GEO HYDRO ENGINEERS

Report of Subsurface Exploration and Geotechnical Engineering Evaluation

Highway 41 Water Main – Phase IV
Cobb County, Georgia

Prepared for Atkins North America
May 22, 2013

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May 22, 2013

Report of Subsurface Exploration
and Geotechnical Engineering Evaluation
Highway 41 Water Main – Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.00

Dear Mr. Puffer:

Geo-Hydro Engineers, Inc. has completed the authorized subsurface exploration for the above referenced project. The scope of services for this project was developed through emails, telephone conversations, and meetings with you and the project team. This report describes our understanding of the project and the subsurface conditions encountered, and contain our conclusions and recommendations regarding the geotechnical aspects of the proposed design and construction.

PROJECT INFORMATION

Proposed Water Main Replacement

Our understanding of the project is based on the information provided in the Attachment A (Scope of Work for Geotechnical Engineering Services) prepared by Atkins, our telephone conversations with you, and our review of project drawings prepared by Atkins. The project consists of about 15,000 feet of new ductile iron pipe with a diameter of 36 inches. The alignment will be located within the right-of-way of U.S. Highway 41 between its intersections with Franklin Road and Herodian Way in Cobb County, Georgia. Figure 1 in the Appendix shows the approximate proposed alignment. More specifically, the proposed alignment is located off the west (south-bound) edge of pavement of U. S. Highway 41. The water line will have a minimum of 10 feet of soil cover and will be deeper in several areas due to existing topography, utilities, and other factors.

The alignment will include seven jack-and-bore crossings beneath various roads and driveways as well as a 72-inch diameter tunnel beneath Windy Hill Road. The tunnel will have a total length of about 1,700 feet and will begin and end at approximate stations 59+00 and 76+00, respectively. The invert elevation of the proposed tunnel will have a maximum depth of 50 feet below the current ground elevation.

Existing Site Conditions

From station 0+00 to 26+00, the project alignment directly borders Dobbins Air Reserve Base. The remainder of the project alignment includes primarily commercial development. Topography along the alignment is typical for the Atlanta area with rolling upland areas separated by creeks and intermittent wet weather drainage features. The water main alignment crosses two perennial streams at approximate

stations 43+00 and 110+00. At both locations, the proposed water line invert elevation will be above the existing box culvert beneath U.S. Highway 41. We do not expect the creeks to impact construction activities. The right-of-way along the roads has numerous underground and overhead utilities.

EXPLORATORY PROCEDURES

Field Exploration

The subsurface exploration consisted of 30 machine-drilled soil test borings performed at the approximate locations shown on Figures 2 through 5 included in the Appendix. The borings were located in the field by Geo-Hydro based on the proposed alignment site plan provided to us. The borings were performed at preselected stations at accessible locations to avoid existing underground utilities, steep terrain, and traffic and safety concerns. After the borings were performed, Atkins surveyors recorded the northing, easting, and elevation of the test borings. That information is presented on the test boring records included in the Appendix. Stationing is included on the soil test boring records and was estimated from the drawings.

Standard penetration testing, as provided for in ASTM Dl586, was performed at select intervals in the machine-drilled borings. Soil samples obtained from the drilling operation were examined and classified in general accordance with ASTM D2488 (Visual-Manual Procedure for Description of Soils). Soil classifications include the use of the Unified Soil Classification System described in ASTM D2487 (Classification of Soils for Engineering Purposes). The soil classifications also include our evaluation of the geologic origin of the soils. Evaluations of geologic origin are based on our experience and may be subject to some degree of interpretation.

Rock coring was performed at two soil test boring locations. Coring was performed in general accordance with ASTM D2113 and rock quality designation (RQD) was determined in accordance with ASTM D6032.

Laboratory Testing

During our field exploration, bulk samples were obtained from the approximate water line elevation for laboratory testing at select boring locations. Laboratory tests for index properties was performed on bulk samples obtained from 12 boring locations and included moisture content (ASTM D2216), Atterberg Limits (ASTM D4318), and sieve analysis with hydrometer (ASTM D422). Additional laboratory testing for use by the corrosion engineer was performed on bulk samples obtained from seven boring locations and included resistivity (ASTM G57), oxidation-reduction potential (ASTM G200), as well as chlorides, sulfides, sulfates, and pH. Laboratory test results are included in the Appendix.

REGIONAL GEOLOGY

The project site is located in the northern Piedmont Geologic Province of Georgia. Published geologic literature indicates that the site is underlain by an un-named unit consisting of intermixed amphibolite, hornblende gneiss, and felsic gneiss. Soils in this area have been formed by the in-place weathering of the underlying crystalline rock, which accounts for their classification as "residual" soils. Residual soils near the ground surface, which have experienced advanced weathering, frequently consist of red brown clayey silt (ML) or silty clay (CL). The thickness of this surficial clayey zone may range up to roughly 6 feet. For various reasons, such as erosion or local variation of mineralization, the upper clayey zone is not always present.

With increased depth, the soil becomes less weathered, coarser grained, and the structural character of the underlying parent rock becomes more evident. These residual soils are typically classified as sandy micaceous silt (ML) or silty micaceous sand (SM). With a further increase in depth, the soils eventually become quite hard and take on an increasing resemblance to the underlying parent rock. When these materials have a standard penetration resistance of 100 blows per foot or greater, they are referred to as partially weathered rock. The transition from soil to partially weathered rock is usually a gradual one, and may occur at a wide range of depths. Lenses or layers of partially weathered rock are not unusual in the soil profile.

Partially weathered rock represents the zone of transition between the soil and the indurated metamorphic rocks from which the soils are derived. The subsurface profile is, in fact, a history of the weathering process which the crystalline rock has undergone. The degree of weathering is most advanced at the ground surface, where fine grained soil may be present. And, the weathering process is in its early stages immediately above the surface of relatively sound rock, where partially weathered rock may be found.

The thickness of the zone of partially weathered rock and the depth to the rock surface have both been found to vary considerably over relatively short distances. The depth to the rock surface may frequently range from the ground surface to 80 feet or more. The thickness of partially weathered rock, which overlies the rock surface, may vary from only a few inches to as much as 40 feet or more.

Stream valleys in the Piedmont Region may contain alluvial (water deposited) soils, depending on ground surface topography, stream flow characteristics, and other factors. By nature, alluvial soils can be highly variable depending upon the energy regime at the time of deposition. Coarse materials such as sand or gravel are deposited in higher energy environments, while fine grained materials such as silt and clay are deposited in low energy environments. Alluvial soils may also contain significant organic materials, and are frequently in a loose, saturated condition. In many cases, fine grained alluvial soils will be highly compressible and have relatively low shear strength.

Overall geologic conditions along sections of the water main alignment have been modified by previous grading activities for the roadways, utilities, commercial developments, etc., and alluvial deposition.

TEST BORING SUMMARY

Sixteen of the 30 borings initially encountered pavement materials consisting of 2 to 12 inches of asphalt underlain by 3 to 16 inches of graded aggregate base (GAB). The remaining borings were performed in landscaped, grassed, and wooded areas and initially encountered approximately 1 to 3 inches of topsoil. Thicker topsoil may be present in other areas of the water main alignment intermediate of the borings.

In general, the overburden soils (cultivated, fill, alluvium, and residuum) consisted mostly of silty clays, clayey silts, sandy silts, and silty sands typical of the Piedmont region. Fill material was encountered in 27 of the 30 borings extending to depths ranging from about 3 to 22 feet. Due to the commercial development along U.S. Highway 41, we expect that fill materials are largely related to roadway construction and localized commercial construction. The quality of fill materials should be expected to vary along the alignment.

Alluvial clays and sands were encountered in borings B-25 and B-26. The alluvial soils ranged in depth from about 6 to 12 feet. Many of the split spoon samples appeared to have high moisture contents.

Twelve of the borings encountered partially weathered rock beginning at depths ranging from about 3 to 37 feet. Partially weathered rock is locally defined as residual material having a standard penetration resistance of 100 blows per foot or greater. Partially weathered rock was encountered at or above the proposed invert elevation at boring locations B-11, B-12, B-17, B-21, B-24, and B-28.

Materials causing auger refusal were encountered in borings B-11, B-12, B-16, B-17, B-24, B-25, and B-28 at depths ranging from 8 to 43 feet. Auger refusal is the condition that prevents further advancement of the boring using conventional soil drilling techniques. The remaining borings were extended to their planned termination depths without encountering auger refusal. Conditions causing auger refusal were encountered at or above the proposed invert elevation at boring locations B-12, B-16, and B-17.

Starting at the depth of auger refusal, rock coring was performed in borings B-16 and B-17 to sample the refusal materials. A total of 38 and 7 feet of rock coring was performed in borings B-26 and B-17, repectively. The recovered rock consisted of unweathered to highly weathered biotite gneiss. The percent recovery ranged from 51 to 100 percent, and the rock quality designation (RQD) ranged from 12 to 100 percent.

Twenty-four hours after drilling completion, groundwater was encountered in 19 of the 30 soil test borings. The depth to groundwater varied from about 6 to 29 feet below the ground surface. Groundwater was encountered at or above the proposed invert elevation at 14 boring locations including all borings performed between stations 70+00 and 104+20. For safety reasons, borings B-26 and B-27 were backfilled immediately upon completion and patched with asphalt. It is important to note that groundwater levels will fluctuate depending on seasonal variations of precipitation and other factors, and may occur at higher elevations in the future.

For more detailed descriptions of subsurface conditions, please refer to the summary table and test boring records included in the Appendix.

EVALUATIONS AND RECOMMENDATIONS

The following evaluations are based on the information available on the proposed water main alignment, the data obtained from the exploratory borings and laboratory testing, and our experience with soils and subsurface conditions similar to those encountered at the explored locations. Because the subsurface exploration represents a statistically small sampling of subsurface conditions, it is possible that conditions between the test borings may be substantially different from those indicated by the borings.

Excavation Characteristics

Borings B-11, B-12, B-17, B-21, B-24, and B-28 encountered partially weathered rock at or above the proposed invert elevation for the water line. Borings B-14 and B-30 encountered partially weathered rock within about 2 to 3 feet of the proposed invert elevation. Borings B-12, B-16, and B-17 encountered conditions causing auger refusal above the planned invert elevation. Based on the soil test boring data, difficult excavation conditions should be expected in these areas. Partially weathered rock can typically be removed with adequate equipment. However, larger boulders, rock lenses, and rock seams within partially weathered rock can hinder excavation. Based on the rock coring data, the underlying rock is weathered to varying degrees and consists of a transition from weathered to unweathered rock. The depth of this weathered rock horizon will vary along the alignment. A budget contingency should be included for rock excavation.

Partially weathered rock and conditions causing auger refusal were also encountered in borings B-13, B-23, B-25, and B-27 at depths ranging from 17 to 22 feet. Based on the proposed water line profiles provided to us, we do not expect difficult excavation conditions in these areas because we do not expect construction activities to extend to these depths.

It is important to note that the geology of the Piedmont is characterized by variable subsurface conditions. Due to the widely-spaced nature of the borings, it is likely that subsurface conditions intermediate of the borings will be different. Weathered rock, mass rock, boulders, and rock seams may all be encountered at different locations along the alignment.

For construction bidding and field verification purposes it is common to provide a verifiable definition of rock in the project specifications. The following is a typical definition of trench rock:

- Trench Rock: Material occupying an original volume of at least one-half cubic yard which cannot be excavated with a hydraulic excavator having a minimum flywheel power rating of 123 kW (165 hp); such as a Caterpillar 322C L, John Deere 230C LC, or a Komatsu PC220LC-7; equipped with a short tip radius bucket not wider than 42 inches.

Crossings

Based on the results of borings B-15, B-16, B-17, and B-18, soil and weathered and unweathered rock will be encountered at the invert elevation of the proposed 72-inch diameter tunnel beneath Windy Hill Road. Current plans include boring a 72-inch casing to house the 36-inch water line. Based on our experience, tunneling techniques for installing tunnels through soil and rock are well established, but the two techniques are difficult to combine on a single tunnel. Boring through soil and rock present separate challenges and are typically performed with different equipment. If possible, we recommend installing the water line using traditional cut and cover techniques along this section of the alignment.

Based on the results of borings B-11 and B-12, we expect that the crossing at Airport Industrial Drive and Caswell Parkway will involve rock excavation for portions of the alignment. Jack-and-bore crossings through variable materials consisting of soil and rock can be problematic and result in change orders and project delays. It may be prudent to install the crossings using conventional cut and cover methods to avoid the delays and cost overruns associated with jack and bore crossings performed through variable subsurface materials.

Borings B-24 and B-28 were performed within planned jack-and-bore bits and encountered partially weathered rock above the bottom of the planned pits. We expect that the materials that will be encountered by the jack and bore rig will include partially weathered rock, dense soil, and soil.

We do not anticipate that the remaining crossings will be significantly hindered by partially weathered rock or rock as long as excavation for installation of the water main does not extend deeper than the depths explored.

Groundwater will be a concern for pipe installation at the creek crossings and near the perennial streams. We provide additional discussion regarding temporary groundwater control in the *Construction Dewatering* section below. In addition to the pipe trench, driving and receiving pits for jack-and-bore crossings will have to be adequately dewatered to allow construction.

Earth Slopes

Temporary construction slopes should be designed in strict compliance with OSHA regulations. The exploratory borings indicate that most soils along the alignment are Type B or C as defined in 29 CFR 1926.650 (1994 Edition). In general, we recommend that temporary construction slopes be no steeper than 1.5H:1V for excavation depths of 20 feet or less. However, temporary excavation slopes in firm residual soils above the groundwater level can have a gradient of 1H:1V. Temporary construction slopes should be closely observed on a daily basis by the contractor's "competent person" for signs of mass movement: tension cracks near the crest, bulging at the toe of the slope, etc. The responsibility for excavation safety and stability of temporary slopes should lie solely with the contractor.

We recommend that extreme caution be observed in trench excavations. Several cases of loss of life due to trench collapses in Georgia point out the lack of attention given to excavation safety on some projects. We recommend that applicable local and federal regulations regarding temporary slopes, and shoring and bracing of trench excavations be closely followed.

Temporary Excavation Bracing

If at a given location a sloped excavation is not feasible, temporary excavation bracing will be required. The most appropriate type of excavation bracing will be dictated by subsurface conditions at the specific excavation or pit location. Typically, the contractor will design and implement temporary excavation bracing as part of means and methods. Temporary excavation support systems submitted by the contractor should be reviewed by Atkins and Geo-Hydro.

Construction Dewatering

Based on the groundwater levels in the borings, groundwater will be encountered in several sections of the water main alignment. The main area that will be affected involves the southern 5,500 feet of the alignment. However, groundwater may be encountered in other low-lying areas along the alignment. Dewatering should be performed to maintain the groundwater level approximately 2 to 3 feet below the lowest prevailing excavation depth. In most cases we expect that direct pumping from the excavation will provide satisfactory temporary construction dewatering. However, the actual dewatering approach will be dictated by conditions at the time of excavation. Sand layers or other more permeable soil layers may significantly increase the amount of water inflow into open excavations.

The amount of temporary dewatering actually required during construction is related not only to the prevailing weather conditions, but also the contractor's sequencing of construction activities. Construction specifications should include performance guidelines for temporary dewatering. Performance guidelines allow the contractor to select the actual means and methods of construction dewatering. The following sample specification[1] could be used as a guide for development of actual specifications.

> *Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavation slopes, and will not result in damage to existing structures. Where necessary to these purposes, the water level shall be lowered in advance of excavation, utilizing trenches, sumps, wells, well points, or similar methods. The water level, as measured in piezometers, shall be maintained a minimum of 3 feet below the prevailing excavation level. Open pumping from sumps and ditches, if it results in boils, loss of soil fines, softening of the ground, or instability of slopes, will not be permitted. Wells and well points shall be installed with suitable screens and filters so that*

[1] The sample specification was adapted from Construction Dewatering - A Guide to Theory and Practice, John Wiley and Sons, and is not intended for direct use as a construction specification without modifications to reflect specific project conditions.

continuous pumping of soil fines does not occur. The discharge shall be arranged to facilitate collection of samples by the Engineer.

We recommend that pipe bedding be used where groundwater is encountered. This will provide a level, stable base for pipe installation. We recommend #57 or #78 crushed stone meeting Georgia DOT specifications as pipe bedding.

Structural Fill Placement

We anticipate that the overburden soils (fill, alluvium, and residuum) can be reused as structural fill to backfill the pipe trench. Materials selected for use as structural fill should be free of organic matter, waste construction debris, and other deleterious materials. In general, the material should not contain rocks having diameters over 4 inches. It is our opinion that the following soils represented by their USCS group symbols will typically be suitable for use as structural fill and are commonly found in abundance in the Piedmont region: (CL), (SM), and (ML). The following soil types are typically suitable but are not abundant in the Piedmont region: (SW), (SP), (SC), (SP-SM), and (SP-SC). The following soil types are considered unsuitable: (MH), (CH), (OL), (OH), and (Pt).

Laboratory Proctor compaction tests should be performed on representative samples of proposed fill materials to provide data necessary to determine acceptability and for quality control. The moisture content of suitable borrow soils should generally be no more than 3 percentage points above or below their optimum moisture contents at the time of compaction. Tighter moisture limits may be necessary with certain soils.

Suitable fill material should be placed in thin lifts. Lift thickness depends on type of compaction equipment; but in general lifts of 8 inches loose measurement are recommended. The soil should be compacted by heavy compaction equipment such as a self-propelled sheepsfoot roller. Within confined areas, such as around the pipe or manhole structures, we recommend the use of "wacker packers" or "Rammax" compactors to achieve the specified compaction. Loose lift thicknesses of 4 to 6 inches are recommended in small area fills.

In general, we recommend that structural fill be compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). Following Georgia DOT guidelines, the upper 12 inches of pavement subgrade soils should be compacted to at least 100 percent of the standard Proctor maximum dry density. Geo-Hydro should perform density tests during fill placement.

We expect that a significant portion of the soils excavated during the water main installation will have moisture contents too high to allow proper compaction. Most or all of the alluvial soils will be too wet for immediate reuse and residual soils excavated from elevations approaching and extending below the groundwater level will have moisture contents that will be too high.

Air-drying can be performed in the warmer, drier periods of the year but drying soil is typically only practical on larger grading sites. We expect that the most practical option will be to use a chemical agent,

such as lime, to dry the soils but areas to spread soils are still needed. One or more staging areas near the project alignment could be used to dry wet soils. The contractor should be prepared to dry soils on this project. We can provide further guidance concerning the use of lime once a contractor is selected and a plan for addressing wet backfill soils is developed. Budget planning should consider the need to dry or replace wet soils.

Some of the alluvial material encountered in boring B-2 contained organic material such as rotten wood. Similar materials may be present in alluvial soils elsewhere along the alignment that were not encountered in the test borings. These materials will have to be wasted regardless of moisture content.

Pipe Support

Based on the results of the test borings and our observations, it is likely that conditions varying from loose alluvium to partially weathered rock or rock will be exposed at bearing elevation for the water main. In order to limit potential differential settlement and stress concentrations at the interface of dissimilar bearing materials, soft soils should be removed and pipe bedding consisting of crushed stone should be placed as necessary. Bedding will likely be needed in conjunction with dewatering as discussed above. This approach will also provide a stable and relatively level working surface during installation of pipe sections.

We recommend that project plans require at least 12 inches of #57 or #78 crushed stone meeting Georgia DOT specifications as bedding for the pipe. This approach should result in satisfactory removal of the upper portion of loose soils, where present, and would establish a relatively uniform bearing surface.

Subsurface conditions will vary, and we recommend that a qualified geotechnical engineer be present during preparation of bearing surfaces for the pipeline.

Thrust Block Design

At the time of this report, locations along the alignment that will require a thrust block had not been provided to us. Once final locations are determined for any thrust blocks along the alignment, please allow us to revise our recommendations. The following paragraphs outline general thrust block recommendations that can be used for planning purposes. Depending on the actual thrust block locations, more favorable parameters and recommendations may be possible.

Passive earth pressure may be evaluated using the following equation:

$$p_h = K_p (D_w Z + q_s) + W_w(Z-d)$$

where: p_h = horizontal earth pressure at any depth below the ground surface (Z)
W_w = unit weight of water
Z = depth to any point below the ground surface

d = depth to groundwater surface
D_w = partially saturated unit weight of the soil backfill (depending on borrow sources). The partially saturated unit weight of most residual soils may be expected to range from approximately 115 to 125 pcf. Below the groundwater level, D_w must be the buoyant weight.
q_s = uniform, permanent surcharge load
K_p = Passive earth pressure coefficient (3.0)

For analysis of sliding resistance at the base of the block, the coefficient of friction may be taken as 0.4 for residual soils in contact with the bottom of the block. This is an ultimate value and an adequate safety factor should be used in design. Full development of the frictional force could require deflection of roughly 0.1 to 0.3 inches.

The base of the thrust block should bear on relatively firm soils. Provided that a stable bearing surface is available, an allowable bearing pressure of 2,000 psf can be used in design of support for the block. The thrust block subgrade must be evaluated by Geo-Hydro to verify that the recommended bearing pressure is available. Also, the block location must be properly dewatered to reduce disturbance to the block subgrade. If the subgrade soils become water-softened, undercutting may be required to remove soft soils. If friction at the base of the block is used to resist sliding, lean concrete must be used to backfill any undercut areas.

Wetlands and Perennial Streams

Based on the work performed by Geo-Hydro's wetlands and ecological sub-consultant, there are no wetlands within 100 feet of the west edge of pavement along the portion of U.S. Highway 41 between Franklin Road and Herodian Way. Perennial streams were located within 200 feet of the west edge of pavement along the relevant section of U.S. Highway 41 at two locations. One stream is located on the east side of U.S. Highway 41 south of Cumberland Point Drive across U. S. Highway 41 from Dobbins Air Reserve Base. The second stream is located on the west side of U.S. Highway 41 from the Lake Park Development south to Calibre Brooke Way.

The Appendix contains field maps prepared by Geo-Hydro's wetlands and ecological sub-consultant showing the field delineated stream locations. The streams were delineated in the field using pink ribbon.

* * * * *

Geo-Hydro Engineers, Inc. has appreciated the opportunity to work with you on this phase of the project, and we look forward to providing any additional services you may require. If you have any questions concerning this report or any of our services, please call us.

Sincerely,

GEO-HYDRO ENGINEERS, INC.

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Luis E. Babler, P.E.
Chief Geotechnical Engineer
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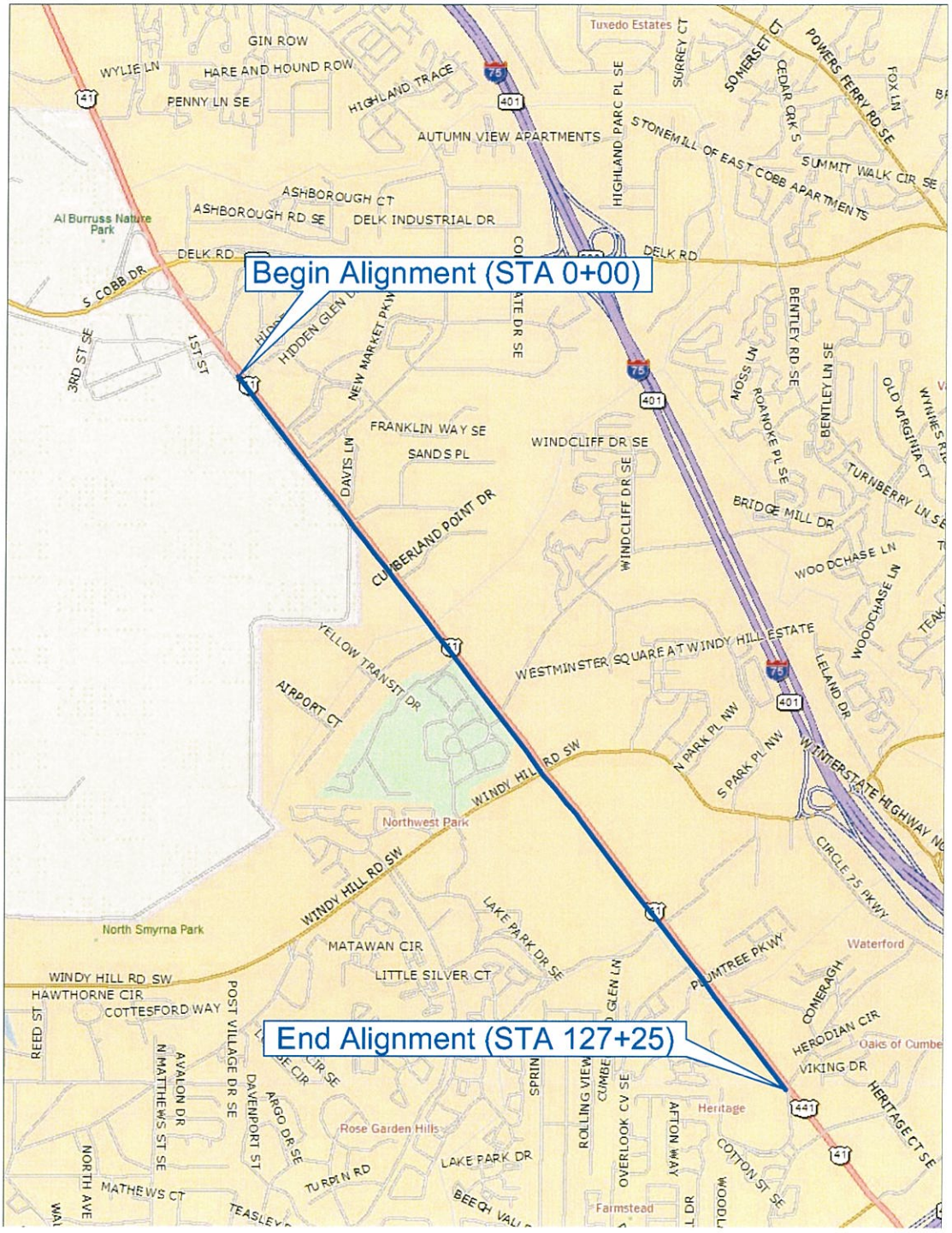
AMP/LEB/130107.00 - U.S. Highway 41 Water Main - Phase IV - Geotechnical Report

APPENDIX



0 0.25 0.5 1 1.5

Approximate Scale, Miles

Figure 1: Site Location Plan

Highway 41 Water Main - Phase IV
Cobb County, Georgia
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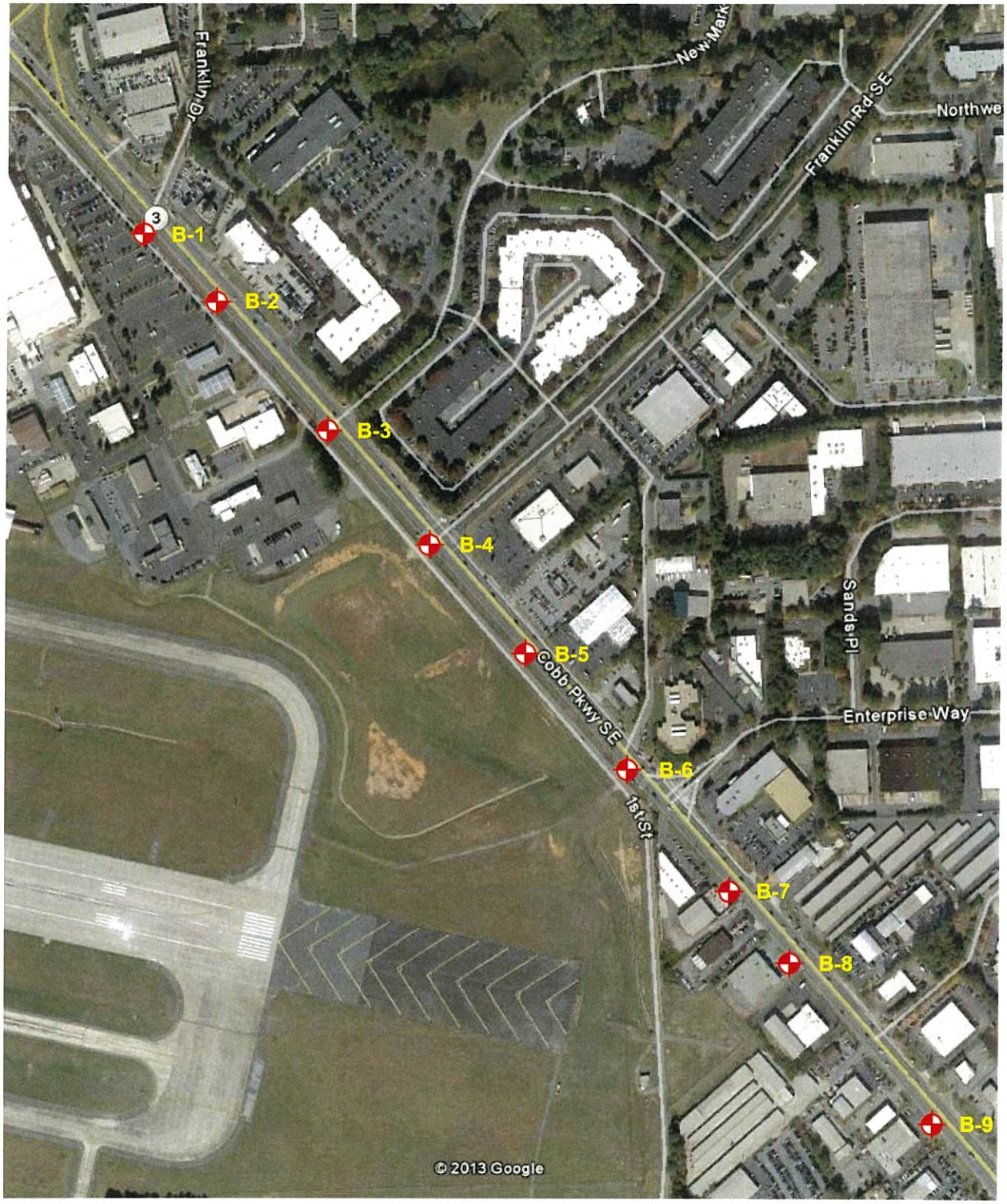


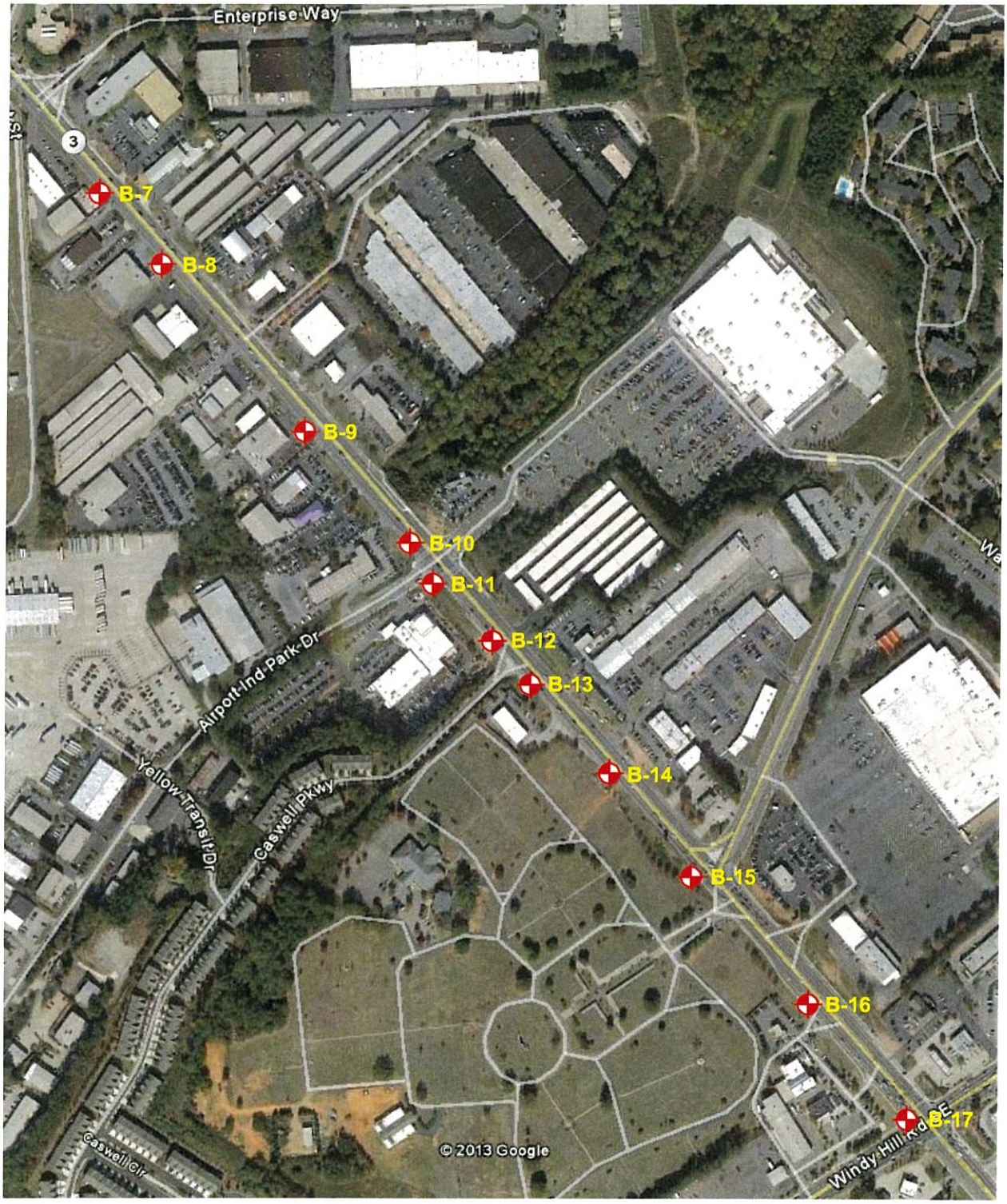
LEGEND: Soil Test Boring

0 250 500 1000 1500

Approximate Scale: 1"=500'

Figure 2: Boring Location Plan
(1 of 4)

Highway 41 Water Main - Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.00



LEGEND: Soil Test Boring

0 250 500 1000 1500

Approximate Scale: 1"=500'

Figure 3: Boring Location Plan
(Page 2 of 4)

Highway 41 Water Main - Phase IV
Cobb County, Georgia
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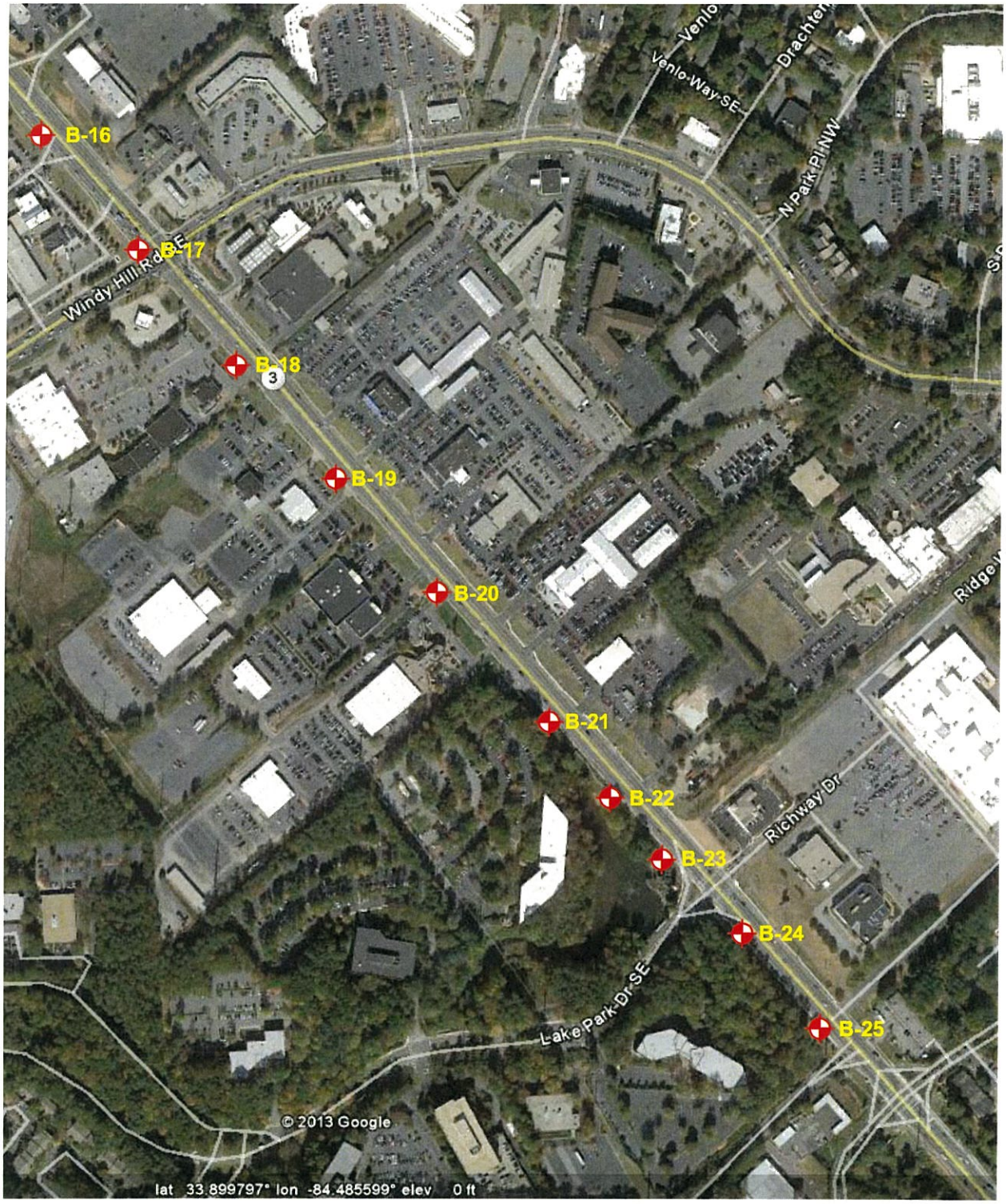

LEGEND: Soil Test Boring

0 250 500 1000 1500

Approximate Scale: 1"=500'

Figure 4: Boring Location Plan
(Page 3 of 4)

Highway 41 Water Main - Phase IV
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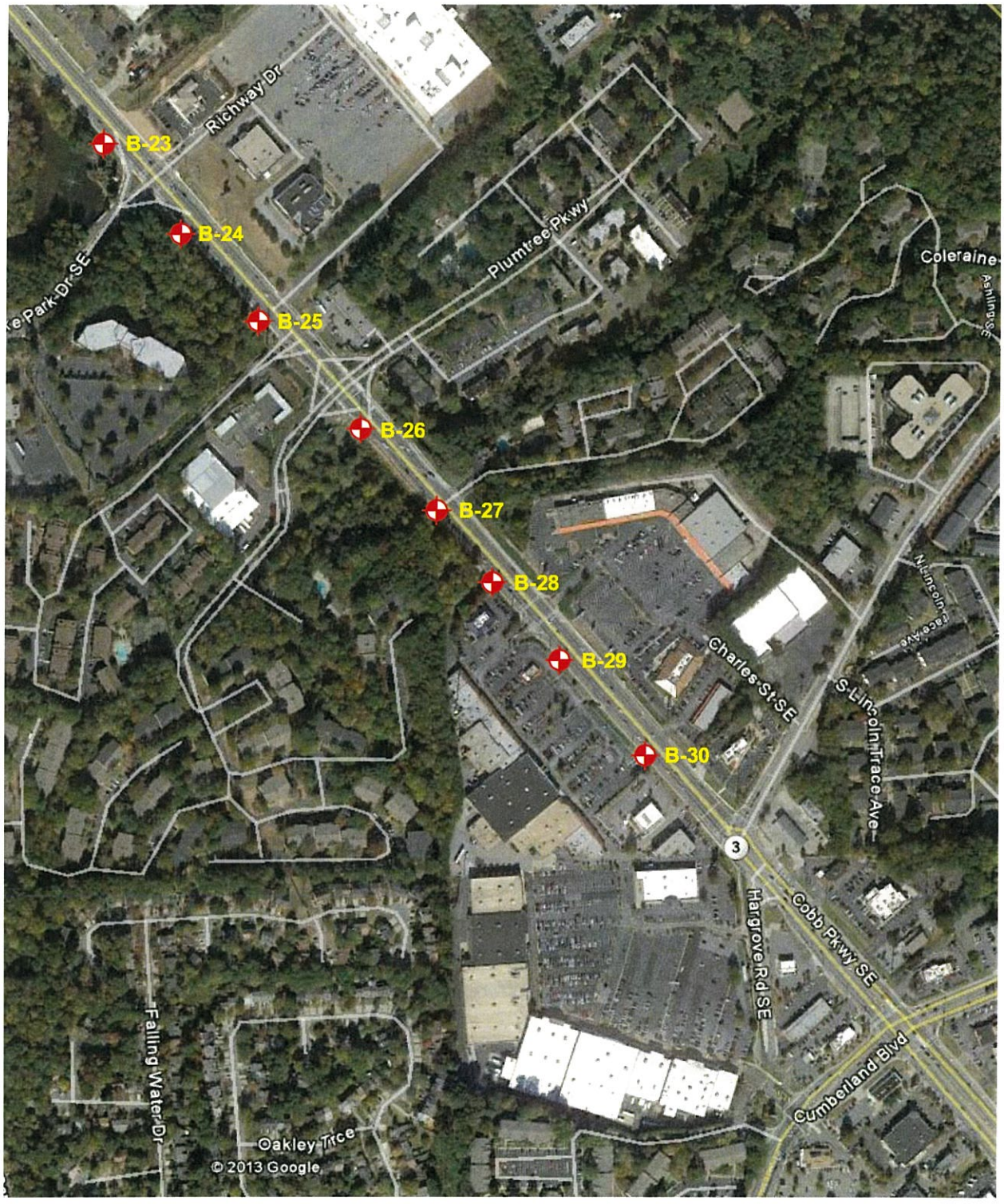


LEGEND: Soil Test Boring

0 250 500 1000 1500

Approximate Scale: 1"=500'

Figure 5: Boring Location Plan
(Page 4 of 4)

Highway 41 Water Main - Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.00

Table 1: Summary of Soil Test Borings
U.S. Highway 41 Water Main - Phase IV
Cobb County, Georgia
Project Number 130107.00

Boring	Approx. Ground Elevation	Approx. Station Number	Prop. Invert Elevation	Groundwater		Bottom of Fill/ Cultivated		Bottom of Alluvium		Top of PWR		Auger Refusal		Boring Termination	
				Depth (feet)	Approx. Elevation	Depth (feet)	Approx. Elevation	Depth (feet)	Approx. Elevation	Depth (feet)	Approx. Elevation	Depth (feet)	Approx. Elevation	Depth (feet)	Approx. Elevation
B-1	1005	1+25	992	16	989	3	1002	N.E.	-	N.E.	-	N.E.	-	20	985
B-2	1003	5+00	990	11	**992**	3	1000	N.E.	-	N.E.	-	N.E.	-	20	983
B-3	1012	10+00	1000	N.E.	-	3	1009	N.E.	-	N.E.	-	N.E.	-	20	992
B-4	1014	15+00	1001	N.E.	-	3	1011	N.E.	-	N.E.	-	N.E.	-	20	994
B-5	992	20+00	977	17	975	3	989	N.E.	-	N.E.	-	N.E.	-	20	972
B-6	985	25+00	970	N.E.	-	6	979	N.E.	-	N.E.	-	N.E.	-	20	965
B-7	982	30+00	968	N.E.	-	3	979	N.E.	-	N.E.	-	N.E.	-	20	962
B-8	972	34+00	954	N.E.	-	6	966	N.E.	-	N.E.	-	N.E.	-	20	952
B-9	950	40+00	937	13	937	6	944	N.E.	-	N.E.	-	N.E.	-	20	930
B-10	968	45+00	955	N.E.	-	22	946	N.E.	-	N.E.	-	N.E.	-	30	938
B-11	985	47+65	973	9	**976**	3	982	N.E.	-	6	**979**	16	969	16	969
B-12	998	49+50	985	N.E.	-	3	995	N.E.	-	6	**992**	8	**990**	8	**990**
B-13	1011	51+50	996	11	**1000**	3	1008	N.E.	-	22	989	N.E.	-	30	981
B-14	1027	55+00	1013	N.E.	-	N.E.	-	N.E.	-	17	1010	N.E.	-	20	1007
B-15	1024	60+00	1008	11	**1013**	12	1012	N.E.	-	N.E.	-	N.E.	-	20	1004
B-16	1046	65+00	1006	N.E.	-	N.E.	-	N.E.	-	N.E.	-	12	**1034**	50	996
B-17	1052	70+00	1003	29	**1023**	N.E.	-	N.E.	-	37	**1015**	43	**1009**	50	1002
B-18	1023	75+00	1000	21	**1002**	8	1015	N.E.	-	N.E.	-	N.E.	-	30	993
B-19	993	80+00	979	8	**985**	3	990	N.E.	-	N.E.	-	N.E.	-	20	973
B-20	963	85+00	949	6	**957**	12	951	N.E.	-	N.E.	-	N.E.	-	20	943
B-21	946	90+00	933	10	**936**	12	934	N.E.	-	12	**934**	N.E.	-	20	926
B-22	939	93+50	920	19	920	12	927	N.E.	-	N.E.	-	N.E.	-	25	914
B-23	934	96+75	921	13	**921**	3	931	N.E.	-	17	917	N.E.	-	30	904
B-24	921	99+75	905	15	**906**	6	915	N.E.	-	8	**913**	27	894	27	894
B-25	899	104+20	883	13	**886**	6	893	8	891	22	877	26	873	26	873
B-26	901	109+00	883	19	882	12	889	22	879	N.E.	-	N.E.	-	30	871
B-27	925	113+00	913	N/A	-	8	917	N.E.	-	17	908	N.E.	-	20	905
B-28	947	116+40	935	6	**941**	3	944	N.E.	-	3	**944**	21	926	21	926
B-29	964	118+60	950	7	**957**	8	956	N.E.	-	N.E.	-	N.E.	-	30	934
B-30	990	124+00	984	6	984	3	987	N.E.	-	8	982	N.E.	-	30	960

N.E.: Not Encountered PWR: Partially Weathered Rock

GEO HYDRO ENGINEERS

Symbols and Nomenclature

Symbols

▮	Thin-walled tube (TWT) sample recovered
▯	Thin-walled tube (TWT) sample not recovered
●	Standard penetration resistance (ASTM D1586)
50/2"	Number of blows (50) to drive the split-spoon a number of inches (2)
65%	Percentage of rock core recovered
RQD	Rock quality designation - % of recovered core sample which is 4 or more inches long
GW	Groundwater
▼	Water level at least 24 hours after drilling
▽	Water level one hour or less after drilling
ALLUV	Alluvium
TOP	Topsoil
PM	Pavement Materials
CONC	Concrete
FILL	Fill Material
RES	Residual Soil
PWR	Partially Weathered Rock
SPT	Standard Penetration Testing

Penetration Resistance Results	Number of Blows, N	Approximate Relative Density
Sands	0-4	very loose
	5-10	loose
	11-20	firm
	21-30	very firm
	31-50	dense
	Over 50	very dense

	Number of Blows, N	Approximate Consistency
Silts and	0-1	very soft
Clays	2-4	soft
	5-8	firm
	9-15	stiff
	16-30	very stiff
	31-50	hard
	Over 50	very hard

Drilling Procedures

Soil sampling and standard penetration testing performed in accordance with ASTM D 1586. The standard penetration resistance is the number of blows of a 140-pound hammer falling 30 inches to drive a 2-inch O.D., 1.4-inch I.D. split-spoon sampler one foot. Rock coring is performed in accordance with ASTM D 2113. Thin-walled tube sampling is performed in accordance with ASTM D 1587.

GEO HYDRO ENGINEERS

B-1

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1005**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **16 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot)
1005	0			Topsoil (Approximately 2 inches)		
				Loose brown silty fine sand (SM) (FILL)	6	
1000	5			Firm pink, tan, and black fine sandy silt (ML) (RESIDUUM)	6	
					6	
995	10				5	
990	15	▼			6	
985	20			Boring Terminated at 20 feet	7	
980	25					
975	30					
970	35					
965	40					
960	45					
955	50					
950	55					
	60					

Standard Penetration Test (Blows/Foot): 0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 1+25
Northing: 1425333.42 Easting: 2195045.98

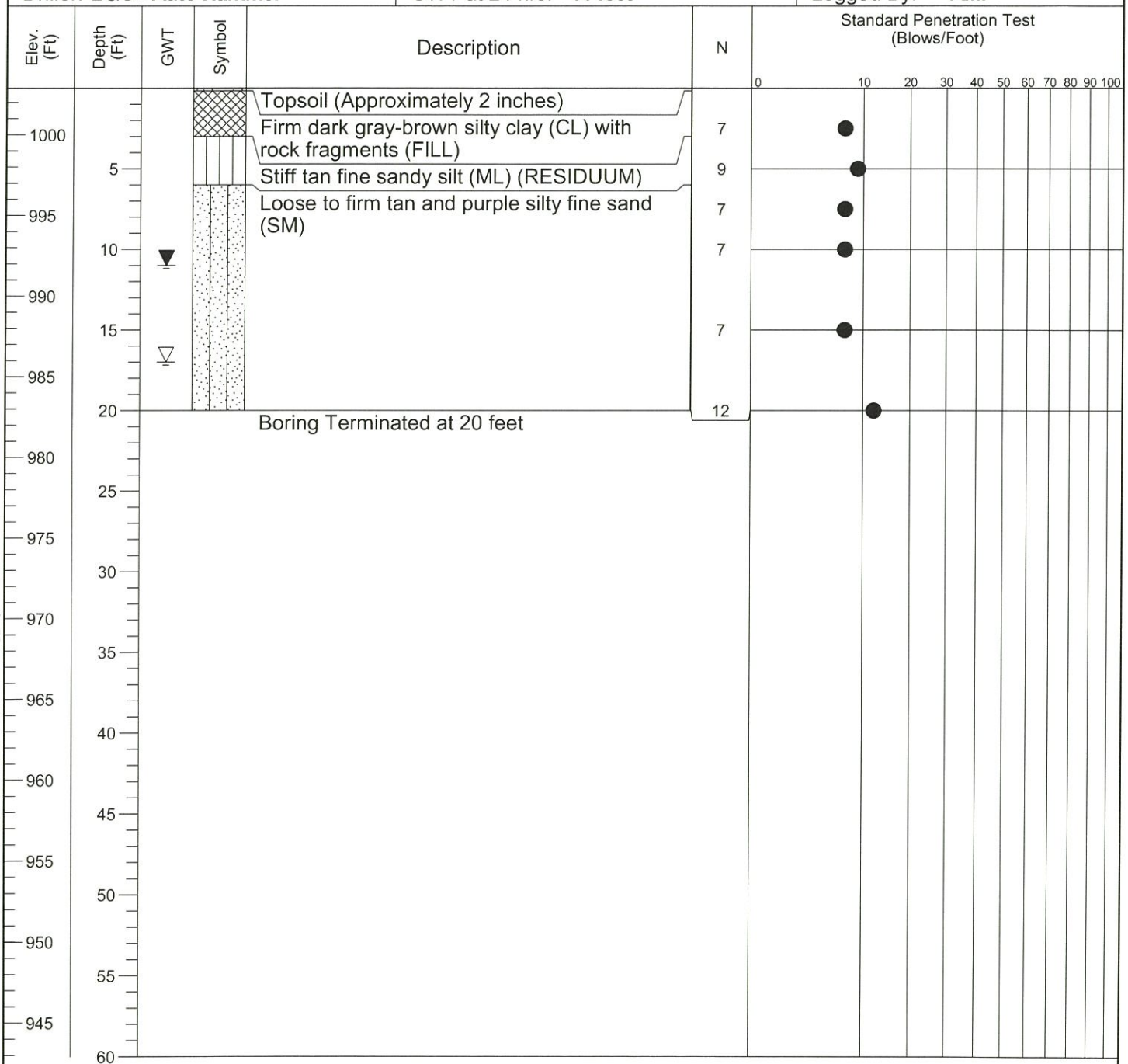
TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-2

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **17 feet**	G.S. Elev: **1003**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **11 feet**	Logged By: **AMP**



Remarks: Approximate Station 5+00
Northing: 1425035.86 Easting: 2195275.34

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-3

Test Boring Record

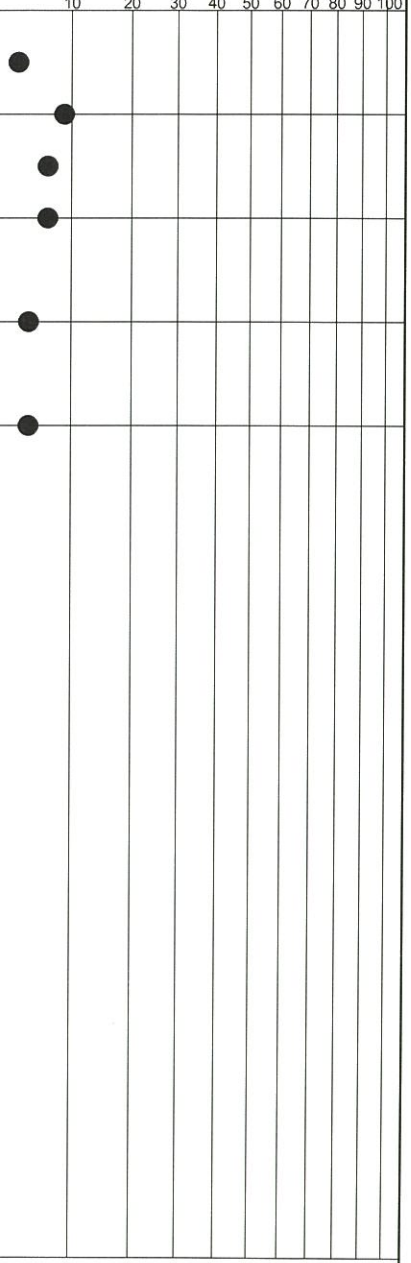
GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1012**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 17 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	Description	N
1010	0	Topsoil (Approximately 2 inches)	
		Soft brown silty clay (CL) (FILL)	4
	5	Firm to stiff orange, black, and pink fine sandy silt (ML) (RESIDUUM)	9
1005			7
	10		7
1000			
	15		5
995			
	20	Boring Terminated at 20 feet	5
990	25		
985			
	30		
980			
	35		
975			
	40		
970			
	45		
965			
	50		
960			
	55		
955			
	60		

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100



Remarks: Approximate Station 10+00
Northing: 1424642.72 Easting: 2195572.99

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-4

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1014**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 17 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	Description	N
1014	0	Topsoil (Approximately 2 inches)	
		Firm red-orange silty clay (CL) (FILL)	6
1010	5	Loose to firm pink and tan micaceous silty fine sand (SM) (RESIDUUM)	11
1005	10		11
			12
1000	15		10
995	20	Boring Terminated at 20 feet	13
990	25		
985	30		
980	35		
975	40		
970	45		
965	50		
960	55		
955	60		

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 15+00
Northing: 1424241.98 Easting: 2195882.72

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-5

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **992**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **17 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
990	0			Topsoil (Approximately 2 inches)	
				Soft gray-brown clayey silt (ML) (FILL)	4
	5			Very loose to loose orange-tan to gray silty fine sand (SM) (RESIDUUM)	6
985					6
	10				6
980					
	15	▼			4
975					
	20			Boring Terminated at 20 feet	6
970					
	25				
965					
	30				
960					
	35				
955					
	40				
950					
	45				
945					
	50				
940					
	55				
935					
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 20+00
Northing: 1423860.79 Easting: 2196178.95

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-6

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **985**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 17 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
985	0			Topsoil (Approximately 2 inches)	
				Firm dark red-brown clayey silt (ML) (FILL)	5
980	5				5
				Firm orange-brown clayey silt (ML) (RESIDUUM)	5
975	10				5
				Loose to firm black and tan to tan silty fine sand (SM)	20
970	15				
965	20			Boring Terminated at 20 feet	8
960	25				
955	30				
950	35				
945	40				
940	45				
935	50				
930	55				
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 25+00
Northing: 1423468.80 Easting: 2196477.52

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

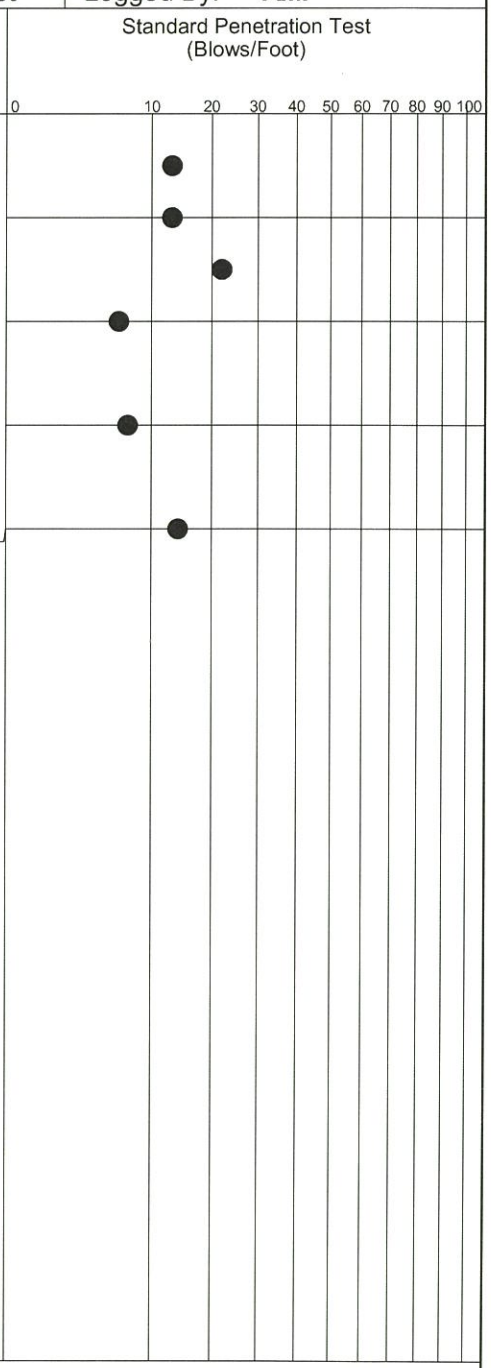
B-7

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **982**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 17 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
980	0			Topsoil (Approximately 3 inches)	
				Stiff orange clayey silt (ML) (FILL)	13
	5			Firm to very firm red to orange micaceous silty fine sand (SM) (RESIDUUM)	13
975					22
	10			Loose to firm purple micaceous silty fine sand (SM)	6
970					
	15				7
965					
	20			Boring Terminated at 20 feet	14
960					
	25				
955					
	30				
950					
	35				
945					
	40				
940					
	45				
935					
	50				
930					
	55				
925					
	60				



Remarks: Approximate Station 30+00
Northing: 1423057.40 Easting: 2196789.12

B-8

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/9/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **972**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 18 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
970	0			Topsoil (Approximately 2 inches)	
				Very loose dark brown micaceous silty fine sand (SM) (FILL)	3
	5			Firm gray-brown silty clay (CL) with colloidal organic material (FILL)	6
965				Stiff orange and red silty clay (CL) (RESIDUUM)	9
	10			Loose orange to gray and white micaceous silty fine sand (SM)	8
960					
	15				8
955					
	20			Boring Terminated at 20 feet	9
950					
	25				
945					
	30				
940					
	35				
935					
	40				
930					
	45				
925					
	50				
920					
	55				
915					
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 34+00
Northing: 1422834.56 Easting: 2196962.42

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-9

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/1/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **13 feet**	G.S. Elev: **950**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **13 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
950	0			Asphalt (Approximately 2 inches)	
				Graded Aggregate Base (Approximately 16 inches)	5
945	5			Soft to firm orange-brown silty clay (CL) (FILL)	4
				Very loose tan silty fine sand (SM) (RESIDUUM)	3
940	10	▼		Very loose to loose tan to dark brown micaceous silty fine sand (SM)	3
935	15				3
930	20			Boring Terminated at 20 feet	6
925	25				
920	30				
915	35				
910	40				
905	45				
900	50				
895	55				
890	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 40+00
Northing: 1422256.94 Easting: 2197406.19

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-10

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **968**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 19 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
968	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 11 inches)	9
965	5			Stiff red-brown silty clay (CL) (FILL)	9
960	10			Loose to firm red-brown and gray silty fine sand (SM) (FILL)	13
				(No sample recovered at 10 feet)	13
955	15			Very loose to loose red-brown to gray and orange silty fine sand (SM) (FILL)	3
950	20				6
945	25			Firm tan to gray silty fine sand (SM) (RESIDUUM)	13
940	30			Boring Terminated at 30 feet	12
935	35				
930	40				
925	45				
920	50				
915	55				
910	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 45+00
Northing: 1421865.59 Easting: 2197706.70

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-11

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **985**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **9 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot)
985	0			Asphalt (Approximately 6 inches)		
				Graded Aggregate Base (Approximately 12 inches)	7	
980	5			Loose brown micaceous silty fine sand (SM) with rock fragments (FILL)	36	
		▼		Dense dark brown and orange micaceous silty fine sand (SM) (RESIDUUM)	50/3"	
975	10			Partially weathered rock sampled as gray and white micaceous silty fine sand (SM) with rock fragments	50/1"	
970	15			(No sample recovered at 10 and 15 feet)	50/1"	
				Auger Refusal at 16 feet		
965	20					
960	25					
955	30					
950	35					
945	40					
940	45					
935	50					
930	55					
	60					

Standard Penetration Test (Blows/Foot): 0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 47+65
Boring was offset after encountered auger refusal at 11 feet and approximate station 47+50
Northing: 1421660.11 Easting: 2197866.38

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-12

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **998**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **N/A (Boring Backfilled)**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot)
998	0			Asphalt (Approximately 10 inches)		
				Graded Aggregate Base (Approximately 10 inches)	11	
995	5			Firm brown and gray micaceous silty fine sand (SM) (FILL)	50/5"	
990	8			Partially weathered rock sampled as gray and brown micaceous silty fine sand (SM)	50/3"	
	10			Auger Refusal at 8 feet		
985	15					
980	20					
975	25					
970	30					
965	35					
960	40					
955	45					
950	50					
945	55					
940	60					

Standard Penetration Test (Blows/Foot): 0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 49+50
Boring was offset to station 49+30 and encountered auger refusal at 5 feet
Northing: 1421500.71 Easting: 2197986.28

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-13

Test Boring Record

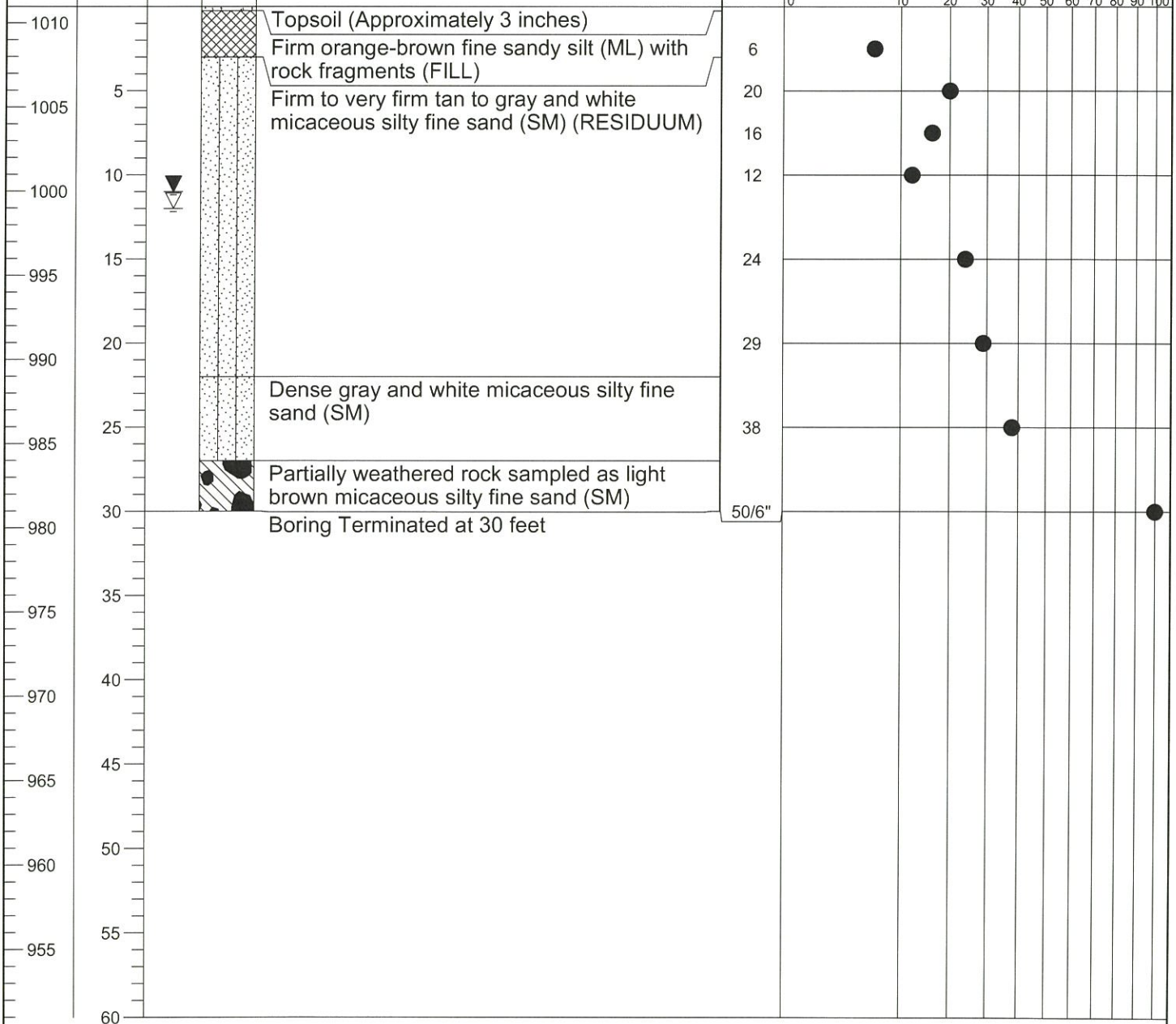
GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **12 feet**	G.S. Elev: **1011**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **11 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1010	0			Topsoil (Approximately 3 inches)	
				Firm orange-brown fine sandy silt (ML) with rock fragments (FILL)	6
1005	5			Firm to very firm tan to gray and white micaceous silty fine sand (SM) (RESIDUUM)	20
					16
1000	10	▼			12
995	15				24
990	20				29
				Dense gray and white micaceous silty fine sand (SM)	
985	25				38
				Partially weathered rock sampled as light brown micaceous silty fine sand (SM)	
980	30			Boring Terminated at 30 feet	50/6"
	35				
975					
	40				
970					
	45				
965					
	50				
960					
	55				
955					
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100



Remarks: Approximate Station 51+50
Northing: 1421336.97 Easting: 2198096.19

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-14

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1027**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 14 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1025	0			Asphalt (Approximately 6 inches)	
				Graded Aggregate Base (Approximately 3 inches)	6
1020	5			Loose to firm red-brown to pink and black micaceous silty fine sand (SM) (RESIDUUM)	10
					9
1015	10				15
				Very firm tan and white micaceous silty fine sand (SM)	
1010	15				23
				Partially weathered rock sampled as light brown silty fine sand (SM) with rock fragments	
1005	20				50/4"
				Boring Terminated at 20 feet	
1000	25				
995	30				
990	35				
985	40				
980	45				
975	50				
970	55				
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 55+00
Northing: 1421061.60 Easting: 2198326.42

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-15

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/17/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **18 feet**	G.S. Elev: **1024**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **11 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1024	0			Topsoil (Approximately 2 inches)	
				Loose red-brown silty fine sand (SM) (FILL)	5
1020	5				9
				Soft red to gray silty clay (CL) (FILL)	2
1015	10	▼			3
				Loose tan and gray clayey fine sand (SC) (RESIDUUM)	6
1010	15				
		▽		Very firm tan and brown silty fine sand (SM) with rock fragments	30
1005	20			Boring Terminated at 20 feet	
1000	25				
995	30				
990	35				
985	40				
980	45				
975	50				
970	55				
965	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 60+00
Northing: 1420649.39 Easting: 2198613.11

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-16

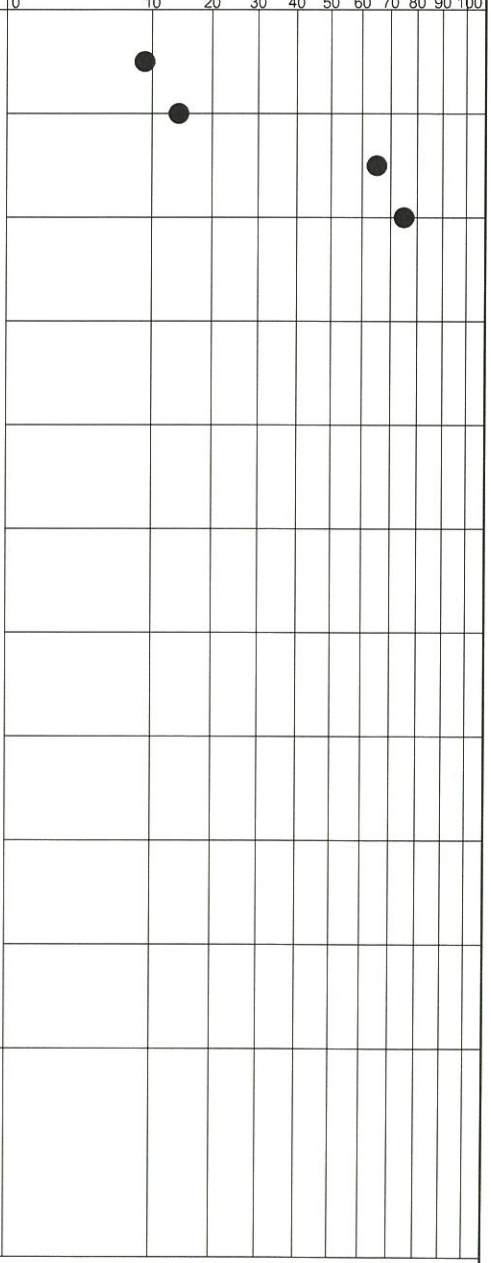
Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/9/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1046**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 16 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1045				Topsoil (Approximately 2 inches)	
				Stiff red silty clay (CL) (RESIDUUM)	9
1040	5			Firm orange-red silty fine sand (SM)	14
				Very dense brown and gray silty fine sand (SM)	65
1035	10				75
				Auger Refusal at 12 feet - Begin Rock Coring	
1030	15			Dark gray speckled white and stained brown, highly weathered, fine to medium grained, closely fractured, soft BIOTITE GNEISS	
1025	20			Run 6.5 feet, REC: 51%, RQD: 12%	
1020	25			Gray speckled white and stained brown, highly weathered to unweathered, fine to medium grained, closely to medium fractured, soft to hard BIOTITE GNEISS	
1015	30			Run: 10 feet, REC: 53%, RQD: 24%	
1010	35			Light gray speckled white, unweathered, fine to medium grained, closely to widely fractured, hard BIOTITE GNEISS	
1005	40			Run: 10 feet, REC: 98%, RQD: 96%	
1000	45			Light gray speckled and banded white, unweathered, fine to medium grained, closely to widely fractured, hard BIOTITE GNEISS	
995	50			Run: 10 feet, REC: 98%, RQD: 96%	
990	55			Light gray speckled white, unweathered, fine to medium grained, widely fractured, hard BIOTITE GNEISS	
	60			Run: 1.5 feet, REC: 100%, RQD: 100%	
				Rock Coring Terminated at 50 feet	

Standard Penetration Test (Blows/Foot)



Remarks: Approximate Station 65+00
Northing: 1420271.49 Easting: 2198894.45

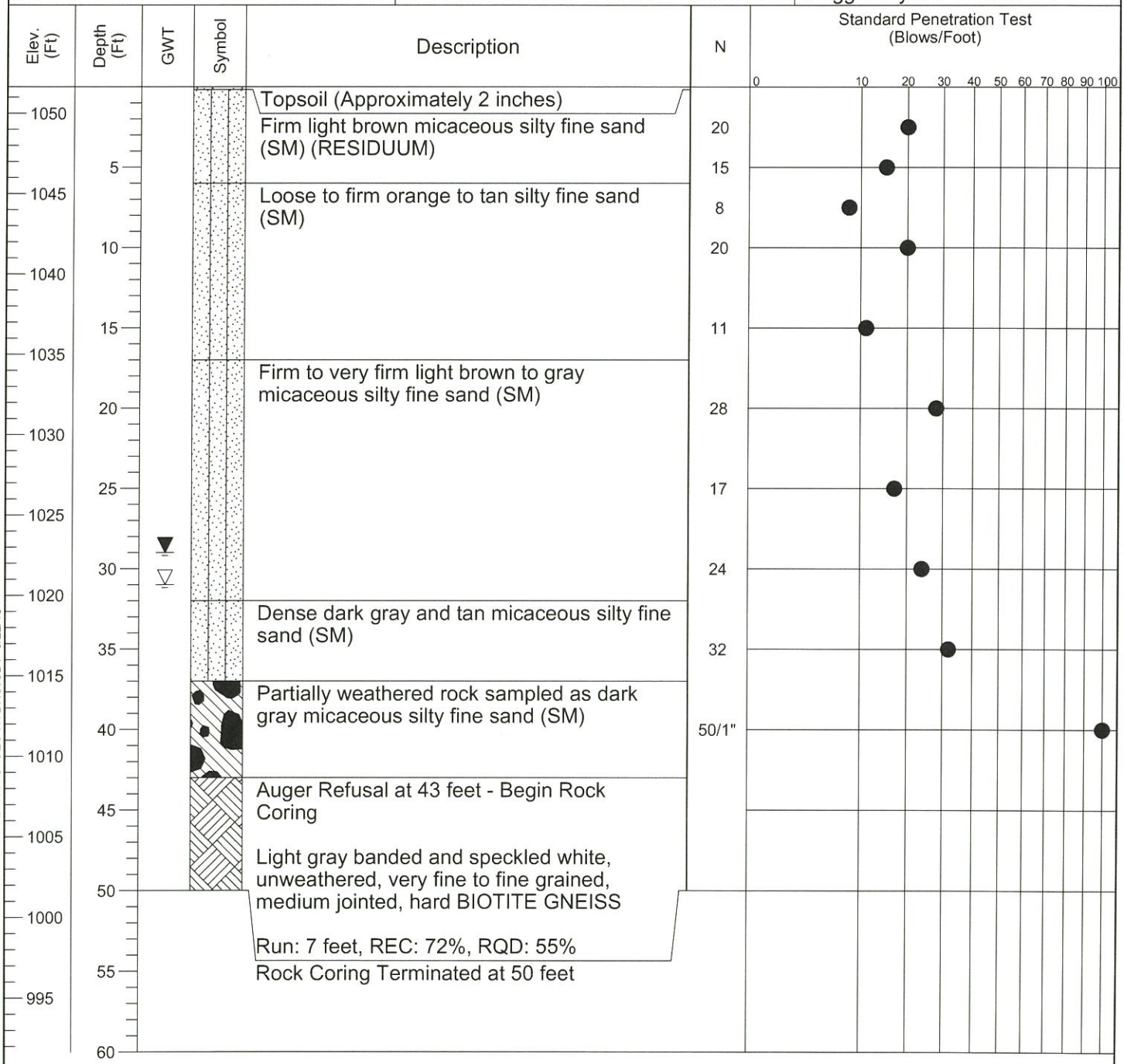
TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-17

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/3/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **31 feet**	G.S. Elev: **1052**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **29 feet**	Logged By: **AMP**



Remarks: Approximate Station 70+00
Northing: 14199172.56 Easting: 2199173.48

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-18

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/3/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **21 feet**	G.S. Elev: **1023**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **21 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1023	0			Topsoil (Approximately 3 inches)	
1020	3			Soft to firm red and brown fine sandy silt (ML) (FILL)	2
	5				5
1015	8			Soft brown and orange silty clay (CL) (FILL)	3
	10			Firm tan, orange, and red fine sandy silt (ML) (RESIDUUM)	7
1010	13			Firm to very firm tan and brown micaceous silty fine sand (SM)	
	15				18
1005					
	20	▼			30
1000					
	25				18
995	28			Loose tan and gray micaceous silty fine sand (SM)	
	30			Boring Terminated at 30 feet	10
990					
	35				
985					
	40				
980					
	45				
975					
	50				
970					
	55				
965					
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 75+00
Northing: 1419483.84 Easting: 2199525.32

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-19

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/3/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **9 feet**	G.S. Elev: **993**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **8 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
993	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 10 inches)	6
990	5			Loose dark brown silty fine sand (SM) with clay (FILL)	3
		▼		Very loose to loose tan and red to brown silty fine sand (SM) (RESIDUUM)	6
985	10			Loose to firm brown and tan micaceous silty fine sand (SM)	10
980	15				16
975	20			Boring Terminated at 20 feet	11
970	25				
965	30				
960	35				
955	40				
950	45				
945	50				
940	55				
935	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 80+00
Northing: 1419096.96 Easting: 2199819.47

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-20

Test Boring Record

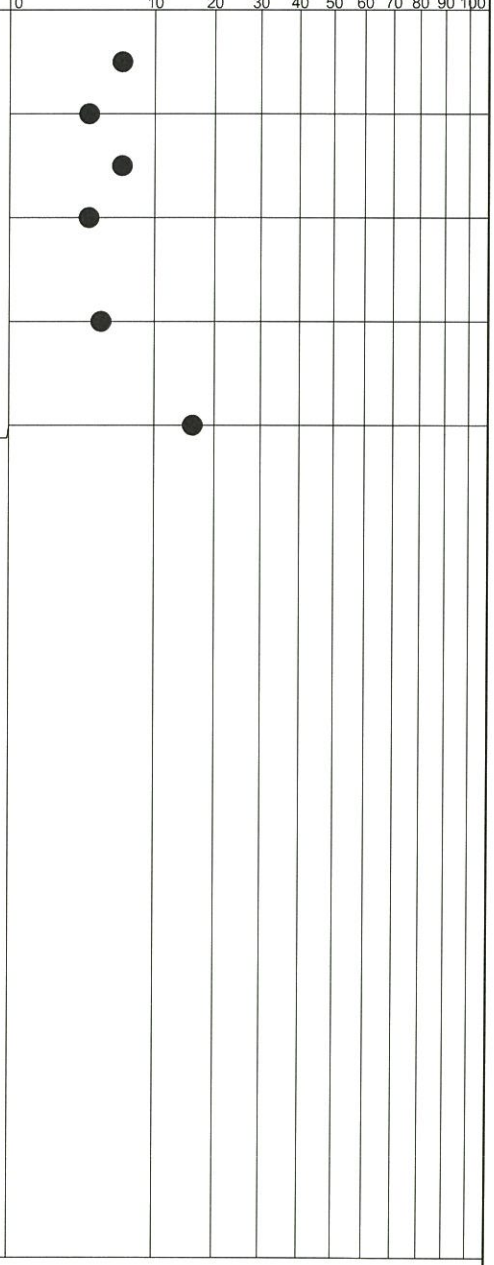
GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/3/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **16 feet**	G.S. Elev: **963**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **6 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
963	0			Topsoil (Approximately 1 inch)	
960	3			Very loose to loose brown to orange-brown silty fine sand (SM) (FILL)	6
	5	▼			3
955	8			Soft to firm gray and orange silty clay (CL) with colloidal organic material (FILL)	6
	10				3
950	13			Very loose gray micaceous silty fine sand (SM)	
	15	▽			4
945	18			Firm gray-brown micaceous silty fine sand (SM)	
	20			Boring Terminated at 20 feet	16
940	25				
935	30				
930	35				
925	40				
920	45				
915	50				
910	55				
905	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100



Remarks: Approximate Station 85+00
Northing: 1418706.78 Easting: 2200125.6

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO.HYDRO.GDT 5/22/13

B-21

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/3/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **12 feet**	G.S. Elev: **946**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **10 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
945	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 12 inches)	6
940	5			Firm orange silty clay (CL) (FILL)	6
				Very loose to loose brown and tan micaceous silty fine sand (SM) (FILL)	8
935	10	▼			4
		▽		Partially weathered rock sampled as brown and gray micaceous silty fine sand (SM) (RESIDUUM)	50/4"
930	15				
925	20			Boring Terminated at 20 feet	50/3"
920	25				
915	30				
910	35				
905	40				
900	45				
895	50				
890	55				
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 90+00
Northing: 1418283.52 Easting: 2200452.17

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-22

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **21 feet**	G.S. Elev: **939**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **19 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
939	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 10 inches)	4
935	5			Very loose red-brown micaceous silty fine sand (SM) (FILL)	10
				Stiff red-orange clayey silt (ML) (FILL)	41
930	10			Brown silty fine sand (SM) with abundant rock fragments (FILL**)	14
925	15			Firm tan-brown micaceous silty fine sand (SM) (FILL)	4
				Very loose red and gray silty fine sand (SM) (FILL)	
920	20	▼		Firm to very firm white to dark gray micaceous silty fine sand (SM) (RESIDUUM)	17
		▽			
915	25			Boring Terminated at 25 feet	22
910	30				
905	35				
900	40				
895	45				
890	50				
885	55				
880	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 93+50
Boring was offset 4 feet west after encountered auger refusal at 11 feet
**Standard penetration resistance not considered representative due to rock fragments in the fill
Northing: 1418035.30 Easting: 2200638.28

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-23

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **20 feet**	G.S. Elev: **934**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **13 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
934	0			Asphalt (Approximately 6 inches)	
				Graded Aggregate Base (Approximately 10 inches)	20
930	5			Firm red silty fine sand (SM) (FILL)	20
				Firm to very firm gray and brown silty fine sand (SM) (RESIDUUM)	22
925	10			Dense gray and brown silty fine sand (SM)	36
		▼			
920	15				35
				Partially weathered rock sampled as gray and orange silty fine sand (SM)	
915	20	▽			50/5"
				Very dense white and brown micaceous silty fine sand (SM)	
910	25				55
905	30			Boring Terminated at 30 feet	61
900	35				
895	40				
890	45				
885	50				
880	55				
875	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 96+75
Northing: 1417779.72 Easting: 2200839.25

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-24

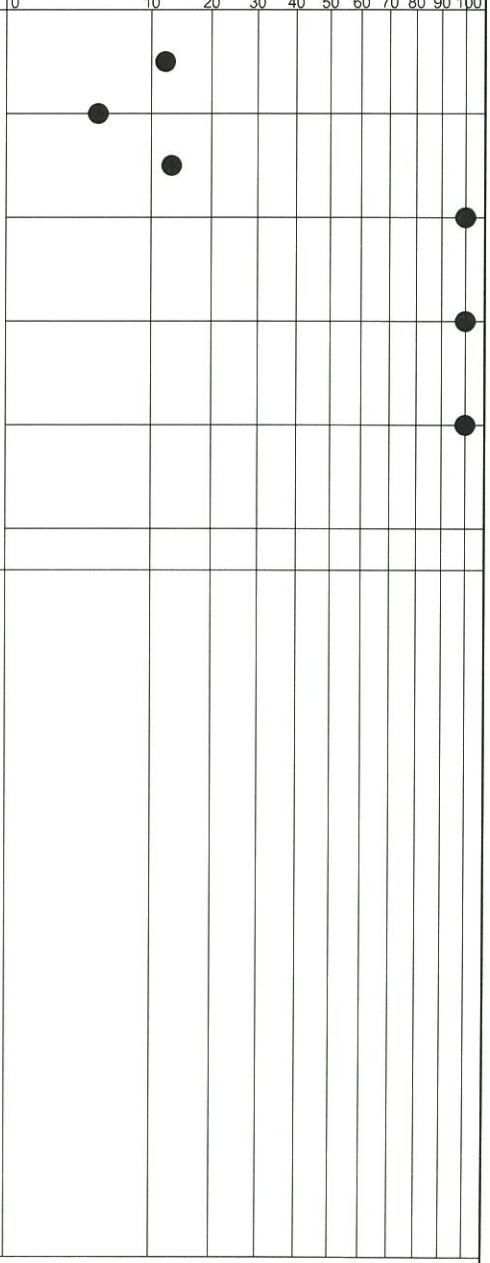
Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **14 feet**	G.S. Elev: **921**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **15 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
920	0			Asphalt (Approximately 6 inches)	
				Graded Aggregate Base (Approximately 10 inches)	12
915	5			Firm brown micaceous silty fine sand (SM) (FILL)	4
				Very loose micaceous silty fine sand (SM) (FILL)	13
910	10			Stiff orange clayey silt (ML) (RESIDUUM)	50/5"
		▽		Partially weathered rock sampled as white and gray micaceous silty fine sand (SM)	
905	15				50/6"
900	20				50/2"
895	25				
				Auger Refusal at 27 feet	
890	30				
885	35				
880	40				
875	45				
870	50				
865	55				
	60				

Standard Penetration Test (Blows/Foot)



Remarks: Approximate Station 99+75
Northing: 1417522.44 Easting: 220134.59

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-25

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **14 feet**	G.S. Elev: **899**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **13 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
899	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 12 inches)	14
895	5			Loose to firm brown to orange silty fine sand (SM) with rock fragments (FILL)	10
				Stiff gray sandy clay (CL) (ALLUVIUM)	10
890	10			Very soft gray and tan sandy clay (CL) (RESIDUUM)	0
		▼		Very firm dark gray micaceous silty fine sand (SM)	24
885	15				
880	20				30
875	25			Partially weathered rock sampled as dark brown and gray silty fine sand (SM)	50/3"
				Auger Refusal at 26 feet	
870	30				
865	35				
860	40				
855	45				
850	50				
845	55				
840	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 104+20
Boring was offset after encountering auger refusal at 5 feet at approximate station 104+10
Northing: 1417185.76 Easting: 2201293.37

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-26

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/15/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **19 feet**	G.S. Elev: **901**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **N/A (Boring Backfilled)**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	Description	N
900	0	Asphalt (Approximately 12 inches)	
		Graded Aggregate Base (Approximately 7 inches)	5
895	5	Loose dark brown silty fine sand (SM) (FILL)	8
		Loose gray-brown to tan silty fine sand (SM) with rock fragments (FILL)	7
890	10		5
		Very loose tan to gray fine sand (SP-SM) with silt (ALLUVIUM)	
885	15		4
	20		5
880		Firm brown micaceous silty fine sand (SM) (RESIDUUM)	
875	25		19
		Very dense gray silty fine sand (SM)	
870	30	Boring Terminated at 30 feet	57
865	35		
860	40		
855	45		
850	50		
845	55		
	60		

GWT: ▽

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 109+00
Northing: 1416808.55 Easting: 2201588.80

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-27

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/15/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **925**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **N/A (Boring Backfilled)**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
925	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 8 inches)	11
920	5			Firm brown and red silty fine sand (SM) (FILL)	13
				Stiff brown silty clay (CL) (FILL)	12
915	10			Firm to very firm tan micaceous silty fine sand (SM) (RESIDUUM)	23
910	15				14
				Partially weathered rock sampled as gray micaceous silty fine sand (SM)	
905	20			Boring Terminated at 20 feet	50/2"
900	25				
895	30				
890	35				
885	40				
880	45				
875	50				
870	55				
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 113+00
Northing: 1416485.81 Easting: 2201836.50

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-28

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **18 feet**	G.S. Elev: **947**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **6 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
945	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 8 inches)	18
	5	▼		Firm red-brown silty fine sand (SM) (FILL)	50/6"
940				Partially weathered rock sampled as white to tan silty fine sand (SM) with rock fragments (RESIDUUM)	50/5"
	10				16
935				Firm tan and gray silty fine sand (SM)	
	15	▽		Partially weathered rock sampled as brown to dark gray micaceous silty fine sand (SM)	50/5"
930					
	20				50/1"
925				Auger Refusal at 21 feet	
	25				
920					
	30				
915					
	35				
910					
	40				
905					
	45				
900					
	50				
895					
	55				
890					
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 116+40
Northing: 1416217.54 Easting: 2202032.66

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-29

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/9/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **16 feet**	G.S. Elev: **964**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **7 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
964	0			Asphalt (Approximately 7 inches)	
				Graded Aggregate Base (Approximately 8 inches)	50/3"
960	5			Gray silty fine sand (SM) with abundant rock fragments (FILL**)	50/5"
		▼			5
955	10			Loose tan silty fine to medium sand (SM) (FILL)	3
				Soft red, orange, and gray silty clay (CL) with sand (RESIDUUM)	
950	15	▽		Soft gray and tan fine sandy silt (ML)	3
945	20				3
				Loose to firm brown to gray micaceous silty fine sand (SM)	
940	25				10
935	30			Boring Terminated at 30 feet	16
930	35				
925	40				
920	45				
915	50				
910	55				
905	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 118+60
**Standard penetration resistance not considered representative due to rock fragments in the fill
Northing: 1416010.16 Easting: 2202190.66

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

B-30

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/9/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **21 feet**	G.S. Elev: **990**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **6 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
				Asphalt (Approximately 8 inches)	
				Graded Aggregate Base (Approximately 10 inches)	7
985	5	▼		Firm red fine sandy silt (ML) (FILL)	5
				Loose orange-tan silty fine sand (SM) (RESIDUUM)	6
980	10			Partially weathered rock sampled as gray silty fine sand (SM) with rock fragments	50/6"
975	15			Dense light gray silty fine sand (SM) with rock fragments	44
970	20	▽		Loose gray-brown highly micaceous silty fine sand (SM)	8
965	25			Partially weathered rock sampled as gray-brown silty fine sand (SM) with rock fragments	50/2"
960	30			Boring Terminated at 30 feet	
955	35				
950	40				
945	45				
940	50				
935	55				
930	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 124+00
Northing: 1415691.86 Easting: 2202438.28

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13

LABORATORY TEST RESULTS

GEO HYDRO ENGINEERS

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084
Phone: 770-938-8233
Fax: 770-923-8973
Web: www.test-llc.com

Tested By	MS
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
Dry Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	2.60	2.40	2.30	2.10	1.90	1.90			
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000	10000			
Measured Resistance, ohms	26000	24000	23000	21000	19000	19000			
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0	1.0			
Measured Resistivity, ohms-cm	26000	24000	23000	21000	19000	19000			

Reported Soil Minimum Resistivity, ohms-cm **19000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Phone: 770-938-8233
Fax: 770-923-8973
Web: www.test-llc.com

Tested By	EB
Date	02/22/13
Checked By	LB

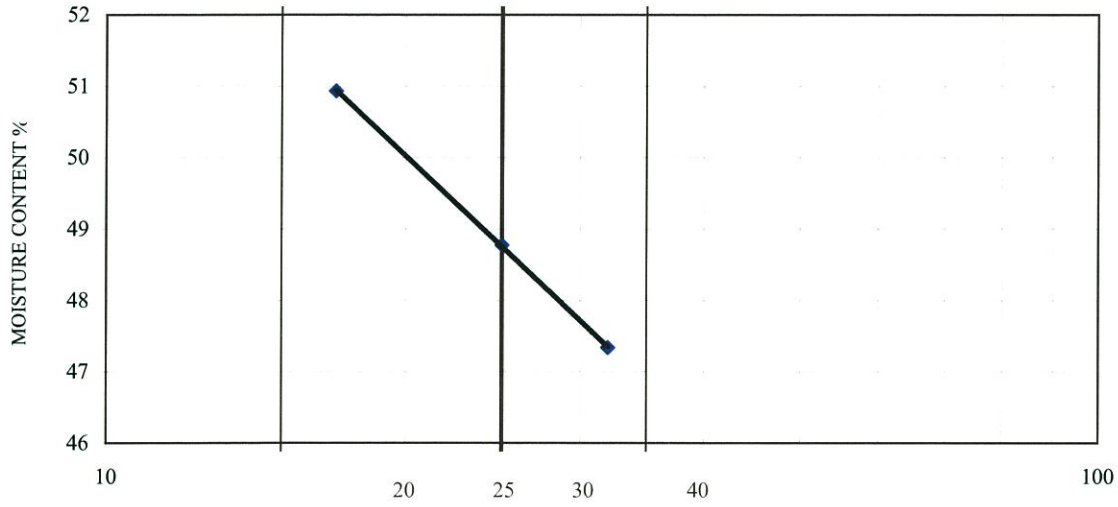
Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 4318/AASHTO T 88, T 89
Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	32	25	17
Mass of Wet Sample & Tare, g	35.78	34.70	42.88
Mass of Dry Sample & Tare, g	31.96	31.32	37.15
Mass of Tare, g	23.89	24.39	25.90
Moisture Content, %	47.34	48.77	50.93

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	31.13	30.22
Mass of Dry Sample & Tare, g	28.42	27.83
Mass of Tare, g	19.19	19.72
Moisture Content, %	29.36	29.47

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	635.30
Mass of Dry Sample & Tare, g	496.60
Mass of Tare, g	153.90
Moisture Content, %	40.47

LIQUID LIMIT (LL)	49
PLASTIC LIMIT (PL)	29
PLASTICITY INDEX (PI)	20
LIQUIDITY INDEX (LI)	0.57

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	635.30
Mass of Dry Sample & Tare, g	496.60
Mass of Tare, g	153.90
Moisture Content, %	40.5

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	346.80
Mass of Dry Sample & Tare, g	308.80
Mass of Tare, g	97.10
Moisture Content, %	17.9

Mass of Total Sample before separation on #4 sieve & Tare, g	2776.80
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2354.22

Mass of Sample used for hydrometer analysis, g	80.80
Dry Mass, g	68.50
% of Total Sample passing #4 sieve	99.9

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"			0.0	100.0
.5"	FINE GRAVEL		0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	2.20	0.1	99.9

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	0.27	99.5
#20	SAND	3.82	94.3
#40		10.21	85.0
#60	FINE SAND	15.47	77.3
#100		20.11	70.6
#200	FINES	25.36	62.9

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:20

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	14.5
% COARSE GRAVEL	0.0	% FINE SAND	22.1
% FINE GRAVEL	0.1	% FINES	62.9
% COARSE SAND	0.4	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	25.7	% CLAY(<0.002mm)	14.9

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:22	2	43.0	20.7	0.01328	6.0	37.0	10.2	0.99	0.0300	53.4
04/23/13	11:25	5	39.0	20.7	0.01328	6.0	33.0	10.9	0.99	0.0196	47.6
04/23/13	11:35	15	34.0	20.7	0.01328	6.0	28.0	11.7	0.99	0.0117	40.4
04/23/13	11:50	30	30.0	20.7	0.01328	6.0	24.0	12.4	0.99	0.0085	34.7
04/23/13	12:20	60	26.5	20.7	0.01328	6.0	20.5	13.0	0.99	0.0062	29.6
04/23/13	15:30	250	19.5	20.7	0.01328	6.0	13.5	14.1	0.99	0.0032	19.5
/24/13	11:20	1440	14.5	20.7	0.01328	6.0	8.5	15.0	0.99	0.0014	12.3

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

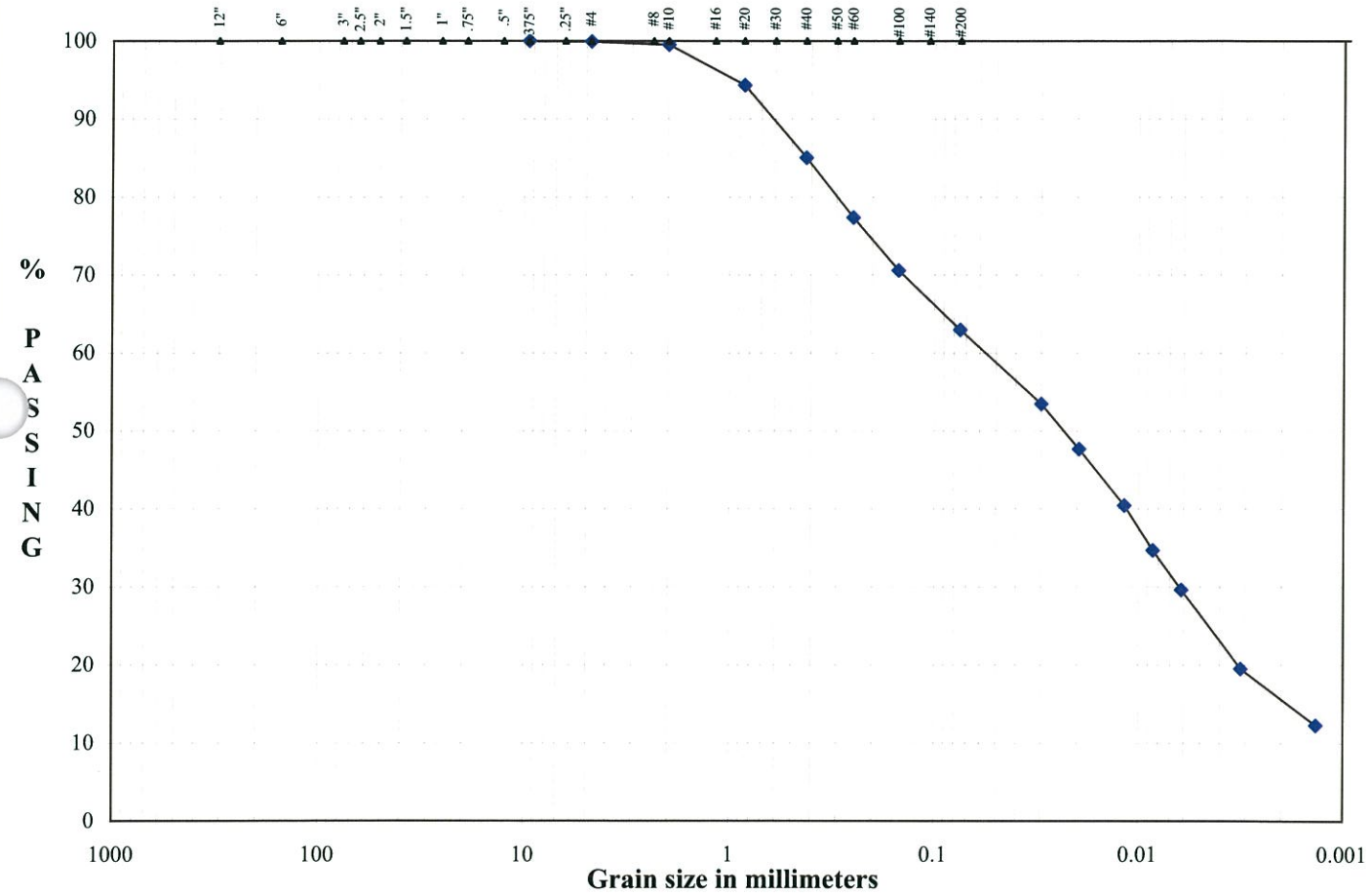
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

CS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15455/B-3	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	2.50	2.20	2.00	1.90	1.90				
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000				
Measured Resistance, ohms	25000	22000	20000	19000	19000				
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0				
Measured Resistivity, ohms-cm	25000	22000	20000	19000	19000				

Reported Soil Minimum Resistivity, ohms-cm **19000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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Tested By	RI
Date	04/21/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15455/B-3	Depth/Elev.	10'-13'
Location	-	Add. Info	-

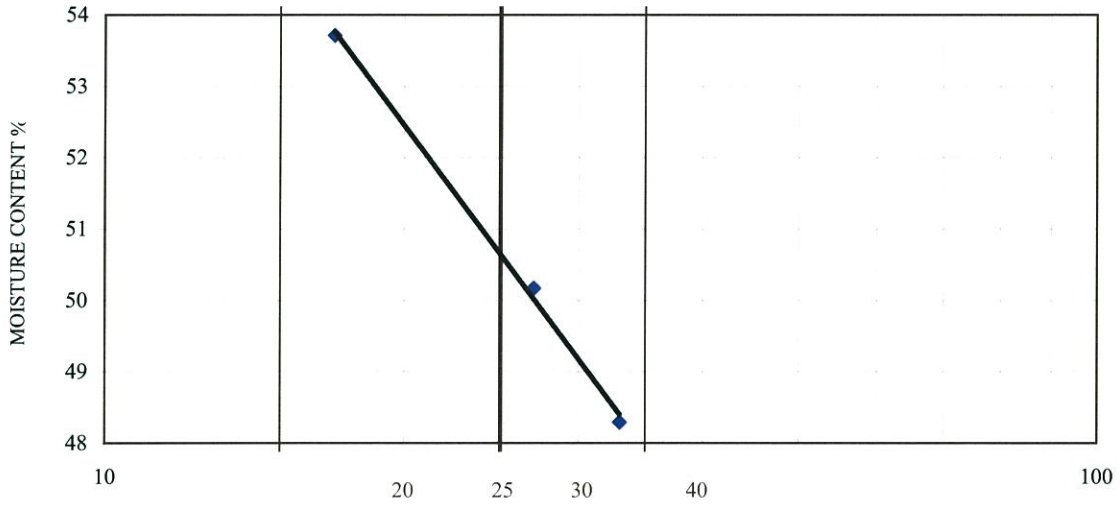
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	33	27	17
Mass of Wet Sample & Tare, g	39.72	36.58	41.20
Mass of Dry Sample & Tare, g	35.06	32.15	35.99
Mass of Tare, g	25.41	23.32	26.29
Moisture Content, %	48.29	50.17	53.71

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	34.09	36.42
Mass of Dry Sample & Tare, g	31.47	33.75
Mass of Tare, g	23.36	25.47
Moisture Content, %	32.31	32.25

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	657.20
Mass of Dry Sample & Tare, g	529.50
Mass of Tare, g	153.00
Moisture Content, %	33.92

LIQUID LIMIT (LL)	51
PLASTIC LIMIT (PL)	32
PLASTICITY INDEX (PI)	19
LIQUIDITY INDEX (LI)	0.10

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15455/B-3	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	657.20
Mass of Dry Sample & Tare, g	529.50
Mass of Tare, g	153.00
Moisture Content, %	33.9

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	383.40
Mass of Dry Sample & Tare, g	353.60
Mass of Tare, g	90.60
Moisture Content, %	11.3

Mass of Total Sample before separation on #4 sieve & Tare, g	2053.20
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	1844.23

Mass of Sample used for hydrometer analysis, g	81.10
Dry Mass, g	72.85
% of Total Sample passing #4 sieve	100.0

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"			0.0	100.0
#4	COARSE SAND	0.00	0.0	100.0

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	0.46	99.4
#20		2.65	96.4
#40	FINE SAND	7.48	89.7
#60		12.92	82.3
#100		18.91	74.0
#200	FINES	26.26	64.0

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:22

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	9.6
% COARSE GRAVEL	0.0	% FINE SAND	25.8
% FINE GRAVEL	0.0	% FINES	64.0
% COARSE SAND	0.6	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	28.3	% CLAY(<0.002mm)	16.1

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:24	2	47.5	20.7	0.01328	6.0	41.5	9.5	0.99	0.0289	56.4
04/23/13	11:27	5	43.5	20.7	0.01328	6.0	37.5	10.2	0.99	0.0189	51.0
04/23/13	11:37	15	37.5	20.7	0.01328	6.0	31.5	11.2	0.99	0.0115	42.8
04/23/13	11:52	30	33.5	20.7	0.01328	6.0	27.5	11.8	0.99	0.0083	37.4
04/23/13	12:22	60	30.0	20.7	0.01328	6.0	24.0	12.4	0.99	0.0060	32.6
04/23/13	15:32	250	21.0	20.7	0.01328	6.0	15.0	13.9	0.99	0.0031	20.4
04/24/13	11:22	1440	16.0	20.7	0.01328	6.0	10.0	14.7	0.99	0.0013	13.6

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

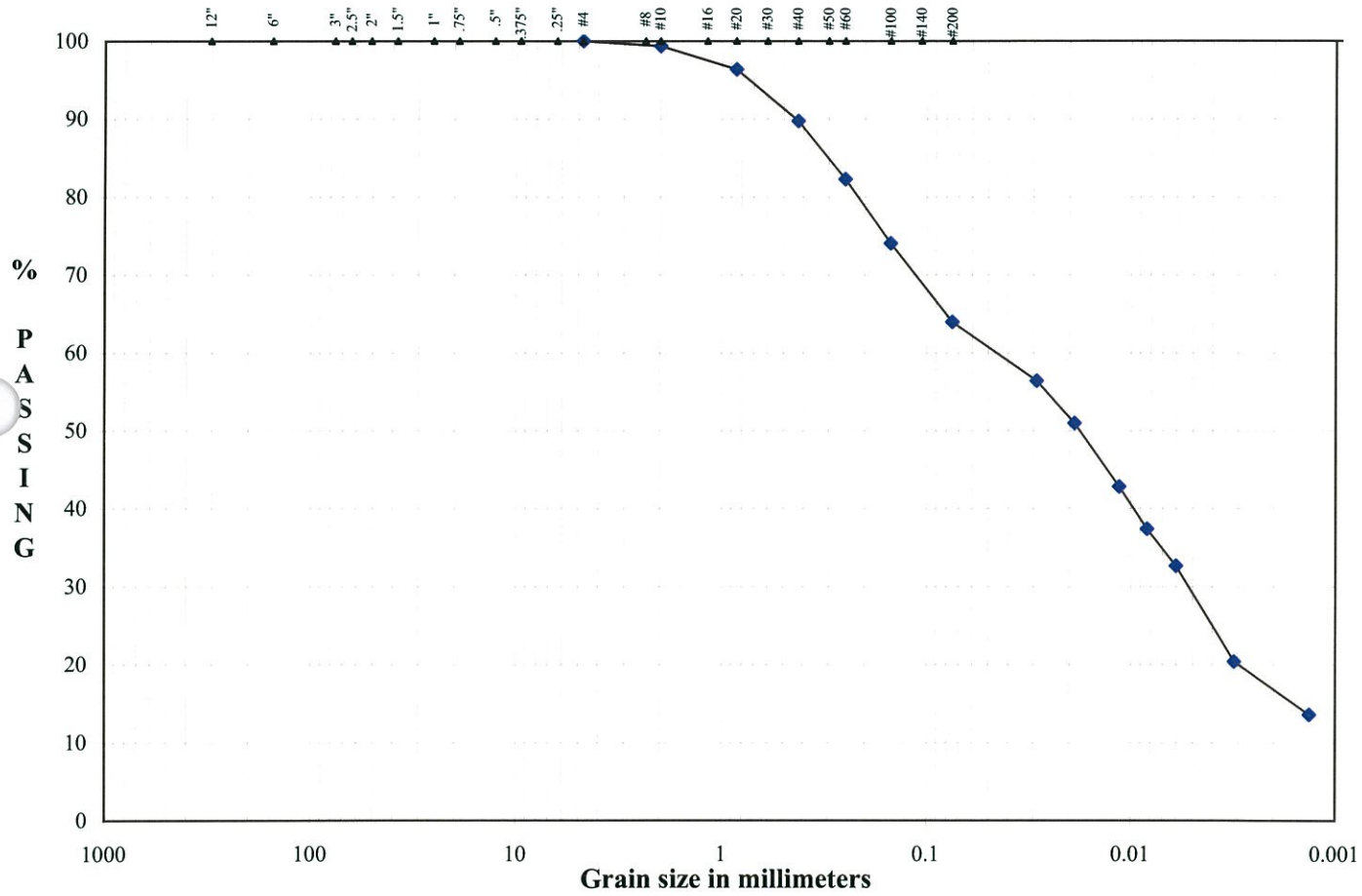
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15455/B-3	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

CS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15456/B-5	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	4.50	3.00	2.40	2.00	2.00				
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000				
Measured Resistance, ohms	45000	30000	24000	20000	20000				
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0				
Measured Resistivity, ohms-cm	45000	30000	24000	20000	20000				

Reported Soil Minimum Resistivity, ohms-cm **20000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084

Phone: 770-938-8233

Fax: 770-923-8973

Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15456/B-5	Depth/Elev.	10'-13'
Location	-	Add. Info	-

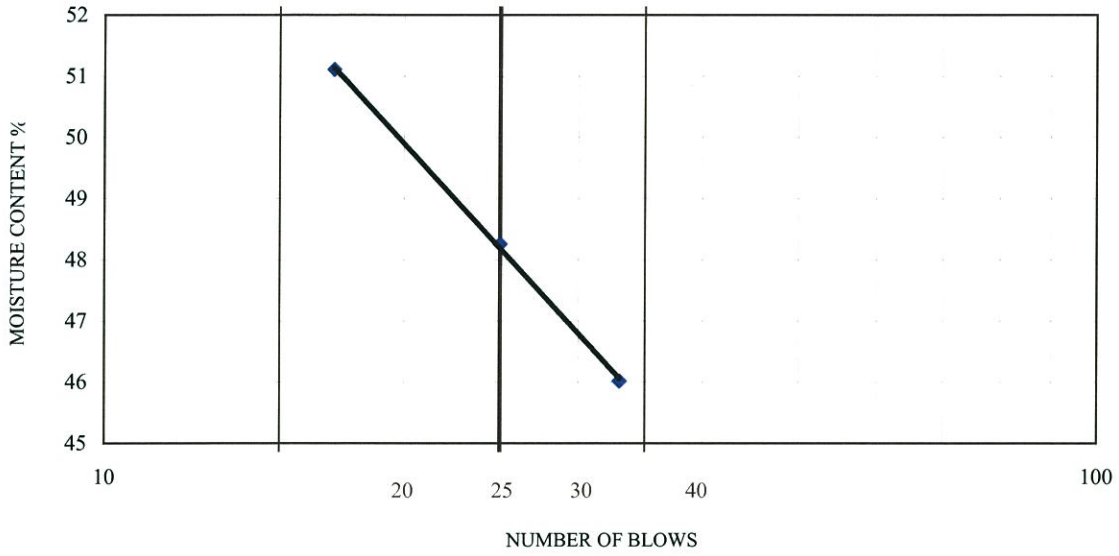
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	33	25	17
Mass of Wet Sample & Tare, g	39.29	38.33	40.58
Mass of Dry Sample & Tare, g	34.84	33.77	35.04
Mass of Tare, g	25.17	24.32	24.20
Moisture Content, %	46.02	48.25	51.11

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	25.10	30.61
Mass of Dry Sample & Tare, g	22.56	27.30
Mass of Tare, g	16.18	19.29
Moisture Content, %	39.81	41.32

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	624.90
Mass of Dry Sample & Tare, g	524.50
Mass of Tare, g	161.80
Moisture Content, %	27.68

LIQUID LIMIT (LL)	48
PLASTIC LIMIT (PL)	41
PLASTICITY INDEX (PI)	7
LIQUIDITY INDEX (LI)	-1.90

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15456/B-5	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	624.90
Mass of Dry Sample & Tare, g	524.50
Mass of Tare, g	161.80
Moisture Content, %	27.7

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	351.60
Mass of Dry Sample & Tare, g	328.40
Mass of Tare, g	94.30
Moisture Content, %	9.9

Mass of Total Sample before separation on #4 sieve & Tare, g	2191.70
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	1994.08

Mass of Sample used for hydrometer analysis, g	95.10
Dry Mass, g	86.53
% of Total Sample passing #4 sieve	99.9

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	1.70	0.1	99.9

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	0.88	98.9
#20		7.59	91.2
#40	FINE SAND	17.53	79.7
#60		27.24	68.5
#100		40.95	52.6
#200	FINES	55.41	35.9

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:24

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	19.2
% COARSE GRAVEL	0.0	% FINE SAND	43.7
% FINE GRAVEL	0.1	% FINES	35.9
% COARSE SAND	1.0	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	9.2	% CLAY(<0.002mm)	5.3

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:26	2	33.0	20.7	0.01328	6.0	27.0	11.9	0.99	0.0324	30.9
04/23/13	11:29	5	27.5	20.7	0.01328	6.0	21.5	12.8	0.99	0.0213	24.6
04/23/13	11:39	15	22.0	20.7	0.01328	6.0	16.0	13.7	0.99	0.0127	18.3
04/23/13	11:54	30	18.5	20.7	0.01328	6.0	12.5	14.3	0.99	0.0092	14.3
04/23/13	12:24	60	16.0	20.7	0.01328	6.0	10.0	14.7	0.99	0.0066	11.4
04/23/13	15:34	250	12.0	20.7	0.01328	6.0	6.0	15.4	0.99	0.0033	6.9
04/24/13	11:24	1440	10.0	20.7	0.01328	6.0	4.0	15.7	0.99	0.0014	4.6

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084

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Fax: 770-923-8973

Web: www.test-llc.com

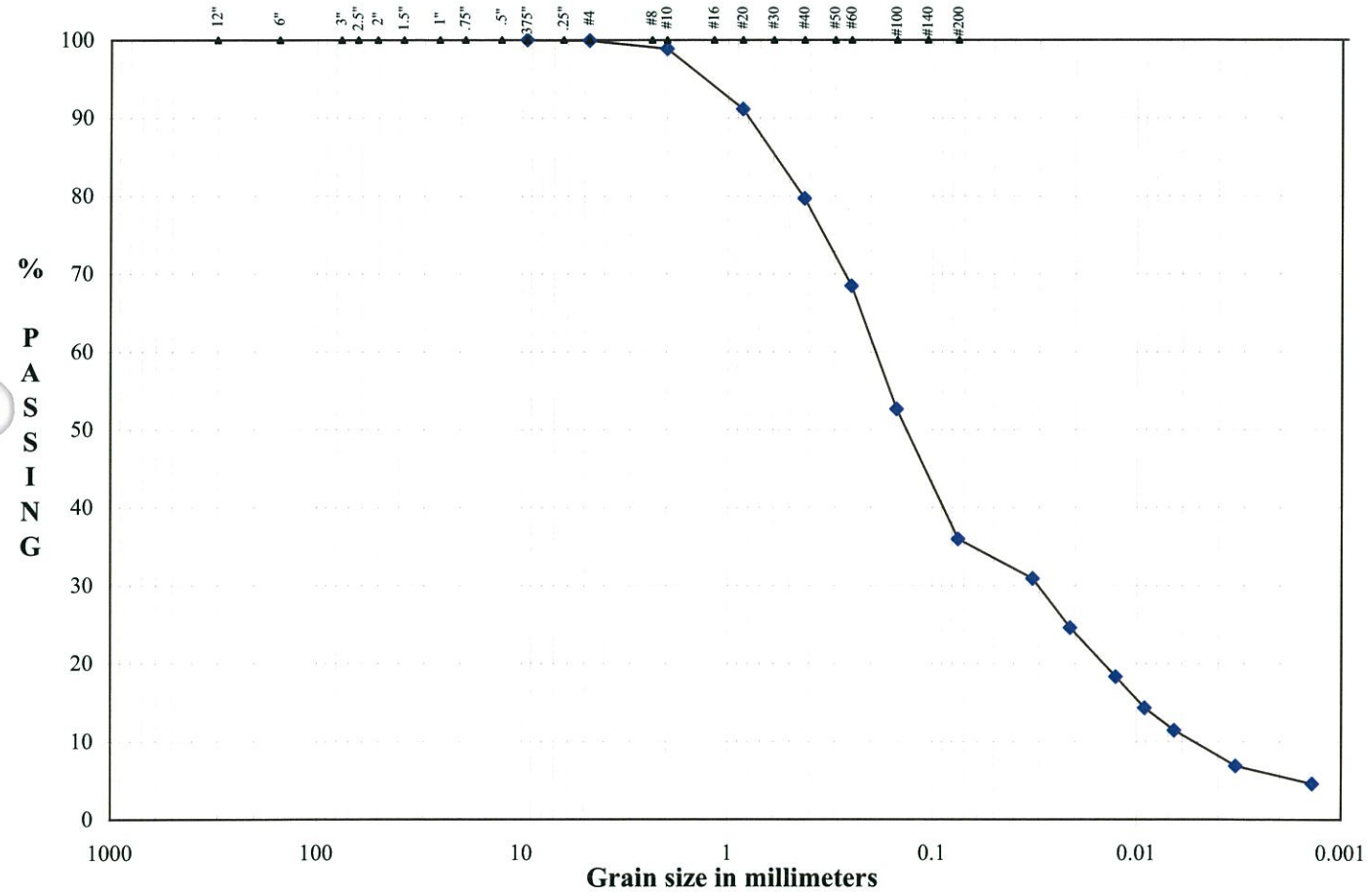
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15456/B-5	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15457/B-7	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
[illegible]y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	7.80	4.50	4.00	3.40	3.30	3.30			
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000	10000			
Measured Resistance, ohms	78000	45000	40000	34000	33000	33000			
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0	1.0			
Measured Resistivity, ohms-cm	78000	45000	40000	34000	33000	33000			

Reported Soil Minimum Resistivity, ohms-cm **33000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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Tested By	EB
Date	04/22/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15457/B-7	Depth/Elev.	10'-13'
Location	-	Add. Info	-

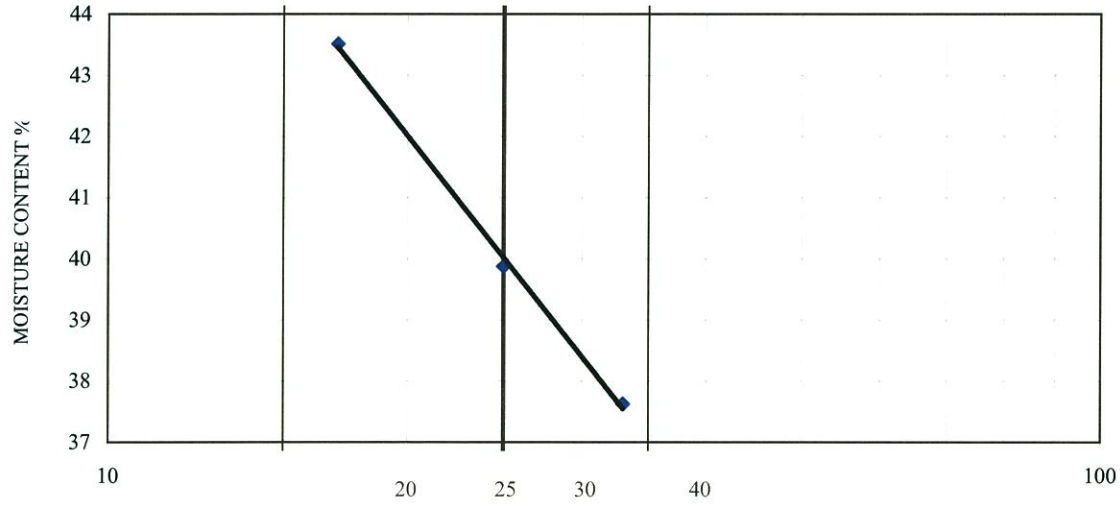
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	33	25	17
Mass of Wet Sample & Tare, g	39.75	41.70	45.69
Mass of Dry Sample & Tare, g	35.31	37.52	39.79
Mass of Tare, g	23.51	27.02	26.23
Moisture Content, %	37.63	39.88	43.51

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	34.77	33.30
Mass of Dry Sample & Tare, g	32.15	30.73
Mass of Tare, g	23.94	22.68
Moisture Content, %	31.91	31.93

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	448.00
Mass of Dry Sample & Tare, g	386.70
Mass of Tare, g	95.70
Moisture Content, %	21.07

LIQUID LIMIT (LL)	40
PLASTIC LIMIT (PL)	32
PLASTICITY INDEX (PI)	8
LIQUIDITY INDEX (LI)	-1.37

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15457/B-7	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	448.00
Mass of Dry Sample & Tare, g	386.70
Mass of Tare, g	95.70
Moisture Content, %	21.1

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	427.90
Mass of Dry Sample & Tare, g	407.00
Mass of Tare, g	101.10
Moisture Content, %	6.8

Mass of Total Sample before separation on #4 sieve & Tare, g	2379.60
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2227.42

Mass of Sample used for hydrometer analysis, g	95.50
Dry Mass, g	89.39
% of Total Sample passing #4 sieve	98.8

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL	0.00	0.0	100.0
.5"		10.80	0.5	99.5
.375"		17.80	0.8	99.2
#4	COARSE SAND	26.60	1.2	98.8

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	0.28	98.5
#20		3.74	94.7
#40	FINE SAND	14.77	82.5
#60		27.88	68.0
#100		41.22	53.2
#200	FINES	55.39	37.6

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:26

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	16.0
% COARSE GRAVEL	0.0	% FINE SAND	44.9
% FINE GRAVEL	1.2	% FINES	37.6
% COARSE SAND	0.3	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	12.0	% CLAY(<0.002mm)	7.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:28	2	36.5	20.7	0.01328	6.0	30.5	11.3	0.99	0.0316	33.4
04/23/13	11:31	5	31.0	20.7	0.01328	6.0	25.0	12.2	0.99	0.0208	27.4
04/23/13	11:41	15	26.0	20.7	0.01328	6.0	20.0	13.1	0.99	0.0124	21.9
04/23/13	11:56	30	22.5	20.7	0.01328	6.0	16.5	13.6	0.99	0.0090	18.1
04/23/13	12:26	60	19.0	20.7	0.01328	6.0	13.0	14.2	0.99	0.0065	14.2
04/23/13	15:36	250	14.5	20.7	0.01328	6.0	8.5	15.0	0.99	0.0032	9.3
04/24/13	11:26	1440	12.0	20.7	0.01328	6.0	6.0	15.4	0.99	0.0014	6.6

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

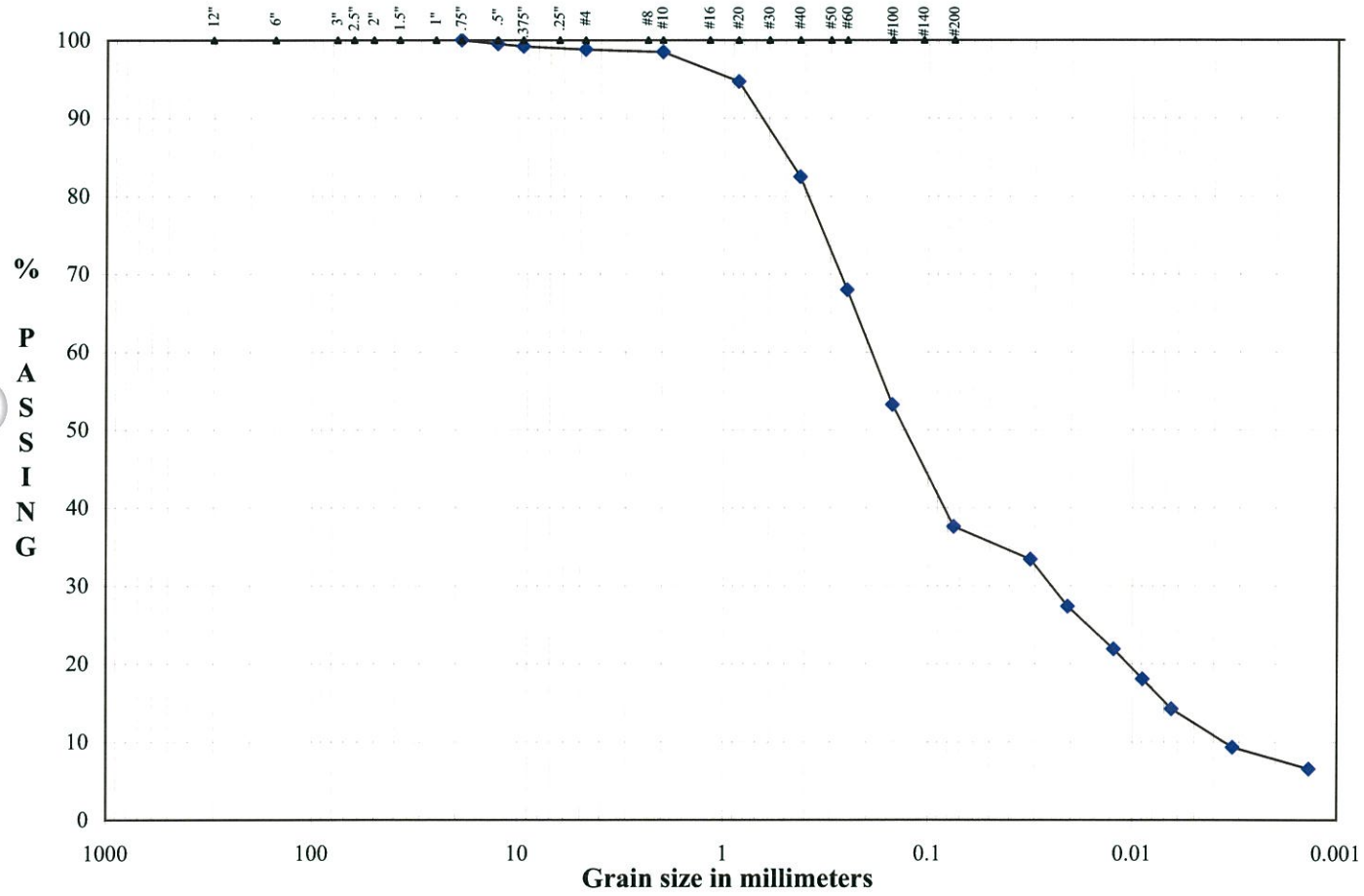
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15457/B-7	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15458/B-9	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	2.40	2.20	1.90	1.90					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	24000	22000	19000	19000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	24000	22000	19000	19000					

Reported Soil Minimum Resistivity, ohms-cm **19000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15458/B-9	Depth/Elev.	10'-13'
Location	-	Add. Info	-

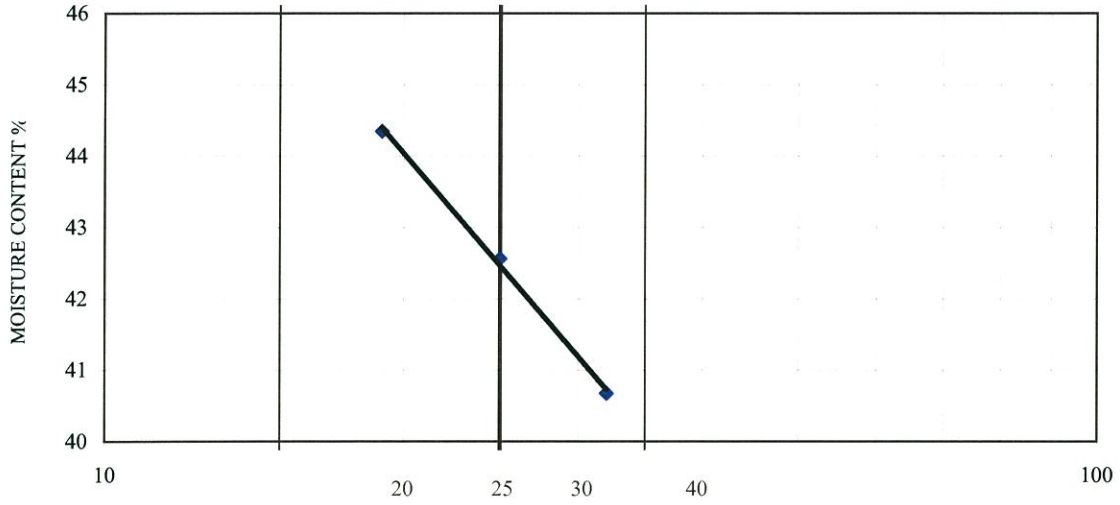
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	32	25	19
Mass of Wet Sample & Tare, g	43.84	40.25	41.20
Mass of Dry Sample & Tare, g	39.15	36.16	36.14
Mass of Tare, g	27.62	26.55	24.73
Moisture Content, %	40.68	42.56	44.35

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	32.35	28.70
Mass of Dry Sample & Tare, g	29.74	26.06
Mass of Tare, g	22.30	18.54
Moisture Content, %	35.08	35.11

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	517.10
Mass of Dry Sample & Tare, g	403.90
Mass of Tare, g	99.90
Moisture Content, %	37.24

LIQUID LIMIT (LL)	42
PLASTIC LIMIT (PL)	35
PLASTICITY INDEX (PI)	7
LIQUIDITY INDEX (LI)	0.32

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15458/B-9	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	517.10
Mass of Dry Sample & Tare, g	403.90
Mass of Tare, g	99.90
Moisture Content, %	37.2

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	423.10
Mass of Dry Sample & Tare, g	366.70
Mass of Tare, g	101.60
Moisture Content, %	21.3

Mass of Total Sample before separation on #4 sieve & Tare, g	3512.00
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2895.90

Mass of Sample used for hydrometer analysis, g	92.80
Dry Mass, g	76.52
% of Total Sample passing #4 sieve	99.6

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"			0.0	100.0
.5"	FINE GRAVEL	0.00	0.0	100.0
.375"		4.50	0.2	99.8
#4	COARSE SAND	11.40	0.4	99.6

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	1.12	98.1
#20	SAND	8.38	88.7
#40		17.75	76.5
#60	FINE SAND	26.80	64.7
#100		36.89	51.6
#200	FINES	49.03	35.8

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:28

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	21.6
% COARSE GRAVEL	0.0	% FINE SAND	40.7
% FINE GRAVEL	0.4	% FINES	35.8
% COARSE SAND	1.5	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	10.4	% CLAY(<0.002mm)	6.2

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:30	2	29.5	20.7	0.01328	6.0	23.5	12.5	0.99	0.0332	30.3
04/23/13	11:33	5	24.0	20.7	0.01328	6.0	18.0	13.4	0.99	0.0217	23.2
04/23/13	11:43	15	21.5	20.7	0.01328	6.0	15.5	13.8	0.99	0.0127	20.0
04/23/13	11:58	30	17.0	20.7	0.01328	6.0	11.0	14.6	0.99	0.0092	14.2
04/23/13	12:28	60	15.5	20.7	0.01328	6.0	9.5	14.8	0.99	0.0066	12.2
04/23/13	15:38	250	12.5	20.7	0.01328	6.0	6.5	15.3	0.99	0.0033	8.4
04/24/13	11:28	1440	10.0	20.7	0.01328	6.0	4.0	15.7	0.99	0.0014	5.2

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

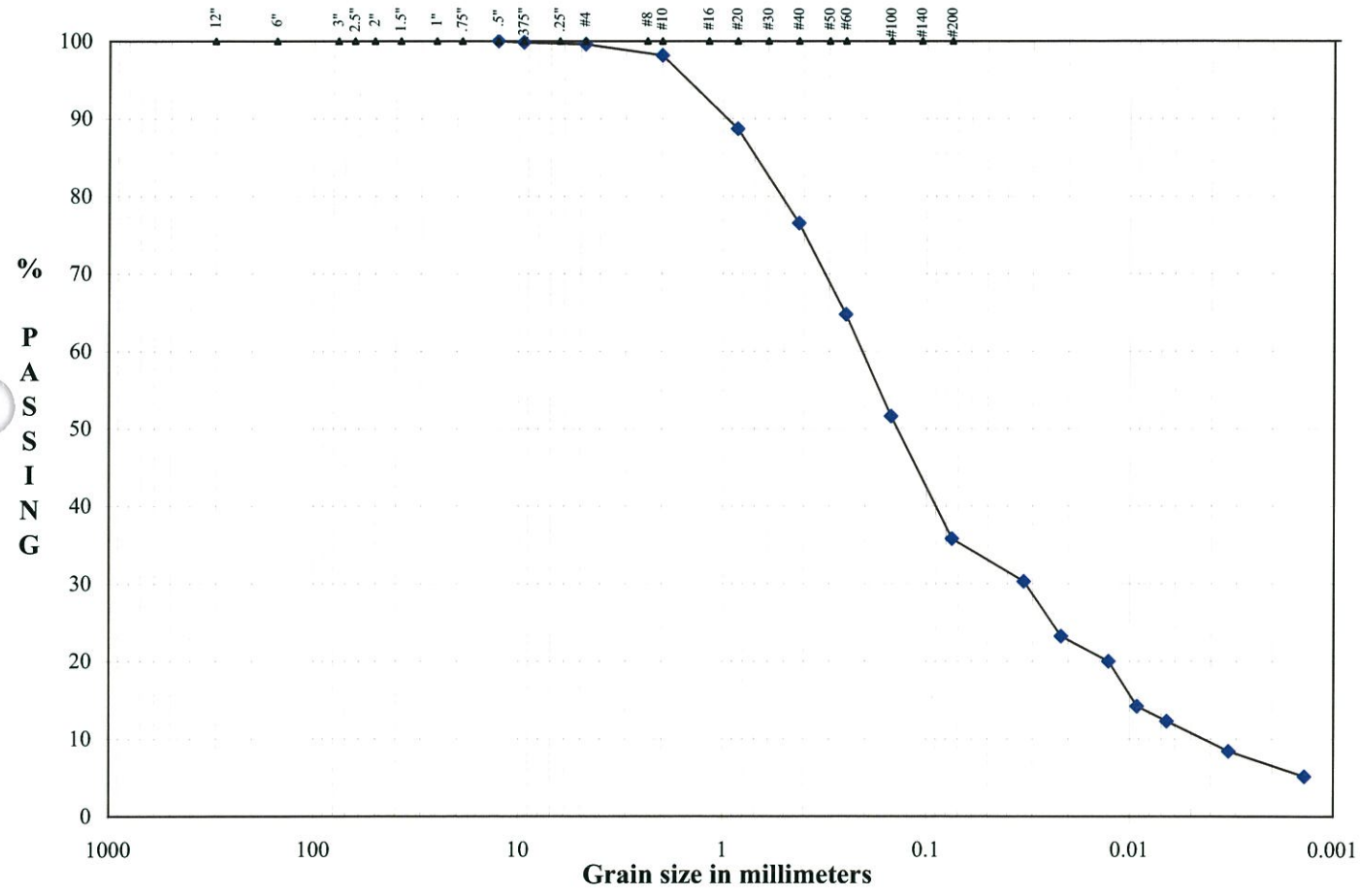
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15458/B-9	Depth/Elev.	10'-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Fax: 770-923-8973
Web: www.test-llc.com

Tested By	MS
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15459/B-12	Depth/Elev.	6-8'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	6.80	1.80	1.70	1.70					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	68000	18000	17000	17000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	68000	18000	17000	17000					

Reported Soil Minimum Resistivity, ohms-cm **17000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description: NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15459/B-12	Depth/Elev.	6-8'
Location	-	Add. Info	-

ASTM D 4318

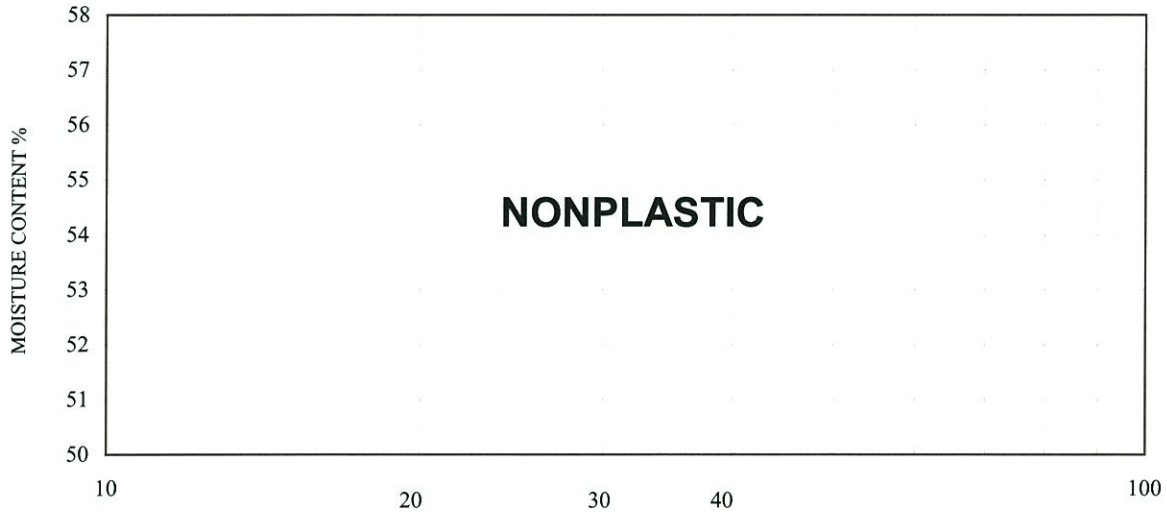
Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	10	10
Weight of Wet Sample & Tare, g	40.59	42.60
Weight of Dry Soil & Tare, g	37.36	38.68
Weight of Tare, g	25.94	24.72
Moisture Content, %	28.28	28.08

Liquid Limit Device ID # 56

NOTES: 1. Material appears to be Nonplastic. (Liquid Limit or Plastic Limit test could not be performed.)
2. Material passing No. 40 sieve was used for test.



PLASTIC LIMIT

Weight of Wet Soil & Tare, g	39.67	45.23
Weight of Dry Soil & Tare, g	37.23	41.02
Weight of Tare, g	28.49	26.08
Moisture Content, %	27.92	28.18

PREPARATION PROCEDURE: DRY

Oven ID Number: 12/13/14/15
Balance ID Number: 2

NATURAL MOISTURE

Weight of Wet Soil & Tare, g	511.80
Weight of Dry Soil & Tare, g	492.40
Weight of Tare, g	95.20
Moisture Content, %	4.88

LIQUID LIMIT (LL)	NP
PLASTIC LIMIT (PL)	NP
PLASTICITY INDEX (PI)	NP
LIQUIDITY INDEX (LI)	-

DESCRIPTION: NA

USCS (ASTM D2487;2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15459/B-12	Depth/Elev.	6-8'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	511.80
Mass of Dry Sample & Tare, g	492.40
Mass of Tare, g	95.20
Moisture Content, %	4.9

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	450.20
Mass of Dry Sample & Tare, g	442.00
Mass of Tare, g	95.20
Moisture Content, %	2.4

Mass of Total Sample before separation on #4 sieve & Tare, g	4356.40
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	4255.77

Mass of Sample used for hydrometer analysis, g	102.60
Dry Mass, g	100.23
% of Total Sample passing #4 sieve	75.1

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"		0.00	0.0	100.0
1"		58.70	1.4	98.6
.75"		210.50	4.9	95.1
.5"	FINE GRAVEL	416.60	9.8	90.2
.375"		594.30	14.0	86.0
#4	COARSE SAND	1059.50	24.9	75.1

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	17.13	62.3
#20	SAND	30.67	52.1
#40		42.31	43.4
#60	FINE SAND	54.03	34.6
#100		65.62	25.9
#200	FINES	78.78	16.1

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:30

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	18.9
% COARSE GRAVEL	4.9	% FINE SAND	27.3
% FINE GRAVEL	19.9	% FINES	16.1
% COARSE SAND	12.8	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	3.7	% CLAY(<0.002mm)	2.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:32	2	20.5	20.7	0.01328	6.0	14.5	14.0	0.99	0.0351	10.8
04/23/13	11:35	5	17.0	20.7	0.01328	6.0	11.0	14.6	0.99	0.0227	8.2
04/23/13	11:45	15	15.0	20.7	0.01328	6.0	9.0	14.9	0.99	0.0132	6.7
04/23/13	12:00	30	13.5	20.7	0.01328	6.0	7.5	15.1	0.99	0.0094	5.6
04/23/13	12:30	60	12.0	20.7	0.01328	6.0	6.0	15.4	0.99	0.0067	4.5
04/23/13	15:40	250	10.0	20.7	0.01328	6.0	4.0	15.7	0.99	0.0033	3.0
04/24/13	11:30	1440	9.0	20.7	0.01328	6.0	3.0	15.9	0.99	0.0014	2.2

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

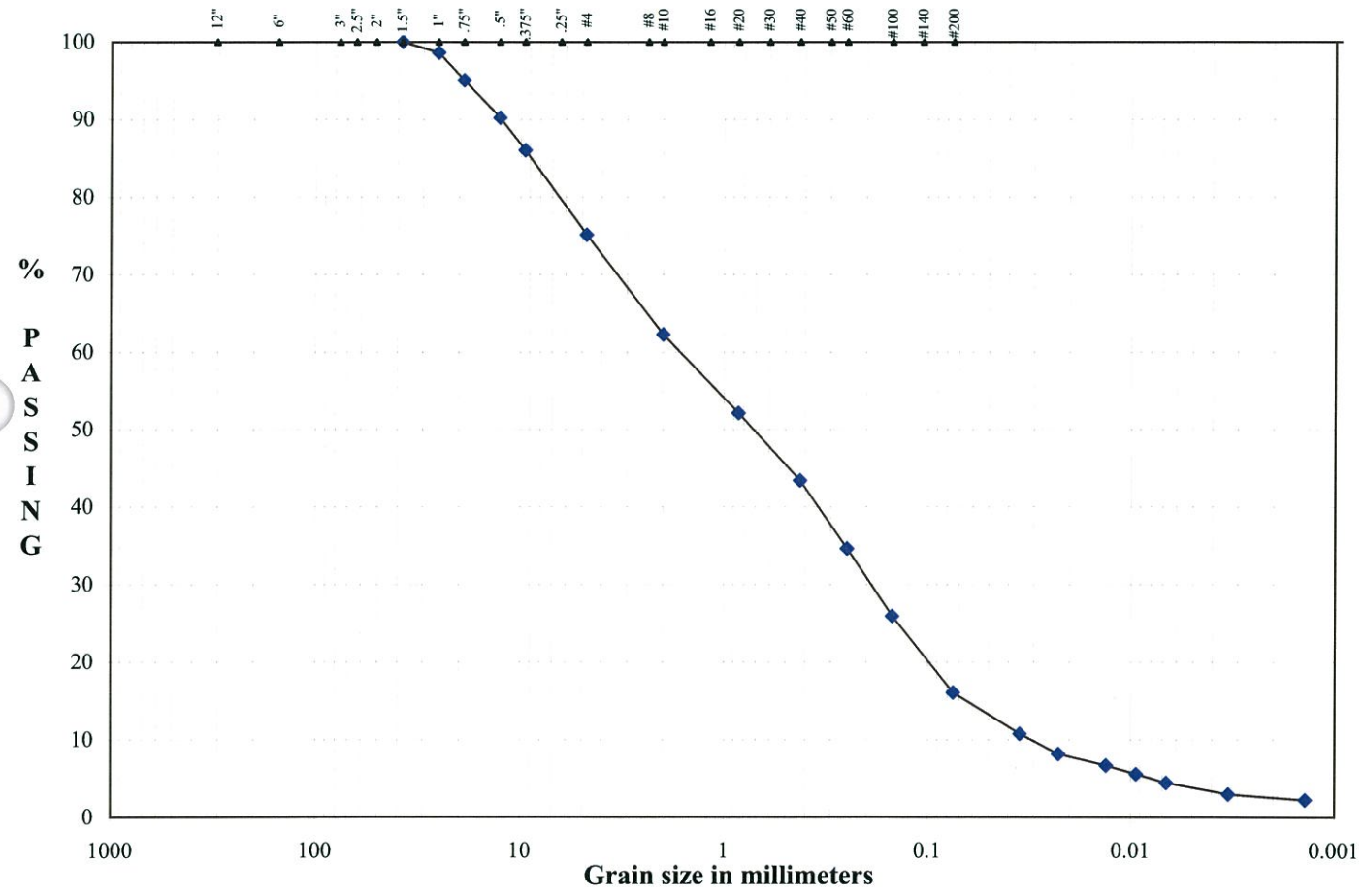
Tested By	RI
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15459/B-12	Depth/Elev.	6-8'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15460/B-15	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
ry Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	3.40	2.70	2.40	2.40					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	34000	27000	24000	24000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	34000	27000	24000	24000					

Reported Soil Minimum Resistivity, ohms-cm **24000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15460/B-15	Depth/Elev.	10-13'
Location	-	Add. Info	-

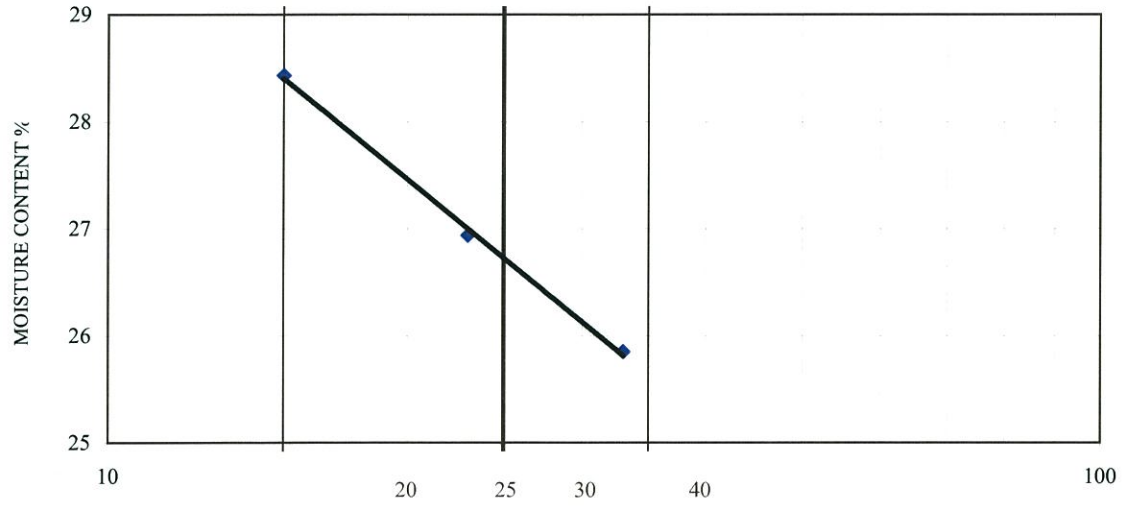
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	33	23	15
Mass of Wet Sample & Tare, g	40.23	44.02	45.11
Mass of Dry Sample & Tare, g	37.26	40.82	40.51
Mass of Tare, g	25.77	28.94	24.33
Moisture Content, %	25.85	26.94	28.43

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	35.70	36.95
Mass of Dry Sample & Tare, g	34.00	35.44
Mass of Tare, g	23.98	26.48
Moisture Content, %	16.97	16.85

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	455.20
Mass of Dry Sample & Tare, g	392.00
Mass of Tare, g	85.40
Moisture Content, %	20.61

LIQUID LIMIT (LL)	27
PLASTIC LIMIT (PL)	17
PLASTICITY INDEX (PI)	10
LIQUIDITY INDEX (LI)	0.36

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15460/B-15	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	455.20
Mass of Dry Sample & Tare, g	392.00
Mass of Tare, g	85.40
Moisture Content, %	20.6

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	477.90
Mass of Dry Sample & Tare, g	462.20
Mass of Tare, g	87.00
Moisture Content, %	4.2

Mass of Total Sample before separation on #4 sieve & Tare, g	3119.40
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2994.11

Mass of Sample used for hydrometer analysis, g	81.70
Dry Mass, g	78.42
% of Total Sample passing #4 sieve	98.7

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"		0.00	0.0	100.0
.75"		13.90	0.5	99.5
.5"	FINE GRAVEL	17.60	0.6	99.4
.375"		27.80	0.9	99.1
#4	COARSE SAND	38.20	1.3	98.7

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	0.90	97.6
#20	SAND	3.65	94.1
#40		10.30	85.8
#60	FINE SAND	18.36	75.6
#100		27.89	63.6
#200	FINES	37.37	51.7

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:32

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	11.8
% COARSE GRAVEL	0.5	% FINE SAND	34.1
% FINE GRAVEL	0.8	% FINES	51.7
% COARSE SAND	1.1	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	26.0	% CLAY(<0.002mm)	19.4

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:34	2	42.5	20.7	0.01328	6.0	36.5	10.3	0.99	0.0302	45.5
04/23/13	11:37	5	40.0	20.7	0.01328	6.0	34.0	10.7	0.99	0.0195	42.4
04/23/13	11:47	15	35.0	20.7	0.01328	6.0	29.0	11.6	0.99	0.0117	36.1
04/23/13	12:02	30	31.5	20.7	0.01328	6.0	25.5	12.1	0.99	0.0085	31.8
04/23/13	12:32	60	28.5	20.7	0.01328	6.0	22.5	12.6	0.99	0.0061	28.0
04/23/13	15:42	250	24.0	20.7	0.01328	6.0	18.0	13.4	0.99	0.0031	22.4
04/24/13	11:32	1440	20.0	20.7	0.01328	6.0	14.0	14.1	0.99	0.0013	17.4

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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Web: www.test-llc.com

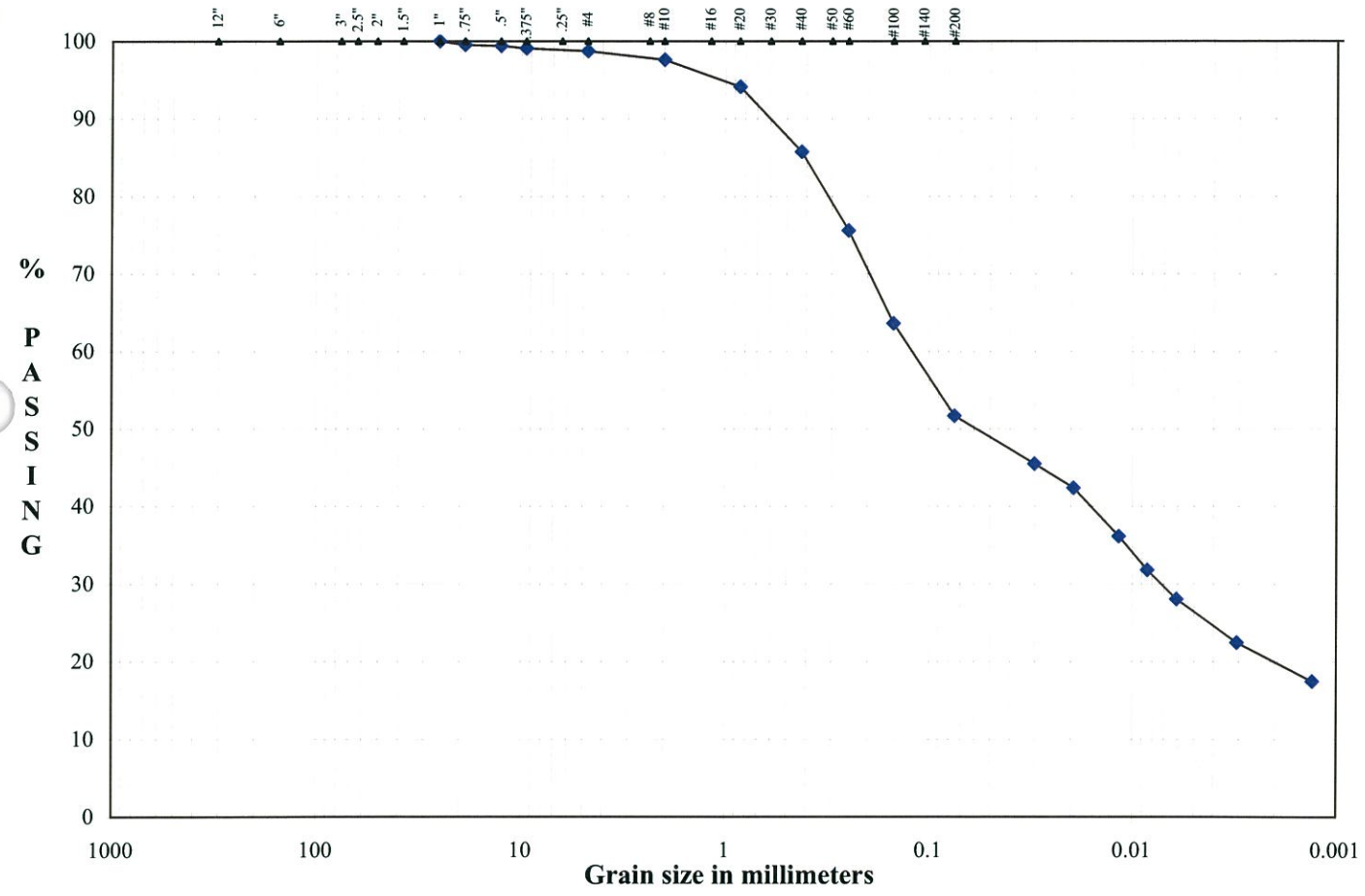
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15460/B-15	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15461/B-17	Depth/Elev.	40-43'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
[illegible]y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	2.20	1.80	1.70	1.60	1.60				
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000				
Measured Resistance, ohms	22000	18000	17000	16000	16000				
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0				
Measured Resistivity, ohms-cm	22000	18000	17000	16000	16000				

Reported Soil Minimum Resistivity, ohms-cm **16000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15461/B-17	Depth/Elev.	40-43'
Location	-	Add. Info	-

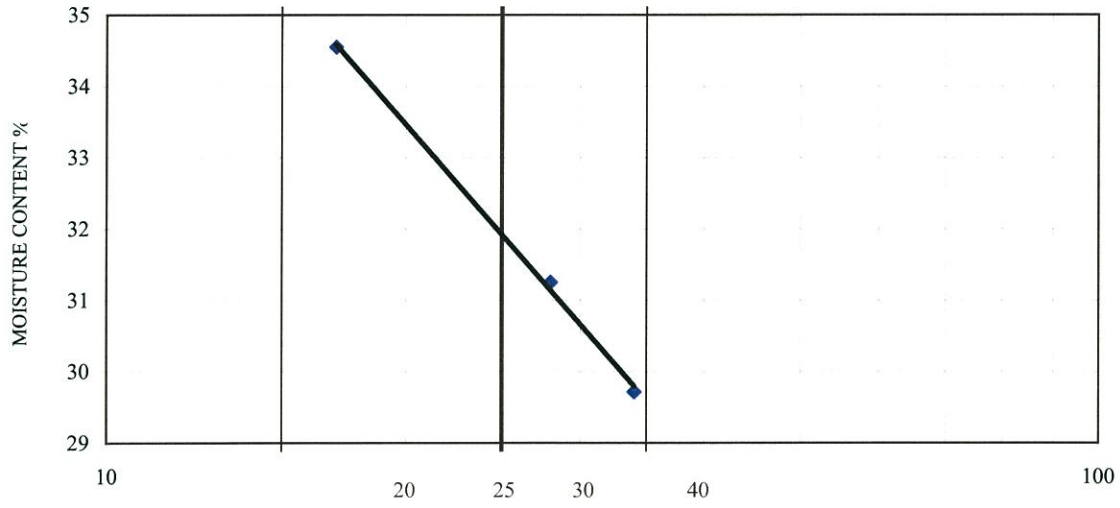
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	34	28	17
Mass of Wet Sample & Tare, g	37.68	39.70	44.46
Mass of Dry Sample & Tare, g	34.67	36.16	40.19
Mass of Tare, g	24.54	24.85	27.83
Moisture Content, %	29.71	31.25	34.55

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	32.00	30.64
Mass of Dry Sample & Tare, g	29.97	28.51
Mass of Tare, g	21.77	19.86
Moisture Content, %	24.76	24.62

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	557.60
Mass of Dry Sample & Tare, g	436.90
Mass of Tare, g	102.50
Moisture Content, %	36.09

LIQUID LIMIT (LL)	32
PLASTIC LIMIT (PL)	25
PLASTICITY INDEX (PI)	7
LIQUIDITY INDEX (LI)	1.58

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084
Phone: 770-938-8233
Fax: 770-923-8973
Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	VB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15461/B-17	Depth/Elev.	40-43'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	557.60
Mass of Dry Sample & Tare, g	436.90
Mass of Tare, g	102.50
Moisture Content, %	36.1

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	389.70
Mass of Dry Sample & Tare, g	359.60
Mass of Tare, g	96.50
Moisture Content, %	11.4

Mass of Total Sample before separation on #4 sieve & Tare, g	2686.00
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2410.25

Mass of Sample used for hydrometer analysis, g	102.30
Dry Mass, g	91.80
% of Total Sample passing #4 sieve	96.0

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"		0.00	0.0	100.0
.75"	FINE GRAVEL	20.90	0.9	99.1
.5"		58.50	2.4	97.6
.375"		70.20	2.9	97.1
#4	COARSE SAND	96.00	4.0	96.0

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	2.15	93.8
#20		10.28	85.3
#40	FINE SAND	21.54	73.5
#60		34.71	59.7
#100		49.35	44.4
#200	FINES	64.69	28.4

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:34

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	20.3
% COARSE GRAVEL	0.9	% FINE SAND	45.1
% FINE GRAVEL	3.1	% FINES	28.4
% COARSE SAND	2.2	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	7.6	% CLAY(<0.002mm)	3.9

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:36	2	24.0	20.7	0.01328	6.0	18.0	13.4	0.99	0.0344	18.6
04/23/13	11:39	5	21.5	20.7	0.01328	6.0	15.5	13.8	0.99	0.0221	16.1
04/23/13	11:49	15	19.5	20.7	0.01328	6.0	13.5	14.1	0.99	0.0129	14.0
04/23/13	12:04	30	17.0	20.7	0.01328	6.0	11.0	14.6	0.99	0.0092	11.4
04/23/13	12:34	60	15.0	20.7	0.01328	6.0	9.0	14.9	0.99	0.0066	9.3
04/23/13	15:44	250	11.5	20.7	0.01328	6.0	5.5	15.5	0.99	0.0033	5.7
04/24/13	11:34	1440	9.0	20.7	0.01328	6.0	3.0	15.9	0.99	0.0014	3.1

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

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Web: www.test-llc.com

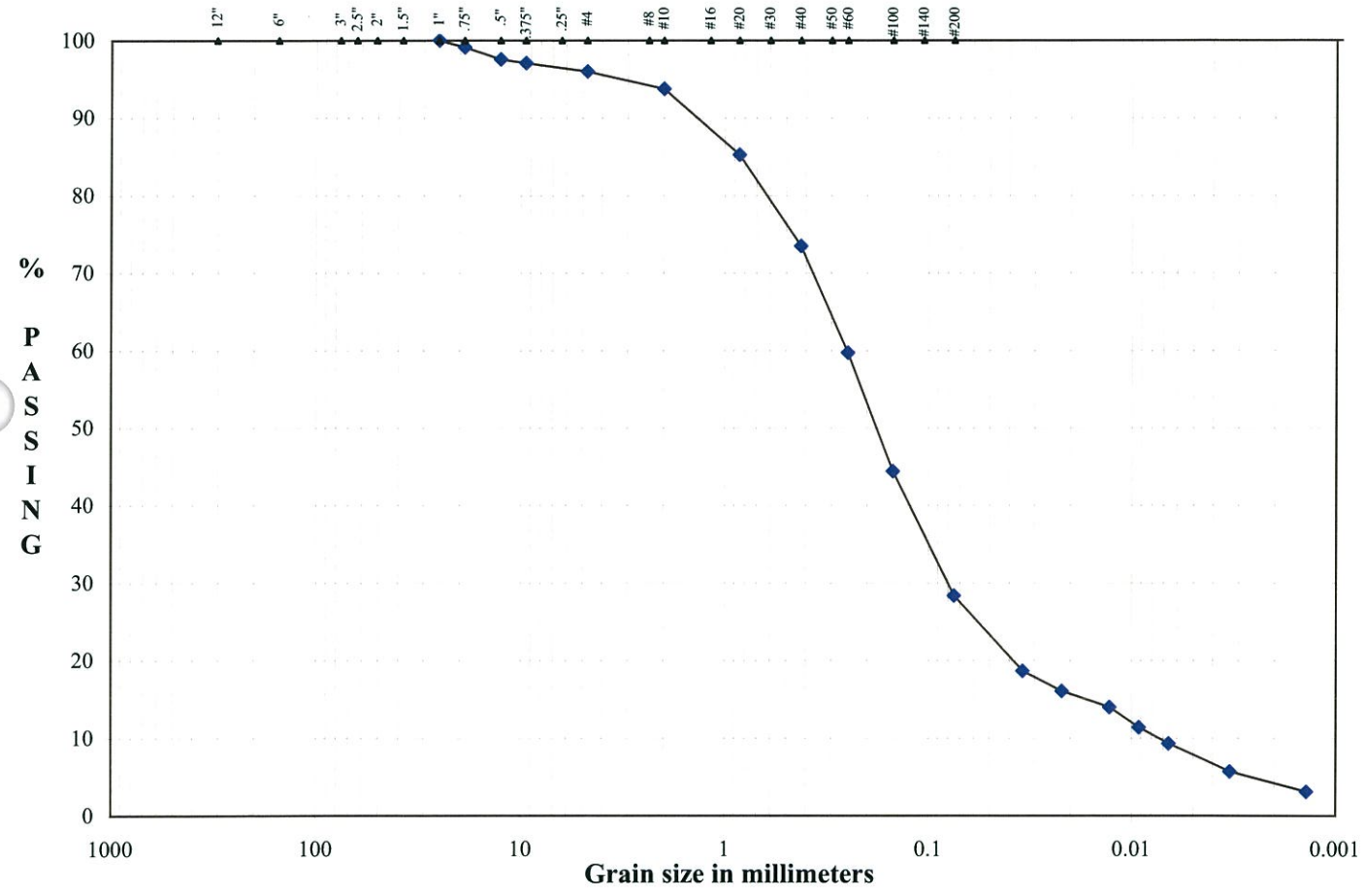
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15461/B-17	Depth/Elev.	40-43'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Web: www.test-llc.com

Tested By	MS
Date	04/22/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15462/B-21	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
[illegible]y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	2.60	2.50	2.40	2.40					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	26000	25000	24000	24000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	26000	25000	24000	24000					

Reported Soil Minimum Resistivity, ohms-cm **24000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Fax: 770-923-8973

Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15462/B-21	Depth/Elev.	10-13'
Location	-	Add. Info	-

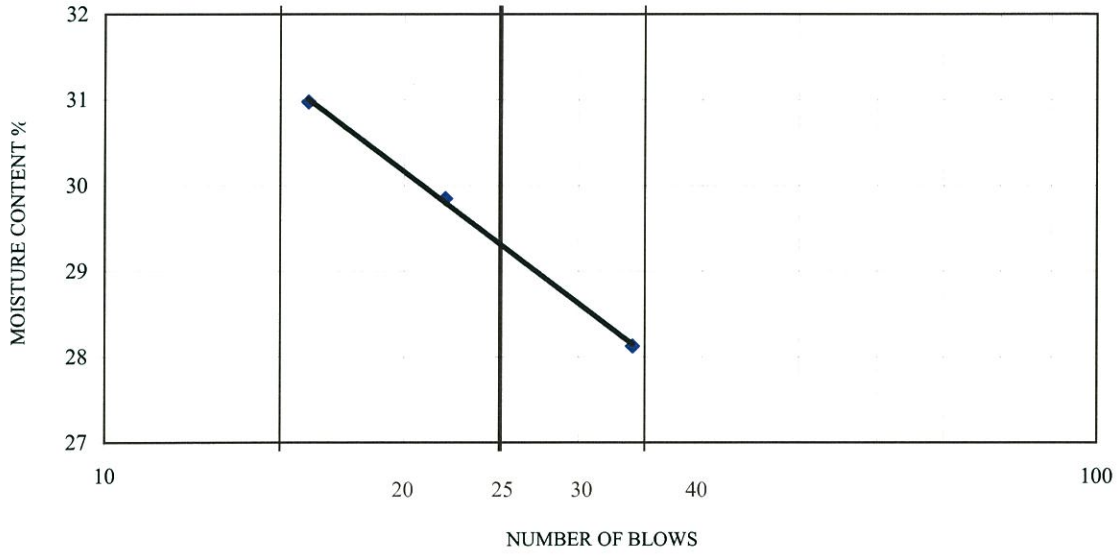
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	34	22	16
Mass of Wet Sample & Tare, g	38.19	39.19	44.73
Mass of Dry Sample & Tare, g	34.86	35.65	40.09
Mass of Tare, g	23.02	23.79	25.11
Moisture Content, %	28.13	29.85	30.97

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	31.23	30.74
Mass of Dry Sample & Tare, g	29.00	28.82
Mass of Tare, g	19.30	20.43
Moisture Content, %	22.99	22.88

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	465.80
Mass of Dry Sample & Tare, g	386.20
Mass of Tare, g	91.40
Moisture Content, %	27.00

LIQUID LIMIT (LL)	29
PLASTIC LIMIT (PL)	23
PLASTICITY INDEX (PI)	6
LIQUIDITY INDEX (LI)	0.67

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

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Fax: 770-923-8973

Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15462/B-21	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	465.80
Mass of Dry Sample & Tare, g	386.20
Mass of Tare, g	91.40
Moisture Content, %	27.0

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	420.10
Mass of Dry Sample & Tare, g	391.90
Mass of Tare, g	102.70
Moisture Content, %	9.8

Mass of Total Sample before separation on #4 sieve & Tare, g	3483.10
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	3173.64

Mass of Sample used for hydrometer analysis, g	90.00
Dry Mass, g	82.00
% of Total Sample passing #4 sieve	97.4

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL	0.00	0.0	100.0
.5"		38.00	1.2	98.8
.375"		56.70	1.8	98.2
#4	COARSE SAND	81.20	2.6	97.4

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	2.58	94.4
#20		7.37	88.7
#40	FINE SAND	13.40	81.5
#60		21.83	71.5
#100		34.44	56.5
#200	FINES	48.72	39.5

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:36

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	12.9
% COARSE GRAVEL	0.0	% FINE SAND	42.0
% FINE GRAVEL	2.6	% FINES	39.5
% COARSE SAND	3.1	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	19.1	% CLAY(<0.002mm)	14.8

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:38	2	35.0	20.7	0.01328	6.0	29.0	11.6	0.99	0.0319	34.1
04/23/13	11:41	5	31.0	20.7	0.01328	6.0	25.0	12.2	0.99	0.0208	29.4
04/23/13	11:51	15	28.0	20.7	0.01328	6.0	22.0	12.7	0.99	0.0122	25.9
04/23/13	12:06	30	26.0	20.7	0.01328	6.0	20.0	13.1	0.99	0.0088	23.5
04/23/13	12:36	60	23.5	20.7	0.01328	6.0	17.5	13.5	0.99	0.0063	20.6
04/23/13	15:46	250	20.5	20.7	0.01328	6.0	14.5	14.0	0.99	0.0031	17.1
04/24/13	11:36	1440	17.5	20.7	0.01328	6.0	11.5	14.5	0.99	0.0013	13.5

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

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Fax: 770-923-8973

Web: www.test-llc.com

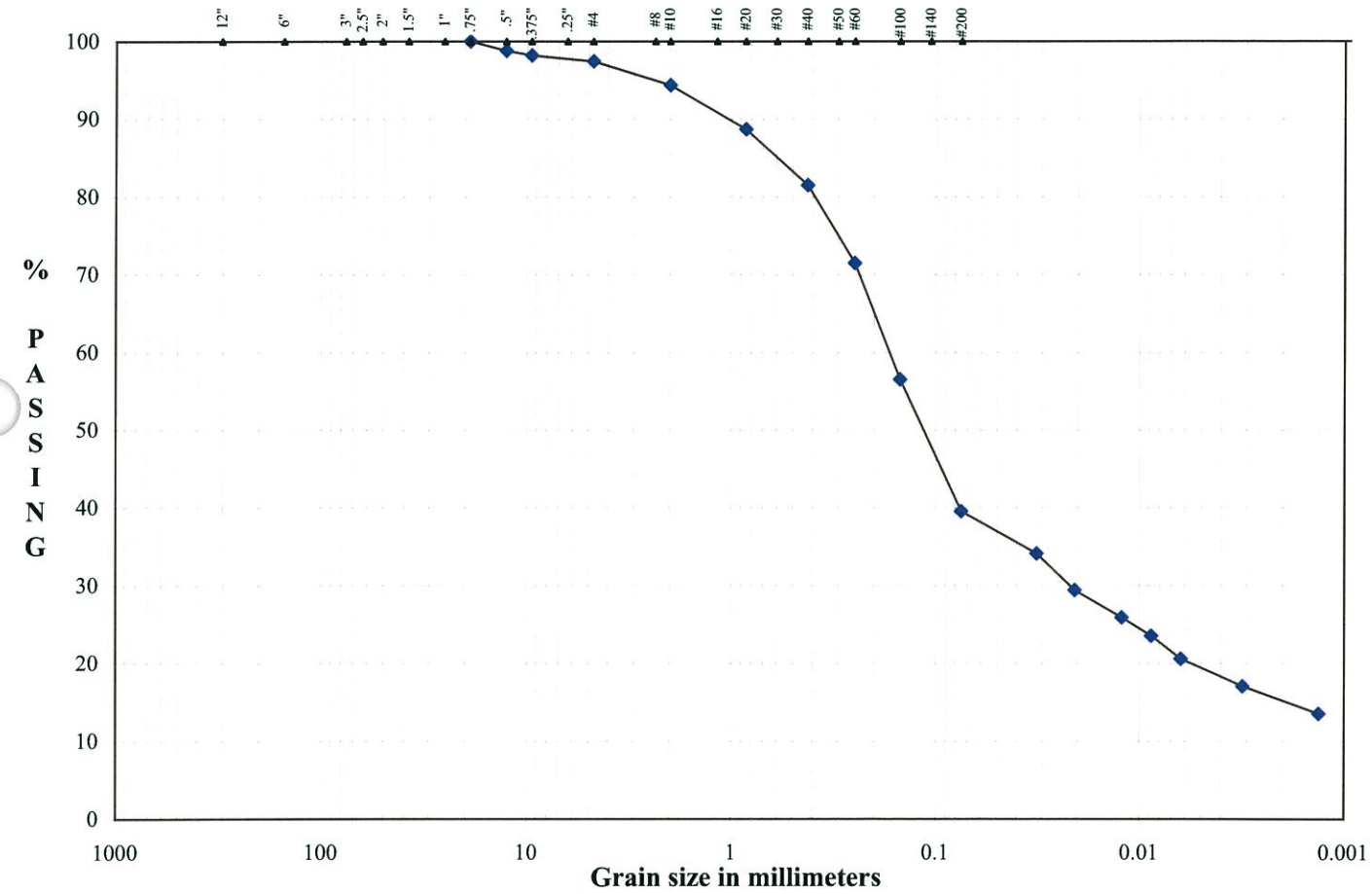
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15462/B-21	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	MS
Date	04/22/13
Checked By	[illegible]

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
[illegible]y Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	7.90	2.30	1.70	1.50	1.50				
Reading of Meter Range Multiplier	10000	10000	10000	10000	10000				
Measured Resistance, ohms	79000	23000	17000	15000	15000				
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0	1.0				
Measured Resistivity, ohms-cm	79000	23000	17000	15000	15000				

Reported Soil Minimum Resistivity, ohms-cm **15000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084
Phone: 770-938-8233
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Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 4318

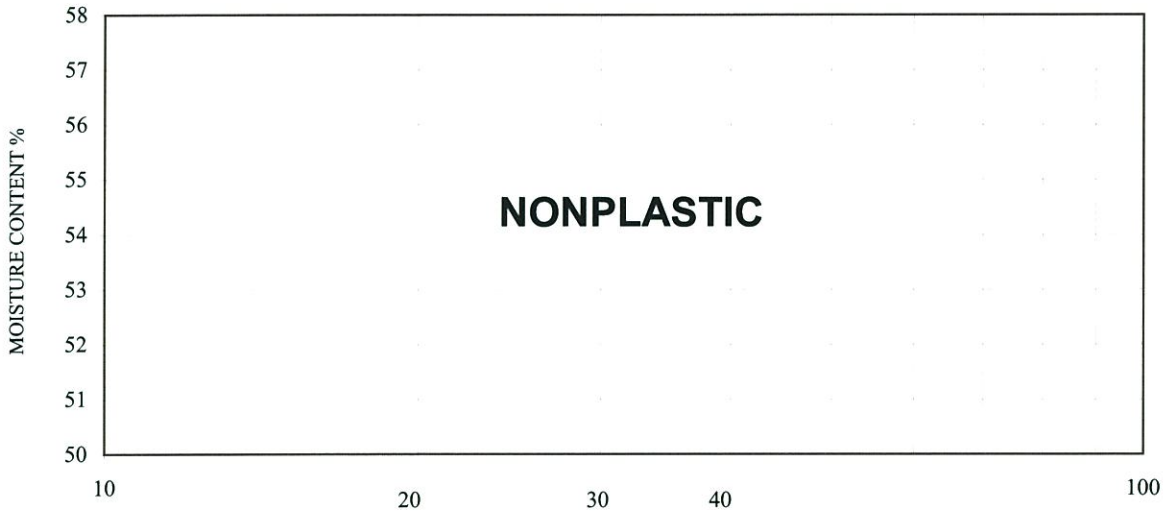
Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	13	13
Weight of Wet Sample & Tare, g	41.33	43.55
Weight of Dry Soil & Tare, g	37.35	39.67
Weight of Tare, g	25.55	28.21
Moisture Content, %	33.73	33.86

Liquid Limit Device ID # 56

NOTES: 1. Material appears to be Nonplastic. (Liquid Limit or Plastic Limit test could not be performed.)
2. Material passing No. 40 sieve was used for test.



PLASTIC LIMIT

Weight of Wet Soil & Tare, g	41.04	46.05
Weight of Dry Soil & Tare, g	37.33	40.61
Weight of Tare, g	26.43	24.72
Moisture Content, %	34.04	34.24

PREPARATION PROCEDURE: DRY

Oven ID Number: 12/13/14/15
Balance ID Number: 2

NATURAL MOISTURE

Weight of Wet Soil & Tare, g	400.60
Weight of Dry Soil & Tare, g	378.50
Weight of Tare, g	93.30
Moisture Content, %	7.75

LIQUID LIMIT (LL)	NP
PLASTIC LIMIT (PL)	NP
PLASTICITY INDEX (PI)	NP
LIQUIDITY INDEX (LI)	-

DESCRIPTION: NA

USCS (ASTM D2487;2488): NA

AASHTO (M 145): NA

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084
Phone: 770-938-8233
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Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	400.60
Mass of Dry Sample & Tare, g	378.50
Mass of Tare, g	93.30
Moisture Content, %	7.7

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	513.00
Mass of Dry Sample & Tare, g	499.60
Mass of Tare, g	98.70
Moisture Content, %	3.3

Mass of Total Sample before separation on #4 sieve & Tare, g	3226.10
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	3121.76

Mass of Sample used for hydrometer analysis, g	106.60
Dry Mass, g	103.15
% of Total Sample passing #4 sieve	89.3

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"		0.00	0.0	100.0
1"		87.80	2.8	97.2
.75"		119.00	3.8	96.2
.5"	FINE GRAVEL	176.80	5.7	94.3
.375"		213.70	6.8	93.2
#4	COARSE SAND	333.40	10.7	89.3

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	11.28	79.6
#20	SAND	21.11	71.0
#40		30.09	63.3
#60	FINE SAND	42.40	52.6
#100		57.65	39.4
#200	FINES	75.75	23.7

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:38

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	16.3
% COARSE GRAVEL	3.8	% FINE SAND	39.5
% FINE GRAVEL	6.9	% FINES	23.7
% COARSE SAND	9.8	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	8.6	% CLAY(<0.002mm)	6.6

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:40	2	30.5	20.7	0.01328	6.0	24.5	12.3	0.99	0.0330	21.0
04/23/13	11:43	5	23.0	20.7	0.01328	6.0	17.0	13.6	0.99	0.0219	14.6
04/23/13	11:53	15	20.0	20.7	0.01328	6.0	14.0	14.1	0.99	0.0129	12.0
04/23/13	12:08	30	18.0	20.7	0.01328	6.0	12.0	14.4	0.99	0.0092	10.3
04/23/13	12:38	60	17.0	20.7	0.01328	6.0	11.0	14.6	0.99	0.0065	9.4
04/23/13	15:48	250	15.0	20.7	0.01328	6.0	9.0	14.9	0.99	0.0032	7.7
04/24/13	11:38	1440	13.0	20.7	0.01328	6.0	7.0	15.2	0.99	0.0014	6.0

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084
Phone: 770-938-8233
Fax: 770-923-8973
Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	400.60
Mass of Dry Sample & Tare, g	378.50
Mass of Tare, g	93.30
Moisture Content, %	7.7

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	513.00
Mass of Dry Sample & Tare, g	499.60
Mass of Tare, g	98.70
Moisture Content, %	3.3

Mass of Total Sample before separation on #4 sieve & Tare, g	3226.10
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	3121.76

Mass of Sample used for hydrometer analysis, g	106.60
Dry Mass, g	103.15
% of Total Sample passing #4 sieve	89.3

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"		0.00	0.0	100.0
1"		87.80	2.8	97.2
.75"		119.00	3.8	96.2
.5"	FINE GRAVEL	176.80	5.7	94.3
.375"		213.70	6.8	93.2
#4	COARSE SAND	333.40	10.7	89.3

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	11.28	79.6
#20	SAND	21.11	71.0
#40		30.09	63.3
#60	FINE SAND	42.40	52.6
#100		57.65	39.4
#200	FINES	75.75	23.7

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:38

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	16.3
% COARSE GRAVEL	3.8	% FINE SAND	39.5
% FINE GRAVEL	6.9	% FINES	23.7
% COARSE SAND	9.8	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	8.6	% CLAY(<0.002mm)	6.6

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:40	2	30.5	20.7	0.01328	6.0	24.5	12.3	0.99	0.0330	21.0
04/23/13	11:43	5	23.0	20.7	0.01328	6.0	17.0	13.6	0.99	0.0219	14.6
04/23/13	11:53	15	20.0	20.7	0.01328	6.0	14.0	14.1	0.99	0.0129	12.0
04/23/13	12:08	30	18.0	20.7	0.01328	6.0	12.0	14.4	0.99	0.0092	10.3
04/23/13	12:38	60	17.0	20.7	0.01328	6.0	11.0	14.6	0.99	0.0065	9.4
04/23/13	15:48	250	15.0	20.7	0.01328	6.0	9.0	14.9	0.99	0.0032	7.7
04/24/13	11:38	1440	13.0	20.7	0.01328	6.0	7.0	15.2	0.99	0.0014	6.0

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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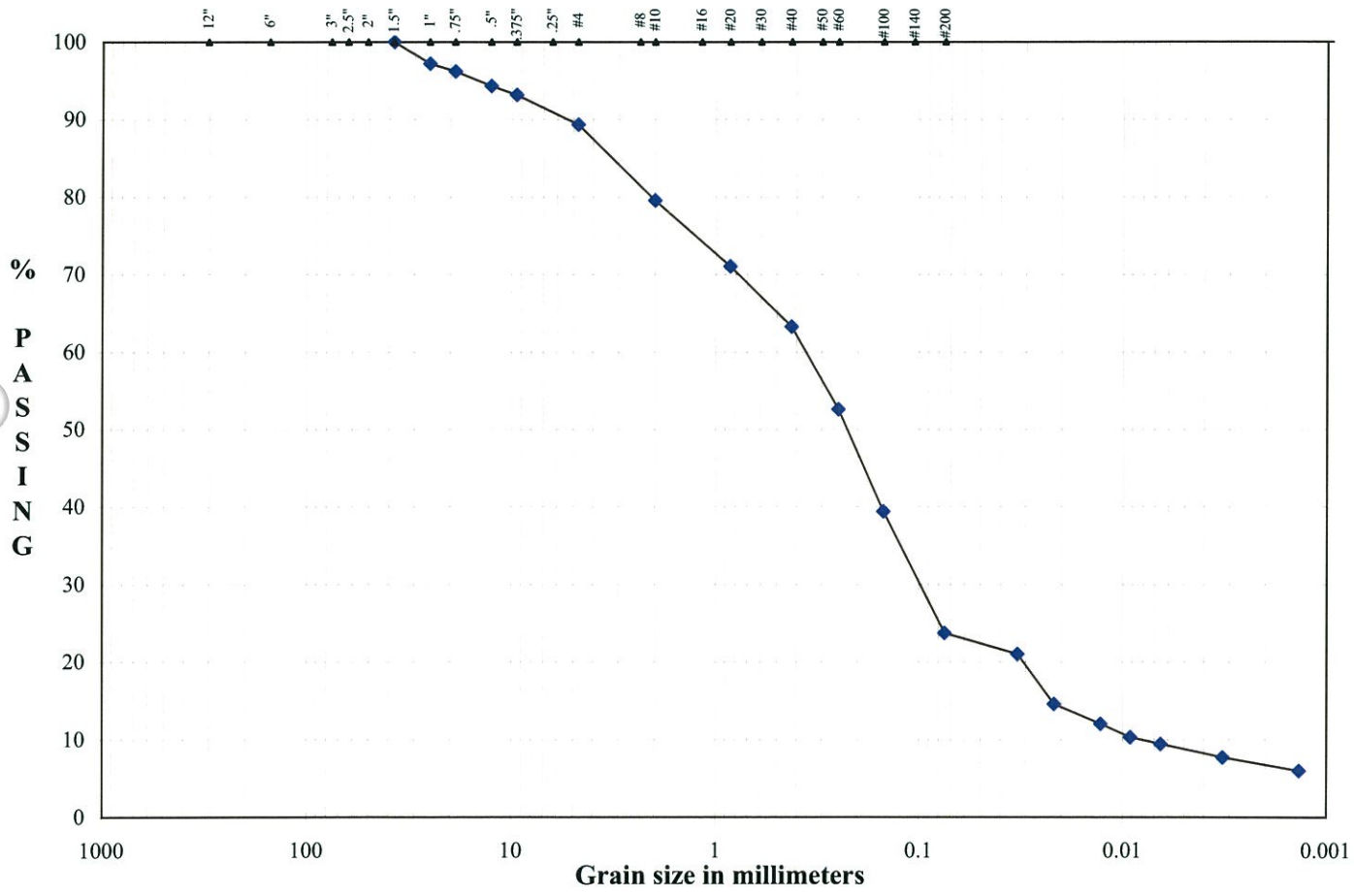
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15464/B-26	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	424.20
Mass of Dry Sample & Tare, g	365.90
Mass of Tare, g	108.40
Moisture Content, %	22.6

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	483.60
Mass of Dry Sample & Tare, g	452.10
Mass of Tare, g	98.60
Moisture Content, %	8.9

Mass of Total Sample before separation on #4 sieve & Tare, g	3226.70
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2962.70

Mass of Sample used for hydrometer analysis, g	104.30
Dry Mass, g	95.77
% of Total Sample passing #4 sieve	92.7

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"		0.00	0.0	100.0
1"		53.00	1.8	98.2
.75"	FINE GRAVEL	58.90	2.0	98.0
.5"		119.70	4.0	96.0
.375"		160.90	5.4	94.6
#4	COARSE SAND	217.40	7.3	92.7

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	3.97	88.8
#20		8.76	84.2
#40	FINE SAND	14.50	78.6
#60		22.57	70.8
#100		35.13	58.7
#200	FINES	51.79	42.6

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:40

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	10.2
% COARSE GRAVEL	2.0	% FINE SAND	36.1
% FINE GRAVEL	5.3	% FINES	42.6
% COARSE SAND	3.8	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	18.4	% CLAY(<0.002mm)	14.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:42	2	41.5	20.7	0.01328	6.0	35.5	10.5	0.99	0.0304	34.0
04/23/13	11:45	5	37.0	20.7	0.01328	6.0	31.0	11.2	0.99	0.0199	29.7
04/23/13	11:55	15	32.5	20.7	0.01328	6.0	26.5	12.0	0.99	0.0119	25.4
04/23/13	12:10	30	28.5	20.7	0.01328	6.0	22.5	12.6	0.99	0.0086	21.6
04/23/13	12:40	60	26.5	20.7	0.01328	6.0	20.5	13.0	0.99	0.0062	19.6
04/23/13	15:50	250	23.0	20.7	0.01328	6.0	17.0	13.6	0.99	0.0031	16.3
04/24/13	11:40	1440	20.0	20.7	0.01328	6.0	14.0	14.1	0.99	0.0013	13.4

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

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Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15465/B-29	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	409.70
Mass of Dry Sample & Tare, g	337.30
Mass of Tare, g	150.60
Moisture Content, %	38.8

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	477.80
Mass of Dry Sample & Tare, g	429.60
Mass of Tare, g	98.80
Moisture Content, %	14.6

Mass of Total Sample before separation on #4 sieve & Tare, g	2618.00
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2285.05

Mass of Sample used for hydrometer analysis, g	90.30
Dry Mass, g	78.82
% of Total Sample passing #4 sieve	99.8

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	3.60	0.2	99.8

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	1.51	97.9
#20		5.34	93.1
#40	FINE SAND	10.56	86.5
#60		18.56	76.3
#100		28.94	63.2
#200	FINES	41.07	47.8

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:42

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	11.5
% COARSE GRAVEL	0.0	% FINE SAND	38.6
% FINE GRAVEL	0.2	% FINES	47.8
% COARSE SAND	1.9	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	19.9	% CLAY(<0.002mm)	14.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:44	2	37.0	20.7	0.01328	6.0	31.0	11.2	0.99	0.0315	38.9
04/23/13	11:47	5	33.0	20.7	0.01328	6.0	27.0	11.9	0.99	0.0205	33.9
04/23/13	11:57	15	28.5	20.7	0.01328	6.0	22.5	12.6	0.99	0.0122	28.2
04/23/13	12:12	30	26.0	20.7	0.01328	6.0	20.0	13.1	0.99	0.0088	25.1
04/23/13	12:42	60	23.5	20.7	0.01328	6.0	17.5	13.5	0.99	0.0063	21.9
04/23/13	15:52	250	19.5	20.7	0.01328	6.0	13.5	14.1	0.99	0.0032	16.9
04/24/13	11:42	1440	16.5	20.7	0.01328	6.0	10.5	14.6	0.99	0.0013	13.2

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC
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Web: www.test-llc.com

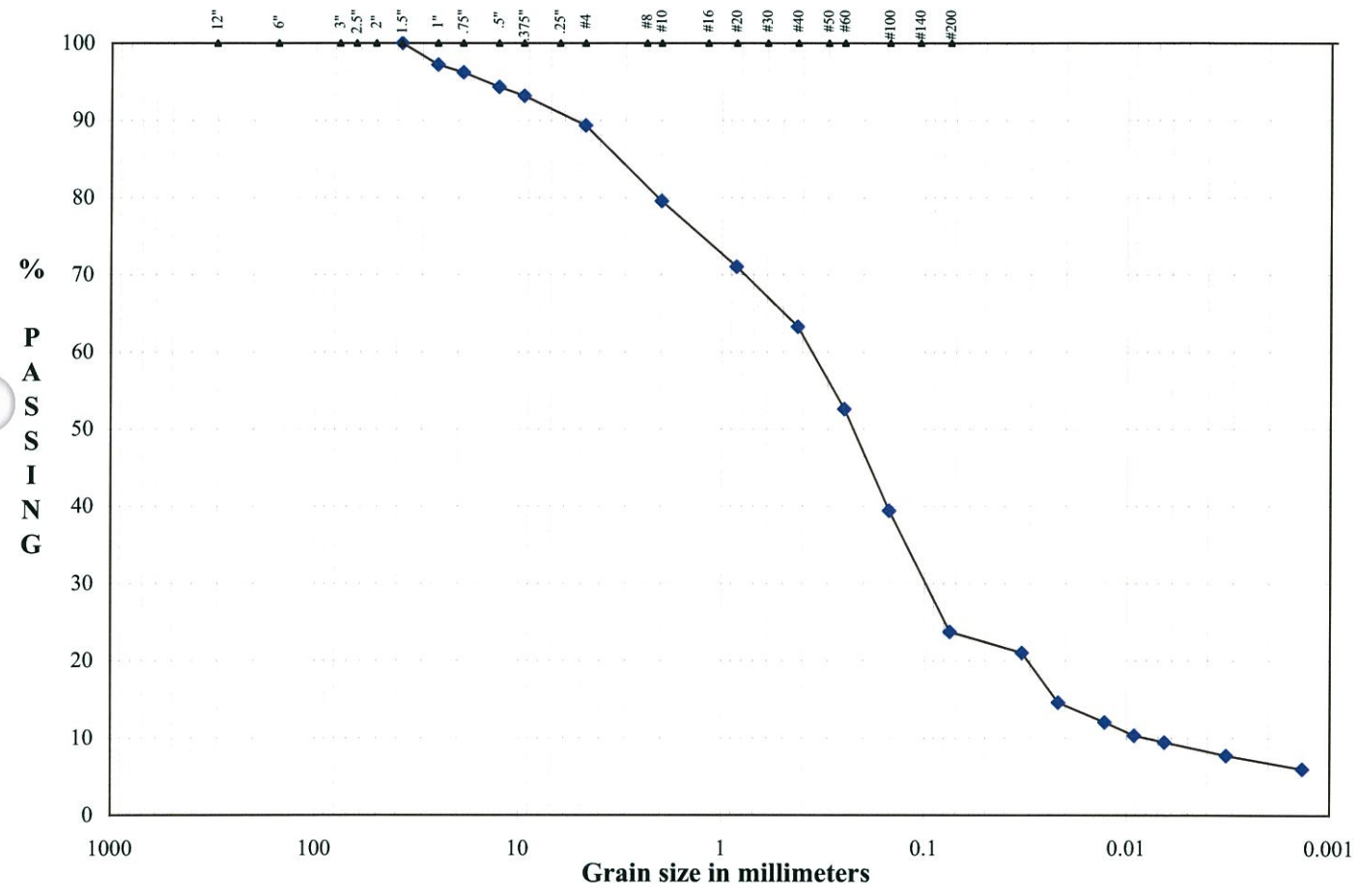
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15463/B-24	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

SCS (ASTM D2487; D2488): NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Web: www.test-llc.com

Tested By	MS
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15464/B-26	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
Dry Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	1.90	1.30	1.20	1.20					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	19000	13000	12000	12000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	19000	13000	12000	12000					

Reported Soil Minimum Resistivity, ohms-cm **12000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Fax: 770-923-8973

Web: www.test-llc.com

Tested By	EB
Date	04/22/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15464/B-26	Depth/Elev.	10-13'
Location	-	Add. Info	-

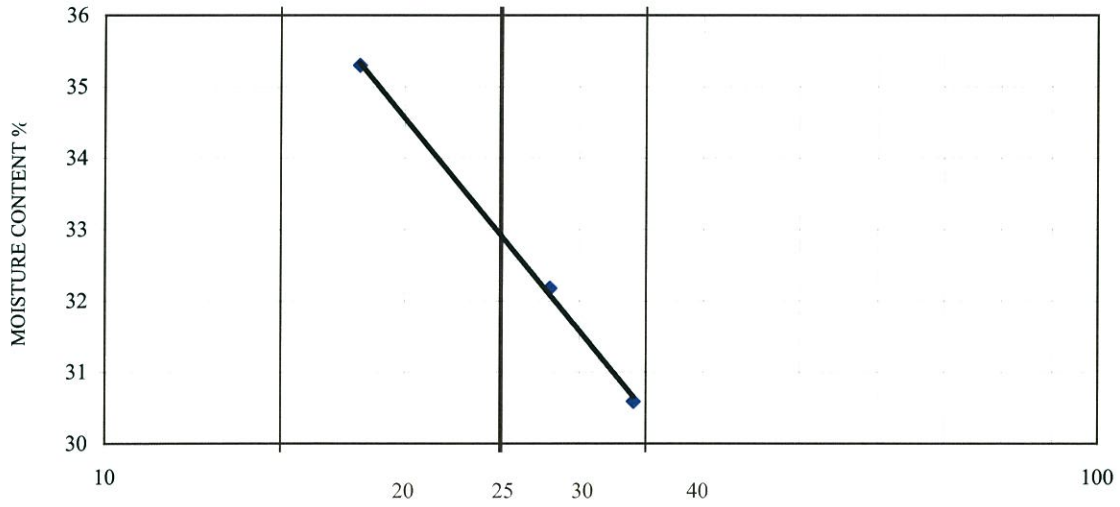
ASTM D 4318/AASHTO T 88, T 89

Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils (Atterberg Limits)

LIQUID LIMIT

Number of Blows	34	28	18
Mass of Wet Sample & Tare, g	44.81	39.81	40.61
Mass of Dry Sample & Tare, g	41.02	35.73	36.42
Mass of Tare, g	28.63	23.05	24.55
Moisture Content, %	30.59	32.18	35.30

Oven ID #	12/13/14/15
Balance ID #	2
Liquid Limit Device ID #	56



PLASTIC LIMIT

Mass of Wet Sample & Tare, g	31.87	34.14
Mass of Dry Sample & Tare, g	29.60	31.94
Mass of Tare, g	20.60	23.24
Moisture Content, %	25.22	25.29

PREPARATION PROCEDURE: DRY

NOTE: MATERIAL PASSING NO. 40 SIEVE WAS USED FOR TEST

NATURAL MOISTURE

Mass of Wet Sample & Tare, g	424.20
Mass of Dry Sample & Tare, g	365.90
Mass of Tare, g	108.40
Moisture Content, %	22.64

LIQUID LIMIT (LL)	33
PLASTIC LIMIT (PL)	25
PLASTICITY INDEX (PI)	8
LIQUIDITY INDEX (LI)	-0.29

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

AASHTO (M 145): NA

TIMELY ENGINEERING SOIL TESTS, LLC

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Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15464/B-26	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	424.20
Mass of Dry Sample & Tare, g	365.90
Mass of Tare, g	108.40
Moisture Content, %	22.6

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	483.60
Mass of Dry Sample & Tare, g	452.10
Mass of Tare, g	98.60
Moisture Content, %	8.9

Mass of Total Sample before separation on #4 sieve & Tare, g	3226.70
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2962.70

Mass of Sample used for hydrometer analysis, g	104.30
Dry Mass, g	95.77
% of Total Sample passing #4 sieve	92.7

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"		0.00	0.0	100.0
1"		53.00	1.8	98.2
.75"	FINE GRAVEL	58.90	2.0	98.0
.5"		119.70	4.0	96.0
.375"		160.90	5.4	94.6
#4	COARSE SAND	217.40	7.3	92.7

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	3.97	88.8
#20		8.76	84.2
#40	FINE SAND	14.50	78.6
#60		22.57	70.8
#100		35.13	58.7
#200	FINES	51.79	42.6

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:40

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	10.2
% COARSE GRAVEL	2.0	% FINE SAND	36.1
% FINE GRAVEL	5.3	% FINES	42.6
% COARSE SAND	3.8	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	18.4	% CLAY(<0.002mm)	14.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:42	2	41.5	20.7	0.01328	6.0	35.5	10.5	0.99	0.0304	34.0
04/23/13	11:45	5	37.0	20.7	0.01328	6.0	31.0	11.2	0.99	0.0199	29.7
04/23/13	11:55	15	32.5	20.7	0.01328	6.0	26.5	12.0	0.99	0.0119	25.4
04/23/13	12:10	30	28.5	20.7	0.01328	6.0	22.5	12.6	0.99	0.0086	21.6
04/23/13	12:40	60	26.5	20.7	0.01328	6.0	20.5	13.0	0.99	0.0062	19.6
04/23/13	15:50	250	23.0	20.7	0.01328	6.0	17.0	13.6	0.99	0.0031	16.3
4/24/13	11:40	1440	20.0	20.7	0.01328	6.0	14.0	14.1	0.99	0.0013	13.4

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

TIMELY ENGINEERING SOIL TESTS, LLC

1874 Forge Street Tucker, GA 30084

Phone: 770-938-8233

Fax: 770-923-8973

Web: www.test-llc.com

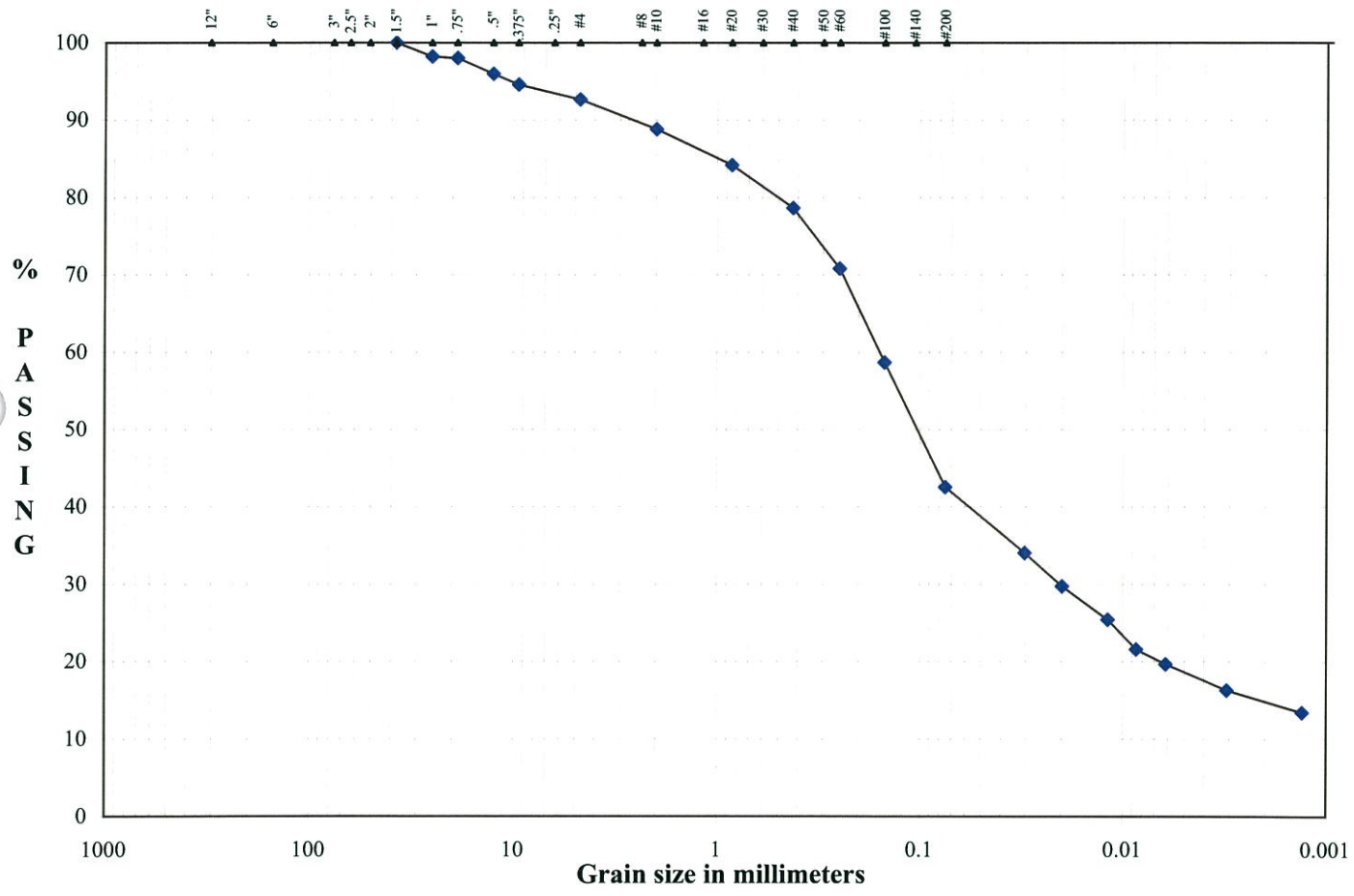
Tested By	RI
Date	04/21/13
Checked By	VB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15464/B-26	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Fax: 770-923-8973
Web: www.test-llc.com

Tested By	MS
Date	04/22/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15465/B-29	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM G 57/G187/AASHTO T 288

Standard Test Method for Determining Minimum Laboratory Soil Resistivity

Determination of Resistivity at as-received moisture content

As-received Moisture Content	
Mass of Wet Sample & Tare, g	
Mass of Dry Sample & Tare, g	
Mass of Tare, g	
Moisture Content, %	NA

Remarks

TEST DATA

Mass of Soil Box, g	-	Meter Dial Reading, ohms	-
Mass of Soil Box + Soil, g	-	Reading of Meter Range Multiplier	-
Mass of Soil, g	-	Measured Resistance, ohms	-
Calibrated Volume of Soil Box, ft^3	0.0027	Calibrated Soil Box Multiplier, cm	1.0
Wet Density of as-placed Soil, pcf	-		
Dry Density of as-placed Soil, pcf	-	**Reported Soil Resistivity, ohms-cm**	**NA**

Determination of Minimum Soil Resistivity

TEST DATA

	Trials at Various Moisture Content								
TRIAL #	1	2	3	4	5	6	7	8	9
Meter Dial Reading, ohms	1.00	0.90	0.80	0.80					
Reading of Meter Range Multiplier	10000	10000	10000	10000					
Measured Resistance, ohms	10000	9000	8000	8000					
Calibrated Soil Box Multiplier, cm	1.0	1.0	1.0	1.0					
Measured Resistivity, ohms-cm	10000	9000	8000	8000					

Reported Soil Minimum Resistivity, ohms-cm **8000**

Note: Material passed # 10 sieve used for testing

Oven ID #	12/13/14/15
Balance ID #	1/2/6
Soil Box ID #	112
Resistivity Meter ID #	111/396

Description

NA

USCS (D2487; D2488)	NA
AASHTO (M145)	NA

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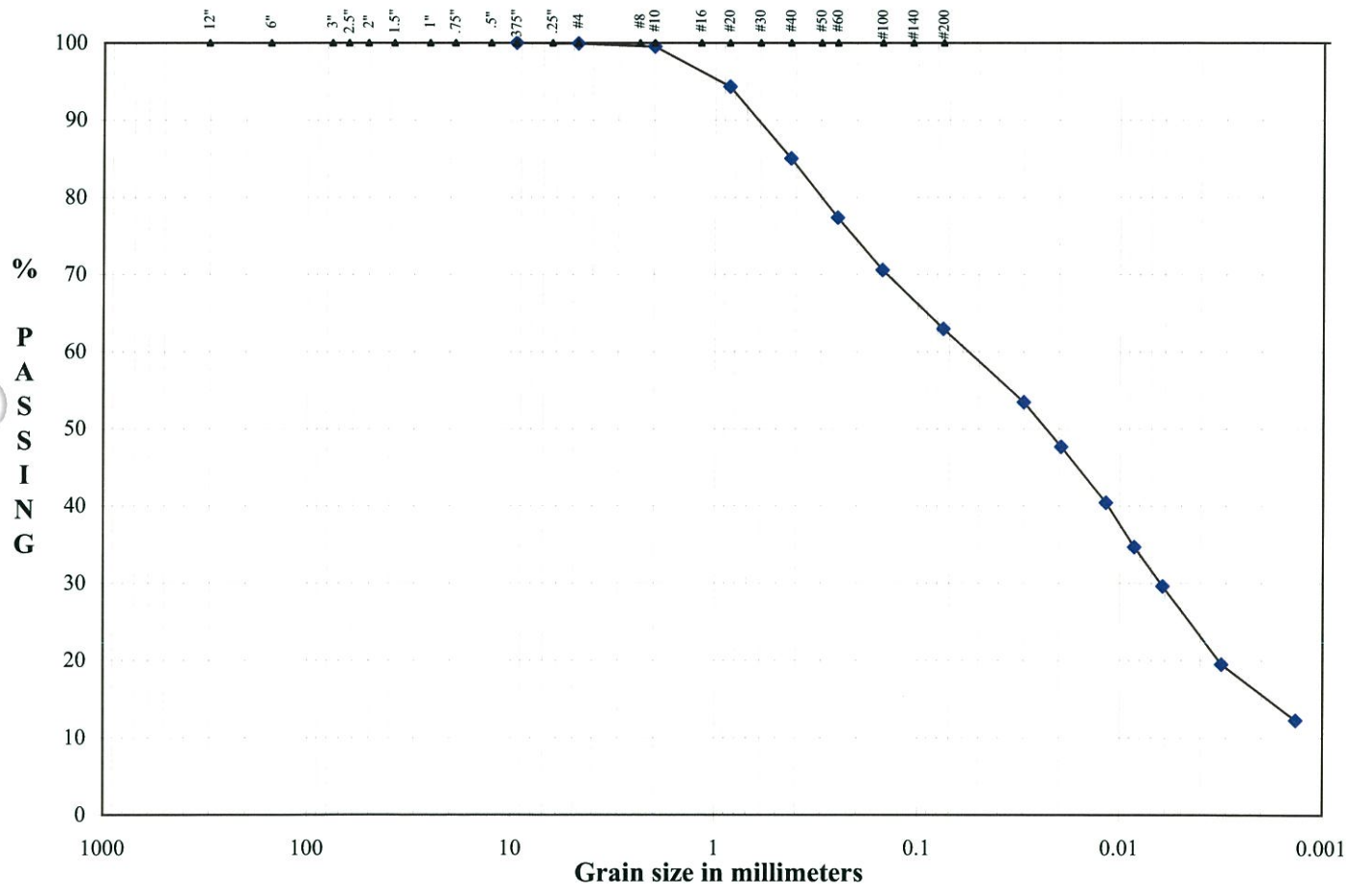
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Fax: 770-923-8973
Web: www.test-llc.com

Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15465/B-29	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	409.70
Mass of Dry Sample & Tare, g	337.30
Mass of Tare, g	150.60
Moisture Content, %	38.8

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	477.80
Mass of Dry Sample & Tare, g	429.60
Mass of Tare, g	98.80
Moisture Content, %	14.6

Mass of Total Sample before separation on #4 sieve & Tare, g	2618.00
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2285.05

Mass of Sample used for hydrometer analysis, g	90.30
Dry Mass, g	78.82
% of Total Sample passing #4 sieve	99.8

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"			0.0	100.0
2.5"	COARSE		0.0	100.0
2"	GRAVEL		0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"			0.0	100.0
.5"	FINE GRAVEL		0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	3.60	0.2	99.8

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM	1.51	97.9
#20	SAND	5.34	93.1
#40		10.56	86.5
#60	FINE SAND	18.56	76.3
#100		28.94	63.2
#200	FINES	41.07	47.8

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:42

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	11.5
% COARSE GRAVEL	0.0	% FINE SAND	38.6
% FINE GRAVEL	0.2	% FINES	47.8
% COARSE SAND	1.9	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	19.9	% CLAY(<0.002mm)	14.5

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:44	2	37.0	20.7	0.01328	6.0	31.0	11.2	0.99	0.0315	38.9
04/23/13	11:47	5	33.0	20.7	0.01328	6.0	27.0	11.9	0.99	0.0205	33.9
04/23/13	11:57	15	28.5	20.7	0.01328	6.0	22.5	12.6	0.99	0.0122	28.2
04/23/13	12:12	30	26.0	20.7	0.01328	6.0	20.0	13.1	0.99	0.0088	25.1
04/23/13	12:42	60	23.5	20.7	0.01328	6.0	17.5	13.5	0.99	0.0063	21.9
04/23/13	15:52	250	19.5	20.7	0.01328	6.0	13.5	14.1	0.99	0.0032	16.9
04/24/13	11:42	1440	16.5	20.7	0.01328	6.0	10.5	14.6	0.99	0.0013	13.2

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

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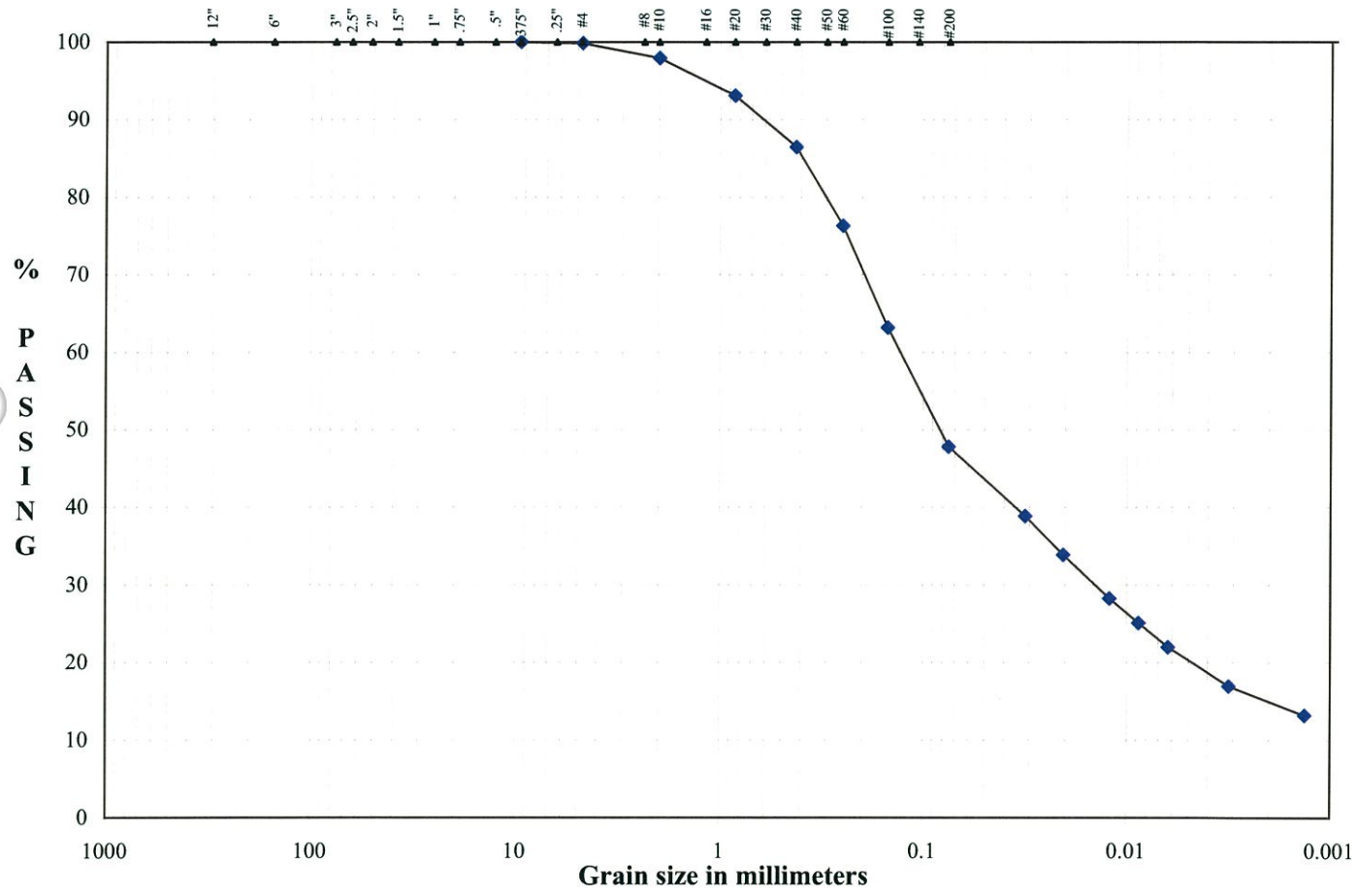
Tested By	RI
Date	04/21/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15465/B-29	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88

Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

Particle-Size Analysis



Boulders	Cobbles	Gravel: Coarse	Gravel: Fine	Sand: Coarse	Sand: Medium	Sand: Fine	Fines: Silt or Clay

D_{10}	NA	mm
D_{30}	NA	mm
D_{60}	NA	mm
Cu	NA	
Cc	NA	

DESCRIPTION: NA

USCS (ASTM D2487; D2488): NA

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Tested By	EB
Date	05/09/13
Checked By	

Client Pr. #	130107.00	Lab. PR. #	1307-10-2
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bulk
Sample ID	See Below	Depth/Elev.	See Below
Location	-	Add. Info	-

ASTM G200

Standard Test Method for Measurement of Oxidation Reduction Potential (ORP) of Soil

SAMPLE PREPARATION

Roots, Stones, Gravel and other deleterious material was removed prior to testing

Measurements performed ar room temperature condition: 23.2 °C

TEST DATA

T.E.S.T. Sample ID	Client Sample ID	ORP meter Reading #1, mV	ORP meter Reading #2, mV	ORP meter Reading #3, mV	**Reported ORP value, mV**
15594	B-1 (10-13')	395.9	383.0	364.4	**381**
15595	B-5 (10-13')	372.4	380.4	385.4	**379**
15596	B-9 (10-13')	393.6	395.1	361.0	**383**
15597	B-17 (40-43')	296.6	327.9	323.7	**316**
15598	B-21 (10-13')	35.5	44.8	44.3	**42**
15599	B-25 (10-13')	139.5	118.3	140.7	**133**
15600	B-30 (10-13')	407.5	403.4	405.2	**405**

REMARKS

Standard ORP calibration solution (420+/-mV) used to standardize ORP meter: P.D. 04/13, Exp.08/14

ORP Meter ID	375
ORP Probe ID	417

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Tested By	RI
Date	04/21/13
Checked By	LB

Client Pr. #	130107.00	Lab. PR. #	1307-10-1
Pr. Name	Hidhway 41 Water Main - Phase IV	S. Type	Bag
Sample ID	15454/B-1	Depth/Elev.	10-13'
Location	-	Add. Info	-

ASTM D 422/AASHTO T 88
Standard Test Method for Particle-Size Analysis of Soils (with Hydrometer Analysis)

As-Received Moisture Content

Mass of Wet Sample & Tare, g	635.30
Mass of Dry Sample & Tare, g	496.60
Mass of Tare, g	153.90
Moisture Content, %	40.5

Moisture Content of Material Used for Hydrometer Analysis

Mass of Wet Sample & Tare, g	346.80
Mass of Dry Sample & Tare, g	308.80
Mass of Tare, g	97.10
Moisture Content, %	17.9

Mass of Total Sample before separation on #4 sieve & Tare, g	2776.80
Mass of Tare, g	0.00
Total Mass of Dry Sample, g	2354.22

Mass of Sample used for hydrometer analysis, g	80.80
Dry Mass, g	68.50
% of Total Sample passing #4 sieve	99.9

SIEVE ANALYSIS

PORTION OF SAMPLE RETAINED ON #4 SIEVE

Mass of Tare, g: 0.00

Sieve Size		Sample & Tare, g	% RETAINED	%PASSING
12"	COBBLES		0.0	100.0
3"	COARSE GRAVEL		0.0	100.0
2.5"			0.0	100.0
2"			0.0	100.0
1.5"			0.0	100.0
1"			0.0	100.0
.75"	FINE GRAVEL		0.0	100.0
.5"			0.0	100.0
.375"		0.00	0.0	100.0
#4	COARSE SAND	2.20	0.1	99.9

PORTION OF SAMPLE PASSING #4 SIEVE (Hydrometer Backsieve)

Sieve Size		Cumulative Mass retained, g	% PASSING
#10	MEDIUM SAND	0.27	99.5
#20		3.82	94.3
#40	FINE SAND	10.21	85.0
#60		15.47	77.3
#100		20.11	70.6
#200	FINES	25.36	62.9

Remarks

HYDROMETER ANALYSIS

Length of Dispersion Period	1 Minute
Mechanical Dispersion Device ID #	61
Amount of Dispersing Agent (ml)	125.0
Specific Gravity (assumed)	2.700
Specific Gravity (tested)	
Starting time	11:20

PARTICLE-SIZE ANALYSIS

% COBBLES	0.0	% MEDIUM SAND	14.5
% COARSE GRAVEL	0.0	% FINE SAND	22.1
% FINE GRAVEL	0.1	% FINES	62.9
% COARSE SAND	0.4	% TOTAL SAMPLE	100.0
% CLAY(<0.005mm)	25.7	% CLAY(<0.002mm)	14.9

Date	Time	Testing time (min)	Reading	Temp (°C)	K	Composite Correction	Actual Reading	Effective Depth (cm)	a	Particle Diam. (mm)	Percent Passing
04/23/13	11:22	2	43.0	20.7	0.01328	6.0	37.0	10.2	0.99	0.0300	53.4
04/23/13	11:25	5	39.0	20.7	0.01328	6.0	33.0	10.9	0.99	0.0196	47.6
04/23/13	11:35	15	34.0	20.7	0.01328	6.0	28.0	11.7	0.99	0.0117	40.4
04/23/13	11:50	30	30.0	20.7	0.01328	6.0	24.0	12.4	0.99	0.0085	34.7
04/23/13	12:20	60	26.5	20.7	0.01328	6.0	20.5	13.0	0.99	0.0062	29.6
04/23/13	15:30	250	19.5	20.7	0.01328	6.0	13.5	14.1	0.99	0.0032	19.5
04/24/13	11:20	1440	14.5	20.7	0.01328	6.0	8.5	15.0	0.99	0.0014	12.3

Hydrometer 152H ID #	451190	Oven ID #	12/13/14/15
Sieve Shaker ID #	54/130	Balance ID#	1/6/7

CASE NARRATIVE

Client: GeoHydro Engineers, Inc. **Report:** 213041204

Gulf Coast Analytical Laboratories received and analyzed the sample(s) listed on the sample cross-reference page of this report. Receipt of the sample(s) is documented by the attached chain of custody. This applies only to the sample(s) listed in this report. No sample integrity or quality control exceptions were identified unless noted below.

No anomalies were found for the analyzed sample(s).

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with GCAL's Standard Operating Procedures.

Common Abbreviations Utilized in this Report

ND	Indicates the result was Not Detected at the specified RDL
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
PQL	Practical Quantitation Limit
MDL	Method Detection Limit
RDL	Reporting Detection Limit
00:00	Reported as a time equivalent to 12:00 AM

Reporting Flags Utilized in this Report

J	Indicates the result is between the MDL and RDL
U	Indicates the compound was analyzed for but not detected
B	Indicates the analyte was detected in the associated Method Blank

Sample receipt at GCAL is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of GCAL. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with the NELAC standard and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer-readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

_____

Authorized Signature
GCAL REPORT 213041204

Report Sample Summary

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304120401	B30 (10-13)	Solid	04/09/2013 12:06	04/11/2013 09:10

Summary of Compounds Detected

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304120401	**B30 (10-13)**	Solid	04/09/2013 12:06	04/11/2013 09:10

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.48	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304120401	B30 (10-13)	Solid	04/09/2013 12:06	04/11/2013 09:10

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/12/2013 15:17	DNM	505063

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.48	1.00		pH unit

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/18/2013 13:00	505430	EPA 9251	1	04/23/2013 08:56	MCP	505836

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	ND	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/17/2013 10:00	505431	SW-846 9038	1	04/18/2013 09:35	JEM	505491

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/13/2013 08:00	505098	SW-846 9030	1	04/15/2013 09:11	JEM	505194

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

General Chemistry Quality Control Summary

Analytical Batch 505836	**Client ID**	MB505430		LCS505430
Prep Batch 505430	**GCAL ID**	1182659		1182660
Prep Method EPA 9251	**Sample Type**	Method Blank		LCS
	Prep Date	04/18/2013 13:00		04/18/2013 13:00
	Analytical Date	04/23/2013 08:54		04/23/2013 08:55
	Matrix	Solid		Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**
	Result	**RDL**	**Added**		**% R**	**Limits % R**
16887-00-6 Chloride	ND	10.0	600	626	104	80 - 120

Analytical Batch 505836	**Client ID**	4-12-13-B	4-12-13- MS	4-12-13- MSD
Prep Batch 505430	**GCAL ID**	21304151303	21304151311	21304151313
Prep Method EPA 9251	**Sample Type**	SAMPLE	MS	MSD
	Prep Date	04/18/2013 13:00	04/18/2013 13:00	04/18/2013 13:00
	Analytical Date	04/23/2013 09:14	04/23/2013 09:16	04/23/2013 09:16
	Matrix	Solid	Solid	Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**	**Result**			**RPD**
	Result	**RDL**	**Added**		**% R**	**Limits % R**		**% R**	**RPD**	**Limit**
16887-00-6 Chloride	2360	100	6000	8820	108	75 - 125	8810	107	0.1	25

General Chemistry Quality Control Summary

Analytical Batch 505491	**Client ID**	MB505431			LCS505431		
Prep Batch 505431	**GCAL ID**	1182662			1182663		
Prep Method SW-846 9038	**Sample Type**	Method Blank			LCS		
	Prep Date	04/17/2013 10:00			04/17/2013 10:00		
	Analytical Date	04/18/2013 09:32			04/18/2013 09:34		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	ND	50.0	200	204	102	80 - 120	

Analytical Batch 505491	**Client ID**	B-26 (10-13)			1182511MS		
Prep Batch 505431	**GCAL ID**	21304171101			1182665		
Prep Method SW-846 9038	**Sample Type**	SAMPLE			MS		
	Prep Date	04/17/2013 10:00			04/17/2013 10:00		
	Analytical Date	04/18/2013 09:37			04/18/2013 09:37		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	9.60	50.0	200	224	107	75 - 125	

Analytical Batch 505491	**Client ID**	B-26 (10-13)	1182511DUP			
Prep Batch 505431	**GCAL ID**	21304171101	1182664			
Prep Method SW-846 9038	**Sample Type**	SAMPLE	DUP			
	Prep Date	04/17/2013 10:00	04/17/2013 10:00			
	Analytical Date	04/18/2013 09:37	04/18/2013 09:37			
	Matrix	Solid	Solid			
SW-846 9038 Sulfate	**Units**	mg/kg	**Result**		**RPD**	
	Result	**RDL**		**RPD**	**Limit**	
14808-79-8 Sulfate	9.60	50.0	9.50	1	25	

General Chemistry Quality Control Summary

Analytical Batch 505194	**Client ID**	MB505098			LCS505098		
Prep Batch 505098	**GCAL ID**	1181101			1181102		
Prep Method SW-846 9030	**Sample Type**	Method Blank			LCS		
	Prep Date	04/13/2013 08:00			04/13/2013 08:00		
	Analytical Date	04/15/2013 09:11			04/15/2013 09:11		
	Matrix	Solid			Solid		
SW-846 9034 Sulfide		**Units**	mg/kg	**Spike**	**Result**		**Control**
		Result	**RDL**	**Added**		**% R**	**Limits % R**
18496-25-8 Sulfide		ND	80	1243	401	32	15 - 120

Analytical Batch 505194	**Client ID**	B30 (10-13)		1180998DUP		
Prep Batch 505098	**GCAL ID**	21304120401		1181103		
Prep Method SW-846 9030	**Sample Type**	SAMPLE		DUP		
	Prep Date	04/13/2013 08:00		04/13/2013 08:00		
	Analytical Date	04/15/2013 09:11		04/15/2013 09:11		
	Matrix	Solid		Solid		
SW-846 9034 Sulfide		**Units**	mg/kg	**Result**	**RPD**	**RPD**
		Result	**RDL**			**Limit**
18496-25-8 Sulfide		0	80	0	0	25

GCAL

7979 GSRI Avenue, Baton Rouge, Louisiana 70820-7402
Phone 225.769.4900 • Fax 225.767.5717

CHAIN OF CUSTODY RECORD

Lab use only	Client Name	Client #	Workorder #	Due Date
	Geo Hydro	4792	213041204	4/17/13

Report to:
Client: Geo-Hydro
Address: 1000 Cobb Place Blvd
Kennesaw, GA 30144
Contact: John O'Brien
Phone: 770-364-8565
Fax:

Bill to:
Client:
Address: SAME
Contact:
Phone:
Fax:

P.O. Number
Project Name/Number: Hwy 41 / 130107.00
Sampled By:

Analytical Requests & Method

Lab use only:
Custody Seal
used ☑ yes ☐ no
intact ☑ yes ☐ no
Temperature °C 5.6

Matrix*	Date	Time (2400)	Comp	Grab	Sample Description	Preservatives	No Containers	Chloride (9251)	Sulfate (9038)	Sulfide (9034)	pH	Lab ID
S	4/2/13	1106		X	B30 (10-13)		2	X	X	X	X	1

Remarks:

Turn Around Time: ☐ 24-48 hrs. ☐ 3 days ☐ 1 week ☒ Standard ☐ Other

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
[signature]	Fed-X	10/4/13	
Fed Ex	[signature]	4/11/13	9:10
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Note: 850794

7948 7162 9275

By submitting these samples, you agree to the terms and conditions contained in our most recent schedule of services.

*Matrix: W = water, S = soil, SD = solid, L = liquid, SL = sludge, O = oil, CT = charcoal tube, A = air bag

We cannot accept verbal changes. Please fax written change

WHITE: CLIENT FINAL REPORT — CANARY: LABORATORY — PINK: CLIENT

GCAL 08/11/98

GCAL ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIVING CHECKLIST

213041204

SAMPLE DELIVERY GROUP	213041204
Client 4792 - GeoHydro Engineers, Inc.	**Transport Method** FEDEX
Profile Number 241446	**Received By** Saucier, Charlotte
Line Item(s) 1 - Soil	**Receive Date(s)** 04/11/13

CHECKLIST

Were all samples received using proper thermal preservation?	☑ Yes	☐ No	☐ NA
When used, were all custody seals intact?	☑ Yes	☐ No	☐ NA
Were all samples received in proper containers?	☑ Yes	☐ No	☐ NA
Were all samples received using proper chemical preservation?	☑ Yes	☐ No	☐ NA
Was preservative added to any container at the lab?	☐ Yes	☑ No	☐ NA
Were all containers received in good condition?	☑ Yes	☐ No	☐ NA
Were all VOA vials received with no head space?	☐ Yes	☐ No	☑ NA
Do all sample labels match the Chain of Custody?	☑ Yes	☐ No	☐ NA
Did the Chain of Custody list the sampling technician?	☐ Yes	☑ No	☐ NA
Was the COC maintained i.e. all signatures, dates and time of receipt included?	☑ Yes	☐ No	☐ NA

COOLERS

Airbill	Temp(oC)
7948 7162 9275	5.6

DISCREPANCIES

None

LABORATORY PRESERVATIONS

None

NOTES

NELAP CERTIFICATE NUMBER 01955
DOD ELAP CERTIFICATE NUMBER ADE - 1482

ANALYTICAL RESULTS

PERFORMED BY

GULF COAST ANALYTICAL LABORATORIES, INC.
7979 GSRI Avenue
Baton Rouge, LA 70820

Report Date 04/19/2013

GCAL Report 213041711

Deliver To	GeoHydro 1000 Cobb Place Blvd. Kennesaw, GA 30144 770-596-6237
Attn	Marty Peniger

Project HWY 41/130107.00

CASE NARRATIVE

Client: GeoHydro Engineers, Inc. **Report:** 213041711

Gulf Coast Analytical Laboratories received and analyzed the sample(s) listed on the sample cross-reference page of this report. Receipt of the sample(s) is documented by the attached chain of custody. This applies only to the sample(s) listed in this report. No sample integrity or quality control exceptions were identified unless noted below.

No anomalies were found for the analyzed sample(s).

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with GCAL's Standard Operating Procedures.

Common Abbreviations Utilized in this Report

ND	Indicates the result was Not Detected at the specified RDL
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
PQL	Practical Quantitation Limit
MDL	Method Detection Limit
RDL	Reporting Detection Limit
00:00	Reported as a time equivalent to 12:00 AM

Reporting Flags Utilized in this Report

J	Indicates the result is between the MDL and RDL
U	Indicates the compound was analyzed for but not detected
B	Indicates the analyte was detected in the associated Method Blank

Sample receipt at GCAL is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of GCAL. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with the NELAC standard and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer-readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

Robyn Migues
Technical Director
GCAL REPORT 213041711

Report Sample Summary

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304171101	B-26 (10-13)	Solid	04/15/2013 09:30	04/17/2013 08:55

Summary of Compounds Detected

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304171101	B-26 (10-13)	Solid	04/15/2013 09:30	04/17/2013 08:55

SW-846 9251 Chloride

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	13.8	10.0		mg/kg

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	5.33	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304171101	B-26 (10-13)	Solid	04/15/2013 09:30	04/17/2013 08:55

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/18/2013 11:30	DNM	505330

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	5.33	1.00		pH unit

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/17/2013 11:00	505429	EPA 9251	1	04/18/2013 11:02	MCP	505490

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	13.8	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/17/2013 10:00	505431	SW-846 9038	1	04/18/2013 09:37	JEM	505491

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/19/2013 07:00	505486	SW-846 9030	1	04/19/2013 09:30	JEM	505595

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

General Chemistry Quality Control Summary

Analytical Batch 505330	**Client ID**	PARTS WASHER WASTE		1181240DUP		
Prep Batch N/A	**GCAL ID**	21304124201		1182110		
	Sample Type	SAMPLE		DUP		
	Analytical Date	04/18/2013 11:30		04/18/2013 11:30		
	Matrix	Solid		Solid		
SW-846 9045D		**Units**	pH unit	**Result**	**RPD**	**RPD Limit**
		Result	**RDL**			
pH	pH	10.7	1.00	10.7	0.09	6

General Chemistry Quality Control Summary

Analytical Batch 505490	**Client ID**	MB505429		LCS505429
Prep Batch 505429	**GCAL ID**	1182652		1182653
Prep Method EPA 9251	**Sample Type**	Method Blank		LCS
	Prep Date	04/17/2013 11:00		04/17/2013 11:00
	Analytical Date	04/18/2013 10:46		04/18/2013 10:47
	Matrix	Solid		Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**
	Result	**RDL**	**Added**		**% R**	**Limits % R**
16887-00-6 Chloride	ND	10.0	600	599	100	80 - 120

Analytical Batch 505490	**Client ID**	TB13-1 5 FEET		1179841MS
Prep Batch 505429	**GCAL ID**	21304094601		1182651
Prep Method EPA 9251	**Sample Type**	SAMPLE		MS
	Prep Date	04/17/2013 11:00		04/17/2013 11:00
	Analytical Date	04/18/2013 10:48		04/18/2013 10:50
	Matrix	Solid		Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**
	Result	**RDL**	**Added**		**% R**	**Limits % R**
16887-00-6 Chloride	31.3	10.0	600	612	97	75 - 125

Analytical Batch 505490	**Client ID**	B-26 (10-13)	1182511MS		1182511MSD
Prep Batch 505429	**GCAL ID**	21304171101	1182980		1182981
Prep Method EPA 9251	**Sample Type**	SAMPLE	MS		MSD
	Prep Date	04/17/2013 11:00	04/17/2013 11:00		04/17/2013 11:00
	Analytical Date	04/18/2013 11:02	04/18/2013 11:16		04/18/2013 11:17
	Matrix	Solid	Solid		Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**	**Result**			**RPD**
	Result	**RDL**	**Added**		**% R**	**Limits % R**		**% R**	**RPD**	**Limit**
16887-00-6 Chloride	13.8	10.0	600	654	107	75 - 125	623	101	5	25

General Chemistry Quality Control Summary

Analytical Batch 505490	**Client ID**	TB13-1 5 FEET	1179841DUP	
Prep Batch 505429	**GCAL ID**	21304094601	1182654	
Prep Method EPA 9251	**Sample Type**	SAMPLE	DUP	
	Prep Date	04/17/2013 11:00	04/17/2013 11:00	
	Analytical Date	04/18/2013 10:48	04/18/2013 11:16	
	Matrix	Solid	Solid	

SW-846 9251 Chloride	**Units** mg/kg				
	Result	**RDL**	**Result**	**RPD**	**RPD Limit**
16887-00-6 Chloride	31.3	10.0	29.9	5	25

General Chemistry Quality Control Summary

Analytical Batch 505491	**Client ID**	MB505431			LCS505431		
Prep Batch 505431	**GCAL ID**	1182662			1182663		
Prep Method SW-846 9038	**Sample Type**	Method Blank			LCS		
	Prep Date	04/17/2013 10:00			04/17/2013 10:00		
	Analytical Date	04/18/2013 09:32			04/18/2013 09:34		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	ND	50.0	200	204	102	80 - 120	

Analytical Batch 505491	**Client ID**	B-26 (10-13)			1182511MS		
Prep Batch 505431	**GCAL ID**	21304171101			1182665		
Prep Method SW-846 9038	**Sample Type**	SAMPLE			MS		
	Prep Date	04/17/2013 10:00			04/17/2013 10:00		
	Analytical Date	04/18/2013 09:37			04/18/2013 09:37		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	9.60	50.0	200	224	107	75 - 125	

Analytical Batch 505491	**Client ID**	B-26 (10-13)	1182511DUP			
Prep Batch 505431	**GCAL ID**	21304171101	1182664			
Prep Method SW-846 9038	**Sample Type**	SAMPLE	DUP			
	Prep Date	04/17/2013 10:00	04/17/2013 10:00			
	Analytical Date	04/18/2013 09:37	04/18/2013 09:37			
	Matrix	Solid	Solid			
SW-846 9038 Sulfate	**Units**	mg/kg	**Result**		**RPD**	
	Result	**RDL**		**RPD**	**Limit**	
14808-79-8 Sulfate	9.60	50.0	9.50	1	25	

General Chemistry Quality Control Summary

Analytical Batch 505595	**Client ID**	MB505486			LCS505486		
Prep Batch 505486	**GCAL ID**	1182923			1182924		
Prep Method SW-846 9030	**Sample Type**	Method Blank			LCS		
	Prep Date	04/19/2013 07:00			04/19/2013 07:00		
	Analytical Date	04/19/2013 09:30			04/19/2013 09:30		
	Matrix	Solid			Solid		
SW-846 9034 Sulfide	**Units**	**Result**	mg/kg **RDL**	**Spike Added**	**Result**	**% R**	**Control Limits % R**
18496-25-8 Sulfide		ND	80	1240	329	26.5	15 - 120

Analytical Batch 505595	**Client ID**	B-26 (10-13)		1182511DUP		
Prep Batch 505486	**GCAL ID**	21304171101		1182925		
Prep Method SW-846 9030	**Sample Type**	SAMPLE		DUP		
	Prep Date	04/19/2013 07:00		04/19/2013 07:00		
	Analytical Date	04/19/2013 09:30		04/19/2013 09:30		
	Matrix	Solid		Solid		
SW-846 9034 Sulfide	**Units**	**Result**	mg/kg **RDL**	**Result**	**RPD**	**RPD Limit**
18496-25-8 Sulfide		0	80	0	0	25

GCAL

7979 GSRI Avenue, Baton Rouge, Louisiana 70820-7402
Phone 225.769.4900 • Fax 225.767.5717

Chain of Custody Record

Lab use only	Client Name	Client #	Workorder #	Due Date
	Geo-Hydro	4792	213041711	4/23/13

Report to:
Client: Geo-Hydro
Address: 1600 Cobb Place Blvd
Kennesaw, GA 30144
Contact: Marty Peniger
Phone: 770-596-6237
Fax:

Bill to:
Client:
Address: SAME
Contact:
Phone:
Fax:

P.O. Number:
Project Name/Number: Hwy 41 / 130107.00
Sampled By:

Analytical Requests & Method

Lab use only:
Custody Seal used ☑ yes ☐ no
intact ☑ yes ☐ no
Temperature °C 4.8

Matrix[1]	Date	Time (2400)	Comp	Grab	Sample Description	Preservatives	No Containers	Chloride (9251)	Sulfate (9038)	Sulfide (9034)	pH	Remarks:	Lab ID
S	15APR13	0930		X	B-26 (10-13)		2	X	X	X	X		4/17 1

Turn Around Time: ☐ 24-48 hrs. ☐ 3 days ☐ 1 week ☑ Standard ☐ Other 7994 5437 HOLD

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
OR	UPS	16APR13	
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
		4/17/13	0855
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Note:

By submitting these samples, you agree to the terms and conditions contained in our most recent schedule of services.

WHITE: CLIENT FINAL REPORT — CANARY: LABORATORY — PINK: CLIENT

GCAL 08 11/98

GCAL ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIVING CHECKLIST

213041711

SAMPLE DELIVERY GROUP	213041711
Client 4792 - GeoHydro Engineers, Inc.	**Transport Method** FEDEX
Profile Number 241446	**Received By** Pfeifer, Ben J.
Line Item(s) 1 - Soil	**Receive Date(s)** 04/17/13

CHECKLIST

Were all samples received using proper thermal preservation?	☑ Yes	☐ No	☐ NA
When used, were all custody seals intact?	☑ Yes	☐ No	☐ NA
Were all samples received in proper containers?	☑ Yes	☐ No	☐ NA
Were all samples received using proper chemical preservation?	☑ Yes	☐ No	☐ NA
Was preservative added to any container at the lab?	☐ Yes	☑ No	☐ NA
Were all containers received in good condition?	☑ Yes	☐ No	☐ NA
Were all VOA vials received with no head space?	☐ Yes	☐ No	☑ NA
Do all sample labels match the Chain of Custody?	☑ Yes	☐ No	☐ NA
Did the Chain of Custody list the sampling technician?	☐ Yes	☑ No	☐ NA
Was the COC maintained i.e. all signatures, dates and time of receipt included?	☑ Yes	☐ No	☐ NA

COOLERS

Airbill	Temp(oC)
7994 5437 8608	4.8

DISCREPANCIES

None

LABORATORY PRESERVATIONS

None

NOTES

NELAP CERTIFICATE NUMBER 01955
DOD ELAP CERTIFICATE NUMBER ADE - 1482

ANALYTICAL RESULTS

PERFORMED BY

GULF COAST ANALYTICAL LABORATORIES, INC.

7979 GSRI Avenue

Baton Rouge, LA 70820

Report Date 04/10/2013

GCAL Report 213040348

Deliver To	GeoHydro 1000 Cobb Place Blvd. Kennesaw, GA 30144 770-596-6237
Attn	Marty Peniger

Project HWY 41/130107.00

CASE NARRATIVE

Client: GeoHydro Engineers, Inc. **Report:** 213040348

Gulf Coast Analytical Laboratories received and analyzed the sample(s) listed on the sample cross-reference page of this report. Receipt of the sample(s) is documented by the attached chain of custody. This applies only to the sample(s) listed in this report. No sample integrity or quality control exceptions were identified unless noted below.

No anomalies were found for the analyzed sample(s).

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with GCAL's Standard Operating Procedures.

Common Abbreviations Utilized in this Report

ND	Indicates the result was Not Detected at the specified RDL
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
PQL	Practical Quantitation Limit
MDL	Method Detection Limit
RDL	Reporting Detection Limit
00:00	Reported as a time equivalent to 12:00 AM

Reporting Flags Utilized in this Report

J	Indicates the result is between the MDL and RDL
U	Indicates the compound was analyzed for but not detected
B	Indicates the analyte was detected in the associated Method Blank

Sample receipt at GCAL is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of GCAL. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with the NELAC standard and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer-readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

Robyn Migues
Technical Director
GCAL REPORT 213040348

Report Sample Summary

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034801	B-5 (10-13)	Solid	04/01/2013 13:00	04/03/2013 09:30
21304034802	B-9 (10-13)	Solid	04/01/2013 15:00	04/03/2013 09:30
21304034803	B-1 (10-13)	Solid	04/01/2013 09:00	04/03/2013 09:30

Summary of Compounds Detected

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034801	B-5 (10-13)	Solid	04/01/2013 13:00	04/03/2013 09:30

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	4.92	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034802	B-9 (10-13)	Solid	04/01/2013 15:00	04/03/2013 09:30

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.99	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034803	B-1 (10-13)	Solid	04/01/2013 09:00	04/03/2013 09:30

SW-846 9251 Chloride

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	13.1	10.0		mg/kg

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	4.86	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034801	B-5 (10-13)	Solid	04/01/2013 13:00	04/03/2013 09:30

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/09/2013 15:00	DNM	504496

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	4.92	1.00		pH unit

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504757	EPA 9251	1	04/09/2013 09:21	MCP	504798

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	ND	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504756	SW-846 9038	1	04/09/2013 09:56	JEM	504801

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/05/2013 06:00	504575	SW-846 9030	1	04/06/2013 14:20	JEM	504687

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034802	B-9 (10-13)	Solid	04/01/2013 15:00	04/03/2013 09:30

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/09/2013 15:00	DNM	504496

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.99	1.00		pH unit

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504757	EPA 9251	1	04/09/2013 09:22	MCP	504798

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	ND	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504756	SW-846 9038	1	04/09/2013 09:58	JEM	504801

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/05/2013 06:00	504575	SW-846 9030	1	04/06/2013 14:20	JEM	504687

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304034803	B-1 (10-13)	Solid	04/01/2013 09:00	04/03/2013 09:30

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/09/2013 15:00	DNM	504496

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	4.86	1.00		pH unit

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504757	EPA 9251	1	04/09/2013 09:28	MCP	504798

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	13.1	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504756	SW-846 9038	1	04/09/2013 09:59	JEM	504801

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/05/2013 06:00	504575	SW-846 9030	1	04/06/2013 14:20	JEM	504687

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

General Chemistry Quality Control Summary

Analytical Batch 504496	Client ID	B-5 (10-13)		1177712DUP		
Prep Batch N/A	GCAL ID	21304034801		1177867		
	Sample Type	SAMPLE		DUP		
	Analytical Date	04/09/2013 15:00		04/09/2013 15:00		
	Matrix	Solid		Solid		
SW-846 9045D	**Units**	pH unit		**Result**	**RPD**	**RPD Limit**
	Result	**RDL**				
pH pH	4.92	1.00		4.92	0	6

General Chemistry Quality Control Summary

Analytical Batch 504798	**Client ID**	MB504757			LCS504757		
Prep Batch 504757	**GCAL ID**	1179261			1179262		
Prep Method EPA 9251	**Sample Type**	Method Blank			LCS		
	Prep Date	04/08/2013 10:40			04/08/2013 10:40		
	Analytical Date	04/09/2013 09:20			04/09/2013 09:20		
	Matrix	Solid			Solid		
SW-846 9251 Chloride	**Units**	**Result**	mg/kg **RDL**	**Spike Added**	**Result**	**% R**	**Control Limits % R**
16887-00-6 Chloride		ND	10.0	600	558	93	80 - 120

Analytical Batch 504798	**Client ID**	B-1 (10-13)			1177714MS			1177714MSD			
Prep Batch 504757	**GCAL ID**	21304034803			1179264			1179599			
Prep Method EPA 9251	**Sample Type**	SAMPLE			MS			MSD			
	Prep Date	04/08/2013 10:40			04/08/2013 10:40			04/08/2013 10:40			
	Analytical Date	04/09/2013 09:28			04/09/2013 09:30			04/09/2013 09:31			
	Matrix	Solid			Solid			Solid			
SW-846 9251 Chloride	**Units**	**Result**	mg/kg **RDL**	**Spike Added**	**Result**	**% R**	**Control Limits % R**	**Result**	**% R**	**RPD**	**RPD Limit**
16887-00-6 Chloride		13.1	10.0	600	577	94	75 - 125	578	94	0.1	25

General Chemistry Quality Control Summary

Analytical Batch 504801	**Client ID**	MB504756			LCS504756		
Prep Batch 504756	**GCAL ID**	1179256			1179257		
Prep Method SW-846 9038	**Sample Type**	Method Blank			LCS		
	Prep Date	04/08/2013 10:40			04/08/2013 10:40		
	Analytical Date	04/09/2013 09:54			04/09/2013 09:55		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg					
	Result		**RDL**	**Spike Added**	**Result**	**% R**	**Control Limits % R**
14808-79-8 Sulfate		ND	50.0	200	191	95	80 - 120

Analytical Batch 504801	**Client ID**	B-5 (10-13)			1177712MS		
Prep Batch 504756	**GCAL ID**	21304034801			1179259		
Prep Method SW-846 9038	**Sample Type**	SAMPLE			MS		
	Prep Date	04/08/2013 10:40			04/08/2013 10:40		
	Analytical Date	04/09/2013 09:56			04/09/2013 09:57		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg					
	Result		**RDL**	**Spike Added**	**Result**	**% R**	**Control Limits % R**
14808-79-8 Sulfate		23.0	50.0	200	235	106	75 - 125

Analytical Batch 504801	**Client ID**	B-5 (10-13)		1177712DUP			
Prep Batch 504756	**GCAL ID**	21304034801		1179258			
Prep Method SW-846 9038	**Sample Type**	SAMPLE		DUP			
	Prep Date	04/08/2013 10:40		04/08/2013 10:40			
	Analytical Date	04/09/2013 09:56		04/09/2013 09:57			
	Matrix	Solid		Solid			
SW-846 9038 Sulfate	**Units**	mg/kg					
	Result		**RDL**	**Result**	**RPD**	**RPD Limit**	
14808-79-8 Sulfate		23.0	50.0	23.2	0.9	25	

General Chemistry Quality Control Summary

Analytical Batch 504687	**Client ID**	MB504575			LCS504575		
Prep Batch 504575	**GCAL ID**	1178165			1178166		
Prep Method SW-846 9030	**Sample Type**	Method Blank			LCS		
	Prep Date	04/05/2013 06:00			04/05/2013 06:00		
	Analytical Date	04/06/2013 14:20			04/06/2013 14:20		
	Matrix	Solid			Solid		
SW-846 9034 Sulfide		**Units**	mg/kg	**Spike**	**Result**		**Control**
		Result	**RDL**	**Added**		**% R**	**Limits % R**
18496-25-8 Sulfide		ND	80	729	473	64.9	15 - 120

Analytical Batch 504687	**Client ID**	B-5 (10-13)		1177712DUP		
Prep Batch 504575	**GCAL ID**	21304034801		1178167		
Prep Method SW-846 9030	**Sample Type**	SAMPLE		DUP		
	Prep Date	04/05/2013 06:00		04/05/2013 06:00		
	Analytical Date	04/06/2013 14:20		04/06/2013 14:20		
	Matrix	Solid		Solid		
SW-846 9034 Sulfide		**Units**	mg/kg	**Result**	**RPD**	**RPD**
		Result	**RDL**			**Limit**
18496-25-8 Sulfide		0	80	0	0	25

GCAL

7979 GSRI Avenue, Baton Rouge, Louisiana 70820-7402
Phone 225.769.4900 • Fax 225.767.5717

Chain of Custody Record

Lab use only	Client #	Workorder #	Due Date
Geo Hydro (Client Name)	4797	13040348	04/05/13

Report to:
Client: Geo Hydro
Address: 1008 Cobb Place Blvd
Kennesaw, GA 30144
Contact: Marty Penner
Phone: 770-596-6237
Fax:

Bill to:
Client:
Address: SAME
Contact:
Phone:
Fax:

P.O. Number:
Project Name/Number: Hwy 41 / 130107.00
Sampled By:

Analytical Requests & Method

Lab use only:
Custody Seal: used ☑ yes ☐ no; intact ☑ yes ☐ no
Temperature °C: 3.2

Matrix[1]	Date	Time (2400)	Comp	Grab	Sample Description	Preservatives	No Containers	Chloride (9251)	Sulfate (9038)	Sulfide (9034)	pH	Lab ID
S	APR13	1300			B-5 (10-13)		2	X	X	X	X	04/03 1
S	APR13	1500			B-9 (10-13)		2	X	X	X	X	2
S	APR13	0900			B-1 (10-13)		2	X	X	X	X	3

Remarks:

Turn Around Time: ☐ 24-48 hrs. ☐ 3 days ☐ 1 week ☑ Standard ☐ Other

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
[signature]	FedEx	4 APR 13	
Fed Ex	[signature] Campaya	4/5/13	09:30
Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:

Note: 7948 - 7162 9360 7

By submitting these samples, you agree to the terms and conditions contained in our most recent schedule of services.

WHITE: CLIENT FINAL REPORT — CANARY: LABORATORY — PINK: CLIENT

GCAL-06 11/96

GCAL ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIVING CHECKLIST

213040348

SAMPLE DELIVERY GROUP	213040348
Client 4792 - GeoHydro Engineers, Inc.	**Transport Method** FEDEX
Profile Number 241446	**Received By** Law, Brittany P.
Line Item(s) 1 - Soil	**Receive Date(s)** 04/03/13

CHECKLIST

Were all samples received using proper thermal preservation?	☑ Yes	☐ No	☐ NA
When used, were all custody seals intact?	☑ Yes	☐ No	☐ NA
Were all samples received in proper containers?	☑ Yes	☐ No	☐ NA
Were all samples received using proper chemical preservation?	☑ Yes	☐ No	☐ NA
Was preservative added to any container at the lab?	☐ Yes	☑ No	☐ NA
Were all containers received in good condition?	☑ Yes	☐ No	☐ NA
Were all VOA vials received with no head space?	☐ Yes	☐ No	☑ NA
Do all sample labels match the Chain of Custody?	☑ Yes	☐ No	☐ NA
Did the Chain of Custody list the sampling technician?	☐ Yes	☑ No	☐ NA
Was the COC maintained i.e. all signatures, dates and time of receipt included?	☑ Yes	☐ No	☐ NA

COOLERS

Airbill	Temp(oC)
7948 7162 9367	5.2

DISCREPANCIES

None

LABORATORY PRESERVATIONS

None

NOTES

NELAP CERTIFICATE NUMBER 01955
DOD ELAP CERTIFICATE NUMBER ADE - 1482

ANALYTICAL RESULTS

PERFORMED BY

GULF COAST ANALYTICAL LABORATORIES, INC.
7979 GSRI Avenue
Baton Rouge, LA 70820

Report Date 04/15/2013

GCAL Report 213040544

Deliver To	GeoHydro 1000 Cobb Place Blvd. Kennesaw, GA 30144 770-596-6237
Attn	Marty Peniger

Project HWY 41/130107.00

CASE NARRATIVE

Client: GeoHydro Engineers, Inc. **Report:** 213040544

Gulf Coast Analytical Laboratories received and analyzed the sample(s) listed on the sample cross-reference page of this report. Receipt of the sample(s) is documented by the attached chain of custody. This applies only to the sample(s) listed in this report. No sample integrity or quality control exceptions were identified unless noted below.

CONVENTIONALS

In the SW-846 9038 analysis, a chemical or physical interference necessitated a dilution for sample 21304054401 (B21 (10-13)) . This is reflected in the elevated reporting limit.

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with GCAL's Standard Operating Procedures.

Common Abbreviations Utilized in this Report

ND	Indicates the result was Not Detected at the specified RDL
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
PQL	Practical Quantitation Limit
MDL	Method Detection Limit
RDL	Reporting Detection Limit
00:00	Reported as a time equivalent to 12:00 AM

Reporting Flags Utilized in this Report

J	Indicates the result is between the MDL and RDL
U	Indicates the compound was analyzed for but not detected
B	Indicates the analyte was detected in the associated Method Blank

Sample receipt at GCAL is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of GCAL. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with the NELAC standard and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer-readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

Robyn Migues
Technical Director
GCAL REPORT 213040544

Report Sample Summary

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304054401	B21 (10-13)	Solid	04/03/2013 15:00	04/05/2013 09:00
21304054402	B17 (40-43)	Solid	04/03/2013 11:00	04/05/2013 09:00

Summary of Compounds Detected

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304054401	B21 (10-13)	Solid	04/03/2013 15:00	04/05/2013 09:00

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.09	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304054402	B17 (40-43)	Solid	04/03/2013 11:00	04/05/2013 09:00

SW-846 9045D

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	pH	6.73	1.00		pH unit

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304054401	**B21 (10-13)**	Solid	04/03/2013 15:00	04/05/2013 09:00

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/09/2013 15:00	DNM	504496

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	**pH**	**6.09**	**1.00**		**pH unit**

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504757	EPA 9251	1	04/09/2013 09:26	MCP	504798

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	ND	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504756	SW-846 9038	10	04/09/2013 10:00	JEM	504801

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	500		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/10/2013 06:30	504709	SW-846 9030	1	04/10/2013 13:30	JEM	504914

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

GCAL ID	Client ID	Matrix	Collect Date/Time	Receive Date/Time
21304054402	**B17 (40-43)**	Solid	04/03/2013 11:00	04/05/2013 09:00

SW-846 9045D

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
			1	04/09/2013 15:00	DNM	504496

CAS#	Parameter	Result	RDL	REG LIMIT	Units
pH	**pH**	**6.73**	**1.00**		**pH unit**

SW-846 9251 Chloride

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504757	EPA 9251	1	04/09/2013 09:27	MCP	504798

CAS#	Parameter	Result	RDL	REG LIMIT	Units
16887-00-6	Chloride	ND	10.0		mg/kg

SW-846 9038 Sulfate

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/08/2013 10:40	504756	SW-846 9038	1	04/09/2013 10:01	JEM	504801

CAS#	Parameter	Result	RDL	REG LIMIT	Units
14808-79-8	Sulfate	ND	50.0		mg/kg

SW-846 9034 Sulfide

Prep Date	Prep Batch	Prep Method	Dilution	Analyzed	By	Analytical Batch
04/10/2013 06:30	504709	SW-846 9030	1	04/10/2013 13:30	JEM	504914

CAS#	Parameter	Result	RDL	REG LIMIT	Units
18496-25-8	Sulfide	ND	80		mg/kg

RESULTS REPORTED ON A WET WEIGHT BASIS

General Chemistry Quality Control Summary

Analytical Batch 504496	Client ID	B-5 (10-13)		1177712DUP		
Prep Batch N/A	GCAL ID	21304034801		1177867		
	Sample Type	SAMPLE		DUP		
	Analytical Date	04/09/2013 15:00		04/09/2013 15:00		
	Matrix	Solid		Solid		
SW-846 9045D	**Units**	pH unit		**Result**	**RPD**	**RPD Limit**
	Result	**RDL**				
pH pH	4.92	1.00		4.92	0	6

General Chemistry Quality Control Summary

Analytical Batch 504798	**Client ID**	MB504757		LCS504757
Prep Batch 504757	**GCAL ID**	1179261		1179262
Prep Method EPA 9251	**Sample Type**	Method Blank		LCS
	Prep Date	04/08/2013 10:40		04/08/2013 10:40
	Analytical Date	04/09/2013 09:20		04/09/2013 09:20
	Matrix	Solid		Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**
	Result	**RDL**	**Added**		**% R**	**Limits % R**
16887-00-6 Chloride	ND	10.0	600	558	93	80 - 120

Analytical Batch 504798	**Client ID**	B-1 (10-13)	1177714MS	1177714MSD
Prep Batch 504757	**GCAL ID**	21304034803	1179264	1179599
Prep Method EPA 9251	**Sample Type**	SAMPLE	MS	MSD
	Prep Date	04/08/2013 10:40	04/08/2013 10:40	04/08/2013 10:40
	Analytical Date	04/09/2013 09:28	04/09/2013 09:30	04/09/2013 09:31
	Matrix	Solid	Solid	Solid

SW-846 9251 Chloride	**Units**	mg/kg	**Spike**	**Result**		**Control**	**Result**			**RPD**
	Result	**RDL**	**Added**		**% R**	**Limits % R**		**% R**	**RPD**	**Limit**
16887-00-6 Chloride	13.1	10.0	600	577	94	75 - 125	578	94	0.1	25

General Chemistry Quality Control Summary

Analytical Batch 504801	**Client ID**	MB504756			LCS504756		
Prep Batch 504756	**GCAL ID**	1179256			1179257		
Prep Method SW-846 9038	**Sample Type**	Method Blank			LCS		
	Prep Date	04/08/2013 10:40			04/08/2013 10:40		
	Analytical Date	04/09/2013 09:54			04/09/2013 09:55		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	ND	50.0	200	191	95	80 - 120	

Analytical Batch 504801	**Client ID**	B-5 (10-13)			1177712MS		
Prep Batch 504756	**GCAL ID**	21304034801			1179259		
Prep Method SW-846 9038	**Sample Type**	SAMPLE			MS		
	Prep Date	04/08/2013 10:40			04/08/2013 10:40		
	Analytical Date	04/09/2013 09:56			04/09/2013 09:57		
	Matrix	Solid			Solid		
SW-846 9038 Sulfate	**Units**	mg/kg	**Spike**	**Result**		**Control**	
	Result	**RDL**	**Added**		**% R**	**Limits % R**	
14808-79-8 Sulfate	23.0	50.0	200	235	106	75 - 125	

Analytical Batch 504801	**Client ID**	B-5 (10-13)	1177712DUP			
Prep Batch 504756	**GCAL ID**	21304034801	1179258			
Prep Method SW-846 9038	**Sample Type**	SAMPLE	DUP			
	Prep Date	04/08/2013 10:40	04/08/2013 10:40			
	Analytical Date	04/09/2013 09:56	04/09/2013 09:57			
	Matrix	Solid	Solid			
SW-846 9038 Sulfate	**Units**	mg/kg	**Result**		**RPD**	
	Result	**RDL**		**RPD**	**Limit**	
14808-79-8 Sulfate	23.0	50.0	23.2	0.9	25	

General Chemistry Quality Control Summary

Analytical Batch	504914	**Client ID**	MB504709			LCS504709		
Prep Batch	504709	**GCAL ID**	1179030			1179031		
Prep Method	SW-846 9030	**Sample Type**	Method Blank			LCS		
		Prep Date	04/10/2013 06:30			04/10/2013 06:30		
		Analytical Date	04/10/2013 13:30			04/10/2013 13:30		
		Matrix	Solid			Solid		
SW-846 9034 Sulfide		**Units**	mg/kg	**Spike**	**Result**		**Control**	
		Result	**RDL**	**Added**		**% R**	**Limits % R**	
18496-25-8	Sulfide	ND	80	1500	423	28.2	15 - 120	

Analytical Batch	504914	**Client ID**	B21 (10-13)		1178634DUP			
Prep Batch	504709	**GCAL ID**	21304054401		1179032			
Prep Method	SW-846 9030	**Sample Type**	SAMPLE		DUP			
		Prep Date	04/10/2013 06:30		04/10/2013 06:30			
		Analytical Date	04/10/2013 13:30		04/10/2013 13:30			
		Matrix	Solid		Solid			
SW-846 9034 Sulfide		**Units**	mg/kg	**Result**		**RPD**		
		Result	**RDL**		**RPD**	**Limit**		
18496-25-8	Sulfide	0	80	0	0	25		

GCAL

7979 GSRI Avenue, Baton Rouge, Louisiana 70820-7402
Phone 225.769.4900 • Fax 225.767.5717

Chain of Custody Record

Lab use only	Client #	Workorder #	Due Date
Geo Hydro (Client Name)	4792	13040544	4/11/13

Report to:
Client: Geo-Hydro
Address: 1000 Cobb Place Blvd
Kennesaw, GA 30144
Contact: Mary Prieger
Phone: 770-596-6277
Fax:

Bill to:
Client:
Address: Same
Contact:
Phone:
Fax:

P.O. Number
Project Name/Number: Hwy 41 / 130107.00
Sampled By:

Analytical Requests & Method

Lab use only:
Custody Seal: used ☑ yes ☐ no; intact ☑ yes ☐ no
Temperature °C 21

Matrix[1]	Date	Time (2400)	Comp	Grab	Sample Description	Preservatives	No Containers	Chloride (9251)	Sulfate (9038)	Sulfide (9034)	pH	Remarks:	Lab ID
S	3 APR 13	1500		X	B21 (10-13)		2	X	X	X	X		1
S	3 APR 13	1100		X	B17 (40-43)		2	X	X	X	X		2

Turn Around Time: ☐ 24-48 hrs. ☐ 3 days ☐ 1 week ☑ Standard ☐ Other

Relinquished by: (Signature)	Received by: (Signature)	Date:	Time:
[signature]	Fed-X	4 APR 13	
FedEx	[signature]	4/5/13	900

Note: 7948 7162 9849

By submitting these samples, you agree to the terms and conditions contained in our most recent schedule of services.

WHITE: CLIENT FINAL REPORT — CANARY: LABORATORY — PINK: CLIENT

GCAL 06 11.98

GCAL ANALYTICAL LABORATORIES, LLC

SAMPLE RECEIVING CHECKLIST

213040544

SAMPLE DELIVERY GROUP	213040544
Client 4792 - GeoHydro Engineers, Inc.	**Transport Method** FEDEX
Profile Number 241446	**Received By** Saucier, Charlotte
Line Item(s) 1 - Soil	**Receive Date(s)** 04/05/13

CHECKLIST

Were all samples received using proper thermal preservation?	☑ Yes	☐ No	☐ NA
When used, were all custody seals intact?	☑ Yes	☐ No	☐ NA
Were all samples received in proper containers?	☑ Yes	☐ No	☐ NA
Were all samples received using proper chemical preservation?	☑ Yes	☐ No	☐ NA
Was preservative added to any container at the lab?	☐ Yes	☑ No	☐ NA
Were all containers received in good condition?	☑ Yes	☐ No	☐ NA
Were all VOA vials received with no head space?	☐ Yes	☐ No	☑ NA
Do all sample labels match the Chain of Custody?	☑ Yes	☐ No	☐ NA
Did the Chain of Custody list the sampling technician?	☐ Yes	☑ No	☐ NA
Was the COC maintained i.e. all signatures, dates and time of receipt included?	☑ Yes	☐ No	☐ NA

COOLERS

Airbill	Temp(oC)
7948 7162 9849	2.1

DISCREPANCIES

None

LABORATORY PRESERVATIONS

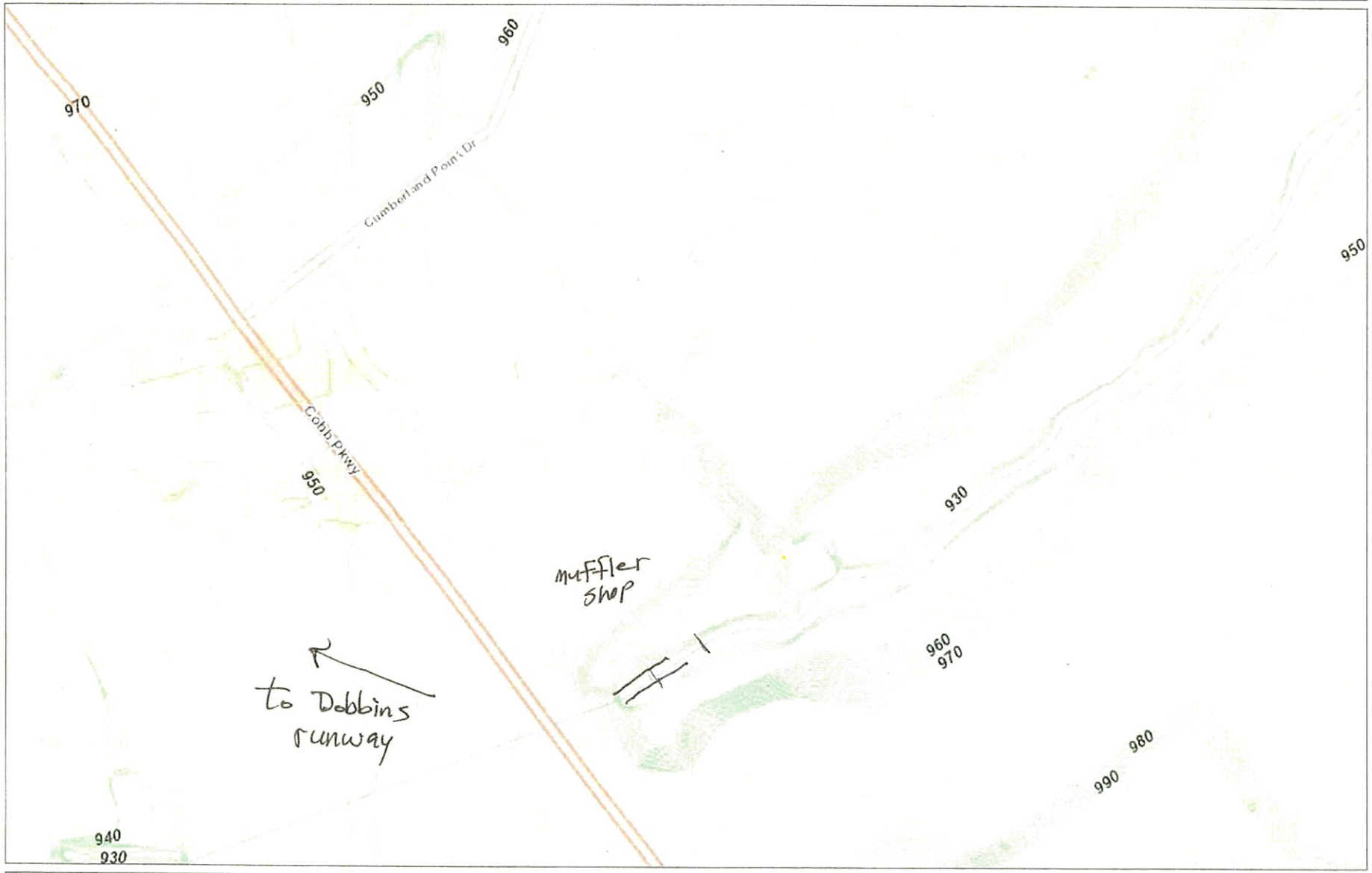
None

NOTES

WETLANDS AND ECOLOGICAL SUB-CONSULTANT FIELD MAPS

GEO HYDRO ENGINEERS

Cobb County Georgia Online Mapping



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WGS_1984_Web_Mercator_Auxiliary_Sphere

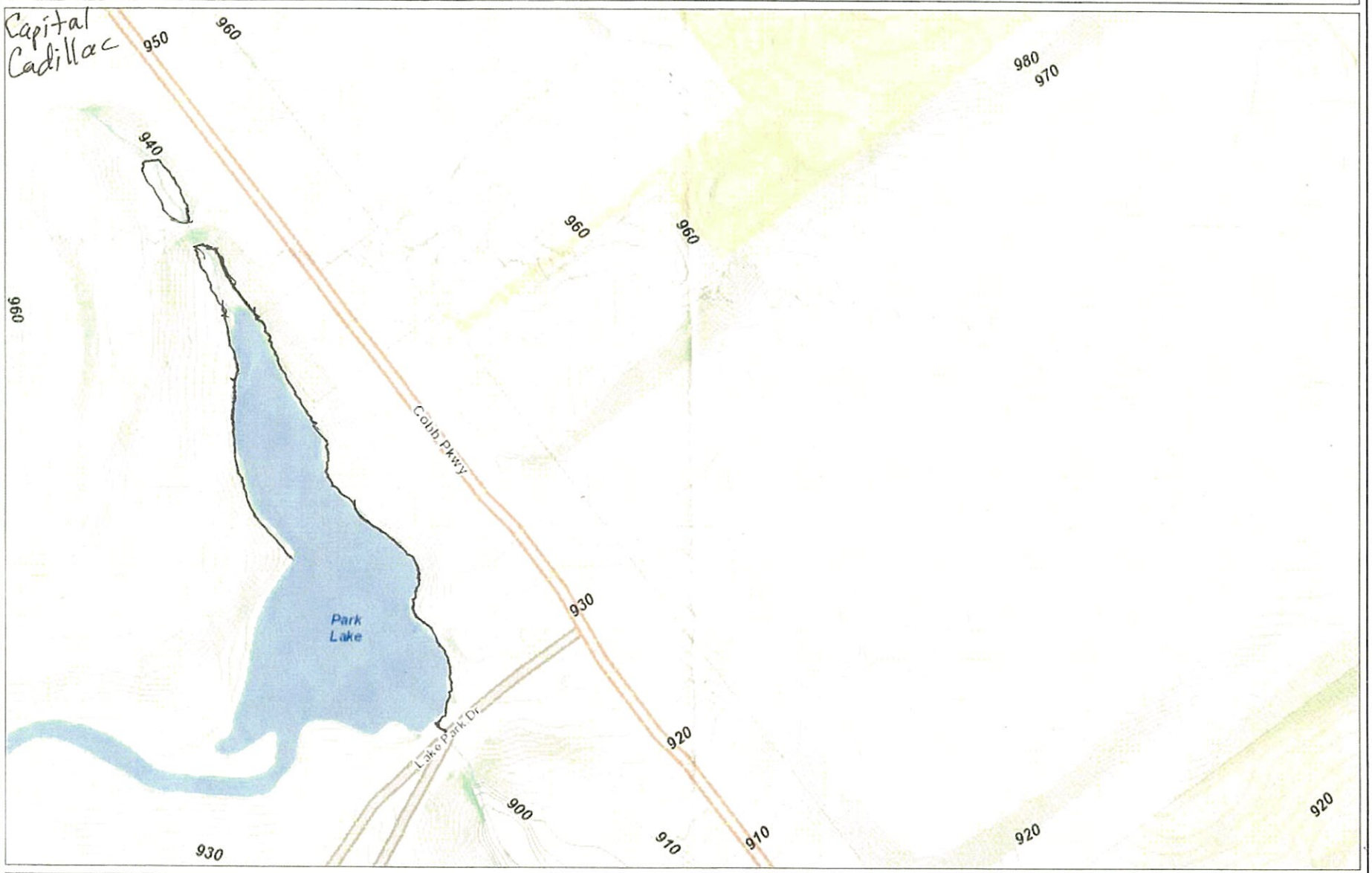
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

1: 2,401

Map Notes:

Cobb County Georgia Online Mapping



0.1 0 0.04 0.1 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere

211.2 ft

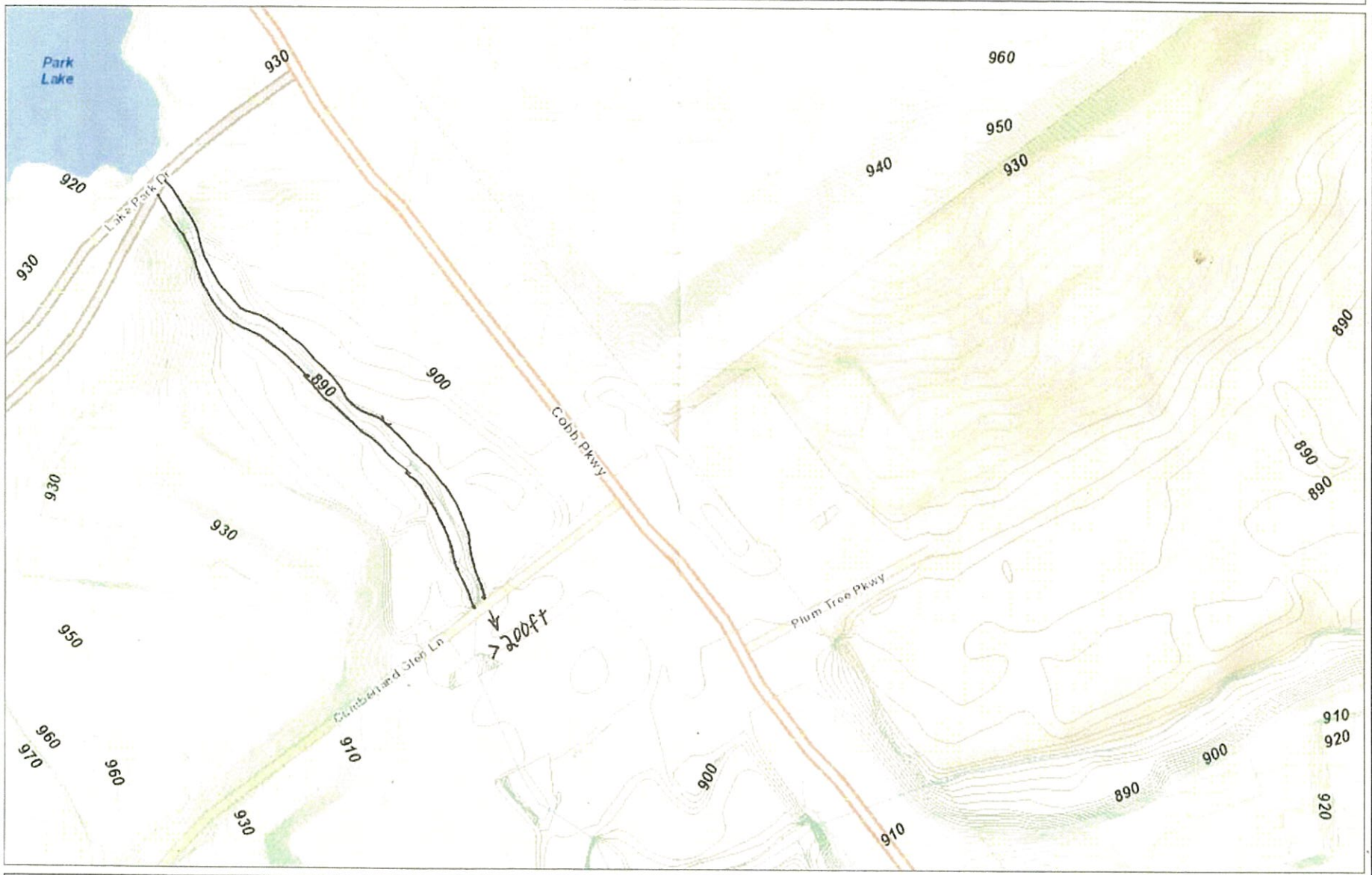
This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

1:2,401

Map Notes:

Cobb County Georgia Online Mapping



0.1 0 0.04 0.1 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere

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1: 2,401

Map Notes:

Cobb County Georgia Online Mapping

0.1 0 0.04 0.1 Miles

WGS_1984_Web_Mercator_Auxiliary_Sphere

This map is a user generated static output from an Internet mapping site and is for reference only. Data layers that appear on this map may or may not be accurate, current, or otherwise reliable.

THIS MAP IS NOT TO BE USED FOR NAVIGATION

1: 2,401

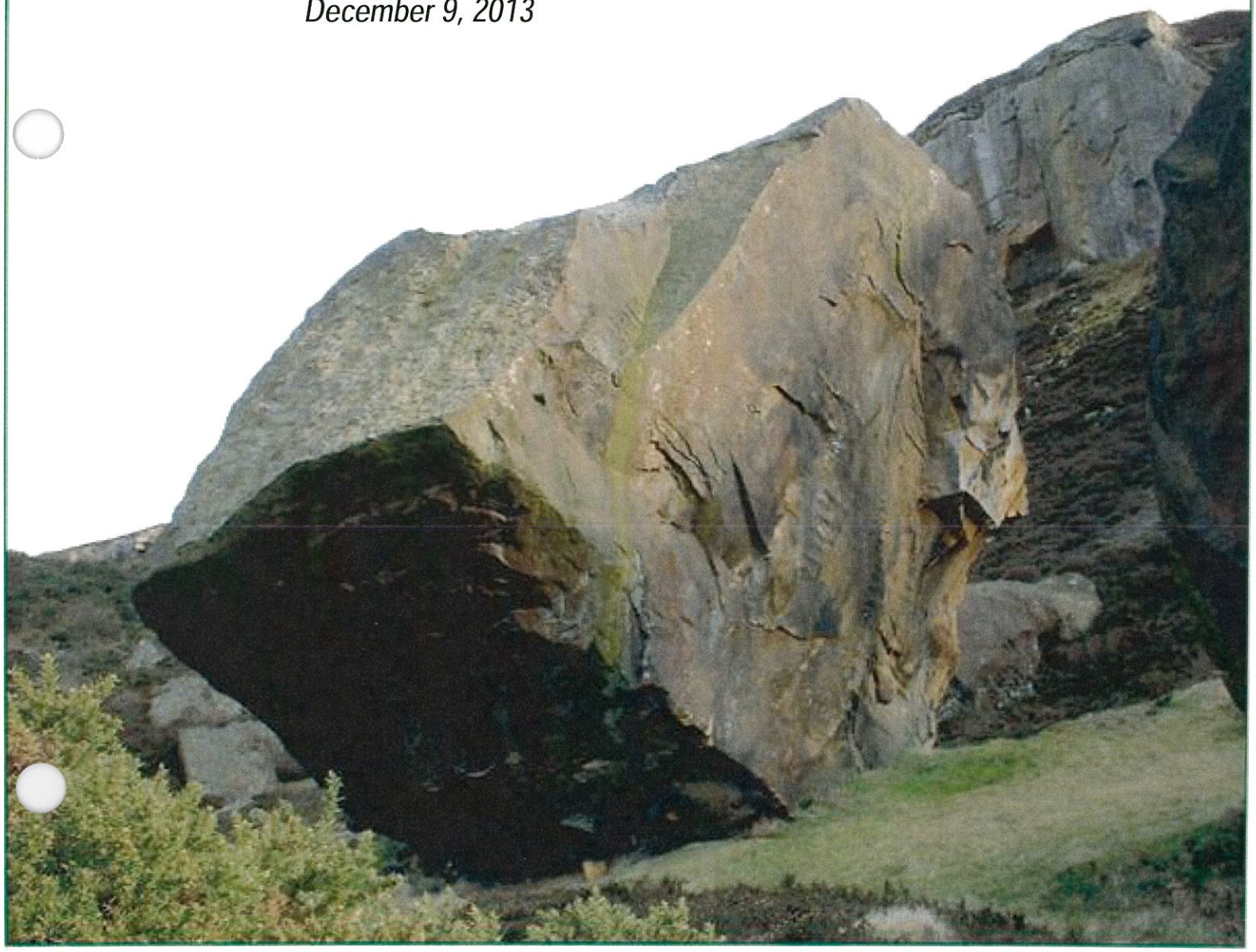
Map Notes:

GEO HYDRO ENGINEERS

Report of Supplemental Subsurface Exploration and Geotechnical Engineering Evaluation

Tunnel Section – STA 52+50 to STA 86+00
Highway 41 Water Main – Phase IV
Cobb County, Georgia

Prepared for Atkins North America
December 9, 2013



Mr. Gilbert R. Puffer, P.E.
Atkins North America
1600 RiverEdge Parkway
Suite 6000
Atlanta, Georgia 30328

December 9, 2013

Report of Supplemental Subsurface Exploration
and Geotechnical Engineering Evaluation
Tunnel Section – STA 52+50 to STA 86+00
Highway 41 Water Main – Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.01

Dear Mr. Puffer:

Geo-Hydro Engineers, Inc. has completed the authorized supplemental subsurface exploration for the above referenced project. The scope of services for this project was developed through emails and telephone conversations with you and the project team. This report describes our understanding of the project and the subsurface conditions encountered, and contain our conclusions and recommendations regarding the geotechnical aspects of the proposed design and construction. Please consider this report supplementary to our Report of Subsurface Exploration and Geotechnical Engineering Evaluation (130107.00) dated May 22, 2013.

PROJECT INFORMATION

Proposed Water Main Replacement

Our understanding of the project is based on our telephone conversations with you, emails, and our review of project drawings prepared by Atkins. The project consists a 72-inch diameter tunnel in the western right-of-way of U.S. Highway 41 as it crosses Windy Hill Road. The tunnel will have a total length of about 3,000 feet and will begin and end at approximate stations 52+50 and 86+00, respectively. Figure 1 in the Appendix shows the approximate proposed alignment. More specifically, the proposed alignment is located off the west (south-bound) edge of pavement of U. S. Highway 41.

Existing Site Conditions

The majority of the project alignment includes primarily commercial development. Topography along the alignment is typical for the Atlanta area with rolling upland areas separated by creeks and intermittent wet weather drainage features. The right-of-way along the roads has numerous underground and overhead utilities.

EXPLORATORY PROCEDURES

Field Exploration

The subsurface exploration consisted of 12 machine-drilled soil test borings including rock coring performed at the approximate locations shown on Figure 2 included in the Appendix. The borings were located in the field by Geo-Hydro based on the proposed alignment site plan provided to us. The borings were performed at preselected stations and boring locations were adjusted in the field as necessary to avoid existing underground utilities, steep terrain, and traffic and safety concerns. Boring stationing is indicated on the test boring records and was estimated from the project drawings.

Standard penetration testing, as provided for in ASTM Dl586, was performed at select intervals in select test borings. Since existing information was available for most of the locations from the previous phase of exploration, standard penetration testing was not started until the borings were advanced below the bottom of the previously performed borings. Soil samples obtained from the drilling operation were examined and classified in general accordance with ASTM D2488 (Visual-Manual Procedure for Description of Soils). Soil classifications include the use of the Unified Soil Classification System described in ASTM D2487 (Classification of Soils for Engineering Purposes). The soil classifications also include our evaluation of the geologic origin of the soils. Evaluations of geologic origin are based on our experience and may be subject to some degree of interpretation.

Rock coring was performed in general accordance with ASTM D2113 and rock quality designation (RQD) was determined in accordance with ASTM D6032.

After the supplementary field exploration was completed, the tunnel alignment was lowered. The exploration program was designed and performed to capture subsurface data for a shallower tunnel interval. As a result of the change in the tunnel alignment elevation, borings B-18, B-18A, B-19, and B-19A were terminated above the revised tunnel interval.

Laboratory Testing

During our field exploration, samples of soil and rock were obtained from the approximate tunnel horizon for laboratory testing. Laboratory tests consisting of sieve analysis with hydrometer (ASTM D422) were performed on select samples from borings B-19, B-19A, and B-22. Unconfined compressive strength testing of rock (ASTM D7012) was performed on select rock cores sampled from borings B-14, B-15A, B-16A, B-17, B-17A, and B-18.

Classification of recovered rock samples was performed in general accordance with the procedures outlined in *A Guide to Core Logging for Rock Engineering, Bulletin of the Association of Engineering Geologists, Vol. XV, No. 3, 1978*. The description includes the recovery percentage and rock quality designation. The recovery percentage is the total length of recovered rock core expressed as a percentage of the length of the core run. The rock quality designation (RQD) is defined as the total length of recovered rock segments which are equal to or longer than four inches; divided by the total length of the core run; multiplied by 100. Recovery and RQD are indices of rock quality.

REGIONAL GEOLOGY

The project site is located in the northern Piedmont Geologic Province of Georgia. Published geologic literature indicates that the site is underlain by an un-named unit consisting of intermixed amphibolite, hornblende gneiss, and felsic gneiss. Soils in this area have been formed by the in-place weathering of the underlying crystalline rock, which accounts for their classification as "residual" soils. Residual soils near the ground surface, which have experienced advanced weathering, frequently consist of red brown clayey silt (ML) or silty clay (CL). The thickness of this surficial clayey zone may range up to roughly 6 feet. For various reasons, such as erosion or local variation of mineralization, the upper clayey zone is not always present.

With increased depth, the soil becomes less weathered, coarser grained, and the structural character of the underlying parent rock becomes more evident. These residual soils are typically classified as sandy micaceous silt (ML) or silty micaceous sand (SM). With a further increase in depth, the soils eventually become quite hard and take on an increasing resemblance to the underlying parent rock. When these materials have a standard penetration resistance of 100 blows per foot or greater, they are referred to as partially weathered rock. The transition from soil to partially weathered rock is usually a gradual one, and may occur at a wide range of depths. Lenses or layers of partially weathered rock are not unusual in the soil profile.

Partially weathered rock represents the zone of transition between the soil and the indurated metamorphic rocks from which the soils are derived. The subsurface profile is, in fact, a history of the weathering process which the crystalline rock has undergone. The degree of weathering is most advanced at the ground surface, where fine grained soil may be present. And, the weathering process is in its early stages immediately above the surface of relatively sound rock, where partially weathered rock may be found.

The thickness of the zone of partially weathered rock and the depth to the rock surface have both been found to vary considerably over relatively short distances. The depth to the rock surface may frequently range from the ground surface to 80 feet or more. The thickness of partially weathered rock, which overlies the rock surface, may vary from only a few inches to as much as 40 feet or more.

Stream valleys in the Piedmont Region may contain alluvial (water deposited) soils, depending on ground surface topography, stream flow characteristics, and other factors. By nature, alluvial soils can be highly variable depending upon the energy regime at the time of deposition. Coarse materials such as sand or gravel are deposited in higher energy environments, while fine grained materials such as silt and clay are deposited in low energy environments. Alluvial soils may also contain significant organic materials, and are frequently in a loose, saturated condition. In many cases, fine grained alluvial soils will be highly compressible and have relatively low shear strength.

Overall geologic conditions along sections of the water main alignment have been modified by previous grading activities for the roadways, utilities, commercial developments, etc., and alluvial deposition.

TEST BORING SUMMARY

All of the test borings were performed in landscaped or grassed areas and initially encountered approximately 1 to 3 inches of topsoil. Thicker topsoil may be present in other areas of the water main alignment intermediate of the borings.

In general, the overburden soils encountered consisted mostly of clayey silts, sandy silts, and silty sands typical of the Piedmont region. Fill materials were encountered in boring B-22 extending to a depth of about 6 feet. Due to the commercial development along U.S. Highway 41, we expect that fill materials are largely related to roadway construction and localized commercial construction. The quality of fill materials should be expected to vary along the alignment.

Materials causing auger refusal were encountered in all borings except B-19, B-19A, and B-22, at depths ranging from 10 to 45 feet. Auger refusal is the condition that prevents further advancement of the boring using conventional soil drilling techniques. Borings B-19, B-19A, and B-22 were extended to their planned termination depths without encountering auger refusal.

Starting at the depth of auger refusal, rock coring was performed in borings B-14, B-14A, B-15, B-15A, B-16A, B-17, B-17A, B-18, and B-18A to sample the rock. Lengths of rock cored ranged from 8 to 39 feet. The recovered rock consisted of unweathered to highly weathered biotite gneiss, granitic gneiss, and mica schist. The percent recovery ranged from 0 to 100 percent and the rock quality designation (RQD) ranged from 0 to 100 percent.

Twenty-four hours after drilling completion, groundwater was encountered in 10 of the 12 soil test borings. The depth to groundwater ranged from about 8 to 27 feet below the ground surface. Groundwater was encountered at or above the proposed invert elevation at all locations where groundwater was measured. It is important to note that groundwater levels will fluctuate depending on seasonal variations of precipitation and other factors, and may occur at higher elevations in the future.

For more detailed descriptions of subsurface conditions, please refer to the summary table and test boring records included in the Appendix.

EVALUATIONS AND RECOMMENDATIONS

The following evaluations are based on the information available on the proposed water main alignment and planned tunnel section, the data obtained from the exploratory borings and laboratory testing, and our experience with soils and subsurface conditions similar to those encountered at the explored locations. Because the subsurface exploration represents a statistically small sampling of subsurface conditions, it is possible that conditions between the test borings may be substantially different from those indicated by the borings.

Tunnel Interval Materials and Conditions

Borings B-14, B-14A, B-15, B-15A, B-16A, B-17, B-17A, B-18 and B-18A encountered conditions causing auger refusal above the planned tunnel invert elevation. Based on the rock coring data, the underlying rock is weathered and fractured to varying degrees and consists of a transition from highly weathered and fractured rock to un-weathered, relatively intact rock. The depth of the weathered rock horizon will vary along the tunnel alignment and rock conditions along the tunnel alignment will vary accordingly. Highly fractured and differentially weathered rock and the transitions from soil to fractured rock to intact rock will be problematic for tunneling activities. Tunneling through soils and partially weathered rock can also be complicated by larger boulders, rock lenses, and rock seams that can hinder operations and may require hand excavation at the face of the tunnel.

It is important to note that the geology of the Piedmont is characterized by variable subsurface conditions. Due to the widely-spaced nature of the borings, it is likely that subsurface conditions intermediate of the borings will be different. Weathered rock, mass rock, boulders, and rock seams may all be encountered at different elevations along the tunnel alignment.

Boring	Approx. Station	Approx. Ground Elevation	Tunnel Interval	Test Sample Interval	Compressive Strength (psi)
B-14	55+00	1026	991-997	991-999	8,000
B-14A	57+50	1018	988-994	N/A (Fractured Rock)	N/A (Fractured Rock)
B-15	60+00	1020	983-989	N/A (Fractured Rock)	N/A (Fractured Rock)
B-15A	62+50	1035	980-986	980-987	5,190
B-16A	67+50	1052	972-978	977-986	10,940
B-17	69+50	1052	969-975	972-983	6,720
B-17A	73+00	1034	963-969	965-975	1,060
B-18*	75+00	1023	960-966	968-978*	2,460
B-18A*	78+00	1005	956-962	N/A*	N/A
B-19*	80+00	997	952-958	N/A (Soil)*	N/A (Soil)
B-19A*	82+00	980	949-955	N/A (Soil)*	N/A (Soil)

** After the field exploration was completed, the tunnel alignment was lowered. The exploration program was designed and performed to capture subsurface data for a shallower tunnel interval. As a result of the change in the tunnel alignment elevation, borings B-18, B-18A, B-19, and B-19A were terminated above the revised tunnel interval.*

Rock compressive strength ranged widely for the tested samples. It is our experience that core samples of biotite gneiss and mica schist tested in compression tend to fail along foliation planes which can range in inclination from a few degrees to near vertical. The steeper the foliation plane angle the greater the tendency of the sample to fail along these weaker features in the rock. Tunneling equipment will typically intersect the rock mass at a near horizontal angle, which is roughly perpendicular to the direction in which the samples were tested. Hence, the rock compressive strength that the tunneling equipment will encounter will be much greater than the compressive strength of rock samples that failed along foliation planes. The higher compressive strength values obtained from the core samples (8,000 to 11,000 psi), as represented by samples from borings B-14 and B-16A, which did not fail primarily along foliation planes, will be more representative of the compressive strength of materials that the tunneling equipment will encounter, and it is likely that rock having greater compressive strengths will be encountered.

Groundwater was encountered in all of the supplemental test borings except B-18 at elevations above the tunnel interval.

Boring	Approximate Ground Elevation	Approximate Groundwater Elevation	Tunnel Interval
B-14	1026	1010	991-997
B-14A	1018	1005	988-994
B-15	1020	1001	983-989
B-15A	1035	1017	980-986
B-16A	1052	1027	972-978
B-17	1052	1025	969-975
B-17A	1034	1009	963-969
B-18	1023	1003	960-966
B-18A	1005	Not Encountered	956-962
B-19	997	978	952-958
B-19A	980	972	949-955
B-22	1026	1001	988-994

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Groundwater is of concern for tunnel construction since groundwater will have to be controlled and removed as necessary to allow construction. The rate of water infiltration in the tunnel will vary along the alignment. In rock, the rate of groundwater infiltration will be greatly influenced by the number of fractures in the rock that may be intercepted or tapped during tunnel construction, the occurrence of which is essentially random. The flow of groundwater in soil will vary depending on the hydrostatic pressure and the makeup of the soil. A typical hydraulic conductivity range for the soils present in the tunnel interval along the tunnel alignment is on the order of 10^{-4} to 10^{-5} cm/second.

* * * * *.

Geo-Hydro Engineers, Inc. has appreciated the opportunity to work with you on this phase of the project, and we look forward to providing any additional services you may require. If you have any questions concerning this report or any of our services, please call us.

Sincerely,

GEO-HYDRO ENGINEERS, INC.

Kelly Stallworth, E.I.T.
Geotechnical Engineer
kstallworth@geohydro.com

Luis E. Babler, P.E.
Chief Geotechnical Engineer
luis@geohydro.com

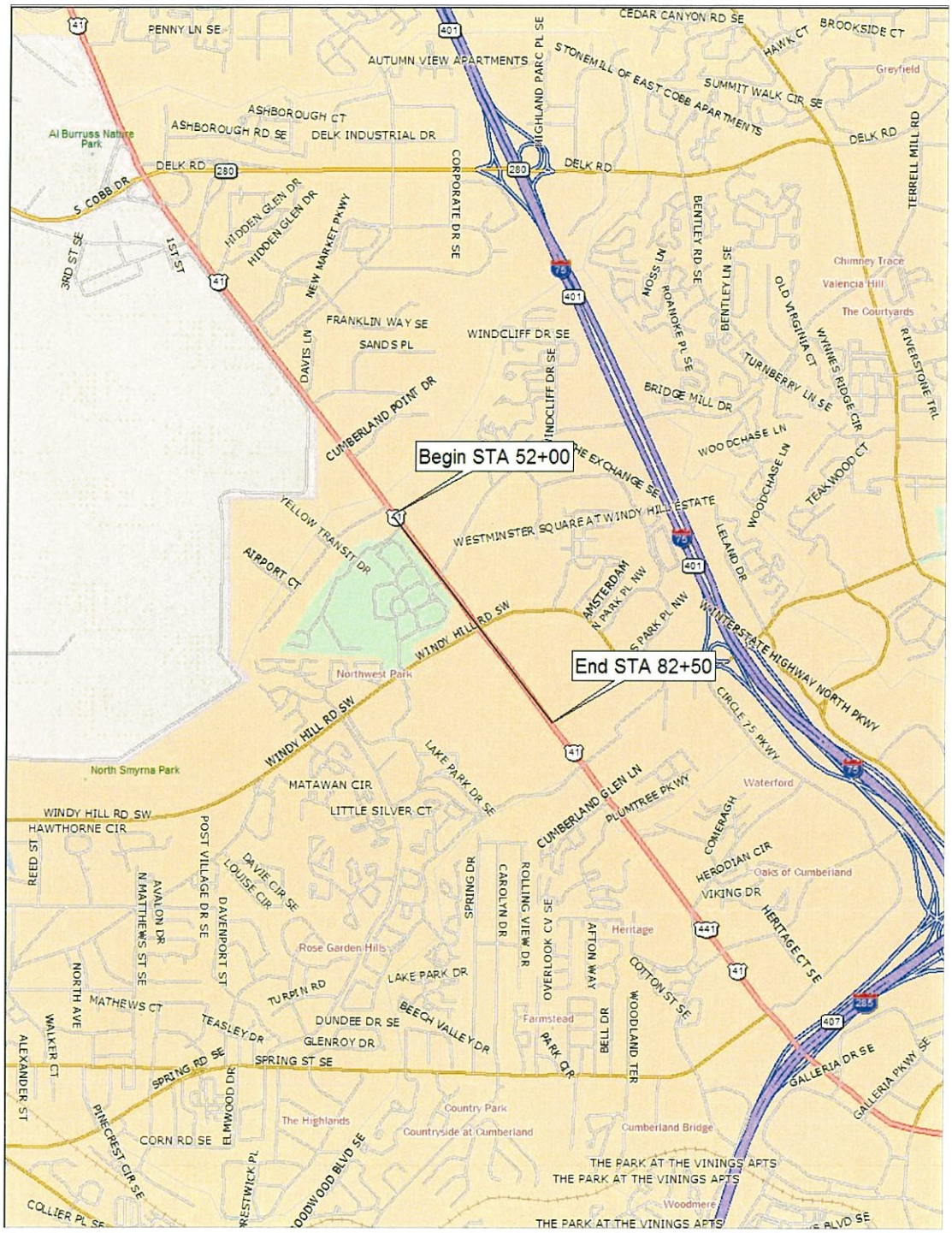
GEORGIA REGISTERED No. 021308 PROFESSIONAL ENGINEER LUIS E. BABLER

KKS/LEB/130107.01 - U.S. Highway 41 Water Main - Phase IV - Geotechnical Report leb

GEO HYDRO ENGINEERS

APPENDIX

GEO HYDRO ENGINEERS



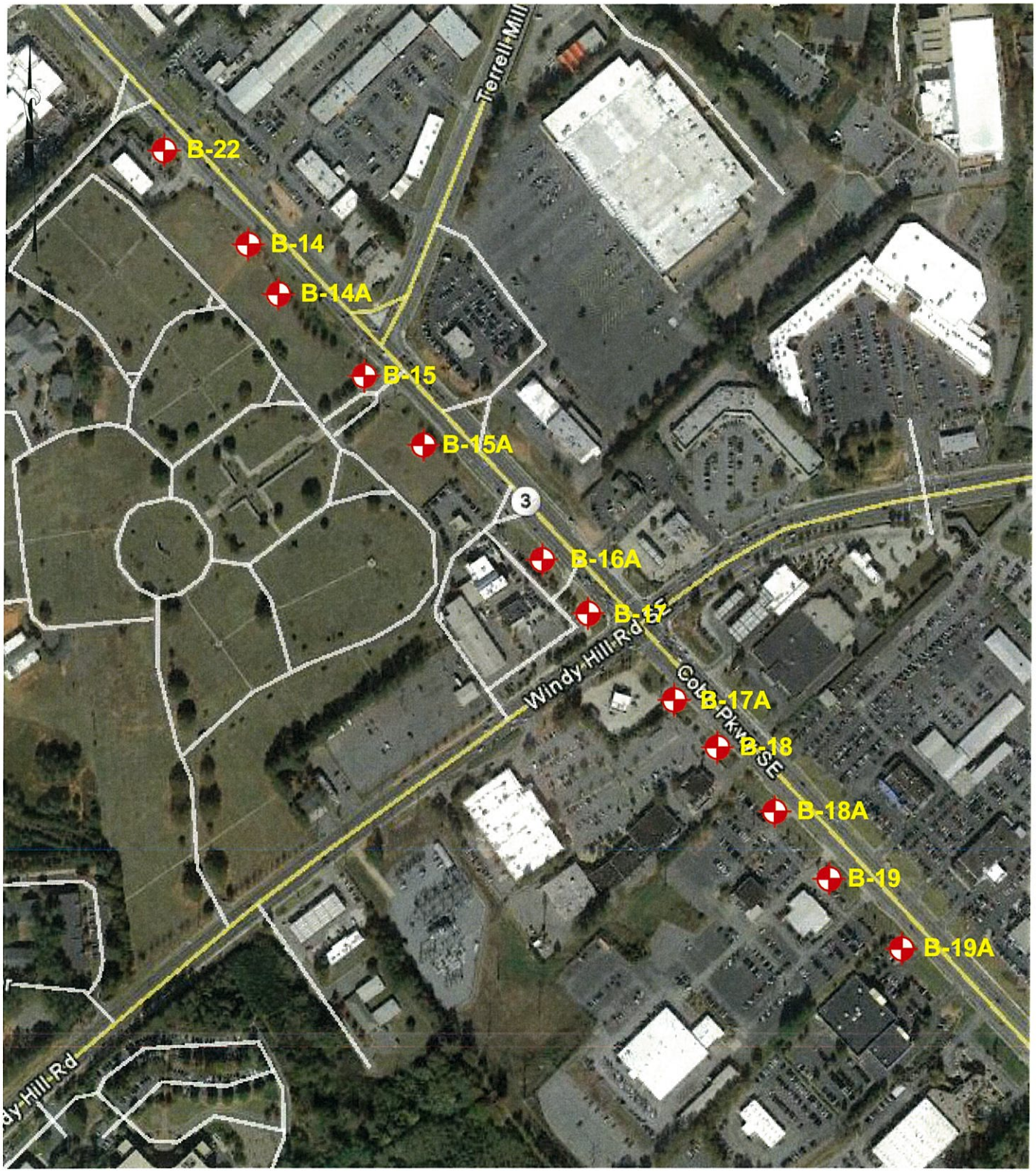
0 0.25 0.5 1 1.5

Approximate Scale, Miles

Figure 1: Site Location Plan

Highway 41 Water Main - Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.01

GEO HYDRO ENGINEERS

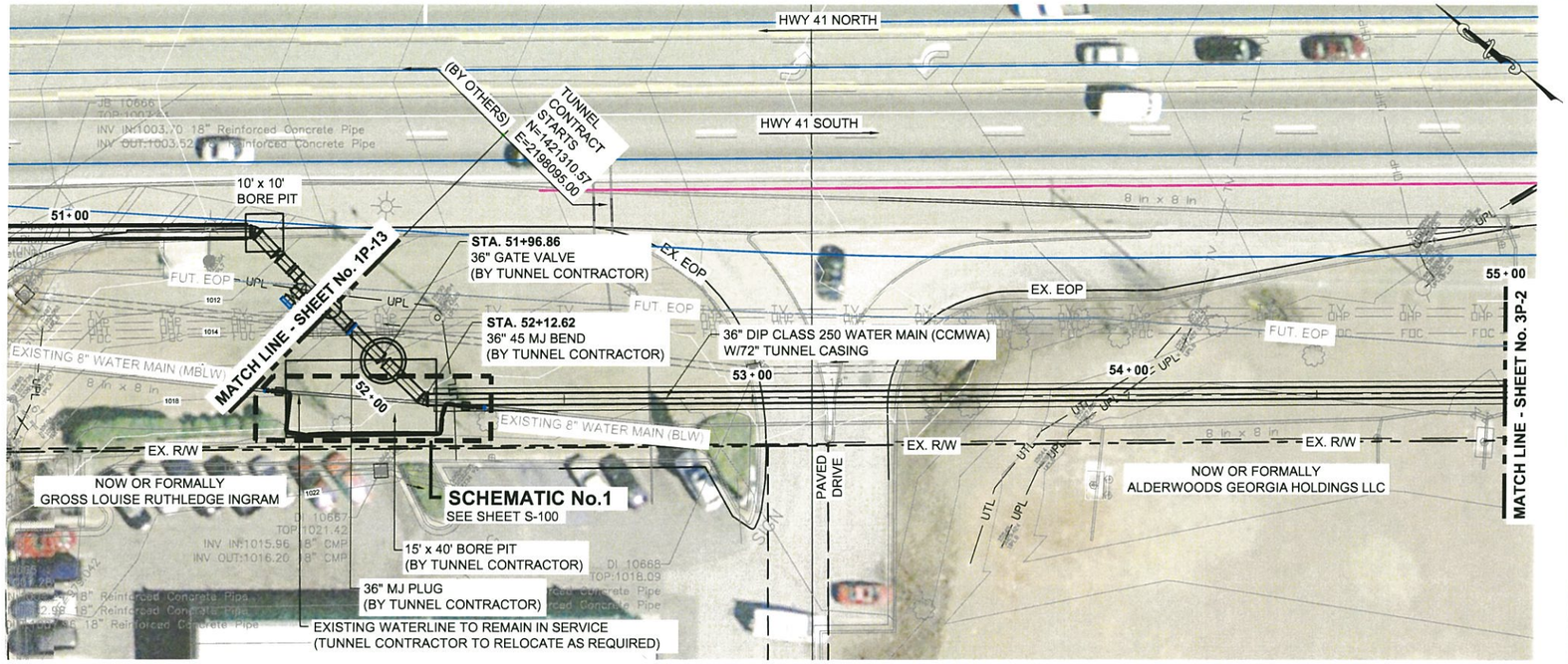


LEGEND: Soil Test Boring

Approximate Scale: 1"= 400'

Figure 2: Boring Location Plan

Highway 41 Water Main - Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.01



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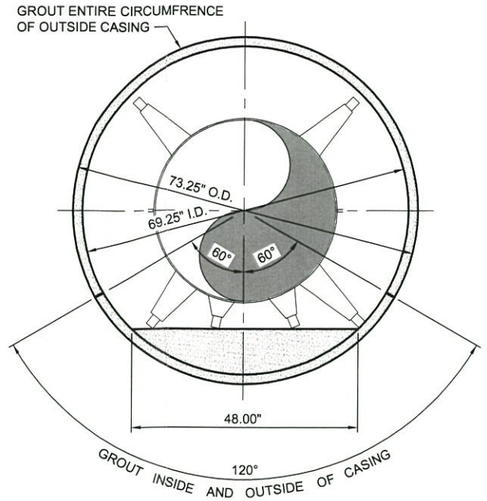

72" TUNNEL LINER SECTION

(NORTH END - LOOKING SOUTH INTO TUNNEL)
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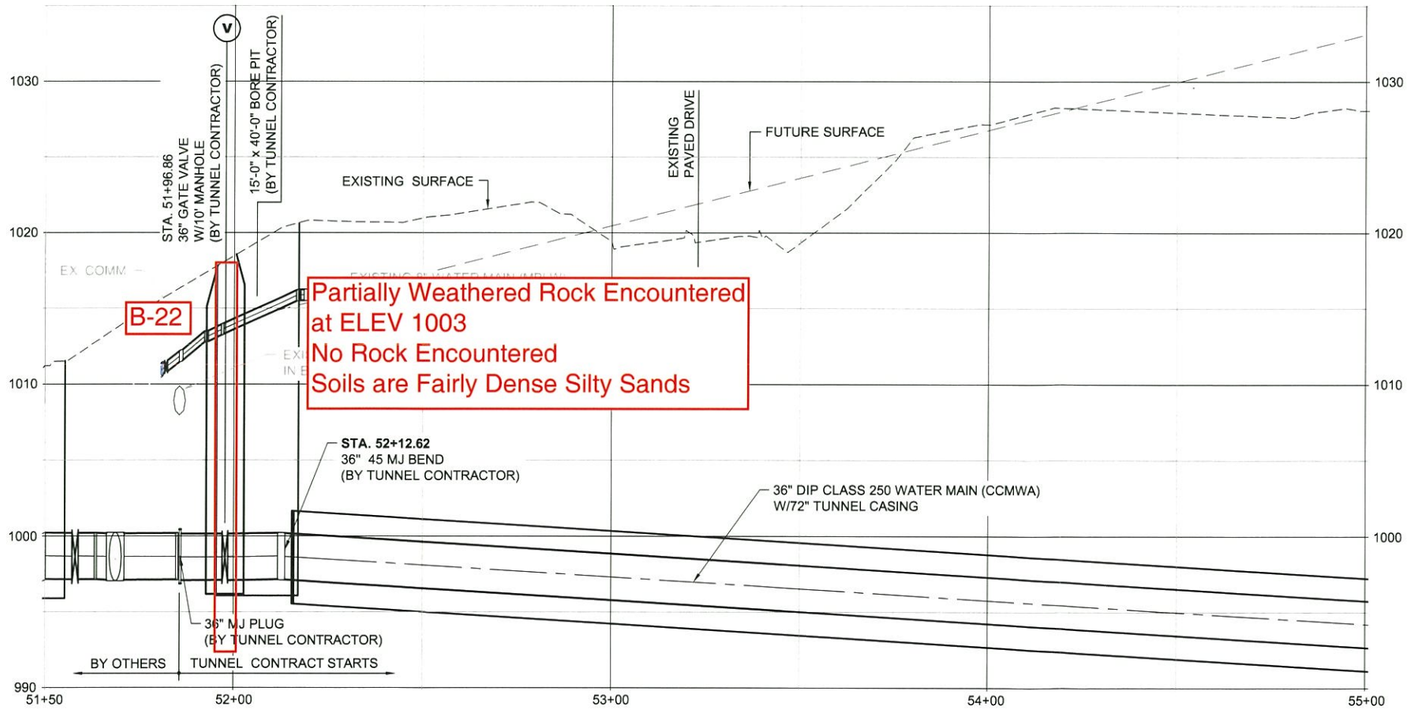

RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
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RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

GEORGIA REGISTERED PROFESSIONAL ENGINEER ROBERT ROBERT PUFFER — PRELIMINARY
NOT VALID FOR CONSTRUCTION UNLESS SIGNED IN THIS BLOCK

ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY — REGIONAL WATER RESOURCE MANAGEMENT

REVISION	DATE

PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE
TUNNEL BORE PIT
TUNNEL LINER SECTION

SHEET No.
3P-1
100032548

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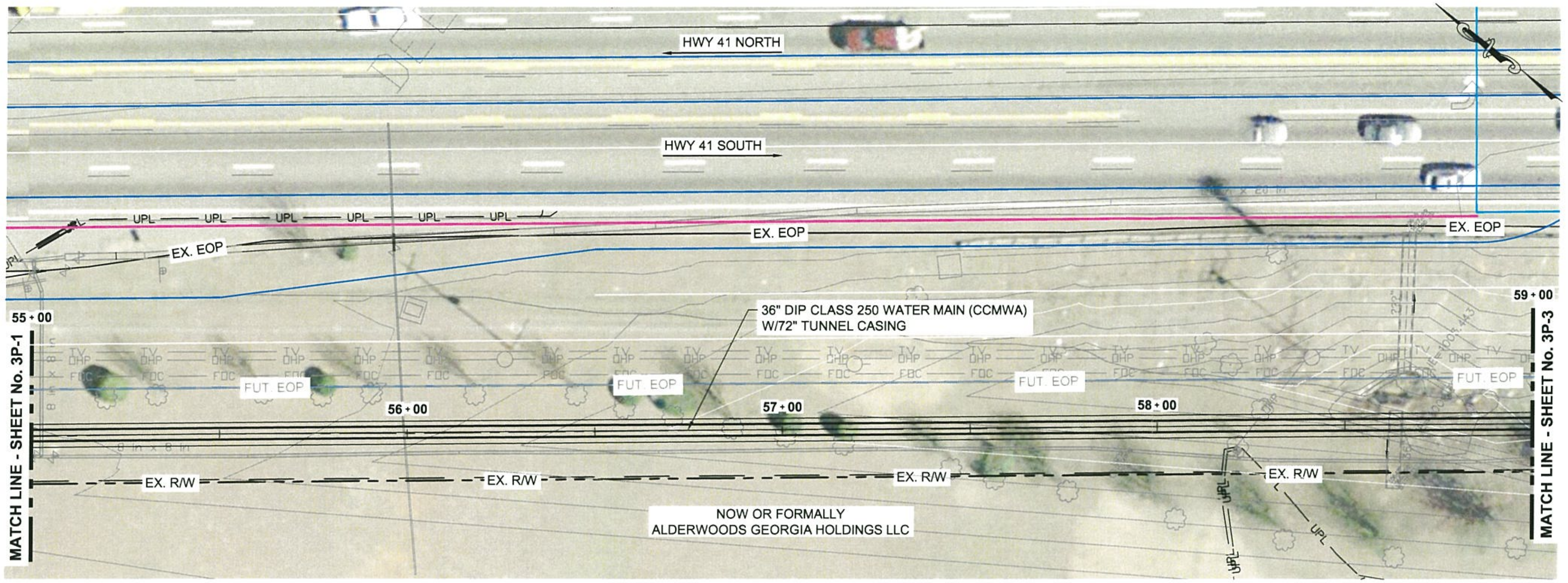

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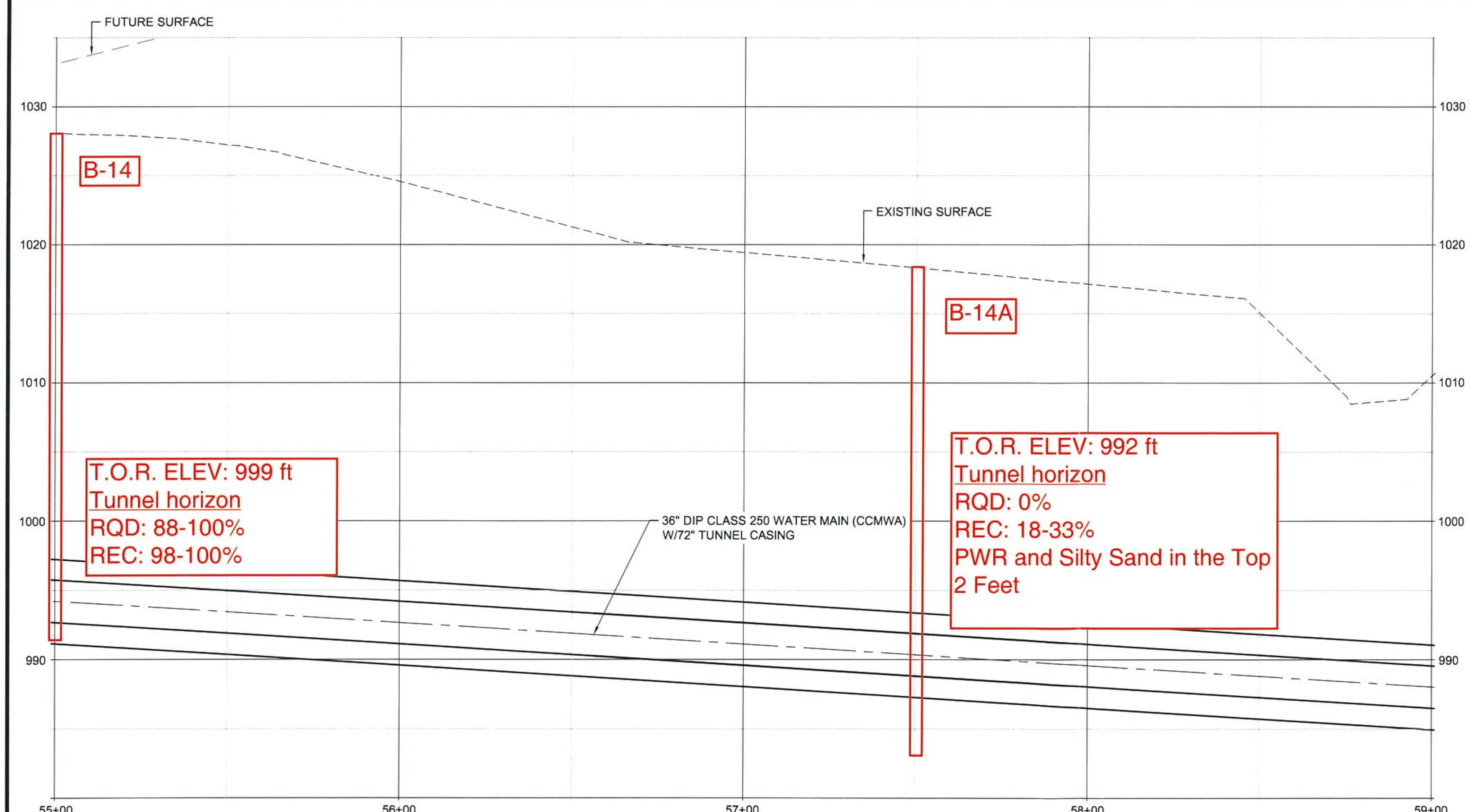

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RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

GEORGIA REGISTERED PROFESSIONAL ENGINEER No. 01[illegible] GILBERT ROBERT PUFFER
PRELIMINARY
NOT VALID FOR CONSTRUCTION UNLESS SIGNED IN THIS BLOCK

ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

REVISION	DATE

PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE

SHEET No.
3P-2
100032548

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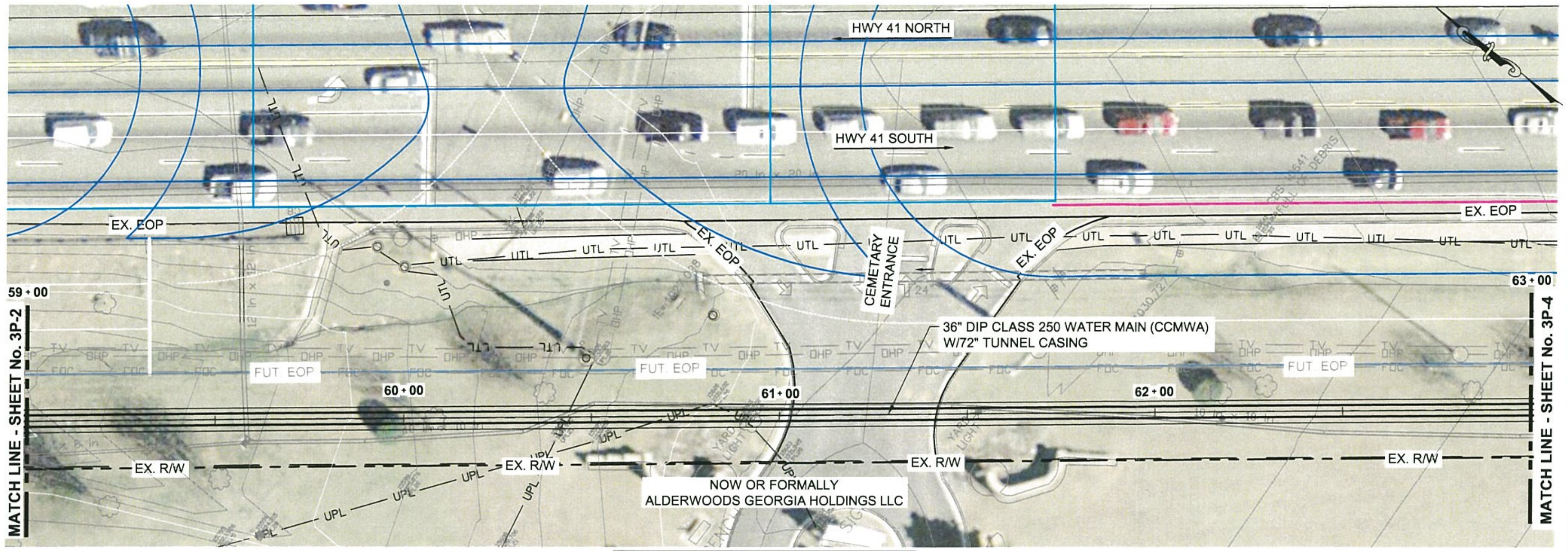

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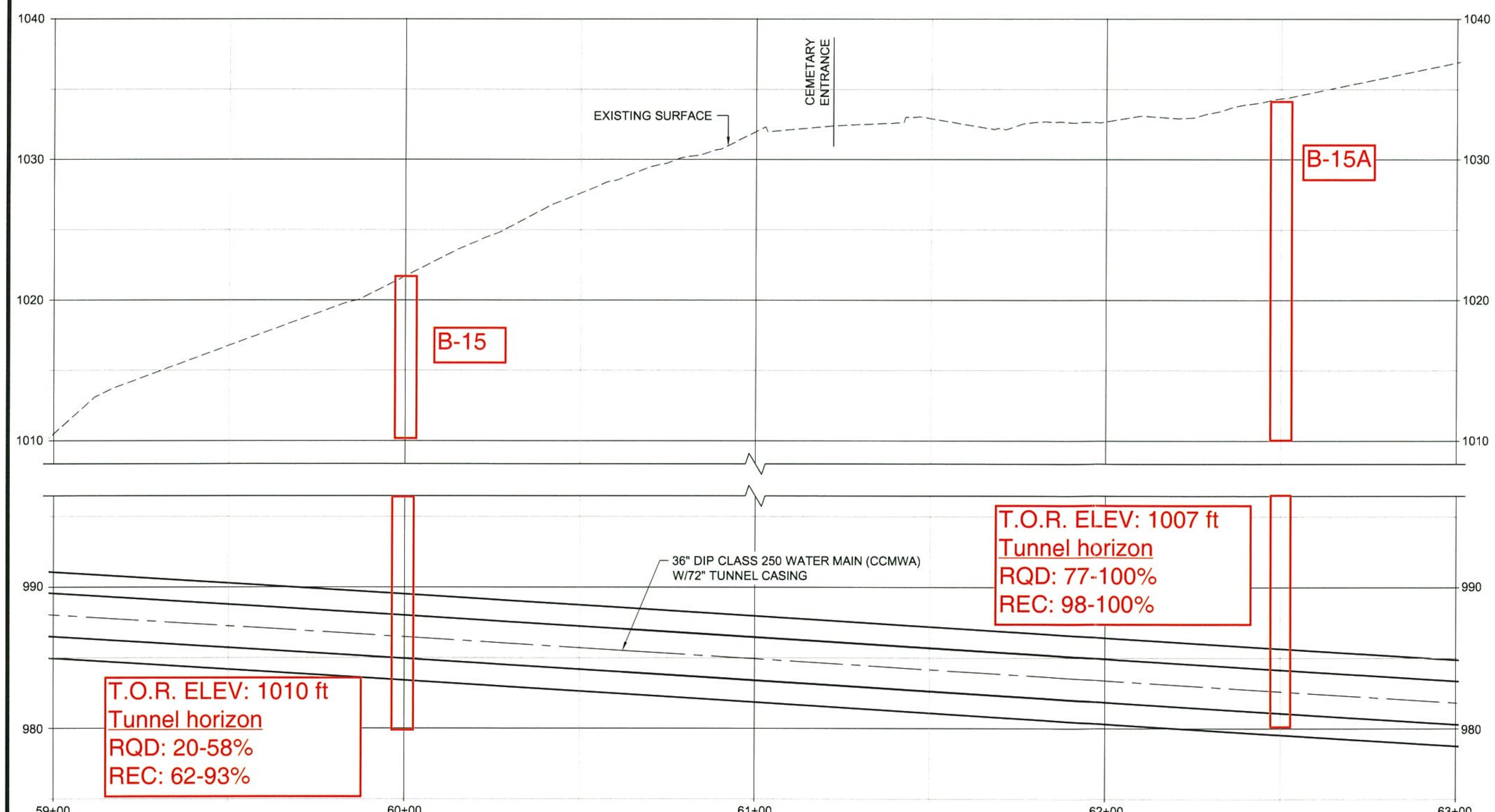

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RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

PRELIMINARY

GEORGIA REGISTERED PROFESSIONAL ENGINEER ROBERT PUFFER

ATKINS

1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

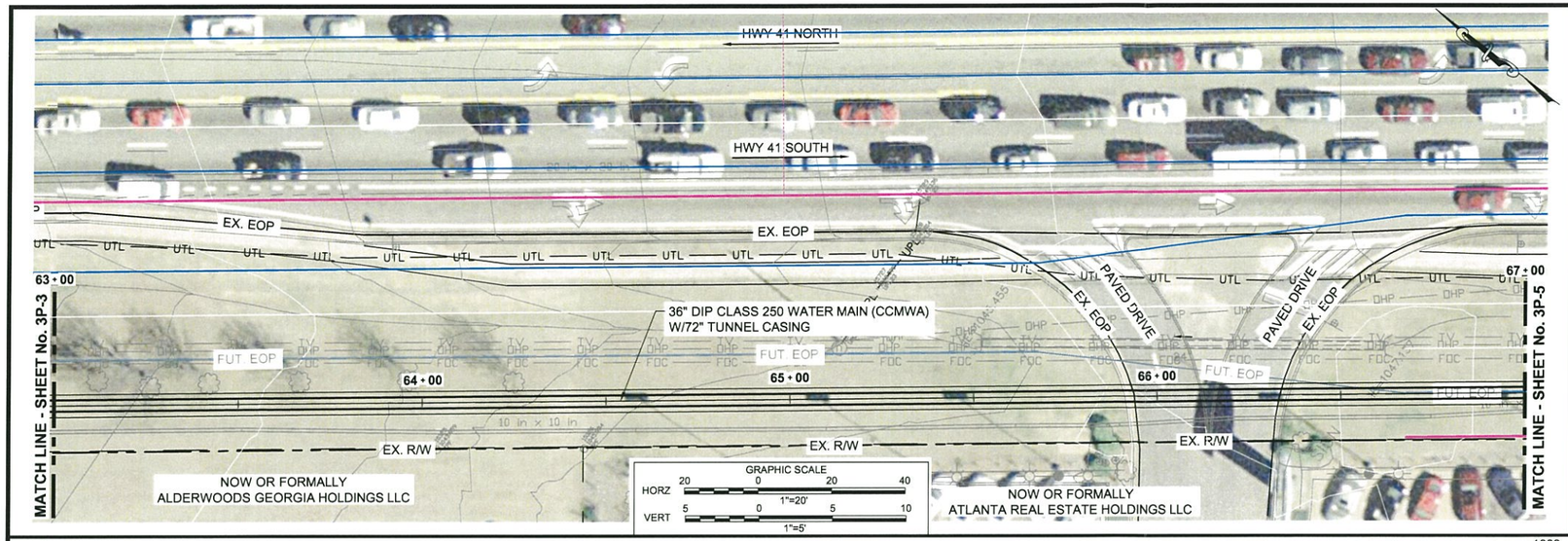
DATE	REVISION

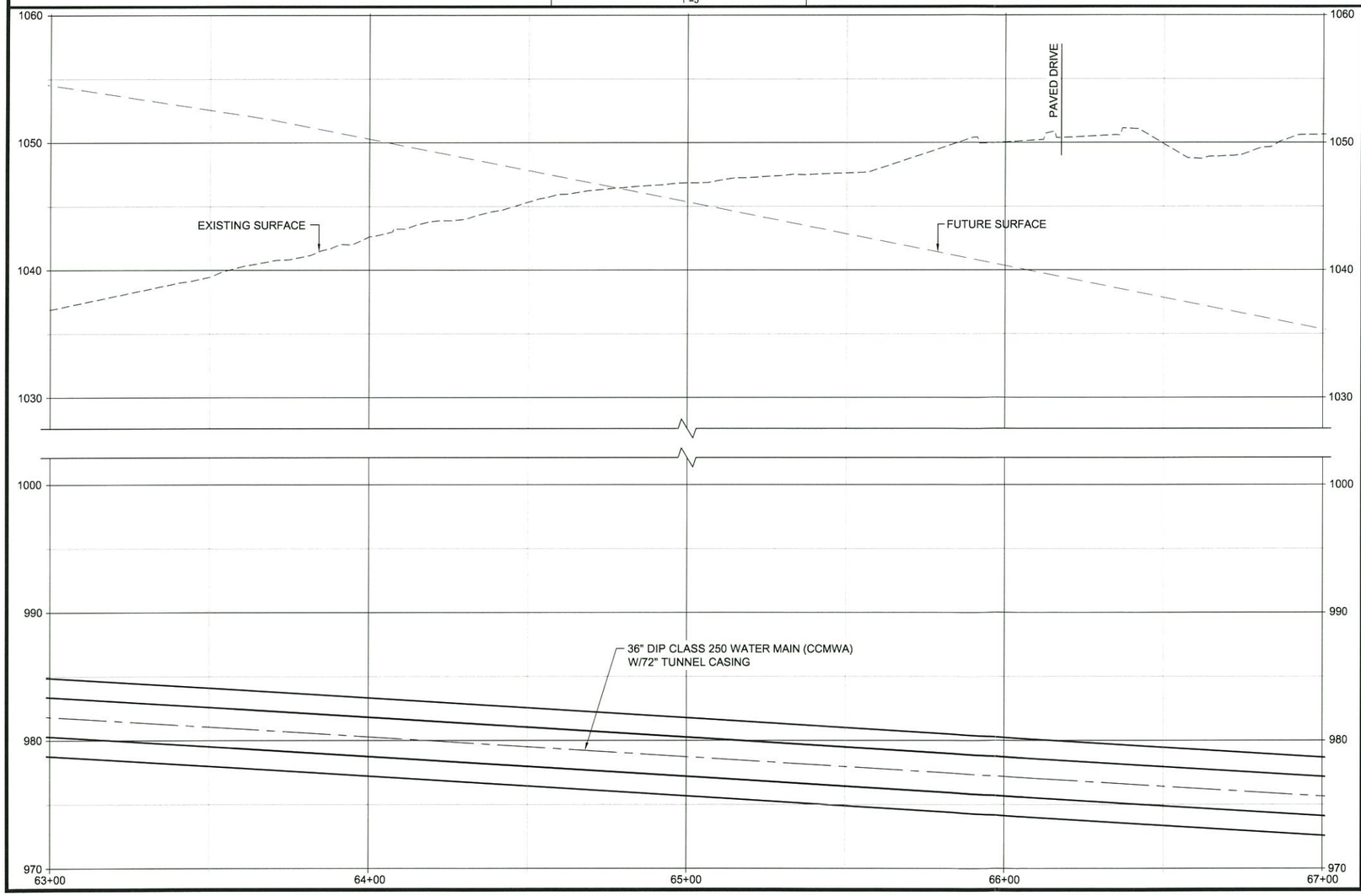
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE

SHEET No.
3P-3
100032548





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RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

PRELIMINARY
GEORGE ROBERT PUFFER
REGISTERED PROFESSIONAL ENGINEER
No. 0
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HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE

SHEET No.
3P-4
100032548

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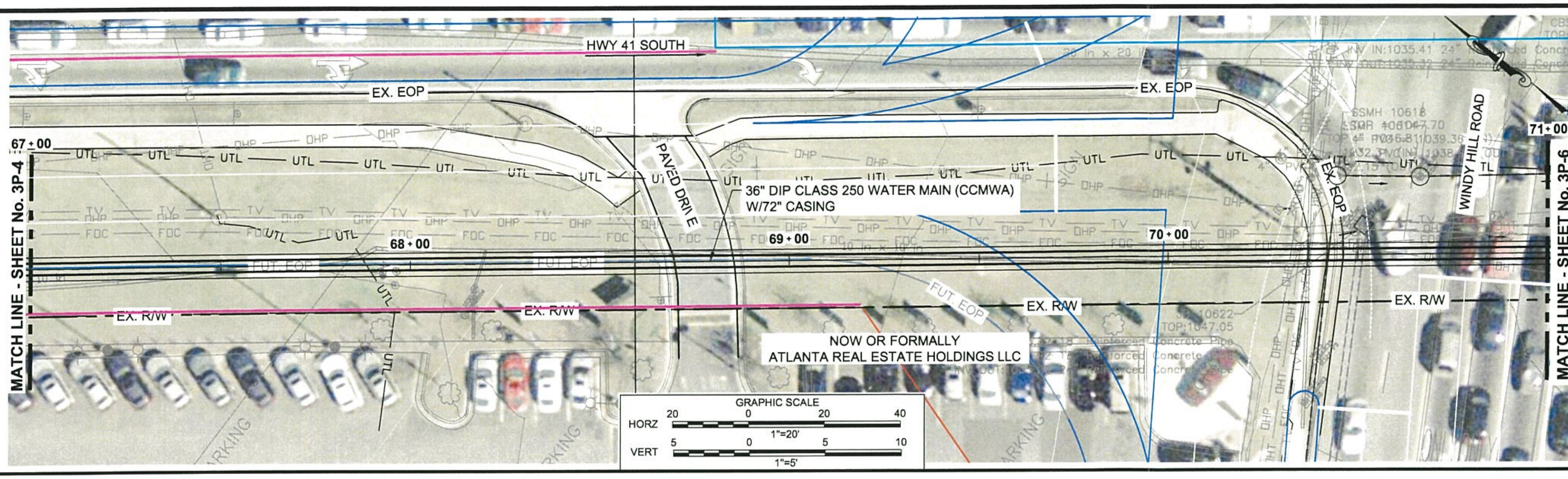
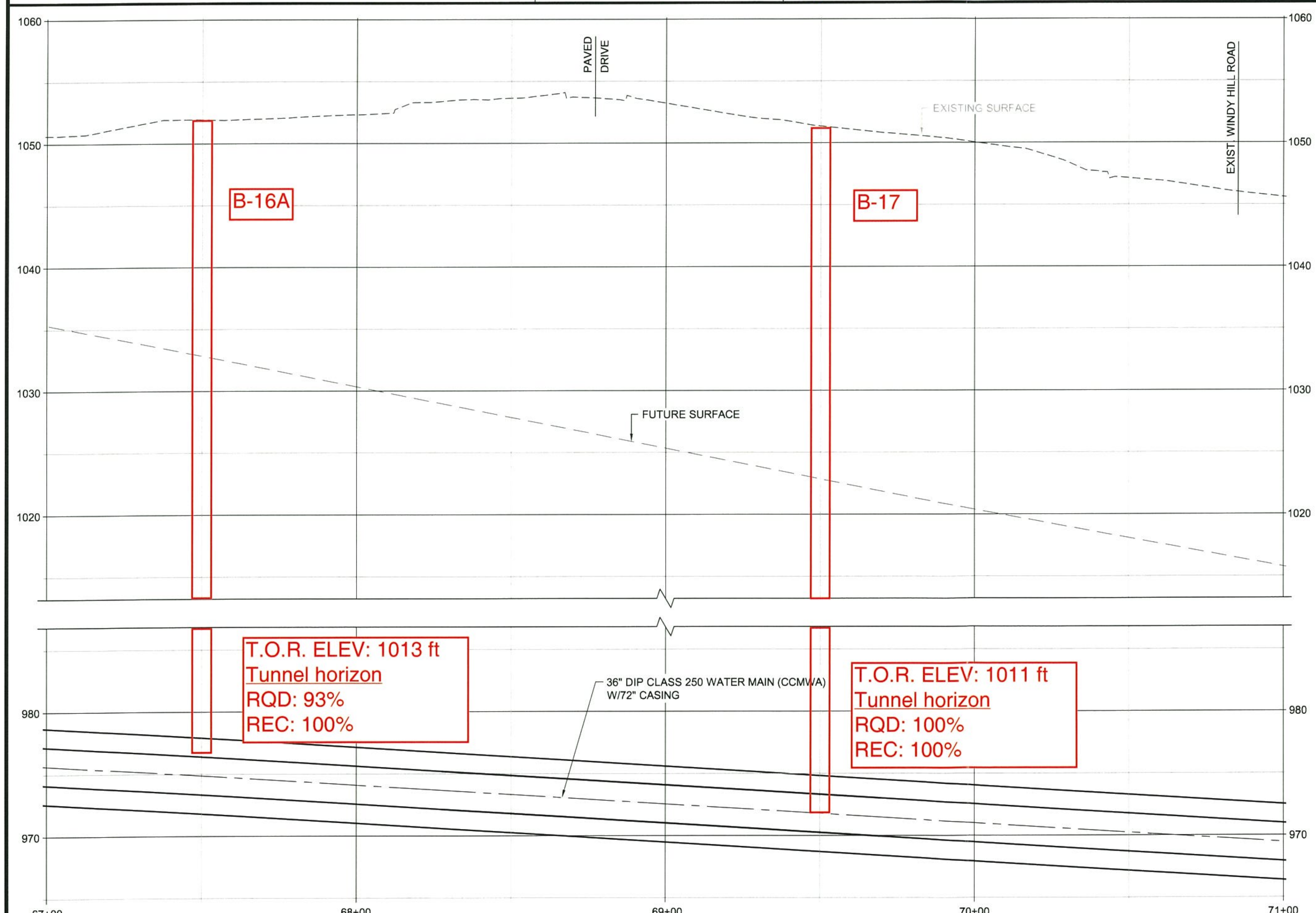




RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
X	X	X	X	X

RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

PRELIMINARY

NOT VALID FOR CONSTRUCTION UNLESS SIGNED IN THIS BLOCK

ATKINS

1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

DATE	REVISION

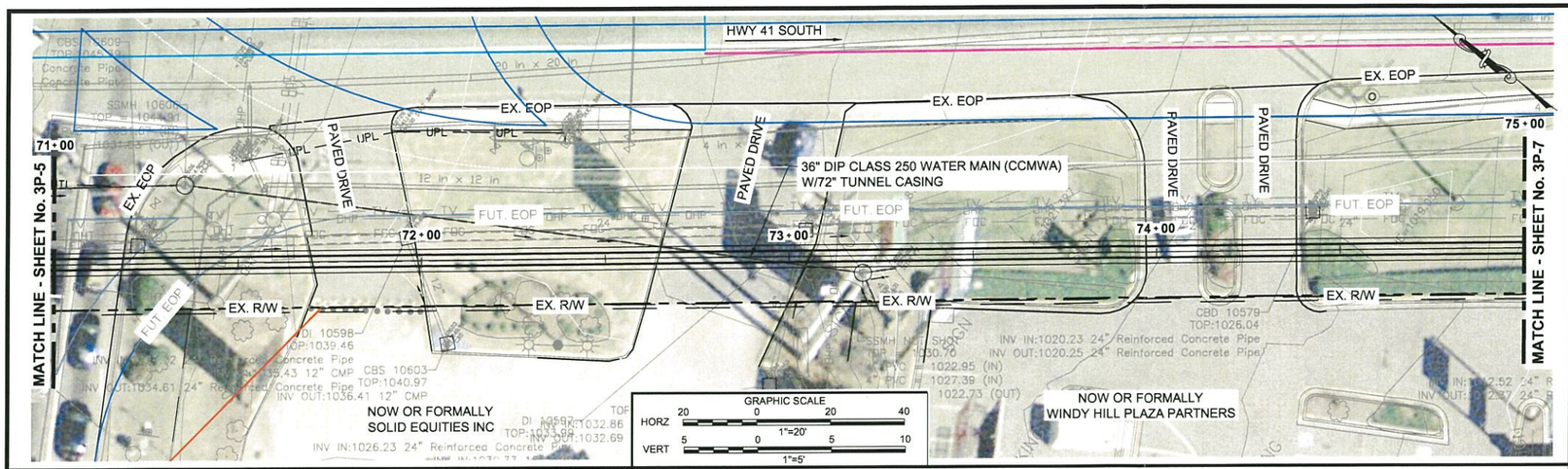
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

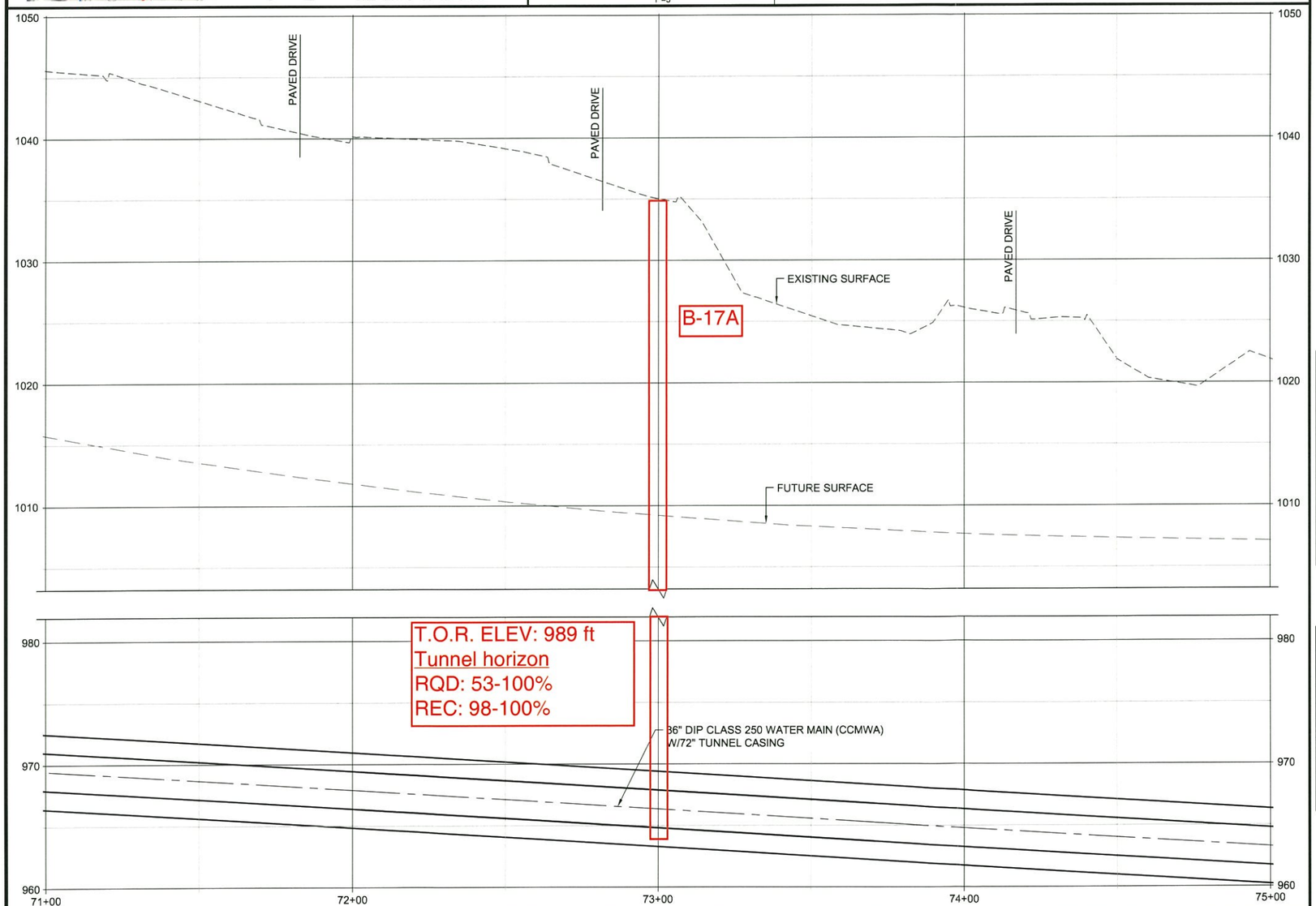
COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE

SHEET No.
3P-5
100032548

File Name: C:\PW WORK\ATKNAFI01\NFWM7492\DMS05902\TUNNEL PLANS AND PROFILES.DWG Tab: 3P-5 Plotted: November 21, 2013 10:28am





RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
X	X	X	X	X

RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

GEORGIA REGISTERED PROFESSIONAL ENGINEER ROBERT ROBERT PUFFER
PRELIMINARY
NOT VALID FOR CONSTRUCTION UNLESS SIGNED IN THIS BLOCK

ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

DATE

REVISION

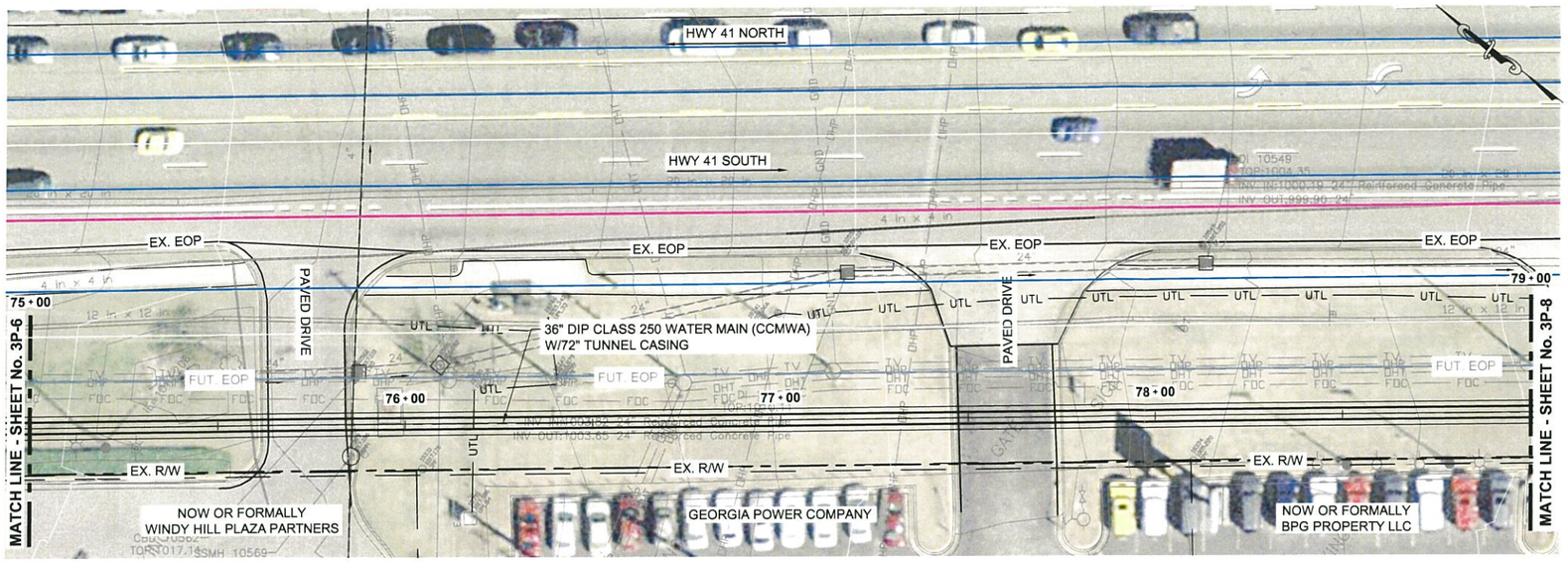
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: JN
DATE: DEC. 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

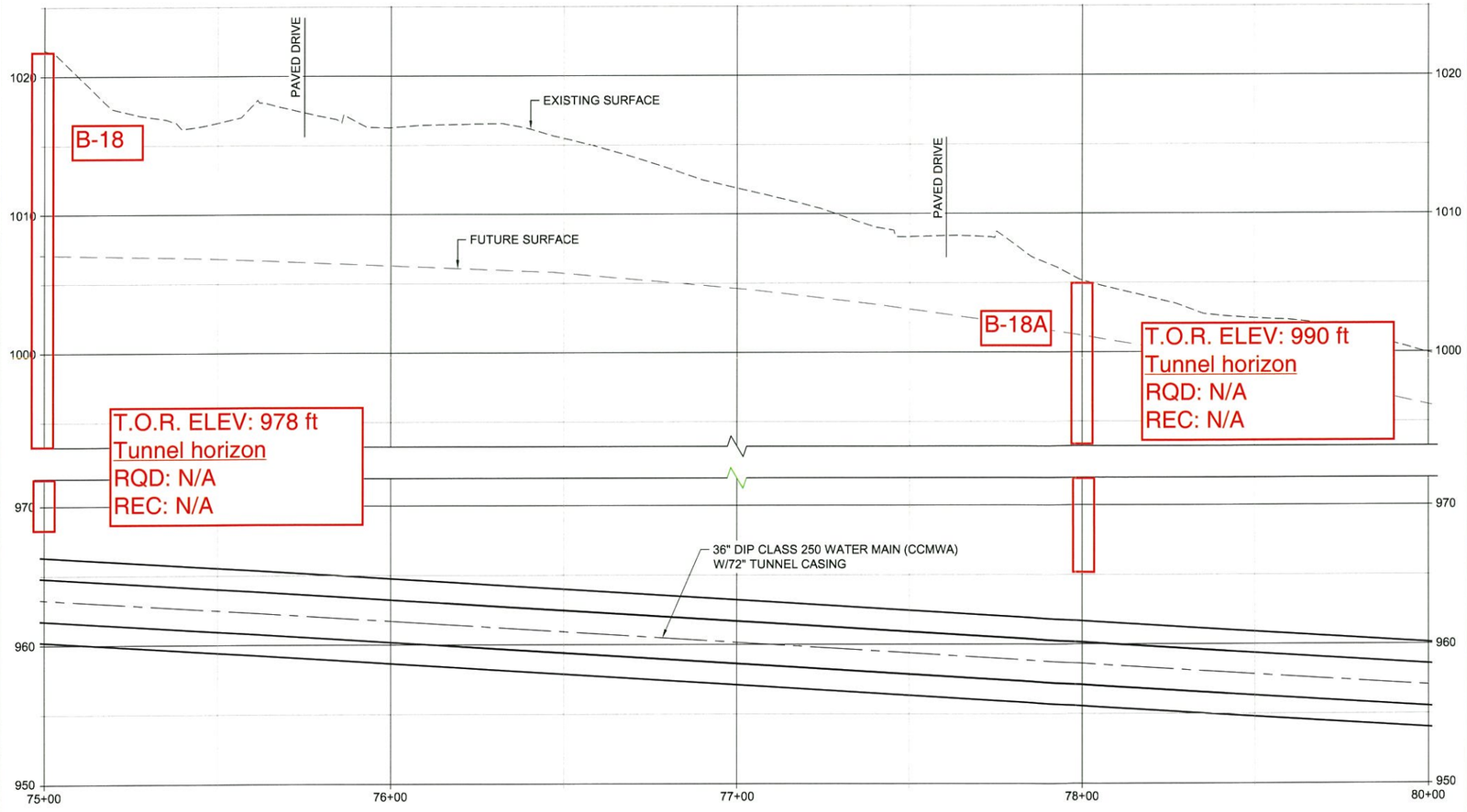
TUNNEL PLAN AND PROFILE

SHEET No.
3P-6
100032548

File Name: C:\PW WORK\ATKNAFL01\NFWM7492\DMS0596\2\TUNNEL PLANS AND PROFILES.DWG\Tab: 3P-6 Plotted: November 21, 2013 10:30am



GRAPHIC SCALE
HORZ 20 0 20 40 1"=20'
VERT 5 0 5 10 1"=5'



RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
X	X	X	X	X

RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

GEORGIA REGISTERED PROFESSIONAL ENGINEER HERT ROBERT PUFFER
PRELIMINARY
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1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

DATE

REVISION

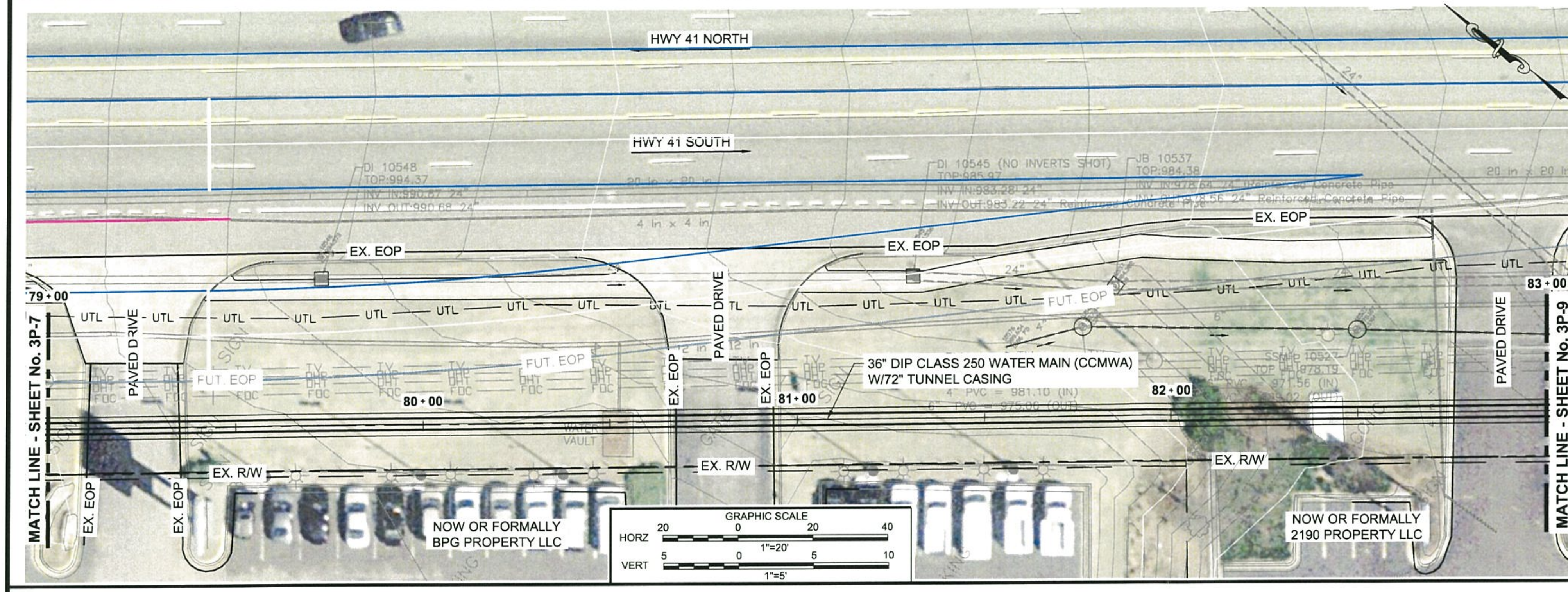
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

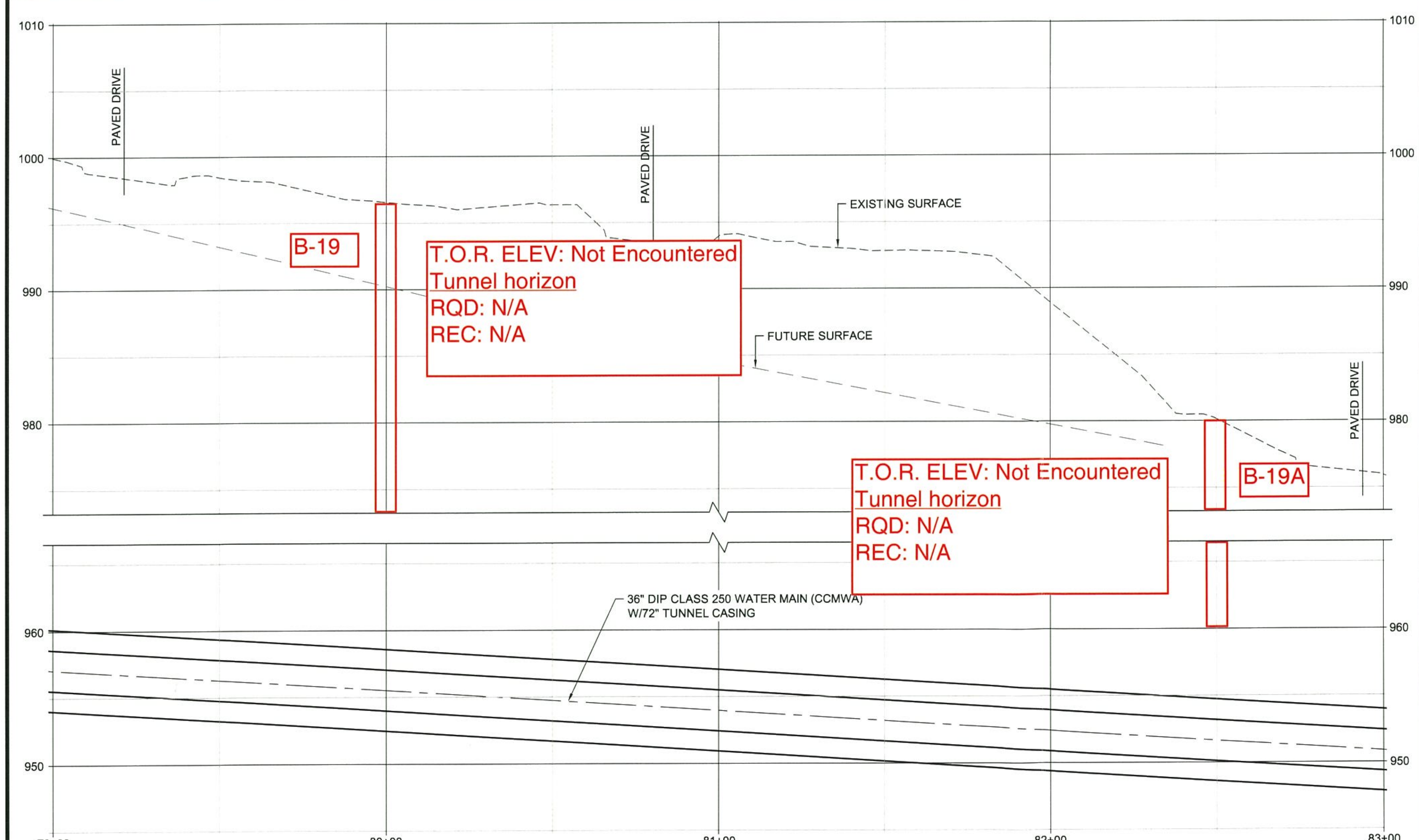
COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

TUNNEL PLAN AND PROFILE

SHEET No.
3P-7
100032548

File Name: C:\PW WORK\ATKNAFL01\NF\WM7492\DM505907\TUNNEL PLANS AND PROFILES\3P-7Plotted: November 21, 2013 10:33am





RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
X	X	X	X	X

RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

PRELIMINARY
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ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

DATE	REVISION

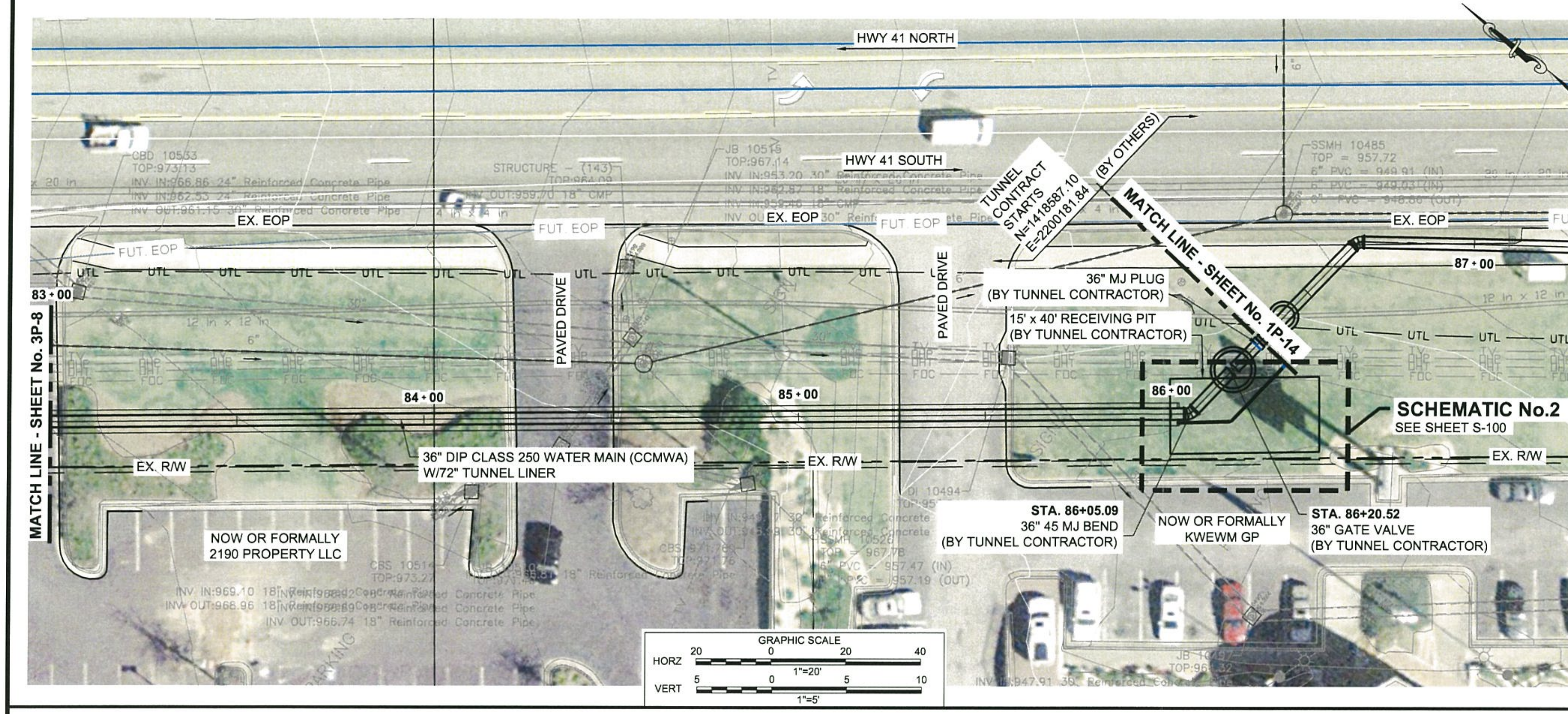
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

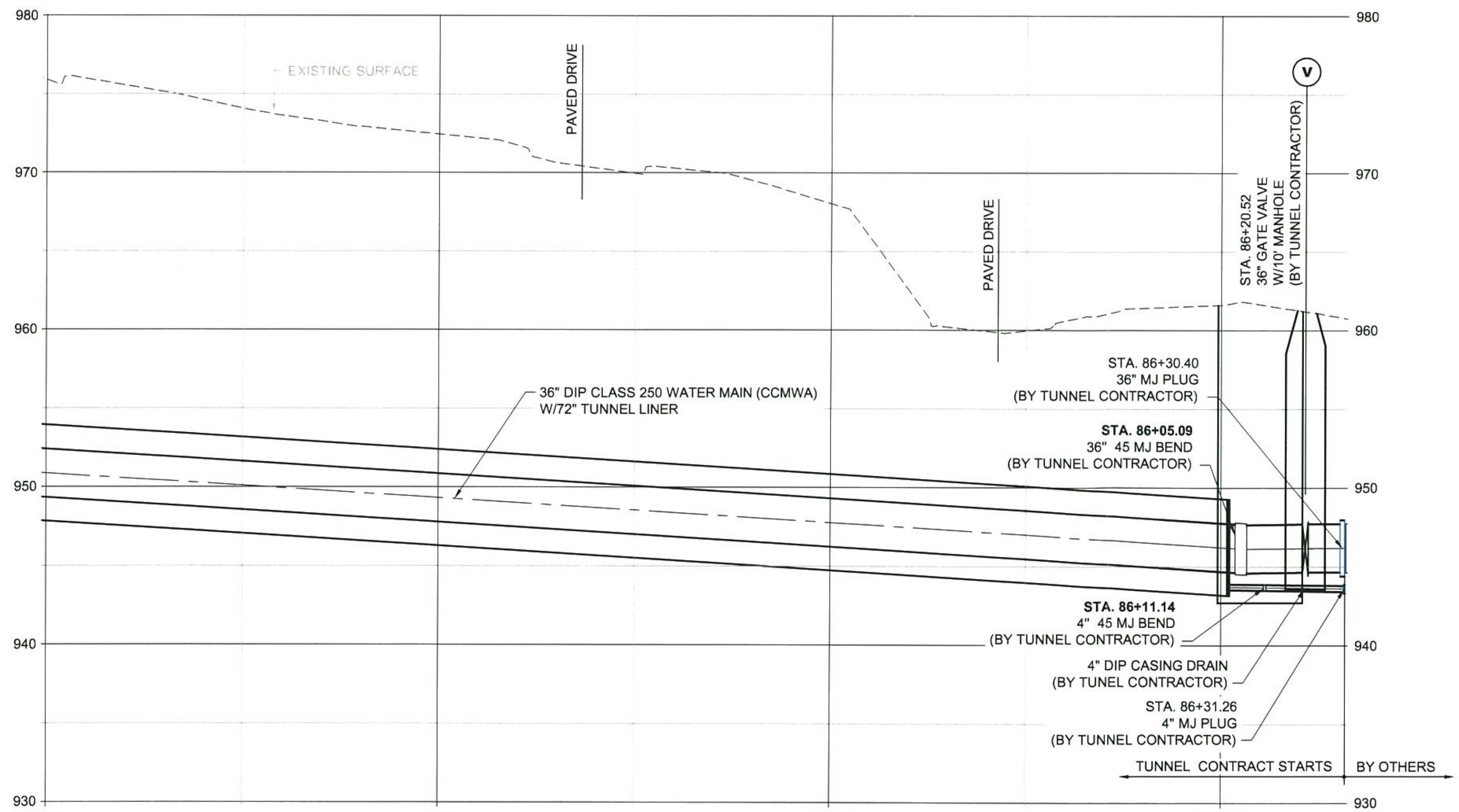
COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

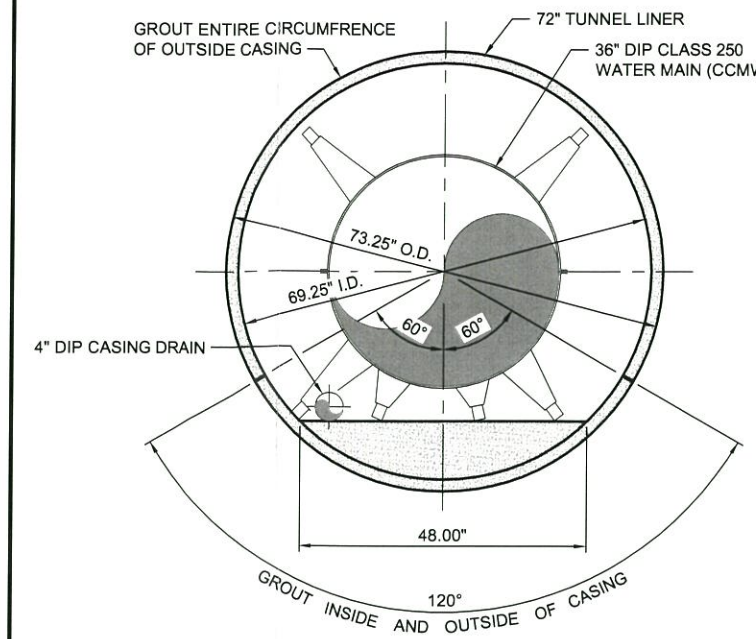
TUNNEL PLAN AND PROFILE

SHEET No.
3P-8
100032548

File Name: C:\PW_WORK\ATKNAF01\NFWM7492\DMS05902\TUNNEL PLANS AND PROFILES.DWG|Tab:3P-8|Plotted: November 21, 2013 10:54am







72" TUNNEL LINER SECTION

(SOUTH END - LOOKING NORTH INTO TUNNEL)
SCALE: 3/4"=1'-0"

RECORD MATERIAL LIST

SIZE	DESCRIPTION	CLASS	MANUFACTURER	COMMENTS
X	X	X	X	X

RECORD INFORMATION

ITEM/DESCRIPTION	STATION	NORTHING	EASTING	ELEVATION	NOTES

PRELIMINARY
GEORGIA REGISTERED PROFESSIONAL ENGINEER ROBERT PUFFER
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ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

DATE	REVISION

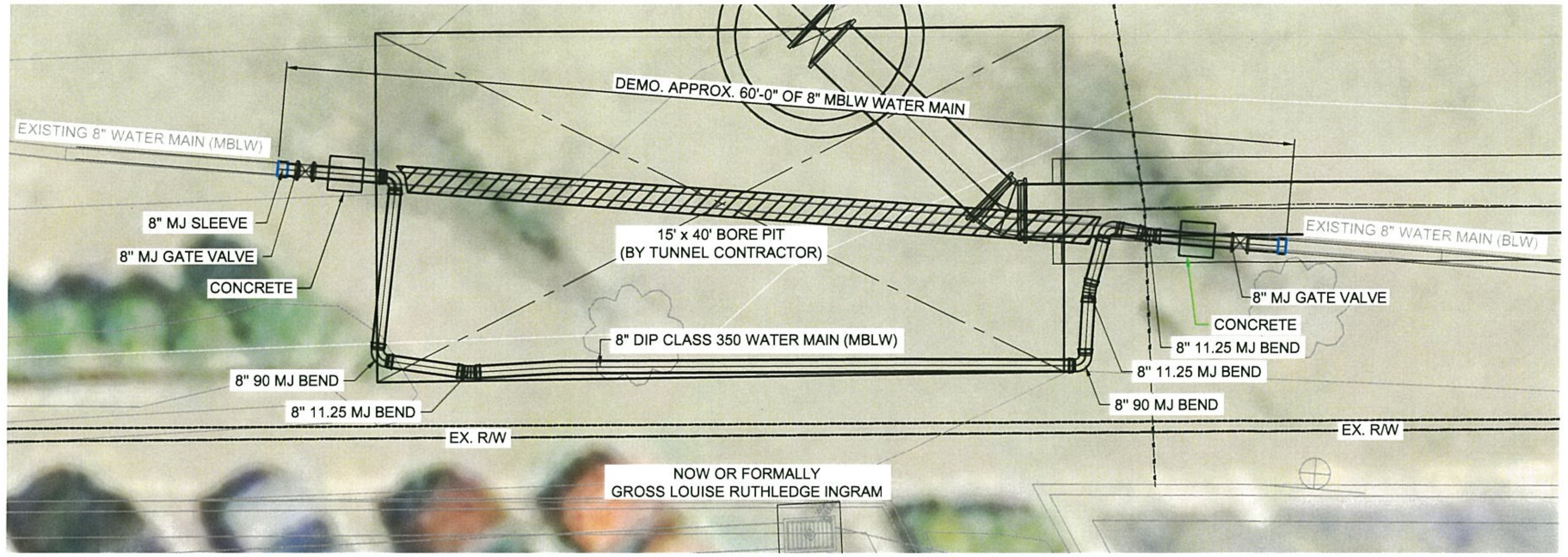
PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

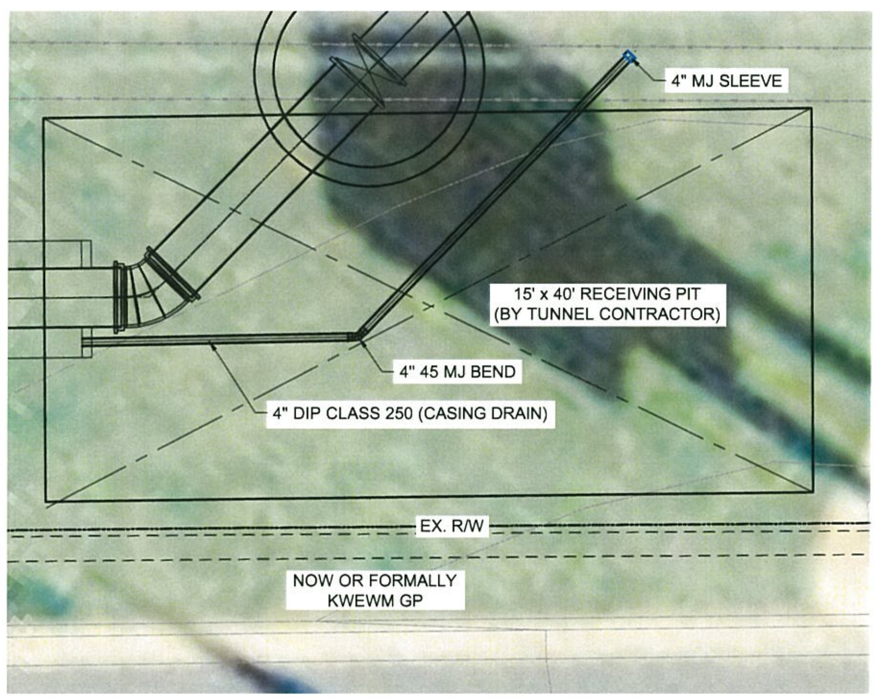
TUNNEL PLAN AND PROFILE
TUNNEL RECEIVING PIT
TUNNEL LINER SECTION

SHEET No.
3P-9
100032548

File Name: C:\PW WORK\ATKNAFL01\NFWM7492\DMS05902\TUNNEL PLANS AND PROFILES.DWGTab: 3P-9Plotted: November 21, 2013 10:39am



SCHEMATIC No.1
SEE SHEET 3P-1
SCALE: 1"=5'-0"



SCHEMATIC No.2
SEE SHEET 3P-9
SCALE: 1"=5'-0"

PRELIMINARY
GEORGIA REGISTERED PROFESSIONAL ENGINEER ROBERT PUFFER
NOT VALID FOR CONSTRUCTION UNLESS SIGNED IN THIS BLOCK

ATKINS
1600 RiverEdge Parkway, NW, Suite 600
Atlanta, Georgia 30328
P: 770-933-0280

COBB COUNTY-MARIETTA WATER AUTHORITY
REGIONAL WATER RESOURCE MANAGEMENT

REVISION	DATE

PROJ. No.: 100032548
DESIGNED BY: GRP
DRAWN BY: JN
CHECKED BY: GRP
APPROVED BY: GRP
DATE: DEC. 2013
SCALE: AS SHOWN

COBB COUNTY-MARIETTA WATER AUTHORITY
HIGHWAY 41 TUNNEL
PHASE 4

PIPELINE SCHEMATICS

SHEET No.
S-100
100032548

File Name: C:\PW WORK\ATKNAFL01\NFWM7492\DMS05902\TUNNEL PLANS AND PROFILES.DWG|Tab:S-100|Plotted: November 21, 2013 10:41am

Symbols and Nomenclature

Symbols

▮	Thin-walled tube (TWT) sample recovered
▯	Thin-walled tube (TWT) sample not recovered
●	Standard penetration resistance (ASTM D1586)
50/2"	Number of blows (50) to drive the split-spoon a number of inches (2)
65%	Percentage of rock core recovered
RQD	Rock quality designation - % of recovered core sample which is 4 or more inches long
GW	Groundwater
▼	Water level at least 24 hours after drilling
▽	Water level one hour or less after drilling
ALLUV	Alluvium
TOP	Topsoil
PM	Pavement Materials
CONC	Concrete
FILL	Fill Material
RES	Residual Soil
PWR	Partially Weathered Rock
SPT	Standard Penetration Testing

Penetration Resistance Results	Number of Blows, N	Approximate Relative Density
Sands	0-4	very loose
	5-10	loose
	11-20	firm
	21-30	very firm
	31-50	dense
	Over 50	very dense

	Number of Blows, N	Approximate Consistency
Silts and	0-1	very soft
Clays	2-4	soft
	5-8	firm
	9-15	stiff
	16-30	very stiff
	31-50	hard
	Over 50	very hard

Drilling Procedures

Soil sampling and standard penetration testing performed in accordance with ASTM D 1586. The standard penetration resistance is the number of blows of a 140-pound hammer falling 30 inches to drive a 2-inch O.D., 1.4-inch I.D. split-spoon sampler one foot. Rock coring is performed in accordance with ASTM D 2113. Thin-walled tube sampling is performed in accordance with ASTM D 1587.

GEO HYDRO ENGINEERS

B-14

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/14/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1026**
Driller: **B&C**	GWT at 24 hrs: **16 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1025	0			Auger Boring Only - No Sampling Preformed	
1020	5				
1015	10				
1010	15	▼			
1005	20			Partially weathered rock sampled as dark brown micaceous silty fine to medium sand (SM) (RESIDUUM)	50/3"
1000	25			Very firm gray and orange micaceous silty fine sand (SM) with rock fragments	27
995	30			Auger Refusal at 27 feet - Begin Rock Coring Light gray speckled pink and banded white, unweathered, fine to medium grained, medium to widely fractured, hard BIOTITE GNEISS	
990	35			27-29 feet - REC: 63%, RQD: 42% 29-34 feet - REC: 98%, RQD: 88% 34-35 feet - REC: 100%, RQD 100% Rock Coring Terminated at 35 feet	
985	40				
980	45				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 55+00
Tunnel Interval: 991-997

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-14 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/13/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1018**
Driller: **B&C**	GWT at 24 hrs: **13 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1015	0			Auger Boring Only - No Sampling Preformed	
1010	5				
1005	10	▼		Dense white and brown micaceous silty fine to coarse sand (SM) with rock fragments (RESIDUUM)	36
1000	15			Firm dark gray-brown micaceous silty fine sand (SM)	15
995	20			Very dense dark gray micaceous silty fine sand (SM) with rock fragments	65
990	25			Auger Refusal at 26 feet - Begin Rock Coring Gray banded black and stained brown, slightly to completely weathered, fine to medium grained, very closely to medium fractured, very soft GRANITIC GNEISS	
985	30			26-29 feet - REC: 33%, RQD: 0% 29-34 feet - REC: 18%, RQD: 0% 34-35 feet - REC: 67%, RQD: 33%	
980	35			Rock Coring Terminated at 35 feet	
975	40				
	45				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 57+50
Tunnel Interval: 988-994

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-15

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/12/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1020**
Driller: **B&C**	GWT at 24 hrs: **19 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
				Auger Boring Only - No Sampling Preformed		
1015	5					
1010	10			Auger Refusal at 10 feet - Begin Rock Coring		
1005	15	▼		Gray stained brown and speckled black and white, slightly to highly weathered, fine to medium grained, very closely to medium fractured, very soft to soft GRANITIC GNEISS		
1000	20			10-14 feet - REC: 52%, RQD: 18% 14-19 feet - REC: 72%, RQD: 15%		
995	25			Gray speckled black and stained brown, slightly to highly weathered, fine to medium grained, very closely to medium fractured, very soft to hard GRANITIC GNEISS and MICA SCHIST		
990	30			19-24 feet - REC: 78%, RQD: 38% 24-29 feet - REC: 80%, RQD: 17%		
985	35			Gray banded dark gray, unweathered to medium weathered, fine to medium grained, closely to widely fractured, soft MICA SCHIST Run: 5 feet, REC: 93%, RQD: 58%		
980	40			Gray stained red, speckled and banded white, slightly to medium weathered, fine to medium grained, very closely to medium fractured, soft to hard GRANITIC GNEISS		
975	45			34-39 feet - REC: 62%, RQD: 20% 39-40 feet - REC: 100%, RQD: 75% Rock Coring Terminated at 40 feet		

Remarks: Approximate Station: 60+00
Tunnel Interval: 983-989

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-15 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/12/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **23 feet**	G.S. Elev: **1035**
Driller: **B&C**	GWT at 24 hrs: **18 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
				Auger Boring Only - No Sampling Preformed		
1030	5					
1025	10					
1020	15					
		▼				
1015	20					
		▽				
1010	25					
				Auger Refusal at 28 feet - Begin Rock Coring		
1005	30			Light gray to gray banded and speckled white, unweathered to medium weathered, fine to medium grained, closely to medium fractured, hard BIOTITE GNEISS		
1000	35			28-33 feet - REC: 97%, RQD: 50% 33-38 feet - REC: 92%, RQD: 83%		
995	40			Light gray to gray banded and speckled white, unweathered to slightly weathered, fine to medium grained, closely to widely fractured, hard BIOTITE GNEISS		
990	45			38-43 feet - REC: 100%, RQD: 88% 43-48 feet - REC: 100%, RQD: 80%		

Remarks: Approximate Station: 62+50
Tunnel Interval: 980-986
Page 1 of 2

B-15 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/12/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **23 feet**	G.S. Elev: **1035**
Driller: **B&C**	GWT at 24 hrs: **18 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
985	50			Light gray banded and mottled white, unweathered to slightly weathered, fine to medium grained, closely to medium fractured, hard BIOTITE GNEISS 48-53 feet - REC: 98%, RQD: 77% 53-55 feet - REC: 100%, RQD: 100%		
980	55			Rock Coring Terminated at 55 feet		
975	60					
970	65					
965	70					
960	75					
955	80					
950	85					
945	90					

Remarks: Approximate Station: 62+50
Tunnel Interval: 980-986
Page 2 of 2

B-16 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/6/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1052**
Driller: **B&C**	GWT at 24 hrs: **25 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1050	0			Auger Boring Only - No Sampling Preformed	
1045	5				
1040	10				
1035	15				
1030	20				
1025	25	▼			
1020	30				
1015	35				
1010	40			Auger Refusal at 39 feet - Begin Rock Coring Light gray to gray banded and speckled white, unweathered, fine to medium grained, closely to widely fractured, very hard BIOTITE GNEISS	
1005	45				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 67+50
Tunnel Interval: 972-978
Page 1 of 2

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-16 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/6/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1052**
Driller: **B&C**	GWT at 24 hrs: **25 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
				39-48 feet - REC: 96%, RQD: 79%		
1000	50			Light gray to gray banded and speckled white, unweathered, fine to medium grained, very closely to widely fractured, very hard BIOTITE GNEISS 48-58 feet - REC: 100%, RQD: 93%		
995	55					
990	60			Gray mottled and banded white, unweathered, fine to medium grained, very closely to widely fractured, very hard BIOTITE GNEISS 58-68 feet - REC: 95%, RQD: 85%		
985	65					
980	70			Light gray to gray banded and speckled white, unweathered to slightly weathered, fine to medium grained, very closely to widely fractured, very hard BIOTITE GNEISS 68-75 feet - REC: 100%, RQD: 93%		
975	75			Rock Coring Terminated at 75 feet		
970	80					
965	85					
960	90					

Remarks: Approximate Station: 67+50
Tunnel Interval: 972-978
Page 2 of 2

B-17

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/7/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1052**
Driller: **B&C**	GWT at 24 hrs: **27 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1050	0			Auger Boring Only - No Sampling Preformed	
1045	5				
1040	10				
1035	15				
1030	20				
1025	25	▼			
1020	30				
1015	35				
1010	40			Auger Refusal at 41 feet - Begin Rock Coring	
1005	45			Gray banded and speckled white, unweathered to slightly weathered, fine to	

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 69+50
Tunnel Interval: 969-975
Page 1 of 2

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-17

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/7/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1052**
Driller: **B&C**	GWT at 24 hrs: **27 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
	50			medium grained, very closely to widely fractured, soft to hard BIOTITE GNEISS		
1000				41-44 feet - REC: 47%, RQD: 28% 44-49 feet - REC: 98%, RQD: 90%		
	55			Gray banded and speckled white, unweathered, fine to medium grained, medium to widely fractured, hard BIOTITE GNEISS		
995				49-54 feet - REC: 100%, RQD: 90% 54-59 feet - REC: 100%, RQD: 97%		
	60			Gray banded white, unweathered, fine to medium grained, widely to very widely fractured, hard BIOTITE GNEISS		
990				59-64 feet - REC: 100%, RQD: 98% 64-69 feet - REC: 98%, RQD: 98%		
	65					
985						
	70			Gray banded and speckled light gray, unweathered, fine to medium grained, hard BIOTITE GNEISS		
980				69-80 feet - REC: 100%, RQD: 100%		
	75					
975						
	80			Rock Coring Terminated at 80 feet		
970						
	85					
965						
	90					
960						

Remarks: Approximate Station: 69+50
Tunnel Interval: 969-975

B-17 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **26 feet**	G.S. Elev: **1034**
Driller: **B&C**	GWT at 24 hrs: **25 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
1030	5			Auger Boring Only - No Sampling Preformed		
1025	10					
1020	15					
1015	20					
1010	25	▼				
1005	30					
1000	35					
995	40					
990	45			Auger Refusal at 45 feet - Begin Rock		

Remarks: Approximate Station: 73+00
Tunnel Interval: 963-969
Page 1 of 2

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-17 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/8/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **26 feet**	G.S. Elev: **1034**
Driller: **B&C**	GWT at 24 hrs: **25 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
985	50			Coring Gray stained brown banded and mottled white, slightly to completely weathered, fine to medium grained, very closely to medium fractured, very soft to soft BIOTITE GNEISS	
980	55			45-49 feet - REC: 46%, RQD: 0% 49-54 feet - REC: 60%, RQD: 45%	
975	60			Gray stained brown, banded dark gray and speckled white, medium to highly weathered, fine to medium grained, very closely to widely fractured soft BIOTITE GNEISS 54-59 feet - REC: 88%, RQD: 33% 59-64 feet - REC: 98%, RQD: 62%	
970	65			Light gray and stained brown banded white, unweathered to medium weathered, fine to medium grained, very closely to widely fractured, soft BIOTITE GNEISS	
965	70			64-69 feet - REC: 98%, RQD: 53% 69-70 feet - REC: 100%, RQD: 100% Rock Coring Terminated at 70 feet	
960	75				
955	80				
950	85				
945	90				
940					

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 73+00
Tunnel Interval: 963-969
Page 2 of 2

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-18

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/6/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **22 feet**	G.S. Elev: **1023**
Driller: **B&C**	GWT at 24 hrs: **20 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1020	0			Auger Boring Only - No Sampling Preformed	
1015	5				
1010	10				
1005	15				
1000	20	▼			
995	25	▽			
990	30			Dense dark brown highly micaceous silty fine to medium sand (SM) (RESIDUUM)	44
985	35			Partially weathered rock sampled as gray micaceous silty fine to coarse sand (SM)	50/3"
980	40				50/6"
	45			Auger Refusal at 45 feet - Begin Rock	50/1"

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 75+00
Tunnel Interval: 960-966

B-18

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/6/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **22 feet**	G.S. Elev: **1023**
Driller: **B&C**	GWT at 24 hrs: **20 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
975	50			Coring Light gray and stained brown, banded white, unweathered to medium weathered fine to medium grained very closely to medium fractured soft to medium hard BIOTITE GNEISS		
970	55			45-49 feet - REC: 96%, RQD: 40% 49-54 feet - REC: 92%, RQD: 43% 54-55 feet - REC: 100%, RQD: 83% Rock Coring Terminated at 55 feet		
965	60					
960	65					
955	70					
950	75					
945	80					
940	85					
935	90					
930						

Remarks: Approximate Station: 75+00
Tunnel Interval: 960-966
Page 2 of 2

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-18 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/11/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **1005**
Driller: **B&C**	GWT at 24 hrs: **NE - Caved at 16 ft**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N	Standard Penetration Test (Blows/Foot) 0 10 20 30 40 50 60 70 80 90 100
				Auger Boring Only - No Sampling Preformed		
1000	5					
995	10					
990	15			Auger Refusal at 15 feet - Begin Rock Coring		
985	20			White speckled black, stained brown and banded, slightly to highly weathered, fine to medium grained, closely to medium fractured with jointing, hard GRANITIC GNEISS and MICA SCHIST		
980	25			15-19 feet - REC: 50%, RQD: 19% 19-24 feet - REC: 72%, RQD: 7%		
975	30			Gray to black, speckled black and white, banded white, unweathered to highly weathered, fine to medium grained, closely to widely fractured with jointing, soft to medium hard BIOTITE GNEISS and MICA SCHIST		
970	35			24-29 feet - REC: 75%, RQD: 12% 29-34 feet - REC: 97%, RQD: 77%		
965	40			Gray speckled black and white, banded white, unweathered to slightly weathered fine to medium grained closely to widely fractured with joints, soft to medium hard BIOTITE GNEISS		
960	45			34-39 feet - REC: 92%, RQD: 77% 39-40 feet - REC: 83%, RQD: 79%		
				Rock Coring Terminated at 40 feet		

Remarks: Approximate Station: 78+00
Tunnel Interval: 956-962

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-19

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/11/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **19 feet**	G.S. Elev: **997**
Driller: **B&C**	GWT at 24 hrs: **NE - Caved at 12 ft**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
995	0			Auger Boring Only - No Sampling Preformed	
990	5				
985	10			Firm brown slightly micaceous silty fine sand (SM) (RESIDUUM)	
980	15	▽		Loose tan to white silty fine sand (SM)	20
975	20			Stiff brown micaceous fine sandy silt (ML)	5
970	25				12
965	30			Boring Terminated at 30 feet	10
960	35				
955	40				
950	45				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station: 80+00
Tunnel Interval: 952-958

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-19 A

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/14/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **NE**	G.S. Elev: **980**
Driller: **B&C**	GWT at 24 hrs: **8 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
				Auger Boring Only - No Sampling Preformed	
975	5	▼			
970	10			Stiff red to brown clayey silt (ML) (RESIDUUM)	9
					19
965	15			Firm gray to tan silty fine sand (SM)	50/2
				No sample recovered	
960	20			Boring Terminated at 20 feet	
955	25				
950	30				
945	35				
940	40				
935	45				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 82+50
Tunnel Interval: 949-955

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

B-22

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main Phase IV Supplemental**		Project No: **130107.01**
Location: **Cobb County, Georgia**		Date: **11/14/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **22 feet**	G.S. Elev: **1020**
Driller: **B&C**	GWT at 24 hrs: **19 feet**	Logged By: **KS**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
				Stiff red-brown fine sandy silt (ML) (FILL)	10
1015	5			Firm orange micaceous fine sandy silt (ML) (FILL)	8
				Firm brown to black micaceous silty fine sand (SM)	17
1010	10				20
1005	15				17
		▼		Partially weathered rock sampled as dark brown highly micaceous silty fine sand (SM)	
1000	20	▽			50/6
				Very firm dark brown micaceous silty fine sand (SM)	
995	25				26
				Very dense tan to white slightly micaceous silty fine sand (SM)	
990	30			Boring Terminated at 30 feet	60
985	35				
980	40				
975	45				

Standard Penetration Test (Blows/Foot)

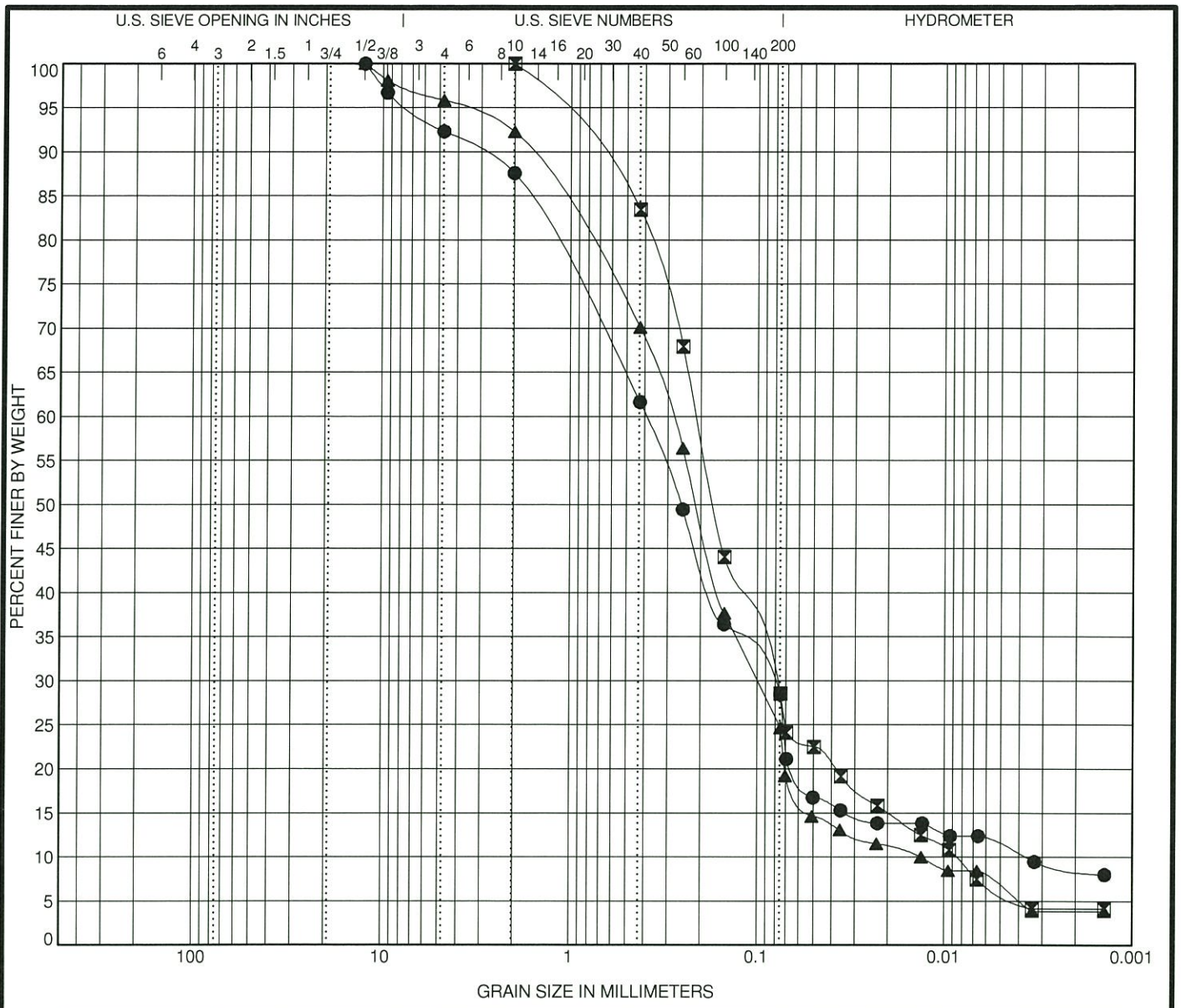
0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 52+00
Tunnel Interval: 997-1000

TEST BORING RECORD CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ GEO HYDRO.GDT 12/9/13

LABORATORY TEST RESULTS

GEO HYDRO ENGINEERS



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification			LL	PL	PI	Cc	Cu
● B-19	25.0	SILTY SAND (SM)	Sta: 80+00	Elev: 972				4.94	105.14
⊠ B-19 A	15.0	SILTY SAND (SM)	Sta: 82+50	Elev: 975				3.51	24.34
▲ B-22	25.0	SILTY SAND (SM)	Sta: 52+00	Elev: 995				2.57	21.36

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-19	25.0	12.5	0.396	0.086	0.004	7.7	63.8	17.3	11.2
⊠ B-19 A	15.0	2	0.211	0.08	0.009	0.0	71.5	22.5	6.0
▲ B-22	25.0	12.5	0.287	0.1	0.013	4.1	71.2	18.2	6.4

GEO HYDRO ENGINEERS

GRAIN SIZE DISTRIBUTION - ASTM D422

Project: Highway 41 Water Main Phase IV Supplemental

Location: Cobb County, Georgia

Number: 130107.01

US_GRAIN_SIZE_CORE LOGS HIGHWAY 41 WATER MAIN PHASE IV SUP.GPJ US_LAB.GDT 12/6/13

PHOTOS

Intact Cores

B-14

GEO HYDRO ENGINEERS

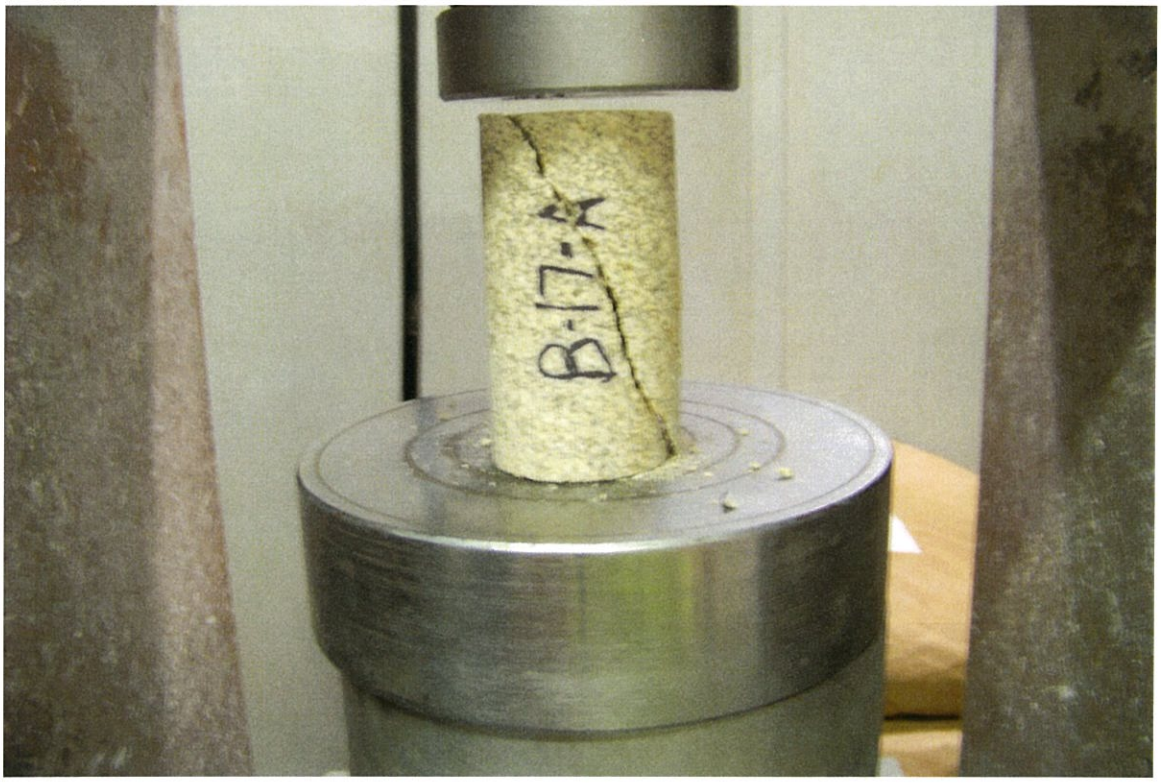
B-15A

B-16A

GEO HYDRO ENGINEERS

B-17

B-17A



GEO HYDRO ENGINEERS

B-18

GEO HYDRO ENGINEERS

GEO HYDRO ENGINEERS

Geotechnical Exploration Summary

Tunnel Section – STA 54+65
CCMWA Highway 41 Water Main – Phase IV
Cobb County, Georgia

Prepared for Atkins North America
February 18, 2015

Mr. Gilbert R. Puffer, P.E.
Atkins North America
1600 RiverEdge Parkway
Suite 6000
Atlanta, Georgia 30328

February 18, 2015

Geotechnical Exploration Summary
Tunnel Section – STA 54+65
CCMWA Highway 41 Water Main – Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.03

Dear Mr. Puffer:

Geo-Hydro Engineers, Inc. has completed the authorized supplemental subsurface exploration to obtain geotechnical data along the planned lateral tunnel at station 54+64.60 of the Highway 41 Water Main Phase IV.

The subsurface exploration consisted of two soil test borings performed at the approximate locations shown on Figure 2 included in the Appendix. Boring B-14 was performed during our initial subsurface exploration for the project, the results of which can be found in our *Report of Subsurface Exploration and Geotechnical Engineering Evaluation* (130107.00) dated May 22, 2013. Boring S-1 was performed on the northbound (east) side of U.S. Highway 41 to supplement the geotechnical data available for the lateral tunnel. The test borings were located in the field by Geo-Hydro by measuring angles and distances from existing site features. Ground surface elevations were interpolated from the tunnel plan and profile provided to us. In general, boring locations and elevations should be considered approximate. The enclosed plan shows the approximate boring locations.

Standard penetration testing, as provided for in ASTM Dl586, was performed at select intervals in the soil test borings. Soil samples obtained from the drilling operation were examined and classified in general accordance with ASTM D2488 (Visual-Manual Procedure for Description of Soils). Soil classifications include the use of the Unified Soil Classification System described in ASTM D2487 (Classification of Soils for Engineering Purposes). The soil classifications also include our evaluation of the geologic origin of the soils. Evaluations of geologic origin are based on our experience and interpretation and may be subject to some degree of error.

Descriptions of the soils encountered, groundwater conditions, standard penetration resistances, and other pertinent information are provided in the test boring records included in the Appendix.

SOIL TEST BORING SUMMARY

Starting at the ground surface, boring B-14 encountered pavement materials consisting of 6 inches of asphalt underlain by 3 inches of graded aggregate base. Boring S-1 encountered fill materials at the ground surface and extending to a depth of about 3 feet. The fill was classified as silty sand with rock fragments. A standard penetration resistance of 19 blows per foot was recorded in the fill.

Beneath pavement materials or fill materials, both borings encountered residual soils typical of the Piedmont Region. Residual soils were classified as micaceous silty sand. Standard penetration resistances recorded in the residuum ranged from 6 to 68 blows per foot.

Partially weathered rock was encountered in both borings at a depth of about 17 feet (approximate elevation 1010 in B-14 and 1008 in S-1). Partially weathered rock is locally defined as residual material with a standard penetration resistance of 100 blows per foot or greater.

Twenty-four hours after drilling completion, groundwater was encountered in boring S-1 at a depth of 18 feet, corresponding to approximate elevation of 1008. Twenty-four hours after drilling completion, groundwater was not encountered in boring B-14, but the borehole had collapsed at a depth of 14 feet, corresponding to an approximate elevation of 1013. The elevation of the borehole collapse may be indicative of a stabilized groundwater level.

For more detailed descriptions of subsurface soil conditions, please refer to the test boring records included in the Appendix.

* * * * * *

Geo-Hydro Engineers, Inc. has appreciated the opportunity to work with you on this phase of the project, and we look forward to providing any additional services you may require. If you have any questions concerning this report or any of our services, please call us.

Sincerely,

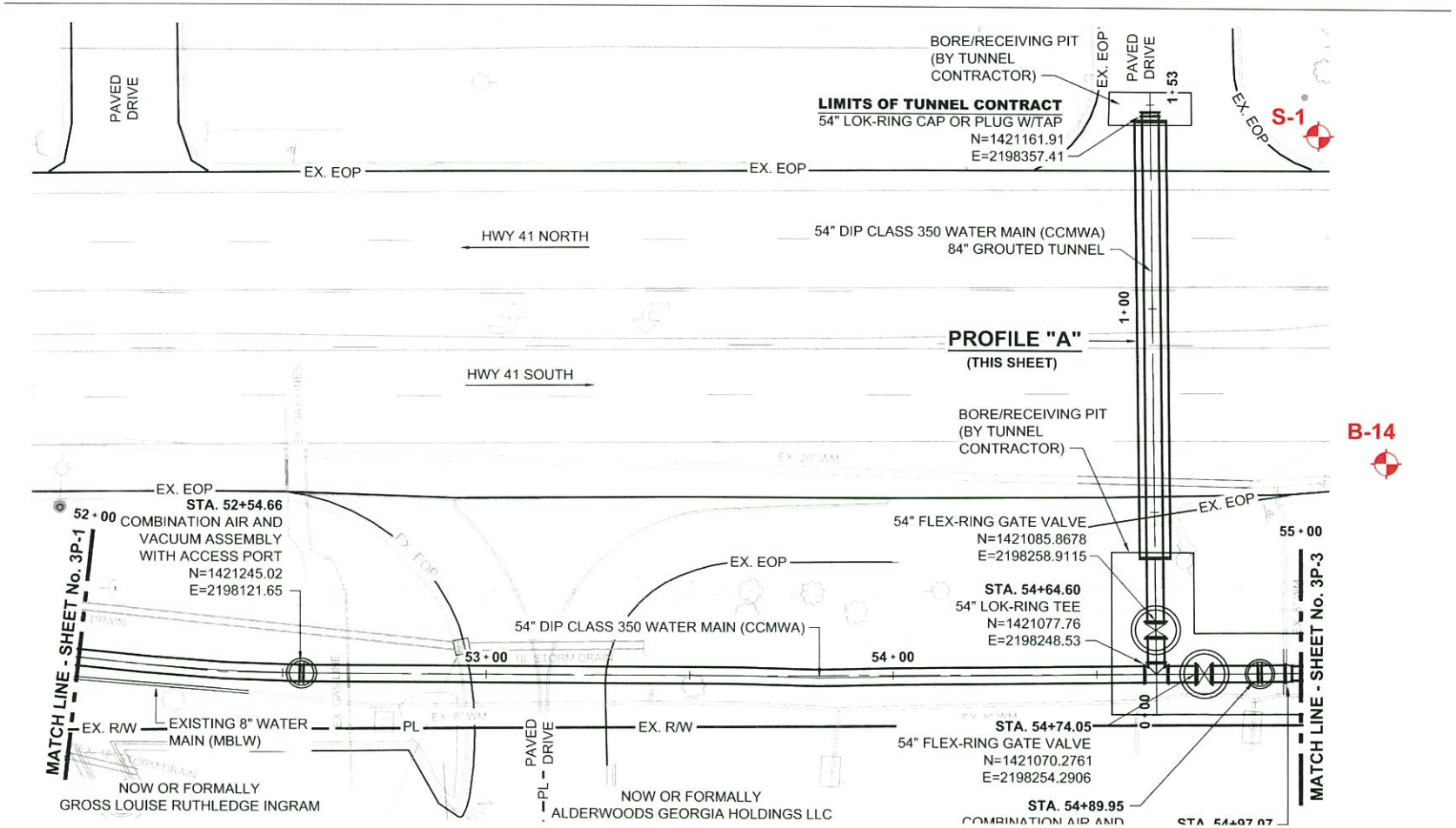
GEO-HYDRO ENGINEERS, INC.

A. Marty Peninger, P.E.
Senior Geotechnical Engineer
mpeninger@geohydro.com

Luis E. Babler, P.E.
Chief Geotechnical Engineer
luis@geohydro.com

AMP/LEB /130107.03 - U.S. Highway 41 Water Main - Phase IV - Tunnel at STA 55+00

GEO HYDRO ENGINEERS



0 20 40 80 120

Approximate Scale: 1"=40'

LEGEND: Soil Test Boring

Boring Location Plan

Tunnel Section - STA 54+65
CCMWA Highway 41 Water Main - Phase IV
Cobb County, Georgia
Geo-Hydro Project Number 130107.03

Symbols and Nomenclature

Symbols

▮	Thin-walled tube (TWT) sample recovered
▯	Thin-walled tube (TWT) sample not recovered
●	Standard penetration resistance (ASTM D1586)
50/2"	Number of blows (50) to drive the split-spoon a number of inches (2)
65%	Percentage of rock core recovered
RQD	Rock quality designation - % of recovered core sample which is 4 or more inches long
GW	Groundwater
▼	Water level at least 24 hours after drilling
▽	Water level one hour or less after drilling
ALLUV	Alluvium
TOP	Topsoil
PM	Pavement Materials
CONC	Concrete
FILL	Fill Material
RES	Residual Soil
PWR	Partially Weathered Rock
SPT	Standard Penetration Testing

Penetration Resistance Results

	Number of Blows, N	Approximate Relative Density
Sands	0-4	very loose
	5-10	loose
	11-20	firm
	21-30	very firm
	31-50	dense
	Over 50	very dense

	Number of Blows, N	Approximate Consistency
Silts and	0-1	very soft
Clays	2-4	soft
	5-8	firm
	9-15	stiff
	16-30	very stiff
	31-50	hard
	Over 50	very hard

Drilling Procedures

Soil sampling and standard penetration testing performed in accordance with ASTM D 1586. The standard penetration resistance is the number of blows of a 140-pound hammer falling 30 inches to drive a 2-inch O.D., 1.4-inch I.D. split-spoon sampler one foot. Rock coring is performed in accordance with ASTM D 2113. Thin-walled tube sampling is performed in accordance with ASTM D 1587.

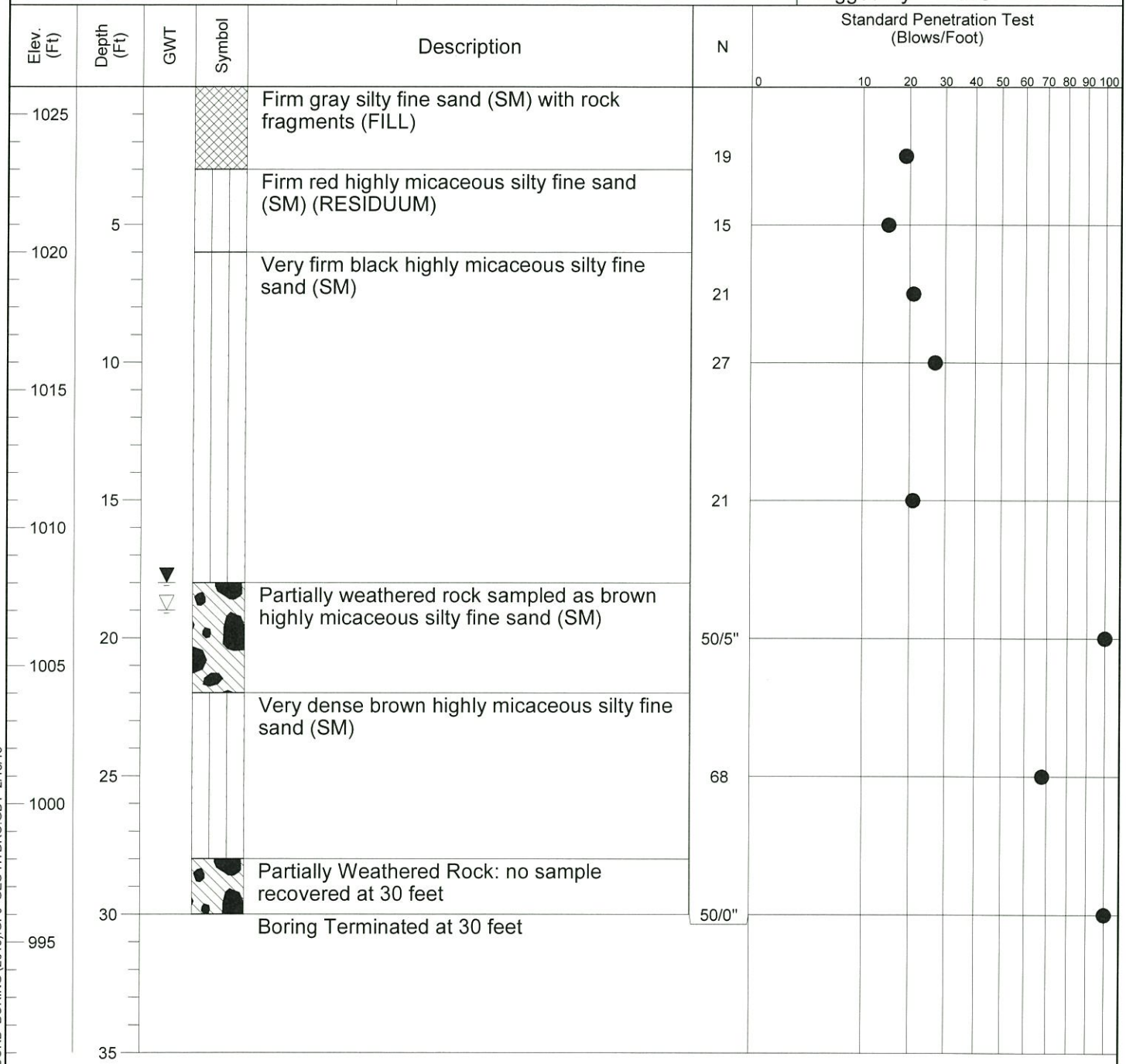
GEO HYDRO ENGINEERS

S-1

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Tunnel Section - STA 54+65**		Project No: **130107.03**
Location: **CCMWA Highway 41 Water Main - Phase IV - Cobb County, Georgia**		Date: **2/11/15**
Method: **HSA- ASTM D1586**	GWT at Drilling: **19 feet**	G.S. Elev: **1026**
Driller: **ACS**	GWT at 24 hrs: **18 feet**	Logged By: **HEG**



Remarks: Approximate Station 1+43

TEST BORING RECORD BORING (2015).GPJ GEO HYDRO.GDT 2/18/15

B-14

Test Boring Record

GEO HYDRO ENGINEERS

Project: **Highway 41 Water Main - Phase IV**		Project No: **130107**
Location: **Cobb County, Georgia**		Date: **4/2/13**
Method: **HSA- ASTM D1586**	GWT at Drilling: **Not Encountered**	G.S. Elev: **1027**
Driller: **B&C - Auto Hammer**	GWT at 24 hrs: **NE: Caved at 14 feet**	Logged By: **AMP**

Elev. (Ft)	Depth (Ft)	GWT	Symbol	Description	N
1025	0			Asphalt (Approximately 6 inches)	
				Graded Aggregate Base (Approximately 3 inches)	6
1020	5			Loose to firm red-brown to pink and black micaceous silty fine sand (SM) (RESIDUUM)	10
					9
1015	10				15
				Very firm tan and white micaceous silty fine sand (SM)	
1010	15				23
				Partially weathered rock sampled as light brown silty fine sand (SM) with rock fragments	
1005	20				50/4"
				Boring Terminated at 20 feet	
1000	25				
995	30				
990	35				
985	40				
980	45				
975	50				
970	55				
	60				

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100

Remarks: Approximate Station 55+00
Northing: 1421061.60 Easting: 2198326.42

TEST BORING RECORD HIGHWAY 41 WATER MAIN - PHASE IV.GPJ GEO HYDRO.GDT 5/22/13