Report of Subsurface Exploration
and Geotechnical Engineering Evaluation

Henry County Fire Station #8
Stockbridge, Georgia
Geo-Hydro Project Number 171088.20

Prepared for Henry County SPLOST Management
December 19, 2017
Dear Ms. Wimpey:

Geo-Hydro Engineers, Inc. has completed the authorized subsurface exploration for the above referenced project. The scope of services for this project was outlined in our bid, Bid #46-18 dated October 19, 2017.

**Project Information**

The project site is parcel #033-02031002 located on the south side of Jodeco Road between Meridian Drive and Summer Leigh Drive in Stockbridge, Georgia. Figure 1 in the Appendix shows the approximate site location.

The project site is an overgrown and partially wooded tract encompassing approximately 3 acres. In general, the terrain slopes down from the north to the south and southeast. The conceptual site plan by The Howell Group provided with the Request for Price Quotation (Bid #46-18, 10-16-2017) shows approximately 16 to 18 feet of topographic relief within the site. The site plan is excerpted below for reference.

The proposed construction consists of a single-story fire station building. We expect the building to have a structural steel and load-bearing masonry system and a concrete slab-on-grade floor. The site plan shows three parking bays for fire equipment. The rest of the building will include typical administrative, storage and living space. No structural load information is presently available, and we have assumed that the maximum column load will be no greater than 150 kips, and that the maximum wall load will be no greater than 5 kips per lineal foot.
Exploratory Procedures

The subsurface exploration consisted of ten requested soil test borings performed at the approximate requested locations shown on Figure 2 in the Appendix. The test borings were located in the field by Geo-Hydro by measuring angles and distances from existing site features. The elevations shown on the test boring records were interpolated from the topographic information contained in the site plan provided to us and were rounded to the nearest whole foot. In general, the locations and elevations of the borings should be considered approximate.

Standard penetration testing, as provided for in ASTM D1586, was performed at select intervals in the machine-drilled 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.

Regional Geology

The project site is located in the Southern Piedmont Geologic Province of Georgia. 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 that 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 that the crystalline rock has undergone. The degree of weathering is most advanced at the ground surface, where fine-grained soil may be present. Conversely, 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.

**Test Boring Summary**

Starting at the ground surface, borings B-1, B-2, B-3, B-5, B-6, and B-7 encountered topsoil ranging in thickness from about 3 to 12 inches. Topsoil thickness at the site should be expected to vary and measurements necessary for detailed quantity estimation were not performed for this report. For planning purposes, we suggest a topsoil thickness of about 10 inches.

Beneath surface materials or starting at the ground surface, all the borings encountered residual soils typical of the Piedmont region. The residual soils were generally classified as silty sand, sandy clay, sandy silt, and clayey sand with varying mica content. Standard penetration resistances in the residual soils ranged from 7 to 48 blows per foot.

Partially weathered rock sampled as silty sand was encountered in boring B-6 at a depth of approximately 58 feet. Partially weathered rock is locally defined as residual material having standard penetration resistance values greater than 100 blows per foot.

Boring B-6 encountered auger refusal at a depth of 62 feet. Auger refusal is the condition that prevents advancement of the boring using conventional soil drilling techniques. The material causing auger refusal may consist of a boulder, a lens or layer of rock, the upper surface of relatively massive rock, or other hard material.

At the time of drilling, groundwater was encountered in boring B-6 at a depth of approximately 24 feet. The rest of the borings did not encounter groundwater. The borings were backfilled with soil cuttings after the groundwater check. It should be noted that groundwater levels will fluctuate depending on yearly and seasonal rainfall variations and other factors, and may rise in the future.

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

The following evaluations and recommendations are based on the information available on the proposed construction, the data obtained from the test borings, and our experience with soils and subsurface conditions similar to those encountered at this site. Because the test borings represent a statistically small sampling of subsurface conditions, it is possible that conditions may be encountered during construction that are substantially different from those indicated by the test borings. In these instances, adjustments to the design and construction may be necessary.

#### Geotechnical Considerations

The following geotechnical characteristics of the site should be taken into account for planning and design:

- Borings B-6 encountered partially weathered rock at a depth of about 58 feet. The test borings indicate generally favorable excavation conditions within the anticipated mass excavation limits. In general, residual soils should be readily removable using conventional soil excavation equipment such as loaders and backhoes.

- Areas of poor-quality or loose cultivated soil or incidental fill material may be encountered in areas unexplored by the soil test borings. Any unstable soil identified by proofrolling or during site preparation or in foundation excavations during foundation bearing surface evaluations should be excavated and replaced with well-compacted graded aggregate base within foundation excavations and well-compacted structural fill otherwise.

- At the time of drilling, groundwater was encountered in boring B-6 at approximately 24 feet. Groundwater is not expected to be a hindrance for design or construction. Regardless of groundwater conditions, the contractor should be prepared to manage surface runoff during rain events and subsurface drainage will be necessary behind all below-grade structures including foundation walls.
Based on the results of the soil test borings, it is our opinion that the planned fire station building can be supported using conventional shallow foundations. We recommend using an allowable bearing pressure of 3,000 psf to support column loads not exceeding 150 kips and wall loads no greater than 5 kips per lineal foot.

The following sections provide recommendations regarding these issues and other geotechnical aspects of the project.

**Potential Existing Fill Materials**

Although the test borings did not encounter fill materials, it is possible that fill may be encountered in unexplored areas of the site intermediate of the test borings. There are several important facts that should be considered regarding potential existing fill materials and the limitations of subsurface exploration.

- The quality of existing fill materials can be highly variable, and test borings are often not able to detect all of the zones or layers of poor quality fill materials.
- Layers of poor quality fill materials that are less than about 2.5 to 5 feet thick may often remain undetected by soil test borings due to the discrete-interval sampling method used in this exploration.
- The interface between existing fill materials and the original ground surface may include a layer of organic material that was not properly stripped off during the original grading. Depending on its relationship to the foundation and floor slab bearing surfaces, an organic layer might adversely affect support of footings and floor slabs. If such organic layers are encountered during construction, it may be necessary to “chase out” the organic layer by excavating the layer along with overlying soils.
- The construction budget should include funds for management of poor quality existing fill materials.
- Subsurface exploration is simply not capable of disclosing all conditions that may require remediation.

**General Site Preparation**

Trees, topsoil, roots, and other deleterious materials should be removed from the proposed construction area. All existing utilities should be excavated and removed unless they are to be incorporated into the new construction. Additionally, site clearing, grubbing, and stripping should be performed only during dry weather conditions. Operation of heavy equipment on the site during wet conditions could result in excessive rutting and mixing of topsoil and debris with underlying soils. All excavations resulting from rerouting of underground utilities should be backfilled in accordance with the *Structural Fill* section of this report.

We recommend, wherever possible, that areas to receive structural fill be proofrolled prior to placement of structural fill. Areas of proposed excavation should be proofrolled after rough finished subgrade is achieved. Proofrolling should be performed with multiple passes in at least two directions using a fully loaded tandem axle dump truck weighing at least 18 tons. If low consistency soils are encountered that
cannot be adequately densified in place, such soils should be removed and replaced with well compacted fill material placed in accordance with the *Structural Fill* section of this report. Proofrolling should be observed by Geo-Hydro to determine if remedial measures are necessary.

For budgeting purposes, we suggest considering that approximately 20 percent of the aggregate building and pavement areas will require undercutting and recompaction or replacement extending to a depth of about 2½ feet below current grades or planned finished grades. The suggested stabilization approach is intended only as a tool to estimate a cost associated with ground stabilization. The need for, extent of, location, and optimal method of ground stabilization should be determined by Geo-Hydro at the time of construction based on actual site conditions. The extent and cost of ground stabilization may exceed the suggested budgetary estimate.

During site preparation, burn pits or trash pits may be encountered. On sites located in or near developed areas, this is not an unusual occurrence. All too frequently such buried material occurs in isolated areas which are not detected by the soil test borings. Any buried debris or trash found during the construction operation should be thoroughly excavated and removed from the site.

Any existing water wells encountered at the site should be filled and plugged in accordance with state law. The 1985 Georgia Water Well Standards Act requires abandoned wells to be filled, sealed, and plugged. The property owner is legally required to have abandoned wells plugged by a water well contractor licensed to practice in Georgia. Hand dug or bored wells are usually plugged by pumping a neat cement or cement-bentonite slurry into the well, filling the entire bore. Drilled, cased wells are also plugged by grouting. However, the grouting may be done only after the casing has been removed. If the annular space around the casing was grouted during the original installation and cannot physically be removed, the certified well contractor will be required to completely perforate the casing with a casing ripper prior to grouting.

If a septic system is encountered during construction, the septic system and leach fields must be removed and the resulting excavation backfilled with well compacted structural fill.

**Excavation Characteristics**

Based on the results of the test borings, difficult excavation conditions are not expected during site grading. Residual soils should be readily removable using conventional earth moving equipment such as loaders and backhoes.

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

- **Mass Rock**: Material that cannot be excavated with a single-tooth ripper drawn by a crawler tractor having a minimum draw bar pull rated at 56,000 pounds (Caterpillar D-8K or equivalent), and occupying an original volume of at least one cubic yard.

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• **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.

The foregoing definitions are based on large equipment typically utilized for mass grading. Subsequent excavations for building foundations, retaining walls, and underground utilities are often performed with smaller equipment such as rubber-tired backhoe/loaders or even mini-excavators. Contractors will often request additional payment for mobilizing larger equipment than that which was anticipated during preparation of their construction bid. The amount of additional compensation, if any, and the minimum equipment size necessary to qualify for any additional compensation should be defined before the start of construction.

**Reuse of Excavated Materials**

Based on the results of test borings and our observations, the residual soils on site should be suitable for reuse as structural fill. Any excavated fill material containing construction debris or other debris in quantities that cannot be readily removed should be considered unsuitable for reuse. Geo-Hydro should observe the excavation of existing fill materials to evaluate their suitability for reuse. Soft, unstable fill soils free of deleterious materials may be reusable after routine moisture adjustment.

It is important to establish as part of the construction contract whether soils having elevated moisture content will be considered suitable for reuse. We often find this issue to be a point of contention and a source of delays and change orders. From a technical standpoint, soils with moisture contents wet of optimum as determined by the standard Proctor test (ASTM D698) can be reused provided that the moisture is properly adjusted to within the workable range. From a practical standpoint, wet soils can be very difficult to dry in small or congested sites and such difficulties should be considered during planning and budgeting. A clear understanding by the general contractor and grading subcontractor regarding the reuse of excavated soils will be important to avoid delays and unexpected cost overruns.

**Structural Fill**

Materials selected for use as structural fill should be free of organic debris, waste construction debris, and other deleterious materials. The material should not contain rocks having a diameter 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 usually found in abundance in the Piedmont: (SM), (ML), and (CL). The following soil types are typically suitable but are not abundant in the Piedmont: (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 and classification tests should be performed on representative samples obtained from the proposed borrow material 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 below or above optimum at the time of compaction. Tighter moisture limits may be necessary with certain soils.
It is possible that highly micaceous soils could be utilized as structural fill material. The use of such materials will require very close attention to quality control of moisture content and density. Additionally, it is our experience that highly micaceous soils tend to rut under rubber-tired vehicle traffic. Continuous maintenance of areas subjected to construction traffic is typically required until construction is completed.

Highly plastic silt or clay, (MH) or (CH) soils, should be used with extreme caution. Such soils will require protection against desiccation or inundation during the construction process. Soils which have a liquid limit greater than 60 and a plasticity index greater than 35 will require blending with less plastic materials to result in lower Atterberg limits.

Suitable fill material should be placed in thin lifts. Lift thickness depends on the type of compaction equipment, but a maximum loose-lift thickness of 8 inches is generally recommended. The soil should be compacted by a self-propelled sheepsfoot roller. Within small excavations such as in utility trenches, around manholes, above foundations, or behind retaining walls, 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.

We recommend that structural fill be compacted to at least 95 percent of the standard Proctor maximum dry density (ASTM D698). The upper 12 inches of floor slab subgrade soils should be compacted to at least 98 percent of the standard Proctor maximum dry density. 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. Additionally, the maximum dry density of structural fill should be no less than 90 pcf. Geo-Hydro should perform density tests during fill placement.

**Earth Pressure**

Three earth pressure conditions are generally considered for retaining wall design: "at rest", "active", and "passive" stress conditions. Retaining walls which are rigidly restrained at the top and will be essentially unable to rotate under the action of earth pressure (such as basement or foundation walls) should be designed for "at rest" conditions. Retaining walls which can move outward at the top as much as 0.5 percent of the wall height (such as free-standing walls) should be designed for "active" conditions. For the evaluation of the resistance of soil to lateral loads the "passive" earth pressure must be calculated. It should be noted that full development of passive pressure requires deflections toward the soil mass on the order of 1.0 percent to 4.0 percent of total wall height.

Earth pressure may be evaluated using the following equation:

\[ p_h = K (D_w Z + q_s) + W_w (Z-d) \]

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 = wet unit weight of the soil backfill (depending on borrow sources). The wet 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 surcharge load (add equivalent uniform surcharge to account for construction equipment loads)

K = earth pressure coefficient as follows:

<table>
<thead>
<tr>
<th>Earth Pressure Condition</th>
<th>Coefficient</th>
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</thead>
<tbody>
<tr>
<td>At Rest (K_o)</td>
<td>0.53</td>
</tr>
<tr>
<td>Active (K_a)</td>
<td>0.36</td>
</tr>
<tr>
<td>Passive (K_p)</td>
<td>2.8</td>
</tr>
</tbody>
</table>

The groundwater term, W_w(Z-d), should be used if no drainage system is incorporated behind retaining walls. If a drainage system is included which will not allow the development of any water pressure behind the wall, then the groundwater term may be omitted. The development of excessive water pressure is a common cause of retaining wall failures. Drainage systems should be carefully designed to ensure that long term permanent drainage is accomplished.

The above design recommendations are based on the following assumptions:

- Horizontal backfill
- 95 percent standard Proctor compactive effort on backfill (ASTM D698)
- No safety factor is included

For convenience, equivalent fluid densities are frequently used for the calculation of lateral earth pressures. For "at rest" stress conditions, an equivalent fluid density of 66 pcf may be used. For the "active" state of stress an equivalent fluid density of 45 pcf may be used. These equivalent fluid densities are based on the assumptions that drainage behind the retaining wall will allow no development of hydrostatic pressure; that native sandy silts or silty sands will be used as backfill; that the backfill soils will be compacted to 95 percent of standard Proctor maximum dry density; that backfill will be horizontal; and that no surcharge loads will be applied.

For analysis of sliding resistance of the base of a retaining wall, the coefficient of friction may be taken as 0.35 for the soils at the project site. This is an ultimate value, and an adequate factor of safety should be used in design. The force which resists base sliding is calculated by multiplying the normal force on the base by the coefficient of friction. Full development of the frictional force could require deflection of the base of roughly 0.1 to 0.3 inches.

**Foundation Design**

After general site preparation and site grading have been completed in accordance with the recommendations of this report, it is our opinion that the proposed restaurant building can be supported using conventional shallow foundations. We recommend that footings be designed for an allowable soil bearing pressure of 3,000 psf. In addition, we recommend a minimum width of 24 inches for column footings and 18 inches for continuous wall footings to prevent general bearing capacity failure. Footings
should bear at a minimum depth of 18 inches below the prevailing exterior ground surface elevation to avoid potential problems due to frost heave. The above recommendation is based on an assumed maximum column load of 150 kips and assumed maximum wall load not exceeding 3 kips per lineal foot. If actual structural loads exceed these assumed maximums, please allow us the opportunity to revisit our recommendations and revise them as necessary.

The recommended allowable soil bearing pressure is based on an estimated maximum total foundation settlement no greater than approximately 1 inch, with anticipated differential settlement between adjacent columns not exceeding about ½ inch. If the architect or structural engineer determine that the estimated total or differential settlement cannot be accommodated by the proposed structure, please contact us. Foundation bearing surface evaluations should be performed in all footing excavations prior to placement of reinforcing steel. These evaluations should be performed by Geo-Hydro to confirm that the design allowable soil bearing pressure is available. Foundation bearing surface evaluations should be performed using a combination of visual observation, hand augering, and portable dynamic cone penetrometer testing (ASTM STP-399).

Remedial measures should be based on actual field conditions. However, in most cases we expect the use of the stone replacement technique to be the primary remedial measure. Stone replacement involves the removal of soft or loose soils, and replacement with well-compacted graded aggregate base (GAB) meeting Georgia Department of Transportation specifications for gradation. Stone replacement is generally performed to depths ranging from a few inches to as much as 2 times the footing width, depending on the actual conditions. For budgeting purposes, we suggest considering a contingency to treat approximately 20 percent of the foundation excavations using stone replacement extending to a depth of 3 feet below bearing elevation. The actual quantity of stone replacement will be different and may exceed the suggested estimate.

Seismic Design

Based on the results of the test borings and following the calculation procedure in the 2012 International Building Code (Chapter 20, ASCE 7-10), the Site Class for the site is D. The mapped and design spectral response accelerations are as follows: $S_S=0.169$, $S_I=0.086$, $S_{DS}=0.180$, $S_{D1}=0.137$.

Based on the information obtained from the soil test borings, it is our opinion that the potential for liquefaction of the native soils at the site due to earthquake activity is relatively low.

Shear Wave Velocity Profile Analysis (SWVPA) is a more sophisticated method to determine the seismic Site Class in accordance with IBC 2012. It is possible that a SWVPA could yield a more favorable Site Class than was obtained from standard penetration test (SPT) data. A more favorable Site Class would be advantageous for the project as that would improve the Seismic Design Category and make structural detailing more favorable, particularly if the fire station will be a Risk Category IV structure (essential facility). Another approach to improve the Seismic Design Category would be to perform a site-specific probabilistic seismic hazard analysis (PSHA). In many cases a site-specific PSHA will yield lower values of $S_S$ and $S_I$, which in turn yield more favorable derivative values and in many cases a more favorable Seismic Design Category.
**Floor Slab Subgrade Preparation**

The soil subgrade in the area of concrete slab-on-grade support is often disturbed during foundation and superstructure construction. We recommend that the floor slab subgrade be evaluated by Geo-Hydro immediately prior to beginning floor slab construction. If low consistency soils are encountered which cannot be adequately densified in place, such soils should be removed and replaced with well-compacted fill material placed in accordance with the *Structural Fill* section of this report or with well-compacted graded aggregate base (GAB).

Assuming that the top 12 inches of floor slab subgrade soils are compacted to at least 98 percent of the standard Proctor maximum dry density, we recommend that a modulus of subgrade reaction of 120 pci be used for floor slab design.

**Moisture Control for Concrete Slabs**

To prevent the capillary rise of groundwater from adversely affecting the concrete slab-on-grade floor system, we recommend that all slab-on-grade construction in areas other than the apparatus bay be underlain by a minimum 4-inch thickness of open-graded stone. Use of #57 crushed stone meeting Georgia DOT specifications for gradation is suggested. The stone should be covered by a vapor retarder consisting of polyethylene sheeting at least 10 mils thick.

The apparatus bay must be treated as a pavement area. However, a vapor retarder must be installed over the crushed stone base for the apparatus bay concrete slab. Pavement design recommendations are provided in the following sections of this report.

**Flexible Pavement Design**

Based on our experience with similar projects, assuming standard pavement design parameters, and contingent upon proper pavement subgrade preparation, we recommend the following pavement sections:

<table>
<thead>
<tr>
<th>Material</th>
<th>Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrance/Exit Driveways and Truck Traffic Areas</td>
<td></td>
</tr>
<tr>
<td>Asphaltic Concrete 12.5mm Superpave</td>
<td>2</td>
</tr>
<tr>
<td>Asphaltic Concrete 19mm Superpave</td>
<td>2</td>
</tr>
<tr>
<td>Graded Aggregate Base (GAB) (Base Course)</td>
<td>8</td>
</tr>
<tr>
<td>Subgrade compacted to at least 100% standard Proctor maximum dry density (ASTM D698)</td>
<td>12</td>
</tr>
<tr>
<td>Automobile Parking and Automobile Traffic Only</td>
<td></td>
</tr>
<tr>
<td>Asphaltic Concrete 9.5mm Superpave</td>
<td>2</td>
</tr>
<tr>
<td>Graded Aggregate Base (GAB) (Base Course)</td>
<td>6</td>
</tr>
<tr>
<td>Subgrade compacted to at least 100% standard Proctor maximum dry density (ASTM D698)</td>
<td>12</td>
</tr>
</tbody>
</table>
Similar to floor slab subgrades, pavement subgrades generally deteriorate due to constructions activities between the time of general site preparation and pavement construction. The top 12 inches of pavement subgrade soils must be compacted to at least 100 percent of the standard Proctor maximum dry density (ASTM D698). Scarification and moisture adjustment will likely be required to achieve the recommended subgrade compaction level. Allowances for pavement subgrade preparation should be considered for budgeting and scheduling.

GAB must be compacted to at least 100 percent of the modified Proctor maximum dry density (ASTM D1557).

All pavement construction should be performed in general accordance with Georgia DOT specifications. Proper subgrade compaction, adherence to Georgia DOT specifications, and compliance with project plans and specifications, will be critical to the performance of the constructed pavement.

**Concrete Pavement**

We recommend the following concrete pavement sections for this project:

<table>
<thead>
<tr>
<th><strong>Apparatus Bay and Fire Truck/Trash Truck Traffic Areas</strong></th>
<th>Material</th>
<th>Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete (min. 570 psi flexural strength at 28 days)</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Graded Aggregate Base (GAB) (Base Course)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Subgrade compacted to at least 100% standard Proctor maximum dry density (ASTM D698)</td>
<td>12</td>
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</tbody>
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<thead>
<tr>
<th><strong>Automobile Parking and Automobile Traffic Only</strong></th>
<th>Material</th>
<th>Thickness (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete (min. 570 psi flexural strength at 28 days)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Graded Aggregate Base (GAB) (Base Course)</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Subgrade compacted to at least 100% standard Proctor maximum dry density (ASTM D698)</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>

A 570-psi or greater flexural strength concrete mix with 3.5 to 5.5 percent air entrainment should be used. The flexural strength requirement is approximately equivalent to a 4,000 psi compressive strength mix. The concrete pavement should be underlain by 4 or 6 inches of compacted graded aggregate base (GAB), depending on the specific traffic area. GAB should be compacted to at least 100 percent of the modified Proctor maximum dry density (ASTM D1557). The top 12 inches of soil subgrade should be compacted to at least 100 percent of the standard Proctor maximum dry density (ASTM D698).

The concrete pavement may be designed as a “plain concrete pavement” with no reinforcing steel, or reinforcing steel may be used at joints. Construction joints and other design details should be in accordance with guidelines provided by the Portland Cement Association and the American Concrete Institute.

In general, all pavement construction should be in accordance with Georgia DOT specifications. Proper subgrade compaction, adherence to Georgia DOT specifications, and compliance with project plans and specifications are critical to the performance of the constructed pavement.
Pavement Design Limitations

The pavement sections discussed above are based on our experience with similar projects and are preliminary. After traffic information has been developed, we recommend that you allow us to review the traffic data and revise our recommendations as necessary.

Pavement Materials Testing

To aid in verifying that the pavement system is installed in general accordance with the design considerations, the following materials testing services are recommended:

- Density testing of subgrade materials.
- Proofrolling of pavement subgrade materials immediately prior to placement of graded aggregate base (GAB). This proofrolling should be performed the same day GAB is installed.
- Density testing of GAB and verification of GAB thickness. In-place density should be verified using the sand cone method (ASTM D1556).
- Coring of the pavement to verify thickness and density (asphalt pavement only). Three cores should suffice to evaluate the finished pavement.
- Preparation and testing of beams and cylinders for flexural and compressive strength testing (Portland cement concrete only). The total number of test specimens required will depend on the number of concrete placement events necessary to construct the pavement.

* * * * *

We appreciate the opportunity to serve as your geotechnical consultant for this project, and are prepared to provide 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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KRD/LEB/171088.20 - Henry County Fire Station #8 - Geotechnical Report KD leb
APPENDIX
Figure 1: Site Location Plan

Henry County Fire Station #8
Stockbridge, Georgia
Geo-Hydro Project Number 171088.20
Figure 2: Boring Location Plan

Henry County Fire Station #8
Stockbridge, Georgia
Geo-Hydro Project Number 171088.20
Symbols and Nomenclature

Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>▐</td>
<td>Thin-walled tube (TWT) sample recovered</td>
</tr>
<tr>
<td>▣</td>
<td>Thin-walled tube (TWT) sample not recovered</td>
</tr>
<tr>
<td>●</td>
<td>Standard penetration resistance (ASTM D1586)</td>
</tr>
<tr>
<td>50/2”</td>
<td>Number of blows (50) to drive the split-spoon a number of inches (2)</td>
</tr>
<tr>
<td>65%</td>
<td>Percentage of rock core recovered</td>
</tr>
<tr>
<td>RQD</td>
<td>Rock quality designation - % of recovered core sample which is 4 or more inches long</td>
</tr>
<tr>
<td>GW</td>
<td>Groundwater</td>
</tr>
<tr>
<td>▼</td>
<td>Water level at least 24 hours after drilling</td>
</tr>
<tr>
<td>▼</td>
<td>Water level one hour or less after drilling</td>
</tr>
<tr>
<td>ALLUV</td>
<td>Alluvium</td>
</tr>
<tr>
<td>TOP</td>
<td>Topsoil</td>
</tr>
<tr>
<td>PM</td>
<td>Pavement Materials</td>
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<tr>
<td>CONC</td>
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<tr>
<td>FILL</td>
<td>Fill Material</td>
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<tr>
<td>RES</td>
<td>Residual Soil</td>
</tr>
<tr>
<td>PWR</td>
<td>Partially Weathered Rock</td>
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<tr>
<td>SPT</td>
<td>Standard Penetration Testing</td>
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Penetration Resistance Results

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<tr>
<th>Number of Blows, N</th>
<th>Approximate Relative Density</th>
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<tr>
<td>Sands</td>
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<tr>
<td>0-4</td>
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</tr>
<tr>
<td>5-10</td>
<td>loose</td>
</tr>
<tr>
<td>11-20</td>
<td>firm</td>
</tr>
<tr>
<td>21-30</td>
<td>very firm</td>
</tr>
<tr>
<td>31-50</td>
<td>dense</td>
</tr>
<tr>
<td>Over 50</td>
<td>very dense</td>
</tr>
<tr>
<td>Silts and Clays</td>
<td>Approximate Consistency</td>
</tr>
<tr>
<td>0-1</td>
<td>very soft</td>
</tr>
<tr>
<td>2-4</td>
<td>soft</td>
</tr>
<tr>
<td>5-8</td>
<td>firm</td>
</tr>
<tr>
<td>9-15</td>
<td>stiff</td>
</tr>
<tr>
<td>16-30</td>
<td>very stiff</td>
</tr>
<tr>
<td>31-50</td>
<td>hard</td>
</tr>
<tr>
<td>Over 50</td>
<td>very hard</td>
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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.
Topsoil (Approximately 3 inches) Firm to stiff red-brown fine to medium sandy clay (CH) (RESIDUUM)

Boring Terminated at 7 feet

Test Boring Record

Project: Henry County Fire Station #8
Location: Stockbridge, Georgia
Method: HSA- ASTM D1586
Driller: SD (Rope and Cathead)

GWT at Drilling: Not Encountered
G.S. Elev: 810
GWT at 24 hrs: N/A: Boring Backfilled
Logged By: KRD

Remarks:
Standard Penetration Test (Blows/Foot)

<table>
<thead>
<tr>
<th>Elev. (ft)</th>
<th>Depth (ft)</th>
<th>GWT</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>805</td>
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<td></td>
<td>Topsoil (Approximately 3 inches) Firm to stiff red-brown fine to medium sandy clay (CH) (RESIDUUM)</td>
</tr>
<tr>
<td>800</td>
<td>5</td>
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<tr>
<td>795</td>
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Date: 11/29/17
**Test Boring Record**

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA- ASTM D1586  
**Driller:** SD (Rope and Cathead)  
**Date:** 11/29/17  
**G.W.T. at Drilling:** Not Encountered  
**G.W.T. at 24 hrs:** N/A: Boring Backfilled  
**G.S. Elev:** 805  
**Logged By:** KRD

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<th>Description</th>
<th>N</th>
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<td>765</td>
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<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td>Stiff to very stiff red-brown fine to medium sandy clay (CH) (RESIDUUM)</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td></td>
<td></td>
<td>Boring Terminated at 7 feet</td>
<td>16</td>
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<tr>
<td></td>
<td>0</td>
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<td></td>
<td>19</td>
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**Remarks:**

Standard Penetration Test (Blows/foot)
B-3 Test Boring Record

Project: Henry County Fire Station #8
Location: Stockbridge, Georgia
Method: HSA- ASTM D1586
Driller: SD (Rope and Cathead)
Date: 11/29/17
G.W.T. at Drilling: Not Encountered
G.W.T. at 24 hrs: N/A: Boring Backfilled
G.S. Elev: 750
Logged By: KRD

Elev. (Ft) | Depth (Ft) | GWT | Symbol | Description | N
-- | -- | -- | -- | -- | --
790 | 5 | | | Topsoil (Approximately 3 inches) | 
790 | | | | Stiff red-brown fine to coarse sandy clay (CL) (RESIDUUM) | 10
790 | | | | Very stiff to hard red-brown fine to medium sandy clay (CH) | 34
790 | | | | Boring Terminated at 7 feet | 28

Remarks: Standard Penetration Test (Blows/Foot)
### Test Boring Record

<table>
<thead>
<tr>
<th>Elev. (Ft)</th>
<th>Depth (Ft)</th>
<th>GWT</th>
<th>Symbol</th>
<th>Description</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>795</td>
<td>0</td>
<td></td>
<td></td>
<td>Very stiff tan and red-brown fine sandy clay (CL) (RESIDUUM)</td>
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<tr>
<td>790</td>
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<td>Very firm tan silty fine sand (SM)</td>
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</table>

Boring Terminated at 7 feet

**Remarks:**

- Standard Penetration Test (Blows/Foot)

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA- ASTM D1586  
**GWT at Drilling:** Not Encountered  
**G.S. Elev:** 797  
**Driller:** SD (Rope and Cathead)  
**GWT at 24 hrs:** N/A: Boring Backfilled  
**Logged By:** KRD  
**Date:** 11/29/17  
**Project No:** 171088.20  
**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA- ASTM D1586  
**GWT at Drilling:** Not Encountered  
**G.S. Elev:** 797  
**Driller:** SD (Rope and Cathead)  
**GWT at 24 hrs:** N/A: Boring Backfilled  
**Logged By:** KRD  
**Date:** 11/29/17  
**Project No:** 171088.20
**B-5 Test Boring Record**

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
**Date:** 11/29/17  
**Logged By:** KRD

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<tbody>
<tr>
<td>800</td>
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<td>Topsoil (Approximately 12 inches)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Stiff red-brown fine to medium sandy clay (CH) (RESIDUUM)</td>
</tr>
<tr>
<td></td>
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<td>Very stiff red-brown and tan fine sandy silt (ML)</td>
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<tr>
<td>795</td>
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<td>Firm gray and tan silty fine sand (SM)</td>
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<tr>
<td></td>
<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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</tbody>
</table>

**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
**Date:** 11/29/17  
**Logged By:** KRD

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<td></td>
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</tr>
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<td></td>
<td>Very stiff red-brown and tan fine sandy silt (ML)</td>
</tr>
<tr>
<td>795</td>
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<td>Firm gray and tan silty fine sand (SM)</td>
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<tr>
<td></td>
<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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</tbody>
</table>

**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
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<td></td>
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<td></td>
<td></td>
<td>Very stiff red-brown and tan fine sandy silt (ML)</td>
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<tr>
<td>795</td>
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<td>Firm gray and tan silty fine sand (SM)</td>
</tr>
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<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
**Date:** 11/29/17  
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<td>Firm gray and tan silty fine sand (SM)</td>
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<tr>
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<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
**Date:** 11/29/17  
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<td>Firm gray and tan silty fine sand (SM)</td>
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<td></td>
<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
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<td>Firm gray and tan silty fine sand (SM)</td>
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<td>15</td>
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<td>Boring Terminated at 15 feet</td>
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**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA - ASTM D1586  
**Date:** 11/29/17  
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<td>Firm gray and tan silty fine sand (SM)</td>
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<td>Boring Terminated at 15 feet</td>
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</tbody>
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**Remarks:**

- Standard Penetration Test (Blows/Foot)
  - 13  
  - 29  
  - 19  

**G.W.T. at Drilling:** Not Encountered

**G.W.T. at 24 hrs:** N/A: Boring Backfilled

**G.S. Elev:** 801

**Project No.:** 171088.20
## Test Boring Record

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA- ASTM D1586  
**Driller:** SD (Rope and Cathead)

- **GWT at Drilling:** 24 feet
- **G.W.T. at 24 hrs:** N/A: Boring Backfilled
- **G.S. Elev:** 805
- **Date:** 11/29/17
- **Logged By:** KRD

### Description

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<thead>
<tr>
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<th>Depth (Ft)</th>
<th>GWT</th>
<th>Symbol</th>
<th>Description</th>
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<td>770</td>
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</tr>
<tr>
<td>800</td>
<td>5</td>
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- **Topsoil (Approximately 3 inches)**
- **Loose dark brown clayey fine sand (SC) (RESIDUUM)**
- **Very stiff red-brown fine to medium sandy clay (CL)**
- **Stiff red-brown and tan fine to coarse sandy silt (ML)**
- **Firm gray and dark gray slightly micaceous silty fine to coarse sand (SM)**
- **Very firm to dense gray and dark gray slightly micaceous silty fine to coarse sand (SM)**

### Remarks

Page 1 of 2
**Test Boring Record**

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Method:** HSA- ASTM D1586  
**Driller:** SD (Rope and Cathead)

<table>
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<th>GWT</th>
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<td>730</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>725</td>
<td>80</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Very firm to dense gray and dark gray slightly micaceous silty fine to coarse sand (SM)

Partially weathered rock sampled as gray and dark gray slightly micaceous silty fine to coarse sand (SM)

Auger Refusal at 62 feet

**Remarks:** Page 2 of 2
Test Boring Record

Project: Henry County Fire Station #8
Location: Stockbridge, Georgia
Method: HSA- ASTM D1586
GWT at Drilling: Not Encountered
G.S. Elev: 805
Driller: SD (Rope and Cathead)
GWT at 24 hrs: N/A: Boring Backfilled
Logged By: KRD

Date: 11/29/17

<table>
<thead>
<tr>
<th>Elev. (Ft)</th>
<th>Depth (Ft)</th>
<th>GWT</th>
<th>Symbol</th>
<th>Description</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>15</td>
<td></td>
<td></td>
<td>Topsoil (Approximately 12 inches)</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
<td>Firm red-brown fine sandy clay (CH) (RESIDUUM)</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
<td>Very stiff red-brown fine sandy clay (CL)</td>
<td>27</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
<td>Very stiff red-brown fine sandy silt (ML)</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>10</td>
<td></td>
<td></td>
<td>Firm red-brown and gray micaceous silty fine sand (SM)</td>
<td>11</td>
</tr>
</tbody>
</table>

Boring Terminated at 15 feet

Remarks:

Standard Penetration Test (Blows/Foot)

0 10 20 30 40 50 60 70 80 90 100
Test Boring Record

Project: Henry County Fire Station #8  Project No: 171088.20
Location: Stockbridge, Georgia  Date: 11/29/17
Method: HSA- ASTM D1586  GWT at Drilling: Not Encountered  G.S. Elev: 803
Driller: SD (Rope and Cathead)  GWT at 24 hrs: N/A: Boring Backfilled  Logged By: KRD

Elev. (Ft)  Depth (Ft)  GWT  Symbol  Description

-800  -800  -800
5  5  5  N
Dense tan and red-brown silty fine sand (SM) (RESIDUUM)

795  795  795
10  10  10
N
Very stiff red-brown and tan fine sandy silt (ML)

790  790  790
15  15  15
N
Stiff red-brown micaceous silty fine sand (SM)

785  785  785
15
Firm gray silty fine sand (SM)

Boring Terminated at 15 feet

Remarks: Standard Penetration Test (Blows/Foot)

N

0  0
10  20  30  40  50  60  70  80  90  100


G.W.T. at drilling: Not Encountered
G.W.T. at 24 hrs: N/A: Boring Backfilled
Logged By: KRD

Method: HSA- ASTM D1586

Remarks:

Standard Penetration Test (Blows/Foot)
## Test Boring Record

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia

<table>
<thead>
<tr>
<th>Depth (Ft)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>795</td>
<td>Orange-brown slightly micaceous silty fine sand (SM) (RESIDUUM)</td>
</tr>
<tr>
<td>775</td>
<td>Boring Terminated at 7 feet</td>
</tr>
</tbody>
</table>

**Method:** HSA- ASTM D1586  
**GWT at Drilling:** Not Encountered  
**G.S. Elev:** 799  
**Driller:** SD (Rope and Cathead)  
**GWT at 24 hrs:** N/A: Boring Backfilled  
**Logged By:** KRD

**Remarks:**

- Standard Penetration Test (Blows/Foot)
**Test Boring Record**

**Project:** Henry County Fire Station #8  
**Location:** Stockbridge, Georgia  
**Project No:** 171088.20  
**Date:** 11/29/17  
**Method:** HSA- ASTM D1586  
**GWT at Drilling:** Not Encountered  
**G.S. Elev:** 805  
**Driller:** SD (Rope and Cathead)  
**GWT at 24 hrs:** N/A: Boring Backfilled  
**Logged By:** KRD

<table>
<thead>
<tr>
<th>Elev. (Ft)</th>
<th>Depth (Ft)</th>
<th>GWT</th>
<th>Symbol</th>
<th>Description</th>
<th>N</th>
<th>Standard Penetration Test (Blows/Foot)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>Orange-brown slightly micaceous silty fine sand (SM) with clay (RESIDUUM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
<td></td>
<td>Orange-brown slightly micaceous silty fine sand (SM)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td></td>
<td>Boring Terminated at 7 feet</td>
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<td></td>
</tr>
</tbody>
</table>

**Remarks:**

**Test Boring Record BORING LOGS.GPJ GEO HYDRO.GDT 12/19/17**