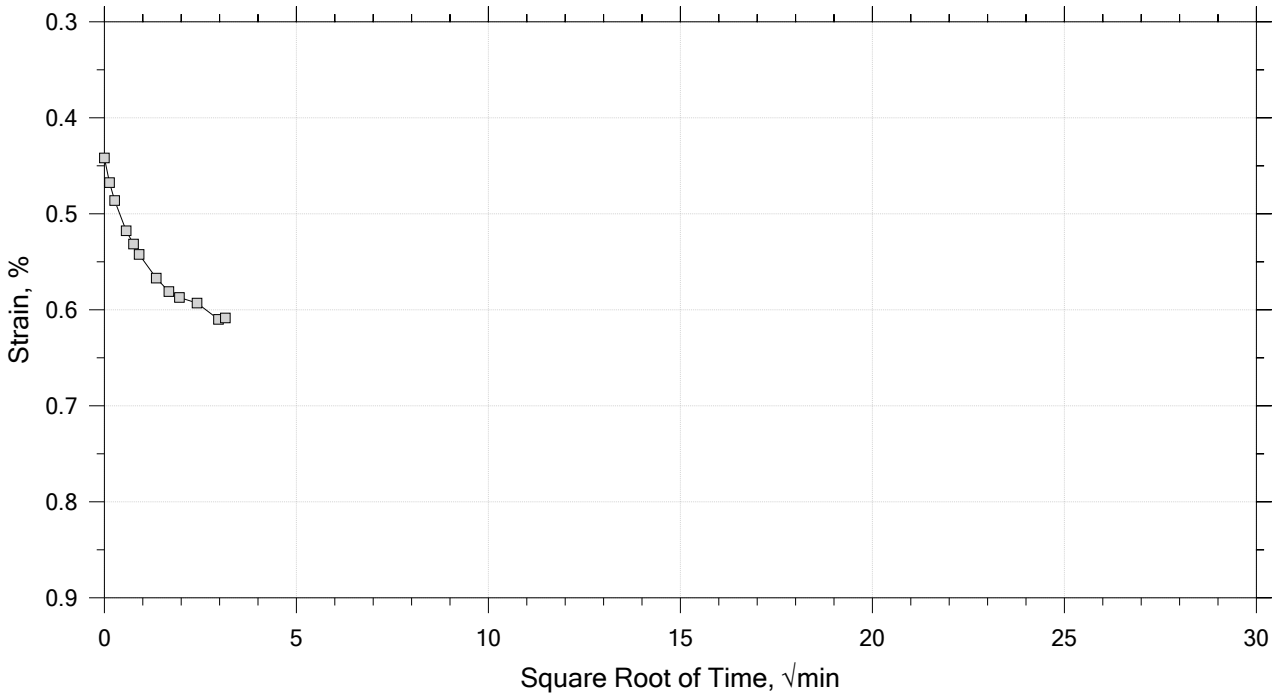


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-1	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with silt and gravel		
Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

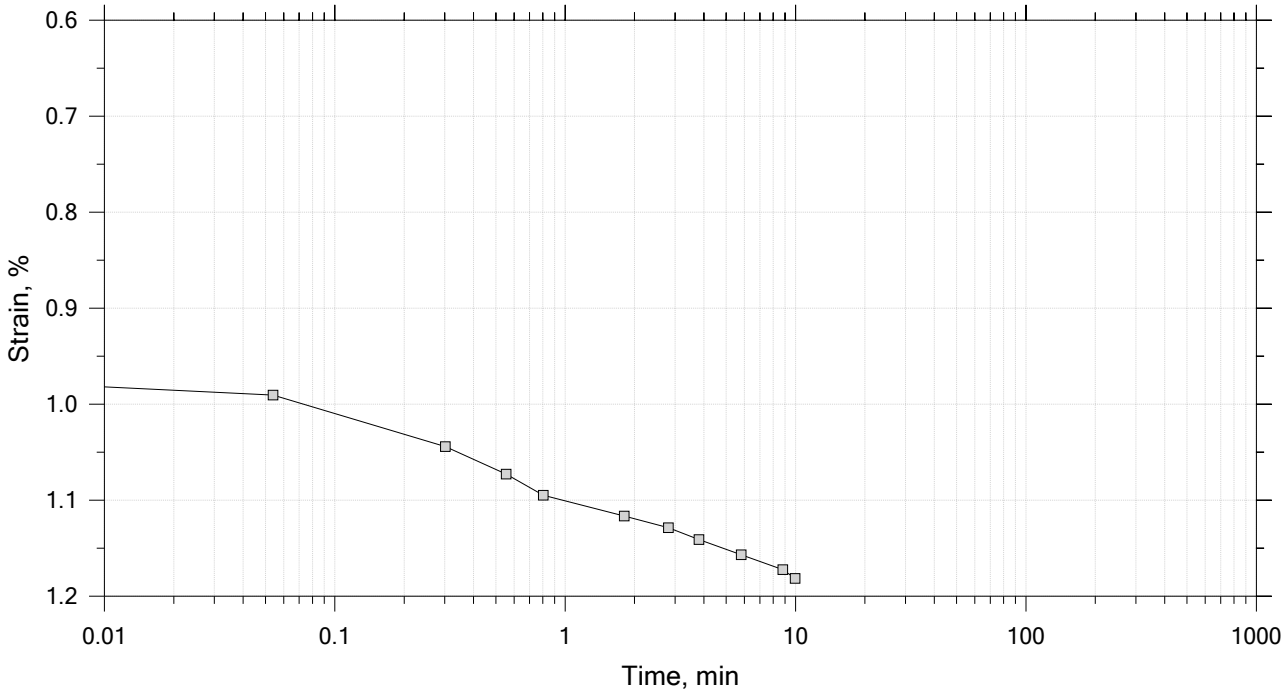


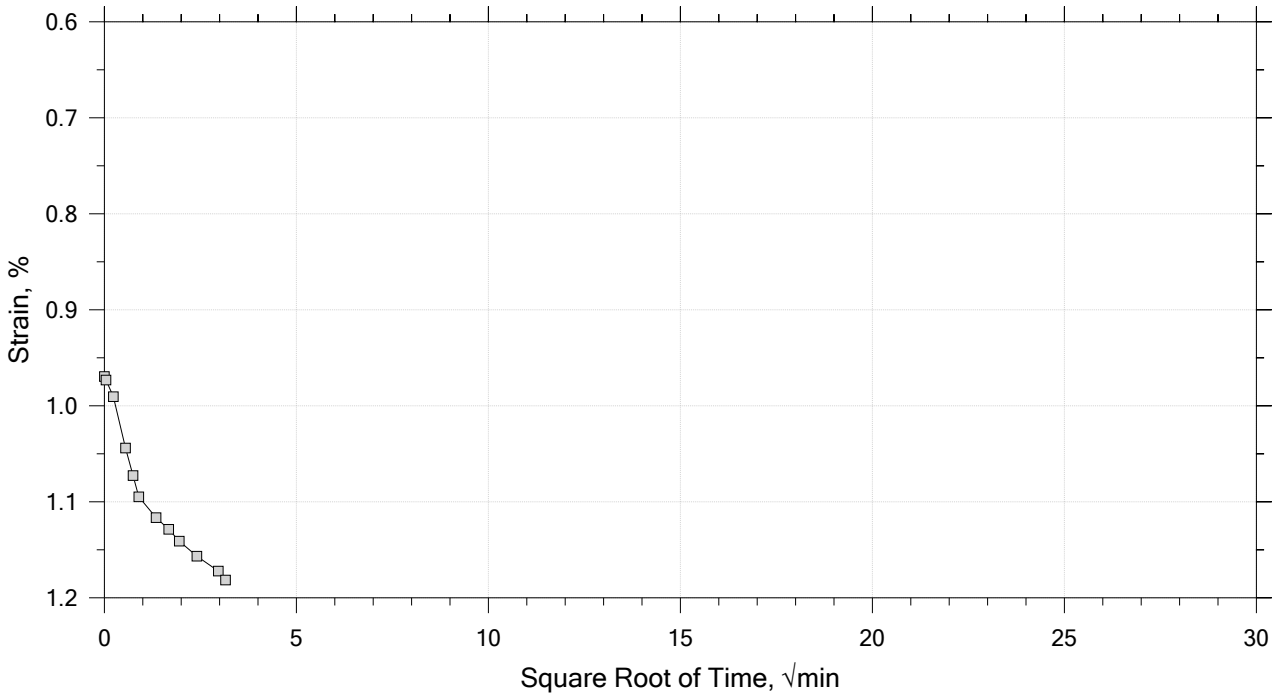


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf

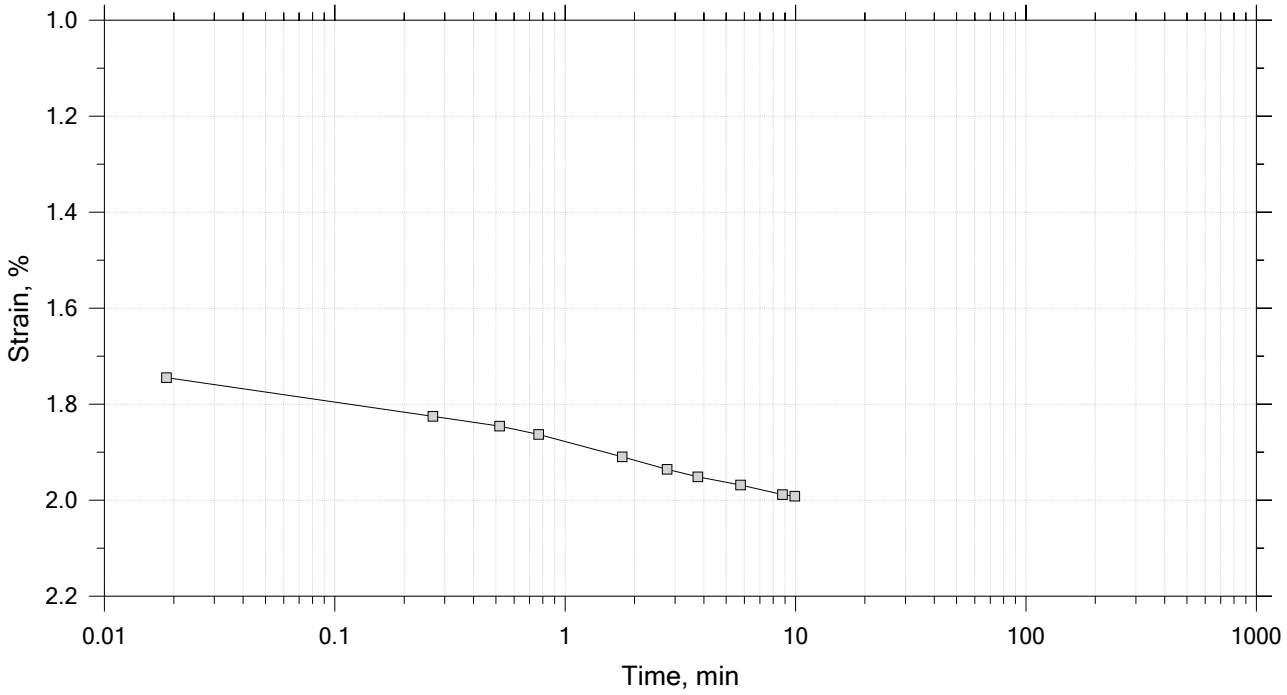


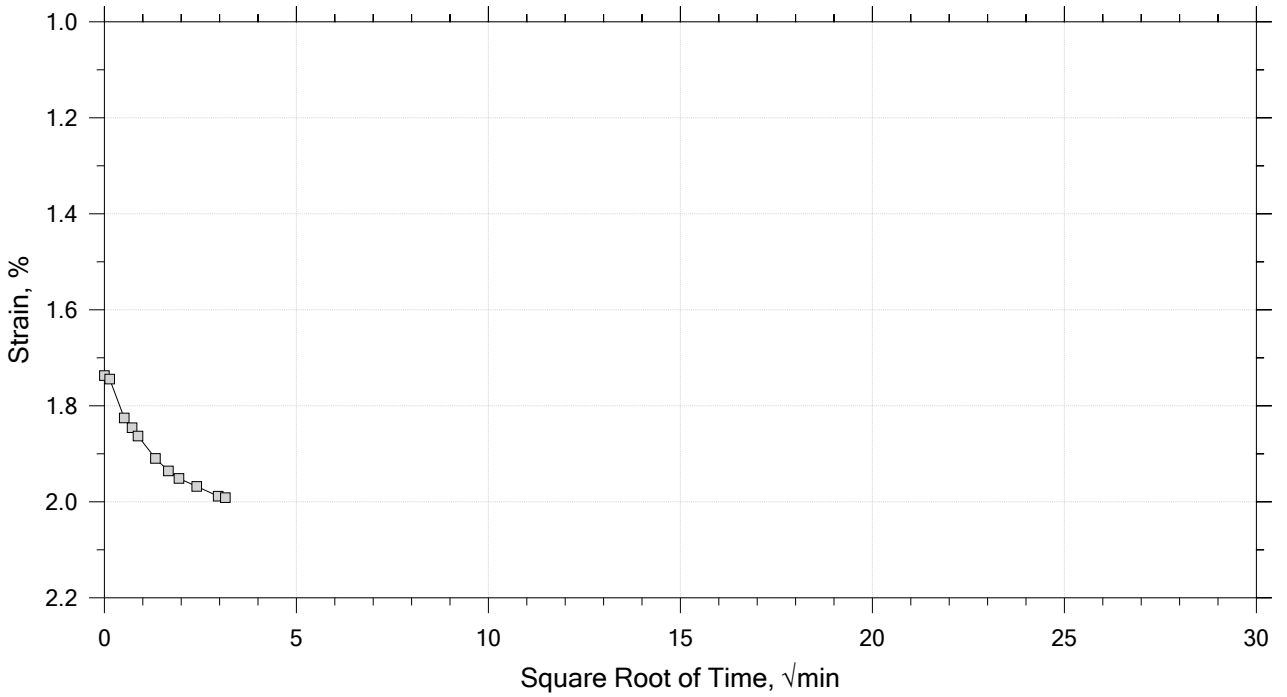


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9
Constant Load Step
Stress: 1 tsf





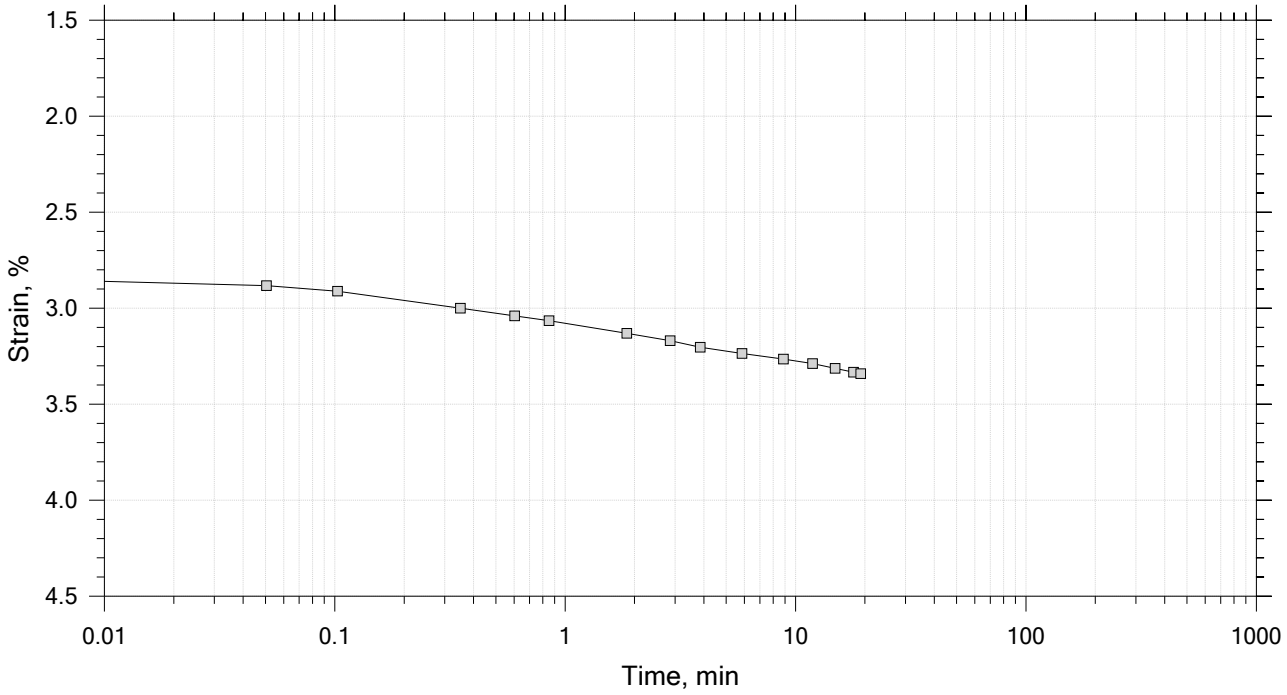
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

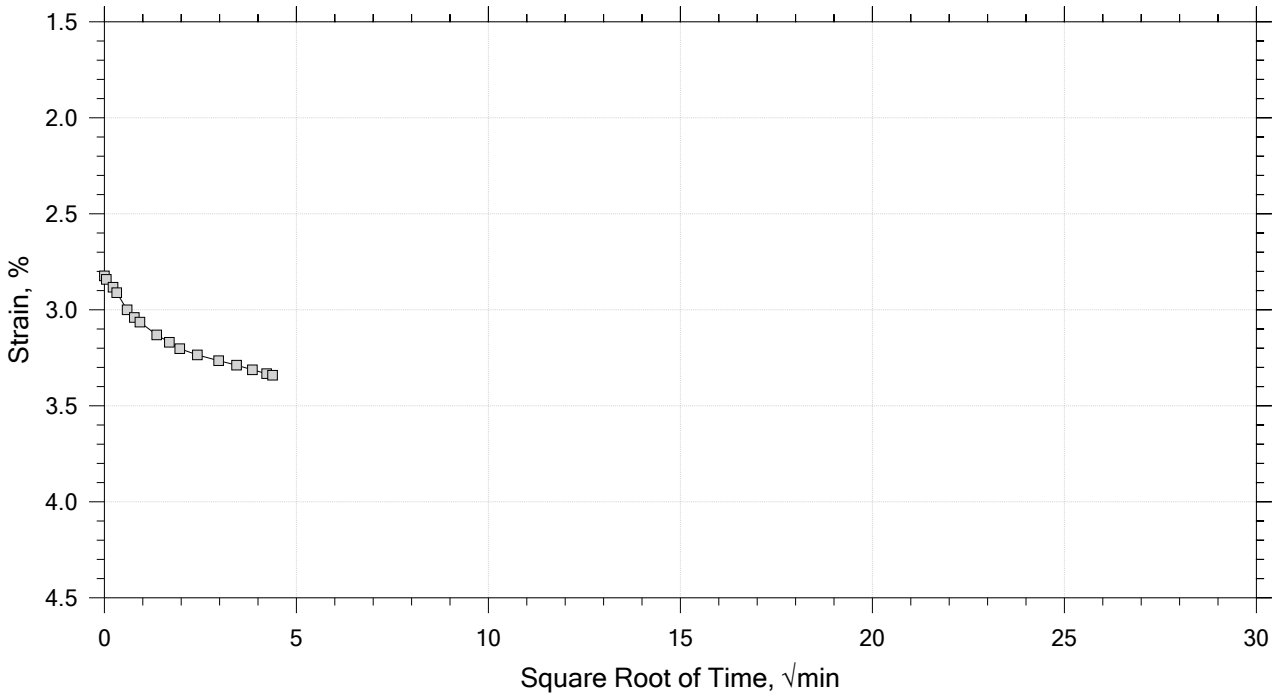
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9

Constant Load Step

Stress: 2 tsf





GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

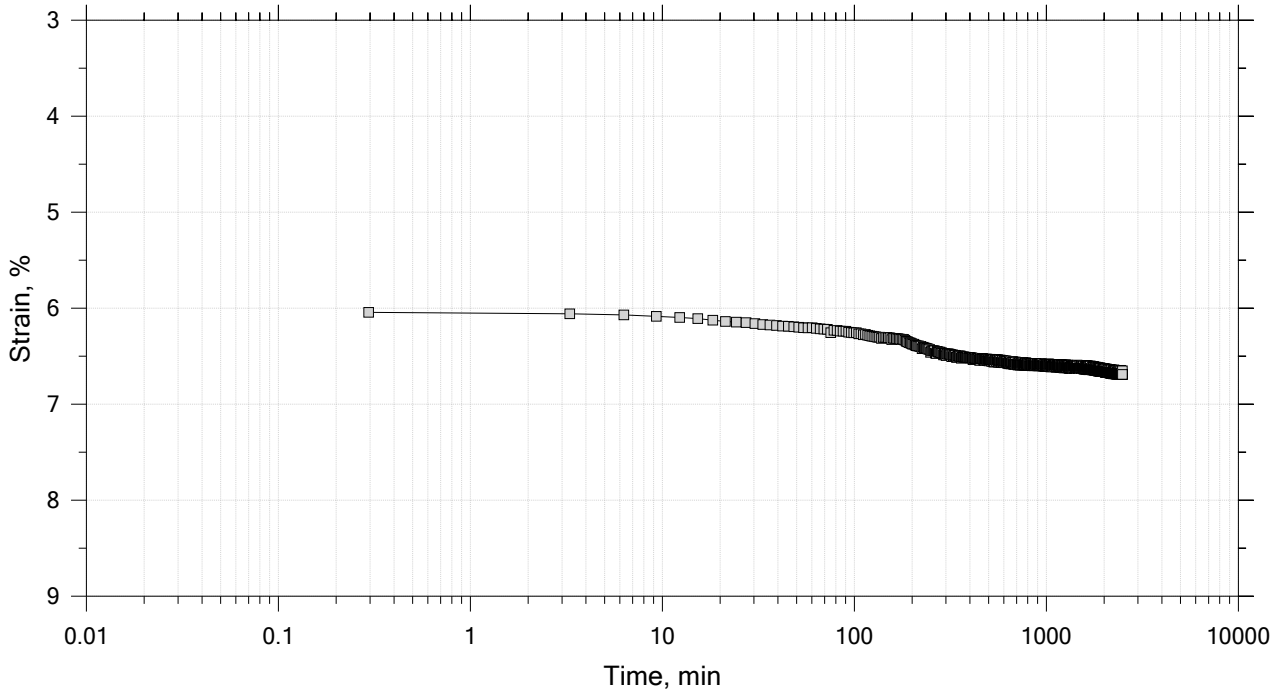
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

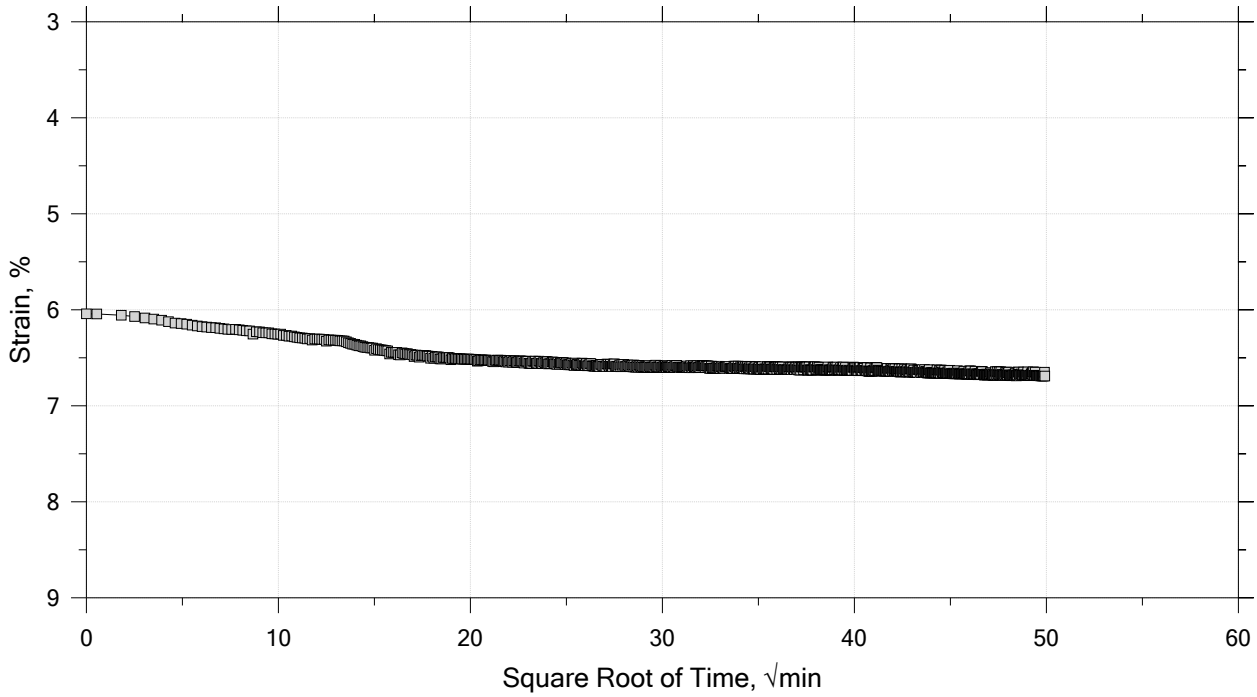
Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

WATER ADDED TO TEST





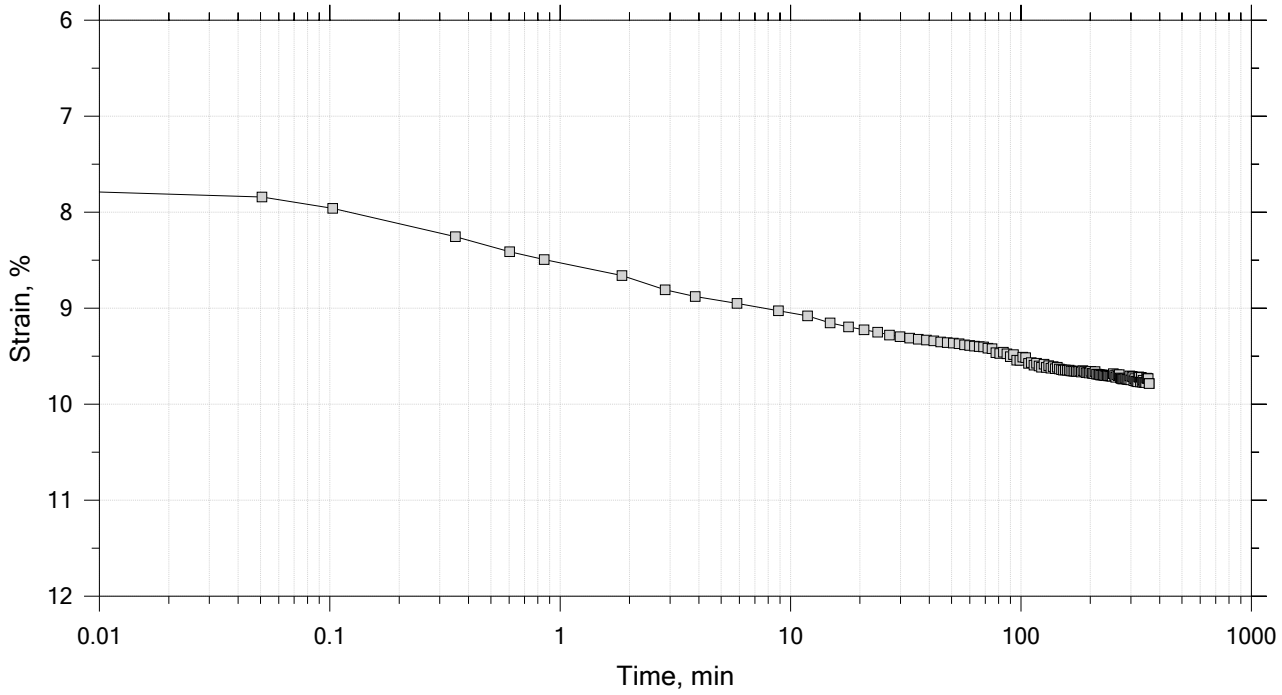
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

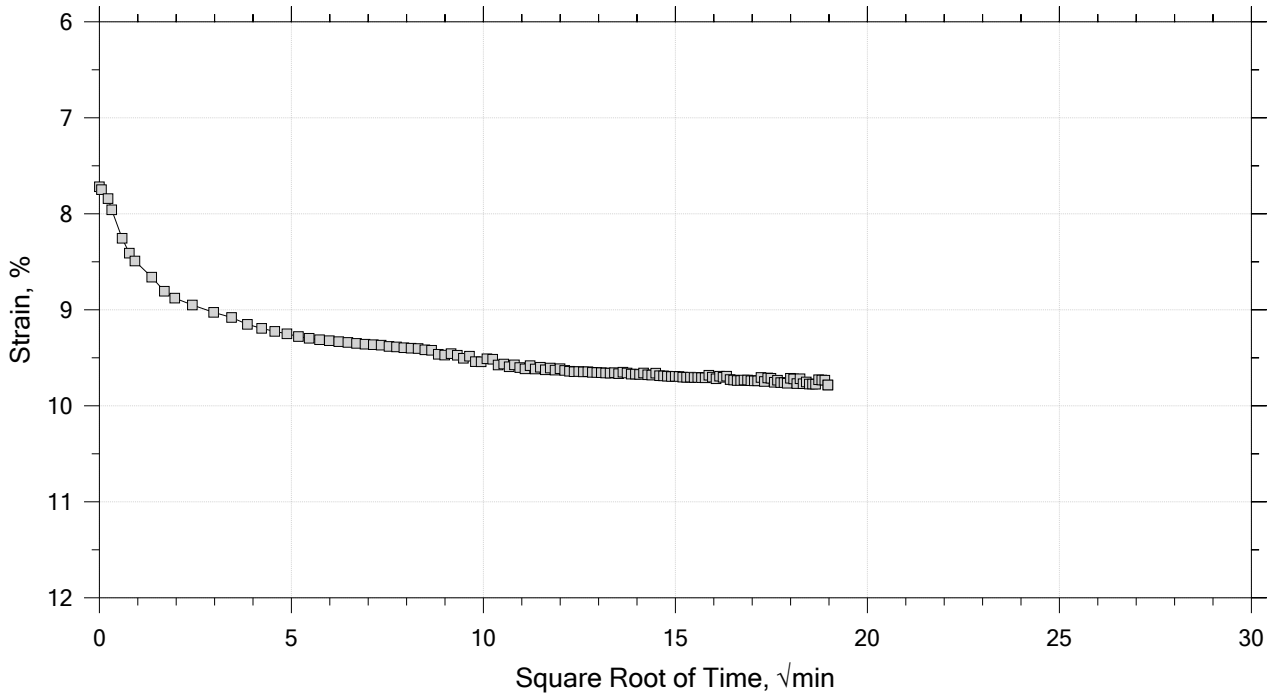
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9

Constant Load Step

Stress: 4 tsf





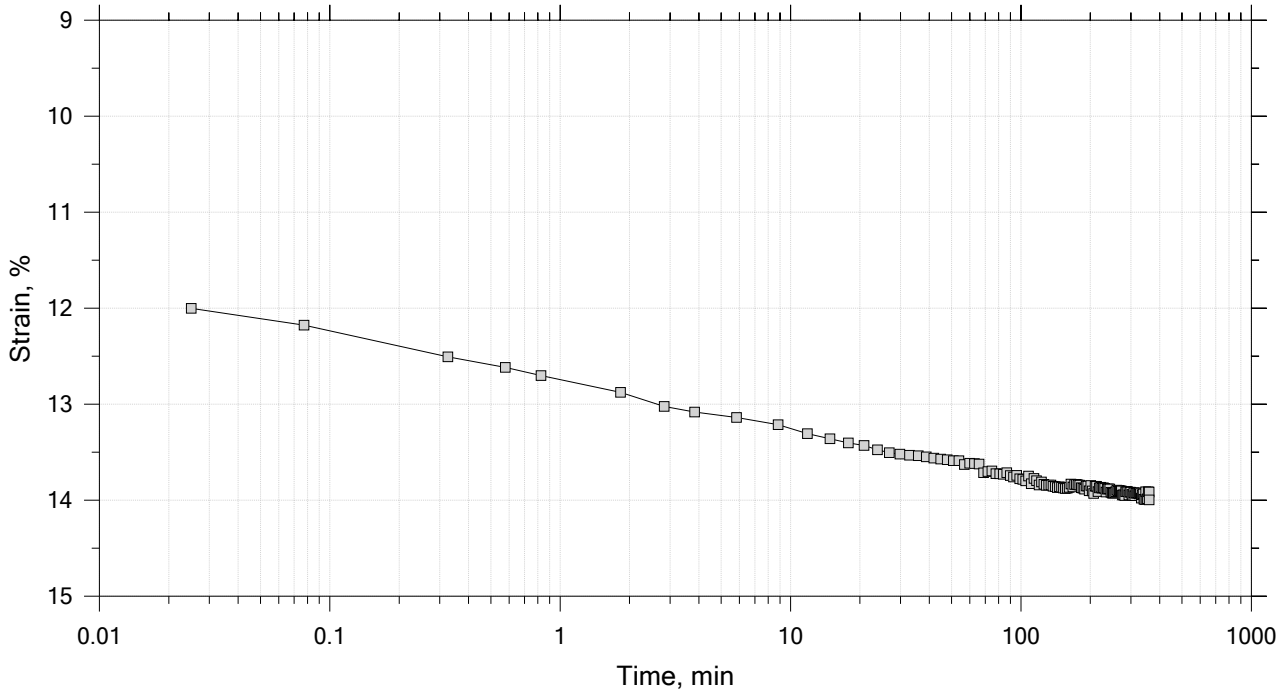
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-1	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with silt and gravel		
Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

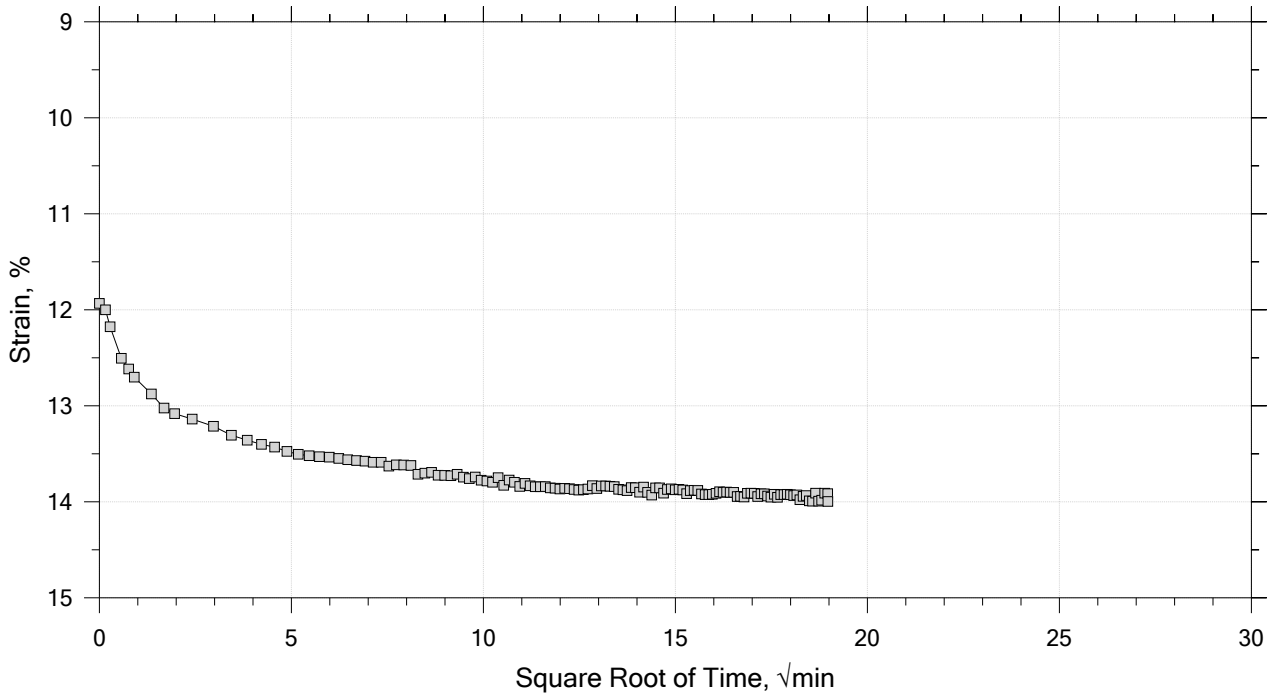
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9

Constant Load Step

Stress: 8 tsf

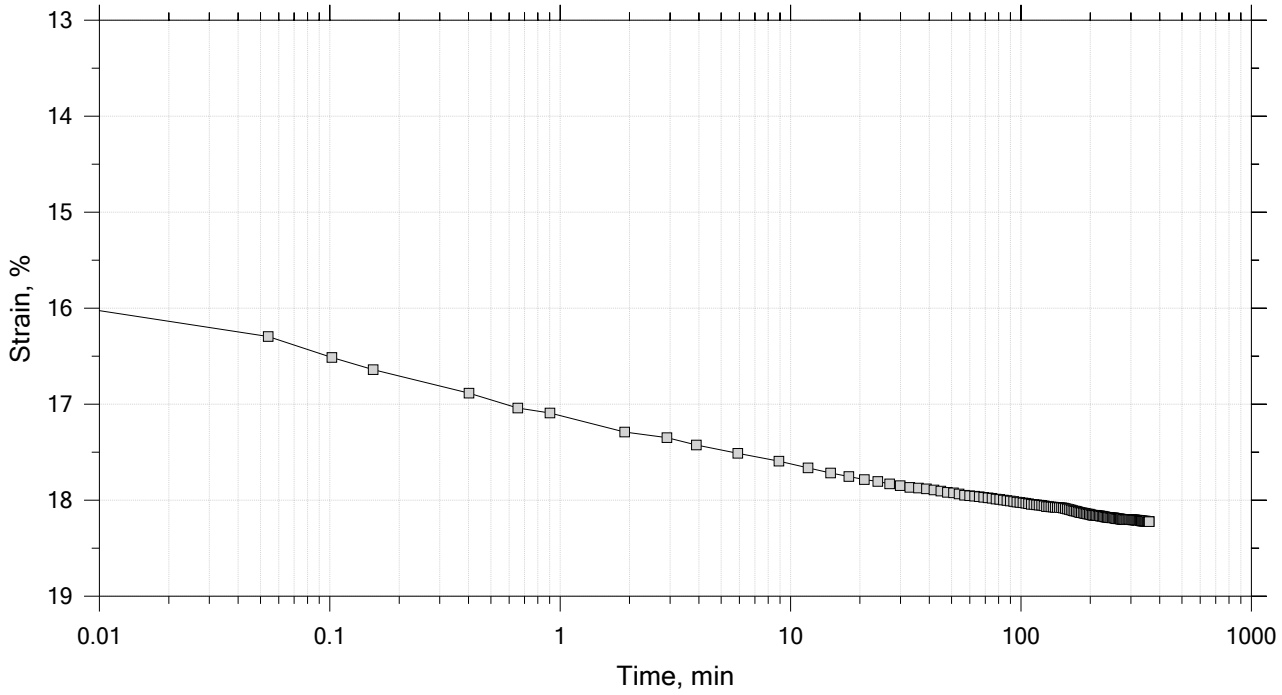


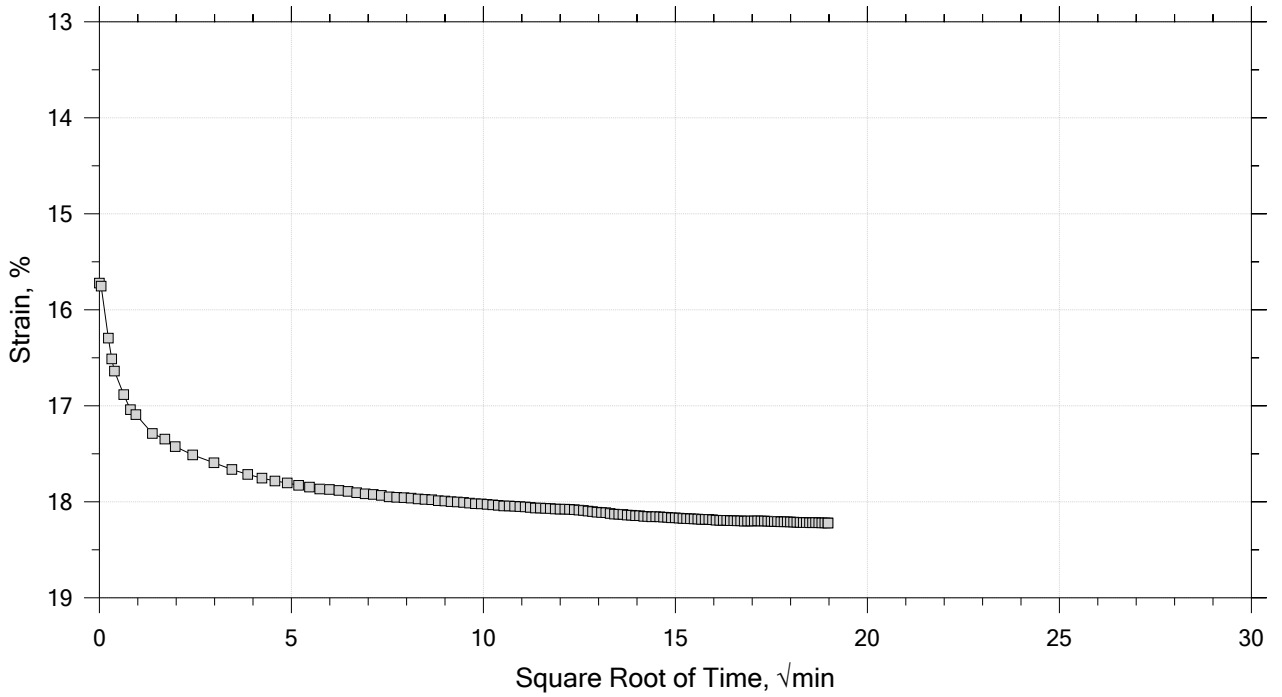


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-1	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with silt and gravel		
	Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-1	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with silt and gravel		
Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.67	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.843	Plastic Limit: ---
Final Height: 0.82 in	Final Void Ratio: 0.511	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	A-2564	RING		
Mass Container, gm	8.29	109.97	109.97	8.3
Mass Container + Wet Soil, gm	61.42	242.32	249	149.68
Mass Container + Dry Soil, gm	54.99	226.7	226.7	127
Mass Dry Soil, gm	46.7	116.73	116.73	118.7
Water Content, %	13.77	13.38	19.11	19.11
Void Ratio	---	0.84	0.51	---
Degree of Saturation, %	---	42.47	100.00	---
Dry Unit Weight, pcf	---	90.59	110.48	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS

Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-1	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with silt and gravel		
Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Square Root of Time Coefficients

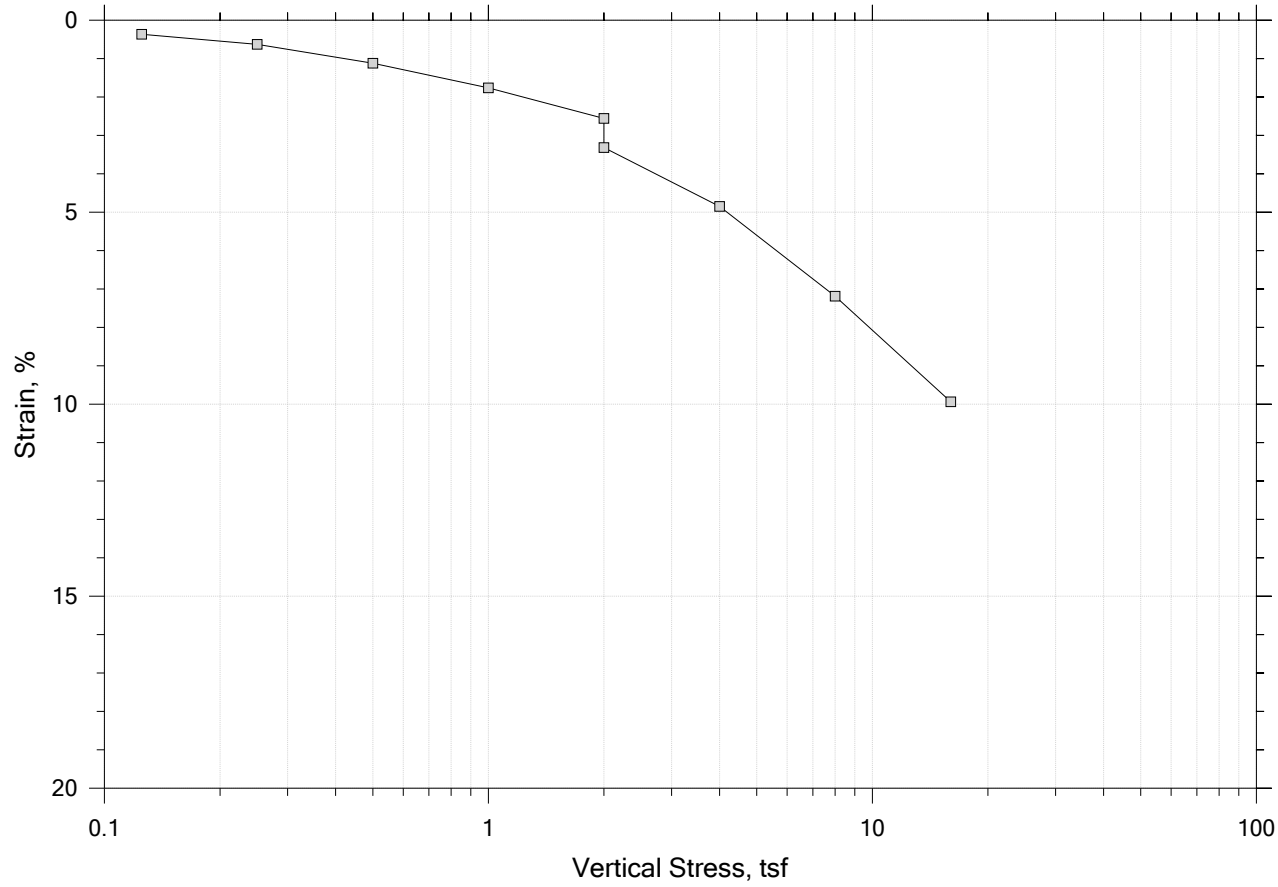
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.125	0.003111	0.837	0.311	5.267	6.69e-04	2.49e-02	3.12e-04
2	0.250	0.006085	0.831	0.608	2.569	1.36e-03	2.38e-02	6.07e-04
3	0.500	0.01182	0.821	1.18	7.149	4.85e-04	2.29e-02	2.08e-04
4	1.00	0.01992	0.806	1.99	3.553	9.63e-04	1.62e-02	2.92e-04
5	2.00	0.03341	0.781	3.34	4.156	8.06e-04	1.35e-02	2.04e-04
6	2.00	0.06690	0.719	6.69	698.739	4.56e-06	---	---
7	4.00	0.09784	0.662	9.78	42.870	6.94e-05	1.55e-02	2.01e-05
8	8.00	0.1400	0.585	14.0	46.726	5.87e-05	1.05e-02	1.16e-05
9	16.0	0.1822	0.507	18.2	44.209	5.62e-05	5.28e-03	5.56e-06

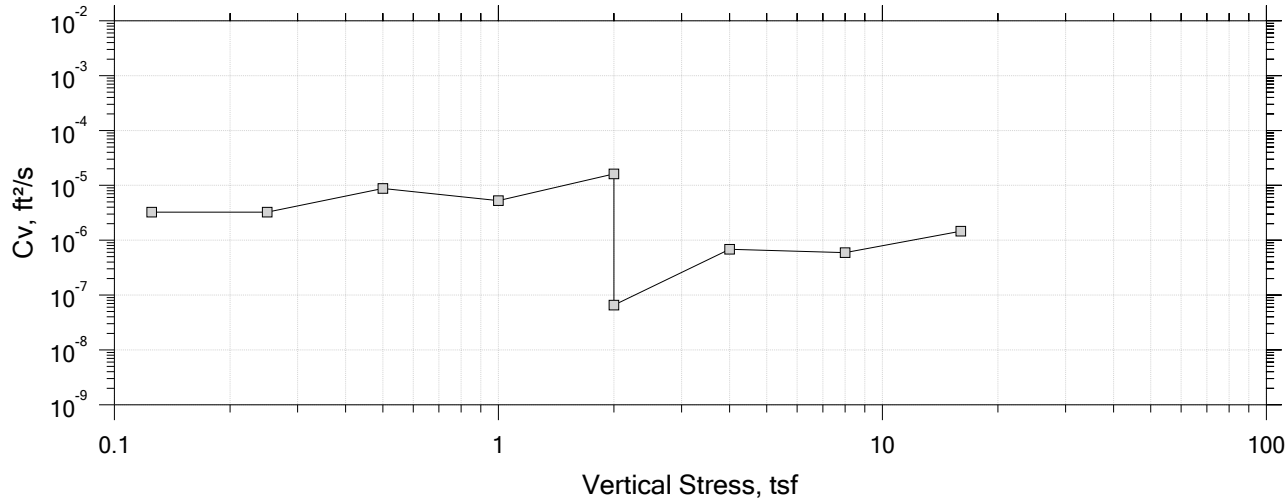
GeoTesting EXPRESS

Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9050 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-1	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with silt and gravel		
Remarks: System LTIII-0837, 95% of 115.7 pcf @ 13.4 MC, Unable to achieve the target density.		
Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report





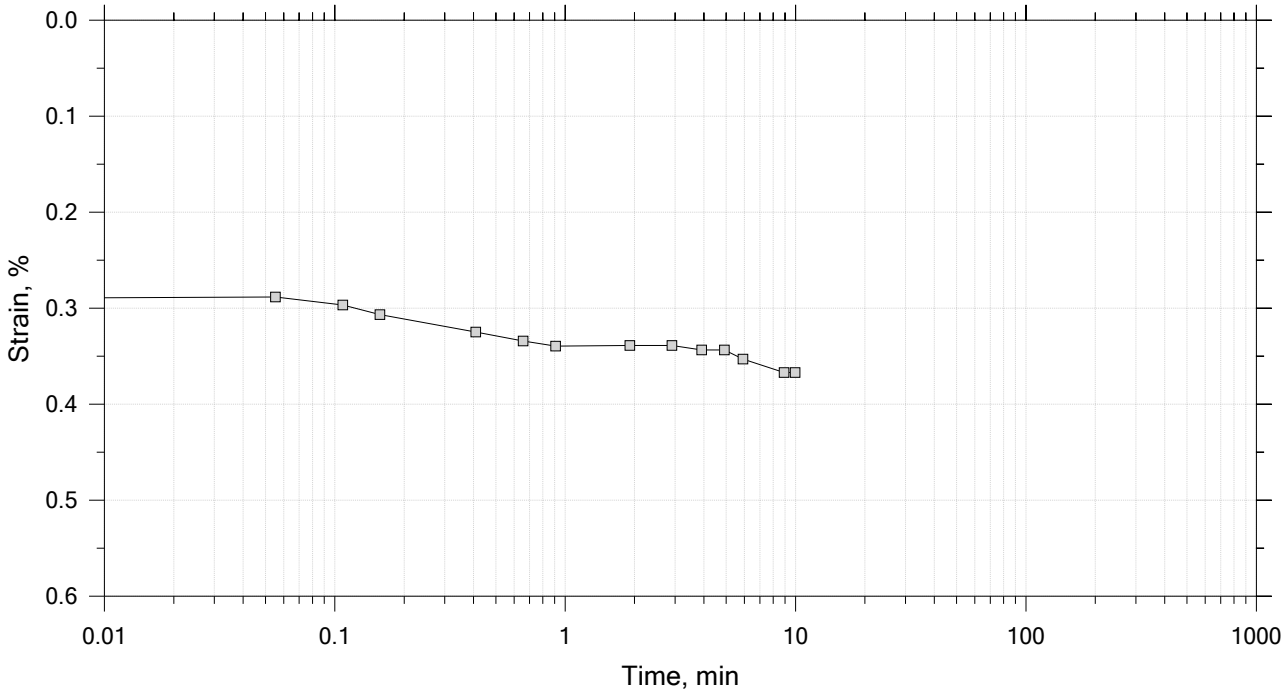
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

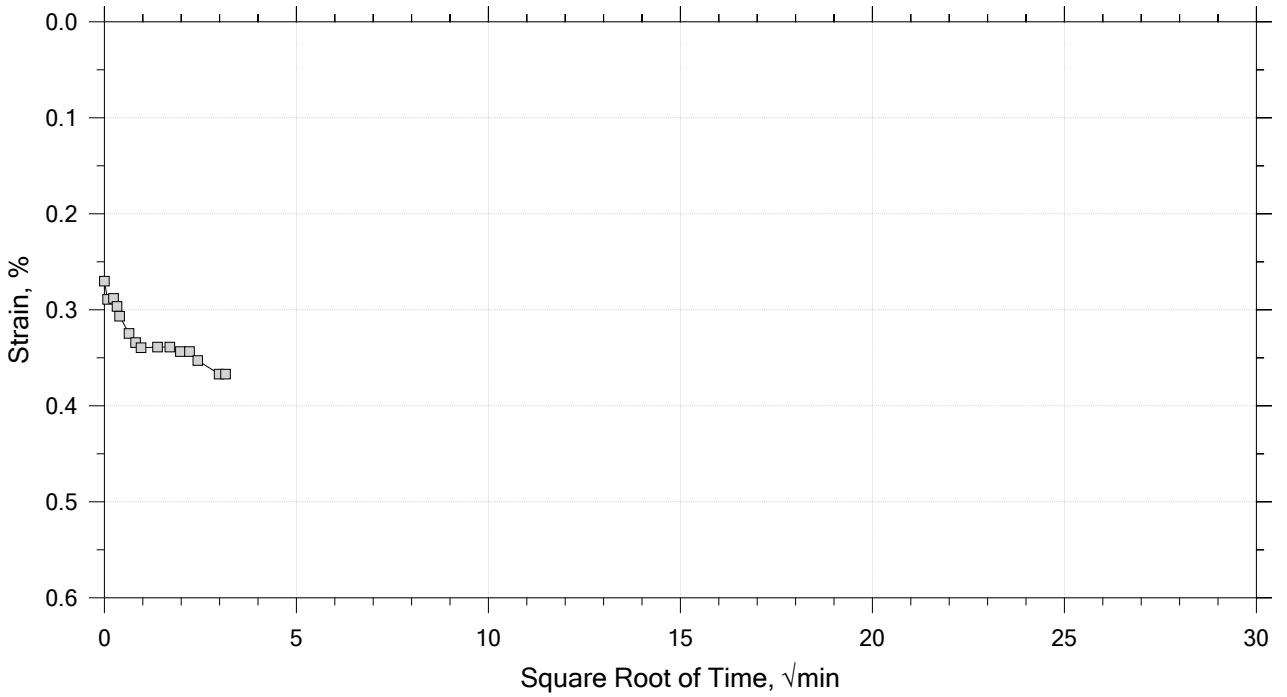
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9

Constant Load Step

Stress: 0.125 tsf

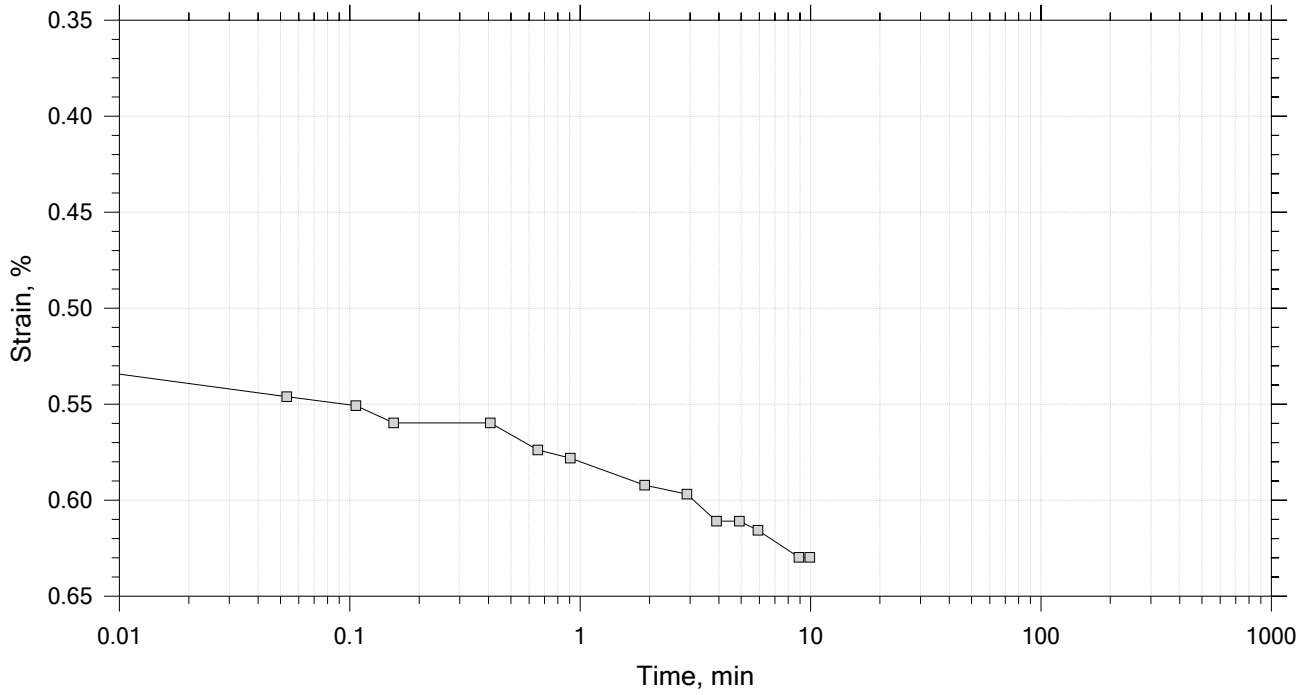


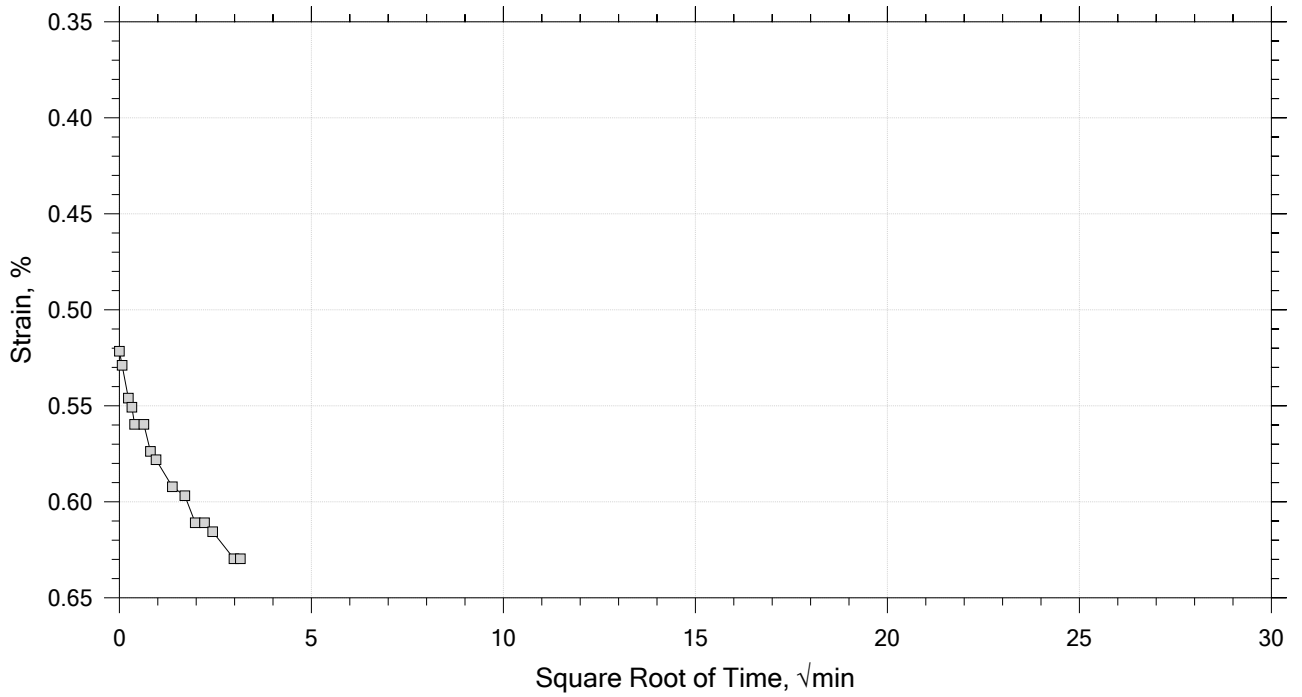


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

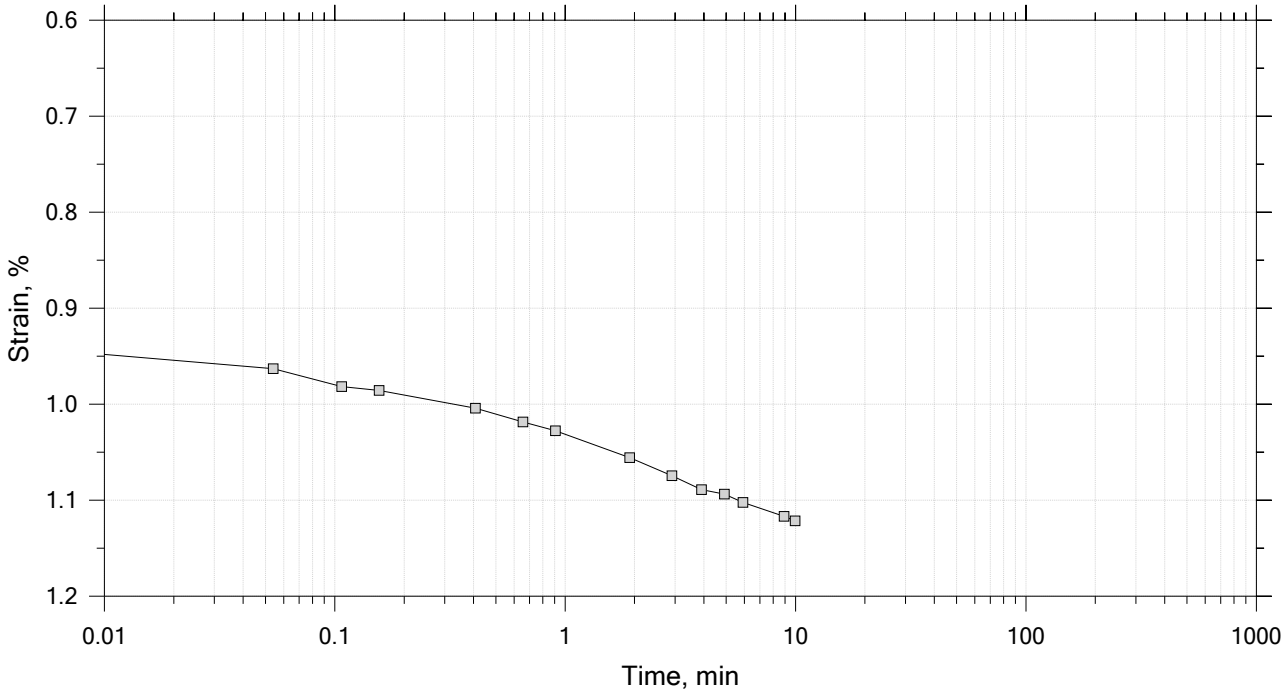


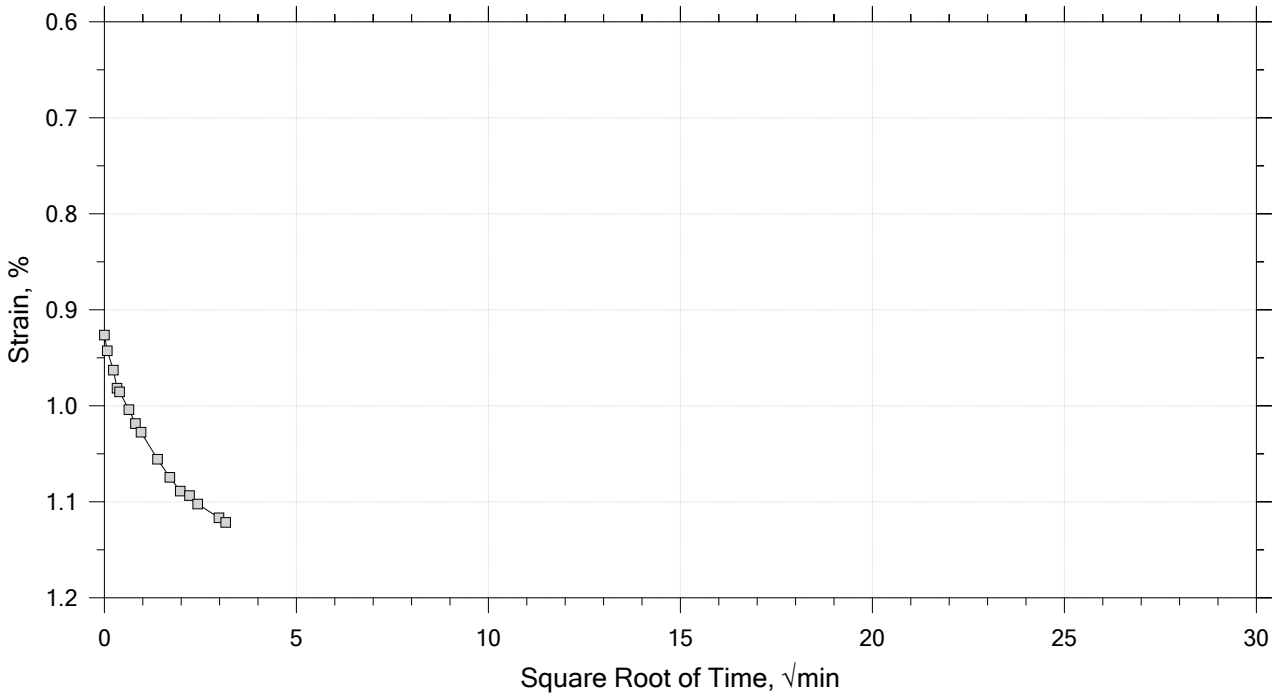


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-4	Sample Type: remolded	Elevation: ---
Description: Moist, dark gray silty sand and gravel		
Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf





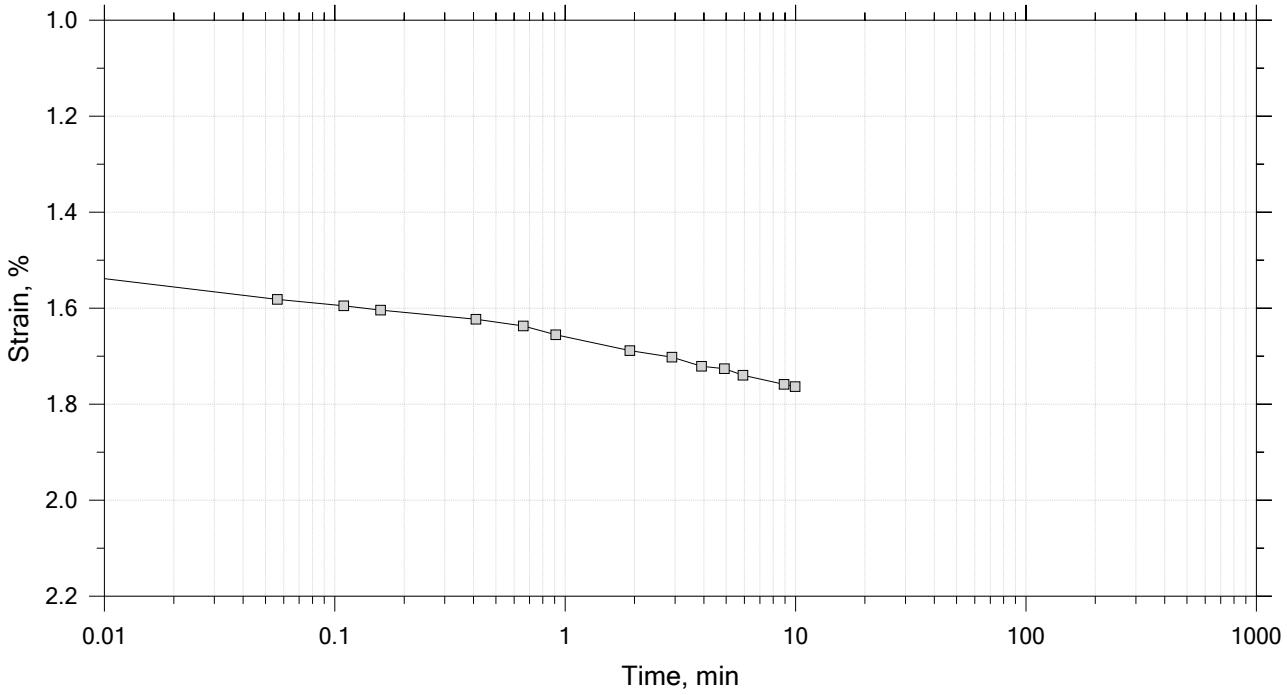
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

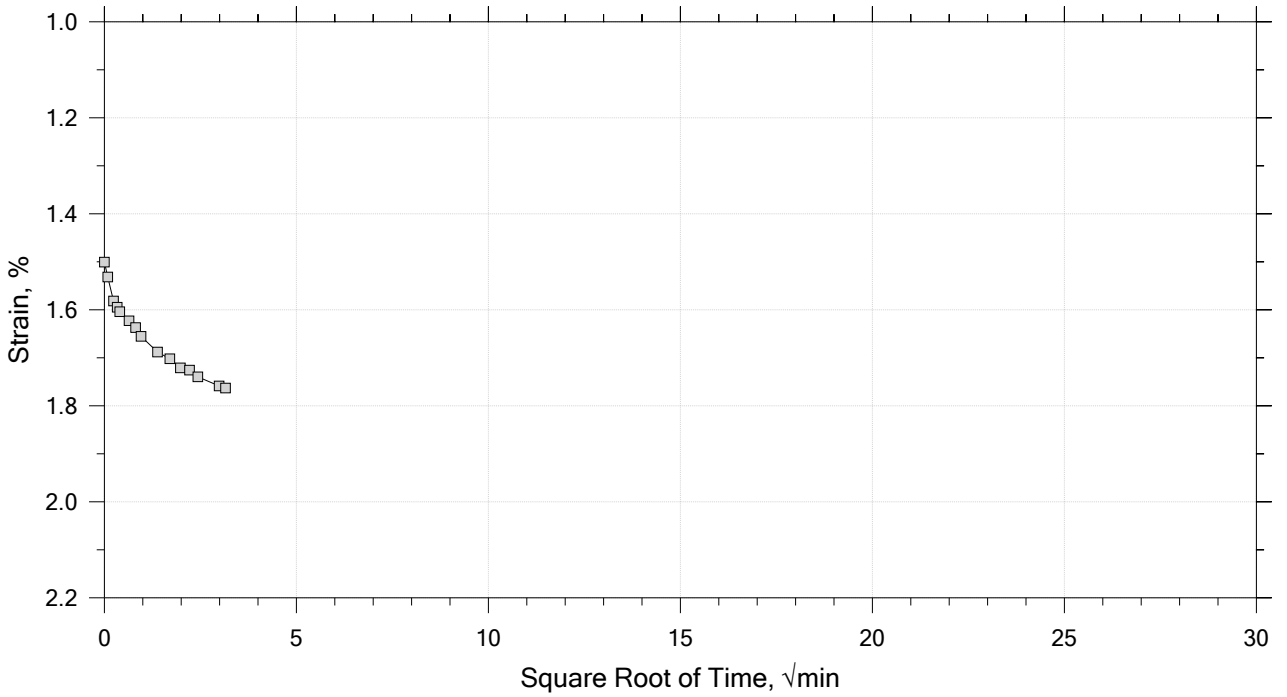
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9

Constant Load Step

Stress: 1 tsf

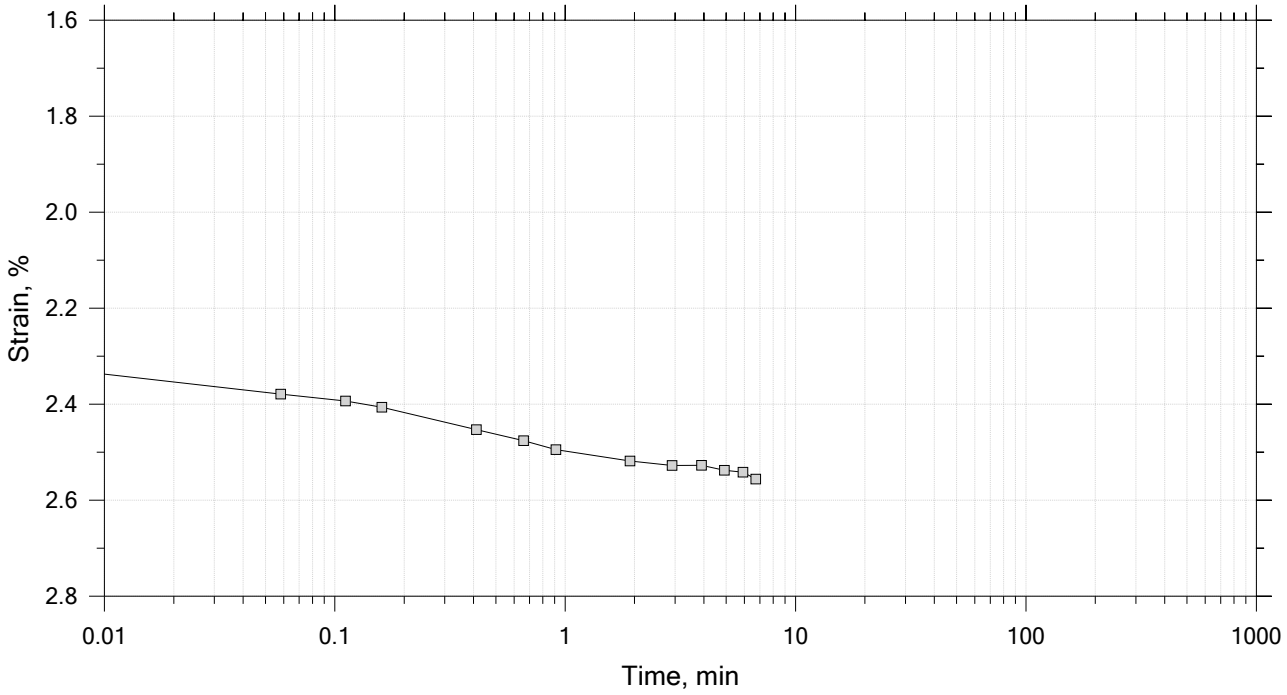


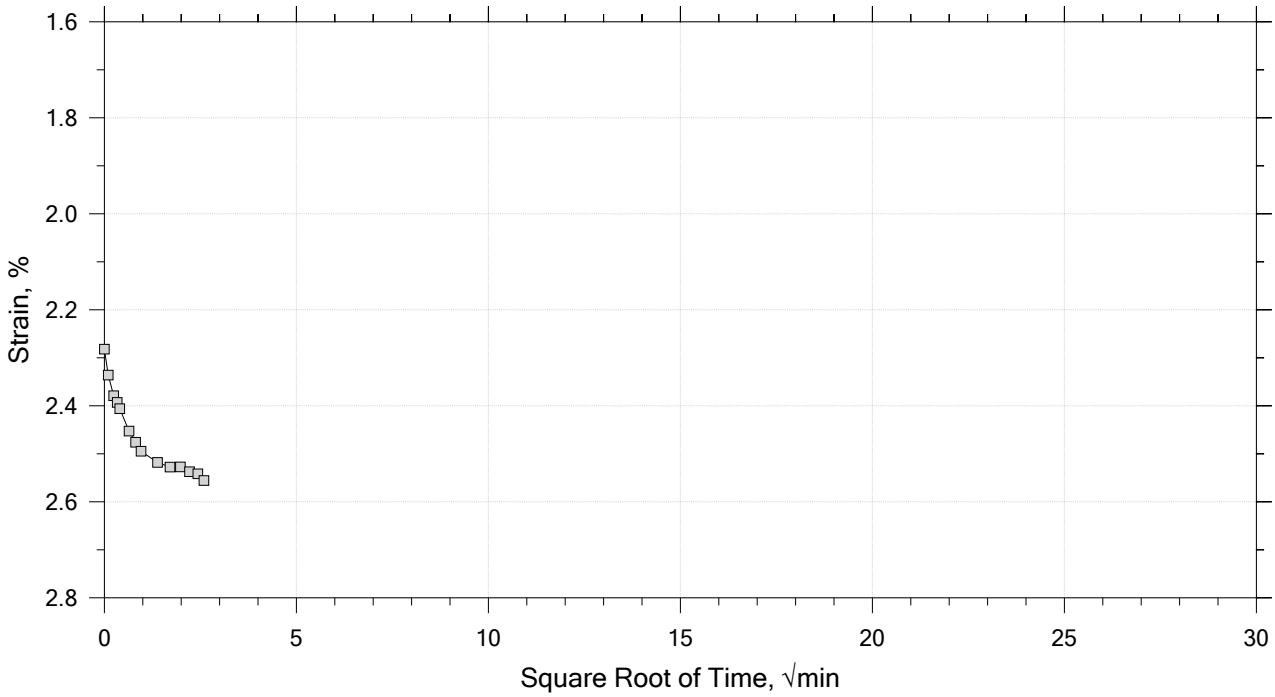


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9
Constant Load Step
Stress: 2 tsf





GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

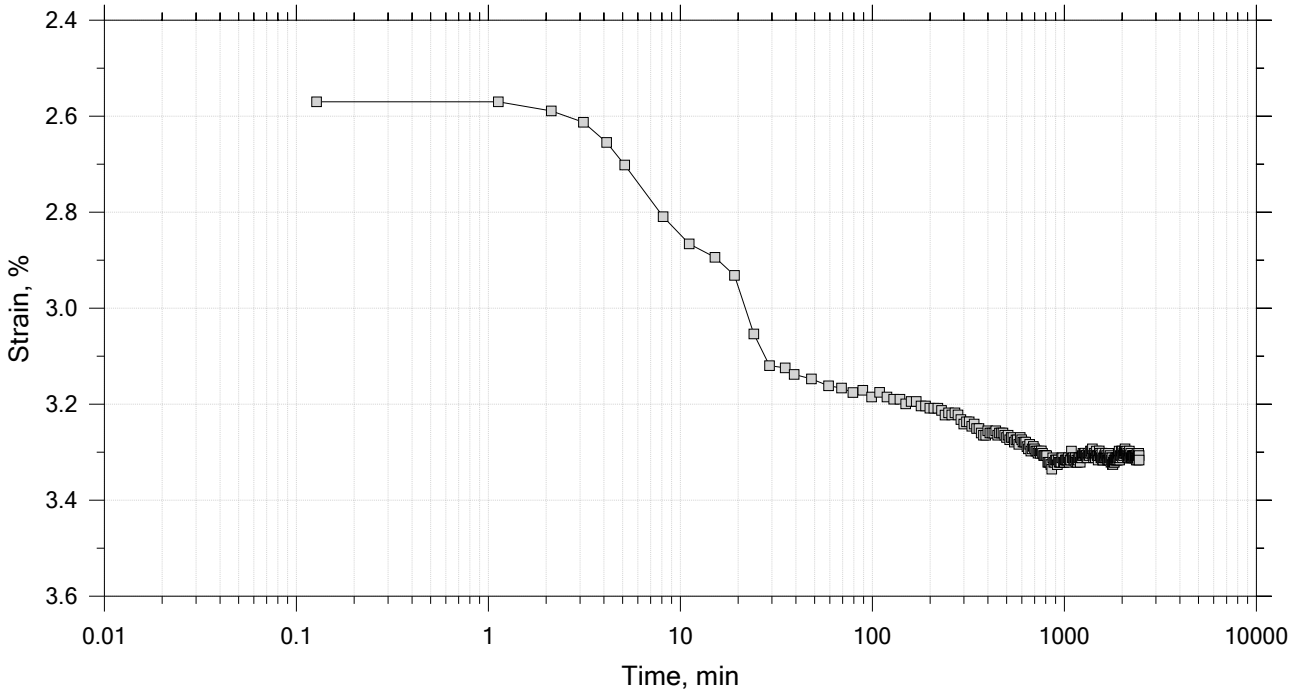
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

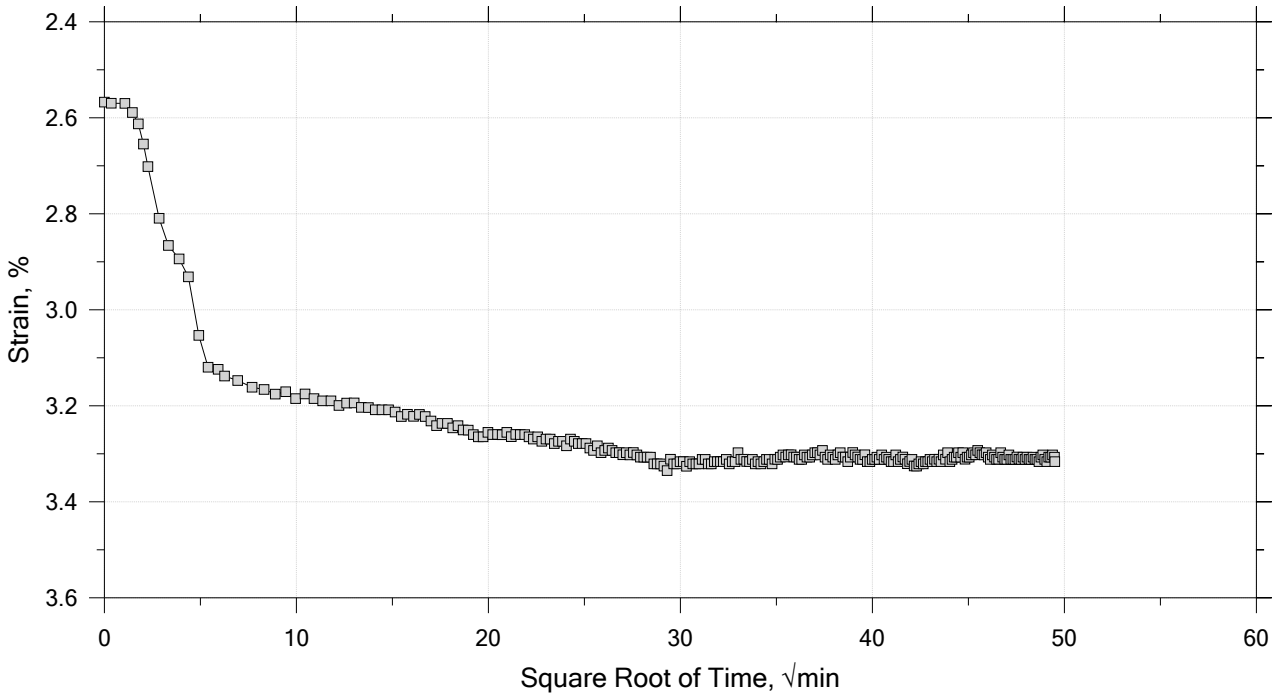
Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

WATER ADDED TO TEST





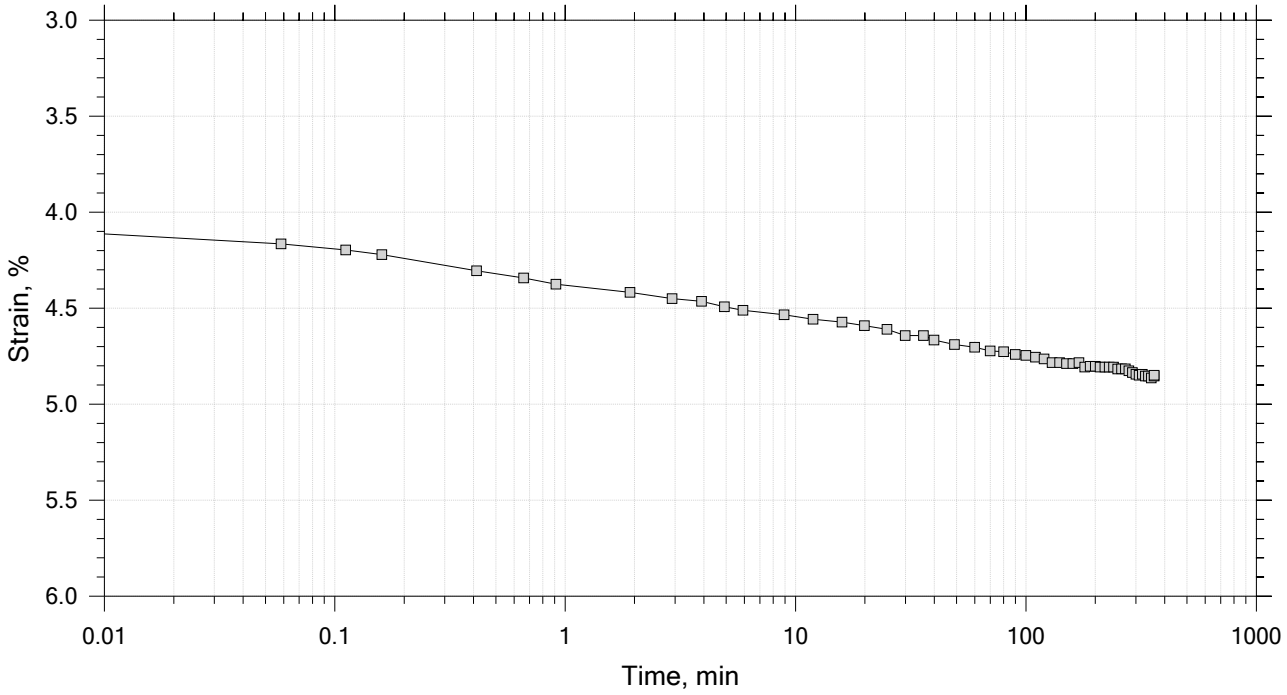
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-4	Sample Type: remolded	Elevation: ---
Description: Moist, dark gray silty sand and gravel		
Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

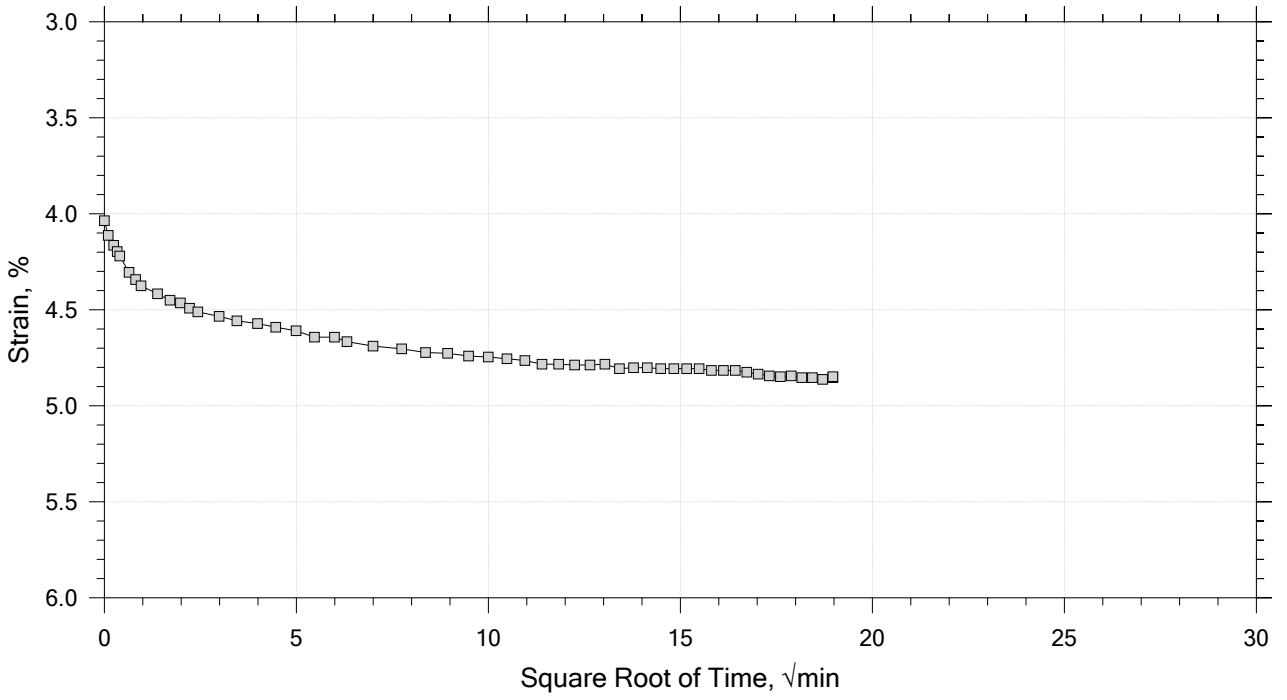
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9

Constant Load Step

Stress: 4 tsf

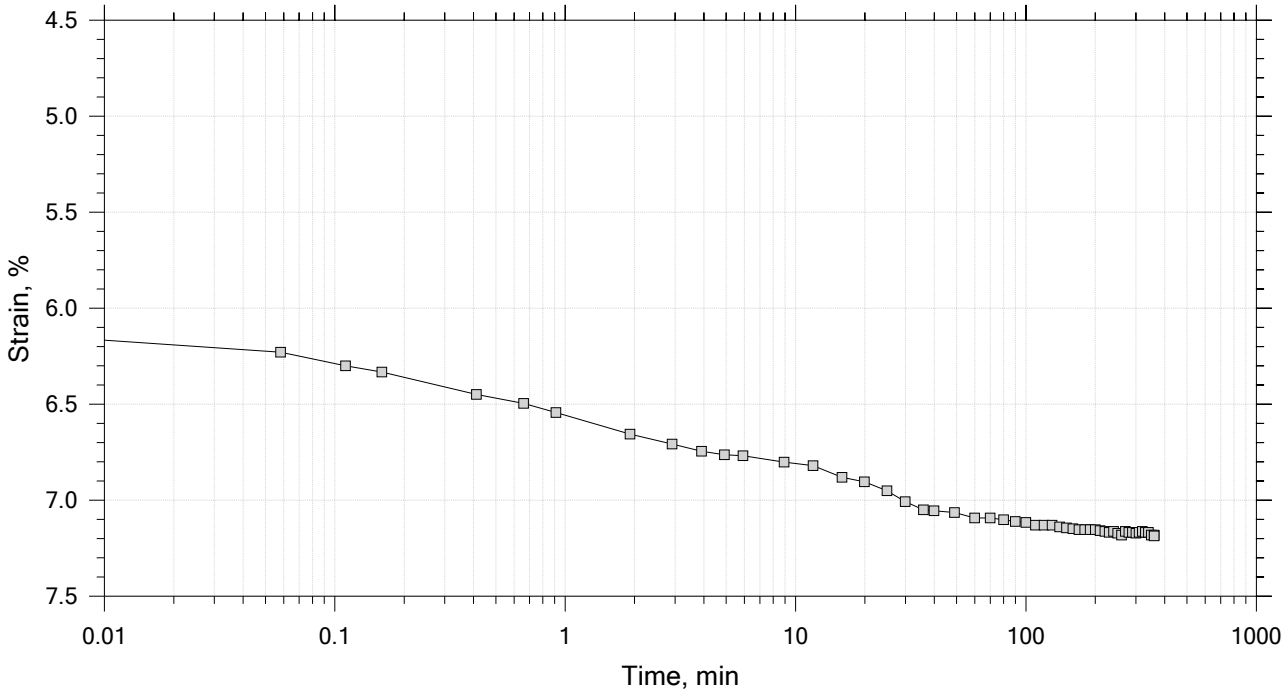


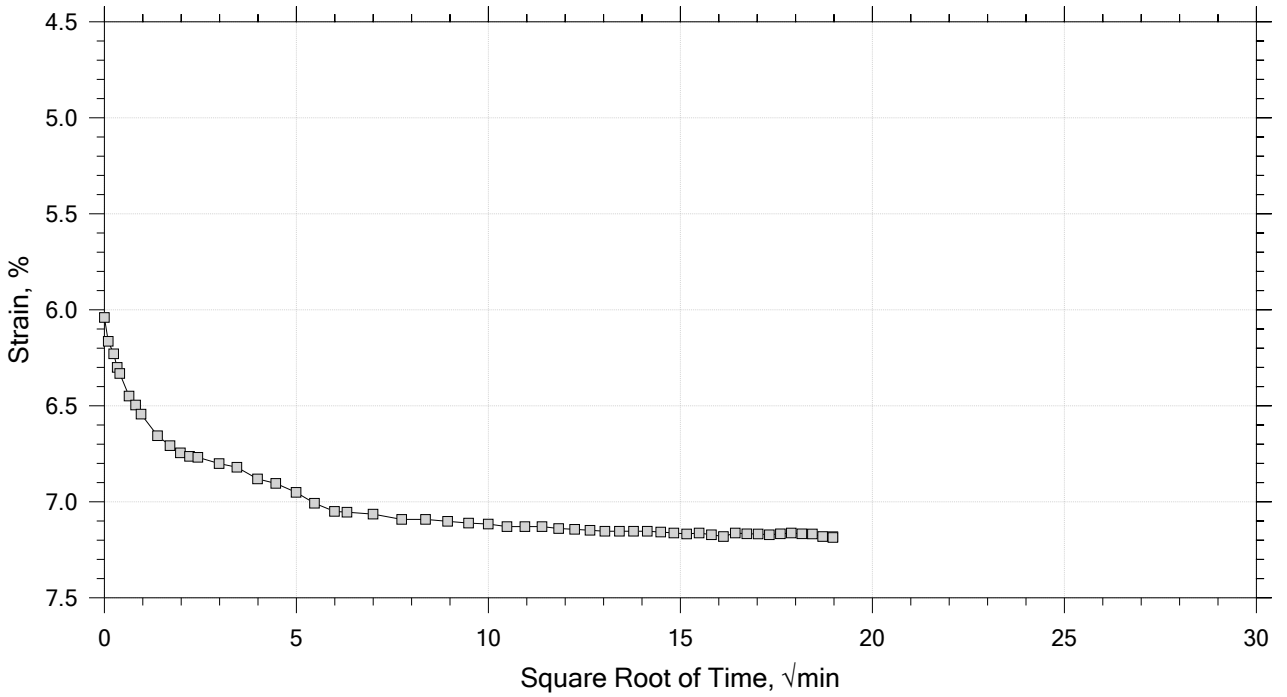


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9
Constant Load Step
Stress: 8 tsf

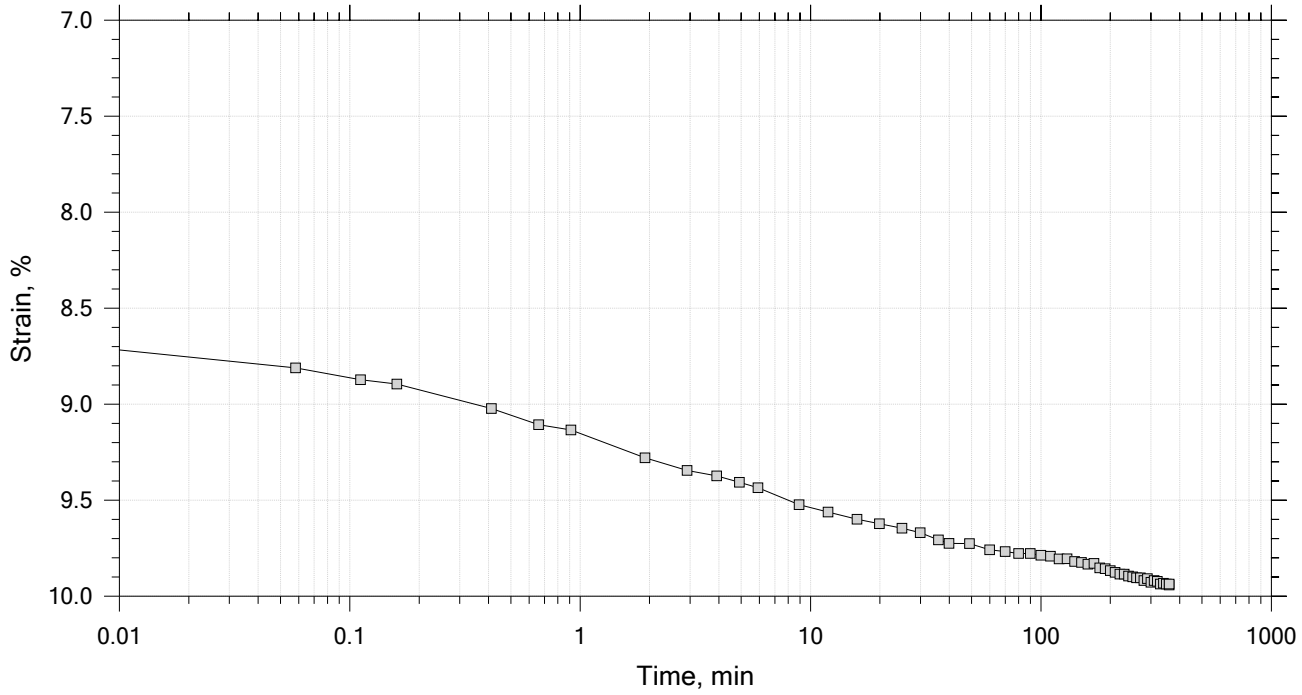


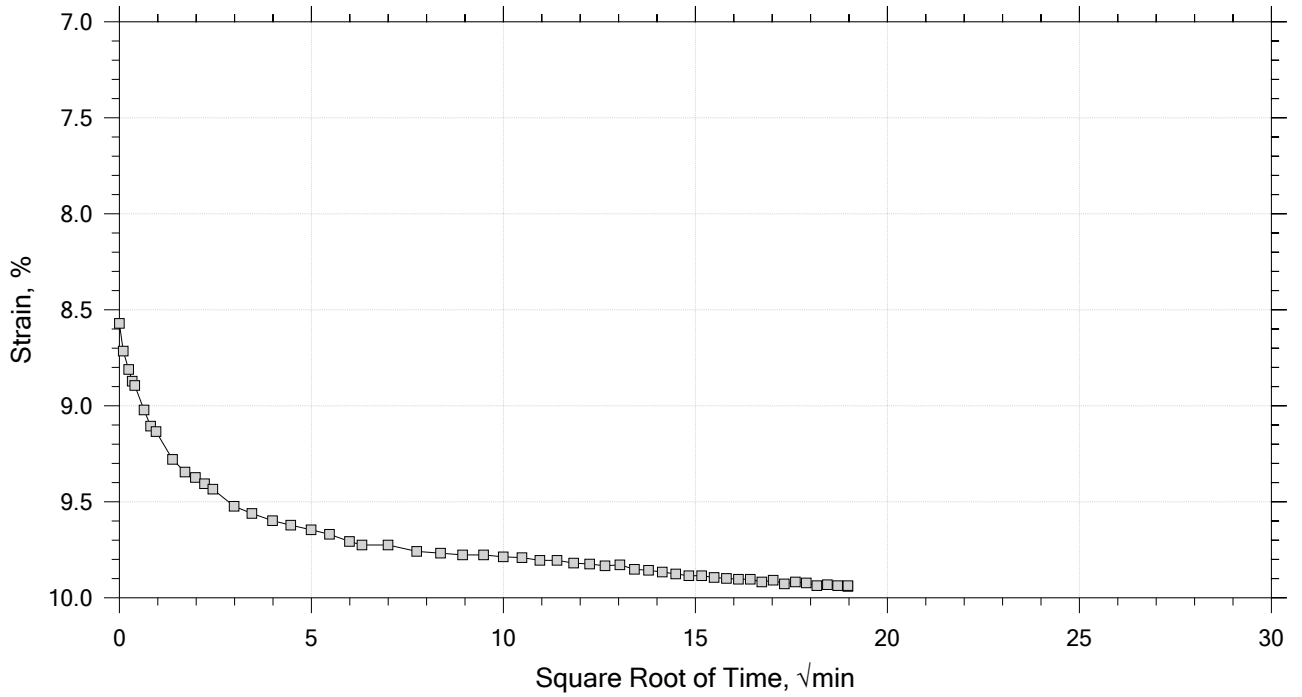


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-4	Sample Type: remolded	Elevation: ---
Description: Moist, dark gray silty sand and gravel		
Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.86	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.58	Plastic Limit: ---
Final Height: 0.91 in	Final Void Ratio: 0.438	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	B-3004	RING		B2413
Mass Container, gm	8.32	110.95	110.95	9.14
Mass Container + Wet Soil, gm	95.35	274.89	279	177.31
Mass Container + Dry Soil, gm	84.85	256.71	256.71	155
Mass Dry Soil, gm	76.53	145.76	145.76	145.86
Water Content, %	13.72	12.48	15.30	15.30
Void Ratio	---	0.58	0.44	---
Degree of Saturation, %	---	61.57	100.00	---
Dry Unit Weight, pcf	---	113.12	124.31	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

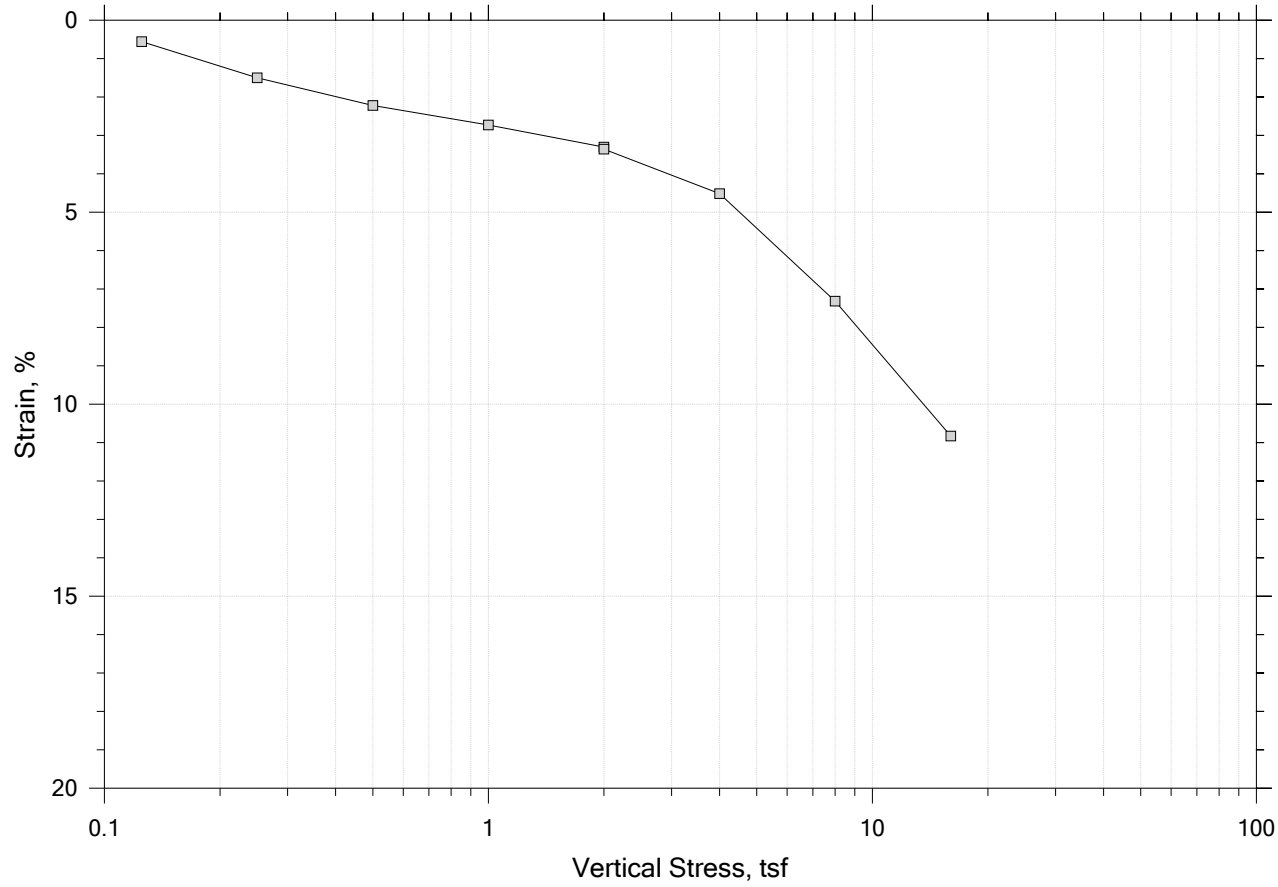
Square Root of Time Coefficients

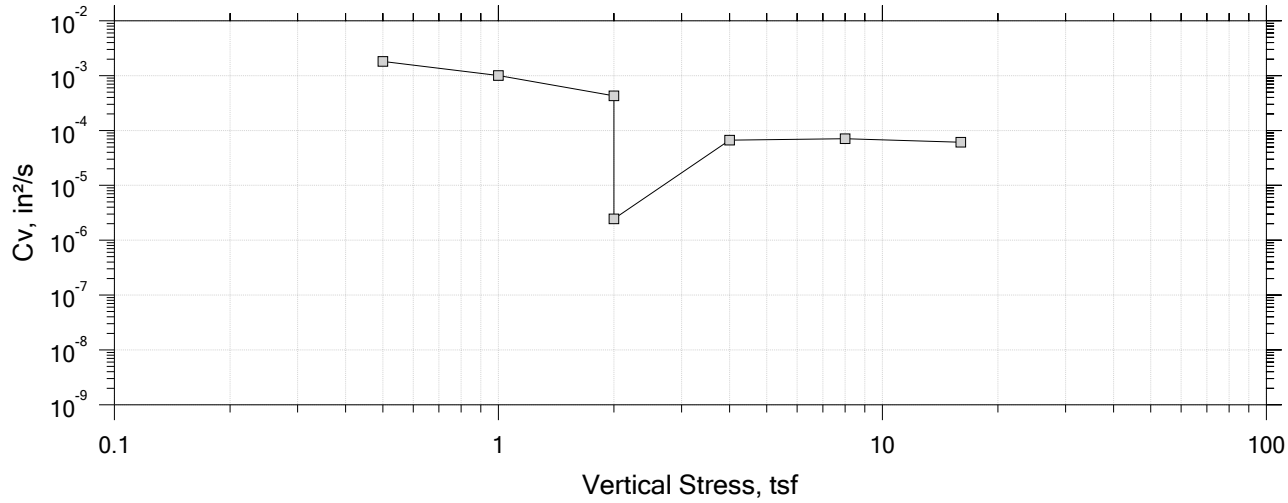
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv ft²/s	Mv 1/tsf	k ft/day
1	0.125	0.003670	0.574	0.367	7.525	3.25e-06	2.94e-02	2.57e-04
2	0.250	0.006297	0.570	0.630	7.507	3.24e-06	2.10e-02	1.83e-04
3	0.500	0.01121	0.562	1.12	2.753	8.76e-06	1.97e-02	4.65e-04
4	1.00	0.01763	0.552	1.76	4.521	5.27e-06	1.28e-02	1.82e-04
5	2.00	0.02556	0.540	2.56	1.457	1.61e-05	7.93e-03	3.45e-04
6	2.00	0.03316	0.528	3.32	353.591	6.54e-08	---	---
7	4.00	0.04849	0.504	4.85	33.086	6.82e-07	7.66e-03	1.41e-05
8	8.00	0.07186	0.467	7.19	36.465	5.94e-07	5.84e-03	9.37e-06
9	16.0	0.09937	0.423	9.94	14.047	1.46e-06	3.44e-03	1.35e-05

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9051 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-4	Sample Type: remolded	Elevation: ---
	Description: Moist, dark gray silty sand and gravel		
	Remarks: System F, 95% of 124.2 pcf @ 13.3% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report





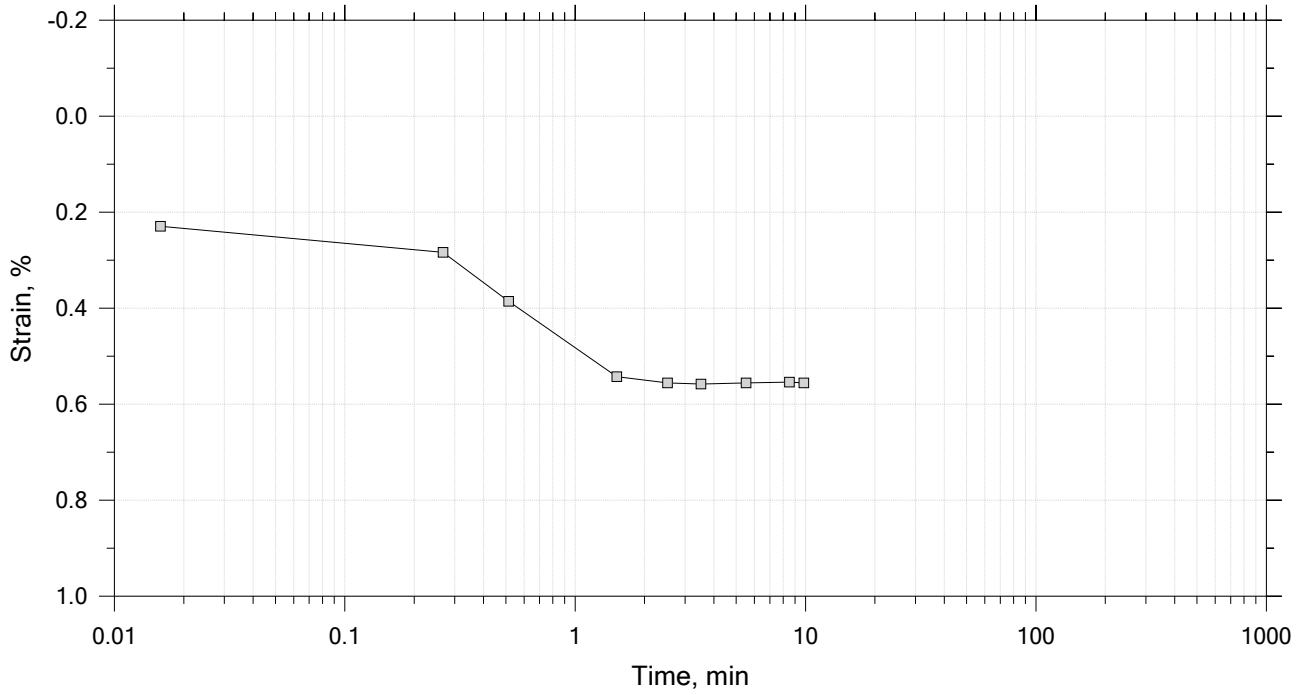
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

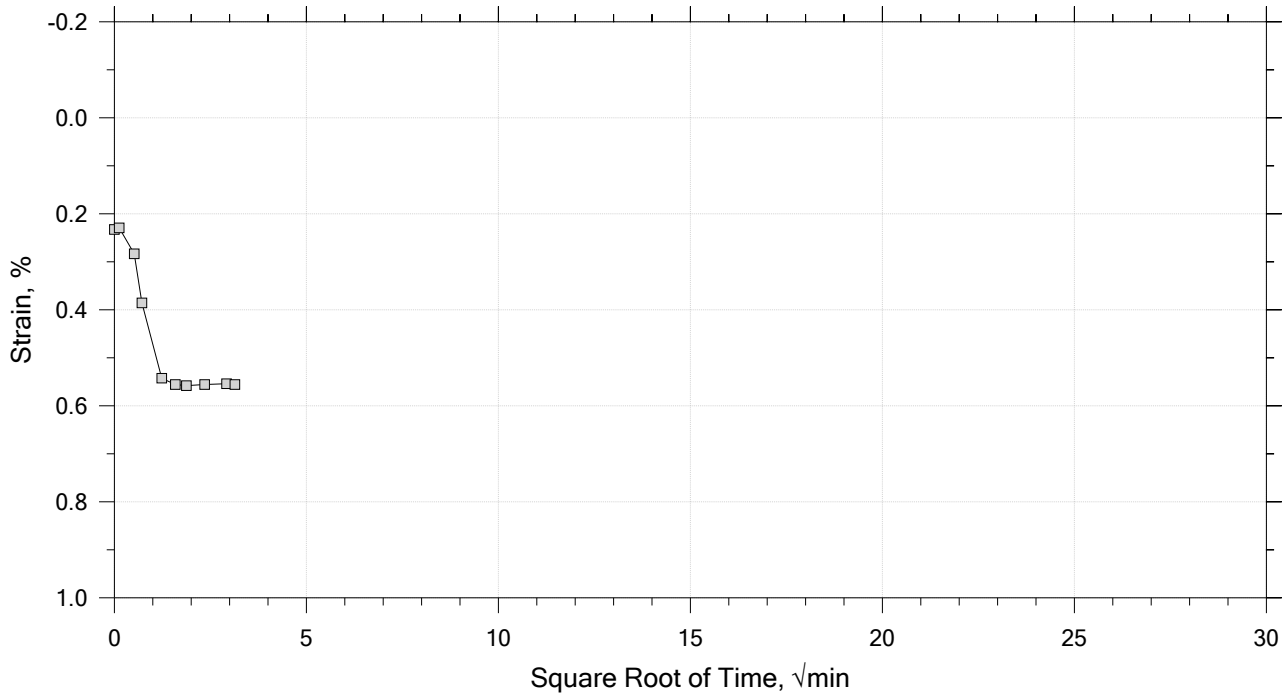
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9

Constant Load Step

Stress: 0.125 tsf

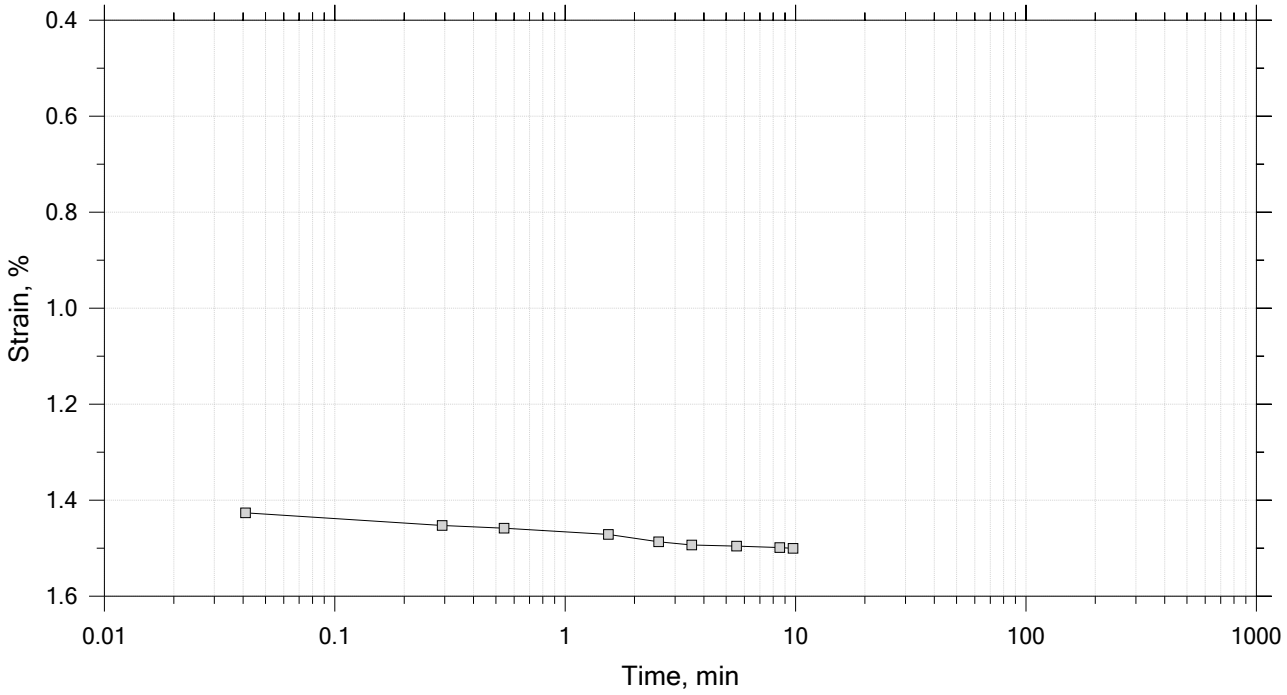


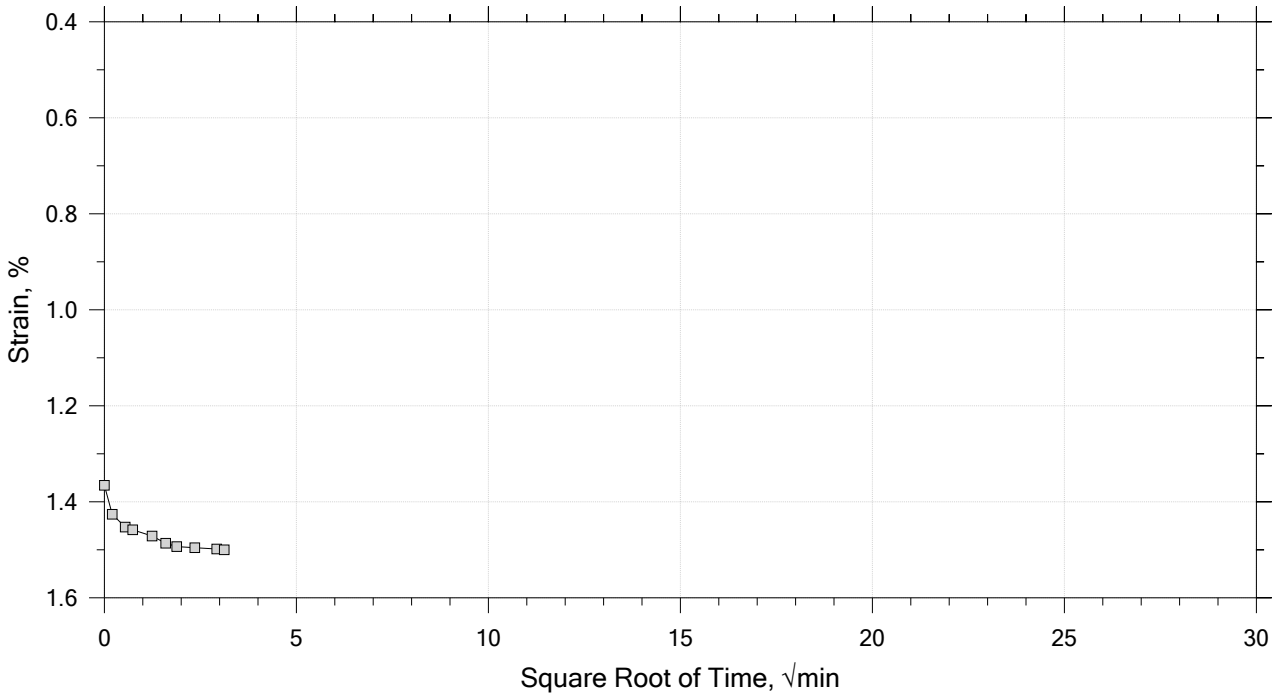


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

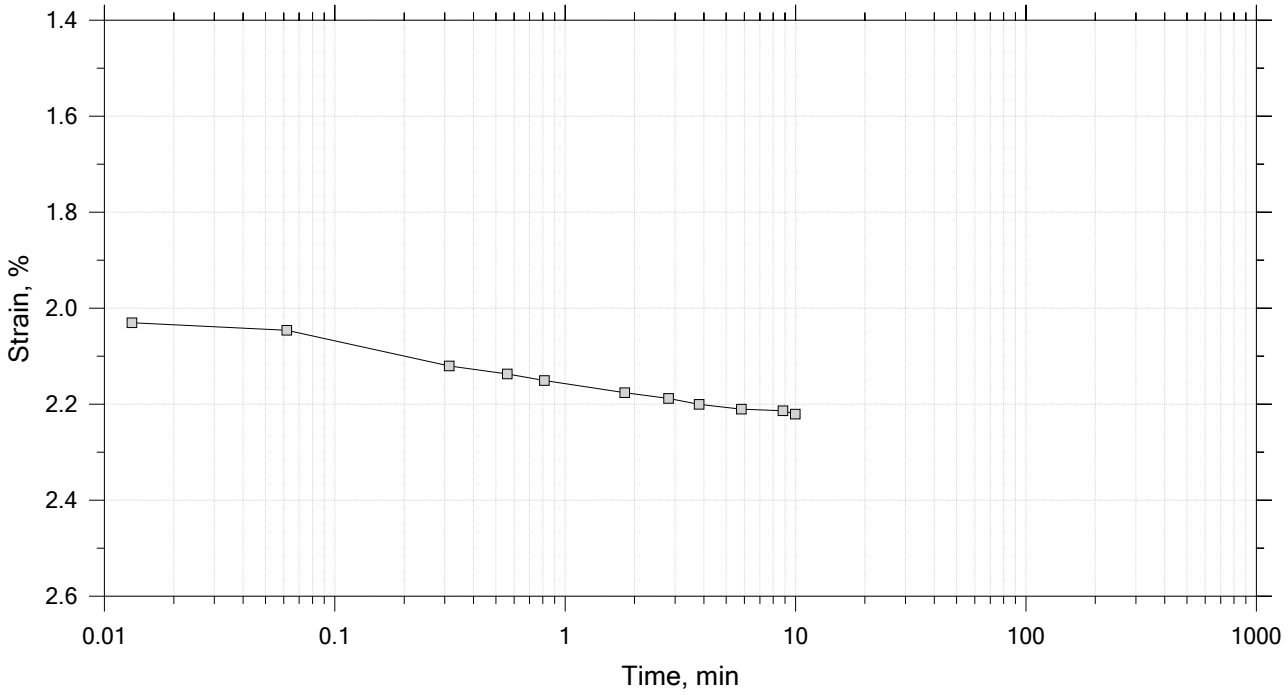


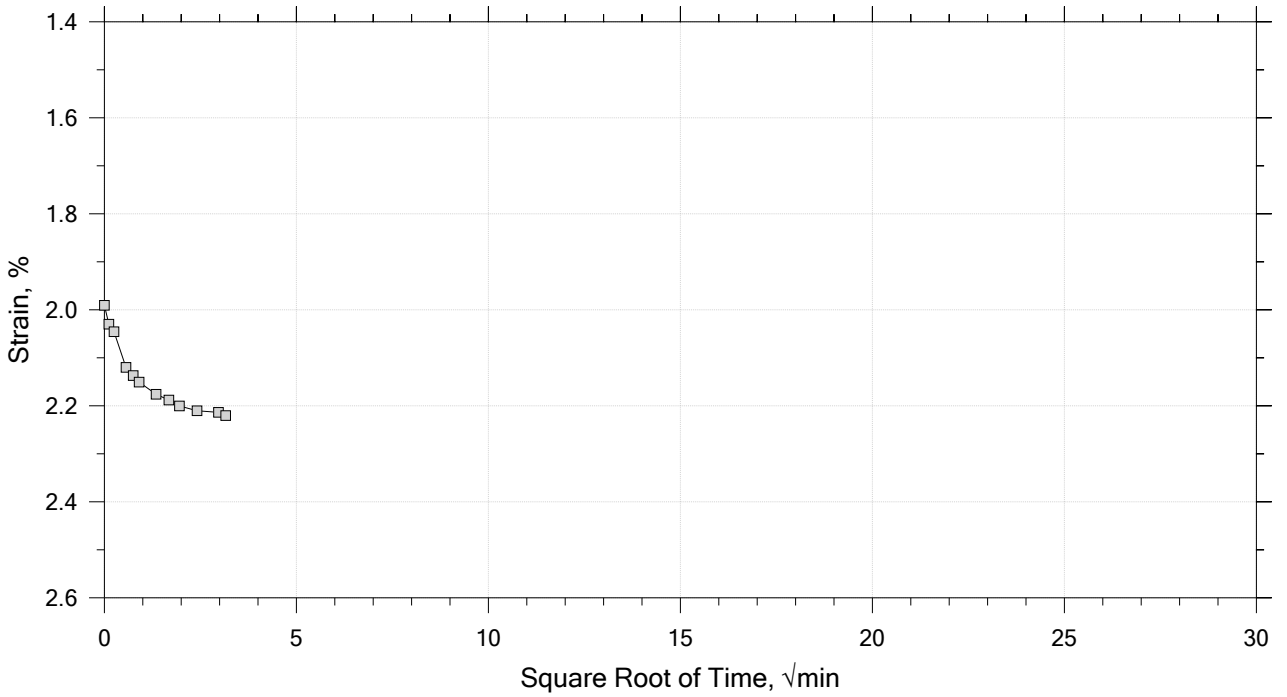


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf

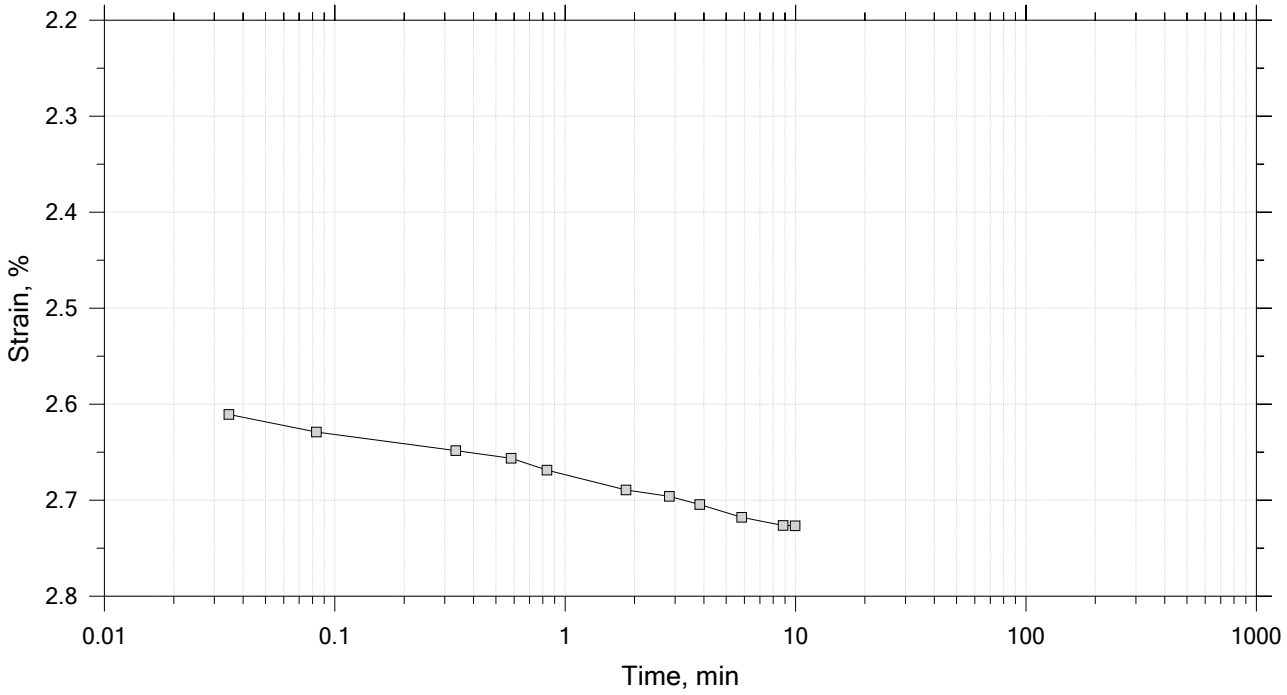


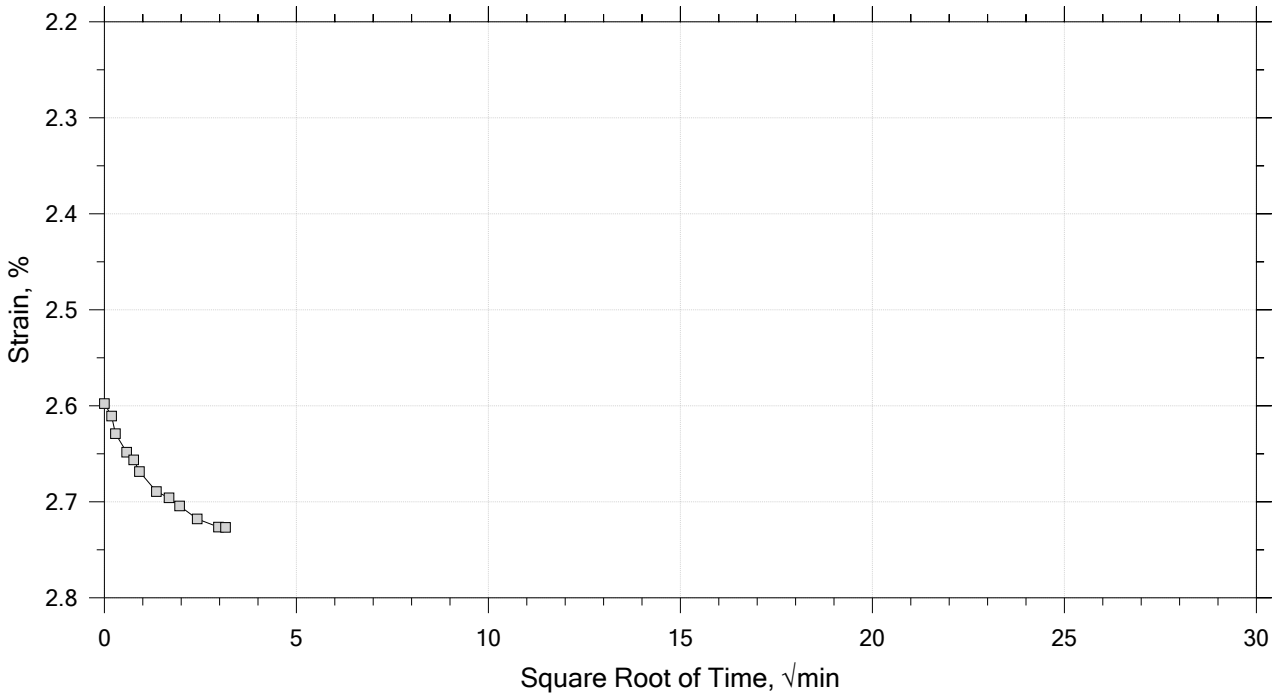


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-5	Sample Type: remolded	Elevation: ---
Description: Moist, light gray silty sand and gravel		
Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9
Constant Load Step
Stress: 1 tsf

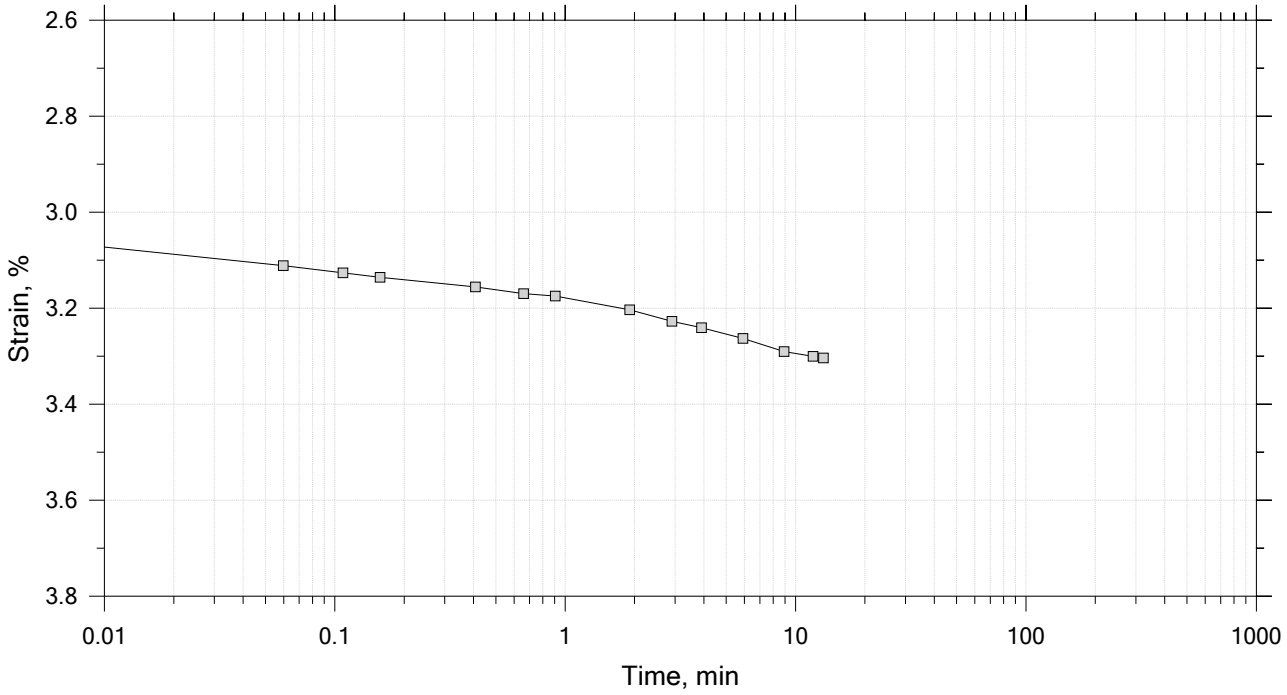


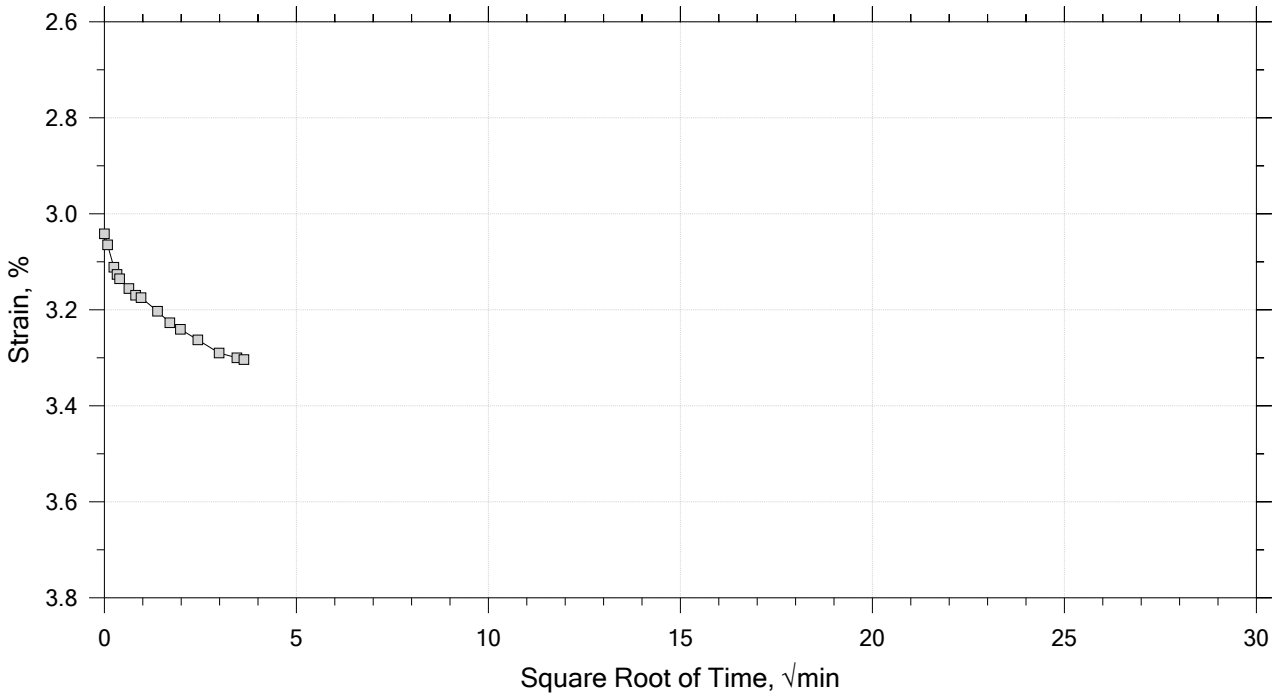


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9
Constant Load Step
Stress: 2 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-5	Sample Type: remolded	Elevation: ---
Description: Moist, light gray silty sand and gravel		
Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

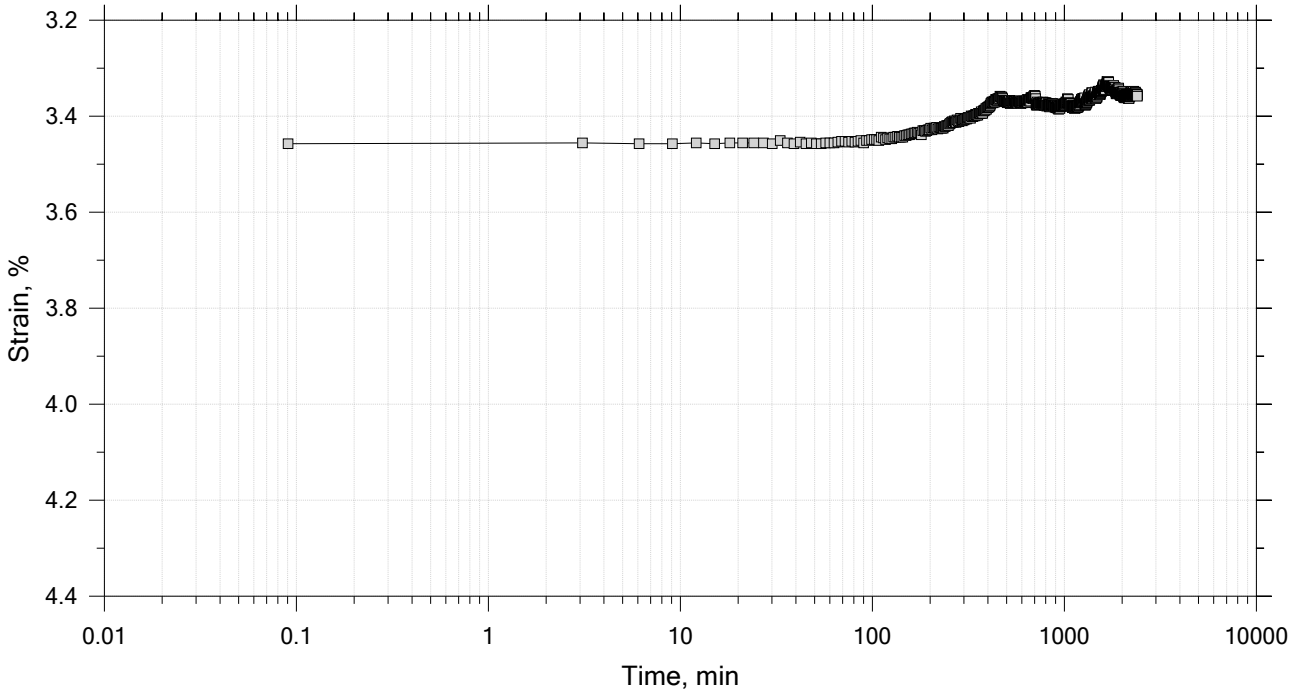
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

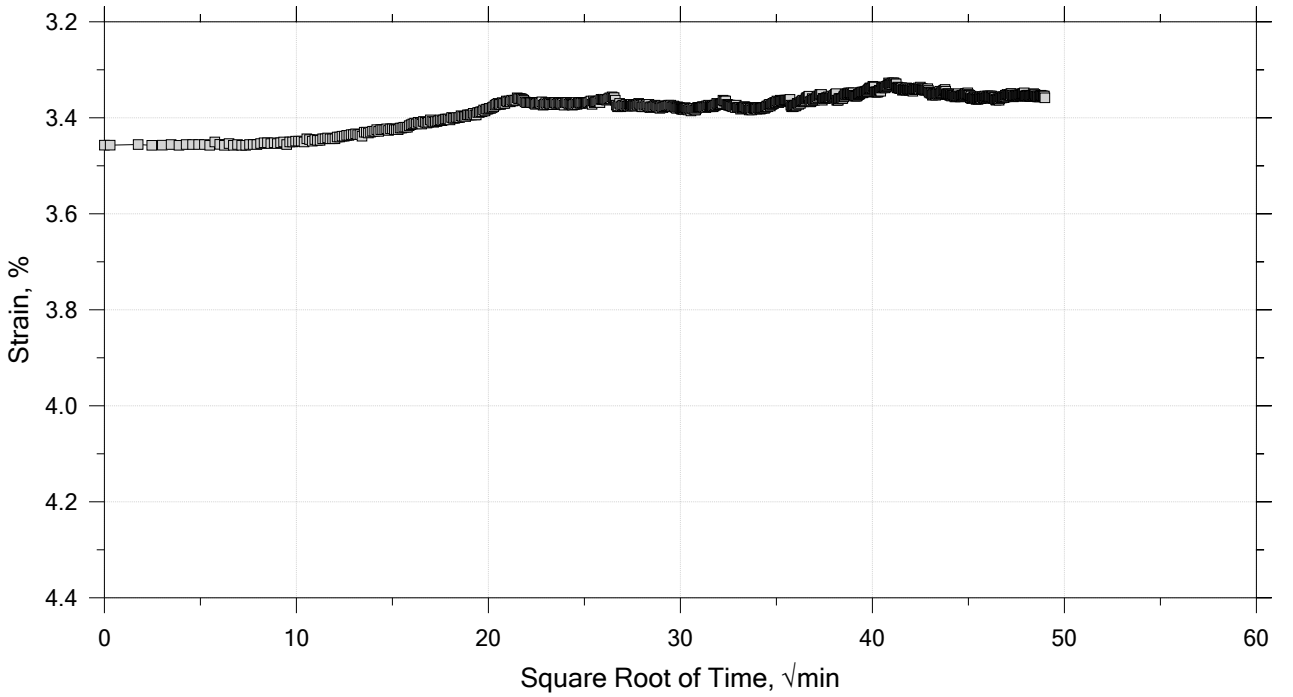
Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

WATER ADDED TO TEST





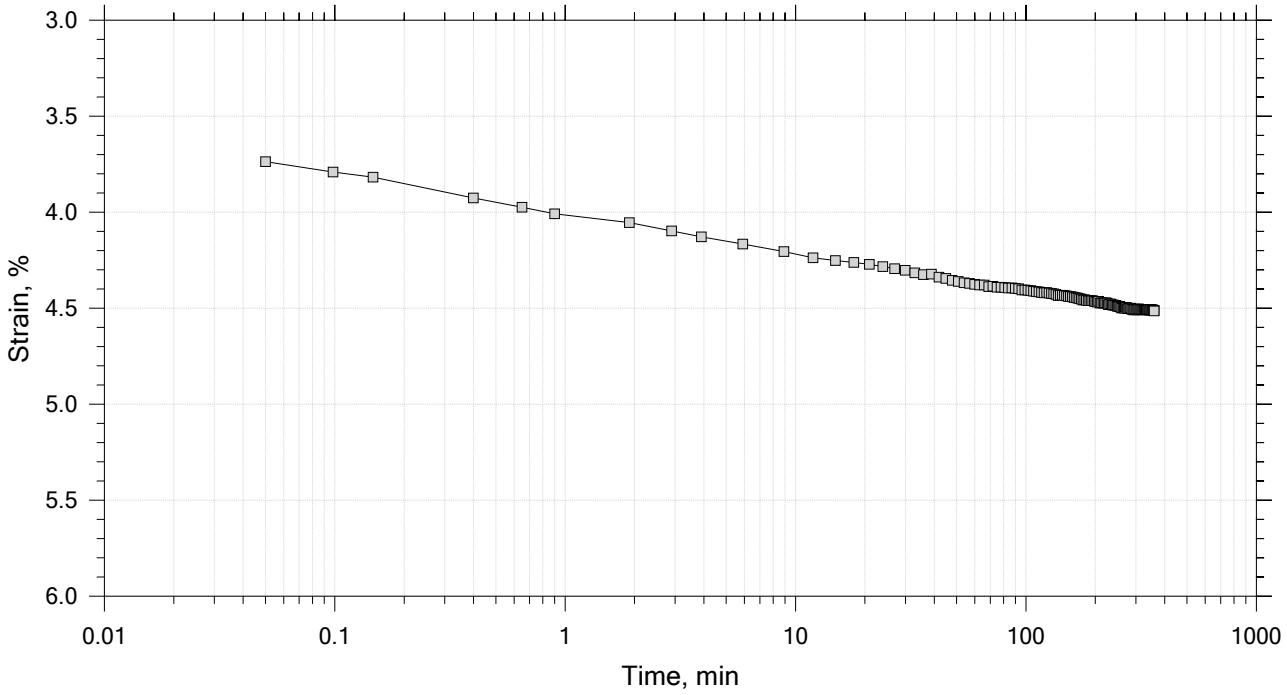
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

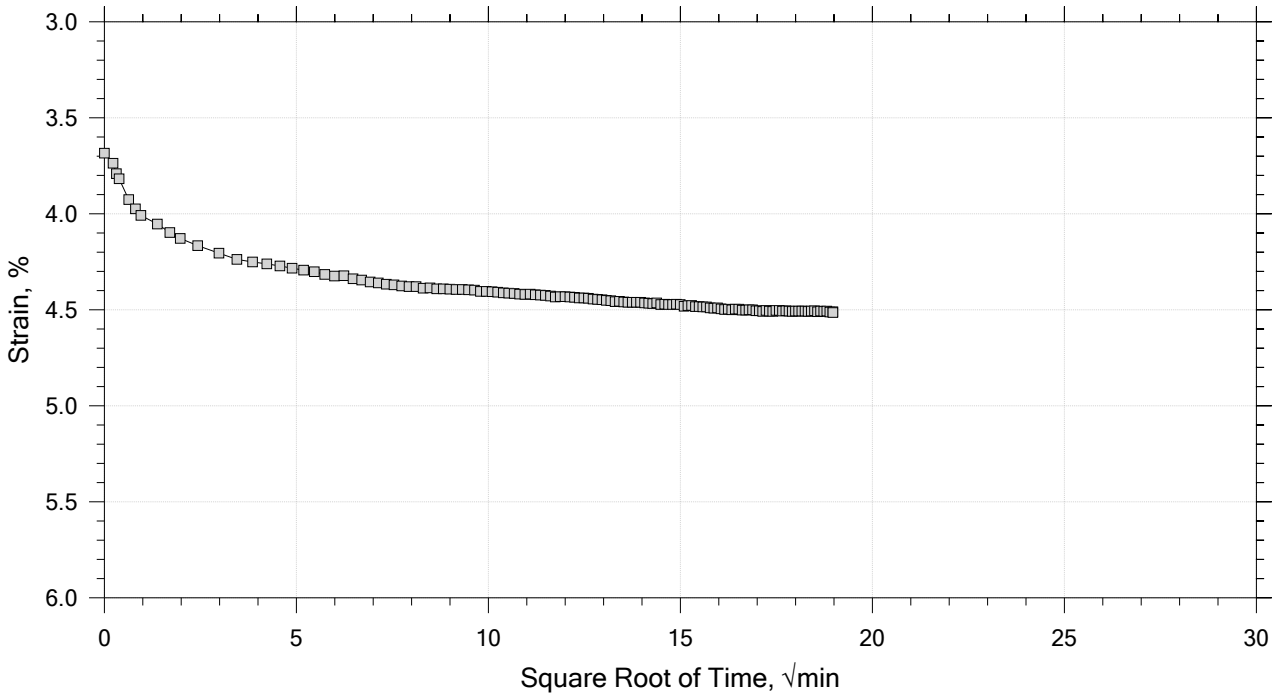
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9

Constant Load Step

Stress: 4 tsf

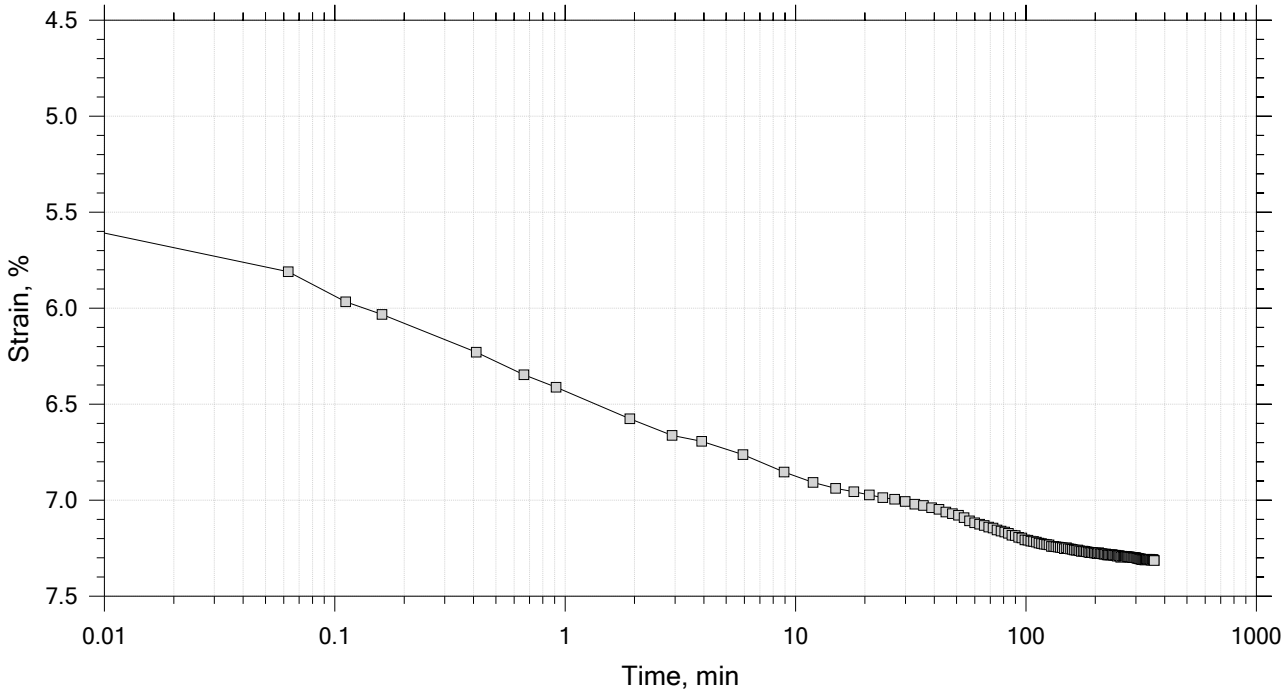


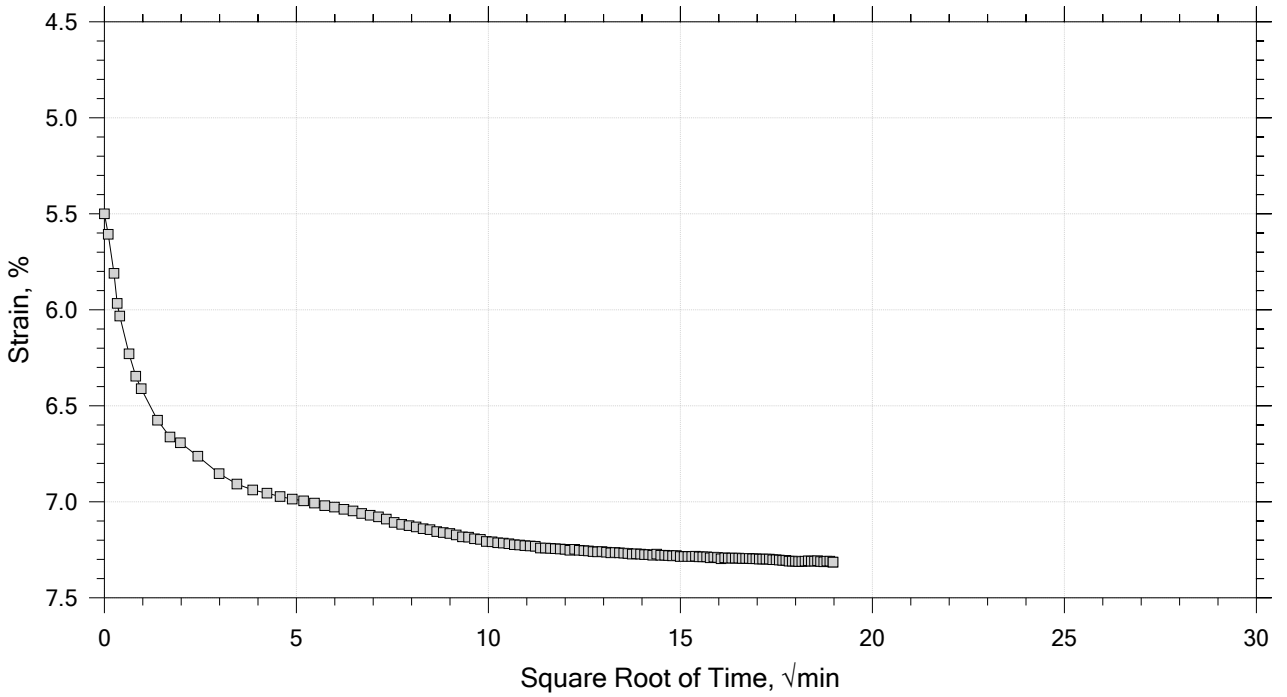


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9
Constant Load Step
Stress: 8 tsf

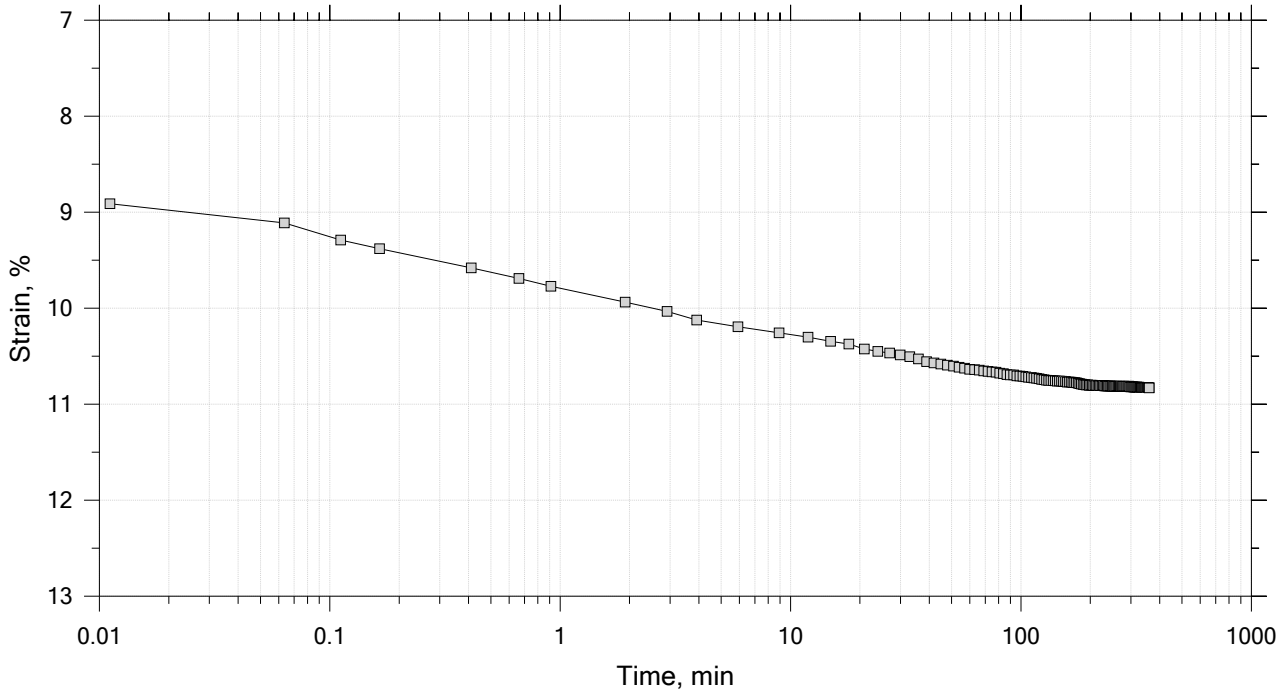


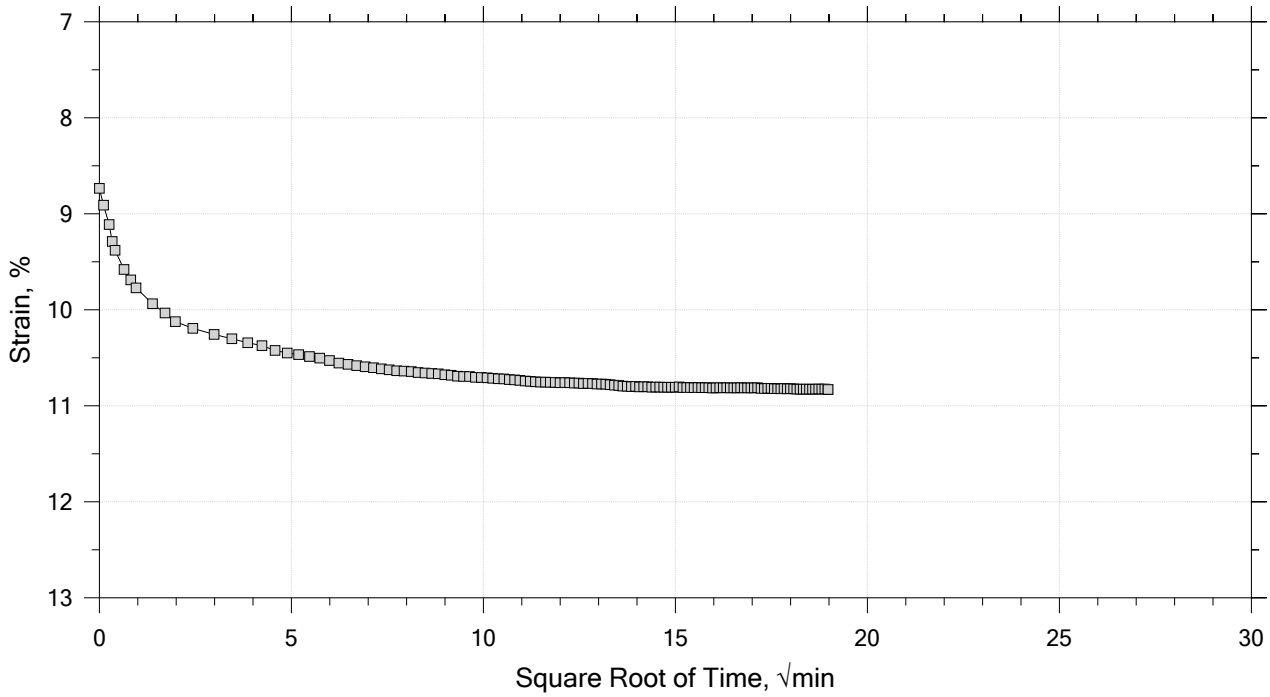


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-5	Sample Type: remolded	Elevation: ---
Description: Moist, light gray silty sand and gravel		
Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-5	Sample Type: remolded	Elevation: ---
Description: Moist, light gray silty sand and gravel		
Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.84	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.658	Plastic Limit: ---
Final Height: 0.95 in	Final Void Ratio: 0.575	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	B-1264	RING		D2076
Mass Container, gm	8.47	109.69	109.69	8.4
Mass Container + Wet Soil, gm	85.43	267.61	275.34	173.46
Mass Container + Dry Soil, gm	75.34	247.43	247.43	145.65
Mass Dry Soil, gm	66.87	137.74	137.74	137.25
Water Content, %	15.09	14.65	20.26	20.26
Void Ratio	---	0.66	0.58	---
Degree of Saturation, %	---	63.20	100.00	---
Dry Unit Weight, pcf	---	106.9	112.52	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-5	Sample Type: remolded	Elevation: ---
	Description: Moist, light gray silty sand and gravel		
	Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Square Root of Time Coefficients

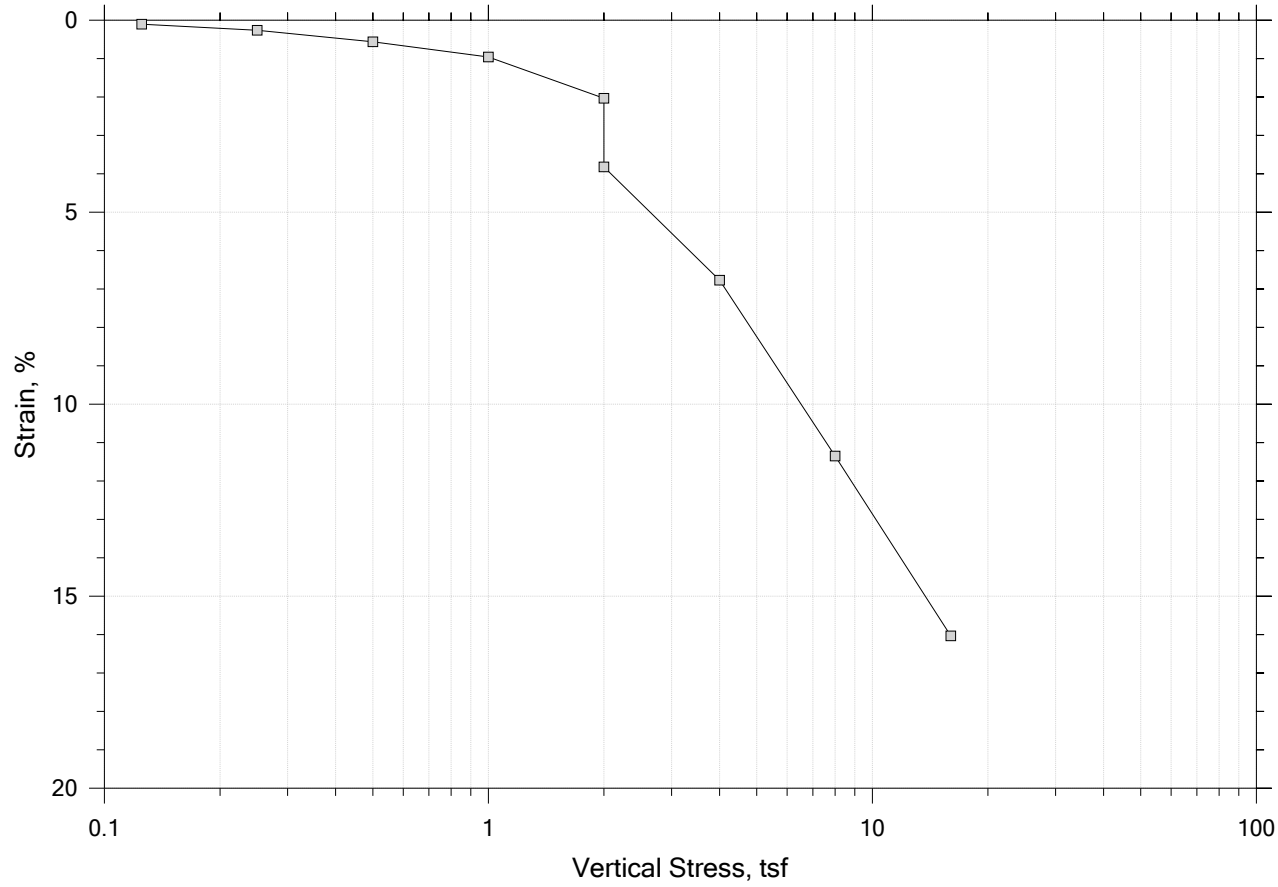
Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.125	0.005558	0.649	0.556	---	---	4.45e-02	---
2	0.250	0.01500	0.633	1.50	---	---	7.56e-02	---
3	0.500	0.02220	0.621	2.22	1.879	1.81e-03	2.88e-02	9.78e-04
4	1.00	0.02727	0.613	2.73	3.342	1.01e-03	1.01e-02	1.91e-04
5	2.00	0.03304	0.603	3.30	7.749	4.29e-04	5.77e-03	4.64e-05
6	2.00	0.03358	0.603	3.36	1346.859	2.45e-06	---	---
7	4.00	0.04514	0.583	4.51	48.983	6.66e-05	5.78e-03	7.20e-06
8	8.00	0.07314	0.537	7.31	44.204	7.08e-05	7.00e-03	9.28e-06
9	16.0	0.1083	0.479	10.8	47.965	6.09e-05	4.40e-03	5.01e-06

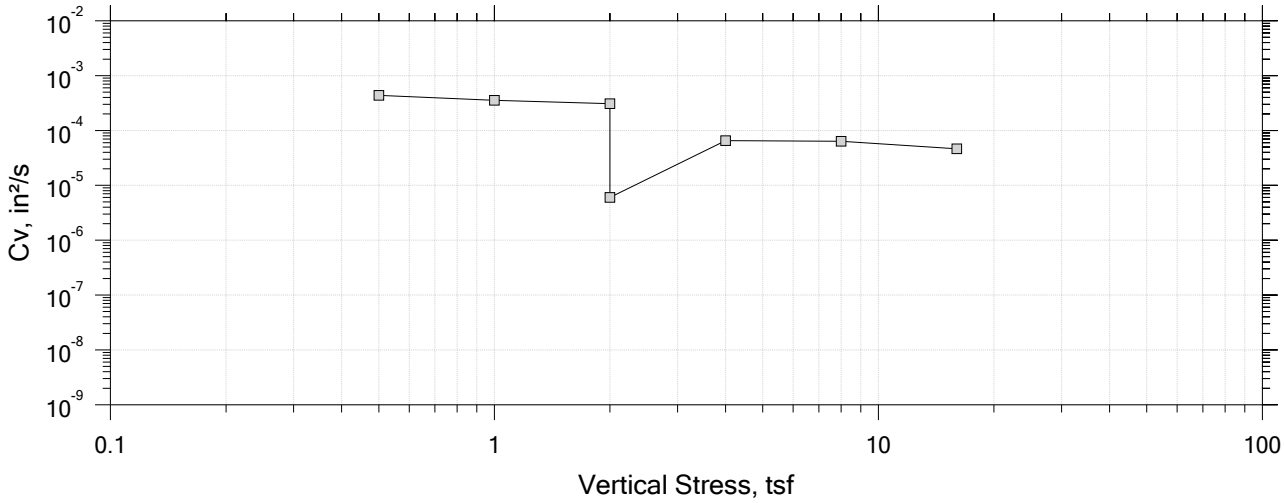
GeoTesting EXPRESS

Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-31963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9052 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-5	Sample Type: remolded	Elevation: ---
Description: Moist, light gray silty sand and gravel		
Remarks: System LTIII-B, 95% of 120.3 pcf @ 14.3% MC, Unable to achieve the target density.		
Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Summary Report

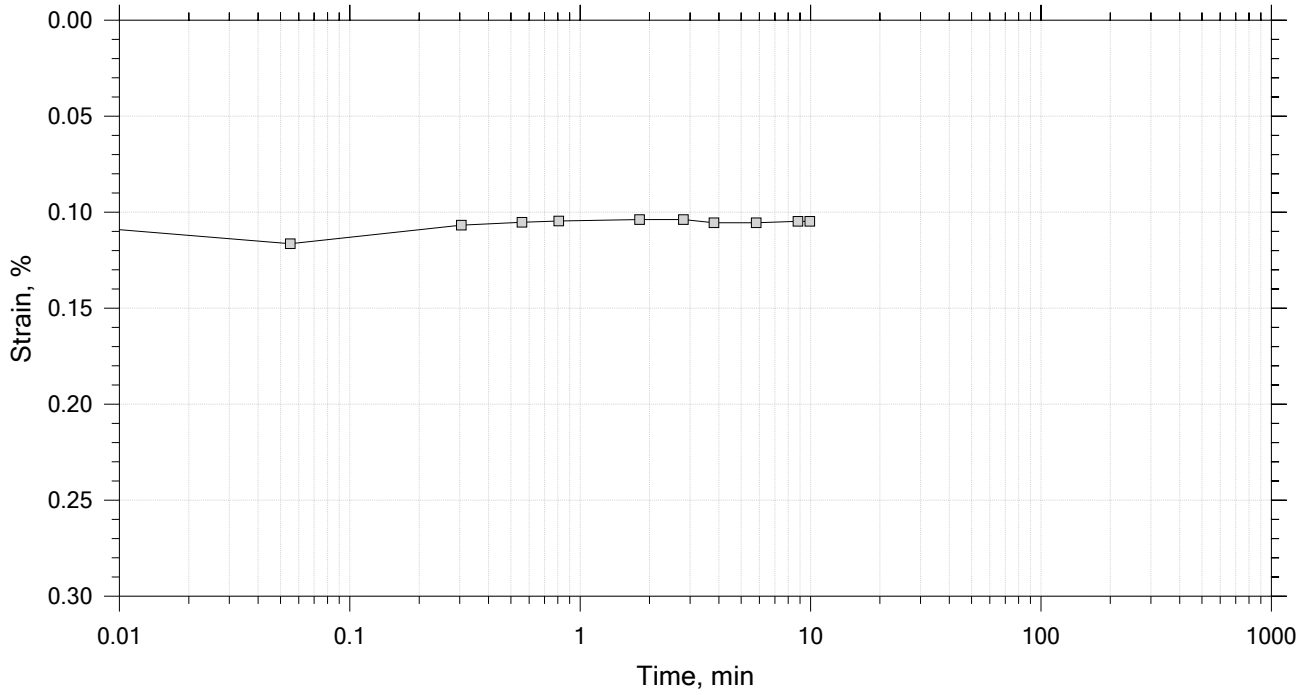


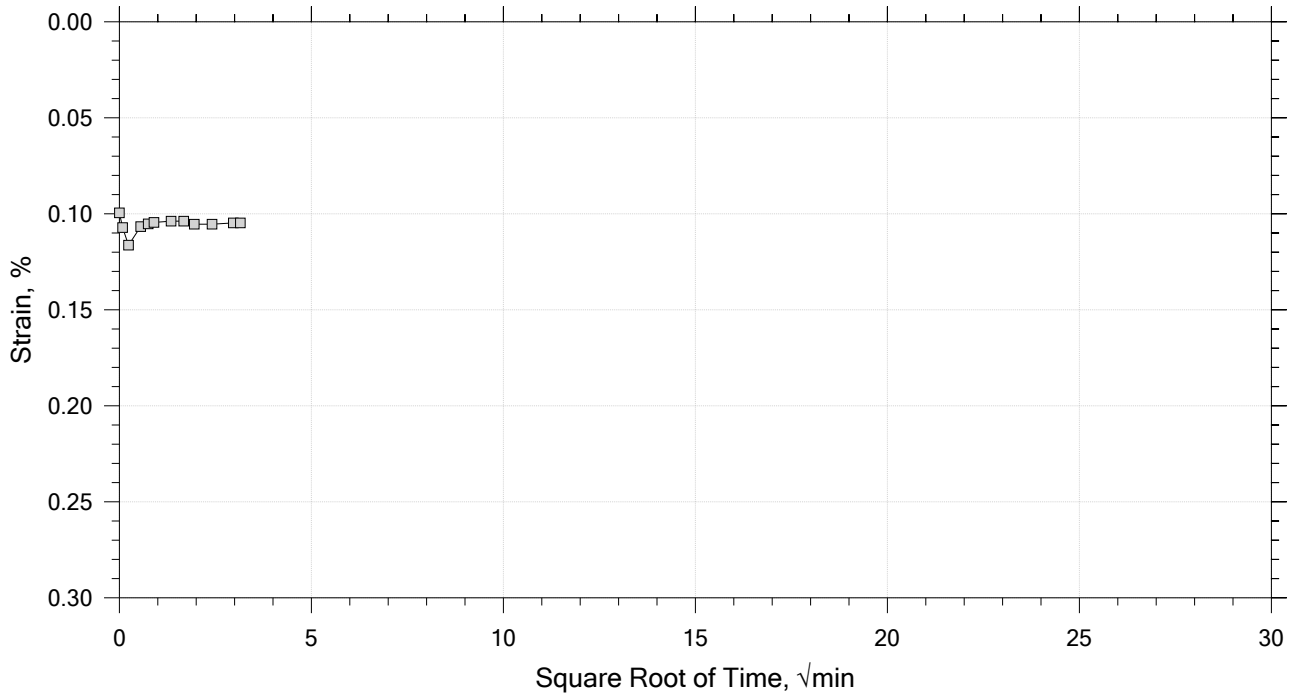


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 1 of 9
Constant Load Step
Stress: 0.125 tsf

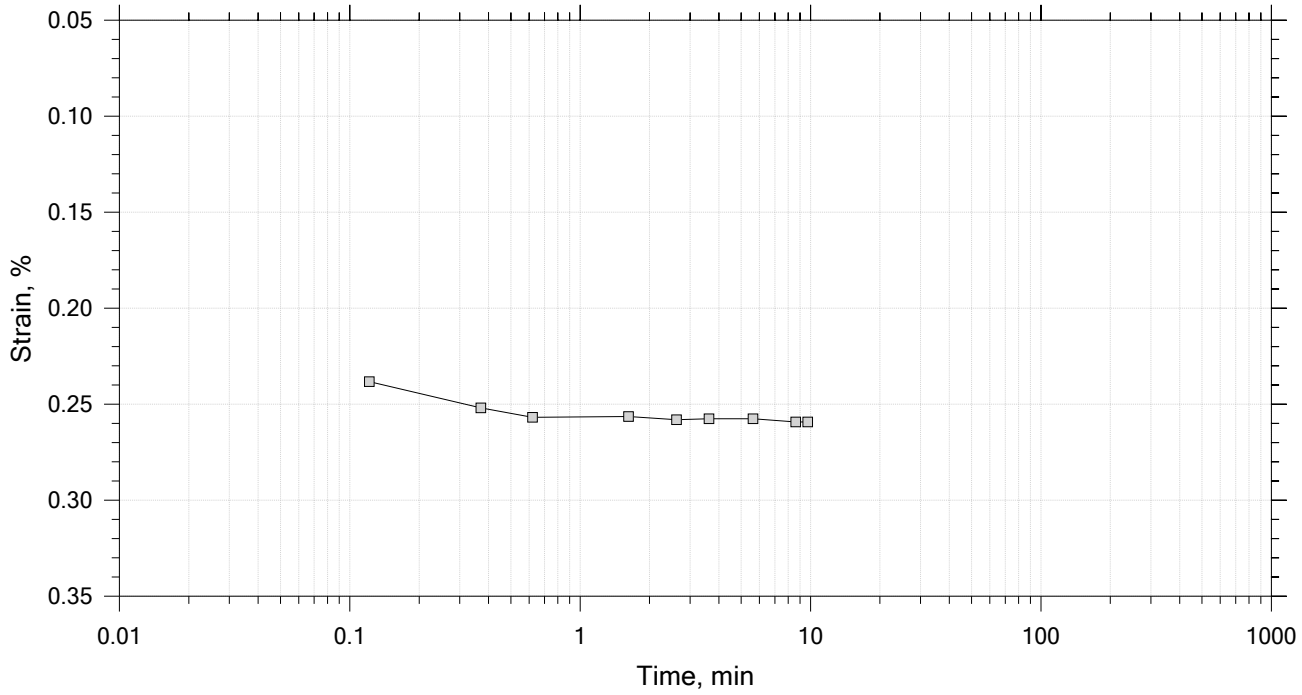


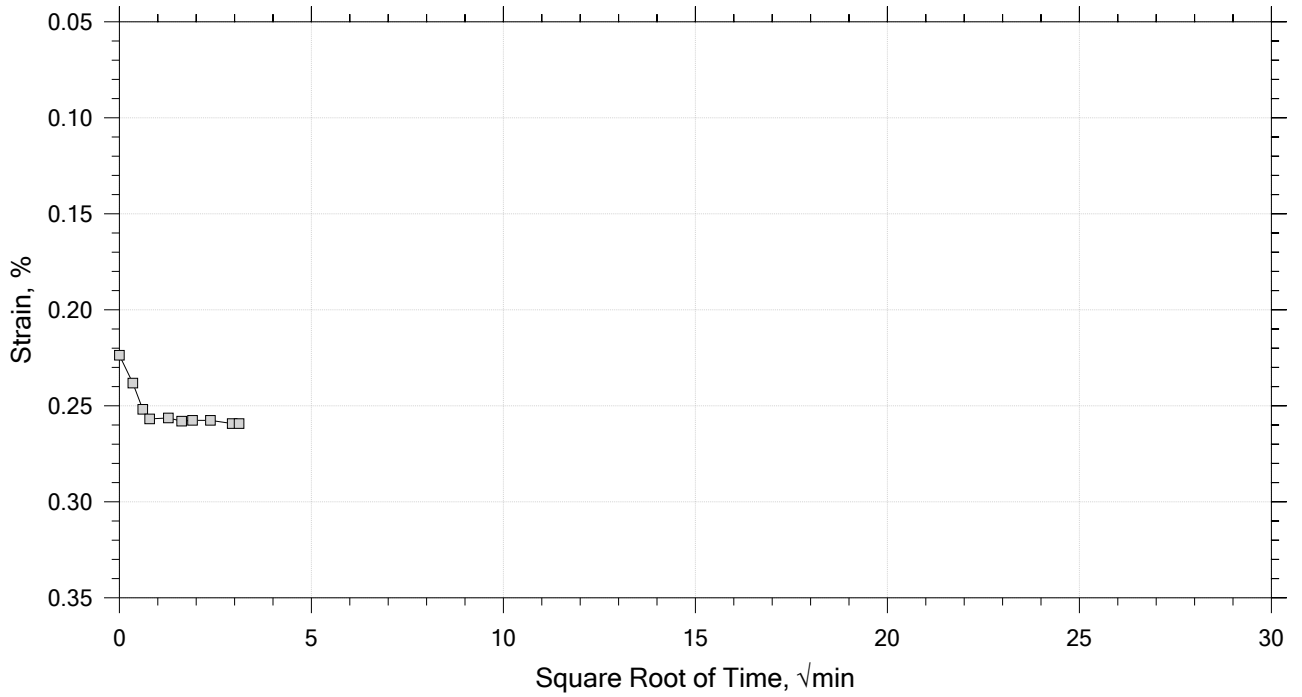


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-2	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 2 of 9
Constant Load Step
Stress: 0.25 tsf

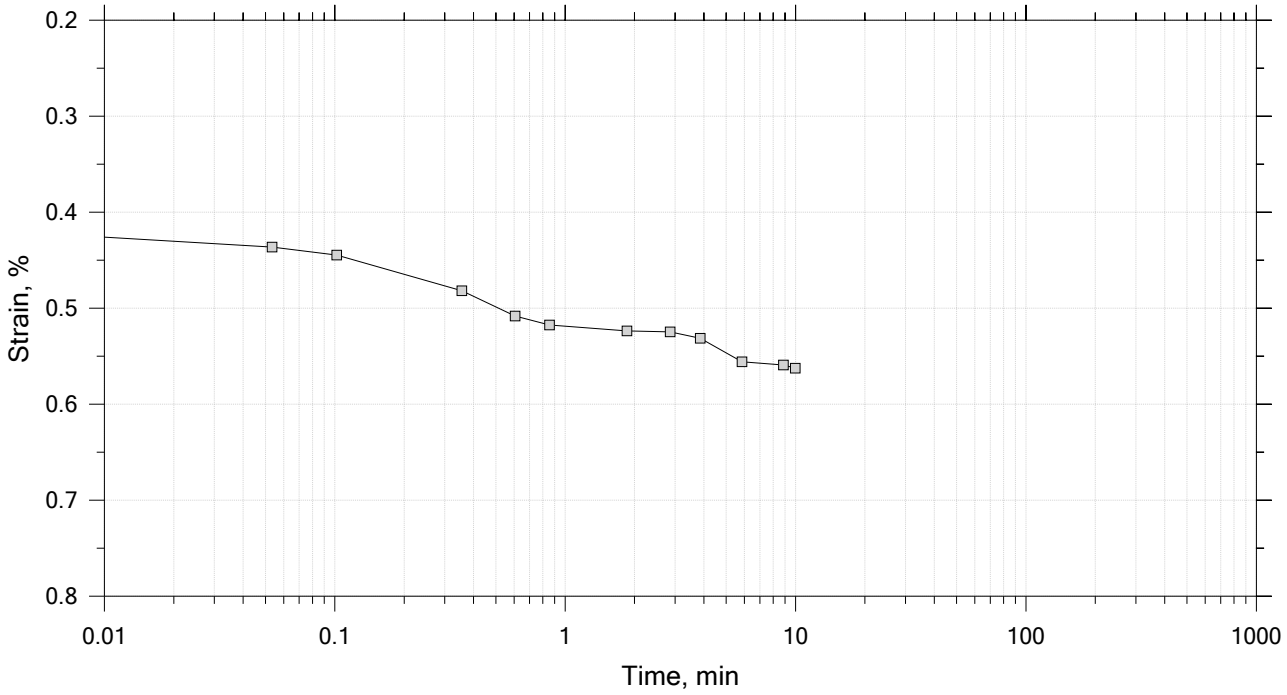


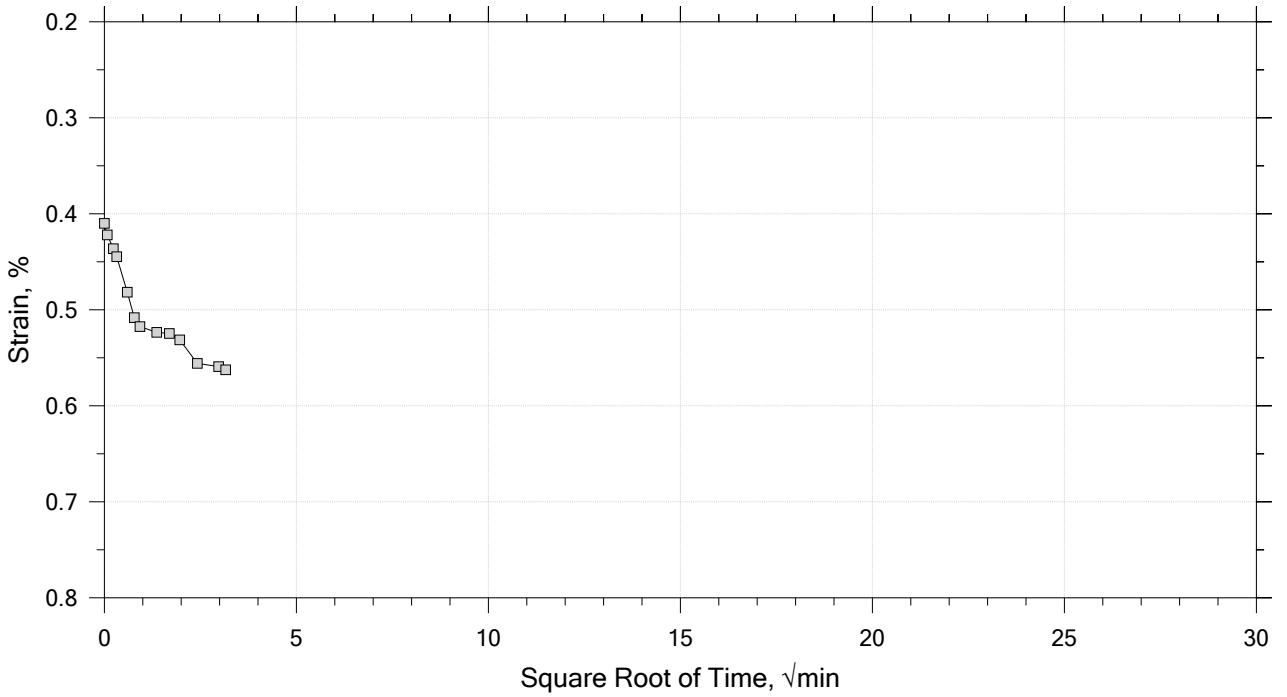


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 3 of 9
Constant Load Step
Stress: 0.5 tsf

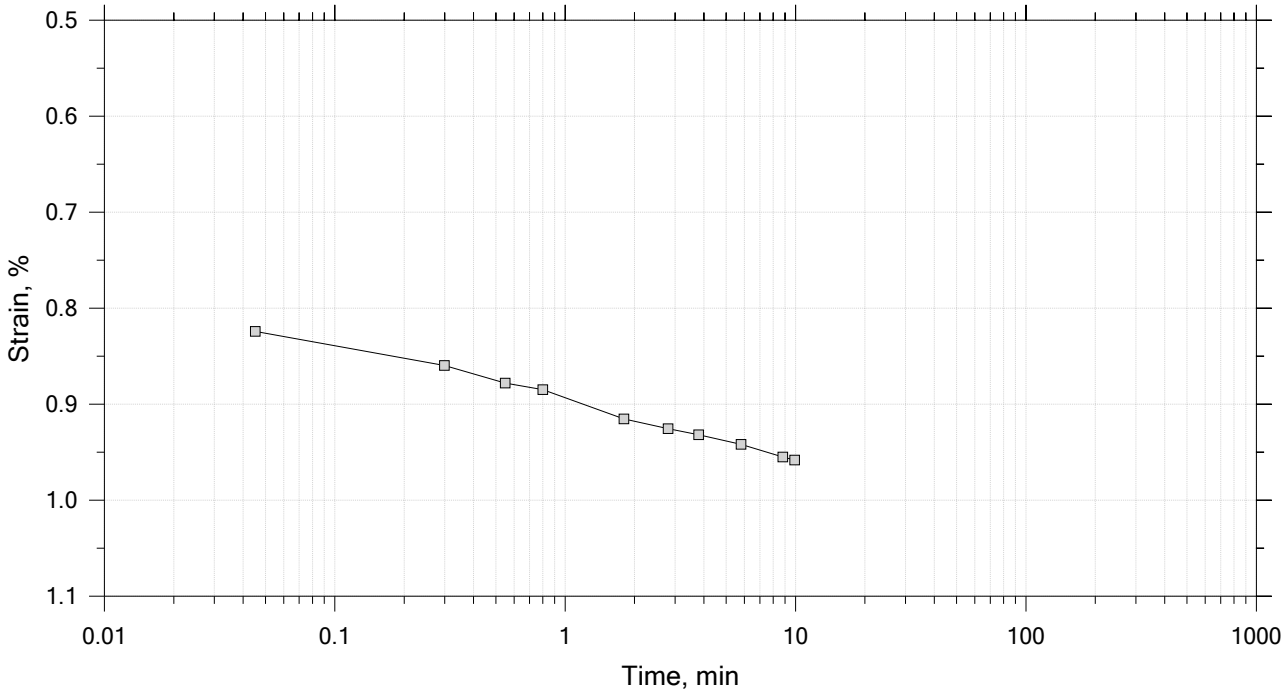


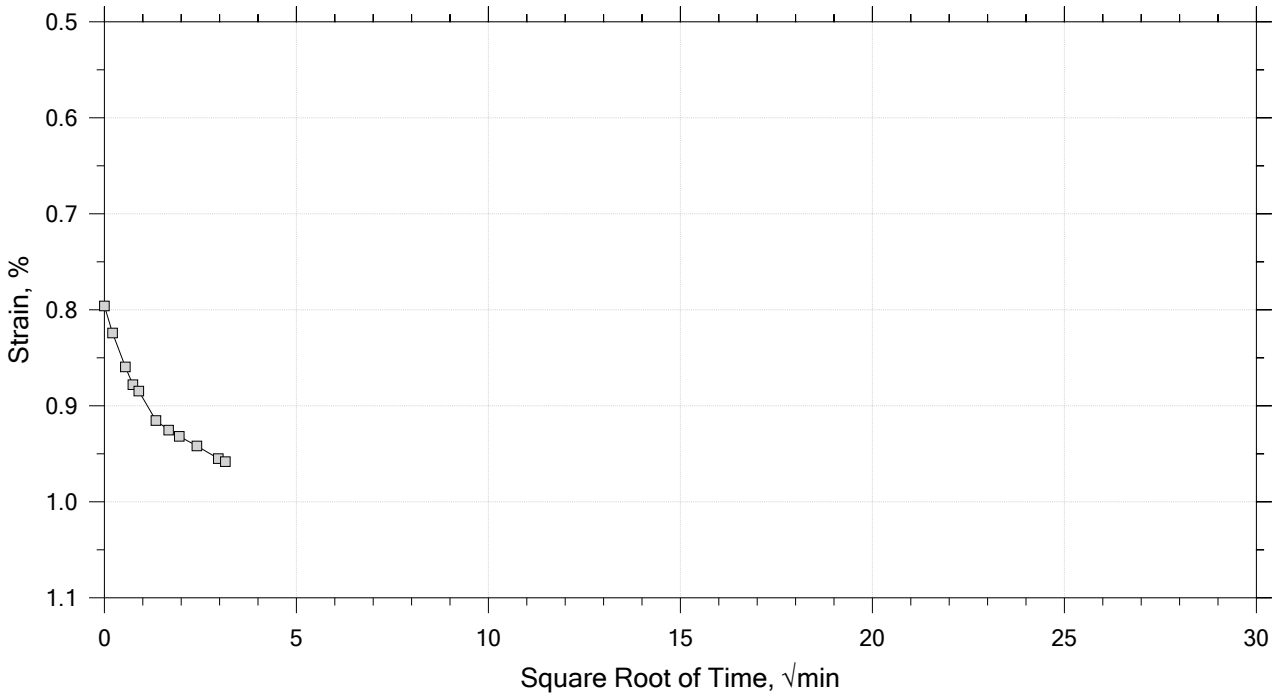


GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 4 of 9
Constant Load Step
Stress: 1 tsf





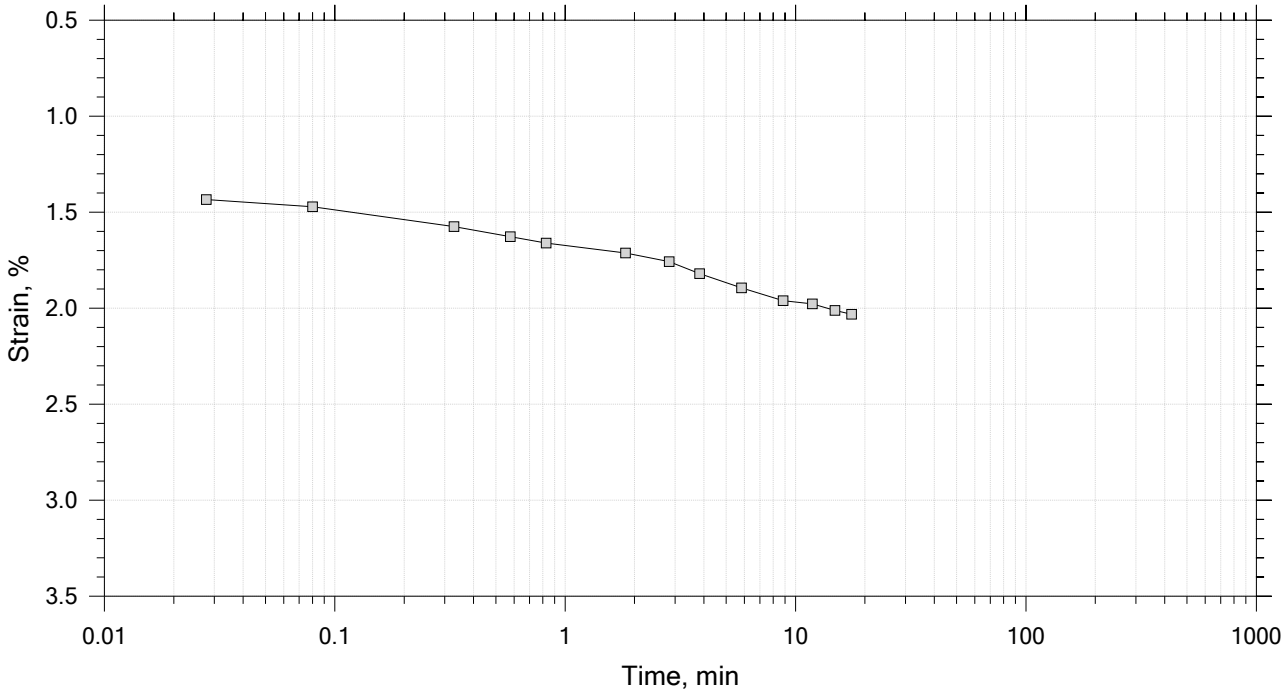
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

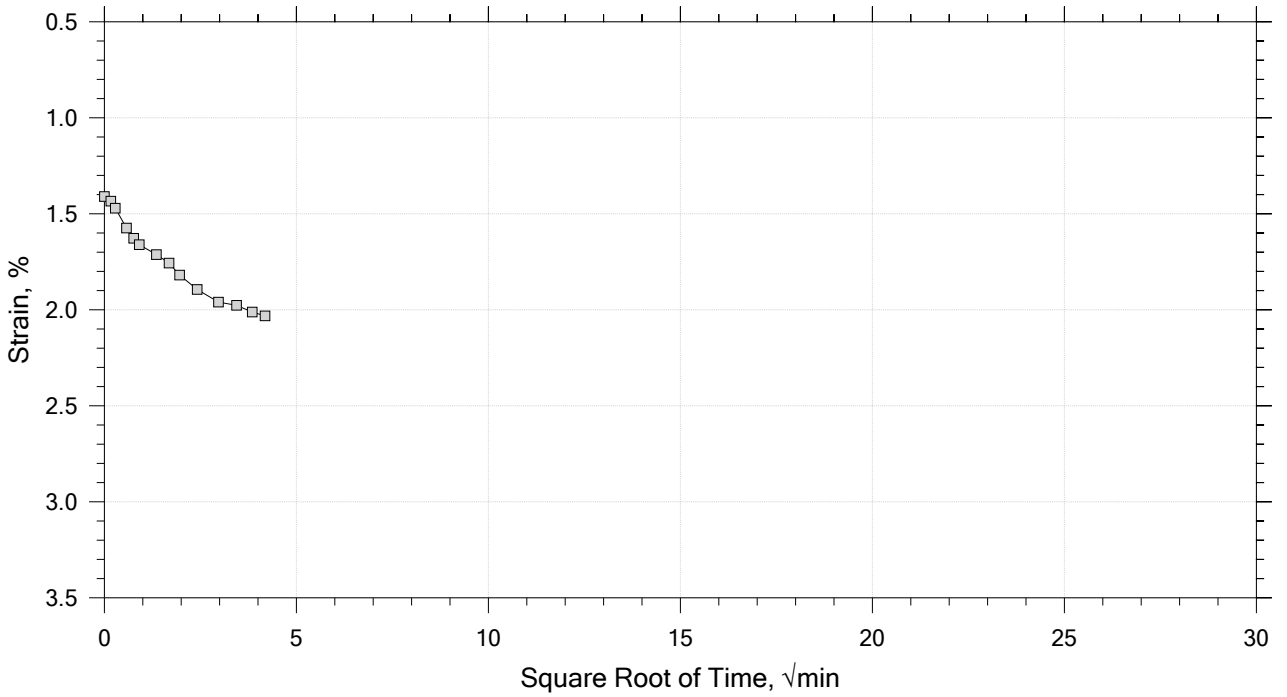
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 5 of 9

Constant Load Step

Stress: 2 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-2	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

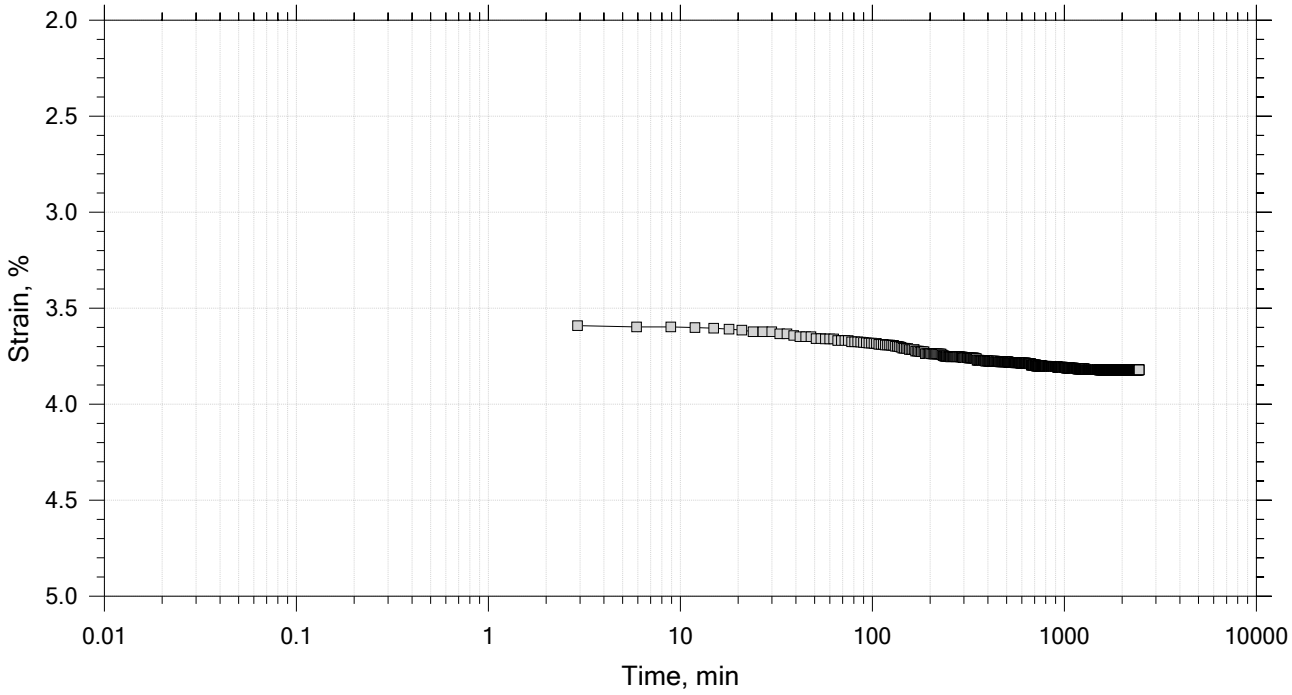
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

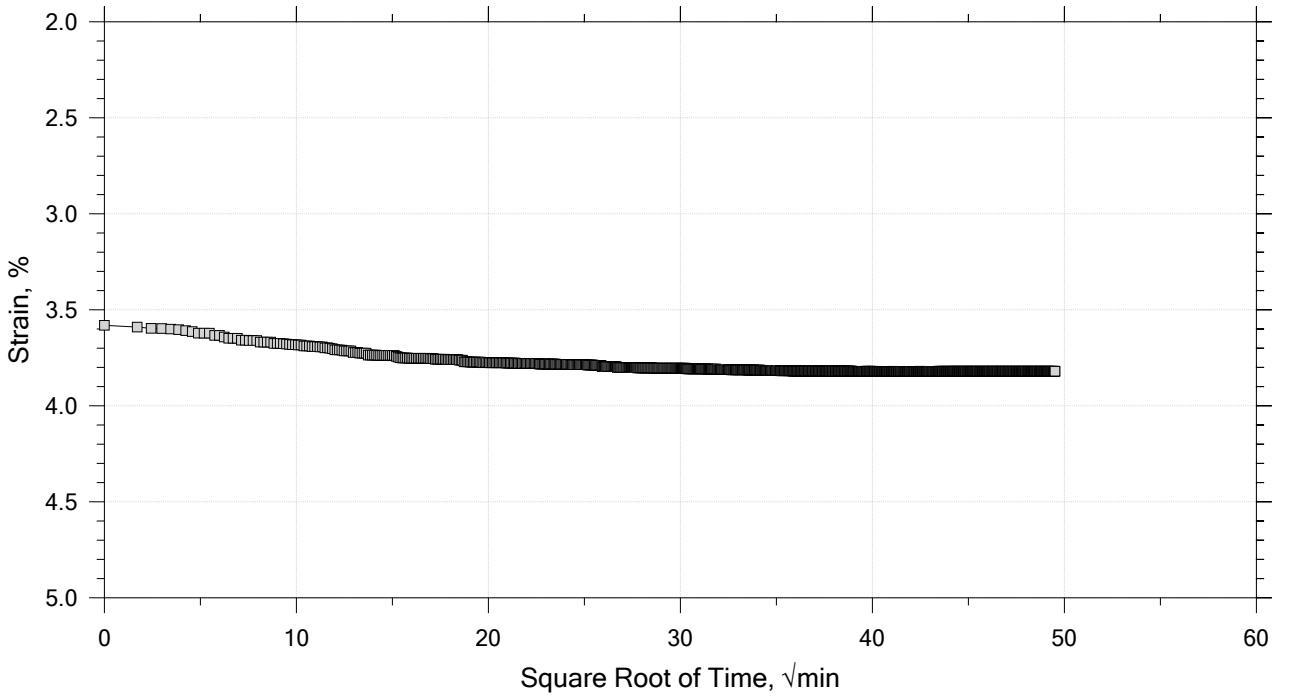
Time Curve 6 of 9

Constant Load Step

Stress: 2 tsf

WATER ADDED TO TEST





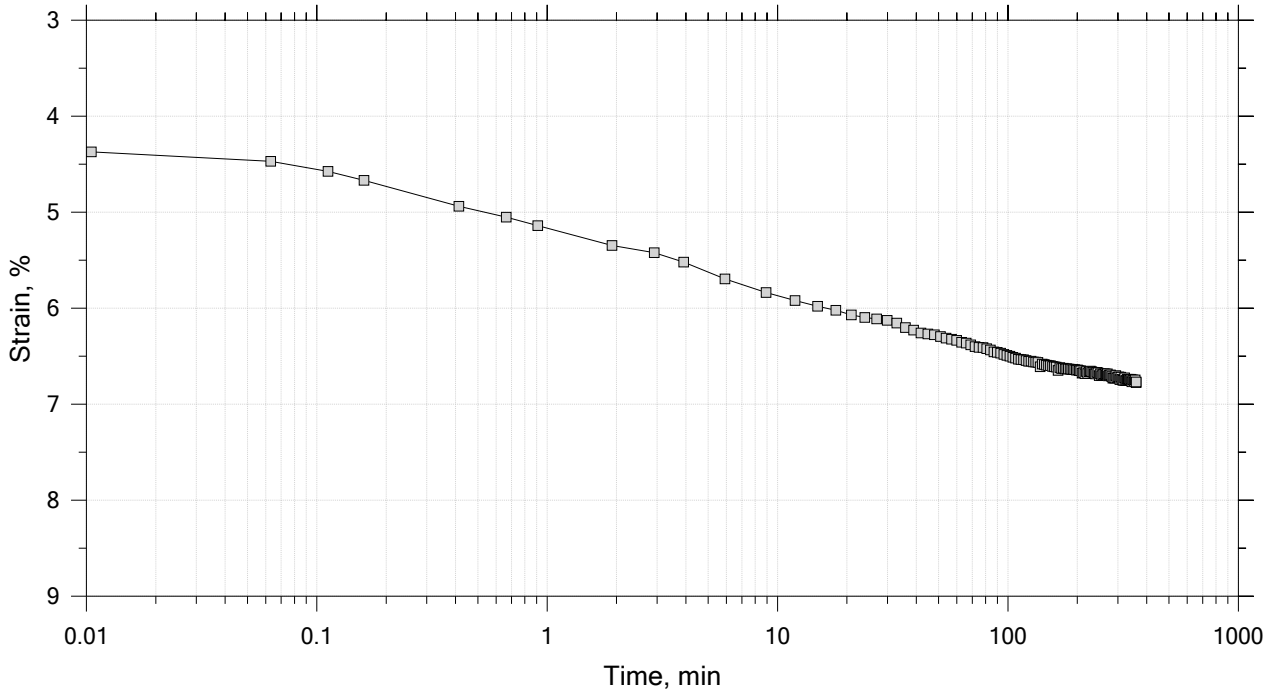
Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-2	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

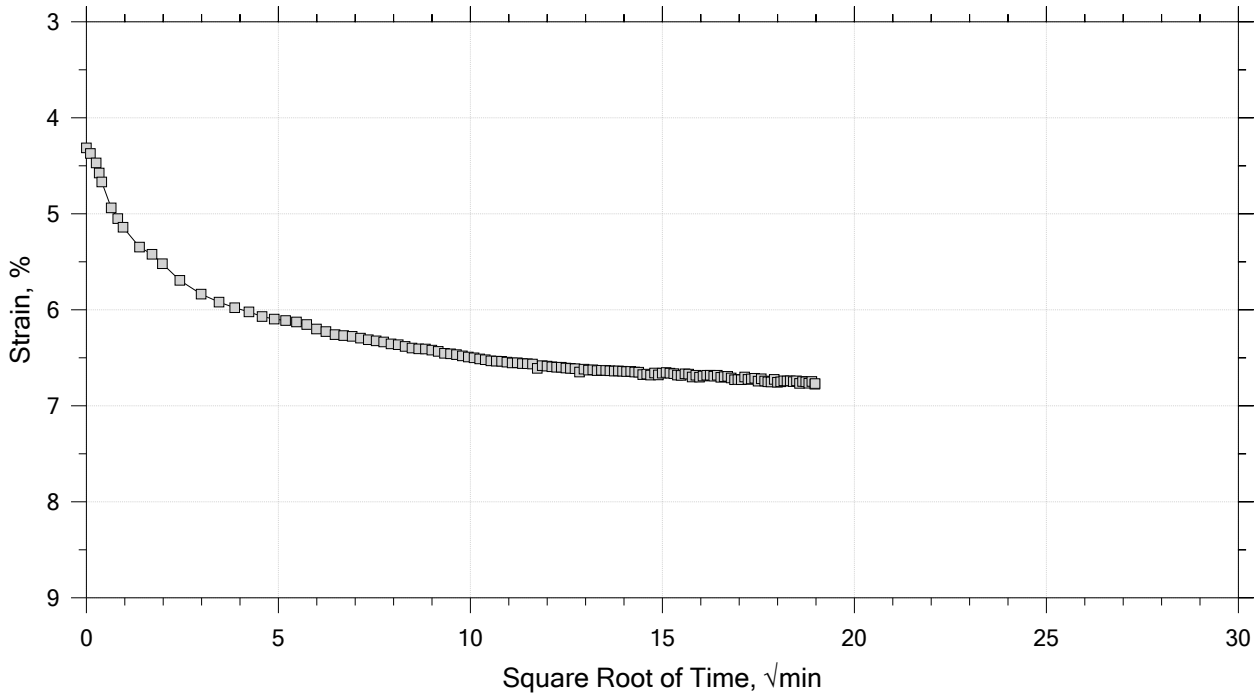
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 7 of 9

Constant Load Step

Stress: 4 tsf





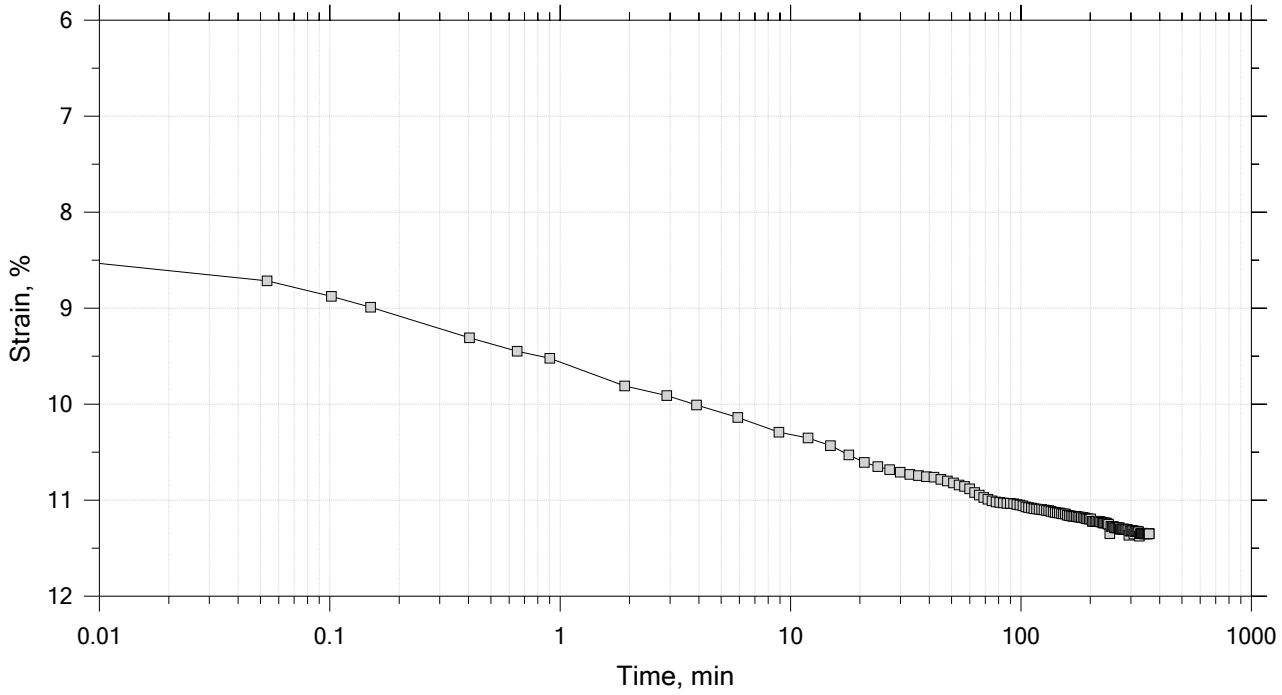
GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

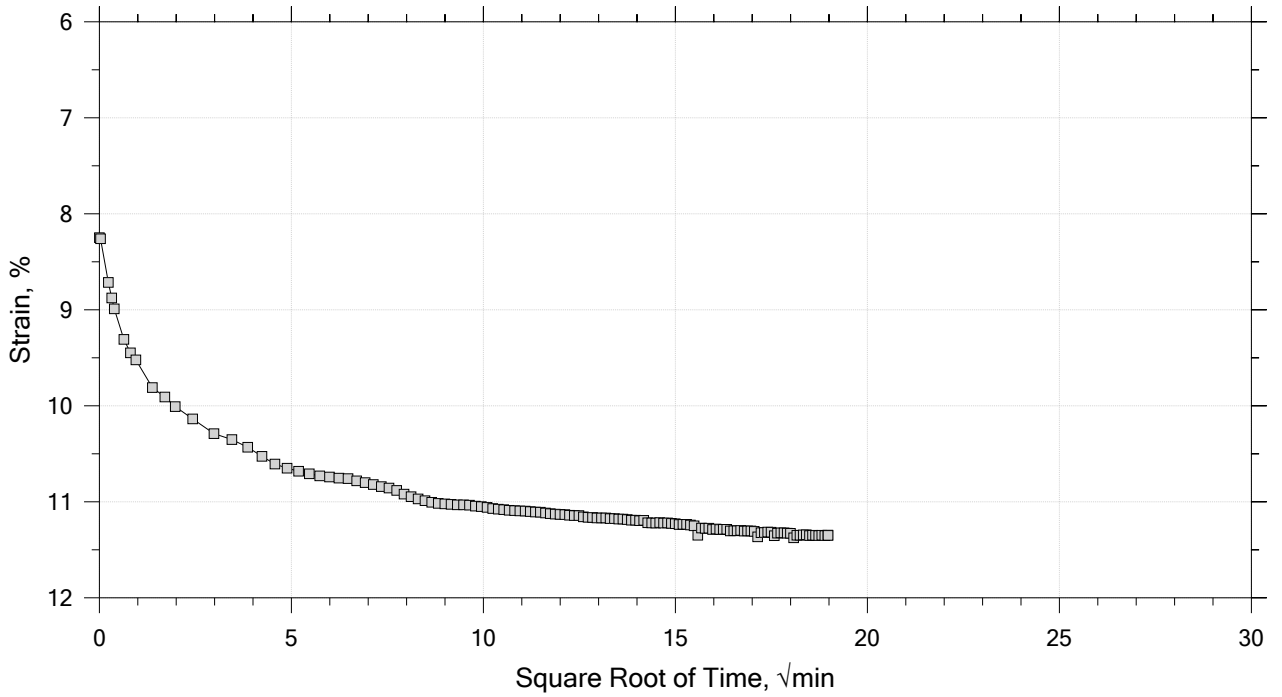
One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 8 of 9

Constant Load Step

Stress: 8 tsf

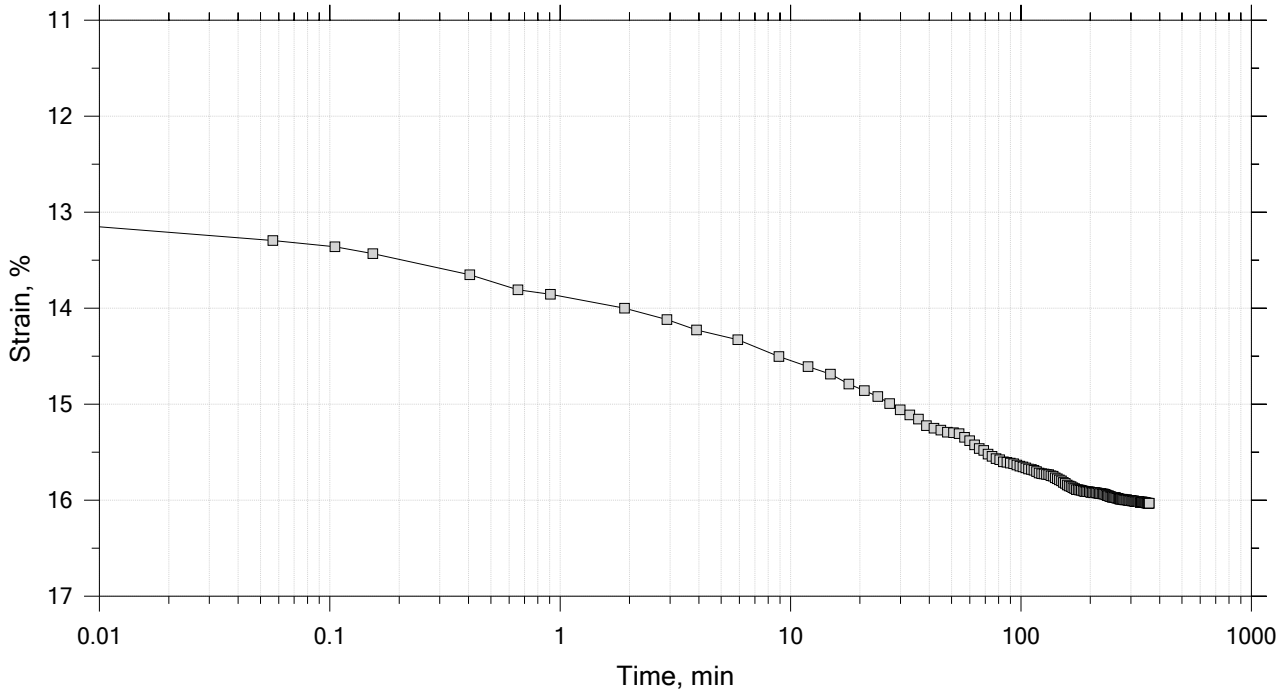


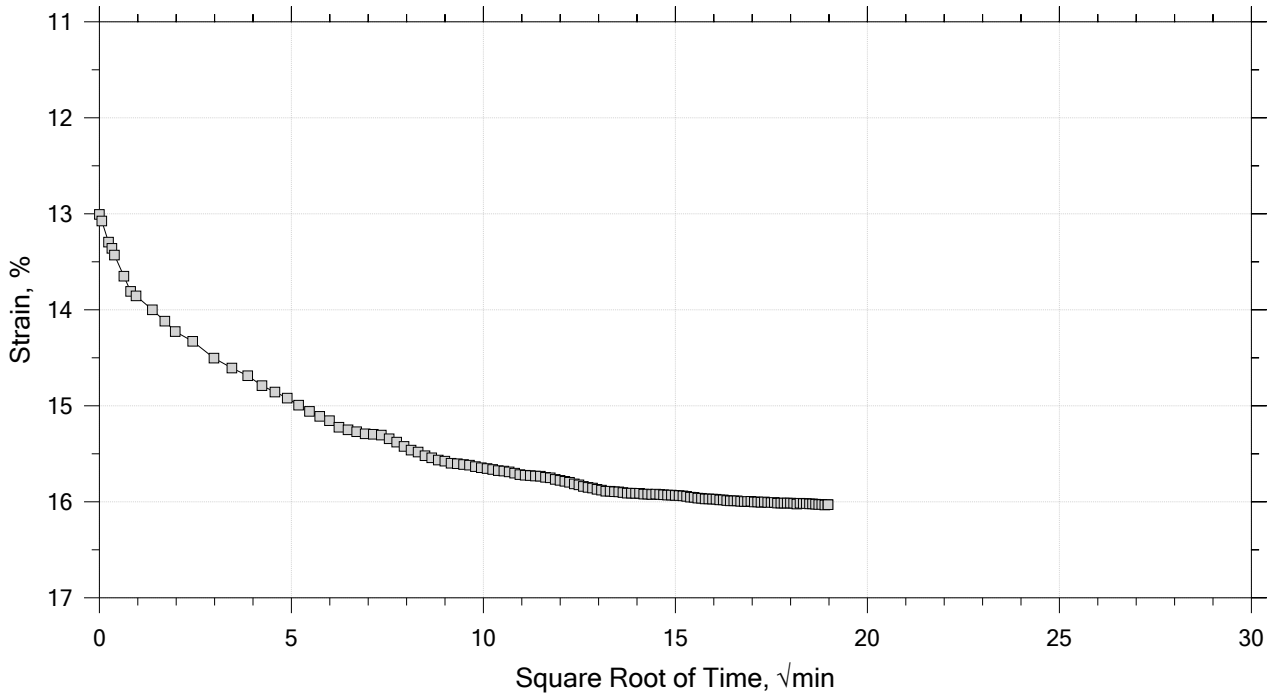


Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-2	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Time Curve 9 of 9
Constant Load Step
Stress: 16 tsf





Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
Boring No.: ---	Tested By: md	Checked By: anm
Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
Test No.: SW-2	Sample Type: remolded	Elevation: ---
Description: Moist, gray sand with gravel and silt		
Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Specimen Diameter: 2.50 in	Estimated Specific Gravity: 2.65	Liquid Limit: ---
Initial Height: 1.00 in	Initial Void Ratio: 0.778	Plastic Limit: ---
Final Height: 0.90 in	Final Void Ratio: 0.6	Plasticity Index: ---

	Before Test Trimmings	Before Test Specimen	After Test Specimen	After Test Trimmings
Container ID	C2276	RING		B1207
Mass Container, gm	9.32	111.24	111.24	8.35
Mass Container + Wet Soil, gm	76.42	250.48	258.42	153.83
Mass Container + Dry Soil, gm	66.89	231.28	231.28	127
Mass Dry Soil, gm	57.57	120.04	120.04	118.65
Water Content, %	16.55	16.00	22.61	22.61
Void Ratio	---	0.78	0.60	---
Degree of Saturation, %	---	54.57	100.00	---
Dry Unit Weight, pcf	---	93.158	103.51	---

Note: Specific Gravity and Void Ratios are calculated assuming the degree of saturation equals 100% at the end of the test. Therefore, values may not represent actual values for the specimen.

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		

One-Dimensional Swell or Collapse by ASTM D4546 - Method B

Square Root of Time Coefficients

Step	Applied Stress tsf	Final Displacement in	Void Ratio	Strain at End %	Sq.Rt. T90 min	Cv in²/s	Mv 1/tsf	k ft/day
1	0.125	0.001047	0.776	0.105	---	---	8.38e-03	---
2	0.250	0.002592	0.773	0.259	---	---	1.24e-02	---
3	0.500	0.005625	0.768	0.562	8.039	4.36e-04	1.21e-02	9.90e-05
4	1.00	0.009582	0.761	0.958	9.825	3.54e-04	7.91e-03	5.25e-05
5	2.00	0.02032	0.741	2.03	11.102	3.09e-04	1.07e-02	6.21e-05
6	2.00	0.03821	0.710	3.82	554.911	6.00e-06	---	---
7	4.00	0.06769	0.657	6.77	48.442	6.54e-05	1.47e-02	1.81e-05
8	8.00	0.1135	0.576	11.4	46.001	6.35e-05	1.15e-02	1.36e-05
9	16.0	0.1603	0.493	16.0	56.841	4.63e-05	5.85e-03	5.07e-06

GeoTesting EXPRESS	Project: Camp Santiago	Location: Salinas, PR	Project No.: GTX-311963
	Boring No.: ---	Tested By: md	Checked By: anm
	Sample No.: TP9053 B	Test Date: 07/29/20	Depth: ---
	Test No.: SW-2	Sample Type: remolded	Elevation: ---
	Description: Moist, gray sand with gravel and silt		
	Remarks: System LTIII-0835, 95% of 105.9 pcf @ 16.3% MC, Unable to achieve the target density.		
	Displacement at End of Increment		

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ATTACHMENT 6
Soil Design Parameters

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Soil Strength Parameters

SO No. 177050
Subject : Camp Santiago
Soil Design Parameters

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Computed By: SED Checked By: DAC Date: 07/30/2020

Problem Statement:

- Estimate the unit weight and strength parameters for geotechnical analysis.

Reference:

- EM 1110-2-2504, 1994

Summary:

Associated Structures	Material Type	Effective Friction Angle, ϕ'	Effective Cohesion, c'	Moist Unit Weight, γ_m	Saturated Unit Weight, γ_{sat}	K_a	K_p	K_o
		(deg.)	(psf)	(pcf)	(pcf)	(--)	(--)	(--)
Barracks/HQ/HQ5	Silty Sand (SM)	30	0	120	125	0.33	3.00	0.50
DFAC/Canopy	Silty Sand (SM)	32	0	120	125	0.31	3.25	0.47

Analysis:

Cohesionless Soils:

The average blow count per foot is as follows:

Boring ID	Depth (m)	Average Blow Count N (blows/ft)*	USCS Symbol
Barracks/HQ/HQ5 Borings	0-5.94	25	SM
DFAC Borings	0-5.95	34	SM

Notes:
*Use N=50 if N > 50 blows per foot, in calculating the average blow count

Per EM 1110-2-2504, 1994 Table 3.1,

Table 3-1
Granular Soil Properties (after Teng 1962)

Compactness	Relative Density (%)	SPT N (blows per ft)	Angle of Internal Friction (deg)	Unit Weight	
				Moist (pcf)	Submerged (pcf)
Very Loose	0-15	0-4	<28	<100	<60
Loose	16-35	5-10	28-30	95-125	55-65
Medium	36-65	11-30	31-36	110-130	60-70
Dense	66-85	31-50	37-41	110-140	65-85
Very Dense	86-100	>51	>41	>130	>75

	Use Moist Unit Weight, γ_{moist}=	**120 pcf**	
	Use Saturated Unit Weight, γ_{sat}=	**125 pcf**	
Barracks/HQ/HQ5	**Use Effective Friction Angle, ϕ'=**	**30 Deg**	**(adjusted to account for fines content)**
DFAC/Canopy	**Use Effective Friction Angle, ϕ'=**	**32 Deg**	**(adjusted to account for fines content)**
	Use cohesion, c=	**0 psf**	

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Subgrade Modulus Correlation

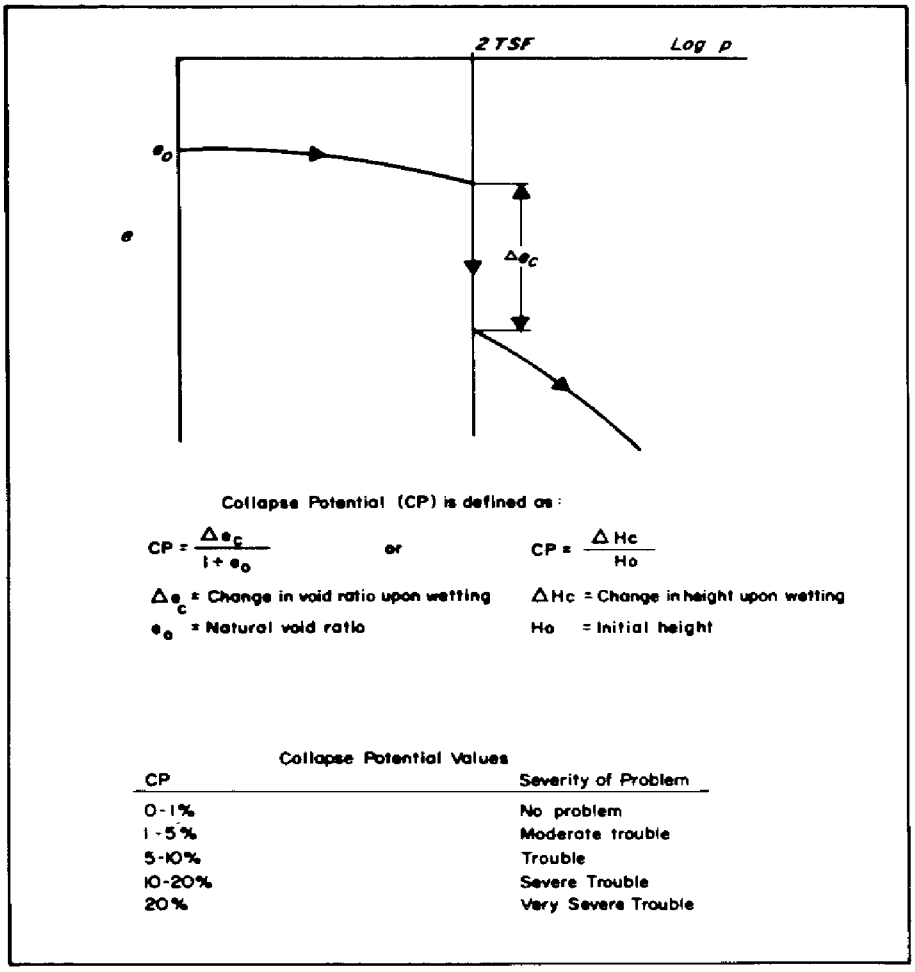
Table 4-1. Typical values of modulus of subgrade reaction

Types of Materials	Modulus of Subgrade Reaction, k, in lb/in³ for Moisture Contents of							
	1 to 4%	5 to 8%	9 to 12%	13 to 16%	17 to 20%	21 to 24%	25 to 28%	Over 29%
Silts and clays Liquid limit > 50 (OH, CH, MH)	--	175	150	125	100	75	50	25
Silts and clays Liquid limit < 50 (OL, CL, ML)	--	200	175	150	125	100	75	50
Silty and clayey sands (SM & SC)	300	250	225	200	150	—	—	--
Gravelly sands (SW & SP)	300+	300	250	—	—	—	—	--
Silty and clayey gravels (GM & GC)	300+	300+	300	250	—	—	—	--
Gravel and sandy gravels (GW & GP)	300+	300+	—	—	—	—	—	--

NOTE: k values shown are typical for materials having dry densities equal to 90 to 95 percent of the maximum CE 55 density. For materials having dry densities less than 90 percent of maximum CE 55 density, values should be reduced by 50 lb/in³, except that a k of 25 lb/in³ will be the minimum used for design.

use 150 pci (40,717 kN/m³)

Collapsible Soils Correlation (UFC 3-220-10N, Figure 6)



Collapse Potential (CP) is defined as:

$$CP = \frac{\Delta e_c}{1 + e_o} \quad \text{or} \quad CP = \frac{\Delta Hc}{Ho}$$

Δe_c = Change in void ratio upon wetting

e_o = Natural void ratio

ΔHc = Change in height upon wetting

Ho = Initial height

Collapse Potential Values

CP	Severity of Problem
0-1%	No problem
1-5%	Moderate trouble
5-10%	Trouble
10-20%	Severe Trouble
20%	Very Severe Trouble

FIGURE 6
Typical Collapse Potential Test Results

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ATTACHMENT 7
Shallow Foundation Analyses

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Bearing Capacity Certification

Camp Santiago Facility Restoration

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DECLARATION

OF

SOIL BEARING CAPACITY

State: Territory of Puerto Rico Date: August 14,,2020

Site Location: Salinas County, Puerto Rico

Address: Camp Santiago

Project: Camp Santiago Joint Training Center Facility Restoration

On the basis of our surface and subsurface investigation, and on generally accepted practices and procedures of the geotechnical engineering profession, I hereby declare to the best of my professional opinion, that the existing soil conditions at the site for this project are of a nature and classification which determine that the undisturbed soils at elevation 149.5 feet (elevation of the bottom of the proposed footing) when considered in conjunction with the supporting capability of the underlying soils strata, are rated at an allowable design bearing capacity of not less than 4700 pounds per square foot for a spread footing type of building foundation.

Mark J Miles

(Signature of Soils Engineer)

Mark J. Miles, P.E.

(Soils Engineer Name)

Technical Manager - Geotechnical

(Title)

Michael Baker International

(Firm Name)

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Bearing Capacity Calculations

Camp Santiago Facility Restoration

MBAKERINTL.COM

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 1 - DL+LL w/ Seismic Loads
Computed By: SED Checked By: DAC Date: 7/29/20

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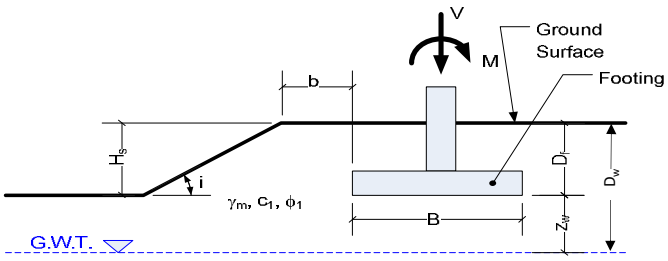
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	8	ft		
- Footing Width:	B =	8	ft		
- Eccentricity:	e =	0.97	= M_B / (P_V + W_s + W_f)	< B/3, OK	(10.6.3.3)
- Effective Footing Width:	B' =	6.1			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	223	kips	(Dead Load + Live Load + Roof Live Load)	
- Horizontal Load	P_H =	23	kips	(Seismic Shear Load)	
- Bearing Pressure	q =	5.1	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	241.0	kip-ft	(Seismic Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	15.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	9.6	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**15.2 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**2.0**	(noting the extreme limit state, seismic loading)	
Allowable Bearing Capacity:	**q_A =**	**7.6 ksf**	= q_n / FS	
Check q_A > q		**7.6 > 5.1 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**61.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**61 > 23 OK**		

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 1 - DL+LL w/ Seismic Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 8 ft
- Effective Footing Width $B' =$ 6.1 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2(45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.46 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.44 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.697 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **15.2 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (D 10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 2 - DL+LL w/ Wind Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

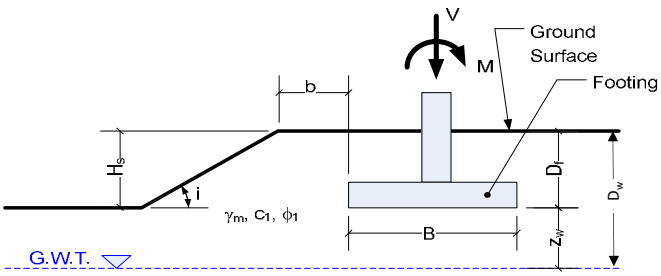
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	8	ft		
- Footing Width:	B =	8	ft		
- Eccentricity:	e =	0.60	ft	= M_B / (P_V + W_s + W_f) < B/3, OK	(10.6.3.3)
- Effective Footing Width:	B' =	6.8	ft		(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1		(10.6.3.4.2)	
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	223	kips	(Dead Load + Live Load + Roof Live Load)	
- Horizontal Load	P_H =	15	kips	(Wind Shear Load)	
- Bearing Pressure	q =	4.6	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	148.0	kip-ft	(Wind Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	15.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	9.6	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**15.9 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.3 ksf**	= q_n / FS	
Check q_A > q		**5.3 > 4.6**	**OK**	
Check q_{max}	**q_{max}=**	**6.5 ksf**	= q_A (B'*L) [1+ (6e/B)] / (B*L)	(11.6.3.2-2)
	use 6.5 ksf for the allowable maximum contact pressure at the toe of the footing			
Sliding Resistance (FS=1.5)	**F_R =**	**61.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**61 > 15**	**OK**	

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 2 - DL+LL w/ Wind Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 8 ft
- Effective Footing Width $B' =$ 6.8 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.52 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.49 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.66 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **15.91 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (D 10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 3 - DL w/ Seismic Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

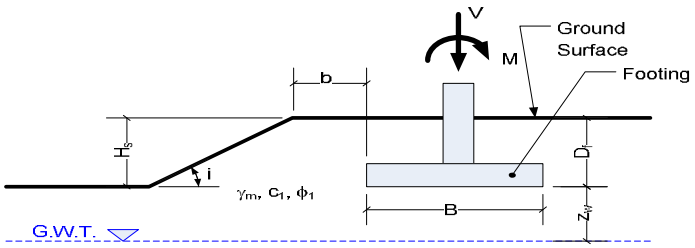
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	8	ft		
- Footing Width:	B =	8	ft		
- Eccentricity:	e =	1.17	= M_B / (P_V + W_s + W_f)	< B/3, OK	(10.6.3.3)
- Effective Footing Width:	B' =	5.7			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	181	kips	(Dead Load)	
- Horizontal Load	P_H =	23	kips	(Seismic Shear Load)	
- Bearing Pressure	q =	4.5	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	241.0	kip-ft	(Seismic Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	15.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	9.6	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**14.8 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**2.0**	(noting the extreme limit state, seismic loading)	
Allowable Bearing Capacity:	**q_A =**	**7.4 ksf**	= q_n / FS	
Check q_A > q		**7.4 > 4.5 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**61.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**61 > 23 OK**		

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 3 - DL w/ Seismic Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 8 ft
- Effective Footing Width $B' =$ 5.7 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.43 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.41 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.717 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **14.78 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 4 - DL w/ Wind Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

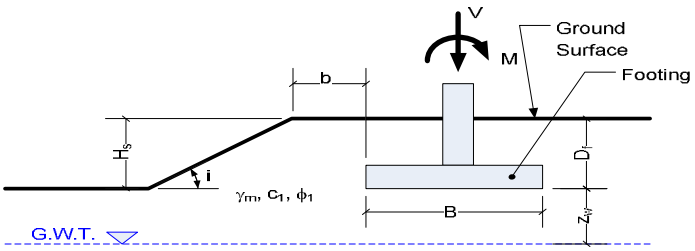
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	8	ft		
- Footing Width:	B =	8	ft		
- Eccentricity:	e =	0.72	= M_B / (P_V + W_s + W_f)	< B/3, OK	(10.6.3.3)
- Effective Footing Width:	B' =	6.6			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	181	kips	(Dead Load)	
- Horizontal Load	P_H =	15	kips	(Wind Shear Load)	
- Bearing Pressure	q =	3.9	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	148.0	kip-ft	(Wind Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	15.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	9.6	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**15.7 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.2 ksf**	= q_n / FS	
Check q_A > q		**5.2 > 3.9 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**61.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**61 > 15 OK**		

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 304,308,310,318,450,452,454,456
Case 4 - DL w/ Wind Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 8 ft
- Effective Footing Width $B' =$ 6.6 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2(45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.50 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.47 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.672 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **15.69 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 1 - DL+LL w/ Seismic Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

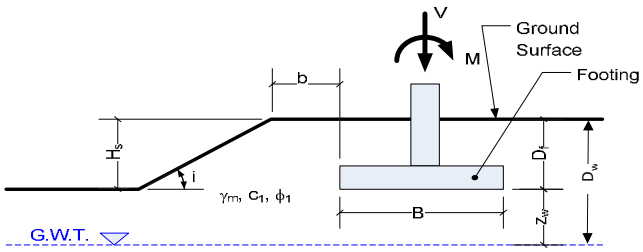
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:

- Footing Length:	L =	9	ft		
- Footing Width:	B =	9	ft		
- Eccentricity:	e =	0.95	= M_B / (P_V + W_s + W_f)	< B/4, OK	(10.6.3.3)
- Effective Footing Width:	B' =	7.1			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1		(10.6.3.4.2)	

Soil:

- Description		Silty Sand (SM); medium dense		
- Cohesion:	c_1 =	0	ksf	
- Angle of Internal Friction:	ϕ_{f1} =	30	°	
- Moist Unit Weight:	γ_m =	0.12	kcf	
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45) (Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)

Load:

- Dead Load	DL =	181	kips	
- Live Load	LL =	23	kips	
- Roof Live Load	RLL =	19	kips	
- Vertical Load	P_V =	223	kips	(Dead Load + Live Load + Roof Live Load)
- Horizontal Load	P_H =	23	kips	(Seismic Shear Load)
- Bearing Pressure	q =	4.0	ksf	(P_v + W_s + W_f) / (B' * L)
- Moment	M_B =	241.0	kip-ft	(Seismic Moment)

Vertical Loads from Overburden and Foundations:

Weight of the soil over footing	W_S =	19.4	kips	(thickness of soil = Df-1ft concrete thickness)
Weight of the footing	W_f =	12.2	kips	(assume 1 ft thick concrete at 150 pcf unit weight)

Sloping Ground Surface

- Calculate Bearing Capacity Using Leveled Ground Only?		Yes		
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**
- Height of Slope	H_s =		ft	
- Slope Inclination	i =		°	

Results:

Nominal Bearing Capacity:	**q_n =**	**16.2 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**2.0**	(noting the extreme limit state, seismic loading)	
Allowable Bearing Capacity:	**q_A =**	**8.1 ksf**	= q_n / FS	
Check q_A > q		**8.1 > 4.0 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**63.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**63 > 23 OK**		

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 1 - DL+LL w/ Seismic Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 9 ft
- Effective Footing Width $B' =$ 7.1 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2(45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.48 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.46 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.684 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **16.18 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 2 - DL+LL w/ Wind Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

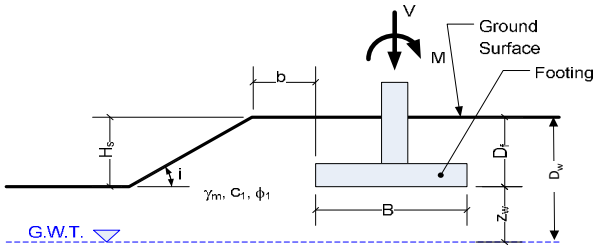
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	9	ft		
- Footing Width:	B =	9	ft		
- Eccentricity:	e =	0.58	= M_B / (P_V + W_s + W_f) < B/3, OK		(10.6.3.3)
- Effective Footing Width:	B' =	7.8			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	223	kips	(Dead Load + Live Load + Roof Live Load)	
- Horizontal Load	P_H =	15	kips	(Wind Shear Load)	
- Bearing Pressure	q =	3.6	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	148.0	kip-ft	(Wind Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	19.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	12.2	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**16.8 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.6 ksf**	= q_n / FS	
Check q_A > q		**5.6 > 3.6**	**OK**	
Check q_{max}	**q_{max}=**	**6.8**	**ksf** = q_A (B') [1+ (6e/B)] / (B)	(11.6.3.2-2)
	use 6.8 ksf for the allowable maximum contact pressure at the toe of the footing			
Sliding Resistance (FS=1.5)	**F_R =**	**63.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**63 > 15**	**OK**	

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 2 - DL+LL w/ Wind Loads

Michael Baker INTERNATIONAL

- Effective Footing Length L' = 9 ft
- Effective Footing Width B' = 7.8 ft

Consider the Effect of Ground Water

C_{wq} = 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma}$ = 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

N_{q1} = 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
N_{c1} = 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
N_{c1} = 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
N_{c1} = 30.1 , since ϕ_{f1}= 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1}$ = 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors u

s_{c1} = 1.53 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
s_{q1} = 1.50 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1}$ = 0.652 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

d_q = 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

q_n = 16.82 ksf $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (D 10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 3 - DL w/ Seismic Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

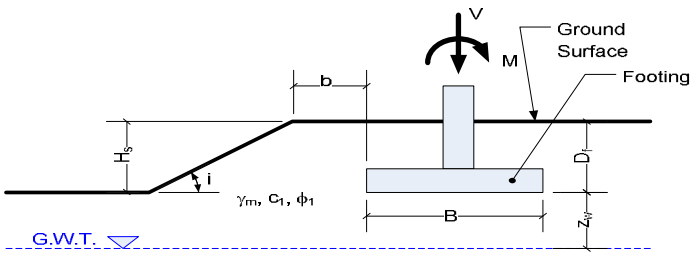
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
Footing Length:	L =	9	ft		
Footing Width:	B =	9	ft		
Eccentricity:	e =	1.13	= M_B / (P_V + W_s + W_f)	< B/3, OK	(10.6.3.3)
Effective Footing Width:	B' =	6.7			(10.6.1.3-1)
Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
Description		Silty Sand (SM); medium dense			
Cohesion:	c_1 =	0	ksf		
Angle of Internal Friction:	ϕ_{f1} =	30	°		
Moist Unit Weight:	γ_m =	0.12	kcf		
Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
Dead Load	DL =	181	kips		
Live Load	LL=	23	kips		
Roof Live Load	RLL =	19	kips		
Vertical Load	P_V =	181	kips	(Dead Load)	
Horizontal Load	P_H =	23	kips	(Seismic Shear Load)	
Bearing Pressure	q =	3.5	ksf	(P_v + W_s + W_f) / (B' * L)	
Moment	M_B =	241.0	kip-ft	(Seismic Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	19.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	12.2	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
Height of Slope	H_s =		ft		
Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**15.8 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**2.0**	(noting the extreme limit state, seismic loading)	
Allowable Bearing Capacity:	**q_A =**	**7.9 ksf**	= q_n / FS	
Check q_A > q		**7.9 > 3.5 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**63.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**63 > 23 OK**		

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 3 - DL w/ Seismic Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 9 ft
- Effective Footing Width $B' =$ 6.7 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors u

$s_{c1} =$ 1.46 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.43 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.701 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **15.83 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (D 10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 4 - DL w/ Wind Loads
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

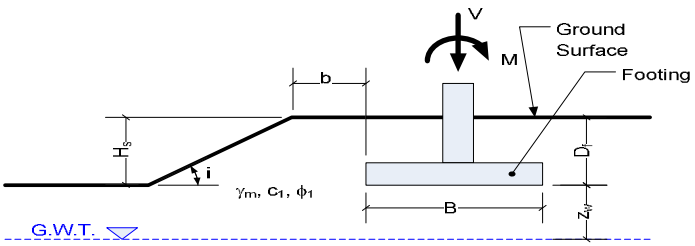
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	9	ft		
- Footing Width:	B =	9	ft		
- Eccentricity:	e =	0.70		= M_B / (P_V + W_s + W_f) < B/3, OK	(10.6.3.3)
- Effective Footing Width:	B' =	7.6			(10.6.1.3-1)
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty Sand (SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	30	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	14.4	ft	(gwt = 14.4 feet below Bottom of Footing based on Boring 456B2)	
Load:					
- Dead Load	DL =	181	kips		
- Live Load	LL=	23	kips		
- Roof Live Load	RLL =	19	kips		
- Vertical Load	P_V =	181	kips	(Dead Load)	
- Horizontal Load	P_H =	15	kips	(Wind Shear Load)	
- Bearing Pressure	q =	3.1	ksf	(P_v + W_s + W_f) / (B' * L)	
- Moment	M_B =	148.0	kip-ft	(Wind Moment)	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing	W_S =	19.4	kips	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing	W_f =	12.2	kips	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**16.6 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.5 ksf**	= q_n / FS	
Check q_A > q		**5.5 > 3.1 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**63.1 kips**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**63 > 15 OK**		

SO No. 177050

Subject : Camp Santiago - Barracks Structures
Buildings 458 & 460
Case 4 - DL w/ Wind Loads

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 9 ft
- Effective Footing Width $B' =$ 7.6 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.52 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.49 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.662 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **16.63 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} C_{w\gamma} + \gamma D_f N_{q1} s_{q1} d_{q1} i_{q1} C_w$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - Canopy Structure at HQ6
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

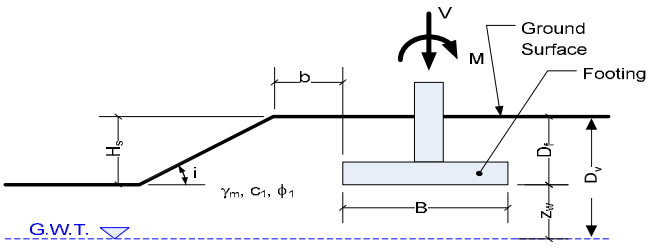
Bearing Capacity of Mat Foundation on Soil

Problem Statement:

Calculate the bearing capacity of the proposed mat foundation on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:				
- Footing Length:	L =	37	ft	(Approximate Length of Mat Based on HQ6 Foundation Plan)
- Footing Width:	B' =	13.5	ft	B'=B
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)
- Assume Cast in Place mat:	C =	1		(10.6.3.4.2)
Soil:				
- Description		Silty Sand (SM); medium dense		
- Cohesion:	c_1 =	0	ksf	
- Angle of Internal Friction:	ϕ_{f1} =	32	°	
- Moist Unit Weight:	γ_m =	0.12	kcf	
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45) (Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	12	ft	(gwt = 12.0 feet below Bottom of Footing based on Boring 306B1)
Loads from Structure:				
- Dead Load	DL=	2.3	kip	
- Roof Live Load	RLL =	1.3	kip	
- Vertical Load	P_V =	43.2	kip	(Dead Load + Roof Live Load) * 12 columns
- Horizontal Load	P_H =	45.6	kip	(Wind Shear Load) * 12 columns
- Bearing Pressure	q =	0.49	ksf	(P_v + W_s + W_f) / (B' * L)
Vertical Loads from Overburden and Foundations:				
- Weight of the soil over footing	W_S =	89.9	kips	(thickness of soil = Df-1.5ft concrete thickness)
- Weight of the footing	W_f =	112.4	kips	(assume 1.5 ft thick concrete mat 150 pcf unit weight)
Sloping Ground Surface				
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes		
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**
- Height of Slope	H_s =		ft	
- Slope Inclination	i =		°	

Results:

Nominal Bearing Capacity:	**q_n =**	**20.7**	**ksf**	(See Sheet 2)
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**6.9**	**ksf**	= q_n / FS
Check q_A > q		**6.9 > 0.5**	**OK**	
Sliding Resistance (FS=1.5)	**F_R =**	**68.2**	**kips**	= (C * (DL+W_s+W_f) * tanδ) / FS (10.6.3.4.2)
Check Sliding		**68 > 46**	**OK**	

SO No. 177050
Subject : Camp Santiago - Canopy Structure at HQ6
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 37 ft
- Effective Footing Width $B' =$ 13.5 ft

Consider the Effect of Ground Water

$C_{wq} =$ **1** (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ **0.5** (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 23.2 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 35.5 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 35.5 , since $\phi_{f1} =$ 32 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 30.2 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.24 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.23 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.854 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ **1** (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$\mathbf{q_n =}$ **20.70 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} + \gamma D_f N_{q1} s_{q1} i_{q1}$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050

Subject : Camp Santiago - DFAC Structures

Computed By: SED Checked By: DAC Date: 7/28/20

Michael Baker INTERNATIONAL

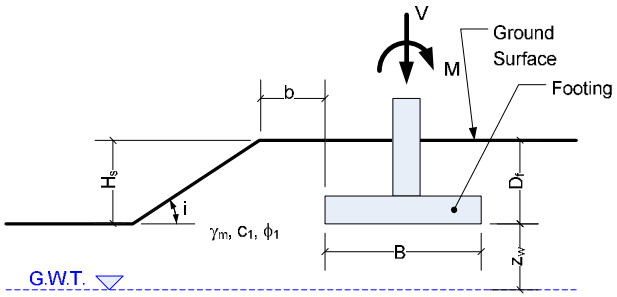
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:					
- Footing Length:	L =	140	ft	(Approximate Length of Structures Based on Boring Plan)	
- Footing Width:	B' =	4.5	ft	B'=B	
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)	
- Assume Cast in Place footing:	C =	1			(10.6.3.4.2)
Soil:					
- Description		Silty sand (sw-sm, SM); medium dense			
- Cohesion:	c_1 =	0	ksf		
- Angle of Internal Friction:	ϕ_{f1} =	32	°		
- Moist Unit Weight:	γ_m =	0.12	kcf		
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45)	(Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	13.5	ft	(gwt = 13.5 feet below Bottom of Footing based on Boring 300B1)	
Loads from Structure:					
- Dead Load	DL =	9.2	klf		
- Roof Live Load	RLL =	6.6	klf		
- Vertical Load	P_V =	15.5	klf	(Dead Load + Roof Live Load)	
- Horizontal Load	P_H =	3.3	klf	(Seismic Shear Load)	
- Bearing Pressure	q =	3.8	ksf	(P_v + W_s + W_f) / B'	
Vertical Loads from Overburden and Foundations:					
Weight of the soil over footing, W_s		1.1	klf	(thickness of soil = Df-1ft concrete thickness)	
Weight of the footing, W_f		0.7	klf	(assume 1 ft thick concrete at 150 pcf unit weight)	
Sloping Ground Surface					
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes			
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**	
- Height of Slope	H_s =		ft		
- Slope Inclination	i =		°		

Results:

Nominal Bearing Capacity:	**q_n =**	**16.6 ksf**	(See Sheet 2)	
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.5 ksf**	= q_n / FS	
Check q_A > q		**5.5 > 3.8 OK**		
Sliding Resistance (FS=1.5)	**F_R =**	**3.3 klf**	= (C * (DL+W_s+W_f) * tanδ) / FS	(10.6.3.4.2)
Check Sliding		**3.3 ≥ 3.3 OK**		

SO No. 177050

Subject : Camp Santiago - DFAC Structures

Computed By: SED Checked By: DAC Date: 7/28/20

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 140 ft
- Effective Footing Width $B' =$ 4.5 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)

$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 23.2 $= \exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)

$N_{c1} =$ 35.5 $= (N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)

$N_{c1} =$ 5.1 $= 2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)

$N_{c1} =$ 35.5 , since $\phi_{f1} =$ 32 ° > 0 (Table 10.6.3.1.2a-1)

$N_{\gamma 1} =$ 30.2 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.02 $= 1 + (B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)

$s_{q1} =$ 1.02 $= 1 + (B'/L') \tan \phi_{f1}$

$s_{\gamma 1} =$ 0.987 $= 1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ **16.56 ksf** $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} + \gamma D_f N_{q1} s_{q1} i_{q1}$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - HQ Structures - 306 to 330
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

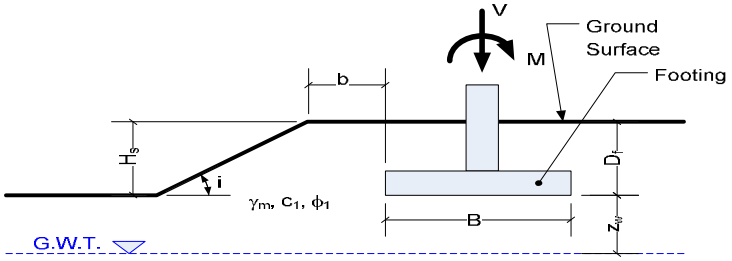
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:				
- Footing Length:	L =	80	ft	(Approximate Length of Structures Based on Boring Plan)
- Footing Width:	B' =	5.5	ft	B'=B
- Bearing Depth:	D_f =	3	ft	(based on 36" Embedment Depth)
- Assume Cast in Place footing:	C =	1		(10.6.3.4.2)
Soil:				
- Description		Silty Sand (SM); medium dense		
- Cohesion:	c_1 =	0	ksf	
- Angle of Internal Friction:	ϕ_{f1} =	30	°	
- Moist Unit Weight:	γ_m =	0.12	kcf	
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45) (Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	9	ft	(gwt = 9.0 feet below Bottom of Footing based on Boring 314B1)
Loads from Structure:				
- Dead Load	DL =	9.2	klf	
- Roof Live Load	RLL =	6.3	klf	
- Vertical Load	P_V =	15.5	klf	(Dead Load + Roof Live Load)
- Horizontal Load	P_H =	3.4	klf	(Seismic Shear Load)
- Bearing Pressure	q =	3.2	ksf	
Vertical Loads from Overburden and Foundations:				
- Weight of the soil over footing	W_S =	1.3	klf	(thickness of soil = Df-1 ft concrete thickness)
- Weight of the footing	W_f =	0.8	klf	(assume 1 ft thick concrete at 150 pcf unit weight)
Sloping Ground Surface				
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes		
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**
- Height of Slope	H_s =		ft	
- Slope Inclination	i =		°	

Results:

Nominal Bearing Capacity:	**q_n =**	**14.1**	**ksf**	(See Sheet 2)
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**4.7**	**ksf**	= q_n / FS
Check q_A > q		**4.7 > 3.2**	**OK**	
Sliding Resistance (FS=1.5)	**F_R =**	**3.4**	**klf**	= (C * (DL+W_s+W_f) * tanδ) / FS (10.6.3.4.2)
Check Sliding		**3.4 ≥ 3.4**	**OK**	

SO No. 177050
Subject : Camp Santiago - HQ Structures - 306 to 330
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 80 ft
- Effective Footing Width $B' =$ 5.5 ft

Consider the Effect of Ground Water

$C_{wq} =$ 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ 1 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.04 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.04 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.973 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ 14.08 ksf $=c\, N_{c1}\, s_{c1}\, i_{c1} + 0.5\, \gamma\, B'\, N_{\gamma 1}\, s_{\gamma 1}\, i_{\gamma 1} + \gamma\, D_f\, N_{q1}\, s_{q1}\, i_{q1}$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - HQ Structures - 440 to 446
Case 1, Df=4
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

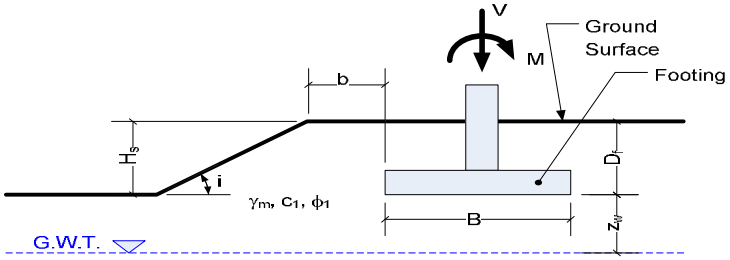
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:				
- Footing Length:	L =	80	ft	(Approximate Length of Structures Based on Boring Plan)
- Footing Width:	B' =	9	ft	B'=B
- Bearing Depth:	D_f =	4	ft	(based on 48" Embedment Depth)
- Assume Cast in Place footing:	C =	1		(10.6.3.4.2)
Soil:				
- Description		Silty Sand (SM); medium dense		
- Cohesion:	c_1 =	0	ksf	
- Angle of Internal Friction:	ϕ_{f1} =	30	°	
- Moist Unit Weight:	γ_m =	0.12	kcf	
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45) (Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	8	ft	(gwt = 8.0 feet below Bottom of Footing based on Boring 314B1)
Loads from Structure:				
- Dead Load	DL =	9.2	klf	
- Roof Live Load	RLL =	6.3	klf	
- Vertical Load	P_V =	15.5	klf	(Dead Load + Roof Live Load)
- Horizontal Load	P_H =	3.4	klf	(Seismic Shear Load)
- Bearing Pressure	q =	2.2	ksf	
Vertical Loads from Overburden and Foundations:				
- Weight of the soil over footing	W_S =	3.2	klf	(thickness of soil = Df-1 ft concrete thickness)
- Weight of the footing	W_f =	1.4	klf	(assume 1 ft thick concrete at 150 pcf unit weight)
Sloping Ground Surface				
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes		
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**
- Height of Slope	H_s =		ft	
- Slope Inclination	i =		°	

Results:

Nominal Bearing Capacity:	**q_n =**	**15.2**	**ksf**	(See Sheet 2)
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.1**	**ksf**	= q_n / FS
Check q_A > q		**5.1 > 2.2**	**OK**	
Sliding Resistance (FS=1.5)	**F_R =**	**4.1**	**klf**	= (C * (DL+W_S+W_f) * tanδ) / FS (10.6.3.4.2)
Check Sliding		**4.1 > 3.4**	**OK**	

SO No. 177050
Subject : Camp Santiago - HQ Structures - 440 to 446
Case 1, Df=4
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

- Effective Footing Length $L' =$ 80 ft
- Effective Footing Width $B' =$ 9 ft

Consider the Effect of Ground Water

$C_{wq} =$ **1** (Table 10.6.3.1.2a-2)
$C_{w\gamma} =$ **0.5** (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

$N_{q1} =$ 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
$N_{c1} =$ 30.1 , since $\phi_{f1} =$ 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1} =$ 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

$s_{c1} =$ 1.07 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
$s_{q1} =$ 1.06 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1} =$ 0.955 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

$d_q =$ **1** (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

$q_n =$ 15.18 ksf $= c N_{c1} s_{c1} i_{c1} + 0.5 \gamma B' N_{\gamma 1} s_{\gamma 1} i_{\gamma 1} + \gamma D_f N_{q1} s_{q1} i_{q1}$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

SO No. 177050
Subject : Camp Santiago - HQ Structures - 440 to 446
Case 2, Df=5
Computed By: SED Checked By: DAC Date: 7/28/2020

Michael Baker INTERNATIONAL

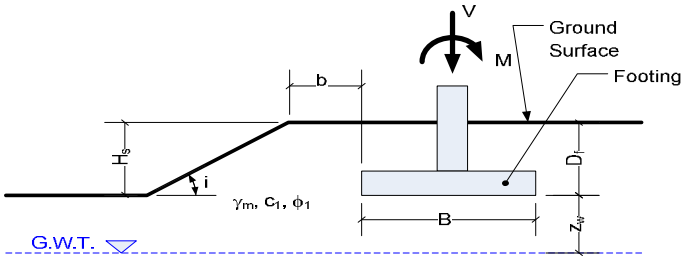
Bearing Capacity of Spread Footing on Soil

Problem Statement:

Calculate the bearing capacity of the proposed spread footing on homogeneous soil using Rational (Theoretical) method.

Assumptions:

- This module does NOT account for Inclined loading or base inclination.
- This module does NOT account for layered soils.
- Punching shear is NOT a concern.
- Wind and Seismic loading are not to be combined since seismic is an extreme event; use the larger of the seismic and wind loading for design.
- Assume finished ground elevation is at the top of boring elevation.



Method of Analysis:

- Calculate bearing capacity using allowable stress design.

Reference:

- AASHTO LRFD 8th Edition

Input:

Footing:				
- Footing Length:	L =	80	ft	(Approximate Length of Structures Based on Boring Plan)
- Footing Width:	B' =	8	ft	B'=B
- Bearing Depth:	D_f =	5	ft	(based on 60" Embedment Depth)
- Assume Cast in Place footing:	C =	1		(10.6.3.4.2)
Soil:				
- Description		Silty Sand (SM); medium dense		
- Cohesion:	c_1 =	0	ksf	
- Angle of Internal Friction:	ϕ_{f1} =	30	°	
- Moist Unit Weight:	γ_m =	0.12	kcf	
- Interface Friction Angle,concrete	δ =	24	°	(equal to coefficient of friction = 0.45) (Table C3.11.5.3-1)
- Depth to Water Table below Bottom of Footing	z_w =	7	ft	(gwt = 7.0 feet below Bottom of Footing based on Boring 314B1)
Loads from Structure:				
- Dead Load	DL =	9.2	klf	
- Roof Live Load	RLL =	6.3	klf	
- Vertical Load	P_V =	15.5	klf	(Dead Load + Roof Live Load)
- Horizontal Load	P_H =	3.4	klf	(Seismic Shear Load)
- Bearing Pressure	q =	2.6	ksf	
Vertical Loads from Overburden and Foundations:				
- Weight of the soil over footing	W_S =	3.8	klf	(thickness of soil = Df-1 ft concrete thickness)
- Weight of the footing	W_f =	1.2	klf	(assume 1 ft thick concrete at 150 pcf unit weight)
Sloping Ground Surface				
- Calculate Bearing Capacity Using Leveled Ground Only?		Yes		
- Distance from Edge of Footing to Crest of Slope	b =		ft	**Input N_{cq1} and $N_{\gamma q1}$ on Sheet 2**
- Height of Slope	H_s =		ft	
- Slope Inclination	i =		°	

Results:

Nominal Bearing Capacity:	**q_n =**	**16.8**	**ksf**	(See Sheet 2)
Factor of Safety for Bearing on Soil	**FS =**	**3.0**		
Allowable Bearing Capacity:	**q_A =**	**5.6**	**ksf**	= q_n / FS
Check q_A > q		**5.6 > 2.6**	**OK**	
Sliding Resistance (FS=1.5)	**F_R =**	**4.2**	**klf**	= (C * (DL+W_s+W_f) * tanδ) / FS (10.6.3.4.2)
Check Sliding		**4.2 > 3.4**	**OK**	

SO No. 177050
Subject : Camp Santiago - HQ Structures - 440 to 446
Case 2, Df=5
Computed By: SED Checked By: DAC Date: 7/28/2020

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- Effective Footing Length L' = 80 ft
- Effective Footing Width B' = 8 ft

Consider the Effect of Ground Water

C_{wq} = 1 (Table 10.6.3.1.2a-2)
$C_{w\gamma}$ = 0.5 (Table 10.6.3.1.2a-2)

Calculate Bearing Capacity Factors for Footing on Leveled Ground

N_{q1} = 18.4 $=\exp(\pi \tan \phi_{f1}) \tan^2 (45° + \phi_{f1}/2)$ (Table 10.6.3.1.2a-1)
N_{c1} = 30.1 $=(N_{q1} - 1) \cot \phi_{f1}$ (for $\phi_{f1} > 0°$) (Table 10.6.3.1.2a-1)
N_{c1} = 5.1 $=2 + \pi$ (for $\phi_{f1} = 0°$) (Table 10.6.3.1.2a-1)
N_{c1} = 30.1 , since ϕ_{f1}= 30 ° > 0 (Table 10.6.3.1.2a-1)
$N_{\gamma 1}$ = 22.4 $= 2(N_{q1} + 1) \tan \phi_{f1}$ (Table 10.6.3.1.2a-1)

Calculate Shape Factors

s_{c1} = 1.06 $=1+(B'/L')(N_{q1}/N_{c1})$ (Table 10.6.3.1.2a-3)
s_{q1} = 1.06 $=1+(B'/L') \tan \phi_{f1}$
$s_{\gamma 1}$ = 0.96 $=1 - 0.4(B'/L')$

Calculate Depth Correction Factor

d_q = 1 (Table 10.6.3.1.2a-4)

Calculate Nominal Bearing Capacity for Footing on Level Ground

q_n = 16.84 ksf $=c\, N_{c1}\, s_{c1}\, i_{c1} + 0.5\, \gamma\, B'\, N_{\gamma 1}\, s_{\gamma 1}\, i_{\gamma 1} + \gamma\, D_f\, N_{q1}\, s_{q1}\, i_{q1}$ (10.6.3.1.2a-1)

Note: All inclination factors (i_{c1}, $i_{\gamma 1}$ and i_{q1}) assumed equal to 1, noting the short term nature of the horizontal loads.

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We Make a Difference

Settlement Calculations

SO No. 177050

Subject : Camp Santiago - Barracks Structures - 304, 308, 310, 318, 450, 452, 454, 456
Settlement

Computed By: SED Checked By: DAC Date: 8/4/2020

Michael Baker INTERNATIONAL

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.36	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	8.0	ft	= Footing Length
B' =	6.8	ft	= Effective Footing Width
q =	4.6	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	4.2	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N1 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	0.5	120	10	0.39	1.548	3.97	15	51	0.12
2	4	Fine to medium silty SAND	0.5	2.5	120	17	0.54	1.440	2.93	24	66	0.29
3	4	Fine to medium silty SAND	2.5	4.5	120	23	0.78	1.317	1.95	30	77	0.17
4	4	Fine to medium silty SAND	4.5	7.5	120	36	1.08	1.208	1.29	43	103	0.12
5	4	Fine to medium silty SAND	7.5	10.5	120	50	1.44	1.112	0.86	56	130	0.06
6	4	Fine to medium silty SAND	10.5	14.4	120	50	1.85	1.027	0.59	51	121	0.05
7	4	Fine to medium silty SAND	14.4	16.5	62.6	50	2.04	0.995	0.44	50	117	0.02
8	4	Fine to medium silty SAND	16.5	19.5	62.6	50	2.20	0.970	0.36	48	114	0.02
9	4	Fine to medium silty SAND	19.5	20	62.6	50	2.31	0.953	0.31	48	112	0.00

Note: Boring information is based on boring 456B3; ; Load information is from load case 2 from the bearing calculations

Total Elastic Settlement, Inch: **0.8**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

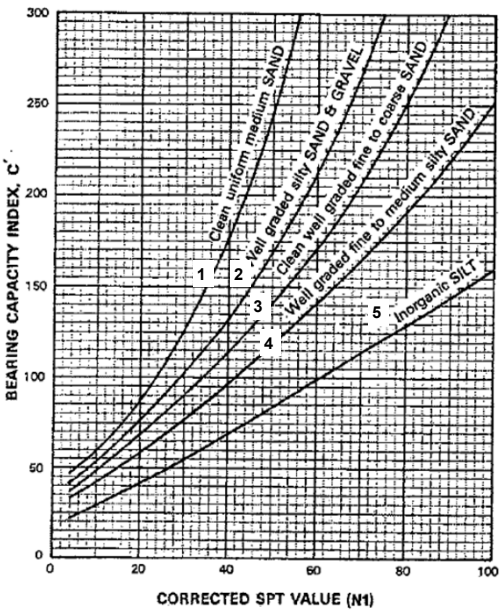
Where:

n = Number od soil layers within zone of stress influence of the footi
ΔH_i = Elastic settlement of layer i
H_c = Initial height of layer i
C' = Bearing capacity index from Figure 10.6.2.4.2-1
σ'^{i}_0 = Initial vertical effective stress at the midpoint of layer i
$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

$N1 = C_N N$

Where

$C_N = [0.77 \log_{10}(40/\sigma'_0)]$, and $C_N < 2.0$



SO No. 177050

Subject : Camp Santiago - Barracks Structures - 458 & 460

Settlement

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/4/2020

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.36	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	9.0	ft	= Footing Length
B' =	7.8	ft	= Effective Footing Width
q =	3.6	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	3.2	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N1 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	0.5	120	17	0.39	1.548	3.05	26	70	0.08
2	4	Fine to medium silty SAND	0.5	2.5	120	9	0.54	1.440	2.33	13	47	0.37
3	4	Fine to medium silty SAND	2.5	4.5	120	20	0.78	1.317	1.61	26	70	0.17
4	4	Fine to medium silty SAND	4.5	7.5	120	24	1.08	1.208	1.10	29	75	0.15
5	4	Fine to medium silty SAND	7.5	10.5	120	25	1.44	1.112	0.75	28	72	0.09
6	4	Fine to medium silty SAND	10.5	14.4	120	32	1.85	1.027	0.52	33	82	0.06
7	4	Fine to medium silty SAND	14.4	16.5	62.6	38	2.04	0.995	0.40	38	92	0.02
8	4	Fine to medium silty SAND	16.5	19.5	62.6	40	2.20	0.970	0.33	39	94	0.02
9	4	Fine to medium silty SAND	19.5	20	62.6	40	2.31	0.953	0.29	38	92	0.00

Note: Boring information is based on boring 458B3; Load information is from load case 2 from the bearing calculations

Total Elastic Settlement, Inch: **1.0**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

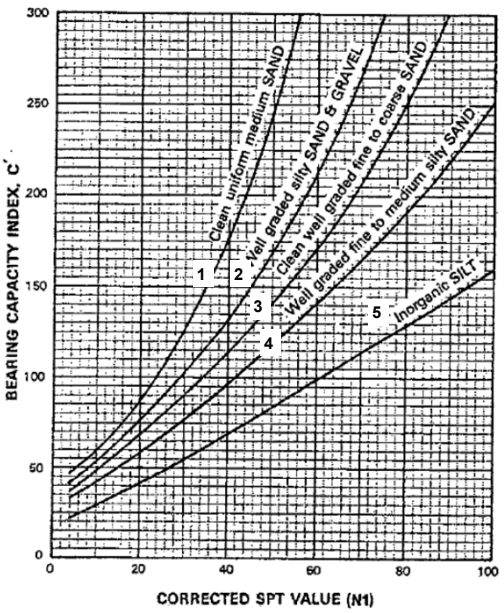
Where:

n = Number od soil layers within zone of stress influence of the footi
ΔH_i = Elastic settlement of layer i
H_c = Initial height of layer i
C' = Bearing capacity index from Figure 10.6.2.4.2-1
σ'_0 = Initial vertical effective stress at the midpoint of layer i
$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

$N1 = C_N N$

Where

$C_N = [0.77 \log_{10}(40/\sigma'_0)]$, and $C_N < 2.0$



SO No. 177050

Subject : Camp Santiago - Canopy Structure at HQ6

Settlement

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/4/2020

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.36	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	37	ft	= Footing Length
B =	13.5	ft	= Footing Width
q =	0.5	ksf	= Bearing Pressure at Bottom of Footing
$\Delta\sigma_{ov}$ =	0.1	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N1 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	1.5	120	53	0.45	1.501	0.13	80	192	0.01
2	4	Fine to medium silty SAND	1.5	3	120	59	0.63	1.388	0.11	81	196	0.01
3	4	Fine to medium silty SAND	3	4.5	120	60	0.81	1.304	0.10	78	188	0.00
4	4	Fine to medium silty SAND	4.5	6	120	56	0.99	1.237	0.09	69	164	0.00
5	4	Fine to medium silty SAND	6	7.5	120	61	1.17	1.181	0.08	72	172	0.00
6	4	Fine to medium silty SAND	7.5	9	120	67	1.35	1.133	0.07	76	180	0.00
7	4	Fine to medium silty SAND	9	10.5	120	67	1.53	1.091	0.06	73	173	0.00
8	4	Fine to medium silty SAND	10.5	12	120	67	1.71	1.054	0.06	70	166	0.00
9	4	Fine to medium silty SAND	12	16.5	62.6	59	1.90	1.019	0.05	60	140	0.00
10	4	Fine to medium silty SAND	16.5	22.5	62.6	67	2.23	0.966	0.04	64	152	0.00
11	4	Fine to medium silty SAND	22.5	27.5	62.6	67	2.57	0.918	0.03	61	144	0.00
12	4	Fine to medium silty SAND	27.5	32.5	62.6	67	2.88	0.879	0.02	59	138	0.00
13	4	Fine to medium silty SAND	32.5	37.5	62.6	67	3.20	0.845	0.02	56	132	0.00
14	4	Fine to medium silty SAND	37.5	42.5	62.6	67	3.51	0.814	0.02	54	127	0.00
15	4	Fine to medium silty SAND	42.5	52.5	62.6	67	3.98	0.772	0.01	51	121	0.00

Note: Boring information is based on boring 306B1

Total Elastic Settlement, Inch: **<0.1**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

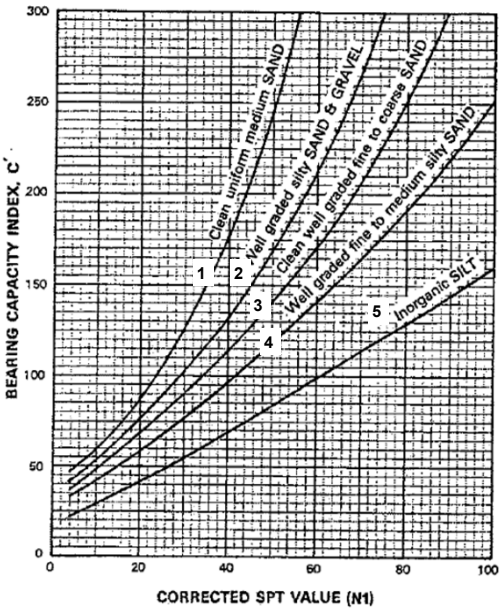
Where:

n = Number od soil layers within zone of stress influence of the footi
ΔH_i = Elastic settlement of layer i
H_c = Initial height of layer i
C' = Bearing capacity index from Figure 10.6.2.4.2-1
σ'_0 = Initial vertical effective stress at the midpoint of layer i
$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

N1 = C_N N

Where

C_N = [0.77 $\log_{10}(40/\sigma'_0)$], and C_N < 2.0



SO No. 177050
Subject : Camp Santiago - DFAC Structures
Settlement
Computed By: SED Checked By: DAC Date: 8/4/2020

Michael Baker INTERNATIONAL

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.36	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	140	ft	= Footing Length
B =	4.5	ft	= Footing Width
q =	3.8	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	3.4	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N1 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	0.5	120	31	0.39	1.548	3.25	48	113	0.05
2	4	Fine to medium silty SAND	0.5	2.5	120	38	0.54	1.440	2.55	55	128	0.14
3	4	Fine to medium silty SAND	2.5	4.5	120	46	0.78	1.317	1.89	61	142	0.09
4	4	Fine to medium silty SAND	4.5	7.5	120	40	1.08	1.208	1.41	48	114	0.11
5	4	Fine to medium silty SAND	7.5	10.5	120	50	1.44	1.112	1.08	56	130	0.07
6	4	Fine to medium silty SAND	10.5	13.5	120	22	1.80	1.037	0.86	23	63	0.10
7	4	Fine to medium silty SAND	13.5	16.5	62.6	17	1.99	1.004	0.72	17	54	0.09
8	4	Fine to medium silty SAND	16.5	19.5	62.6	20	2.18	0.974	0.61	19	58	0.07
9	4	Fine to medium silty SAND	19.5	22.5	62.6	20	2.36	0.946	0.53	19	57	0.06
10	4	Fine to medium silty SAND	22.5	25.5	62.6	20	2.55	0.920	0.46	18	56	0.05
11	4	Fine to medium silty SAND	25.5	28.5	62.6	20	2.74	0.897	0.41	18	55	0.04
12	4	Fine to medium silty SAND	28.5	30	62.6	20	2.88	0.880	0.38	18	55	0.02

Note: Boring information is based on boring 302B1

Total Elastic Settlement, Inch: **0.9**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

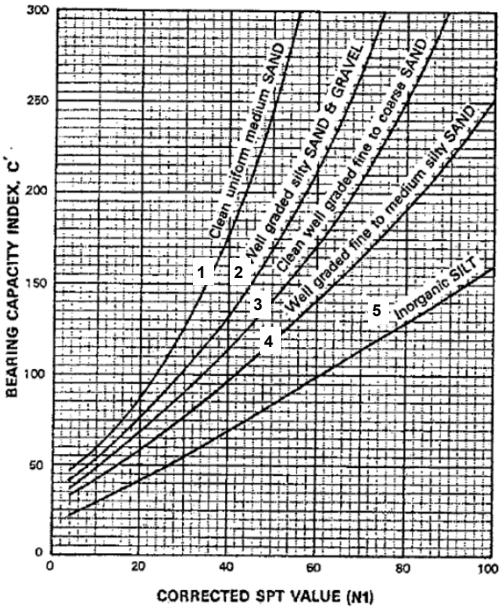
Where:

n = Number od soil layers within zone of stress influence of the footi
ΔH_i = Elastic settlement of layer i
H_c = Initial height of layer i
C' = Bearing capacity index from Figure 10.6.2.4.2-1
σ'_0 = Initial vertical effective stress at the midpoint of layer i
$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

$N1 = C_N N$

Where

$C_N = [0.77 \log_{10}(40/\sigma'_0)]$, and $C_N < 2.0$



SO No. 177050

Subject : Camp Santiago - HQ Structures - 306-330
Settlement

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/4/2020

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.36	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	80	ft	= Footing Length
B =	5.5	ft	= Footing Width
q =	3.2	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	2.8	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N160 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	1.5	120	13	0.45	1.501	2.48	20	59	0.25
2	4	Fine to medium silty SAND	1.5	3	120	20	0.63	1.388	1.96	28	72	0.15
3	4	Fine to medium silty SAND	3	4.5	120	39	0.81	1.304	1.61	50	119	0.07
4	4	Fine to medium silty SAND	4.5	6	120	45	0.99	1.237	1.36	56	131	0.05
5	4	Fine to medium silty SAND	6	7.5	120	32	1.17	1.181	1.18	38	92	0.06
6	4	Fine to medium silty SAND	7.5	9	120	29	1.35	1.133	1.03	33	83	0.05
7	4	Fine to medium silty SAND	9	10.5	62.6	33	1.44	1.111	0.91	37	90	0.04
8	4	Fine to medium silty SAND	10.5	12	62.6	49	1.54	1.090	0.82	54	126	0.03
9	4	Fine to medium silty SAND	12	16	62.6	67	1.71	1.054	0.68	70	166	0.04
10	4	Fine to medium silty SAND	16	20	62.6	67	1.96	1.008	0.54	68	160	0.03
11	4	Fine to medium silty SAND	20	25	62.6	67	2.24	0.964	0.44	65	152	0.03

Note: Boring information is based on boring 330B1

Total Elastic Settlement, Inch: **0.8**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

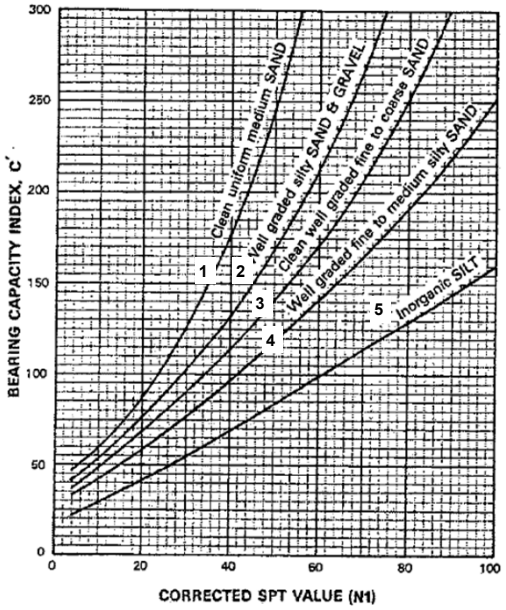
Where:

n = Number od soil layers within zone of stress influence of the footi
ΔH_i = Elastic settlement of layer i
H_C = Initial height of layer i
C' = Bearing capacity index from Figure 10.6.2.4.2-1
σ'_0 = Initial vertical effective stress at the midpoint of layer i
$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

N1 = C_N N

Where

C_N = [0.77 $\log_{10}(40/\sigma'_0)$], and C_N < 2.0



SO No. 177050

Subject : Camp Santiago - HQ Structures - Buildings 440-446

Settlement - Case 1, Df=4

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/4/2020

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.48	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	80	ft	= Footing Length
B =	9.0	ft	= Footing Width
q =	2.2	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	1.7	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N160 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	1.5	120	11	0.57	1.422	1.57	16	51	0.20
2	4	Fine to medium silty SAND	1.5	3.5	120	15	0.78	1.317	1.31	20	58	0.18
3	4	Fine to medium silty SAND	3.5	6.5	120	22	1.08	1.208	1.04	27	70	0.15
4	4	Fine to medium silty SAND	6.5	9.5	120	15	1.44	1.112	0.83	17	53	0.13
5	4	Fine to medium silty SAND	9.5	12.5	62.6	15	1.63	1.071	0.68	16	52	0.11
6	4	Fine to medium silty SAND	12.5	15.5	62.6	17	1.82	1.034	0.57	18	55	0.08
7	4	Fine to medium silty SAND	15.5	18.5	62.6	20	2.00	1.001	0.49	20	59	0.06
8	4	Fine to medium silty SAND	18.5	21.5	62.6	20	2.19	0.971	0.43	19	58	0.05
9	4	Fine to medium silty SAND	21.5	24.5	62.6	25	2.38	0.944	0.38	24	65	0.04
10	4	Fine to medium silty SAND	24.5	27.5	62.6	25	2.57	0.918	0.33	23	64	0.03
11	4	Fine to medium silty SAND	27.5	30	62.6	25	2.74	0.897	0.30	22	63	0.02

Note: Boring information is based on boring 444B1

Total Elastic Settlement, Inch: **1.0**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

Where:

n = Number od soil layers within zone of stress influence of the footi

ΔH_i = Elastic settlement of layer i

H_C = Initial height of layer i

C' = Bearing capacity index from Figure 10.6.2.4.2-1

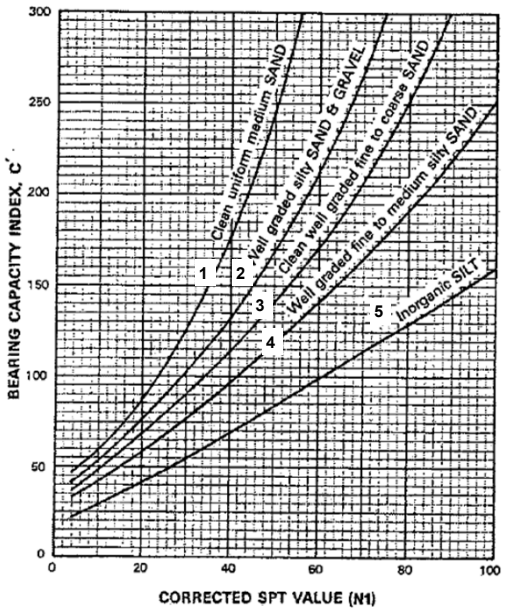
σ'_0 = Initial vertical effective stress at the midpoint of layer i

$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

N1 = C_N N

Where

C_N = [0.77 $\log_{10}(40/\sigma'_0)$], and C_N < 2.0



SO No. 177050

Subject : Camp Santiago - HQ Structures - Buildings 440-446

Settlement - Case 2, Df=5

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/4/2020

Reference: LRFD Bridge Design Specifications, AASHTO, 2017

σ'_{od} =	0.60	ksf	= Effective Overburden Pressure at Bottom of Footing
L =	80	ft	= Footing Length
B =	8.0	ft	= Footing Width
q =	2.6	ksf	= Bearing Pressure
$\Delta\sigma_{ov}$ =	2.0	ksf	= Change in Effective Stress at D_f

Distribution of Vertical Stress by the 2:1 Method (AASHTO Figure 10.7.2.3.1-1)

Sub Soil Layer No.	Soil Type Number	Soil Type Description	Depth (ft, From Bottom of Footing)		Effective Unit Weight (pcf)	SPT N_{60} Value (blows/ft)	Self Effective Stress at Mid Layer σ'_0 (ksf)	C_N	Incremental Effective Stresses at Mid Layer $\Delta\sigma'_v$ (ksf)	Corrected SPT N Value, N160 (blows/ft)	Bearing Capacity Index, C' (From Chart)	Settlement at This Sublayer (inch)
			From	To								
1	4	Fine to medium silty SAND	0	0.5	120	11	0.63	1.388	1.93	15	51	0.07
2	4	Fine to medium silty SAND	0.5	2.5	120	15	0.78	1.317	1.65	20	58	0.20
3	4	Fine to medium silty SAND	2.5	5.5	120	22	1.08	1.208	1.27	27	70	0.17
4	4	Fine to medium silty SAND	5.5	8.5	120	15	1.44	1.112	0.98	17	53	0.15
5	4	Fine to medium silty SAND	8.5	11.5	62.6	15	1.63	1.071	0.79	16	52	0.12
6	4	Fine to medium silty SAND	11.5	14.5	62.6	17	1.82	1.034	0.66	18	55	0.09
7	4	Fine to medium silty SAND	14.5	17.5	62.6	20	2.00	1.001	0.56	20	59	0.07
8	4	Fine to medium silty SAND	17.5	20.5	62.6	20	2.19	0.971	0.48	19	58	0.05
9	4	Fine to medium silty SAND	20.5	23.5	62.6	25	2.38	0.944	0.42	24	65	0.04
10	4	Fine to medium silty SAND	23.5	26.5	62.6	25	2.57	0.918	0.37	23	64	0.03
11	4	Fine to medium silty SAND	26.5	30	62.6	25	2.77	0.893	0.33	22	63	0.03

Note: Boring information is based on boring 444B1

Total Elastic Settlement, Inch: **1.0**

Formulas Used in the Calculations

$$S_e = \sum_{i=1}^{n} \Delta H_i$$

In which:

$$\Delta H_i = H_c \frac{1}{C'} \log\left(\frac{\sigma'_0 + \Delta\sigma_v}{\sigma'_0}\right)$$

Where:

n = Number od soil layers within zone of stress influence of the footi

ΔH_i = Elastic settlement of layer i

H_C = Initial height of layer i

C' = Bearing capacity index from Figure 10.6.2.4.2-1

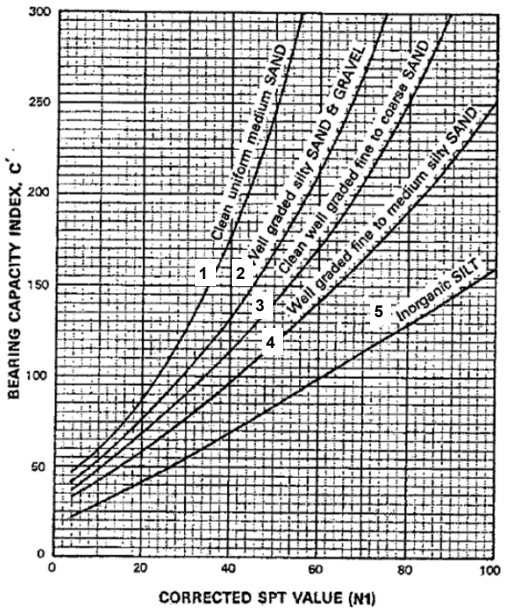
σ'_0 = Initial vertical effective stress at the midpoint of layer i

$\Delta\sigma_v$ = Increase in vertical stress at the midpoint of layer i

N1 = C_N N

Where

C_N = [0.77 $\log_10(40/\sigma'_0)$], and C_N < 2.0



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ATTACHMENT 8
Deep Foundation Analyses

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Axial Capacity Calculations

Camp Santiago Facility Restoration

MBAKERINTL.COM

SO No. 177050
Subject: Camp Santiago - HQ5
Driven Pile Axial Resistance
12-Inch O.D. Pipe Pile
Computed By: SED Checked By: DAC Date: 7/29/20

Michael Baker INTERNATIONAL

Problem Statement:

- Calculate allowable resistance of driven Pipe-Pile using allowable stress design and boring data from 448B1.

References:

- Nordlund/Thurman method (AASHTO Section 10.7.3.8.6f) and Meyerhof method (AASHTO Section 10.7.3.8.6g) are used to estimate nominal geotechnical resistance for driven pipe piles through cohesionless soil.
- Digitized curves from the User's Manual of FHWA software, *Driven 1.0* , are used in calculations. (See attached tables and figures.)

Calculations:

Pile	Pipe O.D.		Perimeter		Tip Area		δ/ϕ
	(in)	(ft)	(in)	(ft)	(ft^2)	(m^2)	(---)
	12	1.00	37.7	3.142	0.79	0.0730	0.5891

The driven pile is considered Displacement pile.

Elevation			
	Boring Elev.	51.50	(ft)
	Bottom of Footing Elev.	50.00	(ft)
	Groundwater Elev. from Boring	33.50	(ft)
	Design Groundwater Elev.	36.00	(ft)

SPT	Hammer Efficiency	60%	(Typically 73% for automatic hammer and 60% for conventional drop type)

Option for Correlation from SPT N-Value to Angle of Internal Friction: AASHTO (2010) Lower Limit

| Strata No. [2] | Bottom Elev. | Soil Type [2] | Estimated Strength Loss During Driving | | Undrained Shear Strength (for Cohesive Soil) | | Adhesion Type (for Cohesive Soil) [5] | User Defined Adhesion [6] | Adhesion Factor | Pile Length | Top Elev. of Each Strata [2] | Depth of Penetration in Bearing Strata [2] | Effective Unit Weight [1] | | Effective Vertical Overburden at Bottom [1] | | Effective Vertical Overburden at Mid Point [1] | | SPT-N Value (Uncorrected) | Over-riding Values | | Overburden Stress Correction Factor | SPT-N Value Corrected for Both Overburden and Hammer Efficiency | Averaged $N1_{60}$ over Twice Pile Diameter | Angle of Internal Friction [11][7] | Coeff. Lat. Earth Press. at Mid Point [1] | Frict. Angle btw Pile and soil [1] | Correct. Factor for K_δ [1] | Unit Side Resistance | | | Incremental Side Resistance (with Different Models for Cohesionless Soil Strata) | | Cumulative Side Resistance (with Different Models for Cohesionless Soil Strata) | | Bearing Capacity Factor [1] | D/B [1] | Coeff. for Tip Resistance Contribution [1] | Unit Tip Resistance | | Limiting Unit Tip Resistance (for Different Models for Cohesionless Soil Strata) | | $min(q_p, q_L)$ (with Different Models for Cohesionless Soil Strata) | | Tip Resistance | | Total Resistance (with Different Models for Cohesionless Soil Strata) | | Allowable Axial Resistance (FS=3) [10] | Allowable Uplift Resistance (FS=2) [11] |
|---|---|---|---|---|---|---|---

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Lateral Capacity Analyses

Camp Santiago Facility Restoration

MBAKERINTL.COM

SO No. 177050
Subject : USACE Camp Santiago
HQ5 Structures
12" Pipe Pile - LPILE Analysis
Computed By: SED Checked By: DAC Date: 8/5/2020
Updated: 8/31/2020

Michael Baker INTERNATIONAL

Problem Statement

- Check lateral response of a 12-in diameter pipe pile considering the provided loading, using LPILE 2018.
- Perform a Pushover Analysis to assess the maximum shear loading that can be applied to a single pile across a range of pile head deflections from 0 to 0.75 inches, using LPile 2018.

Reference

- LPile Technical Manual 5.0
- AASHTO LRFD8

Assumptions

- Consider cyclic loading with 5000 cycles of loading.
- Consider top of pile at EL 50 ft.
- Assume pile spacing of at least 3D center to center.
- Assume shear load is distributed even across 4 piles.

Analysis

- For the LPile analysis, the following loads were applied at top of the pipe pile at ground surface:

Axial =	0 kips		(Wind uplift load exceeds vertical loading)
Shear =	2.7 kips	= 10.8 kips / 4 piles	(Wind)
Moment =	0 kips		(Wind)

- For Pushover analysis, check maximum shear per pile targeting a 0.5" pile head deflection.

Axial =	42 kips		(Maximum Compressive Load, DL+LL)
Moment =	0 kips		(Wind)

- See the following page for a sketch of the LPILE Model
- Borings drilled for the HQ5 structures were used as the basis of the LPile subsurface model.

Summary of Results

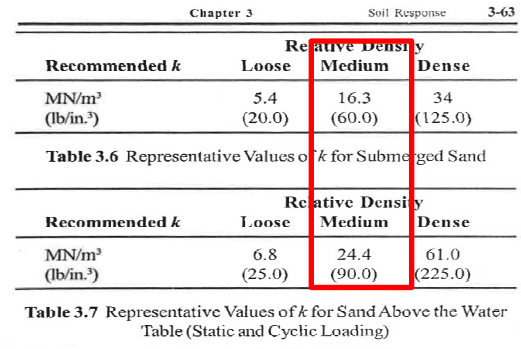
- Critical results are listed in the following table. See summary plots and LPILE output files on the following pages for detail.

LPile Analysis - 4 piles per pile cap			
Length of Pile		(feet)	20
Max. Lateral Deflection		(inches)	0.13
Pipe Pile in Soil	Max. Bending Moment	(in-lbs)	118,713
	Max. Shear	(lbs)	2,700

Pushover Analysis				
Pile Spacing		(pile diameters)	5D	3D
Length of Pile		(feet)	20	20
Target Lateral Deflection		(inches)	0.5	0.5
Pipe Pile in Soil	Max. Shear per pile, pinned	(lbs)	11,260	6,748
	Max. Shear per pile, fixed	(lbs)	29,942	18,377
Notes: D = Pile Diameters				

Soil Parameters:

Layer	Soil Description	ϕ	k	Unit Weight	P-Y Model
--	--	(deg)	(pci)	(pcf)	--
1a/1b	Silty Sand	30	90/60	120/62.6	Reese Sand



Chapter 3 Soil Response 3-63

Recommended k	Relative Density Loose	Medium	Dense
MN/m³ (lb/in.³)	5.4 (20.0)	16.3 (60.0)	34 (125.0)

Table 3.6 Representative Values of k for Submerged Sand

Recommended k	Relative Density Loose	Medium	Dense
MN/m³ (lb/in.³)	6.8 (25.0)	24.4 (90.0)	61.0 (225.0)

Table 3.7 Representative Values of k for Sand Above the Water Table (Static and Cyclic Loading)

SO No. 177050
Subject : USACE Camp Santiago
HQ5 Structures
12" Pipe Pile - LPILE Analysis
Computed By: SED Checked By: DAC Date: 8/5/2020
Updated: 8/31/2020

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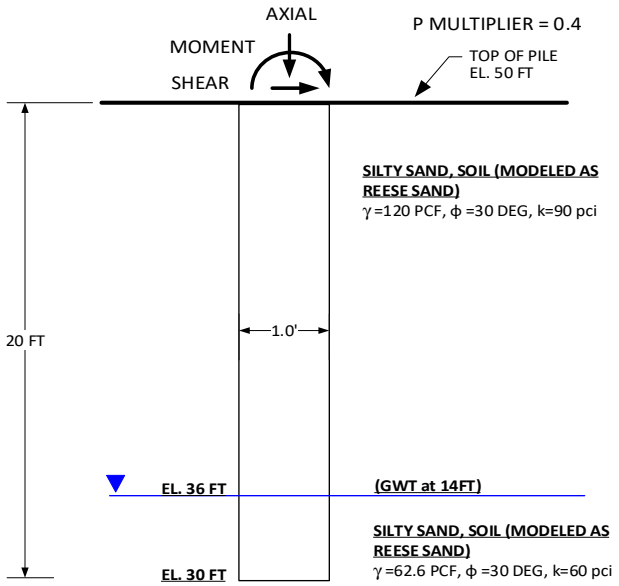
LPILE Model



PIPE PILE:
fy = 60 KSI
E = 29,000,000 KSI
12-INCH OD
0.375-INCH WALL THICKNESS

Table 10.7.2.4-1—Pile P-Multipliers, P_m, for Multiple Row Shading (averaged from Hannigan et al., 2006)

Pile *CTC* spacing (in the direction of loading)	*P*-Multipliers, P_m		
	Row 1	Row 2	Row 3 and higher
3*B*	0.8	0.4	0.3
5*B*	1.0	0.85	0.7

SO No. 177050
Subject : USACE Camp Santiago
HQ5 Structures
12" Pipe Pile - LPILE Analysis
Computed By: SED Checked By: DAC Date: 8/5/2020
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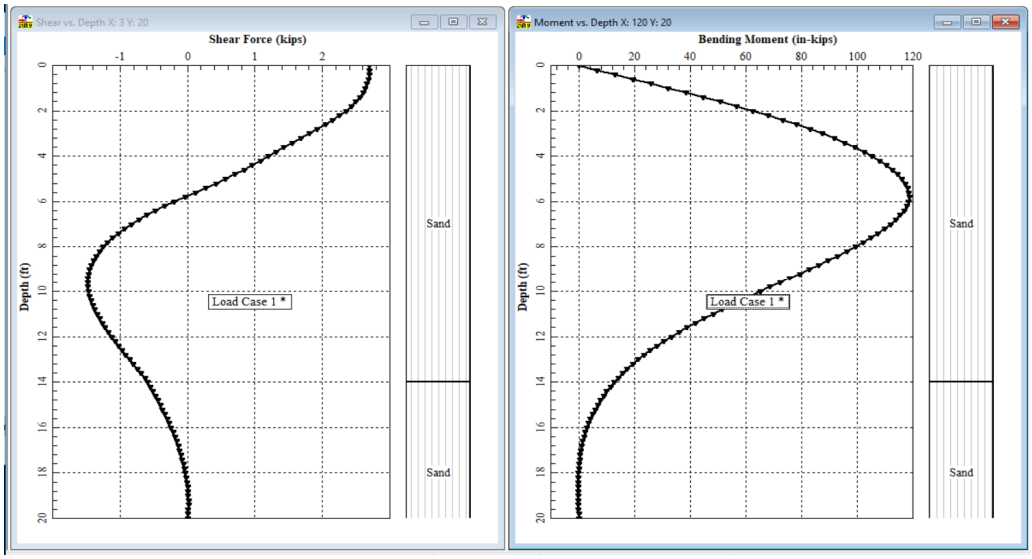
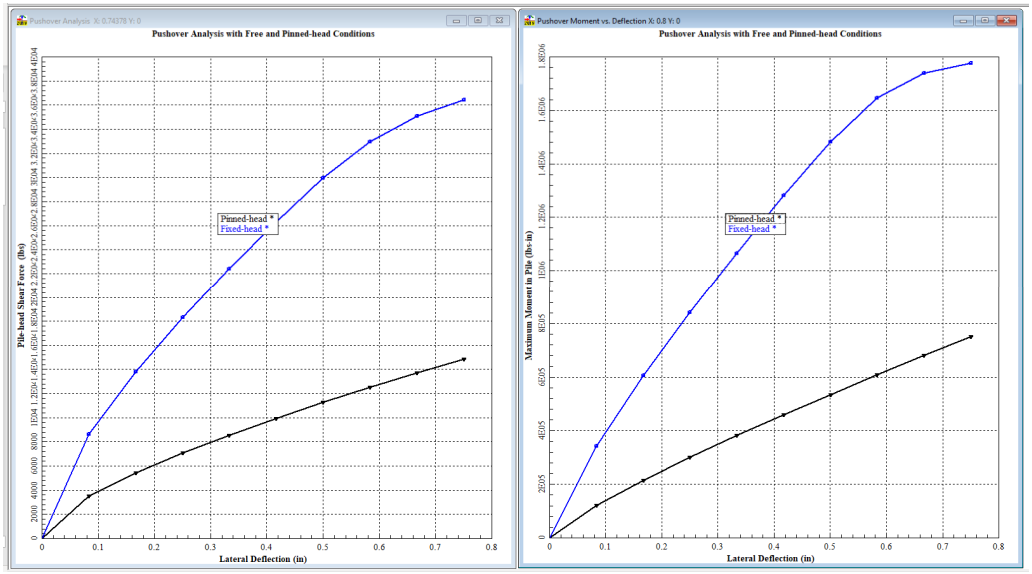
LPILE Results



Pushover Analysis



Completed by: SED
Checked by: DAC

Santiago Pipe Pile

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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This copy of LPile is being used by:

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Serial Number of Security Device: 500126284

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Files Used for Analysis

Path to file locations:
\\moonpa1cl1.bkr.mbakercorp.com\HRH_Projects\Geotech\Proposals\Puerto Rico\Analysis\Bearing Capacity\HQ5 Deep Foundation\LPILE\

Name of input data file:
Santiago Pipe Pile.lp11d

Name of output report file:
Santiago Pipe Pile.lp11o

Name of plot output file:
Santiago Pipe Pile.lp11p

Name of runtime message file:
Santiago Pipe Pile.lp11r

Date and Time of Analysis

Date: August 6, 2020 Time: 14:07:33

Problem Title

Project Name: Camp Santiago

Job Number: 177050

Client: USACE

Engineer: SED

Description: HQ5 LPile Analysis - 12in Pipe Pile

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Cyclic loading specified
 - Number of cycles of loading = 5000 cycles
 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Input of side resistance moment along pile not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Push-over analysis of pile not selected
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 20.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	12.0000
2	20.000	12.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a steel pipe pile		
Length of section	=	20.000000 ft
Pile diameter	=	12.000000 in
Shear capacity of section	=	0.0000 lbs

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	14.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	90.000000 pci
Subgrade k at bottom of layer	=	90.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	14.000000 ft
Distance from top of pile to bottom of layer	=	40.000000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	60.000000 pci
Subgrade k at bottom of layer	=	60.000000 pci

(Depth of the lowest soil layer extends 20.000 ft below the pile tip)

Summary of Input Soil Properties

Layer	Soil Type	Layer	Effective	Angle of

Santiago Pipe Pile

Layer Num.	Name (p-y Curve Type)	Depth ft	Unit Wt. pcf	Friction deg.	kpy pci
1	Sand	0.00	120.0000	30.0000	90.0000
	(Reese, et al.)	14.0000	120.0000	30.0000	90.0000
2	Sand	14.0000	62.6000	30.0000	60.0000
	(Reese, et al.)	40.0000	62.6000	30.0000	60.0000

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.4000	1.0000
2	20.000	0.4000	1.0000

Cyclic Loading Type

Cyclic loading criteria were used for computation of p-y curves for all analyses.

Number of cycles of loading = 5000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 2700. lbs	M = 0.0000 in-lbs	0.0000000	No	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel Pipe Pile:

Length of Section	=	20.000000 ft
Outer Diameter of Pipe	=	12.000000 in
Pipe Wall Thickness	=	0.375000 in
Yield Stress of Pipe	=	36.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	13.695380 sq. in.
Moment of Inertia	=	231.591024 in^4
Elastic Bending Stiffness	=	6716140. kip-in^2
Plastic Modulus, Z	=	50.695312in^3
Plastic Moment Capacity = Fy Z	=	1825.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	493.034 kips
Nominal Axial Tensile Capacity	=	-493.034 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	0.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 0.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000440	29.5278212	6716132.	6.0000000	0.7573500	
0.00000879	59.0556423	6716132.	6.0000000	1.5147000	
0.00001319	88.5834635	6716132.	6.0000000	2.2720500	
0.00001759	118.1112847	6716132.	6.0000000	3.0294001	
0.00002198	147.6391058	6716132.	6.0000000	3.7867501	
0.00002638	177.1669270	6716132.	6.0000000	4.5441001	
0.00003078	206.6947482	6716132.	6.0000000	5.3014501	
0.00003517	236.2225693	6716132.	6.0000000	6.0588001	
0.00003957	265.7503905	6716132.	6.0000000	6.8161501	
0.00004397	295.2782117	6716132.	6.0000000	7.5735001	
0.00004836	324.8060329	6716132.	6.0000000	8.3308501	
0.00005276	354.3338540	6716132.	6.0000000	9.0882002	
0.00005716	383.8616752	6716132.	6.0000000	9.8455502	
0.00006155	413.3894964	6716132.	6.0000000	10.6029002	
0.00006595	442.9173175	6716132.	6.0000000	11.3602502	
0.00007034	472.4451387	6716132.	6.0000000	12.1176002	
0.00007474	501.9729599	6716132.	6.0000000	12.8749502	
0.00007914	531.5007810	6716132.	6.0000000	13.6323002	
0.00008353	561.0286022	6716132.	6.0000000	14.3896502	
0.00008793	590.5564234	6716132.	6.0000000	15.1470003	
0.00009233	620.0842445	6716132.	6.0000000	15.9043503	
0.00009672	649.6120657	6716132.	6.0000000	16.6617003	
0.0001011	679.1398869	6716132.	6.0000000	17.4190503	

0.0001055	708.6677080	6716132.	6.0000000	18.1764003	
0.0001099	738.1955292	6716132.	6.0000000	18.9337503	
0.0001143	767.7233504	6716132.	6.0000000	19.6911003	
0.0001187	797.2511716	6716132.	6.0000000	20.4484503	
0.0001231	826.7789927	6716132.	6.0000000	21.2058004	
0.0001275	856.3068139	6716132.	6.0000000	21.9631504	
0.0001319	885.8346351	6716132.	6.0000000	22.7205004	
0.0001363	915.3624562	6716132.	6.0000000	23.4778504	
0.0001407	944.8902774	6716132.	6.0000000	24.2352004	
0.0001451	974.4180986	6716132.	6.0000000	24.9925504	
0.0001495	1004.	6716132.	6.0000000	25.7499004	
0.0001539	1033.	6716132.	6.0000000	26.5072504	
0.0001583	1063.	6716132.	6.0000000	27.2646005	
0.0001627	1093.	6716132.	6.0000000	28.0219505	
0.0001671	1122.	6716132.	6.0000000	28.7793005	
0.0001715	1152.	6716132.	6.0000000	29.5366505	
0.0001803	1211.	6716132.	6.0000000	31.0513505	
0.0001891	1270.	6716132.	6.0000000	32.5660505	
0.0001978	1329.	6716132.	6.0000000	34.0807506	
0.0002066	1388.	6716132.	6.0000000	35.5954506	
0.0002154	1443.	6697628.	6.0000000	36.0000000	Y
0.0002242	1486.	6626537.	6.0000000	36.0000000	Y
0.0002330	1519.	6519283.	6.0000000	36.0000000	Y
0.0002418	1546.	6395138.	6.0000000	36.0000000	Y
0.0002506	1570.	6263897.	6.0000000	36.0000000	Y
0.0002594	1590.	6129074.	6.0000000	36.0000000	Y
0.0002682	1608.	5994258.	6.0000000	36.0000000	Y
0.0002770	1623.	5859982.	6.0000000	36.0000000	Y
0.0002858	1637.	5727890.	6.0000000	36.0000000	Y
0.0002946	1649.	5598852.	6.0000000	36.0000000	Y
0.0003034	1660.	5473229.	6.0000000	36.0000000	Y
0.0003122	1670.	5351269.	6.0000000	36.0000000	Y
0.0003209	1680.	5233126.	6.0000000	36.0000000	Y
0.0003297	1688.	5118889.	6.0000000	36.0000000	Y
0.0003385	1696.	5008421.	6.0000000	36.0000000	Y
0.0003473	1702.	4901432.	6.0000000	36.0000000	Y
0.0003561	1709.	4798302.	6.0000000	36.0000000	Y
0.0003649	1715.	4698985.	6.0000000	36.0000000	Y
0.0003737	1720.	4602956.	6.0000000	36.0000000	Y
0.0003825	1725.	4510200.	6.0000000	36.0000000	Y
0.0003913	1730.	4421028.	6.0000000	36.0000000	Y
0.0004001	1734.	4334534.	6.0000000	36.0000000	Y
0.0004089	1738.	4251311.	6.0000000	36.0000000	Y
0.0004177	1742.	4170821.	6.0000000	36.0000000	Y
0.0004265	1746.	4093132.	6.0000000	36.0000000	Y
0.0004353	1749.	4018033.	6.0000000	36.0000000	Y
0.0004441	1752.	3945498.	6.0000000	36.0000000	Y
0.0004528	1755.	3875260.	6.0000000	36.0000000	Y
0.0004616	1758.	3807524.	6.0000000	36.0000000	Y
0.0004704	1760.	3741688.	6.0000000	36.0000000	Y
0.0004792	1763.	3678267.	6.0000000	36.0000000	Y
0.0004880	1765.	3616587.	6.0000000	36.0000000	Y
0.0004968	1767.	3556940.	6.0000000	36.0000000	Y
0.0005056	1769.	3499299.	6.0000000	36.0000000	Y
0.0005144	1771.	3443100.	6.0000000	36.0000000	Y
0.0005232	1773.	3388789.	6.0000000	36.0000000	Y
0.0005584	1780.	3187095.	6.0000000	36.0000000	Y
0.0005935	1785.	3007208.	6.0000000	36.0000000	Y
0.0006287	1789.	2846066.	6.0000000	36.0000000	Y
0.0006639	1793.	2700902.	6.0000000	36.0000000	Y
0.0006991	1796.	2569482.	6.0000000	36.0000000	Y
0.0007342	1799.	2450093.	6.0000000	36.0000000	Y
0.0007694	1801.	2341253.	6.0000000	36.0000000	Y
0.0008046	1803.	2241360.	6.0000000	36.0000000	Y
0.0008397	1805.	2149659.	6.0000000	36.0000000	Y

				Santiago Pipe Pile	
0.0008749	1807.	2065011.	6.0000000	36.0000000	Y
0.0009101	1808.	1986787.	6.0000000	36.0000000	Y
0.0009453	1809.	1914118.	6.0000000	36.0000000	Y
0.0009804	1811.	1846663.	6.0000000	36.0000000	Y
0.0010156	1811.	1783627.	6.0000000	36.0000000	Y
0.0010508	1812.	1724771.	6.0000000	36.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	0.00000000	1812.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	212573.
2	14.0000	14.0000	Yes	No	212573.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 2700.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 0.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.1274	-9.71E-08	2700.	-0.00174	2.52E-09	6.72E+09	0.00	0.00	0.00
0.2000	0.1232	6480.	2698.	-0.00174	167.8822	6.72E+09	-1.2874	25.0822	0.00
0.4000	0.1190	12953.	2693.	-0.00173	335.5722	6.72E+09	-3.2911	66.3618	0.00
0.6000	0.1149	19406.	2682.	-0.00173	502.7711	6.72E+09	-5.9689	124.7130	0.00
0.8000	0.1107	25825.	2664.	-0.00172	669.0793	6.72E+09	-9.2012	199.4349	0.00
1.0000	0.1066	32192.	2637.	-0.00171	834.0144	6.72E+09	-13.1421	295.8544	0.00
1.2000	0.1025	38482.	2600.	-0.00170	996.9883	6.72E+09	-17.1727	402.0114	0.00
1.4000	0.09846	44674.	2554.	-0.00168	1157.	6.72E+09	-21.6751	528.3173	0.00
1.6000	0.09445	50741.	2496.	-0.00167	1315.	6.72E+09	-26.3272	669.0127	0.00
1.8000	0.09047	56656.	2427.	-0.00165	1468.	6.72E+09	-30.9694	821.5533	0.00
2.0000	0.08654	62393.	2347.	-0.00162	1616.	6.72E+09	-35.8629	994.5254	0.00
2.2000	0.08267	67923.	2256.	-0.00160	1760.	6.72E+09	-40.1916	1167.	0.00
2.4000	0.07886	73221.	2154.	-0.00158	1897.	6.72E+09	-44.4588	1353.	0.00
2.6000	0.07511	78264.	2043.	-0.00155	2028.	6.72E+09	-48.0047	1534.	0.00
2.8000	0.07142	83030.	1925.	-0.00152	2151.	6.72E+09	-50.5209	1698.	0.00
3.0000	0.06781	87505.	1802.	-0.00149	2267.	6.72E+09	-52.4600	1857.	0.00
3.2000	0.06427	91678.	1675.	-0.00146	2375.	6.72E+09	-52.8166	1972.	0.00
3.4000	0.06081	95547.	1549.	-0.00142	2475.	6.72E+09	-52.2863	2064.	0.00
3.6000	0.05743	99114.	1425.	-0.00139	2568.	6.72E+09	-50.8396	2124.	0.00
3.8000	0.05414	102389.	1306.	-0.00135	2653.	6.72E+09	-48.4774	2149.	0.00
4.0000	0.05093	105385.	1194.	-0.00132	2730.	6.72E+09	-45.2375	2132.	0.00
4.2000	0.04782	108119.	1082.	-0.00128	2801.	6.72E+09	-48.1019	2414.	0.00
4.4000	0.04480	110577.	962.9580	-0.00124	2865.	6.72E+09	-50.9487	2729.	0.00
4.6000	0.04187	112742.	837.2972	-0.00120	2921.	6.72E+09	-53.7686	3082.	0.00
4.8000	0.03904	114596.	704.9122	-0.00116	2969.	6.72E+09	-56.5523	3476.	0.00
5.0000	0.03631	116125.	565.9010	-0.00112	3009.	6.72E+09	-59.2904	3919.	0.00
5.2000	0.03368	117313.	421.1513	-0.00108	3039.	6.72E+09	-61.3343	4371.	0.00
5.4000	0.03115	118147.	271.6995	-0.00103	3061.	6.72E+09	-63.2088	4871.	0.00
5.6000	0.02872	118617.	117.9709	-9.91E-04	3073.	6.72E+09	-64.8984	5424.	0.00
5.8000	0.02639	118713.	-39.2437	-9.49E-04	3076.	6.72E+09	-66.1137	6013.	0.00
6.0000	0.02416	118428.	-193.7259	-9.07E-04	3068.	6.72E+09	-62.6215	6221.	0.00
6.2000	0.02203	117783.	-339.6913	-8.65E-04	3051.	6.72E+09	-59.0164	6428.	0.00
6.4000	0.02001	116798.	-476.8991	-8.23E-04	3026.	6.72E+09	-55.3234	6636.	0.00
6.6000	0.01809	115494.	-605.1666	-7.81E-04	2992.	6.72E+09	-51.5662	6843.	0.00
6.8000	0.01626	113893.	-724.3670	-7.40E-04	2951.	6.72E+09	-47.7675	7050.	0.00
7.0000	0.01453	112017.	-834.4265	-7.00E-04	2902.	6.72E+09	-43.9488	7258.	0.00
7.2000	0.01290	109888.	-935.3215	-6.60E-04	2847.	6.72E+09	-40.1304	7465.	0.00
7.4000	0.01136	107528.	-1027.	-6.21E-04	2786.	6.72E+09	-36.3314	7672.	0.00
7.6000	0.00992	104958.	-1110.	-5.83E-04	2719.	6.72E+09	-32.5696	7880.	0.00
7.8000	0.00857	102201.	-1183.	-5.46E-04	2648.	6.72E+09	-28.8614	8087.	0.00
8.0000	0.00730	99277.	-1248.	-5.10E-04	2572.	6.72E+09	-25.2220	8294.	0.00
8.2000	0.00612	96208.	-1305.	-4.75E-04	2493.	6.72E+09	-21.6653	8502.	0.00
8.4000	0.00502	93015.	-1352.	-4.42E-04	2410.	6.72E+09	-18.2037	8709.	0.00
8.6000	0.00400	89717.	-1392.	-4.09E-04	2324.	6.72E+09	-14.8485	8916.	0.00
8.8000	0.00305	86333.	-1424.	-3.77E-04	2237.	6.72E+09	-11.6096	9124.	0.00
9.0000	0.00219	82882.	-1448.	-3.47E-04	2147.	6.72E+09	-8.4956	9331.	0.00
9.2000	0.00139	79382.	-1465.	-3.18E-04	2057.	6.72E+09	-5.5141	9539.	0.00
9.4000	6.58E-04	75851.	-1475.	-2.90E-04	1965.	6.72E+09	-2.6711	9746.	0.00
9.6000	-6.78E-06	72304.	-1478.	-2.64E-04	1873.	6.72E+09	0.02812	9953.	0.00
9.8000	-6.09E-04	68757.	-1475.	-2.39E-04	1781.	6.72E+09	2.5797	10161.	0.00
10.0000	-0.00115	65225.	-1466.	-2.15E-04	1690.	6.72E+09	4.9806	10368.	0.00
10.2000	-0.00164	61722.	-1451.	-1.92E-04	1599.	6.72E+09	7.2289	10575.	0.00
10.4000	-0.00208	58261.	-1431.	-1.71E-04	1509.	6.72E+09	9.3237	10783.	0.00
10.6000	-0.00246	54853.	-1406.	-1.51E-04	1421.	6.72E+09	11.2648	10990.	0.00
10.8000	-0.00280	51510.	-1377.	-1.32E-04	1335.	6.72E+09	13.0529	11197.	0.00
11.0000	-0.00309	48242.	-1344.	-1.14E-04	1250.	6.72E+09	14.6895	11405.	0.00
11.2000	-0.00334	45059.	-1307.	-9.70E-05	1167.	6.72E+09	16.1765	11612.	0.00
11.4000	-0.00356	41969.	-1266.	-8.15E-05	1087.	6.72E+09	17.5169	11820.	0.00
11.6000	-0.00373	38980.	-1223.	-6.70E-05	1010.	6.72E+09	18.7137	12027.	0.00
11.8000	-0.00388	36099.	-1177.	-5.36E-05	935.2373	6.72E+09	19.7708	12234.	0.00

12.0000	-0.00399	33331.	-1128.	-4.12E-05	863.5407	6.72E+09	20.6923	12442.	0.00
12.2000	-0.00408	30683.	-1078.	-2.97E-05	794.9320	6.72E+09	21.4827	12649.	0.00
12.4000	-0.00413	28159.	-1025.	-1.92E-05	729.5290	6.72E+09	22.1467	12856.	0.00
12.6000	-0.00417	25762.	-971.4768	-9.59E-06	667.4310	6.72E+09	22.6893	13064.	0.00
12.8000	-0.00418	23496.	-916.5108	-7.90E-07	608.7189	6.72E+09	23.1157	13271.	0.00
13.0000	-0.00417	21363.	-860.6549	7.22E-06	553.4564	6.72E+09	23.4309	13478.	0.00
13.2000	-0.00415	19364.	-804.1694	1.45E-05	501.6904	6.72E+09	23.6403	13686.	0.00
13.4000	-0.00410	17503.	-747.3023	2.11E-05	453.4521	6.72E+09	23.7489	13893.	0.00
13.6000	-0.00404	15777.	-690.2893	2.70E-05	408.7580	6.72E+09	23.7619	14100.	0.00
13.8000	-0.00397	14189.	-633.3539	3.24E-05	367.6097	6.72E+09	23.6842	14308.	0.00
14.0000	-0.00389	12737.	-586.1164	3.72E-05	329.9959	6.72E+09	15.6804	9677.	0.00
14.2000	-0.00379	11376.	-548.6797	4.15E-05	294.7220	6.72E+09	15.5169	9815.	0.00
14.4000	-0.00369	10104.	-511.6969	4.53E-05	261.7636	6.72E+09	15.3021	9953.	0.00
14.6000	-0.00358	8920.	-475.2879	4.87E-05	231.0888	6.72E+09	15.0388	10092.	0.00
14.8000	-0.00346	7822.	-439.5656	5.17E-05	202.6582	6.72E+09	14.7298	10230.	0.00
15.0000	-0.00333	6810.	-404.6363	5.44E-05	176.4257	6.72E+09	14.3780	10368.	0.00
15.2000	-0.00319	5880.	-370.5997	5.66E-05	152.3388	6.72E+09	13.9859	10506.	0.00
15.4000	-0.00306	5031.	-337.5495	5.86E-05	130.3389	6.72E+09	13.5560	10644.	0.00
15.6000	-0.00291	4260.	-305.5733	6.02E-05	110.3621	6.72E+09	13.0908	10783.	0.00
15.8000	-0.00277	3564.	-274.7531	6.16E-05	92.3387	6.72E+09	12.5926	10921.	0.00
16.0000	-0.00262	2941.	-245.1659	6.28E-05	76.1946	6.72E+09	12.0634	11059.	0.00
16.2000	-0.00247	2387.	-216.8834	6.37E-05	61.8506	6.72E+09	11.5053	11197.	0.00
16.4000	-0.00231	1900.	-189.9732	6.45E-05	49.2235	6.72E+09	10.9199	11336.	0.00
16.6000	-0.00216	1475.	-164.4984	6.51E-05	38.2261	6.72E+09	10.3091	11474.	0.00
16.8000	-0.00200	1110.	-140.5186	6.56E-05	28.7670	6.72E+09	9.6741	11612.	0.00
17.0000	-0.00184	800.9799	-118.0898	6.59E-05	20.7516	6.72E+09	9.0165	11750.	0.00
17.2000	-0.00168	543.5317	-97.2654	6.62E-05	14.0817	6.72E+09	8.3372	11889.	0.00
17.4000	-0.00152	334.1061	-78.0958	6.63E-05	8.6559	6.72E+09	7.6374	12027.	0.00
17.6000	-0.00136	168.6718	-60.6296	6.64E-05	4.3699	6.72E+09	6.9178	12165.	0.00
17.8000	-0.00121	43.0839	-44.9134	6.64E-05	1.1162	6.72E+09	6.1791	12303.	0.00
18.0000	-0.00105	-46.9125	-30.9923	6.64E-05	1.2154	6.72E+09	5.4218	12442.	0.00
18.2000	-8.86E-04	-105.6793	-18.9105	6.64E-05	2.7379	6.72E+09	4.6464	12580.	0.00
18.4000	-7.27E-04	-137.6830	-8.7112	6.64E-05	3.5671	6.72E+09	3.8531	12718.	0.00
18.6000	-5.68E-04	-147.4929	-0.4370	6.63E-05	3.8212	6.72E+09	3.0420	12856.	0.00
18.8000	-4.09E-04	-139.7807	5.8694	6.63E-05	3.6214	6.72E+09	2.2134	12995.	0.00
19.0000	-2.50E-04	-119.3196	10.1659	6.62E-05	3.0913	6.72E+09	1.3670	13133.	0.00
19.2000	-9.09E-05	-90.9846	12.4097	6.62E-05	2.3572	6.72E+09	0.5029	13271.	0.00
19.4000	6.79E-05	-59.7530	12.5582	6.62E-05	1.5481	6.72E+09	-0.3791	13409.	0.00
19.6000	2.27E-04	-30.7051	10.5684	6.61E-05	0.7955	6.72E+09	-1.2791	13548.	0.00
19.8000	3.85E-04	-9.0246	6.3969	6.61E-05	0.2338	6.72E+09	-2.1972	13686.	0.00
20.0000	5.44E-04	0.00	0.00	6.61E-05	0.00	6.72E+09	-3.1336	6912.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

```
Pile-head deflection             =     0.12736262 inches
Computed slope at pile head      =    -0.00173862 radians
Maximum bending moment           =        118713. inch-lbs
Maximum shear force              =          2700. lbs
Depth of maximum bending moment  =     5.80000000 feet below pile head
Depth of maximum shear force     =       0.000000 feet below pile head
Number of iterations             =             11
Number of zero deflection points =              2
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	2700.	M, in-lb	0.00	0.00	0.1274	-0.00174	2700.	118713.

Maximum pile-head deflection = 0.1273626196 inches
Maximum pile-head rotation = -0.0017386201 radians = -0.099616 deg.

The analysis ended normally.

Completed by: SED
Checked by: DAC

Santiago Pipe Pile - Pushover 5D spacing

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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Files Used for Analysis

Path to file locations:
\\moonpa1cl1.bkr.mbakercorp.com\HRH_Projects\Geotech\Proposals\Puerto Rico\Analysis\Bearing Capacity\HQ5 Deep Foundation\LPILE\

Name of input data file:
Santiago Pipe Pile - Pushover.lp11d

Name of output report file:
Santiago Pipe Pile - Pushover.lp11o

Name of plot output file:
Santiago Pipe Pile - Pushover.lp11p

Name of runtime message file:
Santiago Pipe Pile - Pushover.lp11r

Date and Time of Analysis

Date: August 10, 2020 Time: 13:16:48

Problem Title

Project Name: Camp Santiago

Job Number: 177050

Client: USACE

Engineer: SED

Description: HQ5 Pushover Analysis - 12in Pipe Pile

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Cyclic loading specified
 - Number of cycles of loading = 5000 cycles
 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Input of side resistance moment along pile not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Compute push-over analysis of pile for specified deflections
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 20.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	12.0000
2	20.000	12.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a steel pipe pile		
Length of section	=	20.000000 ft
Pile diameter	=	12.000000 in
Shear capacity of section	=	0.0000 lbs

Control Data for Pushover Analysis

Pile-head fixity condition	=	free and fixed head
Number of pushover points to generate	=	10
Pushover point distribution method	=	arithmetic
Minimum pushover pile-head deflection	=	0.0001000 in
Maximum pushover pile-head deflection	=	0.750000 in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	14.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	90.000000 pci
Subgrade k at bottom of layer	=	90.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	14.000000 ft
Distance from top of pile to bottom of layer	=	40.000000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Friction angle at top of layer	=	30.000000 deg.

Friction angle at bottom of layer = 30.000000 deg.
Subgrade k at top of layer = 60.000000 pci
Subgrade k at bottom of layer = 60.000000 pci

(Depth of the lowest soil layer extends 20.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00 14.0000	120.0000 120.0000	30.0000 30.0000	90.0000 90.0000
2	Sand (Reese, et al.)	14.0000 40.0000	62.6000 62.6000	30.0000 30.0000	60.0000 60.0000

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	1.0000	1.0000
2	20.000	1.0000	1.0000

Cyclic Loading Type

Cyclic loading criteria were used for computation of p-y curves for all analyses.

Number of cycles of loading = 5000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	42000.	No	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).

Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel Pipe Pile:

Length of Section	=	20.000000 ft
Outer Diameter of Pipe	=	12.000000 in
Pipe Wall Thickness	=	0.375000 in
Yield Stress of Pipe	=	36.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	13.695380 sq. in.
Moment of Inertia	=	231.591024 in^4
Elastic Bending Stiffness	=	6716140. kip-in^2
Plastic Modulus, Z	=	50.695312in^3
Plastic Moment Capacity = Fy Z	=	1825.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	493.034 kips
Nominal Axial Tensile Capacity	=	-493.034 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	42.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 42.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000418	28.0481842	6716132.	31.3216298	3.7861268	
0.00000835	56.0963684	6716132.	18.6608149	4.5055260	
0.00001253	84.1445527	6716132.	14.4405433	5.2249253	
0.00001670	112.1927369	6716132.	12.3304074	5.9443245	
0.00002088	140.2409211	6716132.	11.0643260	6.6637238	
0.00002506	168.2891053	6716132.	10.2202716	7.3831231	
0.00002923	196.3372895	6716132.	9.6173757	8.1025223	
0.00003341	224.3854737	6716132.	9.1652037	8.8219216	
0.00003759	252.4336580	6716132.	8.8135144	9.5413208	

0.00004176	280.4818422	6716132.	8.5321630	10.2607201	
0.00004594	308.5300264	6716132.	8.3019663	10.9801193	
0.00005011	336.5782106	6716132.	8.1101358	11.6995186	
0.00005429	364.6263948	6716132.	7.9478177	12.4189179	
0.00005847	392.6745791	6716132.	7.8086878	13.1383171	
0.00006264	420.7227633	6716132.	7.6881087	13.8577164	
0.00006682	448.7709475	6716132.	7.5826019	14.5771156	
0.00007100	476.8191317	6716132.	7.4895076	15.2965149	
0.00007517	504.8673159	6716132.	7.4067572	16.0159142	
0.00007935	532.9155001	6716132.	7.3327174	16.7353134	
0.00008352	560.9636844	6716132.	7.2660815	17.4547127	
0.00008770	589.0118686	6716132.	7.2057919	18.1741119	
0.00009188	617.0600528	6716132.	7.1509832	18.8935112	
0.00009605	645.1082370	6716132.	7.1009404	19.6129105	
0.0001002	673.1564212	6716132.	7.0550679	20.3323097	
0.0001044	701.2046055	6716132.	7.0128652	21.0517090	
0.0001086	729.2527897	6716132.	6.9739088	21.7711082	
0.0001128	757.3009739	6716132.	6.9378381	22.4905075	
0.0001169	785.3491581	6716132.	6.9043439	23.2099068	
0.0001211	813.3973423	6716132.	6.8731596	23.9293060	
0.0001253	841.4455266	6716132.	6.8440543	24.6487053	
0.0001295	869.4937108	6716132.	6.8168268	25.3681045	
0.0001336	897.5418950	6716132.	6.7913009	26.0875038	
0.0001378	925.5900792	6716132.	6.7673221	26.8069031	
0.0001420	953.6382634	6716132.	6.7447538	27.5263023	
0.0001462	981.6864476	6716132.	6.7234751	28.2457016	
0.0001503	1010.	6716132.	6.7033786	28.9651008	
0.0001545	1038.	6716132.	6.6843684	29.6845001	
0.0001587	1066.	6716132.	6.6663587	30.4038993	
0.0001629	1094.	6716132.	6.6492726	31.1232986	
0.0001712	1150.	6716132.	6.6176007	32.5620971	
0.0001796	1206.	6716132.	6.5888751	34.0008956	
0.0001879	1262.	6716132.	6.5627029	35.4396942	
0.0001963	1317.	6708735.	6.5419128	36.0000000	Y
0.0002046	1365.	6669762.	6.5368829	36.0000000	Y
0.0002130	1407.	6603988.	6.5457480	36.0000000	Y
0.0002213	1444.	6524370.	6.5628079	36.0000000	Y
0.0002297	1478.	6436408.	6.5855531	36.0000000	Y
0.0002380	1509.	6340542.	6.6103692	36.0000000	Y
0.0002464	1536.	6232418.	6.6313566	36.0000000	Y
0.0002548	1558.	6114882.	6.6471067	36.0000000	Y
0.0002631	1577.	5992876.	6.6594024	36.0000000	Y
0.0002715	1593.	5869874.	6.6693945	36.0000000	Y
0.0002798	1608.	5747039.	6.6780889	36.0000000	Y
0.0002882	1621.	5625829.	6.6855147	36.0000000	Y
0.0002965	1633.	5506944.	6.6919190	36.0000000	Y
0.0003049	1643.	5390823.	6.6975228	36.0000000	Y
0.0003132	1653.	5277768.	6.7024944	36.0000000	Y
0.0003216	1662.	5167978.	6.7069657	36.0000000	Y
0.0003299	1670.	5061579.	6.7110426	36.0000000	Y
0.0003383	1677.	4958402.	6.7149638	36.0000000	Y
0.0003466	1684.	4858187.	6.7182064	36.0000000	Y
0.0003550	1690.	4761433.	6.7212772	36.0000000	Y
0.0003633	1696.	4668104.	6.7242083	36.0000000	Y
0.0003717	1701.	4577316.	6.7266345	36.0000000	Y
0.0003800	1706.	4489803.	6.7291642	36.0000000	Y
0.0003884	1711.	4405224.	6.7311339	36.0000000	Y
0.0003967	1715.	4323187.	6.7333696	36.0000000	Y
0.0004051	1719.	4244106.	6.7351848	36.0000000	Y
0.0004134	1723.	4167327.	6.7370170	36.0000000	Y
0.0004218	1727.	4093263.	6.7386273	36.0000000	Y
0.0004302	1730.	4021376.	6.7402464	36.0000000	Y
0.0004385	1733.	3951941.	6.7414982	36.0000000	Y
0.0004469	1736.	3884572.	6.7431740	36.0000000	Y
0.0004552	1739.	3819392.	6.7439752	36.0000000	Y

0.0004636	1741.	3756193.	6.7457985	36.0000000	Y
0.0004719	1744.	3694851.	6.7465017	36.0000000	Y
0.0004803	1746.	3635446.	6.7476068	36.0000000	Y
0.0004886	1748.	3577817.	6.7489343	36.0000000	Y
0.0004970	1750.	3521875.	6.7493510	36.0000000	Y
0.0005304	1758.	3313818.	6.7529390	36.0000000	Y
0.0005638	1764.	3128137.	6.7558705	36.0000000	Y
0.0005972	1769.	2961526.	6.7581385	36.0000000	Y
0.0006306	1773.	2811286.	6.7598962	36.0000000	Y
0.0006640	1776.	2675222.	6.7612615	36.0000000	Y
0.0006974	1780.	2551522.	6.7623256	36.0000000	Y
0.0007308	1782.	2438506.	6.7642991	36.0000000	Y
0.0007643	1784.	2334851.	6.7648513	36.0000000	Y
0.0007977	1786.	2239646.	6.7656892	36.0000000	Y
0.0008311	1788.	2151678.	6.7666101	36.0000000	Y
0.0008645	1790.	2070401.	6.7671301	36.0000000	Y
0.0008979	1791.	1994850.	6.7678233	36.0000000	Y
0.0009313	1792.	1924688.	6.7688195	36.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	42.0000000000	1792.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	212573.
2	14.0000	14.0000	Yes	No	212573.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 42000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	0.00	0.00
0.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	518.4000	0.00
0.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	1037.	0.00
0.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	1555.	0.00
0.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	2074.	0.00
1.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	2592.	0.00
1.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	3110.	0.00
1.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	3629.	0.00
1.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	4147.	0.00
1.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	4666.	0.00
2.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	5184.	0.00
2.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	5702.	0.00
2.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	6221.	0.00
2.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	6739.	0.00
2.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	7258.	0.00
3.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	7776.	0.00
3.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	8294.	0.00
3.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	8813.	0.00
3.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	9331.	0.00
3.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	9850.	0.00
4.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	10368.	0.00
4.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	10886.	0.00
4.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	11405.	0.00
4.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	11923.	0.00
4.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	12442.	0.00
5.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	12960.	0.00
5.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	13478.	0.00
5.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	13997.	0.00
5.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	14515.	0.00
5.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	15034.	0.00
6.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	15552.	0.00
6.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	16070.	0.00
6.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	16589.	0.00
6.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17107.	0.00
6.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17626.	0.00
7.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	18144.	0.00
7.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	18662.	0.00
7.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	19181.	0.00
7.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	19699.	0.00
7.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	20218.	0.00
8.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	20736.	0.00
8.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	21254.	0.00
8.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	21773.	0.00
8.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	22291.	0.00
8.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	22810.	0.00
9.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	23328.	0.00
9.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	23846.	0.00
9.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24365.	0.00

9.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24883.	0.00
9.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25402.	0.00
10.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25920.	0.00
10.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26438.	0.00
10.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26957.	0.00
10.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27475.	0.00
10.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27994.	0.00
11.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28512.	0.00
11.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29030.	0.00
11.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29549.	0.00
11.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30067.	0.00
11.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30586.	0.00
12.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31104.	0.00
12.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31622.	0.00
12.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32141.	0.00
12.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32659.	0.00
12.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33178.	0.00
13.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33696.	0.00
13.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34214.	0.00
13.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34733.	0.00
13.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	35251.	0.00
13.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	35770.	0.00
14.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24192.	0.00
14.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24538.	0.00
14.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24883.	0.00
14.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25229.	0.00
14.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25574.	0.00
15.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25920.	0.00
15.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26266.	0.00
15.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26611.	0.00
15.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26957.	0.00
15.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27302.	0.00
16.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27648.	0.00
16.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27994.	0.00
16.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28339.	0.00
16.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28685.	0.00
16.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29030.	0.00
17.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29376.	0.00
17.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29722.	0.00
17.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30067.	0.00
17.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30413.	0.00
17.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30758.	0.00
18.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31104.	0.00
18.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31450.	0.00
18.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31795.	0.00
18.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32141.	0.00
18.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32486.	0.00
19.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32832.	0.00
19.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33178.	0.00
19.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33523.	0.00
19.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33869.	0.00
19.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34214.	0.00
20.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17280.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.000000 inches

```
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =       0.000000 inch-lbs
Maximum shear force              =       0.000000 lbs
Depth of maximum bending moment  =       0.000000 feet below pile head
Depth of maximum shear force     =       0.000000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              0
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	42000.	0.00	0.00	0.00	0.00

Maximum pile-head deflection = 0.0000000000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

Results of Push-over Analysis

Computation Methods Used for Push-over Analyses:
- Computations use both pinned-head and fixed-head conditions
- Computations use an arithmetic distribution of pile-head deflections

```
Number of push-over steps                          =          10
Minimum pushover deflection                        =   0.0001000 in
Maximum pushover deflection                        =    0.750000 in
Axial thrust force for pushover analysis           =      42000. lbs
```

Pushover Point Number	Pile-head Fixity Condition	Pile-head Deflection inches	Pile-head Shear lbs	Max Moment in Pile in-lb(abs)	Max Shear in Pile lbs (abs)	Depth to Max Moment feet	Depth to Max Shear feet
1	Pin-head	1.00E-04	5.1601	151.7378	5.1601	4.2000	0.00
2	Pin-head	0.08342	3527.	120189.	3527.	4.4000	0.00
3	Pin-head	0.1667	5455.	213741.	5455.	5.0000	0.00
4	Pin-head	0.2501	7088.	299868.	7088.	5.4000	0.00
5	Pin-head	0.3334	8564.	381296.	8564.	5.6000	0.00
6	Pin-head	0.4167	9943.	459065.	9943.	5.8000	0.00
7	Pin-head	0.5000	11260.	534703.	11260.	5.8000	0.00
8	Pin-head	0.5834	12520.	607926.	12520.	6.0000	0.00
9	Pin-head	0.6667	13721.	679741.	13721.	6.0000	0.00
10	Pin-head	0.7500	14868.	749803.	14868.	6.0000	0.00
11	Fixed-head	1.00E-04	13.6380	475.3560	13.6380	0.00	0.00
12	Fixed-head	0.08342	8618.	343620.	8618.	0.00	0.00
13	Fixed-head	0.1667	13838.	605287.	13838.	0.00	0.00
14	Fixed-head	0.2501	18317.	842865.	18317.	0.00	0.00
15	Fixed-head	0.3334	22413.	1066588.	22413.	0.00	0.00

16	Fixed-head	0.4167	26298.	1281813.	26298.	0.00	0.00
17	Fixed-head	0.5000	29942.	1483853.	29942.	0.00	0.00
18	Fixed-head	0.5834	32964.	1645506.	32964.	0.00	0.00
19	Fixed-head	0.6667	35062.	1738879.	35062.	0.00	0.00
20	Fixed-head	0.7500	36433.	1777532.	36433.	0.00	0.00

The analysis ended normally.

Santiago Pipe Pile - Pushover

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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Files Used for Analysis

Path to file locations:
\Geotech\Proposals\Puerto Rico\Analysis\Bearing Capacity\HQ5 Deep Foundation\LPILE\

Name of input data file:
Santiago Pipe Pile - Pushover.lp11d

Name of output report file:
Santiago Pipe Pile - Pushover.lp11o

Name of plot output file:
Santiago Pipe Pile - Pushover.lp11p

Name of runtime message file:
Santiago Pipe Pile - Pushover.lp11r

Date and Time of Analysis

Date: September 9, 2020 Time: 21:56:44

Problem Title

Project Name: Camp Santiago

Job Number: 177050

Client: USACE

Engineer: SED

Description: HQ5 Pushover Analysis - 12in Pipe Pile

Program Options and Settings

Computational Options:
 - Conventional Analysis
Engineering Units Used for Data Input and Computations:
 - US Customary System Units (pounds, feet, inches)

Analysis Control Options:
 - Maximum number of iterations allowed = 500
 - Deflection tolerance for convergence = 1.0000E-05 in
 - Maximum allowable deflection = 100.0000 in
 - Number of pile increments = 100

Loading Type and Number of Cycles of Loading:
 - Cyclic loading specified
 - Number of cycles of loading = 5000 cycles
 - Analysis uses p-y modification factors for p-y curves
 - Analysis uses layering correction (Method of Georgiadis)
 - No distributed lateral loads are entered
 - Loading by lateral soil movements acting on pile not selected
 - Input of shear resistance at the pile tip not selected
 - Input of moment resistance at the pile tip not selected
 - Input of side resistance moment along pile not selected
 - Computation of pile-head foundation stiffness matrix not selected
 - Compute push-over analysis of pile for specified deflections
 - Buckling analysis of pile not selected

Output Options:
 - Output files use decimal points to denote decimal symbols.
 - Values of pile-head deflection, bending moment, shear force, and
   soil reaction are printed for full length of pile.
 - Printing Increment (nodal spacing of output points) = 1
 - No p-y curves to be computed and reported for user-specified depths
 - Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 20.000 ft
Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over
the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	12.0000
2	20.000	12.0000

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a steel pipe pile		
Length of section	=	20.000000 ft
Pile diameter	=	12.000000 in
Shear capacity of section	=	0.0000 lbs

Control Data for Pushover Analysis

Pile-head fixity condition	=	free and fixed head
Number of pushover points to generate	=	10
Pushover point distribution method	=	arithmetic
Minimum pushover pile-head deflection	=	0.0001000 in
Maximum pushover pile-head deflection	=	0.750000 in

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 ft
Distance from top of pile to bottom of layer	=	14.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	90.000000 pci
Subgrade k at bottom of layer	=	90.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	14.000000 ft
Distance from top of pile to bottom of layer	=	40.000000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Friction angle at top of layer	=	30.000000 deg.

Friction angle at bottom of layer = 30.000000 deg.
Subgrade k at top of layer = 60.000000 pci
Subgrade k at bottom of layer = 60.000000 pci

(Depth of the lowest soil layer extends 20.000 ft below the pile tip)

Summary of Input Soil Properties

Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00 14.0000	120.0000 120.0000	30.0000 30.0000	90.0000 90.0000
2	Sand (Reese, et al.)	14.0000 40.0000	62.6000 62.6000	30.0000 30.0000	60.0000 60.0000

---

p-y Modification Factors for Group Action

Distribution of p-y modifiers with depth defined using 2 points

Point No.	Depth X ft	p-mult	y-mult
1	0.000	0.4000	1.0000
2	20.000	0.4000	1.0000

Cyclic Loading Type

Cyclic loading criteria were used for computation of p-y curves for all analyses.

Number of cycles of loading = 5000

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 1

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length	Run Analysis
1	1	V = 0.0000 lbs	M = 0.0000 in-lbs	42000.	No	Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).

Thrust force is assumed to be acting axially for all pile batter angles.

Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness

---

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

Dimensions and Properties of Steel Pipe Pile:

Length of Section	=	20.000000 ft
Outer Diameter of Pipe	=	12.000000 in
Pipe Wall Thickness	=	0.375000 in
Yield Stress of Pipe	=	36.000000 ksi
Elastic Modulus	=	29000. ksi
Cross-sectional Area	=	13.695380 sq. in.
Moment of Inertia	=	231.591024 in^4
Elastic Bending Stiffness	=	6716140. kip-in^2
Plastic Modulus, Z	=	50.695312in^3
Plastic Moment Capacity = Fy Z	=	1825.in-kip

Axial Structural Capacities:

Nom. Axial Structural Capacity = Fy As	=	493.034 kips
Nominal Axial Tensile Capacity	=	-493.034 kips

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kips
1	42.000

Definition of Run Messages:

Y = part of pipe section has yielded.

Axial Thrust Force = 42.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Total Stress ksi	Run Msg
0.00000418	28.0481842	6716132.	31.3216298	3.7861268	
0.00000835	56.0963684	6716132.	18.6608149	4.5055260	
0.00001253	84.1445527	6716132.	14.4405433	5.2249253	
0.00001670	112.1927369	6716132.	12.3304074	5.9443245	
0.00002088	140.2409211	6716132.	11.0643260	6.6637238	
0.00002506	168.2891053	6716132.	10.2202716	7.3831231	
0.00002923	196.3372895	6716132.	9.6173757	8.1025223	
0.00003341	224.3854737	6716132.	9.1652037	8.8219216	
0.00003759	252.4336580	6716132.	8.8135144	9.5413208	

0.00004176	280.4818422	6716132.	8.5321630	10.2607201	
0.00004594	308.5300264	6716132.	8.3019663	10.9801193	
0.00005011	336.5782106	6716132.	8.1101358	11.6995186	
0.00005429	364.6263948	6716132.	7.9478177	12.4189179	
0.00005847	392.6745791	6716132.	7.8086878	13.1383171	
0.00006264	420.7227633	6716132.	7.6881087	13.8577164	
0.00006682	448.7709475	6716132.	7.5826019	14.5771156	
0.00007100	476.8191317	6716132.	7.4895076	15.2965149	
0.00007517	504.8673159	6716132.	7.4067572	16.0159142	
0.00007935	532.9155001	6716132.	7.3327174	16.7353134	
0.00008352	560.9636844	6716132.	7.2660815	17.4547127	
0.00008770	589.0118686	6716132.	7.2057919	18.1741119	
0.00009188	617.0600528	6716132.	7.1509832	18.8935112	
0.00009605	645.1082370	6716132.	7.1009404	19.6129105	
0.0001002	673.1564212	6716132.	7.0550679	20.3323097	
0.0001044	701.2046055	6716132.	7.0128652	21.0517090	
0.0001086	729.2527897	6716132.	6.9739088	21.7711082	
0.0001128	757.3009739	6716132.	6.9378381	22.4905075	
0.0001169	785.3491581	6716132.	6.9043439	23.2099068	
0.0001211	813.3973423	6716132.	6.8731596	23.9293060	
0.0001253	841.4455266	6716132.	6.8440543	24.6487053	
0.0001295	869.4937108	6716132.	6.8168268	25.3681045	
0.0001336	897.5418950	6716132.	6.7913009	26.0875038	
0.0001378	925.5900792	6716132.	6.7673221	26.8069031	
0.0001420	953.6382634	6716132.	6.7447538	27.5263023	
0.0001462	981.6864476	6716132.	6.7234751	28.2457016	
0.0001503	1010.	6716132.	6.7033786	28.9651008	
0.0001545	1038.	6716132.	6.6843684	29.6845001	
0.0001587	1066.	6716132.	6.6663587	30.4038993	
0.0001629	1094.	6716132.	6.6492726	31.1232986	
0.0001712	1150.	6716132.	6.6176007	32.5620971	
0.0001796	1206.	6716132.	6.5888751	34.0008956	
0.0001879	1262.	6716132.	6.5627029	35.4396942	
0.0001963	1317.	6708735.	6.5419128	36.0000000	Y
0.0002046	1365.	6669762.	6.5368829	36.0000000	Y
0.0002130	1407.	6603988.	6.5457480	36.0000000	Y
0.0002213	1444.	6524370.	6.5628079	36.0000000	Y
0.0002297	1478.	6436408.	6.5855531	36.0000000	Y
0.0002380	1509.	6340542.	6.6103692	36.0000000	Y
0.0002464	1536.	6232418.	6.6313566	36.0000000	Y
0.0002548	1558.	6114882.	6.6471067	36.0000000	Y
0.0002631	1577.	5992876.	6.6594024	36.0000000	Y
0.0002715	1593.	5869874.	6.6693945	36.0000000	Y
0.0002798	1608.	5747039.	6.6780889	36.0000000	Y
0.0002882	1621.	5625829.	6.6855147	36.0000000	Y
0.0002965	1633.	5506944.	6.6919190	36.0000000	Y
0.0003049	1643.	5390823.	6.6975228	36.0000000	Y
0.0003132	1653.	5277768.	6.7024944	36.0000000	Y
0.0003216	1662.	5167978.	6.7069657	36.0000000	Y
0.0003299	1670.	5061579.	6.7110426	36.0000000	Y
0.0003383	1677.	4958402.	6.7149638	36.0000000	Y
0.0003466	1684.	4858187.	6.7182064	36.0000000	Y
0.0003550	1690.	4761433.	6.7212772	36.0000000	Y
0.0003633	1696.	4668104.	6.7242083	36.0000000	Y
0.0003717	1701.	4577316.	6.7266345	36.0000000	Y
0.0003800	1706.	4489803.	6.7291642	36.0000000	Y
0.0003884	1711.	4405224.	6.7311339	36.0000000	Y
0.0003967	1715.	4323187.	6.7333696	36.0000000	Y
0.0004051	1719.	4244106.	6.7351848	36.0000000	Y
0.0004134	1723.	4167327.	6.7370170	36.0000000	Y
0.0004218	1727.	4093263.	6.7386273	36.0000000	Y
0.0004302	1730.	4021376.	6.7402464	36.0000000	Y
0.0004385	1733.	3951941.	6.7414982	36.0000000	Y
0.0004469	1736.	3884572.	6.7431740	36.0000000	Y
0.0004552	1739.	3819392.	6.7439752	36.0000000	Y

0.0004636	1741.	3756193.	6.7457985	36.0000000	Y
0.0004719	1744.	3694851.	6.7465017	36.0000000	Y
0.0004803	1746.	3635446.	6.7476068	36.0000000	Y
0.0004886	1748.	3577817.	6.7489343	36.0000000	Y
0.0004970	1750.	3521875.	6.7493510	36.0000000	Y
0.0005304	1758.	3313818.	6.7529390	36.0000000	Y
0.0005638	1764.	3128137.	6.7558705	36.0000000	Y
0.0005972	1769.	2961526.	6.7581385	36.0000000	Y
0.0006306	1773.	2811286.	6.7598962	36.0000000	Y
0.0006640	1776.	2675222.	6.7612615	36.0000000	Y
0.0006974	1780.	2551522.	6.7623256	36.0000000	Y
0.0007308	1782.	2438506.	6.7642991	36.0000000	Y
0.0007643	1784.	2334851.	6.7648513	36.0000000	Y
0.0007977	1786.	2239646.	6.7656892	36.0000000	Y
0.0008311	1788.	2151678.	6.7666101	36.0000000	Y
0.0008645	1790.	2070401.	6.7671301	36.0000000	Y
0.0008979	1791.	1994850.	6.7678233	36.0000000	Y
0.0009313	1792.	1924688.	6.7688195	36.0000000	Y

Summary of Results for Nominal Moment Capacity for Section 1

Load No.	Axial Thrust kips	Nominal Moment Capacity in-kips
1	42.0000000000	1792.

Note that the values in the above table are not factored by a strength reduction factor for LRFD.

The value of the strength reduction factor depends on the provisions of the LRFD code being followed.

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to the LRFD structural design standard being followed.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N.A.	No	0.00	212573.
2	14.0000	14.0000	Yes	No	212573.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs
Applied moment at pile head = 0.0 in-lbs
Axial thrust load on pile head = 42000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi*	Bending Stiffness lb-in^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	0.00	0.00
0.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	518.4000	0.00
0.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	1037.	0.00
0.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	1555.	0.00
0.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	2074.	0.00
1.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	2592.	0.00
1.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	3110.	0.00
1.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	3629.	0.00
1.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	4147.	0.00
1.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	4666.	0.00
2.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	5184.	0.00
2.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	5702.	0.00
2.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	6221.	0.00
2.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	6739.	0.00
2.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	7258.	0.00
3.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	7776.	0.00
3.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	8294.	0.00
3.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	8813.	0.00
3.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	9331.	0.00
3.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	9850.	0.00
4.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	10368.	0.00
4.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	10886.	0.00
4.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	11405.	0.00
4.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	11923.	0.00
4.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	12442.	0.00
5.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	12960.	0.00
5.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	13478.	0.00
5.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	13997.	0.00
5.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	14515.	0.00
5.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	15034.	0.00
6.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	15552.	0.00
6.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	16070.	0.00
6.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	16589.	0.00
6.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17107.	0.00
6.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17626.	0.00
7.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	18144.	0.00
7.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	18662.	0.00
7.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	19181.	0.00
7.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	19699.	0.00
7.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	20218.	0.00
8.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	20736.	0.00
8.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	21254.	0.00
8.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	21773.	0.00
8.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	22291.	0.00
8.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	22810.	0.00
9.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	23328.	0.00
9.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	23846.	0.00
9.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24365.	0.00

9.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24883.	0.00
9.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25402.	0.00
10.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25920.	0.00
10.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26438.	0.00
10.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26957.	0.00
10.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27475.	0.00
10.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27994.	0.00
11.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28512.	0.00
11.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29030.	0.00
11.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29549.	0.00
11.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30067.	0.00
11.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30586.	0.00
12.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31104.	0.00
12.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31622.	0.00
12.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32141.	0.00
12.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32659.	0.00
12.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33178.	0.00
13.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33696.	0.00
13.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34214.	0.00
13.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34733.	0.00
13.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	35251.	0.00
13.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	35770.	0.00
14.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24192.	0.00
14.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24538.	0.00
14.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	24883.	0.00
14.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25229.	0.00
14.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25574.	0.00
15.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	25920.	0.00
15.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26266.	0.00
15.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26611.	0.00
15.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	26957.	0.00
15.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27302.	0.00
16.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27648.	0.00
16.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	27994.	0.00
16.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28339.	0.00
16.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	28685.	0.00
16.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29030.	0.00
17.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29376.	0.00
17.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	29722.	0.00
17.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30067.	0.00
17.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30413.	0.00
17.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	30758.	0.00
18.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31104.	0.00
18.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31450.	0.00
18.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	31795.	0.00
18.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32141.	0.00
18.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32486.	0.00
19.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	32832.	0.00
19.2000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33178.	0.00
19.4000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33523.	0.00
19.6000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	33869.	0.00
19.8000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	34214.	0.00
20.0000	0.00	0.00	0.00	0.00	3067.	6.72E+09	0.00	17280.	0.00

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection = 0.000000 inches

```
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =       0.000000 inch-lbs
Maximum shear force              =       0.000000 lbs
Depth of maximum bending moment  =       0.000000 feet below pile head
Depth of maximum shear force     =       0.000000 feet below pile head
Number of iterations             =              6
Number of zero deflection points =              0
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

Load Case No.	Load Type	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	0.00	42000.	0.00	0.00	0.00	0.00

Maximum pile-head deflection = 0.0000000000 inches
Maximum pile-head rotation = 0.0000000000 radians = 0.000000 deg.

Results of Push-over Analysis

Computation Methods Used for Push-over Analyses:
- Computations use both pinned-head and fixed-head conditions
- Computations use an arithmetic distribution of pile-head deflections

```
Number of push-over steps                          =          10
Minimum pushover deflection                        =   0.0001000 in
Maximum pushover deflection                        =    0.750000 in
Axial thrust force for pushover analysis           =      42000. lbs
```

Pushover Point Number	Pile-head Fixity Condition	Pile-head Deflection inches	Pile-head Shear lbs	Max Moment in Pile in-lb(abs)	Max Shear in Pile lbs (abs)	Depth to Max Moment feet	Depth to Max Shear feet
1	Pin-head	1.00E-04	2.9588	105.0066	2.9588	5.0000	0.00
2	Pin-head	0.08342	1998.	82475.	1998.	5.4000	0.00
3	Pin-head	0.1667	3171.	150652.	3171.	6.0000	0.00
4	Pin-head	0.2501	4173.	213313.	4173.	6.4000	0.00
5	Pin-head	0.3334	5082.	272640.	5082.	6.6000	0.00
6	Pin-head	0.4167	5934.	329416.	5934.	6.8000	0.00
7	Pin-head	0.5000	6748.	384458.	6748.	6.8000	0.00
8	Pin-head	0.5834	7529.	437988.	7529.	7.0000	0.00
9	Pin-head	0.6667	8274.	490268.	8274.	7.0000	0.00
10	Pin-head	0.7500	8987.	541469.	8987.	7.2000	0.00
11	Fixed-head	1.00E-04	7.8495	329.4166	7.8495	0.00	0.00
12	Fixed-head	0.08342	5034.	240737.	5034.	0.00	0.00
13	Fixed-head	0.1667	8271.	431025.	8271.	0.00	0.00
14	Fixed-head	0.2501	11061.	604346.	11061.	0.00	0.00
15	Fixed-head	0.3334	13618.	767800.	13618.	0.00	0.00

16	Fixed-head	0.4167	16045.	925147.	16045.	0.00	0.00
17	Fixed-head	0.5000	18377.	1078145.	18377.	0.00	0.00
18	Fixed-head	0.5834	20572.	1226567.	20572.	0.00	0.00
19	Fixed-head	0.6667	22600.	1368433.	22600.	0.00	0.00
20	Fixed-head	0.7500	24420.	1498626.	24420.	0.00	0.00

The analysis ended normally.

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ATTACHMENT 9
Liquefaction Analysis

SO No. 177050
Subject : USACE Camp Santiago
Liquefaction Analysis Summary

Michael Baker INTERNATIONAL

Computed By: SED Checked By: DAC Date: 8/5/20

Problem Statement:

Present results from the liquefaction analysis for Camp Santiago. See individual liquefaction analyses for details on the calculated values.

Summary Table:

Area	Boring	Structure Type	Maximum Design Earthquake (M_w=7.7)			Estimated Mean Design Earthquake (M_w=6.5)		
			Liquifiable Layer (ft-bgs)		Liquefaction Induced Settlement (in)	Liquifiable Layer (ft-bgs)		Liquefaction Induced Settlement (in)
			Top	Bottom		Top	Bottom	
NW Corner (GWT=16ft)	448B1	HQ5	--	--	0.0	--	--	0.0
	442B1	HQ	--	--	0.0	--	--	0.0
	444B1	HQ	13.5	19.5	1.3	13.5	19.5	1.3
	446B1	HQ	--	--	0.0	--	--	0.0
	440B1	HQ	--	--	0.0	--	--	0.0
Central Area (GWT=11.5ft)	452B1	Barracks	--	--	0.0	--	--	0.0
	452B3	Barracks	--	--	0.0	--	--	0.0
	454B3	Barracks	13.5	16.5	0.5	--	--	0.0
	458B3	Barracks	10.5	13.5	0.4	--	--	0.0
	302B1	DFAC	13.5	19.5	1.1	16.5	19.5	0.6
	306B1	HQ	--	--	0.0	--	--	0.0
SE Corner (GWT=13ft)	330B1	HQ	--	--	0.0	--	--	0.0

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Seismic Site Class Calculation

Camp Santiago Facility Restoration

MBAKERINTL.COM

SO No. 177050
Subject : USACE Camp Santiago
Site Class Determination

Michael Baker INTERNATIONAL

Computed By: SED Checked By: GZ Date: 8/6/20

Problem Statement:

Determine the seismic site classification of theUSACE Camp Santiago based on blow counts at boring 444B1.

Reference:

AASHTO LRFD 2014 Bridge Design Specifications 7th Edition, 2014 Table 3.10.3.1-1

Terms:

N: Uncorrect SPT Blow Counts
S_u: Undrainded Shear Strength in ksf
v_s: Shear Wave Velocity in ft/sec

Calculation:

Use **N** SPT Blow Counts to compute the average of the upper 100 ft of soil profile
If the soil requiring site-specific evaluation, such as **No**

* Soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils, quick and highly sensitive clays, and collapsible weakly cemented soils.
* Peats or highly organic clays (H>10 ft of peat or highly organic clay where H=thickness of soil)
* Very high plasticity clays (H>25 ft with PI>25)
* Very thick soft/medium stiff clays (H>120 ft)

If the soil profile with more than 10 ft of soft clay defined as soil with PI>20, w>40%, and S_u<0.5 ksf **No**

The average N at upper **100.0** ft is **17** bpf
Seismic Site Classification: **D**

Calculation:

Boring	Sample Number	Depth D (ft)	Ni (bpf)	di/Ni	Σ(di/Ni)	Weight Average N (bpf)
		(1)	(2)	(3)	(4)	(5)
444B1	S-1	1.5	21	0.071	0.0714	21
	S-2	3.5	12	0.167	0.2381	15
	S-3	5.5	11	0.182	0.4199	13
	S-4	7.5	15	0.133	0.5532	14
	S-5	10.5	22	0.136	0.6896	15
	S-6	13.5	15	0.200	0.8896	15
	S-7	16.5	15	0.200	1.0896	15
	S-8	19.5	17	0.176	1.2661	15
	--	100.0	17	4.735	6.0014	17

Note:
1. Depth to ground surface
2. Standard Penetration Test blow count of a layer i, <=100
3. =(Di-Di-1)/Ni
4. Sum of di/Ni
5. =Σdi/Σ(di/Ni)

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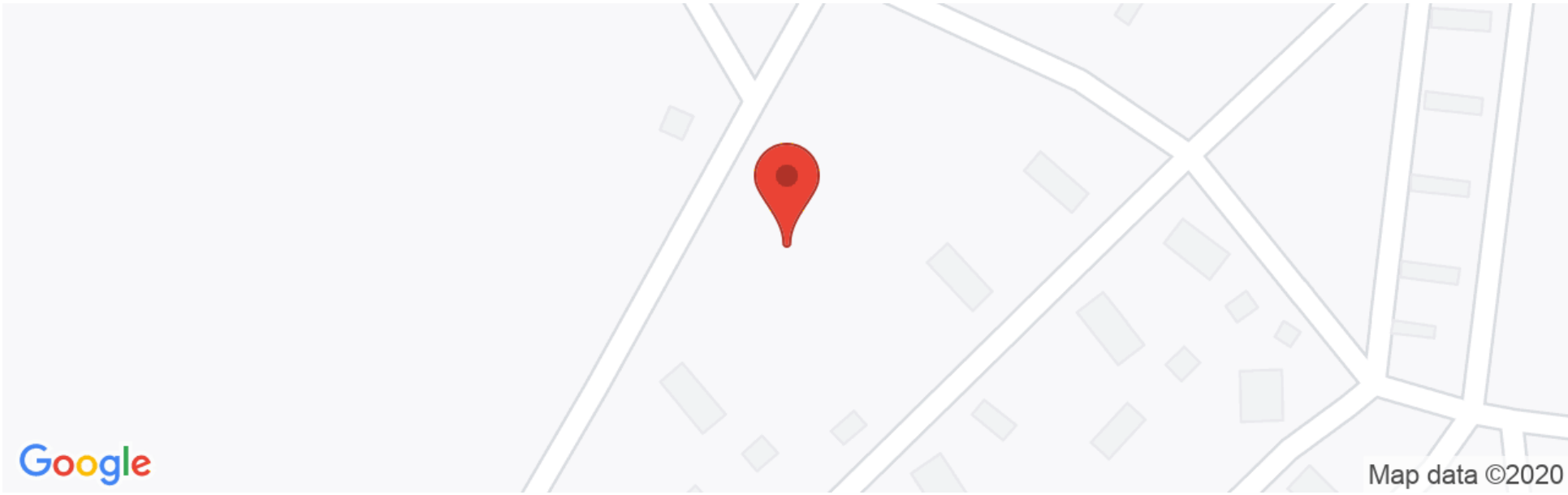
Seismic Coefficient

Camp Santiago

Latitude, Longitude: 18.01038363, -66.29652145



Date	8/10/2020, 9:48:43 AM
Design Code Reference Document	ASCE7-16
Risk Category	IV
Site Class	D - Stiff Soil

Type	Value	Description
S_S	0.937	MCE_R ground motion. (for 0.2 second period)
S_1	0.353	MCE_R ground motion. (for 1.0s period)
S_{MS}	1.054	Site-modified spectral acceleration value
S_{M1}	null -See Section 11.4.8	Site-modified spectral acceleration value
S_{DS}	0.703	Numeric seismic design value at 0.2 second SA
S_{D1}	null -See Section 11.4.8	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	null -See Section 11.4.8	Seismic design category

Type	Value	Description
F_a	1.125	Site amplification factor at 0.2 second
F_v	null -See Section 11.4.8	Site amplification factor at 1.0 second
PGA	0.375	MCE_G peak ground acceleration
F_{PGA}	1.225	Site amplification factor at PGA
PGA_M	0.459	Site modified peak ground acceleration
T_L	12	Long-period transition period in seconds
SsRT	0.937	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.953	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.353	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.354	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	1798.2	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.983	Mapped value of the risk coefficient at short periods
C_{R1}	0.997	Mapped value of the risk coefficient at a period of 1 s

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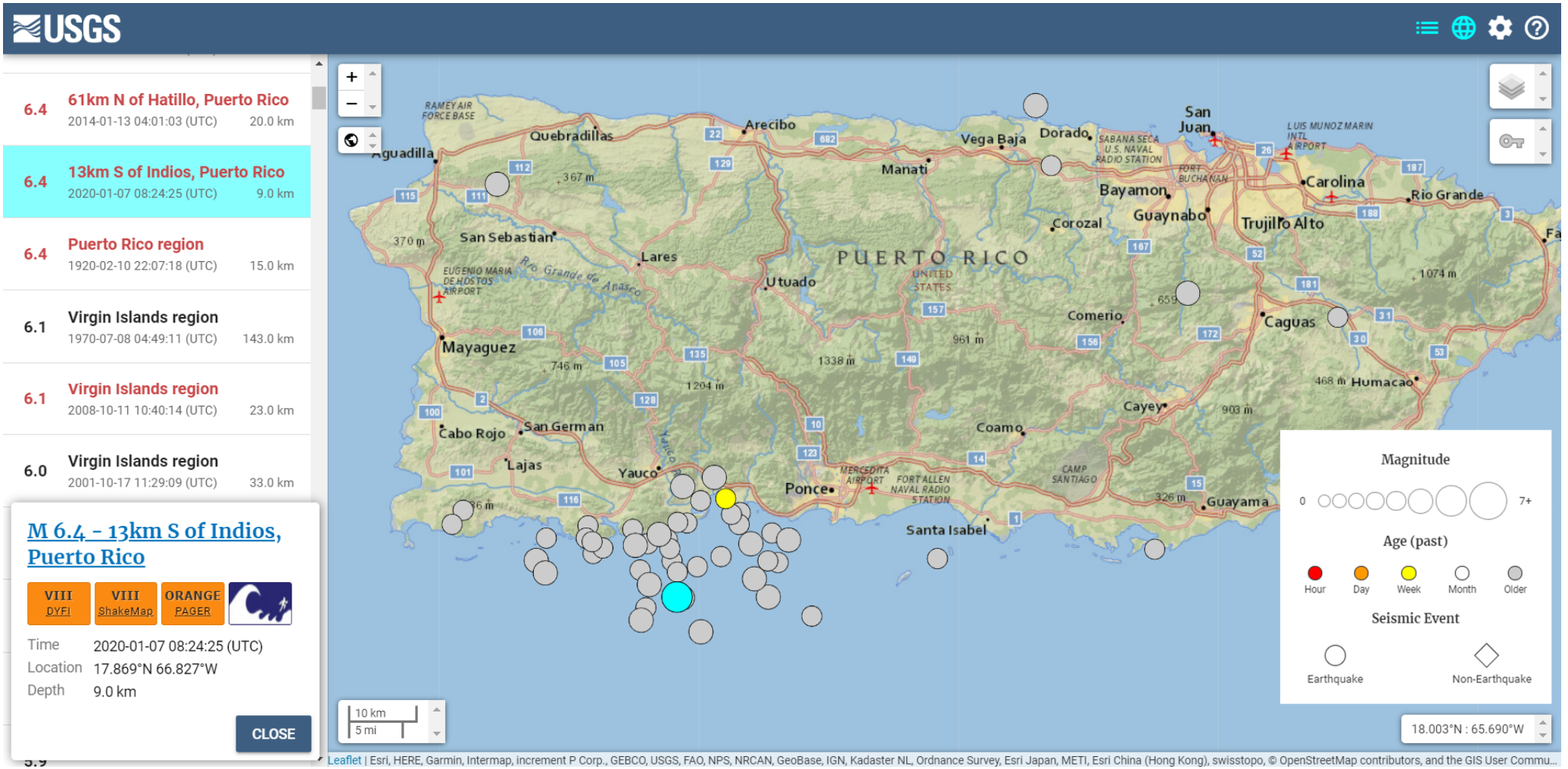
USGS Earthquake Catalog tool



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Liquefaction Analyses

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 302B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

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Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 302B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
302B1	1.5	0.5	14	17.3	24	0.18	0.18	1.7	1.5	0.75	18	1.1	20	Non-Liquefiable	0.468	1.00	0.01	0.30	0.88	1.00	0.57	**N/A**	Low
302B1	3.5	1.1	31	17.3	53	0.42	0.42	1.7	2.1	0.75	40	1.1	43	Non-Liquefiable	0.468	0.99	0.02	0.30	0.74	1.00	0.85	**N/A**	Low
302B1	5.5	1.7	38	17.3	65	0.66	0.66	1.7	2.7	0.75	48	1.1	53	Non-Liquefiable	0.468	0.98	0.03	0.29	0.68	1.00	0.93	**N/A**	Low
302B1	7.5	2.3	46	17.3	78	0.90	0.90	1.5	3.3	0.8	56	1.1	61	Non-Liquefiable	0.468	0.97	0.04	0.29	0.61	1.00	0.99	**N/A**	Low
302B1	10.5	3.2	40	17.3	68	1.26	1.26	1.3	4.2	0.85	44	1.1	48	Non-Liquefiable	0.468	0.96	0.05	0.29	0.66	1.00	0.94	**N/A**	Low
302B1	13.5	4.1	50	17.3	85	1.51	1.63	1.2	5.1	0.85	50	1.1	55	Non-Liquefiable	0.468	0.94	0.07	0.30	0.58	1.00	1.02	**N/A**	Low
302B1	16.5	5.0	22	17.3	37	1.69	2.01	1.1	6.0	0.95	23	1.1	26	0.310	0.310	0.91	0.08	0.32	0.81	1.00	0.73	**0.9**	High
302B1	19.5	5.9	17	17.3	29	1.88	2.38	1.1	6.9	0.95	17	1.1	19	0.205	0.205	0.88	0.09	0.33	0.86	1.00	0.64	**0.6**	High

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
302B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	18	NA	--	0.00	0.00
302B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	40	NA	--	0.00	0.00
302B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	48	NA	--	0.00	0.00
302B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	56	NA	--	0.00	0.00
302B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	44	NA	--	0.00	0.00
302B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	50	NA	--	0.00	0.00
302B1	16.5	5.029	0.9	1.1	Yes	1.2	Yes	1.3	Yes	3.0	23	1.11	1.4	0.50	0.50
302B1	19.5	5.944	0.6	1.1	Yes	1.2	Yes	1.3	Yes	3.0	17	1.74	1.7	0.61	1.12

Results:
- The sand-like soil at this location is subject to liquefaction from 16.5 to 19.5 feet for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 1.12 inches.

Notes:
1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$ (Cetin et al. 2004, Equation 8)

   $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$ $d < 12\,m\ (-40\,ft)$

   $\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

   $d \geq 12\,m\ (-40\,ft)$

   $\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

   where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.
9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\,D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma \leq 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. $\delta = \varepsilon H$

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 302B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 302B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	6.5	($5.5 \le M_w \le 8.5$)	(Estimated Mean Earthquake based on USGS Earthquake Catalog tool)
Magnitude Scaling Factor (Lower Bound), MSF	1.4	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
302B1	1.5	0.5	14	17.3	24	0.18	0.18	1.7	1.5	0.75	18	1.1	20	Non-Liquefiable	0.468	1.00	0.01	0.30	0.88	1.00	0.57	**N/A**	Low
302B1	3.5	1.1	31	17.3	53	0.42	0.42	1.7	2.1	0.75	40	1.1	43	Non-Liquefiable	0.468	0.99	0.02	0.29	0.74	1.00	0.85	**N/A**	Low
302B1	5.5	1.7	38	17.3	65	0.66	0.66	1.7	2.7	0.75	48	1.1	53	Non-Liquefiable	0.468	0.98	0.03	0.29	0.68	1.00	0.93	**N/A**	Low
302B1	7.5	2.3	46	17.3	78	0.90	0.90	1.5	3.3	0.8	56	1.1	61	Non-Liquefiable	0.468	0.97	0.04	0.29	0.61	1.00	0.99	**N/A**	Low
302B1	10.5	3.2	40	17.3	68	1.26	1.26	1.3	4.2	0.85	44	1.1	48	Non-Liquefiable	0.468	0.95	0.05	0.28	0.66	1.00	0.94	**N/A**	Low
302B1	13.5	4.1	50	17.3	85	1.51	1.63	1.2	5.1	0.85	50	1.1	55	Non-Liquefiable	0.468	0.93	0.07	0.30	0.58	1.00	1.02	**N/A**	Low
302B1	16.5	5.0	22	17.3	37	1.69	2.01	1.1	6.0	0.95	23	1.1	26	0.310	0.310	0.90	0.08	0.32	0.81	1.00	0.73	**1.4**	Low
302B1	19.5	5.9	17	17.3	29	1.88	2.38	1.1	6.9	0.95	17	1.1	19	0.205	0.205	0.86	0.09	0.33	0.86	1.00	0.64	**0.9**	High

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
302B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	18	NA	--	0.00	0.00
302B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	40	NA	--	0.00	0.00
302B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	48	NA	--	0.00	0.00
302B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	56	NA	--	0.00	0.00
302B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	44	NA	--	0.00	0.00
302B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	50	NA	--	0.00	0.00
302B1	16.5	5.029	1.4	1.1	No	1.2	No	1.3	No	3.0	23	0.71	--	0.00	0.00
302B1	19.5	5.944	0.9	1.1	Yes	1.2	Yes	1.3	No	3.0	17	1.10	1.7	0.61	0.61

Results:
- The sand-like soil from 16.5 to 19.5 feet-bgs at this location is subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 0.61 inches.

Notes:
1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\ m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\ m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geqslant 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

   where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.
9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\ r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\ D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma \leq 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60} <= 15$ for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 306B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 306B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	($5.5 \le M_w \le 8.5$)	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Automatic-Trip Donut-Type Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.3	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
306B1	1.5	0.5	11	20.6	19	0.18	0.18	1.7	1.5	0.75	18	1.1	21	Non-Liquefiable	0.468	1.00	0.01	0.30	0.91	1.00	0.48	**N/A**	Low
306B1	3	0.9	26	20.6	44	0.36	0.36	1.7	1.9	0.75	43	1.1	48	Non-Liquefiable	0.468	0.99	0.02	0.30	0.78	1.00	0.79	**N/A**	Low
306B1	4.5	1.4	40	20.6	68	0.54	0.54	1.7	2.4	0.75	66	1.1	73	Non-Liquefiable	0.468	0.99	0.03	0.29	0.66	1.00	0.94	**N/A**	Low
306B1	6	1.8	44	20.6	75	0.72	0.72	1.7	2.8	0.75	73	1.1	80	Non-Liquefiable	0.468	0.98	0.03	0.29	0.63	1.00	0.98	**N/A**	Low
306B1	7.5	2.3	45	18.7	77	0.90	0.90	1.5	3.3	0.8	72	1.1	78	Non-Liquefiable	0.468	0.97	0.04	0.29	0.62	1.00	0.99	**N/A**	Low
306B1	9	2.7	42	18.7	71	1.08	1.08	1.4	3.7	0.8	61	1.1	67	Non-Liquefiable	0.468	0.97	0.05	0.29	0.64	1.00	0.96	**N/A**	Low
306B1	10.5	3.2	46	18.7	78	1.26	1.26	1.3	4.2	0.85	66	1.1	72	Non-Liquefiable	0.468	0.96	0.05	0.29	0.61	1.00	0.99	**N/A**	Low
306B1	12	3.7	50	18.7	85	1.41	1.44	1.2	4.7	0.85	68	1.1	74	Non-Liquefiable	0.468	0.95	0.06	0.29	0.58	1.00	1.02	**N/A**	Low
306B1	13.5	4.1	50	18.7	85	1.51	1.63	1.2	5.1	0.85	66	1.1	71	Non-Liquefiable	0.468	0.94	0.07	0.30	0.58	1.00	1.02	**N/A**	Low
306B1	15	4.6	50	18.7	85	1.60	1.82	1.2	5.6	0.85	64	1.1	69	Non-Liquefiable	0.468	0.93	0.07	0.31	0.58	1.00	1.02	**N/A**	Low
306B1	19.5	5.9	44	18.7	75	1.88	2.38	1.1	6.9	0.95	58	1.1	63	Non-Liquefiable	0.468	0.88	0.09	0.33	0.63	1.00	0.98	**N/A**	Low
306B1	25.5	7.8	50	18.7	85	2.26	3.13	1.0	8.8	0.95	60	1.1	65	Non-Liquefiable	0.468	0.82	0.11	0.34	0.58	0.97	1.02	**N/A**	Low
306B1	30.5	9.3	50	18.7	85	2.57	3.76	0.9	10.3	1	59	1.1	64	Non-Liquefiable	0.468	0.75	0.13	0.33	0.58	0.92	1.02	**N/A**	Low
306B1	35.5	10.8	50	18.7	85	2.88	4.38	0.9	11.8	1	56	1.1	61	Non-Liquefiable	0.468	0.70	0.15	0.32	0.58	0.88	1.02	**N/A**	Low
306B1	40.5	12.3	50	18.7	85	3.20	5.01	0.8	13.3	1	53	1.1	58	Non-Liquefiable	0.468	0.65	0.16	0.30	0.58	0.84	1.02	**N/A**	Low
306B1	45.5	13.9	50	18.7	85	3.51	5.63	0.8	14.9	1	50	1.1	55	Non-Liquefiable	0.468	0.62	0.16	0.30	0.58	0.81	1.02	**N/A**	Low
306B1	55.5	16.9	50	18.7	85	4.13	6.88	0.7	17.9	1	47	1.1	51	Non-Liquefiable	0.468	0.58	0.16	0.29	0.58	0.75	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
306B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	18	NA	--	0.00	0.00
306B1	3	0.914	N/A	1.1	No	1.2	No	1.3	No	1.5	43	NA	--	0.00	0.00
306B1	4.5	1.372	N/A	1.1	No	1.2	No	1.3	No	1.5	66	NA	--	0.00	0.00
306B1	6	1.829	N/A	1.1	No	1.2	No	1.3	No	1.5	73	NA	--	0.00	0.00
306B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	1.5	72	NA	--	0.00	0.00
306B1	9	2.743	N/A	1.1	No	1.2	No	1.3	No	1.5	61	NA	--	0.00	0.00
306B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	1.5	66	NA	--	0.00	0.00
306B1	12	3.658	N/A	1.1	No	1.2	No	1.3	No	1.5	68	NA	--	0.00	0.00
306B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	1.5	66	NA	--	0.00	0.00
306B1	15	4.572	N/A	1.1	No	1.2	No	1.3	No	1.5	64	NA	--	0.00	0.00
306B1	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	4.5	58	NA	--	0.00	0.00
306B1	25.5	7.772	N/A	1.1	No	1.2	No	1.3	No	6.0	60	NA	--	0.00	0.00
306B1	30.5	9.296	N/A	1.1	No	1.2	No	1.3	No	5.0	59	NA	--	0.00	0.00
306B1	35.5	10.820	N/A	1.1	No	1.2	No	1.3	No	5.0	56	NA	--	0.00	0.00
306B1	40.5	12.344	N/A	1.1	No	1.2	No	1.3	No	5.0	53	NA	--	0.00	0.00
306B1	45.5	13.868	N/A	1.1	No	1.2	No	1.3	No	5.0	50	NA	--	0.00	0.00
306B1	55.5	16.916	N/A	1.1	No	1.2	No	1.3	No	10.0	47	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes:
1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim{:}5\,\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)
   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785\, V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(0.0785\, V^*_{s,12\ m}+7.586)}}\right]} \pm \sigma_{r_d}$$
   (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785\, V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(0.0785\, V^*_{s,12\ m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12$ m (-40 ft) $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12$ m (-40 ft) $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\,D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 330B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 330B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Automatic-Trip Donut-Type Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	13.0		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.3	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
330B1	1.5	0.5	22	49.6	37	0.18	0.18	1.7	1.5	0.75	36	1.2	43	Non-Liquefiable	0.468	1.00	0.01	0.30	0.81	1.00	0.73	**N/A**	Low
330B1	3	0.9	13	49.6	22	0.36	0.36	1.7	1.9	0.75	22	1.2	26	Non-Liquefiable	0.468	0.99	0.02	0.30	0.89	1.00	0.54	**N/A**	Low
330B1	4.5	1.4	10	49.6	17	0.54	0.54	1.7	2.4	0.75	17	1.2	21	Non-Liquefiable	0.468	0.99	0.03	0.29	0.92	1.00	0.44	**N/A**	Low
330B1	6	1.8	15	49.6	26	0.72	0.72	1.7	2.8	0.75	25	1.2	30	Non-Liquefiable	0.468	0.98	0.03	0.29	0.87	1.00	0.59	**N/A**	Low
330B1	7.5	2.3	29	49.6	49	0.90	0.90	1.5	3.3	0.8	46	1.2	54	Non-Liquefiable	0.468	0.97	0.04	0.29	0.75	1.00	0.83	**N/A**	Low
330B1	9	2.7	34	23.1	58	1.08	1.08	1.4	3.7	0.8	49	1.1	55	Non-Liquefiable	0.468	0.97	0.05	0.29	0.71	1.00	0.89	**N/A**	Low
330B1	10.5	3.2	24	23.1	41	1.26	1.26	1.3	4.2	0.85	34	1.1	39	Non-Liquefiable	0.468	0.96	0.05	0.29	0.80	1.00	0.76	**N/A**	Low
330B1	12	3.7	22	23.1	37	1.44	1.44	1.2	4.7	0.85	29	1.1	33	Non-Liquefiable	0.468	0.95	0.06	0.28	0.81	1.00	0.73	**N/A**	Low
330B1	13.5	4.1	25	23.1	43	1.59	1.62	1.2	5.1	0.85	32	1.1	36	Non-Liquefiable	0.468	0.94	0.07	0.29	0.79	1.00	0.77	**N/A**	Low
330B1	15	4.6	37	23.1	63	1.69	1.81	1.1	5.6	0.85	46	1.1	51	Non-Liquefiable	0.468	0.93	0.07	0.30	0.69	1.00	0.92	**N/A**	Low
330B1	19	5.8	50	23.1	85	1.94	2.31	1.0	6.8	0.95	65	1.1	72	Non-Liquefiable	0.468	0.89	0.09	0.32	0.58	1.00	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
330B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	36	NA	--	0.00	0.00
330B1	3	0.914	N/A	1.1	No	1.2	No	1.3	No	1.5	22	NA	--	0.00	0.00
330B1	4.5	1.372	N/A	1.1	No	1.2	No	1.3	No	1.5	17	NA	--	0.00	0.00
330B1	6	1.829	N/A	1.1	No	1.2	No	1.3	No	1.5	25	NA	--	0.00	0.00
330B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	1.5	46	NA	--	0.00	0.00
330B1	9	2.743	N/A	1.1	No	1.2	No	1.3	No	1.5	49	NA	--	0.00	0.00
330B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	1.5	34	NA	--	0.00	0.00
330B1	12	3.658	N/A	1.1	No	1.2	No	1.3	No	1.5	29	NA	--	0.00	0.00
330B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	1.5	32	NA	--	0.00	0.00
330B1	15	4.572	N/A	1.1	No	1.2	No	1.3	No	1.5	46	NA	--	0.00	0.00
330B1	19	5.791	N/A	1.1	No	1.2	No	1.3	No	4.0	65	NA	--	0.00	0.00

Results:

- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes:

1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\text{ m } (\sim 40\text{ ft})$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\text{ m } (\sim 40\text{ ft})$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 440B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:

- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions

- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 440B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Automatic-Trip Donut-Type Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.3	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
440B1	1.5	0.5	11	18.4	19	0.18	0.18	1.7	1.5	0.75	18	1.1	20	Non-Liquefiable	0.468	1.00	0.01	0.30	0.91	1.00	0.48	**N/A**	Low
440B1	3	0.9	9	50.7	15	0.36	0.36	1.7	1.9	0.75	15	1.3	19	Non-Liquefiable	0.468	0.99	0.02	0.30	0.92	1.00	0.41	**N/A**	Low
440B1	4.5	1.4	14	50.7	24	0.54	0.54	1.7	2.4	0.75	23	1.2	28	Non-Liquefiable	0.468	0.99	0.03	0.29	0.88	1.00	0.57	**N/A**	Low
440B1	6	1.8	12	50.7	20	0.72	0.72	1.7	2.8	0.75	20	1.2	24	Non-Liquefiable	0.468	0.98	0.03	0.29	0.90	1.00	0.51	**N/A**	Low
440B1	7.5	2.3	21	18.4	36	0.90	0.90	1.5	3.3	0.8	33	1.1	37	Non-Liquefiable	0.468	0.97	0.04	0.29	0.82	1.00	0.71	**N/A**	Low
440B1	9	2.7	8	18.4	14	1.08	1.08	1.4	3.7	0.8	12	1.2	13	Non-Liquefiable	0.468	0.97	0.05	0.29	0.93	1.00	0.36	**N/A**	Low
440B1	10.5	3.2	16	18.4	27	1.26	1.26	1.3	4.2	0.85	23	1.1	26	Non-Liquefiable	0.468	0.96	0.05	0.29	0.86	1.00	0.61	**N/A**	Low
440B1	12	3.7	26	18.4	44	1.44	1.44	1.2	4.7	0.85	35	1.1	38	Non-Liquefiable	0.468	0.95	0.06	0.28	0.78	1.00	0.79	**N/A**	Low
440B1	13.5	4.1	50	18.4	85	1.62	1.62	1.1	5.1	0.85	63	1.1	69	Non-Liquefiable	0.468	0.94	0.07	0.28	0.58	1.00	1.02	**N/A**	Low
440B1	15	4.6	50	18.4	85	1.80	1.80	1.1	5.6	0.85	60	1.1	65	Non-Liquefiable	0.468	0.93	0.07	0.28	0.58	1.00	1.02	**N/A**	Low
440B1	19	5.8	50	18.4	85	2.11	2.30	1.0	6.8	0.95	62	1.1	67	Non-Liquefiable	0.468	0.89	0.09	0.29	0.58	1.00	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
440B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	18	NA	--	0.00	0.00
440B1	3	0.914	N/A	1.1	No	1.2	No	1.3	No	1.5	15	NA	--	0.00	0.00
440B1	4.5	1.372	N/A	1.1	No	1.2	No	1.3	No	1.5	23	NA	--	0.00	0.00
440B1	6	1.829	N/A	1.1	No	1.2	No	1.3	No	1.5	20	NA	--	0.00	0.00
440B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	1.5	33	NA	--	0.00	0.00
440B1	9	2.743	N/A	1.1	No	1.2	No	1.3	No	1.5	12	NA	--	0.00	0.00
440B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	1.5	23	NA	--	0.00	0.00
440B1	12	3.658	N/A	1.1	No	1.2	No	1.3	No	1.5	35	NA	--	0.00	0.00
440B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	1.5	63	NA	--	0.00	0.00
440B1	15	4.572	N/A	1.1	No	1.2	No	1.3	No	1.5	60	NA	--	0.00	0.00
440B1	19	5.791	N/A	1.1	No	1.2	No	1.3	No	4.0	62	NA	--	0.00	0.00

Results:

- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes:

1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\text{ m } (\sim 40\text{ ft})$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\text{ m } (\sim 40\text{ ft})$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 442B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 442B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Automatic-Trip Donut-Type Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.3	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
442B1	1.5	0.5	18	15.7	31	0.18	0.18	1.7	1.5	0.75	30	1.1	32	Non-Liquefiable	0.468	1.00	0.01	0.30	0.85	1.00	0.66	**N/A**	Low
442B1	3	0.9	15	15.7	26	0.36	0.36	1.7	1.9	0.75	25	1.1	27	Non-Liquefiable	0.468	0.99	0.02	0.30	0.87	1.00	0.59	**N/A**	Low
442B1	4.5	1.4	7	15.7	12	0.54	0.54	1.7	2.4	0.75	12	1.1	13	Non-Liquefiable	0.468	0.99	0.03	0.29	0.94	1.00	0.32	**N/A**	Low
442B1	6	1.8	10	15.7	17	0.72	0.72	1.7	2.8	0.75	17	1.1	18	Non-Liquefiable	0.468	0.98	0.03	0.29	0.92	1.00	0.44	**N/A**	Low
442B1	7.5	2.3	12	15.7	20	0.90	0.90	1.5	3.3	0.8	19	1.1	21	Non-Liquefiable	0.468	0.97	0.04	0.29	0.90	1.00	0.51	**N/A**	Low
442B1	9	2.7	14	13.9	24	1.08	1.08	1.4	3.7	0.8	20	1.1	22	Non-Liquefiable	0.468	0.97	0.05	0.29	0.88	1.00	0.57	**N/A**	Low
442B1	10.5	3.2	18	13.9	31	1.26	1.26	1.3	4.2	0.85	26	1.1	28	Non-Liquefiable	0.468	0.96	0.05	0.29	0.85	1.00	0.66	**N/A**	Low
442B1	12	3.7	18	13.9	31	1.44	1.44	1.2	4.7	0.85	24	1.1	26	Non-Liquefiable	0.468	0.95	0.06	0.28	0.85	1.00	0.66	**N/A**	Low
442B1	13.5	4.1	29	13.9	49	1.62	1.62	1.1	5.1	0.85	37	1.1	39	Non-Liquefiable	0.468	0.94	0.07	0.28	0.75	1.00	0.83	**N/A**	Low
442B1	15	4.6	35	13.9	60	1.80	1.80	1.1	5.6	0.85	42	1.1	45	Non-Liquefiable	0.468	0.93	0.07	0.28	0.70	1.00	0.90	**N/A**	Low
442B1	19	5.8	34	13.9	58	2.11	2.30	1.0	6.8	0.95	42	1.1	45	Non-Liquefiable	0.468	0.89	0.09	0.29	0.71	1.00	0.89	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
442B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	30	NA	--	0.00	0.00
442B1	3	0.914	N/A	1.1	No	1.2	No	1.3	No	1.5	25	NA	--	0.00	0.00
442B1	4.5	1.372	N/A	1.1	No	1.2	No	1.3	No	1.5	12	NA	--	0.00	0.00
442B1	6	1.829	N/A	1.1	No	1.2	No	1.3	No	1.5	17	NA	--	0.00	0.00
442B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	1.5	19	NA	--	0.00	0.00
442B1	9	2.743	N/A	1.1	No	1.2	No	1.3	No	1.5	20	NA	--	0.00	0.00
442B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	1.5	26	NA	--	0.00	0.00
442B1	12	3.658	N/A	1.1	No	1.2	No	1.3	No	1.5	24	NA	--	0.00	0.00
442B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	1.5	37	NA	--	0.00	0.00
442B1	15	4.572	N/A	1.1	No	1.2	No	1.3	No	1.5	42	NA	--	0.00	0.00
442B1	19	5.791	N/A	1.1	No	1.2	No	1.3	No	4.0	42	NA	--	0.00	0.00

Results:

- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes:

1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34 - (N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS} + 45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341 \cdot (-d + 0.0785 \cdot V^{*2}_{s,12\,m} + 7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341 \cdot (0.0785 \cdot V^{*2}_{s,12\,m} + 7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

   $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341 \cdot (-20 + 0.0785 \cdot V^{*2}_{s,12\,m} + 7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341 \cdot (0.0785 \cdot V^{*2}_{s,12\,m} + 7.586)}}\right]} - 0.0046 \cdot (d - 20) \pm \sigma_{r_d}$$

   $d < 12$ m (~40 ft) $\quad \sigma_{r_d}(d) = e^{0.8500} \cdot 0.0198$

   $d \geq 12$ m (~40 ft) $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

   where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.
9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\,D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. $\delta = \varepsilon H$

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 444B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 444B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
444B1	1.5	0.5	21	16.1	36	0.18	0.18	1.7	1.5	0.75	27	1.1	29	Non-Liquefiable	0.468	1.00	0.01	0.30	0.82	1.00	0.71	**N/A**	Low
444B1	3.5	1.1	12		20	0.42	0.42	1.7	2.1	0.75	15	1.1	17	Non-Liquefiable	0.468	0.99	0.02	0.30	0.90	1.00	0.51	**N/A**	Low
444B1	5.5	1.7	11		19	0.66	0.66	1.7	2.7	0.75	14	1.1	16	Non-Liquefiable	0.468	0.98	0.03	0.29	0.91	1.00	0.48	**N/A**	Low
444B1	7.5	2.3	15	49.5	26	0.90	0.90	1.5	3.3	0.8	18	1.2	23	Non-Liquefiable	0.468	0.97	0.04	0.29	0.87	1.00	0.59	**N/A**	Low
444B1	10.5	3.2	22		37	1.26	1.26	1.3	4.2	0.85	24	1.2	29	Non-Liquefiable	0.468	0.96	0.05	0.29	0.81	1.00	0.73	**N/A**	Low
444B1	13.5	4.1	15		26	1.62	1.62	1.1	5.1	0.85	15	1.3	18	Non-Liquefiable	0.468	0.94	0.07	0.28	0.87	1.00	0.59	**N/A**	Low
444B1	16.5	5.0	15		26	1.95	1.98	1.0	6.0	0.95	15	1.3	19	0.199	0.199	0.91	0.08	0.28	0.87	1.00	0.59	**0.7**	High
444B1	19.5	5.9	17		29	2.14	2.36	1.0	6.9	0.95	16	1.2	20	0.216	0.216	0.88	0.09	0.29	0.86	1.00	0.64	**0.7**	High

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
444B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	27	NA	--	0.00	0.00
444B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	15	NA	--	0.00	0.00
444B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	14	NA	--	0.00	0.00
444B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	18	NA	--	0.00	0.00
444B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	24	NA	--	0.00	0.00
444B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	15	NA	--	0.00	0.00
444B1	16.5	5.029	0.7	1.1	Yes	1.2	Yes	1.3	Yes	3.0	15	1.48	1.9	0.68	0.68
444B1	19.5	5.944	0.7	1.1	Yes	1.2	Yes	1.3	Yes	3.0	16	1.44	1.7	0.61	1.30

Results:
- The sand-like soil at this location from 13.5 to 19.5 feet below the ground surface is subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 1.3 inches.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.

2. Assume rod length = depth + 1 m.

3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).

4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)

5. $$C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim{:5\,\%} \leqslant FC \leqslant 35\%$$ (Cetin et al., 2004, Equation 15)

6. $$N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$$ (Cetin et al., 2004, Equation 14)

7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\text{ m } (-40\text{ ft})$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geqslant 12\text{ m } (-40\text{ ft})$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)

10. $f = 1 - 0.005\,D_R$

11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)

12. $FS = (CRR_{7.5}/CSR)\,MSF\,K_\sigma\,K_\alpha$, K_α is not considered (Youd 2001, Equation 30)

13. If laboratory results are missing, use limit as proposed in USCS

14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)

15. (Tokimatsu and Seed, Figure 6)

16. $\delta = \varepsilon H$

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 444B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 444B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	6.5	($5.5 \le M_w \le 8.5$)	(Estimated Mean Earthquake based on USGS Earthquake Catalog tool)
Magnitude Scaling Factor (Lower Bound), MSF	1.4	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
444B1	1.5	0.5	21	16.1	36	0.18	0.18	1.7	1.5	0.75	27	1.1	29	Non-Liquefiable	0.468	1.00	0.01	0.30	0.82	1.00	0.71	**N/A**	Low
444B1	3.5	1.1	12		20	0.42	0.42	1.7	2.1	0.75	15	1.1	17	Non-Liquefiable	0.468	0.99	0.02	0.29	0.90	1.00	0.51	**N/A**	Low
444B1	5.5	1.7	11		19	0.66	0.66	1.7	2.7	0.75	14	1.1	16	Non-Liquefiable	0.468	0.98	0.03	0.29	0.91	1.00	0.48	**N/A**	Low
444B1	7.5	2.3	15	49.5	26	0.90	0.90	1.5	3.3	0.8	18	1.2	23	Non-Liquefiable	0.468	0.97	0.04	0.29	0.87	1.00	0.59	**N/A**	Low
444B1	10.5	3.2	22		37	1.26	1.26	1.3	4.2	0.85	24	1.2	29	Non-Liquefiable	0.468	0.95	0.05	0.28	0.81	1.00	0.73	**N/A**	Low
444B1	13.5	4.1	15		26	1.62	1.62	1.1	5.1	0.85	15	1.3	18	Non-Liquefiable	0.468	0.93	0.07	0.28	0.87	1.00	0.59	**N/A**	Low
444B1	16.5	5.0	15		26	1.95	1.98	1.0	6.0	0.95	15	1.3	19	0.199	0.199	0.90	0.08	0.27	0.87	1.00	0.59	**1.1**	High
444B1	19.5	5.9	17		29	2.14	2.36	1.0	6.9	0.95	16	1.2	20	0.216	0.216	0.86	0.09	0.28	0.86	1.00	0.64	**1.1**	High

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
444B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	27	NA	--	0.00	0.00
444B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	15	NA	--	0.00	0.00
444B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	14	NA	--	0.00	0.00
444B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	18	NA	--	0.00	0.00
444B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	24	NA	--	0.00	0.00
444B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	15	NA	--	0.00	0.00
444B1	16.5	5.029	1.1	1.1	Yes	1.2	Yes	1.3	Yes	3.0	15	0.95	1.9	0.68	0.68
444B1	19.5	5.944	1.1	1.1	Yes	1.2	Yes	1.3	Yes	3.0	16	0.91	1.7	0.61	1.30

Results:
- The sand-like soil from 13.5 to 19.5 feet-bgs at this location is subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 1.3 inches.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.

2. Assume rod length = depth + 1 m.

3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).

4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)

5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim{:5\%} \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)

6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)

7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\text{ m}\ (-40\text{ ft})$: $\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geqslant 12\text{ m}\ (-40\text{ ft})$: $\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)

10. $f = 1 - 0.005\,D_R$

11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma \leq 1$ if >1 (Youd 2001, Equation 31)

12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)

13. If laboratory results are missing, use limit as proposed in USCS

14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)

15. (Tokimatsu and Seed, Figure 6)

16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 446B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:

- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions

- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 446B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
446B1	1.5	0.5	26	48.8	44	0.18	0.18	1.7	1.5	0.75	33	1.2	40	Non-Liquefiable	0.468	1.00	0.01	0.30	0.78	1.00	0.79	**N/A**	Low
446B1	3.5	1.1	19	48.8	32	0.42	0.42	1.7	2.1	0.75	24	1.2	29	Non-Liquefiable	0.468	0.99	0.02	0.30	0.84	1.00	0.68	**N/A**	Low
446B1	5.5	1.7	31	40.4	53	0.66	0.66	1.7	2.7	0.75	40	1.2	47	Non-Liquefiable	0.468	0.98	0.03	0.29	0.74	1.00	0.85	**N/A**	Low
446B1	7.5	2.3	34	40.4	58	0.90	0.90	1.5	3.3	0.8	42	1.2	49	Non-Liquefiable	0.468	0.97	0.04	0.29	0.71	1.00	0.89	**N/A**	Low
446B1	10.5	3.2	19	40.4	32	1.26	1.26	1.3	4.2	0.85	21	1.2	26	Non-Liquefiable	0.468	0.96	0.05	0.29	0.84	1.00	0.68	**N/A**	Low
446B1	13.5	4.1	24	40.4	41	1.62	1.62	1.1	5.1	0.85	23	1.2	28	Non-Liquefiable	0.468	0.94	0.07	0.28	0.80	1.00	0.76	**N/A**	Low
446B1	16.5	5.0	28	40.4	48	1.95	1.98	1.0	6.0	0.95	28	1.2	33	Non-Liquefiable	0.468	0.91	0.08	0.28	0.76	1.00	0.82	**N/A**	Low
446B1	19.5	5.9	26	40.4	44	2.14	2.36	1.0	6.9	0.95	25	1.2	30	0.451	0.451	0.88	0.09	0.29	0.78	1.00	0.79	**1.4**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
446B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	33	NA	--	0.00	0.00
446B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	24	NA	--	0.00	0.00
446B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	40	NA	--	0.00	0.00
446B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	42	NA	--	0.00	0.00
446B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	21	NA	--	0.00	0.00
446B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	23	NA	--	0.00	0.00
446B1	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	28	NA	--	0.00	0.00
446B1	19.5	5.944	1.4	1.1	No	1.2	No	1.3	No	3.0	25	0.69	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)
where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$

$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$

$d < 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})$ r_d (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 448B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 448B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	16.0	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
448B1	1.5	0.5	26	21.9	44	0.18	0.18	1.7	1.5	0.75	33	1.1	37	Non-Liquefiable	0.468	1.00	0.01	0.30	0.78	1.00	0.79	**N/A**	Low
448B1	3.5	1.1	22	21.9	37	0.42	0.42	1.7	2.1	0.75	28	1.1	32	Non-Liquefiable	0.468	0.99	0.02	0.30	0.81	1.00	0.73	**N/A**	Low
448B1	5.5	1.7	19	21.9	32	0.66	0.66	1.7	2.7	0.75	24	1.1	27	Non-Liquefiable	0.468	0.98	0.03	0.29	0.84	1.00	0.68	**N/A**	Low
448B1	7.5	2.3	14	48.7	24	0.90	0.90	1.5	3.3	0.8	17	1.2	21	Non-Liquefiable	0.468	0.97	0.04	0.29	0.88	1.00	0.57	**N/A**	Low
448B1	10.5	3.2	12	48.7	20	1.26	1.26	1.3	4.2	0.85	13	1.3	17	Non-Liquefiable	0.468	0.96	0.05	0.29	0.90	1.00	0.51	**N/A**	Low
448B1	13.5	4.1	26	48.7	44	1.62	1.62	1.1	5.1	0.85	25	1.2	31	Non-Liquefiable	0.468	0.94	0.07	0.28	0.78	1.00	0.79	**N/A**	Low
448B1	16.5	5.0	50	48.7	85	1.95	1.98	1.0	6.0	0.95	49	1.2	58	Non-Liquefiable	0.468	0.91	0.08	0.28	0.58	1.00	1.02	**N/A**	Low
448B1	19.5	5.9	50	48.7	85	2.14	2.36	1.0	6.9	0.95	47	1.2	56	Non-Liquefiable	0.468	0.88	0.09	0.29	0.58	1.00	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
448B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	33	NA	--	0.00	0.00
448B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	28	NA	--	0.00	0.00
448B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	24	NA	--	0.00	0.00
448B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	17	NA	--	0.00	0.00
448B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	13	NA	--	0.00	0.00
448B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	25	NA	--	0.00	0.00
448B1	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	49	NA	--	0.00	0.00
448B1	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	47	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)
where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d} \quad d < 12\text{ m } (-40\text{ ft})$$

$$\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$$

$$d \geq 12\text{ m } (-40\text{ ft})$$

$$\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 452B1
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:

- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions

- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 452B1 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century within 250km of the site)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5		
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

r_d Standard Deviation	0
$\ln(\varepsilon_v)$ Standard Deviation	0

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
452B1	1.5	0.5	11	11.5	19	0.18	0.18	1.7	1.5	0.75	14	1.1	15	Non-Liquefiable	0.468	1.00	0.01	0.30	0.91	1.00	0.48	**N/A**	Low
452B1	3.5	1.1	18	11.5	31	0.42	0.42	1.7	2.1	0.75	23	1.1	25	Non-Liquefiable	0.468	0.99	0.02	0.30	0.85	1.00	0.66	**N/A**	Low
452B1	5.5	1.7	34	11.5	58	0.66	0.66	1.7	2.7	0.75	43	1.1	46	Non-Liquefiable	0.468	0.98	0.03	0.29	0.71	1.00	0.89	**N/A**	Low
452B1	7.5	2.3	50	11.5	85	0.90	0.90	1.5	3.3	0.8	61	1.1	65	Non-Liquefiable	0.468	0.97	0.04	0.29	0.58	1.00	1.02	**N/A**	Low
452B1	10.5	3.2	50	23	85	1.26	1.26	1.3	4.2	0.85	55	1.1	61	Non-Liquefiable	0.468	0.96	0.05	0.29	0.58	1.00	1.02	**N/A**	Low
452B1	13.5	4.1	28	23	48	1.51	1.63	1.2	5.1	0.85	28	1.1	32	Non-Liquefiable	0.468	0.94	0.07	0.30	0.76	1.00	0.82	**N/A**	Low
452B1	16.5	5.0	32	23	54	1.69	2.01	1.1	6.0	0.95	34	1.1	38	Non-Liquefiable	0.468	0.91	0.08	0.32	0.73	1.00	0.86	**N/A**	Low
452B1	19.5	5.9	40	23	68	1.88	2.38	1.1	6.9	0.95	40	1.1	45	Non-Liquefiable	0.468	0.88	0.09	0.33	0.66	1.00	0.94	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement[14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation[14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement $\Sigma\delta$
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
452B1	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	14	NA	--	0.00	0.00
452B1	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	23	NA	--	0.00	0.00
452B1	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	43	NA	--	0.00	0.00
452B1	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	61	NA	--	0.00	0.00
452B1	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	55	NA	--	0.00	0.00
452B1	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	28	NA	--	0.00	0.00
452B1	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	34	NA	--	0.00	0.00
452B1	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	40	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes:
1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim{:5\ \%} \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34 - (N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS} + 45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(0.0785 V^*_{s,12\ m}+7.586)}}\right]} \pm \sigma_{r_d}$$

$$r_d(d, M_w, a_{max}, V^*_{s,12\ m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\ m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\ m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\ m}+7.586)}}\right]} - 0.0046 \cdot (d - 20) \pm \sigma_{r_d}$$

$d < 12\ m\ (\sim 40\ ft)$ $\quad \sigma_{r_d}(d) = e^{0.8500} \cdot 0.0198$

$d \geq 12\ m\ (\sim 40\ ft)$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. $CSR = 0.65\ (a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\ r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\ D_R$
11. $K_\sigma = (\sigma'_{vo}/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_{sl} K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. $\delta = \varepsilon H$

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 452B3
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:

- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions

- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 452B3 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
452B3	1.5	0.5	19	39.4	32	0.18	0.18	1.7	1.5	0.75	24	1.2	29	Non-Liquefiable	0.468	1.00	0.01	0.30	0.84	1.00	0.68	**N/A**	Low
452B3	3.5	1.1	15	39.4	26	0.42	0.42	1.7	2.1	0.75	19	1.2	24	Non-Liquefiable	0.468	0.99	0.02	0.30	0.87	1.00	0.59	**N/A**	Low
452B3	5.5	1.7	50	39.4	85	0.66	0.66	1.7	2.7	0.75	64	1.2	74	Non-Liquefiable	0.468	0.98	0.03	0.29	0.58	1.00	1.02	**N/A**	Low
452B3	7.5	2.3	50	39.4	85	0.90	0.90	1.5	3.3	0.8	61	1.2	72	Non-Liquefiable	0.468	0.97	0.04	0.29	0.58	1.00	1.02	**N/A**	Low
452B3	10.5	3.2	16	39.4	27	1.26	1.26	1.3	4.2	0.85	18	1.2	22	Non-Liquefiable	0.468	0.96	0.05	0.29	0.86	1.00	0.61	**N/A**	Low
452B3	13.5	4.1	41	39.4	70	1.51	1.63	1.2	5.1	0.85	41	1.2	49	Non-Liquefiable	0.468	0.94	0.07	0.30	0.65	1.00	0.95	**N/A**	Low
452B3	16.5	5.0	47	18.8	80	1.69	2.01	1.1	6.0	0.95	50	1.1	55	Non-Liquefiable	0.468	0.91	0.08	0.32	0.60	1.00	1.00	**N/A**	Low
452B3	19.5	5.9	29	18.8	49	1.88	2.38	1.1	6.9	0.95	29	1.1	32	Non-Liquefiable	0.468	0.88	0.09	0.33	0.75	1.00	0.83	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
452B3	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	24	NA	--	0.00	0.00
452B3	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	19	NA	--	0.00	0.00
452B3	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	64	NA	--	0.00	0.00
452B3	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	61	NA	--	0.00	0.00
452B3	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	18	NA	--	0.00	0.00
452B3	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	41	NA	--	0.00	0.00
452B3	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	50	NA	--	0.00	0.00
452B3	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	29	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 454B3
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 454B3 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
454B3	1.5	0.5	15	20.5	26	0.18	0.18	1.7	1.5	0.75	19	1.1	22	Non-Liquefiable	0.468	1.00	0.01	0.30	0.87	1.00	0.59	**N/A**	Low
454B3	3.5	1.1	17	20.5	29	0.42	0.42	1.7	2.1	0.75	22	1.1	24	Non-Liquefiable	0.468	0.99	0.02	0.30	0.86	1.00	0.64	**N/A**	Low
454B3	5.5	1.7	42	20.5	71	0.66	0.66	1.7	2.7	0.75	54	1.1	59	Non-Liquefiable	0.468	0.98	0.03	0.29	0.64	1.00	0.96	**N/A**	Low
454B3	7.5	2.3	50	20.5	85	0.90	0.90	1.5	3.3	0.8	61	1.1	67	Non-Liquefiable	0.468	0.97	0.04	0.29	0.58	1.00	1.02	**N/A**	Low
454B3	10.5	3.2	50	41.3	85	1.26	1.26	1.3	4.2	0.85	55	1.2	65	Non-Liquefiable	0.468	0.96	0.05	0.29	0.58	1.00	1.02	**N/A**	Low
454B3	13.5	4.1	25	41.3	43	1.51	1.63	1.2	5.1	0.85	25	1.2	30	Non-Liquefiable	0.468	0.94	0.07	0.30	0.79	1.00	0.77	**N/A**	Low
454B3	16.5	5.0	20	41.3	34	1.69	2.01	1.1	6.0	0.95	21	1.2	26	0.312	0.312	0.91	0.08	0.32	0.83	1.00	0.69	**0.9**	High
454B3	19.5	5.9	50	15	85	1.88	2.38	1.1	6.9	0.95	50	1.1	54	Non-Liquefiable	0.468	0.88	0.09	0.33	0.58	1.00	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
454B3	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	19	NA	--	0.00	0.00
454B3	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	22	NA	--	0.00	0.00
454B3	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	54	NA	--	0.00	0.00
454B3	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	61	NA	--	0.00	0.00
454B3	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	55	NA	--	0.00	0.00
454B3	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	25	NA	--	0.00	0.00
454B3	16.5	5.029	0.9	1.1	Yes	1.2	Yes	1.3	Yes	3.0	21	1.10	1.5	0.54	0.54
454B3	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	50	NA	--	0.00	0.54

Results:
- The sand-like soil from 13.5 to 16.5 feet-bgs at this location is subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 0.54 inches.

Notes:
1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $$CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

   where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.
8. $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$ (Cetin et al. 2004, Equation 8)

   $$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

   $d < 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

   $d \geq 12\ m\ (-40\ ft)$ $\quad \sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

   where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.
9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\,D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma \leq 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 454B3
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 454B3 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	6.5	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	1.4	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
454B3	1.5	0.5	15	20.5	26	0.18	0.18	1.7	1.5	0.75	19	1.1	22	Non-Liquefiable	0.468	1.00	0.01	0.30	0.87	1.00	0.59	**N/A**	Low
454B3	3.5	1.1	17	20.5	29	0.42	0.42	1.7	2.1	0.75	22	1.1	24	Non-Liquefiable	0.468	0.99	0.02	0.29	0.86	1.00	0.64	**N/A**	Low
454B3	5.5	1.7	42	20.5	71	0.66	0.66	1.7	2.7	0.75	54	1.1	59	Non-Liquefiable	0.468	0.98	0.03	0.29	0.64	1.00	0.96	**N/A**	Low
454B3	7.5	2.3	50	20.5	85	0.90	0.90	1.5	3.3	0.8	61	1.1	67	Non-Liquefiable	0.468	0.97	0.04	0.29	0.58	1.00	1.02	**N/A**	Low
454B3	10.5	3.2	50	41.3	85	1.26	1.26	1.3	4.2	0.85	55	1.2	65	Non-Liquefiable	0.468	0.95	0.05	0.28	0.58	1.00	1.02	**N/A**	Low
454B3	13.5	4.1	25	41.3	43	1.51	1.63	1.2	5.1	0.85	25	1.2	30	Non-Liquefiable	0.468	0.93	0.07	0.30	0.79	1.00	0.77	**N/A**	Low
454B3	16.5	5.0	20	41.3	34	1.69	2.01	1.1	6.0	0.95	21	1.2	26	0.312	0.312	0.90	0.08	0.32	0.83	1.00	0.69	**1.4**	Low
454B3	19.5	5.9	50	15	85	1.88	2.38	1.1	6.9	0.95	50	1.1	54	Non-Liquefiable	0.468	0.86	0.09	0.33	0.58	1.00	1.02	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
454B3	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	19	NA	--	0.00	0.00
454B3	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	22	NA	--	0.00	0.00
454B3	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	54	NA	--	0.00	0.00
454B3	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	61	NA	--	0.00	0.00
454B3	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	55	NA	--	0.00	0.00
454B3	13.5	4.115	N/A	1.1	No	1.2	No	1.3	No	3.0	25	NA	--	0.00	0.00
454B3	16.5	5.029	1.4	1.1	No	1.2	No	1.3	No	3.0	21	0.70	--	0.00	0.00
454B3	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	50	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequence of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leq FC \leq 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 458B3
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:

- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions

- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 458B3 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	7.7	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	0.9	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners		
Depth to Water Table (ft)	11.5	r_d Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
458B3	1.5	0.5	11	48.8	19	0.18	0.18	1.7	1.5	0.75	14	1.3	18	Non-Liquefiable	0.468	1.00	0.01	0.30	0.91	1.00	0.48	**N/A**	Low
458B3	3.5	1.1	17	48.8	29	0.42	0.42	1.7	2.1	0.75	22	1.2	26	Non-Liquefiable	0.468	0.99	0.02	0.30	0.86	1.00	0.64	**N/A**	Low
458B3	5.5	1.7	9	19.3	15	0.66	0.66	1.7	2.7	0.75	11	1.2	13	Non-Liquefiable	0.468	0.98	0.03	0.29	0.92	1.00	0.41	**N/A**	Low
458B3	7.5	2.3	20	19.3	34	0.90	0.90	1.5	3.3	0.8	25	1.1	27	Non-Liquefiable	0.468	0.97	0.04	0.29	0.83	1.00	0.69	**N/A**	Low
458B3	10.5	3.2	24	19.3	41	1.26	1.26	1.3	4.2	0.85	26	1.1	29	Non-Liquefiable	0.468	0.96	0.05	0.29	0.80	1.00	0.76	**N/A**	Low
458B3	13.5	4.1	25	19.3	43	1.51	1.63	1.2	5.1	0.85	25	1.1	28	0.373	0.373	0.94	0.07	0.30	0.79	1.00	0.77	**1.2**	Medium
458B3	16.5	5.0	32	19.3	54	1.69	2.01	1.1	6.0	0.95	34	1.1	38	Non-Liquefiable	0.468	0.91	0.08	0.32	0.73	1.00	0.86	**N/A**	Low
458B3	19.5	5.9	38	19.3	65	1.88	2.38	1.1	6.9	0.95	38	1.1	42	Non-Liquefiable	0.468	0.88	0.09	0.33	0.68	1.00	0.93	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
458B3	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	14	NA	--	0.00	0.00
458B3	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	22	NA	--	0.00	0.00
458B3	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	11	NA	--	0.00	0.00
458B3	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	25	NA	--	0.00	0.00
458B3	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	26	NA	--	0.00	0.00
458B3	13.5	4.115	1.2	1.1	No	1.2	No	1.3	Yes	3.0	25	0.87	1.0	0.36	0.36
458B3	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	34	NA	--	0.00	0.36
458B3	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	38	NA	--	0.00	0.36

Results:
- The sand-like soil from 10.5 to 13.5 feet at this location is subject to liquefaction for one of the consequences of liquefaction (Lateral Spread) listed in Table 1 2009 NEHRP RP 12.
- The saturated sand settlement calcuation due to seismic loading is approximately 0.36 inches.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.

2. Assume rod length = depth + 1 m.

3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).

4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)

5. $$C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$$ (Cetin et al., 2004, Equation 15)

6. $$N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$$ (Cetin et al., 2004, Equation 14)

7. $$CRR_{7.5} = \frac{1}{34 - (N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS} + 45]^2} - \frac{1}{200}$$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$$

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d - 20) \pm \sigma_{r_d}$$

$d < 12\ m\ (-40\ ft)$

$$\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$$

$d \geqslant 12\ m\ (-40\ ft)$

$$\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. $CSR = 0.65\,(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\,r_d$ (Youd 2001, Equation 1)

10. $f = 1 - 0.005\,D_R$

11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)

12. $FS = (CRR_{7.5}/CSR)\ MSF\ K_\sigma\ K_\alpha$, K_α is not considered (Youd 2001, Equation 30)

13. If laboratory results are missing, use limit as proposed in USCS

14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)

15. (Tokimatsu and Seed, Figure 6)

16. $\delta = \varepsilon H$

SO No. 177050
Subject : USACE - Camp Santiago
Liquefaction Analysis - 458B3
Site Class D
Computed By: SED Checked By: GZ Date: 8/5/2020

Michael Baker INTERNATIONAL

Problem Statement:
- Assess liquefaction potential of sand like soil using SPT data using the "simplified (semi-empirical) procedure", in accordance with Youd et al. (2001)
- Estimated the settlement of saturated sand like soil and compare with dry sand like soil settlement due to earthquake loading, per Tokimatsu and Seed (1987).

References:

- Youd, et al., Liquefaction Resistance of Soils: Summary Report from The 1996 NCEER and 1998 NCEER/NSF Workshops on evaluation of Liquefaction Resistance of Soils, 2001, Journal of Geotechnical and Geoenvironmental Engineering, 817-833.
- Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking, Journal of Geotechnical Engineering, 113(8), 861-878.
- 2009 NEHRP Part 3 Resource Papers (RP) 12, Evaluation of Geologic Hazards and Determination of Seismic Lateral Earth Pressures.
- Martin, G. and Lew, M. 1999. Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Liquefaction Hazards in California.
- Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.
- Cetin et al., Standard Penetration Test-Based Probabilistic and Deterministic Assessment of Seismic Soil Liquefaction Potential, December 2004, Journal of Geotechnical and Geoenvironmental Engineering, 1314-1340.

Assumptions
- Sloping ground factor was not considered in the analysis.
- Use subsurface conditions encountered at 458B3 for this analysis

Liquefaction Evaluation for Sand Like Material

Cetin et al., Probabilistic Model for the Assessment of Cyclically Induced Reconsolidation (Volumetric) Settlements, March 2009, Journal of Geotechnical and Geoenvironmental Engineering, 387-398.

Input Parameters:

Earthquake Magnitude, M_w	6.5	$(5.5 \le M_w \le 8.5)$	(Maximum Earthquake Recorded in past Century)
Magnitude Scaling Factor (Lower Bound), MSF	1.4	$=10^{2.24}/M_w^{2.56}$	(Youd 2001, Equation 24)
Peak Horizontal Acceleration at Ground Surface, a_{max} (g)	0.459		(PGA_M from OSHPD Web Tool - based on ASCE 7-16)
Type of Hammer	Safety Hammer		
Sampling Method	Sampler without liners	r_d Standard Deviation	0
Depth to Water Table (ft)	11.5	$\ln(\varepsilon_v)$ Standard Deviation	0
Average Moist Unit Weight (kcf)	0.12		
Average Saturated Unit Weight (kcf)	0.125		
Shear Wave Velocity, $V^*_{s,12m}$ (m/s)	175	(Cetin et al. 2004, page 1324)	
SPT Correction, C_E	1.0	(Youd 2001, Table 2)	
SPT Correction, C_B	1.0	(Youd 2001, Table 2)	
SPT Correction, C_S	1.0	(Youd 2001, Table 2)	

Boring	Depth		SPT-N, N_m [1]	Fines Content [13]	D_R	σ'_{v0}	σ_{v0}	C_N	Estimated Rod Length [2]	C_R [3]	$(N_1)_{60}$ [4]	C_{FINES} [5]	$(N_1)_{60CS}$ [6]	$CRR_{7.5}$ [7]*	$CRR_{7.5}$ Beyond Limit (Truncate)	r_d [8]	σ_{crd} [8]	CSR [9]	f [10]	K_σ [11]	K_{md}	Calculated FS [12]	Risk of Liquifaction*
(---)	(ft)	(m)	(bpf)	(%)	(%)	(ksf)	(ksf)	(---)	(m)	(---)	(bpf)	(---)	(---)	(---)	(---)	(---)	(---)	(---)		(---)	(---)	(---)	(---)
458B3	1.5	0.5	11	48.8	19	0.18	0.18	1.7	1.5	0.75	14	1.3	18	Non-Liquefiable	0.468	1.00	0.01	0.30	0.91	1.00	0.48	**N/A**	Low
458B3	3.5	1.1	17	48.8	29	0.42	0.42	1.7	2.1	0.75	22	1.2	26	Non-Liquefiable	0.468	0.99	0.02	0.29	0.86	1.00	0.64	**N/A**	Low
458B3	5.5	1.7	9	19.3	15	0.66	0.66	1.7	2.7	0.75	11	1.2	13	Non-Liquefiable	0.468	0.98	0.03	0.29	0.92	1.00	0.41	**N/A**	Low
458B3	7.5	2.3	20	19.3	34	0.90	0.90	1.5	3.3	0.8	25	1.1	27	Non-Liquefiable	0.468	0.97	0.04	0.29	0.83	1.00	0.69	**N/A**	Low
458B3	10.5	3.2	24	19.3	41	1.26	1.26	1.3	4.2	0.85	26	1.1	29	Non-Liquefiable	0.468	0.95	0.05	0.28	0.80	1.00	0.76	**N/A**	Low
458B3	13.5	4.1	25	19.3	43	1.51	1.63	1.2	5.1	0.85	25	1.1	28	0.373	0.373	0.93	0.07	0.30	0.79	1.00	0.77	**1.8**	Low
458B3	16.5	5.0	32	19.3	54	1.69	2.01	1.1	6.0	0.95	34	1.1	38	Non-Liquefiable	0.468	0.90	0.08	0.32	0.73	1.00	0.86	**N/A**	Low
458B3	19.5	5.9	38	19.3	65	1.88	2.38	1.1	6.9	0.95	38	1.1	42	Non-Liquefiable	0.468	0.86	0.09	0.33	0.68	1.00	0.93	**N/A**	Low

Boring	Depth		Cal. FS [12]	Req'd FS for Settlement [14]	Possible Settlement due to Liquefaction?	Req'd FS for Surface Manifestation [14]	Possible Surface Manifestation due to Liquefaction?	Req'd Lateral Spread FS [14]	Possible Lateral Spread due to Liquefaction?	Thickness H	$(N_1)_{60}$ [4]	$CSR_{7.5}/CRR_{7.5}$	ε [15]	Settlement [16] δ	Settlement Σδ
(---)	(ft)	(m)	(---)	(---)	(---)	(---)	(---)	(---)	(---)	(ft)	(bpf)	(---)	(%)	(inch)	(inch)
458B3	1.5	0.457	N/A	1.1	No	1.2	No	1.3	No	1.5	14	NA	--	0.00	0.00
458B3	3.5	1.067	N/A	1.1	No	1.2	No	1.3	No	2.0	22	NA	--	0.00	0.00
458B3	5.5	1.676	N/A	1.1	No	1.2	No	1.3	No	2.0	11	NA	--	0.00	0.00
458B3	7.5	2.286	N/A	1.1	No	1.2	No	1.3	No	2.0	25	NA	--	0.00	0.00
458B3	10.5	3.200	N/A	1.1	No	1.2	No	1.3	No	3.0	26	NA	--	0.00	0.00
458B3	13.5	4.115	1.8	1.1	No	1.2	No	1.3	No	3.0	25	0.56	--	0.00	0.00
458B3	16.5	5.029	N/A	1.1	No	1.2	No	1.3	No	3.0	34	NA	--	0.00	0.00
458B3	19.5	5.944	N/A	1.1	No	1.2	No	1.3	No	3.0	38	NA	--	0.00	0.00

Results:
- The sand-like soil at this location is NOT subject to liquefaction for all of the consequences of liquefaction (Settlement, Surface Manifestations, and Lateral Spread) listed in Table 1 2009 NEHRP RP 12.

Notes: 1. For SPT-N values greater than 50 bpf, the value of 50 bpf is used. Conservative.
2. Assume rod length = depth + 1 m.
3. Correction factor for rod length (Youd & Idriss, et at. 1997, Table 2).
4. $(N_1)_{60} = N_m C_N C_E C_B C_R C_S$ (Youd 2001, Equation 8)
5. $C_{FINES} = (1 + 0.004 \cdot FC) + 0.05 \cdot \left(\frac{FC}{N_{1,60}}\right) \lim: 5\% \leqslant FC \leqslant 35\%$ (Cetin et al., 2004, Equation 15)
6. $N_{1,60,CS} = N_{1,60} \cdot C_{FINES}$ (Cetin et al., 2004, Equation 14)
7. $CRR_{7.5} = \frac{1}{34-(N_1)_{60CS}} + \frac{(N_1)_{60CS}}{135} + \frac{50}{[10*(N_1)_{60CS}+45]^2} - \frac{1}{200}$ (Youd 2001, Equation 4)

where, x = min($(N_1)_{60CS}$, 30), and if $(N_1)_{60CS}$ is equal to or greater than 30, the soil is non liquefiable.

8. $r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-d+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(0.0785 V^*_{s,12\,m}+7.586)}}\right]} \pm \sigma_{r_d}$ (Cetin et al. 2004, Equation 8)

$$r_d(d, M_w, a_{max}, V^*_{s,12\,m}) = \frac{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-20+0.0785 V^*_{s,12\,m}+7.586)}}\right]}{\left[1 + \frac{-23.013 - 2.949 \cdot a_{max} + 0.999 \cdot M_w + 0.0525 \cdot V^*_{s,12\,m}}{16.258 + 0.201 \cdot e^{0.341(-0.0785 V^*_{s,12\,m}+7.586)}}\right]} - 0.0046 \cdot (d-20) \pm \sigma_{r_d}$$

$d < 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = d^{0.8500} \cdot 0.0198$

$d \geq 12\ m\ (-40\ ft)$: $\sigma_{r_d}(d) = 12^{0.8500} \cdot 0.0198$

where, d = depth below ground surface in meters, a_{max} is gravitational acceleration (gs), and $V^*_{s,12m}$ is in m/s.

9. CSR = 0.65 $(a_{max}/g)(\sigma_{vo}/\sigma'_{vo})\, r_d$ (Youd 2001, Equation 1)
10. $f = 1 - 0.005\, D_R$
11. $K_\sigma = (\sigma_{vo}'/P_a)^{f-1}$, use $K_\sigma = 1$ if >1 (Youd 2001, Equation 31)
12. FS = $(CRR_{7.5}/CSR)$ MSF K_σ K_α, K_α is not considered (Youd 2001, Equation 30)
13. If laboratory results are missing, use limit as proposed in USCS
14. Factors of safety for liquefaction hazard assessment, use $(N_1)_{60}$<=15 for each consequence of liquefaction (Table 1 2009 NEHRP RP 12)
15. (Tokimatsu and Seed, Figure 6)
16. δ=εH

Michael Baker
INTERNATIONAL

We Make a Difference

ATTACHMENT 10
Response to Review Comments

Comment Report: All Comments
Project: Joint Training Center, Camp Santiago, PR (CoS)
Review: BAKER-JACOBS Geotech Report
Displaying 5 comments for the criteria specified in this report.

Id	Discipline	Section/Figure	Page Number	Line Number
8791088	Civil	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

No civil comments

Submitted By: Russell Fischer (651-290-5970). Submitted On: Aug 25 2020

1-0 Evaluation **Concurred**
Thank you for the confirmation.

Submitted By: Lois Muller (412-269-6115) Submitted On: Aug 27 2020
Backcheck not conducted
Current Comment Status: **Comment Open**

8798456	Structural	n/a	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

The report has been reviewed and the recommendations will be followed in the next submittal for the DFAC's and HQ's 1,2,4,&6. No comments on the report.

Submitted By: Mohammed Aljuboori (2156560627). Submitted On: Aug 28 2020

1-0 Evaluation **Concurred**
Thank you for the confirmation.

Submitted By: Lois Muller (412-269-6115) Submitted On: Sep 01 2020
Backcheck not conducted
Current Comment Status: **Comment Open**

8798850	Structural	6.4 Deep Foundation	n/a	n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Based on the recommendations for foundations of other structures, the soil at the site is overall in good condition because the soil bearing capacities are greater than 4 ksi (5.3 ksi – 6.9 ksi for barracks, Table 13). Deep foundations are required at HQ5 because wind uplift is high. Have helical anchors been considered a solution to improve uplift resistance for foundation at HQ5?

Submitted By: Tu Ha (215-656-6486). Submitted On: Aug 28 2020

1-0 Evaluation **Concurred**

Helical anchors were considered but ruled out due to lateral stiffness and bending resistance limitations associated with this type of deep foundation element. It is noted that lateral foundation loading occurs in conjunction with wind uplift loading, which would significantly limit any frictional foundation resistance at the footing/pile cap level and require mobilization of deep foundation element lateral resistance.

Submitted By: Lois Muller (412-269-6115) Submitted On: Sep 01 2020

1-1 Backcheck Recommendation **Close Comment**

Closed without comment.

Submitted By: Tu Ha (215-656-6486) Submitted On: Sep 07 2020

Current Comment Status: **Comment Closed**

8798857 Structural 6.4 Deep Foundation n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Section 6.4 Deep Foundations for HQ5 recommends a minimum of four (4) steel piles per foundation, spaced at a minimum of 3 pile diameters. This recommendation was based on the maximum uplift locations at columns E1 and E5 where the maximum uplift and shear are 62 kips and 18 kips, respectively. Uplift and shear forces at other columns are significantly less than those at columns E1 and E5 (see below).

Columns D1 & D5: 32 kips uplift and 14 kips shear
Columns D2.8 & D3.6: 51 kips uplift and 14 kips shear
Columns A1 & A5: 22 kips uplift and 8 kips shear
Note: All forces are unfactored.

1. Is the above recommendation "minimum of four (4) steel piles per foundation" applicable for all columns?

2. If different pile configurations are designed at other columns with smaller uplift and shear forces, the pile spacing is recommended at a minimum of 5 pile diameters. This may result in columns with smaller uplift and shear forces require bigger pile caps. Please verify this.

Submitted By: Tu Ha (215-656-6486). Submitted On: Aug 28 2020

1-0 Evaluation **For Information Only**

1. The 4-pile minimum recommendation is for the most heavily loaded foundation column locations. More lightly loaded foundations may employ fewer piles per unit, based on the discretion and judgement of the structural engineer, and using the allowable pile capacities and criteria provided in Section 6.4 of the geotechnical report (as supplemented in the response to Comment 2, below).

2.The 5-pile diameter minimum spacing recommendation was generally intended for

lightly loaded foundations, where a two-pile column support arrangement might be considered by the structural designer; under this scenario the larger pile spacing would only impact pile cap size in one direction. However, the designer may use a minimum pile spacing of 3-pile diameters, with the following modification to the deep foundation design recommendations: Referring to Section 6.4 of the geotechnical report, the design allowable shear load would be reduced from 11 kips per pile to 6.7 kips per pile for a minimum pile spacing of 3-pile diameters. Uplift capacity and other pile design criteria would be unchanged.

Submitted By: Lois Muller (412-269-6115) Submitted On: Sep 01 2020

1-1 Backcheck Recommendation **Close Comment**
Closed without comment.

Submitted By: Tu Ha (215-656-6486) Submitted On: Sep 07 2020
Current Comment Status: **Comment Closed**

8805949 Geotechnical n/a n/a n/a

Comment Classification: **Unclassified\\For Official Use Only (U\\FOUO)**

Report seems to comply with scope, no geotechnical comments.

Submitted By: Denard Burden (540-665-2593). Submitted On: Sep 01 2020

1-0 Evaluation **Concurred**
Thank you for the confirmation.

Submitted By: Lois Muller (412-269-6115) Submitted On: Sep 02 2020
Backcheck not conducted
Current Comment Status: **Comment Open**