Revised Geotechnical Engineering Report

Proposed Denver BMW
Northeast of South Colorado Boulevard and East Mississippi Avenue
Glendale, Colorado
June 15, 2015
Terracon Project No. 25145052A

Prepared for:
Sonic Automotive, Inc.
Charlotte, North Carolina

Prepared by:
Terracon Consultants, Inc.
Wheat Ridge, Colorado
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June 15, 2015

Sonic Automotive, Inc.
4401 Colwick Road
Charlotte, North Carolina  28211

Attn: c/o Charles Garcia, P.E.

Re: Revised Geotechnical Engineering Report
    Proposed Denver BMW
    Northeast of South Colorado Boulevard and East Mississippi Avenue
    Glendale, Colorado
    Terracon Project No: 25145052A

Mr. Garcia:

Terracon Consultants, Inc. (Terracon) has completed the geotechnical engineering exploration for the above referenced project. This study was performed in general accordance with our Proposal No. P25140385R dated October 30, 2014 and the Supplement to Agreement for Services, dated April 13, 2015. This report presents the findings of the subsurface exploration and provides geotechnical recommendations concerning earthwork and the design and construction of foundation, floor slab and pavement recommendations for the proposed project. Results of the Denver Collision Center project are presented under separate cover (Terracon Project No. 25145052B)

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

TERRACON CONSULTANTS, INC.

Scott B. Myers, P.E.
Geotechnical Department Manager

William D. Rethamel, P.E.
Senior Project Engineer

cc: Addressee (4 hard copies and PDF) 1 - File
EXECUTIVE SUMMARY

A geotechnical engineering exploration has been performed for the proposed Denver BMW to be located northeast of the intersection of South Colorado Boulevard and East Mississippi Avenue in Glendale, Colorado. Based on the information obtained from our subsurface exploration and the laboratory testing completed, the site appears suitable for the proposed construction; however, the following geotechnical conditions will need to be considered:

- Up to about 16-1/2 feet of fill materials was encountered in the borings drilled for this exploration. It is our opinion the existing fill should not be used to support foundation and interior slab construction without complete removal and modification. All existing fill below the proposed building should be overexcavated, processed, moisture conditioned and compacted back to footing and interior slab-on-grade elevations. Existing fill below exterior slabs-on-grade and pavements should be overexcavated to a depth of 2 feet, processed, moisture conditioned and compacted back to subgrade elevation.

- Based on the geotechnical engineering analyses, subsurface exploration and laboratory test results, the proposed building may be constructed on a spread footing foundation system bottomed on native soils or new engineered fill.

- Slabs-on-grade may be utilized for the interior floor system when constructed on native soils or new engineered fill.

- The 2009 International Building Code, Table 1613.5.2 IBC seismic site classification for this site is C.

- It has been our experience that portions of subgrade materials below existing pavements/hardscape will likely be relatively moist to nearly saturated and yielding to unstable. This phenomenon is most likely due to moisture collecting in the subgrade through cracks or seams in the pavements/hardscape and not drying due to the presence of the pavements/hardscape.

- Low strength soils may be locally present on the site. Consequently, low strength soils could be encountered below slabs-on-grade and/or at foundation bearing depth and these conditions will likely require some corrective work. Corrective work could involve removal and re-compaction/replacement, in-place soil densification or deepening footing excavations to suitable bearing materials.

- The amount of movement associated with foundations, floor slabs, slabs-on-grade, etc. will be related to the wetting of the underlying soils. Therefore, it is imperative the recommendations outlined in the “Grading and Drainage” section of this report be followed to reduce potential movement. Moisture conditioning and/or replacement of the
on-site fill materials and/or native soils should follow the recommendations outlined in the “Earthwork” section of this report.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and this report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled GENERAL COMMENTS should be read for an understanding of the report limitations.
1.0 INTRODUCTION

A geotechnical engineering report has been completed for the proposed Denver BMW to be located northeast of the intersection of South Colorado Boulevard and East Mississippi Avenue in Glendale, Colorado.

As part of our subsurface exploration, twenty-four (24) borings (designated as Boring Nos. 1 to 24) were drilled at the site to varying depths of about 40 to 50 feet below the existing grade. The Boring Logs and the Boring Location Plan are included in Appendix A of this report.

The purpose of these services is to provide information and geotechnical engineering recommendations relative to:

- Subsurface soil and bedrock conditions
- Groundwater levels
- Earthwork
- Foundation design and construction
- Floor slab design and construction
- Seismic considerations
- Grading and drainage
- Pavement design and construction

This geotechnical report was revised to reflect the current site plan and the subsurface conditions encountered in seven (7) additional borings (designated as Boring Nos. 18 to 24). In addition, this report presents laboratory data performed on samples from the additional borings.

This geotechnical report was revised in June 2015 based on the conference call on May 3, 2015. Based on the conference call on May 3, 2015, we understand the owner is willing to accept 1 inch of total foundation and slab-on-grade movement and ½ to ¾ inch differential foundation movement. In addition, we understand the owner is willing to accept a greater risk of movement for exterior slabs-on-grade and pavements.
2.0 PROJECT INFORMATION

2.1 Project Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site layout</td>
<td>See Appendix A, Exhibit A-2, Boring Location Plan</td>
</tr>
<tr>
<td><strong>Proposed construction</strong></td>
<td>We understand the proposed project will consist of the construction of two commercial buildings. The larger of the proposed buildings will be about 55,000 square feet in size and will be one-story in height. The smaller of the two buildings will be about 4,500 square feet in size and will be one-story in height.</td>
</tr>
<tr>
<td>A future parking garage may be constructed and attached to the eastern portion of the proposed building. We anticipate the proposed parking garage will be two-stories in height.</td>
<td></td>
</tr>
<tr>
<td>Prior to construction, we understand two existing buildings and a portion of the third building within the new building footprint will be demolished and removed.</td>
<td></td>
</tr>
<tr>
<td>Building construction</td>
<td>We anticipate that the proposed buildings will utilized structural steel construction with spread footing or drilled pier foundation systems. We anticipate the future garage will be of cast-in-place concrete with a drilled pier foundation system.</td>
</tr>
<tr>
<td>Anticipated foundation systems</td>
<td>Shallow spread footings or drilled piers</td>
</tr>
<tr>
<td>Below grade areas</td>
<td>None anticipated</td>
</tr>
</tbody>
</table>
| **Maximum allowable foundation movement** | Total: 1 inch (provided)  
Differential: ½ to ¾ inch (provided)                                                                                                                   |
| **Maximum allowable interior slab-on-grade movement** | 1 inch (provided)                                                                                                                                                                                           |
| Maximum loads                       | Columns: 50 to 1,000 kips (assumed)  
Walls: 4 to 7 klf (assumed)  
Slabs: 200 psf (assumed)                                                                                                                                  |
| Excavation depth                    | 15 feet (assumed)                                                                                                                                                                                             |
| Free-standing retaining walls       | We anticipate retaining walls will be constructed adjacent to the below grade portion of the building.                                                                                                   |
| Grading                             | We assume site work cut and fill depths will be on the order of less than 2 feet.                                                                                                                         |
| Infrastructure                      | We anticipate asphalt or portland cement concrete paved parking areas and drives, along with the installation of utilities within about 5 feet of finished site grades.                                      |
2.2 Site Location and Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>The proposed Denver BMW will be located northeast of the intersection of South Colorado Boulevard and East Mississippi Avenue in Glendale, Colorado. The general location of the proposed project is 39.6976° N 104.9401° W.</td>
</tr>
<tr>
<td>Existing improvements</td>
<td>Six existing buildings are currently present on the overall subject site. The existing buildings generally consist of single-story buildings. The existing buildings do not appear to have basements. The foundations for the existing buildings are unknown at this time; however, we anticipate the existing buildings are supported on shallow spread footing foundation systems.</td>
</tr>
<tr>
<td>Current ground cover</td>
<td>The existing parking surfaces generally consist of asphalt pavement with some areas of concrete pavement.</td>
</tr>
<tr>
<td>Existing topography</td>
<td>The area of the proposed Denver BMW is currently occupied by three buildings and asphalt parking areas.</td>
</tr>
<tr>
<td>Item</td>
<td>Ground cover in the area of the proposed project consists of asphalt pavements.</td>
</tr>
<tr>
<td>Item</td>
<td>The site appears to be generally level with an elevation difference of less than 3 feet.</td>
</tr>
</tbody>
</table>

3.0 SUBSURFACE CONDITIONS

3.1 Geology

Surficial geologic conditions at the site, as mapped by the U.S. Geological Survey (USGS) (Shroba, 1980), consist of Loess of Pleistocene Age. These materials, as mapped in this area, are generally less than 26 feet thick and frequently less than 15 feet thick.

Bedrock underlying the surface units consists of the Denver Formation of Paleocene and Upper Cretaceous Age. This formation within this area has been reported to include silty claystone and sandy siltstone, interbedded within lenticular beds of tuffaceous sandstone and pebble conglomerate. The finer-grained units within the formation contain montmorillonitic clays that

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produce low to very high swelling pressures when moisture content is elevated. The thickness of this unit has been reported to be on the order of 300 to 900 feet.

Due to the flat nature of the site, geologic hazards at the site are anticipated to be low. Seismic activity in the area is anticipated to be low, and the property should be relatively stable from a structural standpoint. With proper site grading around the proposed structure, erosional problems at the site should be reduced.

Mapping completed by the Colorado Geological Survey (Hart, 1972) indicates the site is located in an area of "High Swell Potential". Potentially expansive materials mapped in this area include bedrock, weathered bedrock and colluvium (surficial units).

The geologic conditions presented in this section were obtained by locating the subject site on available large-scale geologic maps. Due to the scales involved, precise location of the site can be difficult to determine. In addition, the large-scale geologic maps describe only general trends. Local variations are possible and site specific geology may differ from those described above. A site-specific detailed geologic description is beyond the scope of this project.

3.2 Typical Profile

Based on the results of the boring, subsurface conditions encountered on the project site can be generalized as follows:

<table>
<thead>
<tr>
<th>Material Description</th>
<th>Approximate Depth to Bottom of Stratum below Existing Site Grade</th>
<th>Density / Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt or concrete</td>
<td>About 1-1/2 to 6 inches</td>
<td>N/A</td>
</tr>
<tr>
<td>Fill consisting of sand with varying amounts of clay and gravel or lean clay with varying amounts of sand, gravel and brick fragments</td>
<td>About 2 to 16-1/2 feet</td>
<td>Sand: very loose to medium dense Clay: medium stiff</td>
</tr>
<tr>
<td>Native soils consisting of sand with varying amounts of silt and clay</td>
<td>About 11 to 33 feet, Not encountered in Boring Nos. 16, 18, 19, 20, 23 and 24</td>
<td>Very loose to loose</td>
</tr>
<tr>
<td>Native soils consisting of lean clay with varying amounts of sand and silt</td>
<td>About 17 to 27 feet, Not encountered in Boring Nos. 1,3 and 16</td>
<td>Clay: medium stiff to very stiff Silt: medium dense</td>
</tr>
</tbody>
</table>

Material Description | Approximate Depth to Bottom of Stratum below Existing Site Grade | Density / Consistency
--- | --- | ---
Bedrock consisting of claystone and sandstone | About 50 feet, Maximum depth explored | Firm to very hard

Subsurface conditions encountered at the boring locations are indicated on the individual Boring Logs attached in Appendix A. Stratification boundaries indicated on the Boring Logs represent the approximate depths of changes in material and soil type, the transition between materials may be gradual. Our interpretation of bedrock surface elevation is presented in Exhibit A-3.

Laboratory testing indicates the clay fill materials and native clay soils have a non- to low expansion potential. The sand fill materials, native sand soils and sandstone bedrock are considered to have a non to low expansion potential. Based on our experience the claystone bedrock is considered to have a low to high expansion potential. The tested samples have the following physical and engineering properties:

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>Fines Content (%)</th>
<th>Liquid Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Expansion/Consolidation (%)¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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<td>+0.1</td>
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<td>14</td>
<td>NV²</td>
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<tr>
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</table>
### Revised Geotechnical Engineering Report

**Proposed Denver BMW ■ Glendale, Colorado**

**June 15, 2015 ■ Terracon Project No. 25145052A**

<table>
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<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>Fines Content (%)</th>
<th>Liquid Limit (%)</th>
<th>Plasticity Index (%)</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Expansion/Consolidation (%)(^1)</th>
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<td>7832</td>
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</tr>
</tbody>
</table>

\(^1\) Expansion/consolidation testing was performed under a 500 psf surcharge load

\(^2\) NV – No value; NP – Non-plastic

Results of water soluble sulfate testing performed on samples of the on-site soils indicated negligible values of less than 1 mg/l. A summary of the laboratory test results is included in Appendix B.

### 3.3 Groundwater

The borings were observed while drilling and one day after drilling for the presence and level of groundwater. The groundwater levels are noted on the Boring Logs included in Appendix A, and are summarized below.
Based on our field exploration and groundwater elevations measured after drilling, it is our opinion the groundwater encountered is a perched groundwater condition. These observations represent groundwater conditions at the time of the field exploration, and may not be indicative of other times or at other locations. Groundwater levels can be expected to fluctuate with varying seasonal and weather conditions, and other factors.

* Due to safety concerns, borings were backfilled immediately after obtaining initial groundwater measurements.
Based upon review of USGS maps, (Hillier, et al, 1983), regional groundwater beneath the project area is located in the Denver Aquifer, generally below a depth of 20 feet, and commonly more than a depth of 100 feet below present ground surface. Locally, shallow groundwater can be found along stream valleys and colluvial deposits.

Zones of perched and/or trapped groundwater may also occur at times in the subsurface soils overlying bedrock, on top of the bedrock surface or within permeable fractures in the bedrock materials. The location and amount of perched water is dependent upon several factors, including hydrologic conditions, type of site development, irrigation demands on or adjacent to the site, fluctuations in water features, seasonal and weather conditions.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on subsurface conditions encountered in the borings, the site appears suitable for the proposed construction from a geotechnical point of view provided certain precautions and design and construction recommendations outlined in this report are followed. We have identified geotechnical conditions that could impact design and construction of the proposed structure and other site improvements.

4.1.1 Existing Fill

Up to about 16-1/2 feet of fill materials was encountered in portions of the site. It should be noted that fill depths presented in the boring logs are approximate and the depth and composition of fill should be expected to vary. We do not possess any information regarding whether the fill was placed under the observation of a geotechnical engineer.

Based upon the results of our field exploration and laboratory testing, it is our opinion the existing fill should not be used to support foundations, interior slabs, exterior slabs-on-grade or pavement construction without complete removal and modification.

It should be noted that there exists the potential for construction debris and/or domestic trash to be encountered within the fill on some portions of the site. Since construction debris was not

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encountered within the borings, the potential for encountering construction debris and/or domestic trash is considered to be low. This should be verified by additional geotechnical exploration or evaluation at the site. If additional exploration is not performed, the owner should make allowances for such conditions to exist in the preparation of the project budget and/or construction plans.

The existing fill can be reused as engineered fill below foundations, slabs-on-grade and pavements, provided any deleterious materials are removed and some movement can be tolerated. Some removal and replacement may be required if unsuitable or soft materials are exposed.

4.1.2 Expansive Soils and Bedrock Materials

Laboratory testing indicates the clay fill materials and native clay soils have a non- to low expansion potential. The sand fill materials, native sand soils and sandstone bedrock are considered to have a non to low expansion potential. Based on our experience the claystone bedrock is considered to have a low to high expansion potential.

This report provides recommendations to help mitigate the effects of soil shrinkage and expansion. However, even if these procedures are followed, some movement and cracking in the building, pavements, and flatwork should be anticipated. The severity of cracking and other damage such as uneven floor slabs will probably increase if any modification of the site results in excessive wetting or drying of the expansive clays and claystone. Eliminating the risk of movement and distress is generally not be feasible, but it may be possible to further reduce the risk of movement if significantly more expensive measures are used during construction. It is imperative the recommendations outlined in the “Grading and Drainage” section of this report be followed to reduce movement.

4.1.3 Low Strength Soils

Test boring data and our experience in the area indicate that low strength soils may be locally present. Consequently, low strength soils could be encountered below on grade slabs and/or at foundation bearing depth and these conditions will likely require some corrective work. Corrective work could involve removal and re-compaction/replacement, in-place soil densification or deepening footing excavations to suitable bearing materials. In any event, Terracon should be contacted to observe foundation excavations to evaluate bearing conditions and to provide guidance concerning corrective work (if needed).

4.1.4 Existing Structures

We understand two of the existing buildings and a portion of a third building along with existing pavements on the site will be demolished and removed. Demolition of the existing buildings should include the removal of foundation systems and loose backfill found adjacent to the structures. Drilled piers, if encountered, should be truncated a minimum 3 feet below new foundation, slab or pavement construction elevations.
In addition to building foundations, any existing utilities to be abandoned should either be completely removed or properly grouted.

All materials derived from the demolition of the structures, exterior flatwork and pavements should be removed from the site and should not be allowed for use in any on-site fills, unless the materials are properly processed and meets the criteria presented in the “Import Material Specifications” section of this report.

4.2 Earthwork

The following presents recommendations for site preparation, excavation, subgrade preparation and placement of engineered fills on the project. All earthwork on the project should be observed and evaluated by Terracon.

4.2.1 Site Preparation

Stripped materials consisting of asphalt, concrete, vegetation (if any), unsuitable fills and organic materials should be wasted from the site or used to revegetate landscaped areas or exposed slopes after completion of grading operations.

It has been our experience that portions of subgrade materials below existing pavements/hardscape will likely be relatively moist to nearly saturated and yielding to unstable. This phenomenon is most likely due to moisture collecting in the subgrade through cracks or seams in the pavements/hardscape and not drying due to the presence of the pavements/hardscape. After removal of pavements/hardscape, unstable subgrade materials will need to be stabilized prior to construction of new pavements. We anticipate the subgrade can be stabilized by scarifying the subgrade soils to a depth of about 12 inches, processing the scarified subgrade soils, allowing the soils to dry, and compacting the subgrade materials in-place. If scarifying and drying is performed, several days may be required before the subgrade is stable enough for recompaction and paving, depending on the weather. However, more aggressive stabilization methods such as removal and replacement or by other means are discussed in this report.

Demolition of the existing buildings should include the removal of foundation system and loose backfill found adjacent to the structures. Drilled piers (if present) should be truncated a minimum of 3 feet below proposed planned foundation, slab or pavement construction elevations. The contractor should consider surveying existing pier locations (if piers are present) so new construction does not encounter abandoned pier locations. Any existing utilities to be abandoned should either be completely removed or properly grouted.

Consideration could be given to reusing the on-site asphalt pavement and/or concrete materials provided the materials are properly processed and blended with on-site materials. In order to
reuse the asphalt and/or concrete, the materials should be processed to a maximum size of 3-inches and blended with the on-site soils at a ratio of 50 percent asphalt/concrete to 50 percent soil. This blended material can be used in both building and parking areas.

Where possible, the site should be initially graded to create a relatively level surface to receive fill and to provide for a relatively uniform thickness of fill beneath the proposed structure. All exposed areas which will receive fill, once properly cleared, should be scarified to a minimum depth of 12 inches, properly moisture conditioned and compacted. It is imperative the moisture content of prepared materials be protected from moisture loss.

Although evidence of underground facilities such as grease pits, septic tanks, cesspools, existing foundations and basements was not observed during the site reconnaissance, such features could be encountered during construction. If unexpected fills or underground facilities are encountered, such features should be removed and the excavation thoroughly cleaned prior to backfill placement and/or construction.

It is anticipated that excavations for the proposed construction can be accomplished with conventional earthmoving equipment.

Depending upon depth of excavation and seasonal conditions, groundwater may be encountered in excavations on the site. Groundwater seeping into excavations at this site could most likely be controlled by shallow trenches leading to a sump pit where the water could be removed by pumping.

The stability of subgrade soils may be affected by precipitation, repetitive construction traffic or other factors. If unstable conditions are encountered or develop during construction, workability may be improved by overexcavation of wet zones and mixing these soils with crushed gravel or recycled concrete/asphalt and recompaction. Use of geotextiles could be considered as a stabilization technique. Lightweight excavation equipment may be required to reduce subgrade pumping.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required maintaining stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current Occupational Safety and Health Administration (OSHA) excavation and trench safety standards.

4.2.2 Material Types
Engineered fill should meet the following material property requirements:
### Fill Type \(^1\) | USCS Classification | Acceptable location for placement
--- | --- | ---
On-site clay soils | CL | On-site clay soils are considered suitable for reuse as compacted fill below foundation, slab and pavement areas.
On-site sand soils | SC, SM | On-site sand soils are considered suitable for reuse as compacted fill below foundation, slab and pavement areas.
Imported soils | Varies | Imported soils meeting the gradation outlined herein can be considered acceptable for use as engineered fill beneath slabs and pavements.

1. Controlled, compacted fill should consist of approved materials that are free of organic matter and debris. Frozen material should not be used, and fill should not be placed on a frozen subgrade. A sample of each material type should be submitted to the geotechnical engineer for evaluation.

2. Care should be taken during the fill placement process to avoid zones of dis-similar fill. Improvements constructed over varying fill types are at a higher risk of differential movement compared to improvements over a uniform fill zone.

3. Demolition debris (asphalt and concrete) should be processed to maximum size of 3 inches and blended with on-site soils prior to reuse.

Imported soils for general fills (if required) should meet the following material property requirements:

<table>
<thead>
<tr>
<th>Gradation</th>
<th>Percent finer by weight (ASTM C136)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>100</td>
</tr>
<tr>
<td>No. 4 Sieve</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 200 Sieve</td>
<td>15-50</td>
</tr>
</tbody>
</table>

- Liquid Limit…………………………………………………………30 (max)
- Plastic Index………………………………………………………15 (max)
- Maximum Expansive Potential (%)…………………………….1.0*  

*Measured on a sample compacted to approximately 95 percent of the ASTM D698 maximum dry density at optimum water content. The sample is confined under a 200 psf surcharge and submerged.

Imported soils for use with the reinforced zone for Mechanically Stabilized Earth (MSE) retaining walls (if used) should conform to the following:

<table>
<thead>
<tr>
<th>Gradation</th>
<th>Percent finer by weight (ASTM C136)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3”</td>
<td>100</td>
</tr>
<tr>
<td>¾”</td>
<td>50-100</td>
</tr>
<tr>
<td>No. 4 Sieve</td>
<td>50-75</td>
</tr>
<tr>
<td>No. 200 Sieve</td>
<td>30 (max)</td>
</tr>
</tbody>
</table>

- Liquid Limit…………………………………………………………30 (max)
As an alternative, the imported soils for use with the reinforced zone for MSE retaining walls (if used) can also conform to Colorado Department of Transportation specifications for Class 1 aggregate base.

<table>
<thead>
<tr>
<th>Gradation</th>
<th>Percent finer by weight (ASTM C136)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2”</td>
<td>100</td>
</tr>
<tr>
<td>2”</td>
<td>95-100</td>
</tr>
<tr>
<td>No. 4 Sieve</td>
<td>30-65</td>
</tr>
<tr>
<td>No. 200 Sieve</td>
<td>3-15</td>
</tr>
</tbody>
</table>

We recommend the on-site soils not be placed within the reinforced zone of the MSE retaining walls.

Consideration could be given to reusing the on-site asphalt pavement and/or concrete materials provided the materials are properly processed and blended with on-site materials. In order to reuse the asphalt and/or concrete, the materials should be processed to a maximum size of 3-inches and blended with the on-site soils at a ratio of 50 percent asphalt/concrete to 50 percent soil. This blended material can be used in both building and parking areas.

### 4.2.3 Compaction Requirements

Engineered fill should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill lift thickness</td>
<td>8-inches or less in loose thickness when heavy, self-propelled compaction equipment is used</td>
</tr>
<tr>
<td></td>
<td>4 to 6-inches in loose thickness when hand-guided equipment (i.e. jumping jack, plate compactor) is used</td>
</tr>
<tr>
<td>Compaction requirements</td>
<td>Minimum of 95% of the materials maximum standard Proctor dry density (ASTM D698)</td>
</tr>
<tr>
<td>Moisture content cohesive soil (Clays)</td>
<td>+1 to +4 % of the optimum moisture content</td>
</tr>
<tr>
<td></td>
<td>0 to +2% of the optimum moisture content in pavement areas</td>
</tr>
<tr>
<td>Moisture content cohesionless soil (Sands)</td>
<td>-3 to +3 % of the optimum moisture content</td>
</tr>
</tbody>
</table>
### Processing of demolition debris (asphalt and concrete)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>We recommend that engineered fill be tested for water content and compaction during placement. Should the results of the in-place density tests indicate the specified water or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified water and compaction requirements are achieved.</td>
</tr>
<tr>
<td>2.</td>
<td>Water levels should be maintained low enough to allow for satisfactory compaction to be achieved without the compacted fill material pumping when proofrolled.</td>
</tr>
<tr>
<td>3.</td>
<td>Moisture conditioned clay soils should not be allowed to dry out. A loss of moisture within these materials could result in an increase in the materials' expansive potential. Subsequent wetting of these materials could result in undesirable movement.</td>
</tr>
<tr>
<td>4.</td>
<td>Asphalt to be used as fill material should be processed to a maximum size of 3-inches in diameter. Additional testing methods may be required at the time of placement in order to determine acceptable compaction effort.</td>
</tr>
</tbody>
</table>

### 4.2.4 Excavation and Trench Construction

Excavations into the subsurface soils will encounter a variety of conditions. Excavations into the clay fill materials and native clay soils may remain stable for a short time period. Excavations into the sand fill materials and native sand soils may be subject caving and sloughing. The individual contractor(s) should be made responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottom. All excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

Soils penetrated by the proposed excavations may vary significantly across the site. The soil classifications are based solely on the materials encountered in the exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, the actual conditions should be evaluated to determine any excavation modifications necessary to maintain safe conditions.

As a safety measure, it is recommended that all vehicles and soil piles be kept to a minimum lateral distance from the crest of slopes equal to no less than the slope height. The exposed slope face should be protected against the elements.

Utility trenches are a common source of water infiltration and migration. All utility trenches that penetrate beneath each building should be effectively sealed to restrict water intrusion and flow through the trenches that could migrate below the building. We recommend constructing an effective clay “trench plug” that extends at least 5 feet out from the face of the building exterior. The clay plug material should consist of friable on-site lean clay compacted at a water content at or above the soils optimum water content. The clay fill should completely surround the utility line and be properly placed and compacted in accordance with recommendations in this report.
4.2.5 Grading and Drainage

All grades must be adjusted to provide positive drainage away from the structure during construction and maintained throughout the life of the proposed project. Infiltration of water into utility or foundation excavations must be prevented during construction. Landscaped irrigation adjacent to the foundation system should be minimized or eliminated. Water permitted to pond near or adjacent to the perimeter of the structure (either during or post-construction) can result in significantly higher soil movements than those discussed in this report. As a result, any estimations of potential movement described in this report cannot be relied upon if positive drainage is not obtained and maintained, and water is allowed to infiltrate the fill and/or subgrade.

Exposed ground should be sloped at a minimum of 10 percent grade for at least 5 feet beyond the perimeter of the structure, where possible. The use of swales, chases and/or area drains may be required to facilitate drainage in unpaved areas around the perimeter of the structure. Backfill against grade beams, exterior walls and in utility and sprinkler line trenches should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration. After construction and prior to project completion, we recommend that verification of final grading be performed to document that positive drainage, as described above, has been achieved.

Flatwork will be subject to post construction movement. Maximum grades practical should be used for paving and flatwork to prevent areas where water can pond. In addition, allowances in final grades should take into consideration post-construction movement of flatwork, particularly if such movement would be critical. Where paving or flatwork abuts the structure, care should be taken that joints are properly sealed and maintained to prevent the infiltration of surface water.

Where landscape or xeriscape areas are within 10 feet of the foundation systems, the areas shall have positive drainage away from the foundation that is not hindered by landscape edging, grade variations or vegetation. In addition, consideration should be given to snow removal practices that will minimize the stockpiling of snow in planter and landscaped areas adjacent to structural improvements.

Roof drains should discharges on pavements or be extended away from the structures a minimum of 10 feet through the use of splash blocks or downspout extensions. A preferred alternative is to have the roof drains discharge to storm sewers by solid pipe or daylighted to a detention pond or other appropriate outfall.

Planters located adjacent to the structure should preferably be self-contained. Sprinkler mains and spray heads should be located a minimum of 5 feet away from the building line. Roof drains should discharge on pavements or be extended away from the structure a minimum of 10 feet through the use of splash blocks or downspout extensions. A preferred alternative is to
have the roof drains discharge to storm sewers by solid pipe or daylighted to a detention pond or other appropriate outfall.

4.2.6 Earthwork Construction Considerations
Upon completion of grading operations, care should be taken to maintain the moisture content of the subgrade prior to construction of foundations, floor slabs, pavements, etc. Construction traffic over prepared subgrade should be minimized and avoided to the extent practical. Construction traffic over processed clay subgrade will eventually reduce the moisture content and increase the density of the subgrade. Subsequent wetting of these materials will result in undesirable movement.

The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. If the subgrade should become frozen, desiccated, saturated, or disturbed, the affected material should be removed or these materials should be scarified, moisture conditioned, and recompacted prior to foundation or floor slab construction.

It has been our experience that portions of subgrade materials below existing pavements/hardscape will likely be relatively moist to nearly saturated and yielding to unstable. This phenomenon is most likely due to moisture collecting in the subgrade through cracks or seams in the pavements/hardscape and not drying due to the presence of the pavements/hardscape. After removal of pavements/hardscape, unstable subgrade materials will need to be stabilized prior to construction.

Unstable subgrade conditions could be present below existing pavements/hardscape or develop during general construction operations, particularly if the soils are wetted and/or subjected to repetitive construction traffic. Should unstable subgrade conditions develop, stabilization measures will need to be employed. Options for subgrade stabilization can include removal of unsuitable material and replacement with approved fill material. An alternative can include the use of TX-140 Tensar geogrid (or approved equivalent) overlain by Colorado Department of Transportation (CDOT) Class 5 or 6 aggregate base course. The depth of aggregate base course will depend on the severity of unstable soils.

Trees or other vegetation whose root systems have the ability to remove excessive moisture from the subgrade and foundation soils should not be planted next to the structures. Trees and shrubbery should be kept away from the exterior edges of foundations, a distance at least equal to their expected mature height.

The geotechnical engineer should be retained during the construction phase of the project to observe earthwork and to perform necessary tests and observations during overexcavation operations, excavations, subgrade preparation; proof-rolling; placement and compaction of controlled compacted fills; backfilling of excavations into the completed subgrade, and just prior to construction of building floor slabs.
4.2.7 Soluble Sulfate Test Results

The following table lists the results of laboratory soluble sulfate testing. These values may be used to estimate potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction.

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Sample Depth (feet)</th>
<th>Soluble Sulfate ($'$ mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>4</td>
<td>&lt;1</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>&lt;1</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>&lt;1</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>&lt;1</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>&lt;1</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>&lt;1</td>
</tr>
<tr>
<td>17</td>
<td>2</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>

1. Results of soluble sulfate testing indicate that samples of the on-site soils tested possess negligible sulfate concentrations when classified in accordance with Table 4.3.1 of the ACI Design Manual. The results of the testing indicate ASTM Type I Portland Cement is suitable for project concrete on and below grade. However, if there is no (or minimal) cost differential, use of ASTM Type II Portland Cement is recommended for additional sulfate resistance of construction concrete. Concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4.

4.3 Foundations

Based upon the results of the field exploration and laboratory testing program, the following foundation systems were evaluated for use in supporting the proposed structure:

- Shallow spread footing foundations.
- Straight-shaft, cast-in-place piers/shafts founded in bedrock.

Based on the geotechnical engineering analyses, subsurface exploration and laboratory test results, the proposed building may be constructed on a spread footing foundation system bottomed on native soils or new engineered fill. However, due to the potential future construction with heavy loads, it may be prudent to support the proposed building on a drilled pier foundation system.

4.3.1 Spread Footing Design Recommendations

Based on the geotechnical engineering analyses, subsurface exploration and laboratory test results, the proposed building may be constructed on spread footing foundation systems bottomed on native soils or new engineered fill.

Design recommendations for a spread footing foundation system are presented in the following paragraphs.
### Description | Value
--- | ---
**Overexcavation/Modification depth** | All fill below foundations must be overexcavated to native soils
**Material at base of foundations** | Native soils or new engineered fill
**Maximum Net Allowable Bearing Pressure** | 2,500 psf
**Minimum Dead Load Pressure** | None
**Void Thickness, if needed** | N/A
**Coefficient of Friction (sliding)** | 0.3
**Minimum Footing Dimensions** | Isolated footings: 24 inches
Continuous footings: 16 inches
**Minimum Embedment Below Finished Grade for Frost Protection** | 3 feet
**Approximate Total Settlement from Foundation Loads** | About 1 inch
**Estimated Differential Settlement from Foundation Loads** | ½ to 3/4 inch

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the footing base elevation. This pressure assumes that any existing fill or lower strength soils, if encountered, will be excavated and replaced with engineered fill.

2. For perimeter footings, footings beneath unheated areas, and footings that will be exposed to freezing conditions during construction. Interior footings may bottom at a minimum depth of 12 inches below finished grade in heated areas.

3. Foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of engineered fill, and the quality of the earthwork operations and footing construction.

4. Differential settlement is considered over a distance of about 40 feet.

Footings should be proportioned on the basis of equal total dead load pressure to reduce differential movement between adjacent footings. Additional foundation movements could occur if water from any source infiltrates the foundation soils; therefore, proper drainage should be provided in the final design and during construction and throughout the life of the structure. Failure to maintain the proper drainage as recommended in the “Grading and Drainage” section of this report will nullify the movement estimates provided above.
4.3.2 Spread Footing Construction Considerations

Based upon the field penetration resistance values, in-situ dry densities and the laboratory consolidation test data, it is our opinion that all of the existing fill materials (if encountered) should be overexcavated to native soils, moisture conditioned and compacted to footing elevation.

The base of the footing excavations should be scarified to a depth of at least 1 foot, moisture conditioned and compacted prior to footing construction.

Unstable subgrade conditions may be encountered at the base of the footing excavations. Unstable surfaces will need to be stabilized prior to backfilling excavations and/or constructing spread footings. The use of angular rock, recycled concrete and/or gravel pushed into the yielding subgrade is considered suitable means of stabilizing the subgrade. The use of bi-axial geogrid materials in conjunction with gravel could also be considered and could be more cost effective. As an alternative, consideration could also be given to chemically treating the subgrade.

Unstable subgrade conditions should be observed by the geotechnical engineer to assess the subgrade and provide suitable alternatives for stabilization. Stabilized areas should be proofrolled prior to continuing construction to assess the stability of the subgrade.

Overexcavation of existing fill below footings should extend laterally beyond all edges of the footings at least 8 inches per foot of overexcavation depth below footing base elevation. The overexcavation should then be backfilled up to the footing base elevation with approved fill placed in lifts of 9 inches or less in loose thickness (6 inches or less if using hand-guided compaction equipment) and compacted to at least 95 percent of the material's standard effort maximum dry density (ASTM D698). The over-excavation and backfill procedure is described in the following figure.

The base of all foundation excavations should be free of water and loose soil prior to concrete placement. Concrete should be placed soon after excavating to reduce bearing soil disturbance.
Should the soils at bearing level become excessively dry, disturbed or saturated, or frozen, the affected soil should be removed prior to placing concrete.

Footings, foundations and masonry walls should be detailed and reinforced as necessary to reduce the potential for distress caused by differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

4.3.3 Drilled Pier Design Recommendations
If foundation loads are high, consideration could be given to supporting the proposed building on a drilled pier foundation system bottomed in the underlying bedrock.

Design recommendations for drilled shaft foundation systems at this site are presented in the following paragraphs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum pier length</td>
<td>25 feet</td>
</tr>
<tr>
<td>Minimum bedrock embedment</td>
<td>5 feet</td>
</tr>
<tr>
<td>Maximum end-bearing pressure</td>
<td>30,000 psf</td>
</tr>
<tr>
<td>Skin friction</td>
<td>2,000 psf³</td>
</tr>
<tr>
<td>Uplift force (tension due to soil uplift, kips)</td>
<td>N/A</td>
</tr>
<tr>
<td>Minimum pier diameter</td>
<td>18 inches or Length/Diameter &lt; 30</td>
</tr>
<tr>
<td>Void Thickness</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1. Drilled shafts should be embedded into firm or harder bedrock materials.
2. Required shaft penetration should be balanced against uplift forces for the portion of the shaft within bedrock below a depth of 15 feet from finished grade to resist axial loads and uplift forces.
3. Skin friction value to be applied from bedrock surface to a depth of 25 feet below existing ground surface.
4. Skin friction value to be applied below 25 feet below existing ground surface.
5. A minimum dead load is not necessary.
6. A 1/3 increase in stress is allowed for wind and seismic loads.

Piers should be considered to work in group action if the horizontal spacing is less than three pier diameters. A minimum practical horizontal clear spacing between piers of at least three diameters should be maintained, and adjacent piers should bottom at the same elevation. The capacity of individual piers must be reduced when considering the effects of group action. Capacity reduction is a function of pier spacing and the number of piers within a group. For drilled piers spaced between about 3 diameters apart, pier capacities should be reduced by 70 percent.

To satisfy forces in the horizontal direction using LPile®, piers may be designed for the following lateral load criteria:
<table>
<thead>
<tr>
<th>Soil Layer</th>
<th>Unit Weight (pcf)</th>
<th>Undrained Shear Strength (psf)</th>
<th>Angle of Internal Friction, (\Phi) (degrees)</th>
<th>Coeff. of Subgrade Reaction, (k) (pci)</th>
<th>Strain, (\varepsilon_{50}) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay</td>
<td>100</td>
<td>500</td>
<td>0</td>
<td>750-static</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>250-cyclic</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>110</td>
<td>N/A</td>
<td>30</td>
<td>30</td>
<td>N/A</td>
</tr>
<tr>
<td>Claystone/sandstone</td>
<td>115</td>
<td>5,000</td>
<td>0</td>
<td>2,000-static</td>
<td>0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>800-cyclic</td>
<td></td>
</tr>
</tbody>
</table>

* The claystone and sandstone bedrock may be modeled as a hard clay.

Lateral analysis should account for the center to center spacing and P-Y multiplier values per the following table:

<table>
<thead>
<tr>
<th>Pier center to center spacing (in direction of loading)</th>
<th>P-multiplier, (P_M) Row 1</th>
<th>P-multiplier, (P_M) Row 2</th>
<th>P-multiplier, (P_M) Row 3 and higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 x diameter</td>
<td>0.8</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>5 x diameter</td>
<td>1.0</td>
<td>0.85</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**4.3.4 Drilled Pier Construction Considerations**

All piers should be reinforced full depth for the applied axial, lateral and uplift stresses imposed. The amount of reinforcing steel for expansion should be determined by the tensile force created by the uplift force on each pier, with allowance for dead load.

Drilling to design depth should be possible with conventional single-flight power augers; however, very hard and potentially heavily cemented bedrock layers could require the use of heavy-duty equipment. In addition, because caving sand soils may be encountered temporary steel casing will likely be required in some areas to properly drill and clean some piers prior to concrete placement.

Groundwater (if encountered) should be removed from each pier hole prior to concrete placement. Pier concrete should be placed immediately after completion of drilling and cleaning. If pier concrete cannot be placed in dry conditions, a tremie should be used for concrete placement. Due to potential sloughing and raveling, foundation concrete quantities may exceed calculated geometric volumes. Pier-bearing surfaces must be cleaned prior to concrete placement. A representative of the geotechnical engineer should observe the bearing surface and shaft configuration.

If casing is required for construction of drilled piers, the casing should be withdrawn in a slow continuous manner maintaining a sufficient head of concrete to prevent infiltration of water or
caving soils or the creation of voids in pier concrete. Pier concrete should have a relatively high fluidity when placed in cased pier holes or through a tremie. Pier concrete with slump in the range of 5 to 7 inches is recommended.

We recommend the sides of each pier should be mechanically roughened in the claystone bearing strata. This should be accomplished by a roughening tooth placed on the auger. Shaft bearing surfaces must be cleaned prior to concrete placement. A representative of the geotechnical engineer should observe the bearing surface and shaft configuration.

Free-fall concrete placement in piers will only be acceptable if provisions are taken to avoid striking the concrete on the sides of the hole or reinforcing steel. The use of a bottom-dump hopper, or an elephant's trunk discharging near the bottom of the hole where concrete segregation will be minimized, is recommended.

### 4.4 Seismic Considerations

Based on our subsurface exploration and laboratory testing, it is our opinion that the soils have a low risk of liquefaction. The following table presents the seismic site classification based on the 2009 International Building Code:

<table>
<thead>
<tr>
<th>Code Used</th>
<th>Site Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 International Building Code (IBC) ¹</td>
<td>C²</td>
</tr>
</tbody>
</table>

1. In general accordance with the *2009 International Building Code*, Table 1613.5.2.
2. The 2009 International Building Code (IBC) requires a site soil profile determination extending a depth of 100 feet for seismic site classification. The current scope requested does not include the required 100 foot soil profile determination. The deepest borings of this exploration extended to a maximum depth of about 50 feet and this seismic site class definition considers that similar soil conditions exist below the maximum depth of the subsurface exploration. Additional exploration to deeper depths could be performed to confirm the conditions below the current depth of exploration.

### 4.5 Interior Floors

Slabs-on-grade may be utilized for the interior floor systems when constructed on native soils or new engineered fill.

All existing fill below slabs-on-grade should be modified by being overexcavated to native soils, processed, properly moisture conditioned and compacted back to slab-on-grade elevation. The moisture content and compaction of subgrade soils should be maintained until slab construction.
4.5.1 Design Recommendations

For structural design of concrete slabs-on-grade, a modulus of subgrade reaction of 100 pounds per cubic inch (pci) may be used for point or limited area loads for floors supported on native soils or new compacted fill at the site.

Additional floor slab design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between slabs and all foundations, columns or utility lines to allow independent movement.
- Control joints should be provided in slabs to control the location and extent of cracking.
- A minimum 2-inch void space should be constructed above or below non-bearing partition walls (if any) placed on the floor slab. Special framing details should be provided at doorjambs and frames within partition walls to avoid potential distortion. Partition walls should be isolated from suspended ceilings.
- Interior trench backfill placed beneath slabs should be compacted in accordance with recommended specifications outlined in this report.
- The use of a vapor retarder should be considered beneath concrete slabs on grade that will be covered with wood, tile, carpet or other moisture sensitive or impervious coverings, or when the slab will support equipment sensitive to moisture. When conditions warrant the use of a vapor retarder, the slab designer and slab contractor should refer to ACI 302 for procedures and cautions regarding the use and placement of a vapor retarder.
- Floor slabs should not be constructed on frozen subgrade.
- Other design and construction considerations, as outlined in Section 302.1R of the ACI Design Manual, are recommended.

4.5.2 Construction Considerations

All existing fill encountered below interior slabs-on-grade should be overexcavated, moisture conditioned and compacted back to subgrade elevation. The moisture content and compaction of subgrade soils should be maintained until slab construction.

Additional floor slab movement could occur should the floor slab supporting soils be allowed to dry out and subsequently become rewetted which could result in potential excessive movement causing uneven floor slabs and severe cracking. Future wetting could occur due to over watering of landscaping, poor drainage, improperly functioning drain systems, and/or broken
utility lines. Therefore, it is imperative that the recommendations outlined in the “Grading and Drainage” section of this report be followed.

4.6 Exterior Flatwork

Exterior slabs-on-grade and exterior architectural features may be constructed on native soils or new engineered fill. Exterior slabs-on-grade constructed on existing fill may experience some movement due to the volume change of the material. We recommend the upper 2 feet of subgrade soils below exterior slabs-on-grade be overexcavated, processed, properly moisture conditioned and compacted back to slab-on-grade elevation.

4.6.1 Design Recommendations

For structural design of exterior concrete slabs-on-grade, a modulus of subgrade reaction of 100pci for point or limited area loads for may be used for exterior slabs-on-grade at this site.

Additional slab-on-grade design and construction recommendations are as follows:

- Positive separations and/or isolation joints should be provided between exterior slabs and the building to allow independent movement.

- Control joints should be provided in slabs to control the location and extent of cracking.

- Exterior slabs should not be constructed on frozen subgrade.

- Other design and construction considerations, as outlined in Section 302.1R of the ACI Design Manual, are recommended.

4.6.2 Construction Considerations

The upper 2 feet of subgrade soils below exterior slabs-on-grade should be overexcavated, processed, properly moisture conditioned and compacted back to slab-on-grade elevation.

Movements of exterior slab-on-grades using the above technique will likely be reduced and tend to be more uniform. Additional movement could occur should the subsurface soils become wetted to significant depths, which could result in potential excessive movement causing uneven exterior slabs and severe cracking. This could be due to over watering of landscaping, poor drainage, and/or broken utility lines. Therefore, it is imperative that the recommendations outlined in the “Grading and Drainage” section of this report be followed.

4.7 Lateral Earth Pressures

Reinforced concrete walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of
construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety and do not provide for possible hydrostatic pressure on the walls.

**EARTH PRESSURE COEFFICIENTS**

<table>
<thead>
<tr>
<th>Earth Pressure Conditions</th>
<th>Coefficient For Backfill Type</th>
<th>Equivalent Fluid Density (pcf)</th>
<th>Surcharge Pressure, ( p_1 ) (psf)</th>
<th>Earth Pressure, ( p_2 ) (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active (Ka)</td>
<td>Granular - 0.33</td>
<td>40</td>
<td>((0.33)S)</td>
<td>((40)H)</td>
</tr>
<tr>
<td></td>
<td>Lean Clay - 0.47</td>
<td>60</td>
<td>((0.47)S)</td>
<td>((60)H)</td>
</tr>
<tr>
<td>At-Rest (Ko)</td>
<td>Granular - 0.50</td>
<td>60</td>
<td>((0.50)S)</td>
<td>((60)H)</td>
</tr>
<tr>
<td></td>
<td>Lean Clay - 0.64</td>
<td>80</td>
<td>((0.64)S)</td>
<td>((80)H)</td>
</tr>
<tr>
<td>Passive (Kp)</td>
<td>Granular - 3.0</td>
<td>360</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>Lean Clay - 2.1</td>
<td>280</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 \( H \) to 0.004 \( H \), where \( H \) is wall height
- For passive earth pressure to develop, wall must move horizontally to mobilize resistance.
- Uniform surcharge, where \( S \) is surcharge pressure
- In-situ soil backfill weight a maximum of 120 pcf
Horizontal backfill, compacted to at least 95 percent of standard Proctor maximum dry density
- Loading from heavy compaction equipment not included
- No hydrostatic pressures acting on wall
- No dynamic loading
- No safety factor included in soil parameters

To control hydrostatic pressure behind below grade walls we recommend that a drain be installed below the foundation of the wall with a collection pipe leading to a reliable discharge. If this is not possible, then combined hydrostatic and lateral earth pressures should be calculated for clay backfill using an equivalent fluid weighing 90 and 100 pcf for active and at-rest conditions, respectively. For granular backfill, an equivalent fluid weighing 85 and 90 pcf should be used for active and at-rest, respectively. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added. Heavy equipment should not operate within a distance closer than the exposed height of below grade walls to prevent lateral pressures more than those provided.

4.8 Retaining Wall Design and Construction

New retaining walls (if constructed) could consist of a Cast-in-Place (CIP) concrete retaining walls or Mechanically Stabilized Earth (MSE) walls. Provided the owner is willing to accept some risk of movement, retaining walls may be constructed on the existing clay or sand fill materials or native soils. Retaining walls constructed on the existing clay fill or native soils may be designed using an allowable bearing pressure of 1,500 psf.

Movement of retaining walls on the order of about 1 inch or more is possible at this site.

If the owner is not willing to accept the risk of movement, the wall system could be constructed on drilled piers. Drilled piers could be designed as previously recommended in this report.

If the owner is willing to accept the risk of movement, CIP walls may be designed using the lateral earth pressures previously presented in this report while the following design parameters may be used for design of MSE retaining walls:
Based upon the engineering properties of the on-site clay fill and native clay soils, we recommend that an imported free-draining granular soil will be used in the reinforced zone behind the walls. We recommend the on-site soils not be placed within the reinforced zone of the MSE retaining walls. Properties of granular backfill materials to be used in the reinforced zone should be determined with additional laboratory testing including direct shear testing. We should be contacted to confirm and verify the design parameters outlined above once preliminary wall designs have been established through additional field exploration and/or laboratory testing.

We recommend “wet” utilities not be placed within the reinforced zone of the MSE retaining walls.

We should be provided with final designs to assess and evaluate global stability issues of the walls prior to construction.

### 4.9 Retaining Wall Drainage

To reduce hydrostatic loading on retaining walls, a subsurface drain system should be placed behind the walls. The drain system should consist of free-draining granular soils containing less than 10 percent fines (by weight) passing a No. 200 sieve placed adjacent to the wall. The free-draining granular material should be graded to prevent the intrusion of fines or encapsulated in a suitable filter fabric. A drainage system consisting of either weep holes or perforated drain lines (placed near the base of the wall) should be used to intercept and discharge water which would tend to saturate the backfill. Where used, drain lines should be embedded in a uniformly graded filter material and provided with adequate clean-outs for periodic maintenance. As an alternative, a prefabricated drainage structure, such as geocomposite, may be used as a substitute for the granular backfill adjacent to the wall.
4.10 Pavement Design and Construction

Design of privately maintained pavements for the project has been based on the procedures outlined by the Asphalt Institute (AI) and the American Concrete Institute (ACI). Many of the recommendations included in this section are applicable to the design and maintenance of site sidewalks and other flatwork. This pavement design does not address improvements to public streets.

We recommend the upper 2 feet of subgrade soils below exterior slabs-on-grade be overexcavated, processed, properly moisture conditioned and compacted back to subgrade elevation.

4.10.1 Design Traffic
We assumed the following design parameters for Asphalt Institute flexible pavement thickness design:

- **Automobile Parking Areas**
  - Parking stalls and parking lots for cars and pick-up trucks, up to 50 stalls
- **Main Traffic Corridors**
  - Parking lots with a maximum of 5 trucks per day
- **Subgrade Soil Characteristics**
  - USCS Classification – CL, SC and SM (Poor to Medium Subgrade)

We assumed the following design parameters for ACI rigid pavement thickness design based upon the average daily truck traffic (ADTT):

- **Automobile Parking Areas**
  - ACI Category A-1: Automobile parking with an ADTT of 1 over 20 years
- **Main Traffic Corridors**
  - ACI Category B: Commercial entrance and service lanes with an ADTT of 25 over 20 years
- **Subgrade Soil Characteristics**
  - USCS Classification – CL, SC and SM
- Concrete modulus of rupture value of 600 psi

We should be contacted to confirm and/or modify the recommendations contained herein if actual traffic volumes differ from the assumed values shown above.

4.10.2 Subgrade Soils
Based on a subgrade soil Unified Soil Classification of CL, SC and SM, AI classifies the subgrade soil as poor to medium. We recommend pavements be constructed on at least 2 feet of modified existing fill or native soils. Modification of the existing fill should consist of overexcavation to a minimum depth of at least 2 feet below top of subgrade, moisture
conditioning and recompaction and/or replacement with non- to low expansive imported fill materials.

4.10.3 Recommended Minimum Pavement Sections and Materials

Recommended alternatives for flexible and rigid pavements are summarized for each traffic area as follows:

<table>
<thead>
<tr>
<th>Traffic Area</th>
<th>Alternative</th>
<th>Recommended Pavement Thickness (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Asphalt Concrete Surface</td>
</tr>
<tr>
<td>Automobile Parking (AI Class I and ACI Category A)</td>
<td>A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Main Traffic Corridors (AI Class III and ACI Category B)</td>
<td>A</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>6</td>
</tr>
</tbody>
</table>

1. The minimum pavement section thickness per ACI

Each alternative should be investigated with respect to current material availability and economic conditions. A minimum 6-inch thickness of rigid reinforced concrete pavement is recommended at the location of dumpsters where trash trucks park and load, and in areas of tight turning radius.

For analysis of pavement costs, the following specifications should be considered for each pavement component:

<table>
<thead>
<tr>
<th>Pavement Component</th>
<th>Colorado Department of Transportation Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Concrete Surface</td>
<td>Grading S or SX</td>
</tr>
<tr>
<td>Aggregate Base Course</td>
<td>Class 5 or 6</td>
</tr>
<tr>
<td>Portland Cement Concrete</td>
<td>Class P</td>
</tr>
</tbody>
</table>

4.10.4 Drainage Adjacent to Pavements

Clay subgrade materials will expand and/or lose stability with increases in moisture content. Therefore, to reduce pavement distress due to wetting of the subgrade in areas of water intensive landscaping or other nearby water sources (or if aggregate base course is used) located adjacent to pavements, we recommend edge drains be considered. The drain system
should consist of a properly sized pipe embedded in free-draining material directed to a suitable outfall such as an underdrain or storm sewer.

4.10.5 Construction Considerations
Site grading is generally accomplished early in the construction phase. However, as construction proceeds, the subgrade may be disturbed due to utility excavations, construction traffic, desiccation, or rainfall. As a result, the pavement subgrade may not be suitable for pavement construction and corrective action will be required. The subgrade should be carefully evaluated at the time of pavement construction for signs of disturbance or excessive rutting. If disturbance has occurred, pavement subgrade areas should be reworked, moisture conditioned, and properly compacted to the recommendations in this report immediately prior to paving.

We recommend the pavement areas be rough graded and then thoroughly proof rolled with a loaded tandem axle dump truck prior to final grading and paving. Particular attention should be paid to high traffic areas that were rutted and disturbed earlier and to areas where backfilled trenches are located. Areas where unsuitable conditions are located should be repaired by removing and replacing the materials with properly compacted fills. All pavement areas should be moisture conditioned and properly compacted to the recommendations in this report immediately prior to paving.

The placement of a partial pavement thickness for use during construction is not recommended without a detailed pavement analysis incorporating construction traffic. In addition, if the actual traffic varies from the assumptions outlined above, we should be contacted to confirm and/or modify the pavement thickness recommendations outlined above.

4.10.6 Pavement Performance
Future performance of pavements constructed at this site will be dependent upon several factors, including:

- Maintaining stable moisture content of the subgrade soils both before and after pavement construction.
- Providing for a planned program of preventative maintenance.

The performance of all pavements can be enhanced by minimizing excess moisture, which can reach the subgrade soils. The following recommendations should be considered at minimum:

- Site grading at a minimum 2 percent grade onto or away from the pavements.
- Water should not be allowed to pond behind curbs.
- Compaction of any utility trenches for landscaped areas to the same criteria as the pavement subgrade.
- Sealing all landscaped areas in or adjacent to pavements or providing drains to reduce the risk of moisture migration to subgrade soils.
- Placing compacted backfill against the exterior side of curb and gutter.
Placing curb, gutter and/or sidewalk directly on subgrade soils without the use of base course materials.

Placing shoulder or edge drains in pavement areas adjacent to water sources.

Preventative maintenance should be planned and provided for an ongoing pavement management program in order to enhance future pavement performance. Preventative maintenance activities are intended to slow the rate of pavement deterioration.

Preventative maintenance consists of both localized maintenance (e.g. crack sealing and patching) and global maintenance (e.g. surface sealing). Preventative maintenance is usually the first priority when implementing a planned pavement maintenance program.

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.
APPENDIX A

FIELD EXPLORATION
Field Exploration Description
The locations of borings are presented in Exhibit A-2. The borings were located in the field by measuring with a measuring wheel from property lines and/or existing site features. The latitude and longitude coordinates of the boring locations were obtained by locating the borings on Google Earth and recording the values. The accuracy of the latitude and longitude values is typically about +/- 25 feet when obtaining the values using this method. Elevations of borings were estimated by locating the borings on a topographic map and interpreting the elevations from the map. The accuracy of the boring locations and elevations should only be assumed to the level implied by the methods used.

The borings were drilled with a CME-55 truck-mounted rotary drill rig with solid-stem augers. During the drilling operations, lithologic logs of the borings were recorded by the field engineer. Relatively undisturbed samples were obtained at selected intervals utilizing a 3-inch outside diameter ring barrel sampler (RS). Disturbed bulk samples (BS) were obtained from auger cuttings. Penetration resistance values were recorded in a manner similar to the standard penetration test (SPT). This test consists of driving the sampler into the ground with a 140-pound hammer free-falling through a distance of 30 inches. The number of blows required to advance the ring-barrel sampler 12 inches (18-inches for standard split-spoon samplers, final 12-inches are recorded) or the interval indicated, is recorded and can be correlated to the standard penetration resistance value (N-value). The blow count values are indicated on the boring logs at the respective sample depths, ring barrel sample blow counts are not considered N-values.

An automatic hammer was used to advance the samplers in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The standard penetration test provides a reasonable indication of the in-place density of sandy type materials, but only provides an indication of the relative stiffness of cohesive materials since the blow count in these soils may be affected by the soils moisture content. In addition, considerable care should be exercised in interpreting the N-values in gravelly soils, particularly where the size of the gravel particle exceeds the inside diameter of the sampler.

Groundwater measurements were obtained in the borings at the time of drilling. Due to safety concerns, borings were backfilled with auger cuttings and patched with asphalt after drilling. Some settlement of the backfill and patches may occur and should be repaired as soon as possible.

Exhibit A-1
Boring Nos. 1 to 17 were drilled for our initial exploration in January 2015. Boring Nos. 18 to 24 were additional borings drilled in April 2015.
RESULTS OF DENVER COLLISION CENTER GEOTECHNICAL EXPLORATION PRESENTED IN TERRACON REPORT NO. 25145052B

1. Elevations of borings were estimated by locating the borings on a topographic map and interpreting the elevations from the map. Accuracy of the boring locations and elevations should only be assumed to the level implied by the methods used.

2. Estimated bedrock contours are based on the elevation of the borings, obtained as noted above, and the depth to bedrock encountered in the borings for this exploration. Actual bedrock surface elevation could vary from the estimated bedrock surface contours presented in this map.

Boring Nos. 1 to 17 were drilled for our initial exploration in January 2015. Boring Nos. 18 to 24 were additional borings drilled in April 2015.
**BOERING LOG NO. 1**

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

**LOCATION**  
Latitude: 39.697633° Longitude: -104.940023°  
Approximate Surface Elev: 5412.5 (FL) +/-

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DEPTH (FL)</th>
<th>WATER LEVEL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>ASPHALT (About 2 inches)</td>
</tr>
<tr>
<td>2.2</td>
<td>FILL - FINE TO COARSE SAND (SM), trace gravel, dark brown, medium dense</td>
</tr>
<tr>
<td>3.5</td>
<td>SILTY SAND (SM), fine to coarse grained, brown, loose</td>
</tr>
<tr>
<td>11.0</td>
<td>CLAYEY SAND (SC), fine to medium grained, brown, loose</td>
</tr>
<tr>
<td>19.0</td>
<td>CLAYSTONE, reddish-brown to light to brown to light gray, medium hard</td>
</tr>
<tr>
<td>20.0</td>
<td>Boring Terminated at 40 Feet</td>
</tr>
</tbody>
</table>

**FIELD TEST RESULTS**

<table>
<thead>
<tr>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>PERCENT FINES</th>
<th>WATER CONTENT (%)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 8-12</td>
<td>12 3-4</td>
<td>12 4-5</td>
<td>12 3-4 +0.1 @ 500 psi</td>
</tr>
<tr>
<td>8 1111</td>
<td>15 1111</td>
<td>23 97</td>
<td>8 50/6</td>
</tr>
<tr>
<td>12 30-20</td>
<td></td>
<td></td>
<td>12 25-25</td>
</tr>
<tr>
<td>6 50/6</td>
<td></td>
<td></td>
<td>6 50/6</td>
</tr>
</tbody>
</table>

**ADVANCEMENT METHOD:**  
4-inch outside diameter solid stem auger

**ABANDONMENT METHOD:**  
Boring backfilled with auger cuttings and patched with asphalt after drilling

**NOTES:**

- Boring Started: 1/7/2015
- Boring Completed: 1/7/2015
- Drill Rig: CME-55
- Driller:
- Project No.: 25145052A
- Exhibit: A-4

**Boering Terminated at 40 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic
### BORING LOG NO. 2

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**CLIENT:** Sonic Automotive, Inc.

| LOCATION | See Exhibit A-2  
| Depth (ft.) | Approximate Surface Elev: 5411 (FL) +/- |
| Elevation (FL) | 5409+/- |

**WATER LEVELS**

<table>
<thead>
<tr>
<th>Depth (ft.)</th>
<th>Sample</th>
<th>Recovery (in.)</th>
<th>Field Test Results</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Swell (%)</th>
<th>Water Content (%)</th>
<th>Specific Gravity</th>
<th>Atterberg Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.5</td>
<td>12</td>
<td>3-6</td>
<td>11</td>
<td>102</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.5</td>
<td>12</td>
<td>6-7</td>
<td>7</td>
<td>103</td>
<td>NP</td>
<td>14</td>
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<td>24.0</td>
<td>12</td>
<td>4-6</td>
<td>11</td>
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<td>25.0</td>
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<td>3-6</td>
<td>19</td>
<td>102</td>
<td>33-19-14</td>
<td>74</td>
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<td>40.0</td>
<td>12</td>
<td>15-25</td>
<td>4</td>
<td>50/4&quot;</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>41.5</td>
<td>5</td>
<td>50/5&quot;</td>
<td></td>
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<tr>
<td>42.5</td>
<td>12</td>
<td>20-30</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- Advancement Method: 4-inch outside diameter solid stem auger
- Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling
- WATER LEVEL OBSERVATIONS: None encountered

**Stratification lines are approximate. In-situ, the transition may be gradual.**

**Hammer Type:** Automatic

**Location:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**Site:** Denver, Colorado  
**Exhibit:** A-5

**Graphical Log:** See Exhibit A-2

**Project No.:** 25145052A

**Boring Started:** 1/7/2015  
**Boring Completed:** 1/7/2015

**Drill Rig:** CME-55  
**Driller:**

**See Exhibit A-1 for description of field procedures.**

**See Appendix B for description of laboratory procedures and additional data (if any).**

**See Appendix C for explanation of symbols and abbreviations.**
### BORING LOG NO. 3

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.

**SITE:**  
NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

**LOCATION**  
See Exhibit A-2  
Latitude: 39.697513°  Longitude: -104.939744°  
Approximate Surface Elev: 5411 (Ft.) +/-

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>SAMPLE TYPE</th>
<th>RECOVERY</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
<th>PERCENT FINES</th>
<th>LL-PL-PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>ASPHALT, (About 2 inches)</td>
<td>12</td>
<td>2-3</td>
<td></td>
<td>10 98</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>SILTY SAND (SM), fine to medium grained, brown</td>
<td>12</td>
<td>4-6</td>
<td></td>
<td>7 104</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.5</td>
<td>SILTY SAND (SM), fine to medium grained, brown, very loose to loose</td>
<td>12</td>
<td>5-5</td>
<td>-0.9 @ 500 psf</td>
<td>9 104</td>
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<tr>
<td>19.5</td>
<td>CLAYEY SAND (SC), fine to medium grained, brown, loose</td>
<td>12</td>
<td>4-5</td>
<td></td>
<td>14 103</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.0</td>
<td>CLAYSTONE, dark gray to light to brown to light gray, firm to hard</td>
<td>12</td>
<td>10-35</td>
<td></td>
<td>22 102</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Boring Terminated at 40 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

**Advancement Method:**  
4-inch outside diameter solid stem auger

**Abandonment Method:**  
Boring backfilled with auger cuttings and patched with asphalt after drilling

**WATER LEVEL OBSERVATIONS:** None encountered

**Notes:**

See Exhibit A-1 for description of field procedures  
See Appendix B for description of laboratory procedures and additional data (if any).  
See Appendix C for explanation of symbols and abbreviations.

**LOCATION**  
10625 W I-70 Frontage Road N., Ste. 3  
Wheat Ridge, Colorado

**EXHIBIT:** A-6

**PROJECT NO.:** 25145052A

**Terrain:**  
Boring Started: 1/7/2015  
Boring Completed: 1/7/2015  
Drill Rig: CME-55  
Driller:

---

**LOCATION**  
39.697513°  -104.939744°  
Approximate Surface Elev: 5411 (Ft.) +/–
## BORING LOG NO. 4

### PROJECT: Proposed Denver BMW

### SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

### CLIENT: Sonic Automotive, Inc.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>See Exhibit A-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude: 39.697537°</td>
<td>Longitude: -104.9395°</td>
</tr>
</tbody>
</table>

Approximate Surface Elev: 5407 (FL) +/-

### DEPTH | ELEVATION (FL)
--- | ---
4.4 | 5405.5+/
2.0 | 5400.5+/
8.5 | 5396.5+/
11.5 | 5388+/
19.0 | 5388+/
25.0 | 5367+/
40.0 | 5367+/

### WATER LEVEL OBSERVATIONS

- **ASPHALT**: (About 5 inches)
- **FILL - LEAN CLAY (CL)**, dark brown to dark gray
- **SILTY SAND (SM)**, fine to medium grained, brown, loose
- **CLAYEY SAND (SC)**, fine to medium grained, brown, very loose
- **LEAN CLAY (CL)**, with sand, brown, stiff
- **CLAYSTONE**: interbedded with SANDSTONE, reddish-brown to light to brown to light gray, firm to hard

### Boring Terminated at 40 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

### Advancement Method:
- 4-inch outside diameter solid stem auger

### Abandonment Method:
- Boring backfilled with auger cuttings and patched with asphalt after drilling

### Notes:

- Drill Rig: CME-55
- Driller: A-7
- Project No.: 25145052A
- Boring Started: 1/9/2015
- Boring Completed: 1/9/2015

---

### WATER LEVEL OBSERVATIONS

- 31 feet during drilling

---

### FIELD TEST RESULTS

<table>
<thead>
<tr>
<th>UNCONFINED COMPRESSIVE STRENGTH (psf)</th>
<th>PERCENT FINES</th>
<th>WATER CONTENT (%)</th>
<th>DRY UNITWEIGHT (pcf)</th>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### LOCATION

- Latitude: 39.697537°
- Longitude: -104.9395°

### SITE:

- NE. of S. Colorado Blvd. and E. Mississippi Ave.
- Denver, Colorado

---

### Advancement Method:
- 4-inch outside diameter solid stem auger

### Abandonment Method:
- Boring backfilled with auger cuttings and patched with asphalt after drilling

### Notes:

- Drill Rig: CME-55
- Driller: A-7
- Project No.: 25145052A
- Boring Started: 1/9/2015
- Boring Completed: 1/9/2015

---

### WATER LEVEL OBSERVATIONS

- 31 feet during drilling

---

### LOCATION

- Latitude: 39.697537°
- Longitude: -104.9395°

### SITE:

- NE. of S. Colorado Blvd. and E. Mississippi Ave.
- Denver, Colorado

---

### Advancement Method:
- 4-inch outside diameter solid stem auger

### Abandonment Method:
- Boring backfilled with auger cuttings and patched with asphalt after drilling

### Notes:

- Drill Rig: CME-55
- Driller: A-7
- Project No.: 25145052A
- Boring Started: 1/9/2015
- Boring Completed: 1/9/2015

---

### WATER LEVEL OBSERVATIONS

- 31 feet during drilling
### WATER LEVEL OBSERVATIONS

None encountered

---

**FIELD TEST RESULTS**

<table>
<thead>
<tr>
<th>WATER LEVEL OBSERVATIONS</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>ATTERBERG LIMITS</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>RECOVERY (In.)</td>
<td>SWELL (%)</td>
<td>DRY UNIT WEIGHT (pcf)</td>
<td>LL-PL-PI</td>
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<tr>
<td>60</td>
<td>6-6</td>
<td>8</td>
<td>97</td>
<td>NP</td>
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<td>12</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>2-3</td>
<td>12</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>3-5</td>
<td>-0.1 @ 500 psf</td>
<td>16</td>
<td>110</td>
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<td>25-25</td>
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<tr>
<td>6</td>
<td>50/6&quot;</td>
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<td></td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>3</td>
<td>50/3&quot;</td>
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</table>

### Advancement Method:
- 4-inch outside diameter solid stem auger

### Abandonment Method:
- Boring backfilled with auger cuttings and patched with asphalt after drilling

### Notes:
- Boring Started: 1/9/2015
- Boring Completed: 1/9/2015
- Drill Rig: CME-55
- Driller:
- Project No.: 25145052A
- Exhibit: A-8
### Location

- **Latitude:** 39.697906°
- **Longitude:** -104.939151°
- Approximate Surface Elev: 5404 (FL) +/-

### Graphical Log

- **ASPHALT** (About 2 inches)
- **FILL - CLAYEY SAND (SC)**, fine to medium grained, dark brown, loose
- **CLAYEY SAND (SC)**, fine to medium grained, brown, loose
- **SANDY LEAN CLAY (CL)**, brown, stiff
- **CLAYSTONE**, interbedded with SANDSTONE, reddish-brown to light brown to dark gray, hard to very hard

### FIELD TEST RESULTS

<table>
<thead>
<tr>
<th>Depth (Ft.)</th>
<th>Sample Type</th>
<th>Recovery (In.)</th>
<th>Field Test Results</th>
<th>Unconfined Compressive Strength (psi)</th>
<th>Effective Unit Weight (pcf)</th>
<th>Atterberg Limits LL-PL-PI</th>
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<tbody>
<tr>
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<td>60</td>
<td>-</td>
<td></td>
<td>3-4</td>
<td></td>
<td></td>
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<tr>
<td>5.5</td>
<td>12</td>
<td>5-6</td>
<td></td>
<td>15</td>
<td>112</td>
<td>28-16-12 36</td>
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<tr>
<td>16.5</td>
<td>12</td>
<td>4-6</td>
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<td>110</td>
<td></td>
</tr>
<tr>
<td>15.0</td>
<td>12</td>
<td>5-7</td>
<td></td>
<td>12</td>
<td>104</td>
<td>26-15-11 48</td>
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<td>22.0</td>
<td>12</td>
<td>5-7</td>
<td></td>
<td>14</td>
<td>101</td>
<td></td>
</tr>
<tr>
<td>25.0</td>
<td>5</td>
<td></td>
<td></td>
<td>50/5°</td>
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<td>30.0</td>
<td>6</td>
<td>50/6°</td>
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<td>50.0</td>
<td>6</td>
<td>50/6°</td>
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<td></td>
<td></td>
<td></td>
</tr>
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</table>

*Stratification lines are approximate. In-situ, the transition may be gradual.*

**Notes:**

- **Advancement Method:** 4-inch outside diameter solid stem auger
- **Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling
- **Boring Terminated at 50 Feet**
- **Hammer Type:** Automatic

---

**WATER LEVEL OBSERVATIONS**

- 49 feet during drilling

---

**Exhibit:** A-9
**BOURING LOG NO. 7**

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.

**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>See Exhibit A-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude: 39.697672°</td>
<td>Longitude: -104.939154°</td>
</tr>
<tr>
<td>Approximate Surface Elev: 5405 (FL) +/-</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH (FL)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMRESSIVE STRENGTH (psi)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>CONCRETE, (About 5 inches)</td>
<td>12 2-3 24 92</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 4-4</td>
</tr>
<tr>
<td>4.0</td>
<td>FILL - LEAN CLAY (CL), dark gray, medium stiff</td>
<td>12 7-8 14 113</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 5-7</td>
</tr>
<tr>
<td>7.0</td>
<td>FILL - CLAYEY SAND (SC), fine to medium grained, dark brown, loose</td>
<td>12 4-3 0.0 @ 500 psf</td>
<td>21 103</td>
<td>12 25-25</td>
<td>6130 22 100</td>
</tr>
<tr>
<td>14.0</td>
<td>SILTY SAND (SM), fine to medium grained, brown, loose</td>
<td>12 5-7 14 109</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 5-7</td>
</tr>
<tr>
<td>23.0</td>
<td>SANDY LEAN CLAY (CL), brown, medium stiff to stiff</td>
<td>12 5-7 14 109</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 5-7</td>
</tr>
<tr>
<td>25.0</td>
<td>CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light to brown to light gray, medium hard to very hard</td>
<td>12 5-7 14 109</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 5-7</td>
</tr>
<tr>
<td>50.0</td>
<td>Boring Terminated at 50 Feet</td>
<td>12 5-7 14 109</td>
<td>25-14-11 30</td>
<td>11 105</td>
<td>12 5-7</td>
</tr>
</tbody>
</table>

- Stratification lines are approximate. In-situ, the transition may be gradual.
- Hammer Type: Automatic

**Advancement Method:** 4-inch outside diameter solid stem auger  
**Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

**WATER LEVEL OBSERVATIONS**  
40 feet during drilling

- Notes:
  - See Exhibit A-1 for description of field procedures.  
  - See Appendix B for description of laboratory procedures and additional data (if any).  
  - See Appendix C for explanation of symbols and abbreviations.

**LOCATION**  
Latitude: 39.697672° Longitude: -104.939154°

**GRAPHIC LOG**  
See Exhibit A-2

**PROJECT:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

**FIELD TEST RESULTS**

- **UNCONFINED COMRESSIVE STRENGTH (psi)**
  - 25-14-11 30
  - 21 103
  - 6130 22 100
  - 21 103
  - 21 103
  - 21 103
  - 21 103
  - 21 103

- **DRY UNIT WEIGHT (pcf)**
  - 5401 +/-
  - 5401 +/-
  - 5398 +/-
  - 5391 +/-
  - 5382 +/-
  - 5382 +/-
  - 5382 +/-
  - 5382 +/-

- **PERCENT FINES**
  - 24 92
  - 14 113
  - 14 105
  - 14 109
  - 14 109
  - 14 109
  - 14 109
  - 14 109

**Boring Started:** 1/7/2015  
**Boring Completed:** 1/7/2015

**Drill Rig:** CME-55  
**Driller:**

**Project No.:** 25145052A  
**Exhibit:** A-10
**BORING LOG NO. 8**

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.

**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

| LOCATION | See Exhibit A-2  
Latitude: 39.6979°  
Longitude: -104.938792°  
Approximate Surface Elev: 5402 (FL) +/-  
DEPTH | ELEVATION (FL) |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>ASPHALT, (About 3 inches)</td>
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<tr>
<td>2.0</td>
<td>FILL - LEAN CLAY (CL), dark brown</td>
</tr>
<tr>
<td></td>
<td>SEDimentary DIOSENOLOGY SAND (SC-SM), fine to medium grained, brown, very loose to loose</td>
</tr>
<tr>
<td>15.5</td>
<td>SANDY LEAN CLAY (CL), brown, very stiff</td>
</tr>
<tr>
<td>27.5</td>
<td>CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light brown to light gray, firm to very hard</td>
</tr>
<tr>
<td>50.0</td>
<td>Boring Terminated at 50 Feet</td>
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</tbody>
</table>

**FIELD TEST RESULTS**

<table>
<thead>
<tr>
<th>WATER LEVEL</th>
<th>RECOVERY (In.)</th>
<th>UNCONFINED COMPRESSION STRENGTH (psf)</th>
<th>SWELL (%)</th>
<th>PERCENT FINES</th>
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</thead>
<tbody>
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<td>27.5</td>
<td>7</td>
<td>103</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.0</td>
<td>7</td>
<td>104</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hammer Type:** Automatic  
**Stratification lines are approximate. In-situ, the transition may be gradual.**

**Advancement Method:**  
4-inch outside diameter solid stem auger

**Abandonment Method:**  
Boring backfilled with auger cuttings and patched with asphalt after drilling

**Notes:**

<table>
<thead>
<tr>
<th>WATER LEVEL OBSERVATIONS</th>
<th>None encountered</th>
</tr>
</thead>
</table>

**LOCATION**

**DEPTH**  
**ELEVATION (FL)**

**Driller:** Boring Completed: 1/6/2015  
**Drill Rig:** CME-55  
**Boring Started: 1/6/2015**  
**Project No:** 25145052A  
**Exhibit:** A-11

*See Exhibit A-1 for description of field procedures.  
See Appendix B for description of laboratory procedures and additional data (if any).  
See Appendix C for explanation of symbols and abbreviations.*
BORING LOG NO. 9

PROJECT: Proposed Denver BMW
CLIENT: Sonic Automotive, Inc.

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

LOCATION See Exhibit A-2
Latitude: 39.697682° Longitude: -104.938784°
Approximate Surface Elev: 5402 (FL) +/-

DEPTH ELEVATION (FL)

0.2 ASPHALT, (About 2-1/2 inches) 5402 +/-
3.5 brown, loose 5398.5 +/-

FILL - FINE TO MEDIUM SAND (SC), dark 5398.5 +/-
3 brown, loose

FILL - CLAYEY SAND (SC), fine to medium
grained, dark brown, loose

7.5 CLAYEY SAND (SC), fine to medium grained,
ligh brown, loose

11.5 SANDY LEAN CLAY (CL), light brown,
medium stiff to stiff

24.0 CLAYSTONE, interbedded with SANDSTONE,
reddish-brown to light brown to light gray,
medium hard to very hard

50.0

Boring Terminated at 50 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.
Hammer Type: Automatic

Advancement Method:
4-inch outside diameter solid stem auger
Abandonment Method:
Boring backfilled with auger cuttings and patched with asphalt after drilling

FIELD TEST RESULTS

DEPTH (FT.) WATER LEVEL OBSERVATIONS

Sonic Automotive, Inc.

FIELD TEST RESULTS

UNCONFINED COMPRESSIVE STRENGTH (psf)
PERCENT FINES
WATER CONTENT (%)
DRY UNIT WEIGHT (pcf)
ATTERBERG LIMITS

Sample Type

Depth (Ft.)

RECOVERY (in.)

SWELL (%)

5101520253035404550

None encountered

WATER LEVEL OBSERVATIONS

Notes:

See Exhibit A-1 for description of field
procedures
See Appendix B for description of laboratory
procedures and additional data (if any).
See Appendix C for explanation of symbols and
abbreviations.

Boring Started: 1/6/2015
Boring Completed: 1/6/2015
Drill Rig: CME-55
Driller:
Project No.: 25145052A
Exhibit: A-12
## BORING LOG NO. 10

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**CLIENT:** Sonic Automotive, Inc.

### LOCATION

See Exhibit A-2  
Latitude: 39.697627°  
Longitude: -104.938553°  
Approximate Surface Elev: 5400 (FT) +/-

### DEPTH

<table>
<thead>
<tr>
<th>WATER LEVEL OBSERVATIONS</th>
<th>ELEVATION (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>5400+/-</td>
</tr>
<tr>
<td>0.1 ASPHALT, (About 1-1/2 inches)</td>
<td>5398+/-</td>
</tr>
<tr>
<td>2.0 FILL - SANDY LEAN CLAY (CL), dark brown</td>
<td>5389+/-</td>
</tr>
<tr>
<td>11.0 SILTY SAND (SM), fine to medium grained, brown, loose</td>
<td>5389+/-</td>
</tr>
<tr>
<td>22.0 SANDY LEAN CLAY (CL), brown, medium stiff to stiff</td>
<td>5378+/-</td>
</tr>
<tr>
<td>49.0 CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light to brown to light gray, medium hard to very hard</td>
<td>5378+/-</td>
</tr>
</tbody>
</table>

### GRAPHIC LOG

Boring Terminated at 50 Feet

### WATER LEVEL OBSERVATIONS

None encountered

### FIELD TEST RESULTS

<table>
<thead>
<tr>
<th>UNCONFined COMPRESSIVE STRENGTH (psf)</th>
<th>PERCENT FINES</th>
<th>WATER CONTENT (%)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>50/7”</td>
<td>12</td>
<td>10</td>
<td>99</td>
<td>NP</td>
</tr>
<tr>
<td>50/3”</td>
<td>12</td>
<td>19</td>
<td>89</td>
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</tr>
<tr>
<td>50/1”</td>
<td>12</td>
<td>19</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>50/3”</td>
<td>3</td>
<td>25</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>50/2”</td>
<td>3</td>
<td>104</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50/4”</td>
<td>4</td>
<td>25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Notes:

- Advancement Method: 4-inch outside diameter solid stem auger
- Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling
- Hammer Type: Automatic
- Approximate Surface Elev: 5400 (FT) +/-
- Stratification lines are approximate. In-situ, the transition may be gradual.
- ELEVATION (FT)
- Sample Type
- Recovery (In.)
- Field Test Results
- Water Level Observations
- Unconfined Compressive Strength (psf)
- Percent Finest
- Water Content (%)
- Dry Unit Weight (pcf)
- Atterberg Limits

### Project Information

- Boring Started: 1/6/2015
- Boring Completed: 1/6/2015
- Drill Rig: CME-55
- Driller:
- Project No.: 25145052A
- Exhibit: A-13
- Notes:
- See Exhibit A-1 for description of field procedures
- See Appendix B for description of laboratory procedures and additional data (if any).
- See Appendix C for explanation of symbols and abbreviations.
### Boring Log No. 11

**Project:** Proposed Denver BMW  
**Client:** Sonic Automotive, Inc.  
**Site:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**Denver, Colorado**

<table>
<thead>
<tr>
<th>Depth (ft)</th>
<th>Sample Type</th>
<th>Recovery</th>
<th>Field Test Results</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Percent Fineness</th>
<th>Water Content (%)</th>
<th>Dry Unit Weight (pcf)</th>
<th>Atterberg Limits (LL-PL-PI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>ASPHALT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>FILL - LEAN CLAY (CL)</td>
<td>5395.5</td>
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<td></td>
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</tr>
<tr>
<td>4.0</td>
<td>SILTY SAND (SM)</td>
<td>510</td>
<td>12</td>
<td>2-3</td>
<td>5</td>
<td>108</td>
<td>NP</td>
<td>27</td>
</tr>
<tr>
<td>13.0</td>
<td>CLAYEY SAND (SC)</td>
<td>5386.5</td>
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<td>5-4</td>
<td>9</td>
<td>101</td>
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</tr>
<tr>
<td>18.0</td>
<td>SANDY LEAN CLAY (CL)</td>
<td>5381.5</td>
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<td>5-8</td>
<td>14</td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28.5</td>
<td>CLAYSTONE, interbedded with SANDSTONE</td>
<td>5370.5</td>
<td>6</td>
<td>50/6&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>40.0</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Boring Terminated at 50 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Automatic

**Advancement Method:** 4-inch outside diameter solid stem auger

**Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

**Notes:**
- Boring Started: 1/5/2015  
- Boring Completed: 1/5/2015  
- Drill Rig: CME-55  
- Driller:

---

**Water Level Observations:**
- 35 feet during drilling
BORING LOG NO. 12

PROJECT: Proposed Denver BMW
CLIENT: Sonic Automotive, Inc.

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

LOCATION See Exhibit A-2
Latitude: 39.697765° Longitude: -104.938239°
Approximate Surface Elev: 5397.5 (FT) +/-

DEPTH FIELD TEST RESULTS UNCONFINED COMPRESSION STRENGTH (psi) SWELL (%) DRY UNIT WEIGHT (pcf) ATTERBERG LIMITS PERCENT FINES

0.2 ASPHALT, (About 2 inches)

3.5 FILL - CLAYEY SAND (SC), fine to medium grained, dark brown, loose

5.0 SILTY SAND (SM), fine to medium grained, brown, loose

11.0 SANDY LEAN CLAY (CL), brown, medium stiff to stiff

23.0 CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light brown to light gray, medium hard to very hard

Boring Terminated at 50 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: 4-inch outside diameter solid stem auger
Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling

WATER LEVEL OBSERVATIONS
30 feet during drilling

Notes:

See Exhibit A-1 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.

Boring Started: 1/6/2015 Boring Completed: 1/6/2015
Drill Rig: CME-55 Driller:
Project No.: 25145052A Exhibit: A-15
BORING LOG NO. 13

PROJECT: Proposed Denver BMW
CLIENT: Sonic Automotive, Inc.

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

LOCATION
Latitude: 39.697886° Longitude: -104.937984°
Approximate Surface Elev: 5396 (FL) +/-

DEPTH
ELEVATION (FL)

WATER LEVEL OBSERVATIONS
None encountered

Sonic Automotive, Inc.

FIELD TEST RESULTS

UNCONFINED
COMPRESSIVE STRENGTH (psf)
PERCENT FINES
WATER CONTENT (%)
DRY UNIT WEIGHT (pcf)


t27-17-10

SWELL (%)

40

50

Boring Terminated at 50 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
4-inch outside diameter solid stem auger

Abandonment Method:
Boring backfilled with auger cuttings and patched with asphalt after drilling

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

Boring Started: 1/5/2015
Boring Completed: 1/5/2015
Drill Rig: CME-55
Driller:

Project No.: 25145052A
Exhibit: A-16
<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>WATER LEVEL</th>
<th>RECOVERY (In.)</th>
<th>UNCONFINED COMPR SS STRENGTH (psi)</th>
<th>SWELL (%)</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>None encountered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>ASPHALT, (About 3 inches)</td>
<td>5397 +/-</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>FILL - SILTY SAND (SM), fine to medium grained, dark brown, very loose</td>
<td>5393 +/-</td>
<td>2-3</td>
<td>13</td>
<td>106</td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>FILL - CLAYEY SAND (SC), fine to medium grained, brown, loose</td>
<td>5390 +/-</td>
<td>5-7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.5</td>
<td>SILTY CLAYEY SAND (SC-SM), fine to medium grained, light brown, loose</td>
<td>5379.5 +/-</td>
<td>6-9</td>
<td>8</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>24.0</td>
<td>SANDY LEAN CLAY (CL), brown, very stiff</td>
<td>5373 +/-</td>
<td>6-5</td>
<td>15</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>27.5</td>
<td>CLAYEY SAND (SC), fine to medium grained, brown, medium dense</td>
<td>5369 +/-</td>
<td>10-11</td>
<td>18</td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>50.0</td>
<td>CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light brown to light gray, medium hard to very hard</td>
<td>5347 +/-</td>
<td>20-30</td>
<td>5461</td>
<td>27</td>
<td>95</td>
</tr>
</tbody>
</table>

Boring Terminated at 50 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: 4-inch outside diameter solid stem auger

Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling

Notes:

Boring Started: 1/5/2015  Boring Completed: 1/5/2015

See Exhibit A-1 for description of field procedures

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Drill Rig: CME-55  Driller:

Project No.: 25145052A  Exhibit: A-17
**BORING LOG NO. 15**

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.

**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

---

**LOCATION**  
See Exhibit A-2  
Latitude: 39.697859°  
Longitude: -104.940436°  
Approximate Surface Elev: 5412 (Ft.) +/-

---

### GRAPHIC LOG

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>SAMPLE TYPE</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
<th>WATERSHED CONTENT (%)</th>
<th>SWELL (%)</th>
<th>LL-PL-PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>ASPHALT</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>FILL - CLAYEY SAND (SC)</td>
<td>fine to coarse-grained, dark brown, loose to medium dense</td>
<td>x 12 10-15 12 105 25-16-9 29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5</td>
<td>CLAYEY SAND (SC)</td>
<td>fine to medium grained, brown, loose</td>
<td>x 12 4-6 9 105</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.5</td>
<td>SANDY LEAN CLAY (CL)</td>
<td>brown, medium stiff to stiff</td>
<td>x 12 3-4 9 95</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.0</td>
<td>CLAYSTONE</td>
<td>interbedded with SANDSTONE, reddish-brown to light brown to light gray, medium hard to hard</td>
<td>x 12 3-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.2</td>
<td></td>
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<td></td>
</tr>
<tr>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Boring Terminated at 40 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

---

**ADVANCEMENT METHOD:** 4-inch outside diameter solid stem auger

**ABANDONMENT METHOD:** Boring backfilled with auger cuttings and patched with asphalt after drilling

---

**WATER LEVEL OBSERVATIONS**  
37 feet during drilling

---

**LOCATION**  
NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

---

**DEPTH**  
Latitude: 39.697859°  
Longitude: -104.940436°

---

**WATER LEVEL OBSERVATIONS**  
37 feet during drilling
### BORING LOG NO. 16

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.

**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>See Exhibit A-2</th>
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<tbody>
<tr>
<td>Latitude: 39.69768°</td>
<td>Longitude: -104.940433°</td>
</tr>
<tr>
<td>Approximate Surface Elev: 5412 (FL) +/-</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>DEPTH (FT.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>None encountered</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELEVATION (FL.)</th>
<th>FIELD TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>RECOVERY (ft.)</td>
<td>UNCONFINED COMPRESSION (MPa)</td>
</tr>
<tr>
<td>12</td>
<td>22</td>
</tr>
<tr>
<td>3-4</td>
<td>104</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SAMPLE TYPE</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Asphalt</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>WET UNITWEIGHT (pcf)</th>
<th>SWELL (%)</th>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>104</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WATER CONTENT (%)</th>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>DRILL TYPE</th>
<th>Hammer Type: Automatic</th>
</tr>
</thead>
</table>

**Advancement Method:** 4-inch outside diameter solid stem auger  
**Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

**Notes:**

- See Exhibit A-1 for description of field procedures  
- See Appendix B for description of laboratory procedures and additional data (if any).  
- See Appendix C for explanation of symbols and abbreviations.
<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>SAMPLE TYPE</th>
<th>FIELD TEST RESULTS</th>
<th>SWELL (%)</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>DRY UNIT WEIGHT (pcf)</th>
<th>ATTERBERG LIMITS</th>
<th>LL-PL-PI</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4</td>
<td>ASPHALT, (About 4-1/2 inches)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>FILL - CLAYEY SAND (SC), fine to medium grained, with gravel, dark brown, loose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.0</td>
<td>CLAYEY SAND (SC), fine to medium grained, brown to light brown, loose</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.0</td>
<td>SANDY LEAN CLAY (CL), brown, stiff</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.0</td>
<td>CLAYEY SAND (SC), fine to medium grained, brown, medium dense</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31 feet during drilling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.0</td>
<td>CLAYSTONE, interbedded with SANDSTONE, reddish-brown to light to brown to light gray, medium hard to hard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Annex 1: Additional Information*

- Advancement Method: 4-inch outside diameter solid stem auger
- Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling
- Notes: See Exhibit A-2 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.
### BORING LOG NO. 18

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**CLIENT:** Sonic Automotive, Inc.

**LOCATION**  
See Exhibit A-2  
Latitude: 39.6974°  
Longitude: -104.9401°  
Approximate Surface Elev: 5412.5 (Fl.) +/-

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>WATER LEVEL OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5</td>
<td>ASPHALT, (About 6 inches)</td>
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<tr>
<td>8.0</td>
<td>FILL - SILTY SAND (SM), fine to medium grained, dark brown, loose</td>
</tr>
<tr>
<td>17.0</td>
<td>SANDY LEAN CLAY (CL), brown, medium stiff to stiff</td>
</tr>
<tr>
<td>25.0</td>
<td>CLAYSTONE, brown, medium hard to very hard</td>
</tr>
<tr>
<td>40.0</td>
<td>SANDSTONE, fine to medium grained, brown, medium hard to very hard</td>
</tr>
</tbody>
</table>

**Boring Terminated at 40 Feet**

<table>
<thead>
<tr>
<th>DEPTH (Ft.)</th>
<th>FIELD TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>4-4</td>
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<td>12</td>
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<td>8</td>
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<td>3-8</td>
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<tr>
<td>12</td>
<td>7-8</td>
</tr>
<tr>
<td>7</td>
<td>50/7”</td>
</tr>
<tr>
<td>8</td>
<td>50/6” +1.2 @500 psf</td>
</tr>
<tr>
<td>19</td>
<td>110</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>10</td>
<td>50/10”</td>
</tr>
<tr>
<td>8</td>
<td>50/6”</td>
</tr>
</tbody>
</table>

**Notes:**  
Advancement Method: 4-inch outside diameter solid stem auger  
Abandonment Method: Boring backfilled with auger cuttings and patched with asphalt after drilling  
Notes:

- **DATE**  
  Boring Started: 4/29/2015  
  Boring Completed: 4/29/2015

- **DRILL RIG**  
  CME-55

- **DRILLER**  
  A-21

- **ADDRESS**  
  10625 W I-70 Frontage Road N., Ste. 3  
  Wheat Ridge, Colorado

- **PROJECT NO.**  
  25145052A

- **EXHIBIT**  
  A-21
## BORING LOG NO. 19

### PROJECT: Proposed Denver BMW

### CLIENT: Sonic Automotive, Inc.

### SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

**LOCATION**
- See Exhibit A-2
- Latitude: 39.6972°
- Longitude: -104.9399°
- Approximate Surface Elev: 5412 (FL) +/-

### DEPTH AND ELEVATION
<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>ELEVATION (FL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.0</td>
<td>5404 +/-</td>
</tr>
<tr>
<td>17.0</td>
<td>5395 +/-</td>
</tr>
<tr>
<td>25.0</td>
<td>5387 +/-</td>
</tr>
<tr>
<td>50.0</td>
<td>5362 +/-</td>
</tr>
</tbody>
</table>

### WATER LEVEL OBSERVATIONS
- *Approximate Surface Elev: 5412 (Ft.) +/-*
- 24.5 feet during drilling

### FIELD TEST RESULTS

<table>
<thead>
<tr>
<th>SAMPLE TYPE</th>
<th>RECOVERY (FL)</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSION STRENGTH (psf)</th>
<th>PERCENT FINES</th>
<th>LL-PL-PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>2-3</td>
<td></td>
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<tr>
<td>12</td>
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<tr>
<td>12</td>
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<td>30-50/2</td>
<td>-0.1 @ 500 psf</td>
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<td></td>
</tr>
<tr>
<td>4</td>
<td>50/4</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>50/6</td>
<td></td>
<td></td>
<td></td>
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<td>50/3</td>
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</table>

### Advancement Method:
- 4-inch outside diameter solid stem auger

### Abandonment Method:
- Boring backfilled with auger cuttings and patched with asphalt after drilling

### Notes:
- See Exhibit A-1 for description of field procedures
- See Appendix B for description of laboratory procedures and additional data (if any).
- See Appendix C for explanation of symbols and abbreviations.
### BORING LOG NO. 20

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

#### LOCATIONS

- **Location:** See Exhibit A-2  
- **Latitude:** 39.6973°  
- **Longitude:** -104.9395°  
- **Approximate Surface Elev:** 5408 (FL) +/-

#### FIELD TEST RESULTS

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Recovery (in.)</th>
<th>Field Test</th>
<th>Swell (%)</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Water Content (%)</th>
<th>Dry Unit Weight (pcf)</th>
<th>Atterberg Limits</th>
<th>LL - PL - PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>4-6</td>
<td>-0.8 @ 500 psf</td>
<td>8</td>
<td>107</td>
<td></td>
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<tr>
<td>12</td>
<td>3-5</td>
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<tr>
<td>12</td>
<td>3-4</td>
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<td>101</td>
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<td>2-4</td>
<td></td>
<td>21</td>
<td>97</td>
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<tr>
<td>10</td>
<td>50/10&quot;</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>3</td>
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<td></td>
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<tr>
<td>4</td>
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<td></td>
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<tr>
<td>3</td>
<td>50/3&quot;</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

#### WATER LEVEL OBSERVATIONS

- **Approximate Surface Elev:** 5408 (Ft.) +/-
- **Depth (Ft.):** 34 feet during drilling
- **Boring Terminated at 40 Feet**

**Stratification lines are approximate. In-situ, the transition may be gradual.**

**Hammer Type:** Automatic

**Advancement Method:** 4-inch outside diameter solid stem auger

**Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

**Notes:**

- See Exhibit A-1 for description of field procedures  
- See Appendix B for description of laboratory procedures and additional data (if any).  
- See Appendix C for explanation of symbols and abbreviations.

**Water Level Observations:** 34 feet during drilling

**Location:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**Client:** Sonic Automotive, Inc.  
**Project No.:** 25145052A  
**Exhibit:** A-23
### Water Level Observations

- **Elevation (Ft.):**
  - 51
  - 10
  - 15
  - 20
  - 25
  - 30
  - 35
  - 40

- **Recovery (In.):**
  - 3

- **Swell (%):**
  - 35

- **Unconfined Compressive Strength (psf):**
  - 509

### Advancement Method
- **4-inch outside diameter solid stem auger**

### Abandonment Method
- **Boring backfilled with auger cuttings and patched with asphalt after drilling**

### Notes:
- **Project No.:** 25145052A
- **Driller:**
- **Drill Rig:** CME-55
- **Exhibit:** A-24
- **Boring Started:** 4/29/2015
- **Boring Completed:** 4/29/2015

### Additional Information
- **Approximate Surface Elev:** 5406.5 (Ft.) +/-
- **Lat:** 39.6974°, **Long:** -104.9392°
## BORING LOG NO. 22

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado  
**CLIENT:** Sonic Automotive, Inc.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>DEPTH (FT)</th>
<th>WATER LEVEL OBSERVATIONS</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSION STRENGTH (psi)</th>
<th>PERCENT FINES</th>
<th>ATTERBERG LIMITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASPHALT (About 5 inches)</td>
<td>4.4</td>
<td>542</td>
<td>12</td>
<td>5-6</td>
<td>-0.1 @ 500 psf</td>
<td>12</td>
</tr>
<tr>
<td>FILL - SILTY SAND (SM), fine to medium grained, dark brown, loose</td>
<td>8.0</td>
<td>539</td>
<td>12</td>
<td>7-8</td>
<td>24</td>
<td>97</td>
</tr>
<tr>
<td>SILTY SAND (SM), fine to medium grained, dark brown, loose</td>
<td>12.0</td>
<td>531</td>
<td>12</td>
<td>4-5</td>
<td>24</td>
<td>97</td>
</tr>
<tr>
<td>SANDY LEAN CLAY (CL), brown, medium stiff to stiff</td>
<td>22.5</td>
<td>538</td>
<td>12</td>
<td>5-8</td>
<td>24</td>
<td>97</td>
</tr>
<tr>
<td>CLAYSTONE, brown, medium hard to hard</td>
<td>33.0</td>
<td>537</td>
<td>8</td>
<td>506</td>
<td>24</td>
<td>97</td>
</tr>
<tr>
<td>SANDSTONE, fine to medium grained, dark brown, medium hard to very hard</td>
<td>42.5</td>
<td>536</td>
<td>8</td>
<td>508</td>
<td>24</td>
<td>97</td>
</tr>
<tr>
<td>CLAYSTONE, brown, very hard</td>
<td>50.0</td>
<td>535</td>
<td>4</td>
<td>504</td>
<td>24</td>
<td>97</td>
</tr>
</tbody>
</table>

**Boring Terminated at 50 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Advancement Method:** 4-inch outside diameter solid stem auger  
**Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**LOCATION**  
Latitude: 39.6975°  
Longitude: -104.9388°

**GRAPHIC LOG See Exhibit A-2**

**FIELD TEST RESULTS**

- **UNCONFINED COMPRESSIVE STRENGTH (psi)**
- **PERCENT FINES**
- **ATERBERG LIMITS**

**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado  
**CLIENT:** Sonic Automotive, Inc.

**Location:** See Exhibit A-2  
**Depth:** Approximate Surface Elev. 5403 (Ft.) +/-  
**DEPT:** ELEVATION (FT)

**Boring Terminated at 50 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25

**WATER LEVEL OBSERVATIONS**
- 35 feet during drilling

**Hammer Type:** Automatic

**Notes:**
- Project No.: 25145052A  
- Exhibit: A-25
### BORING LOG NO. 23

**PROJECT:** Proposed Denver BMW  
**CLIENT:** Sonic Automotive, Inc.  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
Denver, Colorado

#### GRAPHIC LOG

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>See Exhibit A-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude: 39.6969°</td>
<td>Longitude: -104.9392°</td>
</tr>
<tr>
<td>Approximate Surface Elev: 5406 (FL) +/-</td>
<td></td>
</tr>
</tbody>
</table>

#### DEPTH ELEVATION (FL)

<table>
<thead>
<tr>
<th>SAMPLE TYPE</th>
<th>RECOVERY (hr.)</th>
<th>FIELD TEST RESULTS</th>
<th>UNCONFINED COMPRESSIVE STRENGTH (psi)</th>
<th>SWELL (%)</th>
<th>WATERSHED CONDUCTIVITY (%)</th>
<th>DRILL CORE WEIGHT (lb.)</th>
<th>PERCENT FINES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASPHALT, (About 5 inches)</td>
<td>12</td>
<td>4-6</td>
<td>5405.5 +/-</td>
<td>5402 +/-</td>
<td>5393 +/-</td>
<td></td>
<td></td>
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<tr>
<td>FILL - LEAN CLAY (CL), dark brown, stiff</td>
<td>12</td>
<td>4-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SANDY LEAN CLAY (CL), brown, medium stiff</td>
<td>12</td>
<td>4-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ELASTIC SILT (MH), brown to orange brown, medium dense</td>
<td>12</td>
<td>11-13</td>
<td>23</td>
<td>104</td>
<td>58-26-32</td>
<td>97</td>
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</tr>
<tr>
<td>CLAYSTONE, brown to gray, medium hard to hard</td>
<td>8</td>
<td>50/8&quot;</td>
<td></td>
<td></td>
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<td>6</td>
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<td>11557</td>
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</tr>
<tr>
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<td>6</td>
<td>50/6&quot;</td>
<td></td>
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<td></td>
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</tbody>
</table>

**Boring Terminated at 40 Feet**

Stratification lines are approximate. In-situ, the transition may be gradual.

**Hammer Type:** Automatic

**Notes:**

- **Advancement Method:** 4-inch outside diameter solid stem auger  
- **Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling  
- **WATER LEVEL OBSERVATIONS:** 30 feet during drilling  
- **Notes:** See Exhibit A-1 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.  
- **Boring Started:** 4/29/2015  
- **Boring Completed:** 4/29/2015  
- **Drill Rig:** CME-55  
- **Driller:**  
- **Project No.:** 25145052A  
- **Exhibit:** A-26
## Boring Log No. 24

**Project:** Proposed Denver BMW  
**Client:** Sonic Automotive, Inc.  
**Site:** NE. of S. Colorado Blvd. and E. Mississippi Ave., Denver, Colorado

### Graphical Log
- Location: See Exhibit A-2
- Approximate Surface Elev: 5402 (FL) +/-

### Stratification
- **Asphalt:** (About 4 inches)
  - **Fill - Lean Clay (CL):** dark brown, medium stiff
- **Sandy Lean Clay (CL):** brown to tan, medium stiff to very stiff
- **Claystone:** brown to gray, medium hard to very hard

### Water Level Observations
- **Approximate Surface Elev:** 5402 (Ft.) +/-
- **27 feet during drilling**

### Field Test Results
<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Recovery (ft.)</th>
<th>Swell (%)</th>
<th>Unconfined Compressive Strength (psi)</th>
<th>Water Content (%)</th>
<th>Dry Unit Weight (pcf)</th>
<th>Atterberg Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>3-4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>12</td>
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<td>12</td>
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<td>+0.4 @ 500 psf</td>
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</tbody>
</table>

### Advancement and Abandonment Methods
- **Advancement Method:** 4-inch outside diameter solid stem auger
- **Abandonment Method:** Boring backfilled with auger cuttings and patched with asphalt after drilling

### Additional Notes
- Monitor 3-4-44-415-2850/10"50/8"50/9"50/4"50/4"
- Hammer Type: Automatic
- 2401.5+/=-5398.5+/=-5385+/=-5362+/-
- 121212108944+0.4 @500 psf
- In-situ, the transition may be gradual.

### Location
- Latitude: 39.6968°  
- Longitude: -104.9385°  
- Site: 10625 W I-70 Frontage Road N., Ste. 3, Wheat Ridge, Colorado

---

**Driller:**  
**Boring Started:** 4/29/2015  
**Boring Completed:** 4/29/2015  
**Drill Rig:** CME-55  
**Exhibit:** A-27  
**Project No.:** 25145052A  
**Notes:** See Exhibit A-1 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.
APPENDIX B
LABORATORY TESTING
Laboratory Testing
Samples retrieved during the field exploration were returned to the laboratory for observation by the project geotechnical engineer, and were classified in general accordance with the Unified Soil Classification System described in Appendix C.

At this time, an applicable laboratory-testing program was formulated to determine engineering properties of the subsurface materials. Following the completion of the laboratory testing, the field descriptions were confirmed or modified as necessary, and the Boring Logs were prepared. The boring logs are included in Appendix A.

Laboratory test results are included in Appendix B. These results were used for the geotechnical engineering analyses and the development of foundation and earthwork recommendations. All laboratory tests were performed in general accordance with the applicable local or other accepted standards.

Selected soil samples were tested for the following engineering properties:

- Water content
- Dry density
- Grain size distribution
- Atterberg limits
- Swell/consolidation
- Unconfined compressive strength
- Water soluble sulfate content
SWELL CONSOLIDATION TEST

NOTES: Water added at 500 psf

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Classification</th>
<th>( \gamma_d ), pcf</th>
<th>WC, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14 - 15 ft</td>
<td>CLAYEY SAND</td>
<td>111</td>
</tr>
</tbody>
</table>

NOTES: Water added at 500 psf
NOTES: Water added at 500 psf

Specimen Identification | Classification | \( \gamma_d \), pcf | WC, %
--- | --- | --- | ---
3 | 9 - 10 ft SILTY SAND | 104 | 9
NOTES: Water added at 500 psf

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Classification</th>
<th>$\gamma_d$, pcf</th>
<th>WC, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>9 - 10 ft</td>
<td>115</td>
<td>10</td>
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</tbody>
</table>

SWELL CONSOLIDATION TEST
SWELL CONSOLIDATION TEST

Specimen Identification | Classification | $\gamma_d$, pcf | WC, %
--- | --- | --- | ---
4 | 14 - 15 ft | LEAN CLAY | 107 | 19

NOTES: Water added at 500 psf

PROJECT: Proposed Denver BMW
SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

PROJECT NUMBER: 25145052A
CLIENT: Sonic Automotive, Inc.

10625 W I-70 Frontage Road N., Ste. 3
Wheat Ridge, Colorado
EXHIBIT: B-5
AXIAL STRAIN, %

PRESSURE, psf

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Classification</th>
<th>(\gamma_d), pcf</th>
<th>WC, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>14 - 15 ft</td>
<td>SILTY CLAYEY SAND</td>
<td>110</td>
</tr>
</tbody>
</table>

NOTES: Water added at 500 psf
SWELL CONSOLIDATION TEST

Notes: Water added at 500 psf

<table>
<thead>
<tr>
<th>Specimen Identification</th>
<th>Classification</th>
<th>( \gamma_d ), pcf</th>
<th>WC, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>9 - 10 ft</td>
<td>110</td>
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</tbody>
</table>

Specimen Identification:

Classification:

\( \gamma_d \), pcf:

WC, %:

-8 -6 -4 -2 0 2 4 6 8

AXIAL STRAIN, %

100 1,000 10,000

PRESSURE, psf

Project: Proposed Denver BMW

Client: Sonic Automotive, Inc.

Project Number: 25145052A

Exhibit: B-7
**SWELL CONSOLIDATION TEST**

**AXIAL STRAIN, %**

**PRESSURE, psf**

<table>
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<th>WC, %</th>
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</thead>
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<tr>
<td>7</td>
<td>19 - 20 ft</td>
<td>SANDY LEAN CLAY</td>
<td>103</td>
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</tbody>
</table>

**NOTES:** Water added at 500 psf
SWELL CONSOLIDATION TEST

Specimen Identification | Classification            | $\gamma_d$, pcf | WC, %
---|---|---|---
9 | 4 - 5 ft | FILL, CLAYEY SAND | 108 | 13

NOTES: Water added at 500 psf
SWELL CONSOLIDATION TEST

NOTES: Water added at 500 psf

<table>
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<th>WC, %</th>
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</thead>
<tbody>
<tr>
<td>16</td>
<td>CLAYSTONE</td>
<td>98</td>
<td>26</td>
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-claystone 19 - 20 ft
SWELL CONSOLIDATION TEST

AXIAL STRAIN, %

PRESSURE, psf

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<th>WC, %</th>
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<td>14 - 15 ft SANDY LEAN CLAY</td>
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NOTES: Water added at 500 psf
SWELL CONSOLIDATION TEST

NOTES:

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<td>24 - 25 ft</td>
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<td>19</td>
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PROJECT: Proposed Denver BMW

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

PROJECT NUMBER: 25145052A

CLIENT: Sonic Automotive, Inc.

EXHIBIT: B-12
SWELL CONSOLIDATION TEST

NOTES:

- Laboratory tests are not valid if separated from original report.
- TC CONSOL STRAIN USCS AND ASTM 25145052A.TERRACON2012.GDT 5/13/15

Specimen Identification | Classification | $\gamma_d$, pcf | WC, %
--- | --- | --- | ---
019 | 19 - 20 ft | CLAYSTONE | 105 | 22

PROJECT: Proposed Denver BMW

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

10625 W I-70 Frontage Road N., Ste. 3, Wheat Ridge, Colorado

PROJECT NUMBER: 25145052A

CLIENT: Sonic Automotive, Inc.

EXHIBIT: B-13
SWELL CONSOLIDATION TEST

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<th>WC, %</th>
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</thead>
<tbody>
<tr>
<td>● 20</td>
<td>2 - 3 ft</td>
<td>FILL, SILTY SAND</td>
<td>107 8</td>
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</table>

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. TC CONSL. STRAIN-USCS AND ASTM D2516/02.AMP. TERRACON 2012.GPT 5/13/15
SWELL CONSOLIDATION TEST

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<th>WC, %</th>
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</thead>
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<td>SANDY LEAN CLAY</td>
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<td>23</td>
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</tbody>
</table>

Specimen Identification

Classification

\( \gamma_d, \) pcf

WC, %

NOTES:

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. 
TC_CONSOL STRAIN-USCS-NO ASTM 25145052A.GPJ TERRACON 2012.GDT 5/13/15

PROJECT: Proposed Denver BMW

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

CLIENT: Sonic Automotive, Inc.

PROJECT NUMBER: 25145052A

EXHIBIT: B-15
Specimen Identification | Classification               | $\gamma_s$, pcf | WC, %
--- | --- | --- | ---
• 22 | 4 - 5 ft FILL, SILTY SAND | 117 | 12

NOTES:
**NOTES:**

<table>
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<th>WC, %</th>
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</thead>
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<td>• 24</td>
<td>14 - 15 ft</td>
<td>SANDY LEAN CLAY</td>
<td>107</td>
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<td></td>
<td></td>
<td>23</td>
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**PROJECT:** Proposed Denver BMW  
**SITE:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**CLIENT:** Sonic Automotive, Inc.  
**PROJECT NUMBER:** 25145052A  
**PROJECT NUMBER:** 25145052A  
**EXHIBIT:** B-17
## Grain Size Distribution

**ASTM D422**

### Grain Size Distribution Chart

![Grain Size Distribution Chart](image)

### Table: USCS and AASHTO Classification

<table>
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<th>Boring ID</th>
<th>Depth</th>
<th>USCS Classification</th>
<th>AASHTO Classification</th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Cc</th>
<th>Cu</th>
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</thead>
<tbody>
<tr>
<td>10</td>
<td>9-10</td>
<td>SILTY SAND(SM)</td>
<td>A-2-4(0)</td>
<td>NP</td>
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<td>NP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>4-5</td>
<td>SILTY SAND(SM)</td>
<td>A-2-4(0)</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>14-15</td>
<td>SANDY LEAN CLAY(CL)</td>
<td>A-4(3)</td>
<td>27</td>
<td>17</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>2-3</td>
<td>SILTY SAND(SM)</td>
<td>A-4(0)</td>
<td>NP</td>
<td>NP</td>
<td>NP</td>
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### Table: Hydrometer Analysis

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<th>D&lt;sub&gt;5&lt;/sub&gt;</th>
<th>D&lt;sub&gt;20&lt;/sub&gt;</th>
<th>D&lt;sub&gt;10&lt;/sub&gt;</th>
<th>%Gravel</th>
<th>%Sand</th>
<th>%Silt</th>
<th>%Clay</th>
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</thead>
<tbody>
<tr>
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<td>9-10</td>
<td>2</td>
<td>0.169</td>
<td>0.0</td>
<td>0.0</td>
<td>66.3</td>
<td>33.7</td>
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<td>4-5</td>
<td>2.36</td>
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<td>72.9</td>
<td>27.1</td>
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<tr>
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<td>0.0</td>
<td>64.5</td>
<td>35.5</td>
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</table>

**Project Details**

**Project Number:** 25145052A

**Site:** NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

**Client:** Sonic Automotive, Inc.

**Exhibit:** B-20

**Note:** Laboratory tests are not valid if separated from original report.

**Grain Size:** USCS & AASHTO combined 25145052A GPJ TERRACON 2012.GDT 5/13/15
UNCONFINED COMPRESSION TEST
ASTM D2166

SPECIMEN FAILURE MODE

Moisture Content:  %
Dry Density:  pcf
Diameter:  in.
Height:  in.
Height / Diameter Ratio:  2.07
Calculated Saturation:  %
Calculated Void Ratio:
Assumed Specific Gravity:
Failure Strain:  %
Unconfined Compressive Strength (psf)
Undrained Shear Strength (psf)
Strain Rate:  in/min
Remarks:

SAMPLE TYPE: D&M RING
DESCRIPTION: CLAYSTONE

SAMPLE LOCATION:  7 @ 24 - 25 feet

PROJECT: Proposed Denver BMW
SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave. Denver, Colorado

EXHIBIT: B-22
UNCONFINED COMPRESSION TEST
ASTM D2166

SPECIMEN FAILURE MODE

Failure Mode: Shear (dashed)

SPECIMEN TEST DATA

<table>
<thead>
<tr>
<th>Moisture Content:</th>
<th>%</th>
<th>25</th>
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</thead>
<tbody>
<tr>
<td>Dry Density:</td>
<td>pcf</td>
<td>90</td>
</tr>
<tr>
<td>Diameter:</td>
<td>in.</td>
<td>2.42</td>
</tr>
<tr>
<td>Height:</td>
<td>in.</td>
<td>3.82</td>
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<tr>
<td>Height / Diameter Ratio:</td>
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<td>1.58</td>
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<tr>
<td>Calculated Saturation:</td>
<td>%</td>
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</tr>
<tr>
<td>Calculated Void Ratio:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assumed Specific Gravity:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Failure Strain:</td>
<td>%</td>
<td>4.26</td>
</tr>
<tr>
<td>Unconfined Compressive Strength (psf):</td>
<td></td>
<td>3893</td>
</tr>
<tr>
<td>Undrained Shear Strength (psf):</td>
<td></td>
<td>1946</td>
</tr>
<tr>
<td>Strain Rate:</td>
<td>in/min</td>
<td></td>
</tr>
<tr>
<td>Remarks:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SAMPLE TYPE: D&M RING

DESCRIPTION: CLAYSTONE

SAMPLE LOCATION: 10 @ 24 - 25 feet

PROJECT: Proposed Denver BMW

SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

PROJECT NUMBER: 25145052A

CLIENT: Sonic Automotive, Inc.

EXHIBIT: B-23
### UNCONFINED COMPRESSION TEST
ASTM D2166

<table>
<thead>
<tr>
<th>SPECIMEN FAILURE MODE</th>
<th>SPECIMEN TEST DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Moisture Content: 27%</td>
</tr>
<tr>
<td></td>
<td>Dry Density: 95 pcf</td>
</tr>
<tr>
<td></td>
<td>Diameter: 2.42 in.</td>
</tr>
<tr>
<td></td>
<td>Height: 5.00 in.</td>
</tr>
<tr>
<td></td>
<td>Height / Diameter Ratio: 2.07</td>
</tr>
<tr>
<td></td>
<td>Calculated Saturation:</td>
</tr>
<tr>
<td></td>
<td>Calculated Void Ratio:</td>
</tr>
<tr>
<td></td>
<td>Assumed Specific Gravity:</td>
</tr>
<tr>
<td></td>
<td>Failure Strain: 3.00%</td>
</tr>
<tr>
<td></td>
<td>Unconfined Compressive Strength: 5461 (psf)</td>
</tr>
<tr>
<td></td>
<td>Undrained Shear Strength: 2730 (psf)</td>
</tr>
<tr>
<td></td>
<td>Strain Rate: in/min</td>
</tr>
<tr>
<td>Remarks:</td>
<td></td>
</tr>
</tbody>
</table>

**Sample Type:** D&M Ring  
**Sample Location:** 14 @ 29 - 30 feet  
**Description:** Claystone

<table>
<thead>
<tr>
<th></th>
<th>LL</th>
<th>PL</th>
<th>PI</th>
<th>Percent &lt; #200 Sieve</th>
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</table>

**Project:** Proposed Denver BMW  
**Site:** NE. of S. Colorado Blvd. and E. Mississippi Ave.  
**Client:** Sonic Automotive, Inc.  
**Exhibit:** B-24  
**Project Number:** 25145052A
UNCONFINED COMPRESSION TEST
ASTM D2166

SPECIMEN FAILURE MODE

Moisture Content: 22%
Dry Density: 95pcf
Diameter: 2.42in.
Height: 4.95in.
Height / Diameter Ratio: 2.04
Calculated Saturation: %
Calculated Void Ratio:
Assumed Specific Gravity:
Failure Strain: 2.27%
Unconfined Compressive Strength (psf) 3668
Undrained Shear Strength (psf) 1834
Strain Rate: in/min
Remarks:

SPECIMEN TEST DATA

SAMPLE TYPE: D&M RING
DESCRIPTION: CLAYSTONE
SAMPLE LOCATION: 21 @ 29 - 30 feet

PROJECT: Proposed Denver BMW
SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

CLIENT: Sonic Automotive, Inc.
PROJECT NUMBER: 25145052A
EXHIBIT: B-25
UNCONFINED COMPRESSION TEST
ASTM D2166

SPECIMEN FAILURE MODE

<table>
<thead>
<tr>
<th>SPECIMEN TEST DATA</th>
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<tbody>
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<td>Moisture Content: 22%</td>
</tr>
<tr>
<td>Dry Density: 98 pcf</td>
</tr>
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<tr>
<td>Height: 5.00 in.</td>
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<td>Height / Diameter Ratio: 2.07</td>
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<td>Calculated Saturation:</td>
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<td>Calculated Void Ratio:</td>
</tr>
<tr>
<td>Assumed Specific Gravity:</td>
</tr>
<tr>
<td>Failure Strain: 2.75%</td>
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<tr>
<td>Unconfined Compressive Strength: 11557 psi</td>
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<td>Undrained Shear Strength: 5779 psi</td>
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<tr>
<td>Strain Rate: in/min</td>
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</tbody>
</table>

Remarks:

Failure Mode: Shear (dashed)

SAMPLE TYPE: D&M RING
DESCRIPTION: CLAYSTONE

SAMPLE LOCATION: 23 @ 29 - 30 feet

PROJECT: Proposed Denver BMW
SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

PROJECT NUMBER: 25145052A
CLIENT: Sonic Automotive, Inc.

EXHIBIT: B-26
UNCONFINED COMPRESSION TEST
ASTM D2166

SPECIMEN FAILURE MODE

SPECIMEN TEST DATA

Failure Mode: Bulge (dashed)

Moisture Content: %
Dry Density: pcf
Diameter: in.
Height: in.
Height / Diameter Ratio:
Calculated Saturation: %
Calculated Void Ratio:
Assumed Specific Gravity:
Failure Strain: %
Unconfined Compressive Strength (psf)
Undrained Shear Strength (psf)
Strain Rate: in/min
Remarks:

SAMPLE TYPE: D&M RING
SAMPLE LOCATION: 24 @ 29 - 30 feet
DESCRIPTION: CLAYSTONE

PROJECT: Proposed Denver BMW
SITE: NE. of S. Colorado Blvd. and E. Mississippi Ave.
Denver, Colorado

PROJECT NUMBER: 25145052A
CLIENT: Sonic Automotive, Inc.

EXHIBIT: B-27
### SUMMARY OF LABORATORY TEST RESULTS

**Proposed Denver BMW - Denver, Colorado**  
**Terracon Project No. 25145052A**

<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>USCS Class.</th>
<th>Initial Dry Density (pcf)</th>
<th>Initial Water Content (%)</th>
<th>Swell/Consolidation</th>
<th>Particle Size Distribution, Percent Passing by Weight</th>
<th>Atterberg Limits</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Water Soluble Sulfates (mg/l)</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>1</td>
<td>4</td>
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<td>98</td>
<td>11</td>
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</tr>
</tbody>
</table>

**Notes:**  
Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.  
* = Partially disturbed sample  
- = Compression/settlement  
NV = no value  
NP = non-plastic

**Remarks:**  
1. Remolded compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)  
2. Remolded compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)  
3. Water added to sample  
4. Dry density and/or moisture content determined from one ring of a multi-ring sample  
5. Minus #200 Only  
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180
### SUMMARY OF LABORATORY TEST RESULTS

Proposed Denver BMW - Denver, Colorado  
Terracon Project No. 25145052A

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<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>USCS Class.</th>
<th>Initial Dry Density (pcf)</th>
<th>Initial Water Content (%)</th>
<th>Swell/Consolidation</th>
<th>Particle Size Distribution, Percent Passing by Weight</th>
<th>Atterberg Limits</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Water Soluble Sulfates (mg/l)</th>
<th>Remarks</th>
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**Notes:**  
Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.  
* = Partially disturbed sample  
- = Compression/settlement  
NV = no value  
NP = non-plastic

**Remarks:**  
1. Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)  
2. Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)  
3. Water added to sample  
4. Dry density and/or moisture content determined from one ring of a multi-ring sample  
5. Minus #200 Only  
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-29
### SUMMARY OF LABORATORY TEST RESULTS

Proposed Denver BMW - Denver, Colorado
Terracon Project No. 25145052A

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<th>Boring No.</th>
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7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-30
## SUMMARY OF LABORATORY TEST RESULTS

### Proposed Denver BMW - Denver, Colorado

**Terracon Project No. 25145052A**

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5. Minus #200 Only
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-31
# SUMMARY OF LABORATORY TEST RESULTS

Proposed Denver BMW - Denver, Colorado
Terracon Project No. 25145052A

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  - - = Compression/settlement
  - NV = no value
  - NP = non-plastic

**Remarks:**
1. Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)
2. Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)
3. Water added to sample
4. Dry density and/or moisture content determined from one ring of a multi-ring sample
5. Minus #200 Only
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-32
<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>USCS Class.</th>
<th>Initial Dry Density (pcf)</th>
<th>Initial Water Content (%)</th>
<th>Swell/Consolidation</th>
<th>Particle Size Distribution, Percent Passing by Weight</th>
<th>Atterberg Limits</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Water Soluble Sulfates (mg/l)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>4</td>
<td>SC-SM</td>
<td>109</td>
<td>15</td>
<td></td>
<td>100 100 99 89 26 22 5</td>
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</tr>
<tr>
<td>19</td>
<td>14</td>
<td>CL</td>
<td>96</td>
<td>22</td>
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<td>4</td>
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<tr>
<td>19</td>
<td>19</td>
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<td>105</td>
<td>22</td>
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<td>-0.1</td>
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<tr>
<td>20</td>
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<td>21</td>
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<td>SM</td>
<td>93</td>
<td>8</td>
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<tr>
<td>21</td>
<td>24</td>
<td></td>
<td>105</td>
<td>23</td>
<td>0.5</td>
<td>+0.1</td>
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<td>3,4</td>
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<tr>
<td>22</td>
<td>19</td>
<td>CL</td>
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<td>24</td>
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<td></td>
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<td>4</td>
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<tr>
<td>23</td>
<td>14</td>
<td>CH</td>
<td>104</td>
<td>23</td>
<td></td>
<td>100 100 100 100 97 58 32</td>
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<td>4</td>
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<td>23</td>
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<td>98</td>
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</tr>
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<td>24</td>
<td>9</td>
<td>CL</td>
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<td>23</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

Notes:
- Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.
- * = Partially disturbed sample
- - = Compression/settlement
- NV = no value
- NP = non-plastic

Remarks:
1. Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)
2. Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)
3. Water added to sample
4. Dry density and/or moisture content determined from one ring of a multi-ring sample
5. Minus #200 Only
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-33
<table>
<thead>
<tr>
<th>Boring No.</th>
<th>Depth (ft.)</th>
<th>USCS Class.</th>
<th>Initial Dry Density (pcf)</th>
<th>Initial Water Content (%)</th>
<th>Swell/Consolidation</th>
<th>Particle Size Distribution, Percent Passing by Weight</th>
<th>Atterberg Limits</th>
<th>Unconfined Compressive Strength (psf)</th>
<th>Water Soluble Sulfates (mg/l)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>14</td>
<td>CL</td>
<td>107</td>
<td>23</td>
<td>0.5</td>
<td>+0.4</td>
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<td>3,4</td>
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<td>99</td>
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<td>7832</td>
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<td>4</td>
</tr>
</tbody>
</table>

Notes:
- Initial Dry Density and Initial Water Content are in-situ values unless otherwise noted.
- * = Partially disturbed sample
- - = Compression/settlement
- NV = no value
- NP = non-plastic

Remarks:
1. Remolded Compacted density (about 95% of ASTM D698 maximum density near optimum moisture content)
2. Remolded Compacted density (about 95% of ASTM D1557 maximum density near optimum moisture content)
3. Water added to sample
4. Dry density and/or moisture content determined from one ring of a multi-ring sample
5. Minus #200 Only
7. Moisture-Density Relationship Test Method ASTM D1557/AASHTO T180

Exhibit B-34
APPENDIX C
SUPPORTING DOCUMENTS
**GENERAL NOTES**

### DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

- **Auger**
- **Shelby Tube**
- **Split Spoon**
- **Rock Core**
- **Macro Core**
- **Modified California Ring Sampler**
- **Grab Sample**
- **No Recovery**
- **Modified Dames & Moore Ring Sampler**

**WATER LEVEL**

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

**FIELD TESTS**

- (HP) Hand Penetrometer
- (T) Torvane
- (b/f) Standard Penetration Test (blows per foot)
- N N value
- (PID) Photo-ionization Detector
- (OVA) Organic Vapor Analyzer

### DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

### LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

### RELATIVE DENSITY OF COARSE-GRAINED SOILS

| Strength Terms    | Descriptive Term (Density) | Standard Penetration or N-Value Blows/ft. | Ring Sampler Blows/ft. | Descriptive Term (Consistency) | Unconfined Compressive Strength, Qu. psf | Standard Penetration or N-Value Blows/ft. | Ring Sampler Blows/ft. | Consistency of Fine-Grained Soils
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Loose</td>
<td>0-3</td>
<td>0-6</td>
<td>0-6</td>
<td>Very Soft</td>
<td>less than 500</td>
<td>0-1</td>
<td>3-4</td>
<td>50 or more passing the No. 200 sieve.</td>
</tr>
<tr>
<td>Loose</td>
<td>4-9</td>
<td>7-18</td>
<td>7-18</td>
<td>Soft</td>
<td>500 to 1,000</td>
<td>2-4</td>
<td>3-4</td>
<td>Firm</td>
</tr>
<tr>
<td>Medium Dense</td>
<td>10-29</td>
<td>19-58</td>
<td>19-58</td>
<td>Medium-Strong</td>
<td>1,000 to 2,000</td>
<td>5-7</td>
<td>5-9</td>
<td>Medium Hard</td>
</tr>
<tr>
<td>Dense</td>
<td>30-50</td>
<td>59-98</td>
<td>59-98</td>
<td>Stiff</td>
<td>2,000 to 4,000</td>
<td>8-14</td>
<td>10-18</td>
<td>Hard</td>
</tr>
<tr>
<td>Very Dense</td>
<td>&gt; 50</td>
<td>&gt; 99</td>
<td>&gt; 99</td>
<td>Very Stiff</td>
<td>4,000 to 8,000</td>
<td>15-30</td>
<td>19-42</td>
<td>Very Hard</td>
</tr>
<tr>
<td>Hard</td>
<td>&gt; 8,000</td>
<td>&gt; 30</td>
<td>&gt; 30</td>
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<td></td>
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### RELATIVE PROPORTIONS OF SAND AND GRAVEL

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
<th>Major Component of Sample</th>
<th>Particle Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 15</td>
<td>Boulders</td>
<td>Over 12 in. (300 mm)</td>
</tr>
<tr>
<td>With</td>
<td>15 - 29</td>
<td>Cobbles</td>
<td>12 in. to 3 in. (300mm to 75mm)</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 30</td>
<td>Gravel</td>
<td>3 in. to #4 sieve (75mm to 4.75 mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sand</td>
<td>#4 to #200 sieve (4.75mm to 0.075mm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Silt or Clay</td>
<td>Passing #200 sieve (0.075mm)</td>
</tr>
</tbody>
</table>

### RELATIVE PROPORTIONS OF FINES

<table>
<thead>
<tr>
<th>Descriptive Term(s) of other constituents</th>
<th>Percent of Dry Weight</th>
<th>Term</th>
<th>Plasticity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace</td>
<td>&lt; 5</td>
<td>Non-plastic</td>
<td>0</td>
</tr>
<tr>
<td>With</td>
<td>5 - 12</td>
<td>Low</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Modifier</td>
<td>&gt; 12</td>
<td>Medium</td>
<td>11 - 30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High</td>
<td>&gt; 30</td>
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</table>

### GRAIN SIZE TERMINOLOGY

<table>
<thead>
<tr>
<th>Term</th>
<th>Plasticity Index</th>
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<tbody>
<tr>
<td>Non-plastic</td>
<td>0</td>
</tr>
<tr>
<td>Low</td>
<td>1 - 10</td>
</tr>
<tr>
<td>Medium</td>
<td>11 - 30</td>
</tr>
<tr>
<td>High</td>
<td>&gt; 30</td>
</tr>
</tbody>
</table>
# UNIFIED SOIL CLASSIFICATION SYSTEM

## Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests

<table>
<thead>
<tr>
<th>Gravel Classification</th>
<th>Group Symbol</th>
<th>Group Name</th>
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</thead>
<tbody>
<tr>
<td>Gravels: More than 50% of coarse fraction retained on No. 4 sieve</td>
<td>Clean Gravels: Less than 5% fines</td>
<td>GW Well-graded gravel</td>
</tr>
<tr>
<td>Gravels with Fines: More than 12% fines</td>
<td>Fines classify as ML or MH</td>
<td>GM Silty gravel</td>
</tr>
<tr>
<td>Sands: 50% or more of coarse fraction passes No. 4 sieve</td>
<td>Clean Sands: Less than 5% fines</td>
<td>SW Well-graded sand</td>
</tr>
<tr>
<td>Sands with Fines: More than 12% fines</td>
<td>Fines classify as ML or MH</td>
<td>SM Silty sand</td>
</tr>
</tbody>
</table>

## Coarse Grained Soils: More than 50% retained on No. 200 sieve

### Gravels:
- More than 50% of coarse fraction retained on No. 4 sieve
- Gravels: More than 50% of coarse fraction retained on No. 4 sieve
- Clean Gravels: Less than 5% fines
- Gravels with Fines: More than 12% fines
- Sands: 50% or more of coarse fraction passes No. 4 sieve
- Clean Sands: Less than 5% fines
- Sands with Fines: More than 12% fines

### Sands:
- 50% or more of coarse fraction passes No. 4 sieve
- Clean Sands: Less than 5% fines
- Sands with Fines: More than 12% fines

## Fine-Grained Soils: 50% or more passes the No. 200 sieve

### Silts and Clays:
- Liquid limit less than 50
- Inorganic: PI plots on or above “A” line
- Organic: Liquid limit - oven dried
- Liquid limit - not dried

### Highly organic soils:
- Primarily organic matter, dark in color, and organic odor

## For classification of fine-grained soils and fine-grained fraction of coarse-grained soils

- Equation of “A” line
  - Horizontal at Pl = 4 to LL = 25.5, then Pl = 0.73 (LL-20)
  - Equation of “U” line
  - Vertical at LL = 16 to Pl = 7, then Pl = 0.9 (LL-8)

---

**Note:**
- **A** Based on the material passing the 3-inch (75-mm) sieve
- **B** If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.
- **C** Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.
- **D** Sands with 5 to 12% fines require dual symbols: SW-SC well-graded sand with clay, SP-SC poorly graded sand with clay.
- **E** $Cu = \frac{D_{60}}{D_{10}}$ and $Cc = \frac{(D_{60})^2}{D_{10} \times D_{60}}$
- **F** If soil contains ≥ 15% sand, add “with sand” to group name.
- **G** If fines classify as CL-ML, use dual symbol GC-GM, or SC-SC.
- **H** If fines are organic, add “with organic fines” to group name.
- **I** If soil contains ≥ 15% gravel, add “with gravel” to group name.
- **J** If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.
- **K** If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.
- **L** If soil contains ≥ 30% plus No. 200, predominantly sand, add “sandy” to group name.
- **M** If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.
- **N** PI plots on or above “A” line.
- **O** PI plots below “A” line.
DESCRIPTION OF ROCK PROPERTIES

WEATHERING

Fresh
Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.

Very slight
Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.

Slight
Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.

Moderate
Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.

Moderately severe
All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist’s pick.

Severe
All rock except quartz discolored or stained. Rock “fabric” clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.

Very severe
All rock except quartz discolored or stained. Rock “fabric” discernible, but mass effectively reduced to “soil” with only fragments of strong rock remaining.

Complete
Rock reduced to “soil”. Rock “fabric” not discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh’s scale for minerals)

Very hard
Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist’s pick.

Hard
Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.

Moderately hard
Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist’s pick. Hand specimens can be detached by moderate blow.

Medium
Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist’s pick.

Soft
Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.

Very soft
Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

<table>
<thead>
<tr>
<th>Joint, Bedding, and Foliation Spacing in Rock</th>
<th>Spacing</th>
<th>Joints</th>
<th>Bedding/Foliation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 2 in.</td>
<td>Very close</td>
<td>Very thin</td>
<td></td>
</tr>
<tr>
<td>2 in. – 1 ft.</td>
<td>Close</td>
<td>Thin</td>
<td></td>
</tr>
<tr>
<td>1 ft. – 3 ft.</td>
<td>Moderately close</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>3 ft. – 10 ft.</td>
<td>Wide</td>
<td>Thick</td>
<td></td>
</tr>
<tr>
<td>More than 10 ft.</td>
<td>Very wide</td>
<td>Very thick</td>
<td></td>
</tr>
</tbody>
</table>

a. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

<table>
<thead>
<tr>
<th>Rock Quality Designator (RQD)</th>
<th>RQD, as a percentage</th>
<th>Diagnostic description</th>
<th>Joint Openness Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceeding 90</td>
<td>Excellent</td>
<td></td>
<td>No Visible Separation</td>
</tr>
<tr>
<td>90 – 75</td>
<td>Good</td>
<td></td>
<td>Less than 1/32 in.</td>
</tr>
<tr>
<td>75 – 50</td>
<td>Fair</td>
<td></td>
<td>1/32 to 1/8 in.</td>
</tr>
<tr>
<td>50 – 25</td>
<td>Poor</td>
<td></td>
<td>1/8 to 3/8 in.</td>
</tr>
<tr>
<td>Less than 25</td>
<td>Very poor</td>
<td></td>
<td>3/8 in. to 0.1 ft.</td>
</tr>
<tr>
<td>RQD (given as a percentage)</td>
<td>length of core in pieces greater than 4 in. and longer/length of run.</td>
<td>Greater than 0.1 ft.</td>
<td>wider</td>
</tr>
</tbody>
</table>