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GEOTECHNICAL ENGINEERING STUDY
AND PAVEMENT THICKNESS DESIGN
PROPOSED AMERICAN FAMILY CARE – URGENT CARE FACILITY
11310 EAST COLFAX
AURORA, COLORADO

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Project No. 21-1-303 Date: April 30, 2021

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This electronic plan is a facsimile of the signed and sealed pdf set

James A Noll
4-30-2021

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Approved for Two Years From This Date	
City Engineer	Date

TABLE OF CONTENTS

SUMMARY

1. Beneath the pavement, existing man-placed fill extended to natural clay soils at depths ranging from about 2 to 8 feet. The natural soils extended to the maximum drilled depths of about 5 feet in Borings P-1, P-2, and Perc-1, or to claystone bedrock at depths of about 9 and 9.5 feet in Borings 1 and 2, respectively. Where encountered, the claystone bedrock extended to the maximum drilled depths of about 25 feet.

   Groundwater was encountered in Borings 1 and 2 at a depth of about 13 feet at the time of drilling. Those borings were left open for a period of 7 days in order to obtain stabilized groundwater measurements. Stabilized groundwater was measured at depths of about 4.3 and 3.3 feet in Borings 1 and 2 respectively. Groundwater levels are expected to fluctuate with time, and may fluctuate upward after wet weather or subsequent to landscape irrigation.

   The higher groundwater levels encountered at shallower depths when measured at 7 days may have been seepage into the bore hole from storm events.

2. Based on conditions encountered in the borings, it appears that the site is underlain by up to 8 feet of fill in places. Without documentation regarding placement of the existing fill, the fill should be considered non-engineered and be completely removed from beneath foundations and floor slabs. An alternative for leaving a portion of the fill in place is provided herein.

3. Based on the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we believe shallow spread footings placed on a prepared subgrade are feasible.

   Footings placed on a prepared subgrade as described herein should be designed for a net allowable bearing pressure of 2,000 psf. The allowable bearing pressure may be increased by one-third for seismic and/or wind loads.

4. Pavement section alternatives based on the on-site material properties and local industry standard of practice are presented below:

Pavement Type	**Full-Depth Asphalt (in)**	**Composite HMA over ABC (in)**	**PCCP (in)**
Light-Duty Pavements	6.0	4.0/8.0	6.0
Medium-Duty Pavements	7.0	4.5/8.0	7.0

HMA = Hot Mix Asphalt, ABC = Aggregate Base Course, PCCP= Portland Cement Concrete Pavement

PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study and pavement thickness design for the proposed American Family Care (AFC) Urgent Care facility to be located at 11310 East Colfax Avenue in Aurora, Colorado. The project site is generally shown on Fig. 1. The study was conducted for the purpose of developing recommendations for foundations, floor slabs, site grading and site pavements. The study was conducted in accordance with the scope of work presented in our Proposal No. P-21-283 dated March 9, 2021.

A field exploration program consisting of drilling exploratory borings was conducted to obtain information on subsurface conditions. Samples of the soils and bedrock materials obtained during the field exploration program were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration program and laboratory testing were analyzed to develop geotechnical engineering recommendations for use in site earthwork and in design and construction of the proposed development.

This report has been prepared to summarize the data obtained during this study and to present our conclusions and recommendations based on the proposed construction and the subsurface conditions encountered. Design parameters and a discussion of geotechnical engineering considerations related to construction of the proposed development are included in the report.

PROPOSED CONSTRUCTION

We understand the proposed construction will include a single-story, at-grade building with an approximately 6,781 sf footprint area, with new site pavements on the south and west sides of the building. Prior to construction the existing building will be razed. Foundation loads are expected to be light to moderate, typical of this type of construction. Site grading is expected to be minimal with a finished floor elevation slightly elevated above existing site grades.

If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations provided herein.

SITE CONDITIONS

The site is located at the southwest corner of the intersection of East Colfax Avenue and Macon Street. The site is generally surrounded by commercial properties to the west, north, and east, with multifamily residences to the south. At the time of our field exploration program, the site was occupied by an existing single-story, at-grade, restaurant building situated on the western portion of the lot. The remaining portion of the lot is covered with asphalt pavement. Topography is nearly level.

SUBSURFACE CONDITIONS

Field Exploration: The field exploration program for the project was conducted on April 13, 2021 and consisted of drilling four exploratory borings and a percolation test hole at the approximate locations shown on Fig. 1. The boring locations were determined in the field by pacing from existing site features and referencing the proposed site plan provided. The logs of the exploratory borings along with a legend and associated explanatory notes are presented on Fig. 2.

The borings were advanced with either a 4-inch-diameter or 6-inch-diameter, continuous-flight auger and were logged by a representative of Kumar & Associates, Inc. (K+A). Samples of the soils were obtained with a 2-inch I.D. California-liner sampler driven into the various strata with blows from a 140-pound hammer falling 30 inches. The California-liner sampler is similar to the standard penetration test described by ASTM International (ASTM) Method D1586 and is used locally for obtaining relatively undisturbed cohesive samples. The interpreted penetration resistance values (blow counts) provide an indication of the relative density or consistency of the soils and bedrock. The depths at which the samples were taken and the blow counts are shown to the right of the boring logs on Fig. 2.

Subsurface Soil Conditions: The borings generally encountered a pavement section consisting of about 2 to 4 inches of asphalt pavement underlain by about 2 to 4 inches of aggregate base course. The pavement section in Boring 1 was underlain immediately by an approximately 4-inch-thick concrete slab. The pavement was underlain by existing man-placed fill extending to natural clay soils at depths ranging from about 2 to 8 feet. The natural soils extended to the maximum drilled depths of about 5 feet in Borings P-1, P-2, and Perc-1, or to claystone bedrock at depths of about 9 and 9.5 feet in Borings 1 and 2, respectively. Where encountered, the claystone bedrock extended to the maximum drilled depths of about 25 feet.

The fill consisted of brown to dark brown to dark gray, slightly moist to moist, lean clay with a variable fine- to medium-grained sand fraction. The lateral and vertical extent, along with the degree of compaction, was not determined as part of this study. The fill materials generally appeared to be locally derived from natural soils, and the transition from suspected fill to natural soils may not be evident until the soils are exposed during excavation.

The natural overburden soils generally consisted of light brown to brown, slightly moist to moist, sandy lean clay with a fine- to medium-grained sand fraction. Based on sampler blow counts, the natural clay soils were medium stiff to stiff.

The claystone bedrock was generally light brown to gray, moist to very moist, with a fine to medium-grained sand fraction and was iron-stained. Based on sampler blow counts the bedrock was weathered to firm.

Groundwater Conditions: Groundwater was encountered in Borings 1 and 2 at a depth of about 13 feet at the time of drilling. Those borings were left open for a period of 7 days in order to obtain stabilized groundwater measurements. Stabilized groundwater was measured at depths of about 4.3 and 3.3 feet in Borings 1 and 2 respectively. Groundwater levels are expected to fluctuate with time, and may fluctuate upward after wet weather or subsequent to landscape irrigation.

The higher groundwater levels encountered at shallower depths when measured at 7 days may have been seepage into the bore hole from storm events.

LABORATORY TESTING

Laboratory testing was performed on representative soil samples obtained from the borings to determine in-situ soil moisture content and dry density, Atterberg limits, swell-consolidation characteristics, minimum electrical resistivity, and concentration of water-soluble sulfates. The results of the laboratory tests are shown to the right of the logs on Fig. 2 and summarized in Table I. The results of specific tests are graphically plotted on Figs. 3 through 5. The testing was conducted in accordance with recognized ASTM and Colorado Department of Transportation (CDOT) test procedures.

Swell-Consolidation: Swell-consolidation tests were conducted on representative samples of the overburden soils and bedrock materials in order to evaluate their compressibility and swell characteristics under loading and when submerged in water. Each sample was prepared and placed in a confining ring between porous discs, subjected to surcharge pressures of 200 psf or 1,000 psf, and allowed to consolidate before being submerged. The sample height was monitored until deformation practically ceased under each load increment.

Results of the swell-consolidation tests are plotted as a curve of the final strain at each increment of pressure against the log of the pressure and are presented on Figs. 3 and 4. Based on the results of the laboratory swell-consolidation testing the overburden soils and bedrock materials exhibited a nil to low swell potential upon wetting under the applied surcharge pressure.

Index Properties: Samples were classified into categories of similar engineering properties in general accordance with the Unified Soil Classification System. This system is based on index properties, including liquid limit and plasticity index and gradation characteristics. Values for moisture content, dry density, liquid limit and plasticity index, and the percent of soil passing the U.S. No. 200 sieve are presented in Table I and adjacent to the corresponding sample on the boring logs.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Based on conditions encountered in the borings, it appears that the site is underlain by up to about 8 feet of fill in places. Without documentation of placement conditions including density testing documenting the degree of compaction, the existing fill materials should be considered non-engineered and generally not suitable in their current condition for support of foundations or movement-sensitive flatwork. We recommend the fill be completely removed from beneath shallow foundations. Based on the information obtained from the exploratory borings and the results of the laboratory testing, we believe structures may be founded on spread footings placed on engineered fill. Slabs-on-grade are also considered feasible with subgrade preparation.

Subgrade preparation below shallow foundations should consist of a minimum of 3 feet of engineered fill extending down and out at a 1H:1V (Horizontal:Vertical) projection from the base of the footing, where feasible. This should result in the removal of the majority of the existing fills for the perimeter footing installed below frost depth. Should existing fills extend below the recommended overexcavation depth, the fill should be removed down to natural soils and replaced as engineered fill.

We are of the opinion a portion of the existing fill can be left in place under floor slabs, pavements, and exterior flatwork, provided the owner recognizes and accepts the risk of distress due to settlement in excess of normally accepted tolerances may occur. If acceptable, we recommend a minimum of 3 feet of the existing fill be removed and replaced with engineered fill under floor slabs, pavements, and movement-sensitive flatwork according to the "Site Grading and Earthwork" section of this report.

We believe the majority of the onsite soils, including the existing fill, may be suitable for reuse as engineered fill, provided they meet the material and placement criteria presented in the "Site Grading and Earthwork" section of this report.

Two significant precipitation events occurred between the drill date and the stabilized groundwater level measurements taken 7 days after completion of drilling. The presence of an aggregate base course layer beneath the asphalt combined with the recent precipitation events may have resulted in a perched groundwater condition beneath the pavement. Based on a review of previous studies in the site vicinity, we believe the shallow groundwater is a result of a combination of surface water and perched groundwater as described above. However, shallow groundwater should be anticipated and may require use of a dewatering system during construction. If significant seepage is encountered during the overexcavation process, we should be notified to evaluate if the overexcavation/removal depth may be waived.

FOUNDATION RECOMMENDATIONS

Considering the subsurface conditions encountered in the exploratory borings and the nature of the proposed construction, we recommend structures be founded on spread footings placed on a minimum of 3 feet of engineered fill. As mentioned in the "Geotechnical Engineering Considerations" section, we recommend complete removal of existing undocumented fills. The majority of the fills should be removed during subgrade preparation. However, if the fill extends to below the depth of overexcavation, the fill should be removed to natural soils and replaced as engineered fill. Criteria for engineered fill is addressed in the "Site Grading and Earthwork" section of this report.

The design and construction criteria presented below should be observed for a spread footing foundation system. The construction details should be considered when preparing project documents.

1. Footings placed on a minimum of 3 feet of engineered fill extending should be designed for a net allowable bearing pressure of 2,000 psf. The allowable bearing pressure may be increased by one-third for transient seismic and/or wind loads.

2. Based on experience, we estimate total settlement for footings designed and constructed as discussed in this section will be approximately 1 inch. Differential settlements across the building footprints are estimated to be approximately ½ to ¾ of the total settlement.

3. Spread footings placed on a prepared engineered fill zone should have a minimum footing width of 16 inches for continuous footings and 24 inches for isolated pads.

4. Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below the exterior grade is typically used in this area.

5. The lateral resistance of a spread footing placed on properly compacted structural fill material will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.30. Passive pressure against the sides of the footings can be calculated using an equivalent fluid unit weight of 175 pcf. These lateral resistance values are working values.

6. Care should be taken to provide adequate surface drainage during the excavation of footings, and the contractor should have equipment available for removing water from excavations following precipitation, if needed. Footing excavations that are inundated as a result of uncontrolled surface runoff may soften, requiring possible moisture conditioning and recompaction of the exposed subgrade soils, or removal of soft subgrade soils and replacement with new compacted structural fill.

7. Areas of loose and/or soft material or deleterious substances encountered within the foundation excavation should be removed and the footings extended to adequate natural bearing material. As an alternate, the loose and/or soft material or deleterious substances may be removed and replaced compacted to 98% of the standard Proctor (ASTM D 698) maximum dry density at moisture contents within 0 to +3 percentage points of the optimum moisture content. New fill should extend down from the edges of the footings at a 1H:1V projection.

8. If seepage into the foundation excavation becomes problematic, placement of a layer of clean crushed gravel may be required to provide an adequate working platform and for allowing placing the concrete in a dry condition.

9. Care should be taken when excavating the foundations to avoid disturbing the supporting materials.

10. A representative of the geotechnical engineer should observe all footing excavations, observe and test compaction, and evaluate the suitability of all fill materials prior to concrete placement.

FLOOR SLABS

We recommend that slabs on grade be placed on a minimum of 3 feet of properly compacted engineered fill material to mitigate against potential of post-construction moisture-related movements.

To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Interior non-bearing partitions resting on floor slabs should be provided with slip joints so that, if the slabs move, the movement cannot be transmitted to the upper structure. This detail is also important for wallboards, stairways and door frames. Slip joints which will allow at least 1½ inches of vertical movement are recommended.

Floor slab control joints should be used to reduce damage due to shrinkage cracking. Joint spacing is dependent on slab thickness, concrete aggregate size, and slump, and should be consistent with recognized guidelines such as those of the Portland Cement Association (PCA) and American Concrete Institute (ACI). The joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. We suggest joints be provided on the order of about 12 to 15 feet apart in both directions. The requirements for slab reinforcement should be established by the designer based on experience and the intended slab use.

If moisture-sensitive floor coverings will be used, mitigation of moisture penetration into the slabs, such as by use of a vapor barrier, may be required. If an impervious vapor barrier membrane is used, special precautions may be required to prevent differential curing problems which could cause the slabs to warp. ACI 301.1R addresses this topic.

EXTERIOR FLATWORK

To limit potential moisture-related movements, subgrade preparation beneath exterior flatwork immediately adjacent to the buildings, including sidewalks and patio areas, where reduction of post-construction movement is considered critical should be done in accordance with the recommendations provided in the "Floor Slabs" section of this report, including depth of subexcavation and backfilling with compacted fill. Proper surface drainage measures as recommended in following sections of this report are also critical to limiting moisture-related movement.

It is extremely important that exterior flatwork and pavements be isolated from the building foundations. Many problems associated with expansive soils are related to ineffective isolation between pavements and exterior slabs and foundation-supported components of structures. Careful design detailing is necessary at locations such as exterior stairway landings and entry points.

Upward heave-related movement of exterior flatwork adjacent to the building may result in adverse drainage conditions with runoff directed toward the building. In addition, upward movement of exterior flatwork may restrict movement of outward swinging doors. Site grading and drainage design should consider those possibilities, particularly at entryways.

SEISMIC DESIGN CRITERIA

The soil profile after construction will generally consist of relatively dense soils extending to weathered to firm bedrock to depths of at least 25 feet. Overburden consisting of new fill and/or existing overburden soils will generally classify as Site Class D in accordance with the International Building Code (IBC). Given the consistency of the bedrock materials, and in absence of measured shear wave velocities, we believe the site profile will classify as Site Class D. Based on the subsurface profile, site seismicity, and the anticipated ground conditions, liquefaction is not a design consideration.

WATER SOLUBLE SULFATES

The concentration of water-soluble sulfates measured in samples of the onsite overburden soils was 0.06%, and the bedrock materials was 0.69%. Concentrations of water-soluble sulfates less than 0.10% represent Class S0 severity exposure to sulfate attack on concrete exposed to these materials, and concentrations greater than 0.2% represent a Class S2 severity. The degree of attack is based on a range of Class S0, Class S1, Class S2, and Class S3 severity exposure as presented in ACI 201.

Based on the laboratory test results, we believe special sulfate resistant cement will not be required for concrete exposed to the overburden soils. Although not anticipated, should concrete be exposed to the bedrock materials, C 150 Type V, or equivalent may be required.

SURFACE DRAINAGE

Proper surface drainage is very important for acceptable performance of the building during construction and after the construction has been completed. Drainage recommendations provided by local, state and national entities should be followed based on the intended use of the structures. The following recommendations should be used as guidelines and changes should be made only after consultation with the geotechnical engineer.

1. Excessive wetting or drying of the foundation and slab subgrades should be avoided during construction.

2. Care should be taken when compacting around the foundation walls and underground structures to avoid damage to the structure. Hand compaction procedures, if necessary, should be used to prevent lateral pressures from exceeding the design values.

3. The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas. Site drainage beyond the 10-foot zone should be designed to promote runoff and reduce infiltration. A minimum slope of 3 inches in the first 10 feet is recommended in the paved areas. These slopes may be changed as required for handicap access points in accordance with the Americans with Disabilities Act.

4. Ponding of water should not be allowed in foundation backfill material or in a zone within 10 feet of the building.

5. Roof downspouts and drains should discharge well beyond the limits of all backfill or be tight-lined to planned storm water facilities.

6. Landscaping adjacent to buildings underlain by moisture-sensitive soils should be designed to avoid irrigation requirements that would significantly increase soil moisture

and potential infiltration of water within at least ten feet of foundation walls. Landscaping located within 10 feet of the building should be designed for irrigation rates that do not significantly exceed evapotranspiration rates. Use of vegetation with low water demand and/or drip irrigation systems are frequently used methods for limiting irrigation quantities.

Lawn sprinkler heads and landscape vegetation that requires relatively heavy irrigation should be located at least 10 feet from the building. Even in areas away from the building, it is important to provide good drainage to promote runoff and reduce infiltration. Main pressurized zone supply lines, including those supplying drip systems, should be located more than 10 feet from the building in the event leaks occur. All irrigation systems, including zone supply lines, drip lines, and sprinkler heads should be routinely inspected for leaks, damage, and improper operation.

7. Plastic membranes should not be used to cover the ground surface adjacent to foundations.

BURIED METAL CORROSION

The potential for corrosion of buried metal placed beneath the ground surface at the site was evaluated based on the results of laboratory testing performed on a representative sample of the natural clay soils. The samples were tested to determine electrical resistivity and pH. The results of the pH tests indicated the sample of native clay had a pH value of 8.22 which is slightly basic, and should not accelerate corrosion.

The results of the laboratory electrical resistivity testing indicate the tested sample of the natural clay soil had a minimum electrical resistivity value of 1,060 ohm-cm with a resistivity value of 1,160 ohm-cm at an in-situ moisture content of 19.7%. Based on the resistivity test results, the native clay soils would generally be classified as very corrosive at moisture contents above about 14% and moderately corrosive at moisture contents below 13%. The test results are presented on Fig. 5 and summarized in Table I.

Corrosion of buried metal is a complex process and requires an understanding of the combined effects of the parameters measured for this study, as well as other conditions not evaluated as part of this study. We recommend a qualified corrosion engineer review the information presented herein to determine the need for an appropriate level of corrosion protection for buried metals at the site.

PERCOLATION TESTING

Percolation testing, for the purpose of aiding in landscape design, was conducted in general accordance with recognized test procedures across the Front Range of Colorado. Data obtained from the in-situ percolation testing of the soils was used to determine the corresponding infiltration rate using procedures from the Michigan LID Manual. The percolation rates measured at the test location, the corresponding infiltration rates calculated using procedures from the Michigan LID Manual procedure, and corresponding Hydrologic Soil Group (HSG) are summarized in the following table.

Test Hole	Depth of Percolation Test Hole (in.)	Calculated Infiltration Rate (cm /sec)	Calculated Infiltration Rate (in /hr.)	Hydrologic Soil Group Classification
Perc-1	57.96	1.04 E-5	0.015	D

The infiltration rate calculated from the testing, indicating the clay soils in the percolation test hole have relatively low rates. The calculated infiltration rate correlates with the range of infiltration rates anticipated for HSG-D according to USDA's NRCS Part 630 Hydrology National Engineering Handbook, Chapter 7.

SITE GRADING AND EARTHWORK

Temporary Excavations: We assume that temporary excavations will be constructed by overexcavating the slopes to a stable configuration where enough space is available. Excavations generally will extend through existing clay fill and natural soils. All excavations should be constructed in accordance with OSHA requirements, as well as state, local and other applicable requirements. Existing fills should generally classify as OSHA Type C soils. The natural clay soils will generally classify as Type B soils.

As mentioned in the "Geotechnical Engineering Considerations" section, we believe the shallow groundwater measured during follow-up groundwater measurements is a result of the recent precipitation events entering the bore holes from the surface and from a perched position in the aggregate base course beneath the asphalt. However, the presence of groundwater should be anticipated when planning excavations, which could require much flatter side slopes than those allowed by OSHA.

Excavated slopes may soften due to construction traffic and erode from surface runoff. Measures to keep surface runoff from excavation slopes, including diversion berms, should be considered.

Fill Material: Unless specifically modified in the other sections of this report, the following recommended material and compaction requirements are presented for fill materials on the project site. A representative of the geotechnical engineer should evaluate the suitability of all proposed fill materials for the project prior to placement.

1. *Engineered Fill beneath Footings, Slab-on-Grade Floors, and Settlement-Sensitive Exterior Flatwork*: Engineered fill should consist of moisture-conditioned on-site natural soils and existing fill free of organics and deleterious matter. Imported soils, if necessary, should be free of claystone fragments and have a maximum of 70% passing the No. 200 sieve, a maximum liquid limit of 40, and a maximum plasticity index of 25. Imported fill source materials not meeting one or more of these criteria may be acceptable if they meet the swell criteria presented below.

   Fill source materials for the structural fill zone beneath foundations and/or floor slabs not meeting the above liquid limit and plasticity index criteria may be acceptable if the swell potential when remolded to 95% of the standard Proctor (ASTM D698) maximum dry density at optimum moisture content and wetted under a 200 psf surcharge pressure does not exceed ½%. Potential off-site structural fill sources not meeting the above liquid limit and plasticity index criteria should be tested to assess their acceptability prior to importing them to the site.

2. *Aggregate Base Course:* Material should satisfy material requirements for CDOT Class 6 aggregate base course.

3. *Utility Trench Backfill*: Materials excavated from the utility trenches may be used for trench backfill above the pipe zone fill provided they do not contain unsuitable material or particles larger than 4 inches.

4. *Material Suitability*: Unless otherwise defined herein, all fill material should be a non- to low-swelling, free of vegetation, brush, sod, trash and debris, and other deleterious

substances, and should not contain rocks or lumps having a diameter of more than 4 inches. Based on the results of laboratory testing, the on-site soils should be suitable for reuse as compacted site grading fill and as structural fill beneath foundations and floor slabs, provided they do not contain organic material or other deleterious materials.

Compaction Requirements: We recommend the following compaction criteria be used on the project:

1. *Moisture Content*: Fill materials consisting of onsite or imported predominantly clay soils should be compacted between optimum moisture content and 3 percentage points above optimum. Fill materials consisting of predominantly granular soils should be compacted at uniform moisture contents within 2 percentage points above or below optimum moisture content. The contractor should be aware that the clay soils, including on-site and import materials, may become somewhat unstable and deform under wheel loads if placed near the upper end of the moisture range.

2. *Placement and Degree of Compaction*: Structural fill beneath foundations and exterior flatwork, and adjacent to foundations, should be placed in maximum 8-inch lifts. The following compaction criteria should be followed during construction:

Fill Location	Percentage of Maximum Standard Proctor Density (ASTM D698)[1]
Beneath Foundations	98%
Beneath Building Floor Slabs and Foundation Wall Backfill	
Less than 8 Feet Thick	95%
More than 8 Feet Thick	100%
Utility Trenches	95%
Aggregate Base Course	95%[2]
Beneath Pavements, and General Site Grading	95%
Landscape and Other Areas	90%

[1] Some difficulty could be encountered achieving adequate compaction with small equipment to avoid exerting excessive compaction stresses on walls

[2] Compaction should be controlled to ASTM D1557.

Construction Monitoring: A representative of the geotechnical engineer should observe prepared fill subgrades and fill placement on a full-time basis.

PAVEMENT THICKNESS DESIGN

A pavement section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the pavement structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for pavement design purposes by means of a soil support value for flexible pavements and a modulus of subgrade reaction for rigid pavements.

Subgrade Materials: Based on the results of the field and laboratory studies, the majority of the anticipated pavement subgrade soils primarily classifying as A-6 and A-7-6 soils with group indices ranging between 11 and 20 in accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification. For design purposes, a resilient modulus value of 3,025 psi was selected for flexible pavements and a modulus of subgrade reaction of 40 pci was selected for rigid pavements.

Design Traffic: Since anticipated traffic loading information was not available at the time of report preparation, an equivalent 18-kip equivalent single axle loading (ESAL) value of 36,500 was assumed for automobile parking areas (light-duty pavements) and ESAL value of 73,000 was assumed for combined automobile and heavier truck traffic areas, including fire lanes (medium-duty pavements).

The designer should verify if the assumed traffic loads are valid for the project. If higher ESAL values are anticipated, the pavement sections presented in this report will have to be reevaluated.

Pavement Thickness Requirements: The pavement thicknesses were determined in accordance with the 1993 AASHTO pavement design procedures. For design, initial and terminal serviceability indices of 4.5 and 2.0, respectively, and a reliability of 80 percent were selected. If other design parameters are preferred, we should be contacted in order to reevaluate the recommendations presented herein. Site pavement sections should be constructed as presented in the following table.

Pavement Type	Full-Depth Asphalt (in)	Composite HMA over ABC (in)	PCCP (in)
Light-Duty Pavements	6.0	4.0/8.0	6.0
Medium-Duty Pavements	7.0	4.5/8.0	7.0

HMA = Hot Mix Asphalt, ABC = Aggregate Base Course, PCCP= Portland Cement Concrete Pavement

Pavement Materials: HMA and PCCP should meet the latest applicable requirements, including the CDOT Standard Specifications for Road and Bridge Construction. We recommend HMA placed for the project is designed in accordance with the SuperPave gyratory mix design method. The mix should generally meet Grading S or SX requirements with a SuperPave gyratory design revolution (N_{DESIGN}) of 75. Asphalt mixes should have a PG 58-28 asphalt binder. PCCP should meet CDOT Class P specifications and requirements, including matching the coarse aggregate size to the presence of dowels, if used.

The concrete sections presented above are assumed to be un-reinforced. Providing dowels at construction joints would help reduce the risk of differential movements between panel sections. Providing a grid mat of deformed rebar within the concrete pavement section would assist in mitigating corner breaks and differential panel movements. If a rebar mat is installed, we recommend the bars be placed in the lower half of the pavement section. On projects electing to install rebar mats, we have commonly seen No. 4 rebar placed at 24-inch centers in each direction, however we recommend a structural engineer evaluate the placement and spacing of rebar if needed.

ABC materials should meet CDOT requirements for Class 6 aggregate base course.

Subgrade Preparation: Prior to placing the pavement section or engineered fill, the pavement subgrade should be prepared as described in the “Site Grading and Earthwork” section of this report. As a minimum we recommend the pavements be underlain by 2 feet of site grading fill meeting the material and placement requirements presented in the “Site Grading and Earthwork” section of this report. The subgrade should also be proofrolled with a heavily loaded pneumatic-tired vehicle. Pavement design procedures assume a stable subgrade. Areas which deform under heavy wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

Drainage: The collection and diversion of surface drainage away from paved areas is extremely important to the satisfactory performance of pavement. Drainage design should provide for the removal of water from paved areas and prevent the wetting of the subgrade soils.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

K+A should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary, to accommodate possible changes in the proposed construction.

We recommend that K+A be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

LIMITATIONS

The conclusions and recommendations submitted in this report are based upon data obtained from the exploratory borings at the locations indicated on Fig. 1, and the proposed construction. This report may not reflect subsurface variations that occur between the explorations, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, existing fill, soil, bedrock or groundwater conditions appear to be different from those described herein, K+A should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. K+A is not responsible for liability associated with interpretation of subsurface data by others. The scope of services for this project does not include any environmental assessment of the site or identification of contaminated or hazardous materials or conditions. If the owner is concerned about the potential for such contamination, other studies should be undertaken.

AJY/as
Rev By: JAN
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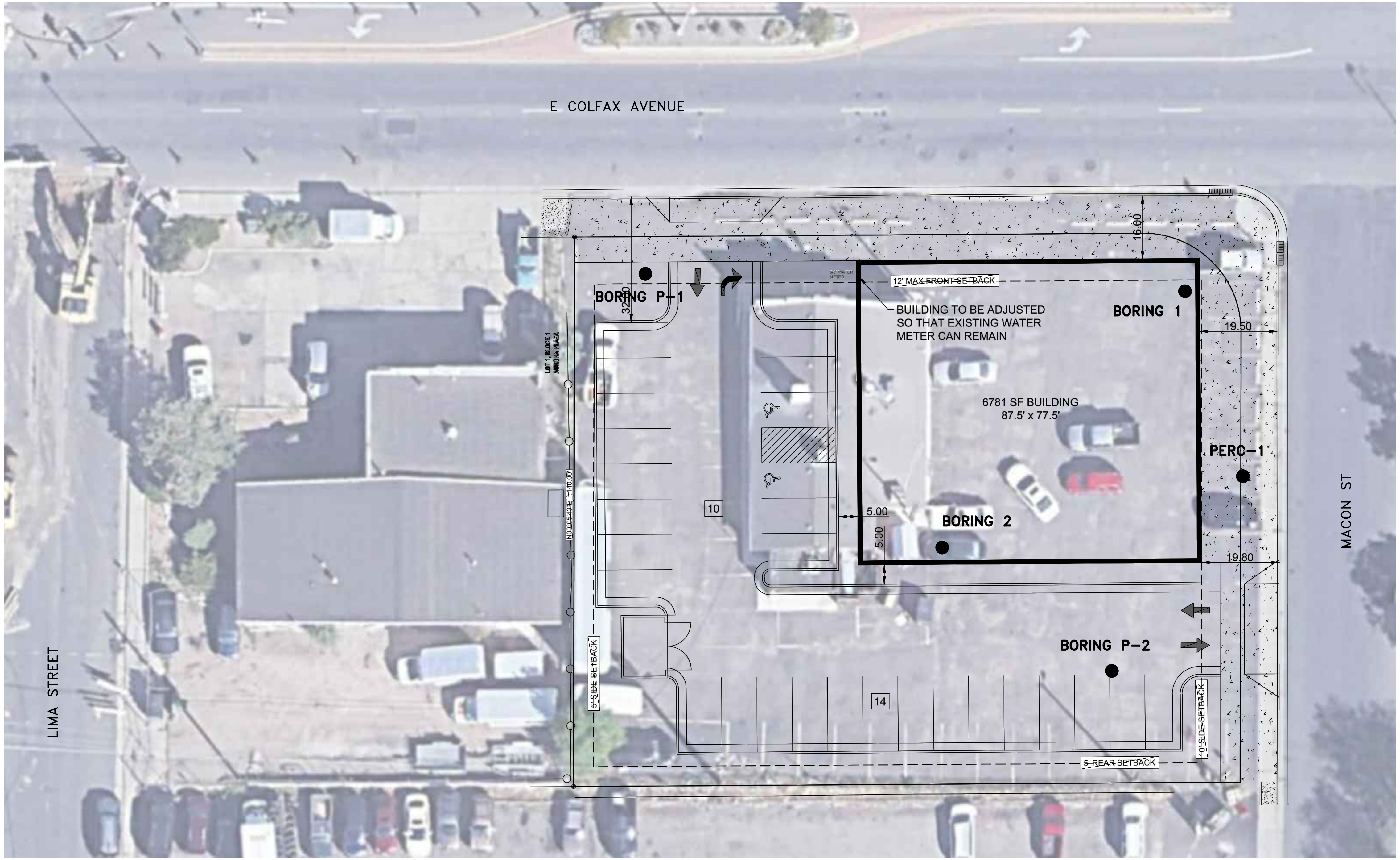

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APPROXIMATE SCALE–FEET

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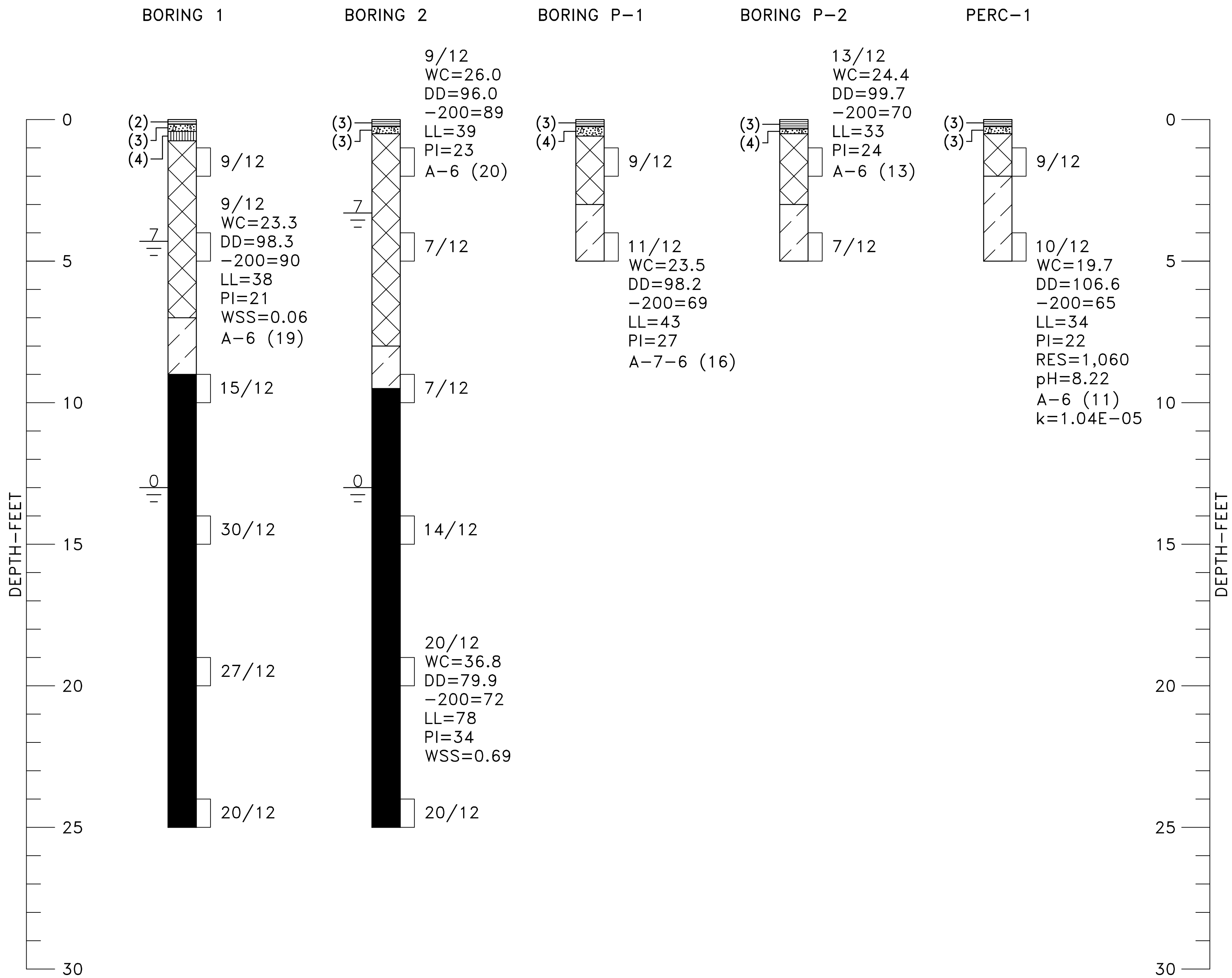
21–1–303	Kumar & Associates	AFC URGENT CARE – 11310 EAST COLFAX AVENUE, AURORA, COLORADO	LOCATION OF EXPLORATORY BORINGS	Fig. 1



LEGEND

(2) ASPHALT, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

(3) AGGREGATE BASE COURSE, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

(4) CONCRETE, THICKNESS IN INCHES SHOWN IN PARENTHESES TO LEFT OF THE LOG.

FILL: LEAN CLAY TO SANDY LEAN CLAY (CL), FINE- TO MEDIUM-GRAINED SAND FRACTION, SLIGHTLY MOIST, BROWN TO DARK-BROWN TO DARK GRAY.

SANDY LEAN CLAY (CL), FINE- TO MEDIUM-GRAINED SAND FRACTION, MEDIUM STIFF TO STIFF, SLIGHTLY MOIST TO MOIST, LIGHT BROWN TO BROWN.

CLAYSTONE BEDROCK, FINE- TO MEDIUM-GRAINED SAND FRACTION, WEATHERED TO FIRM, SLIGHTLY MOIST, LIGHT BROWN TO BROWN TO GRAY, IRON STAINED.

DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

9/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 9 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

7 DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON APRIL 13, 2021 WITH A 4-INCH-DIAMETER CONTINUOUS-FLIGHT POWER AUGER. PERC-1 WAS DRILLED USING A 6-INCH DIAMETER CONTINUOUS-FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE NOT MEASURED AND THE LOGS OF THE EXPLORATORY BORINGS ARE PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D2216);
   DD = DRY DENSITY (pcf) (ASTM D2216);
   +4 = PERCENTAGE RETAINED ON NO. 4 SIEVE (ASTM D6913);
   -200= PERCENTAGE PASSING NO. 200 SIEVE (ASTM D1140);
   LL = LIQUID LIMIT (ASTM D4318);
   PI = PLASTICITY INDEX (ASTM D4318);
   WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103);
   RES = MINIMUM LABORATORY RESISTIVITY (ohm-cm.) (ASTM G57);
   pH = HYDROGEN ION CONCENTRATION (ASTM E70);
   A-6 (19) = AASHTO CLASSIFICATION (GROUP INDEX) (AASHTO M145);
   k = PERMEABILITY (cm/sec).

21-1-303	Kumar & Associates	AFC URGENT CARE – 11310 EAST COLFAX AVENUE, AURORA, COLORADO	LOGS, LEGEND AND EXPLANATORY NOTES OF EXPLORATORY BORINGS	Fig. 2

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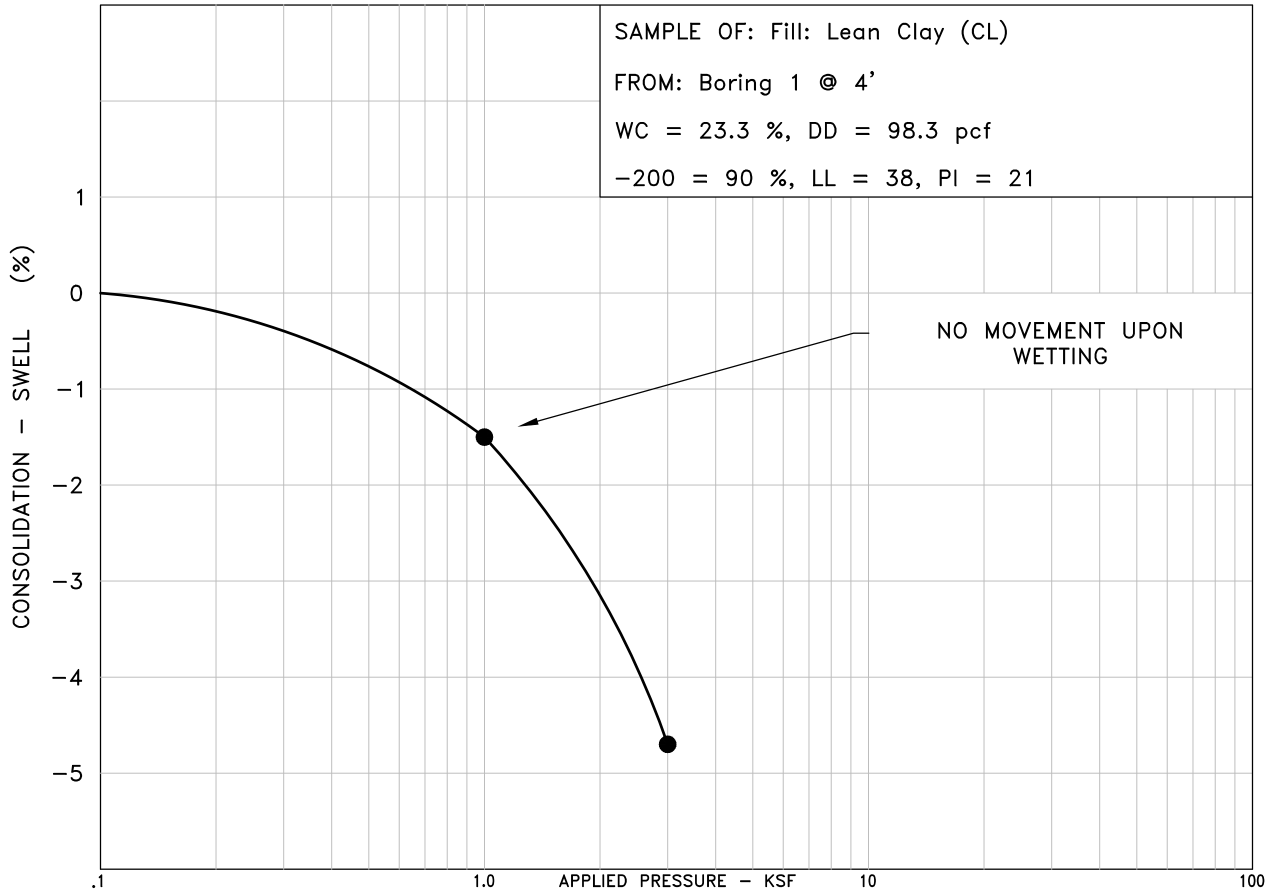
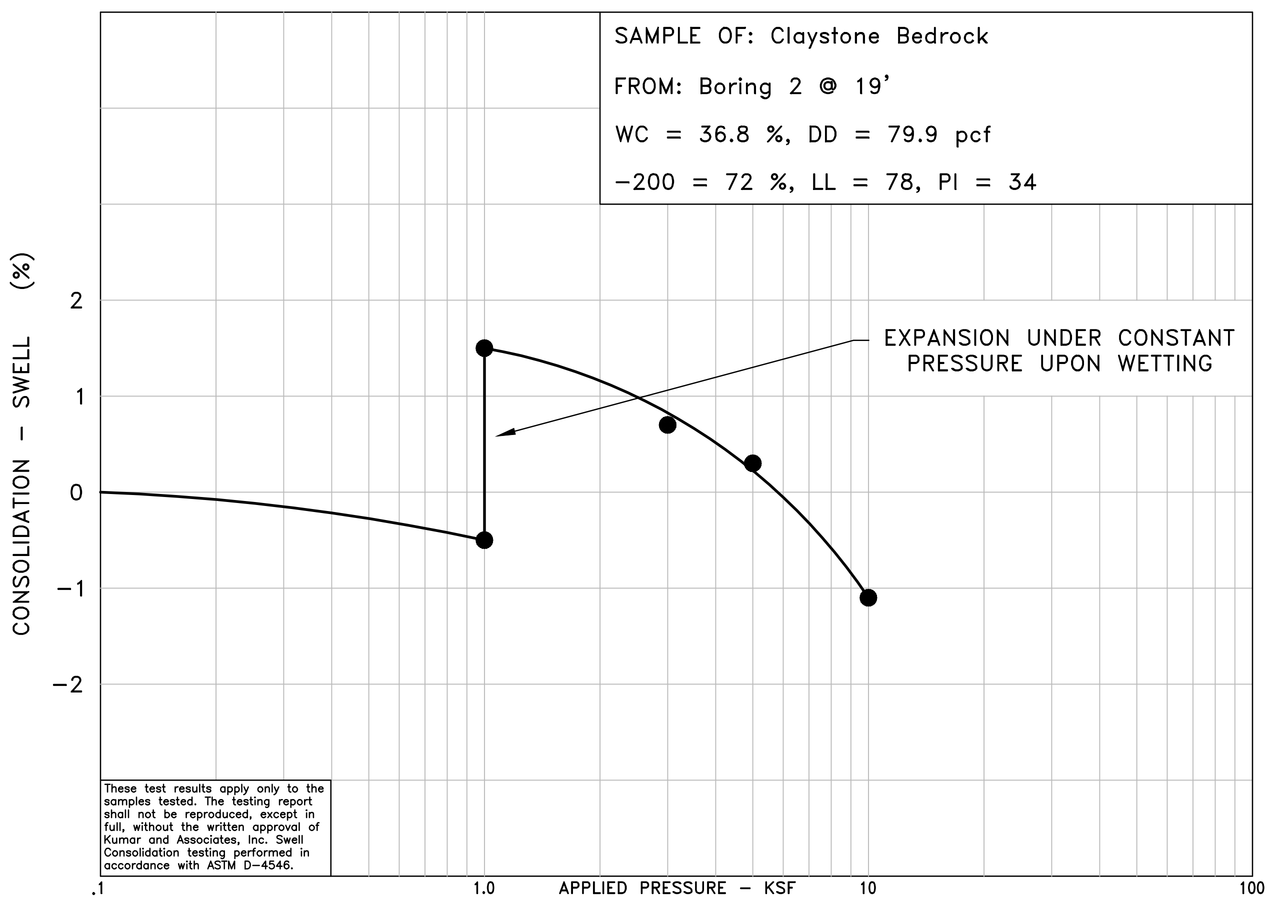
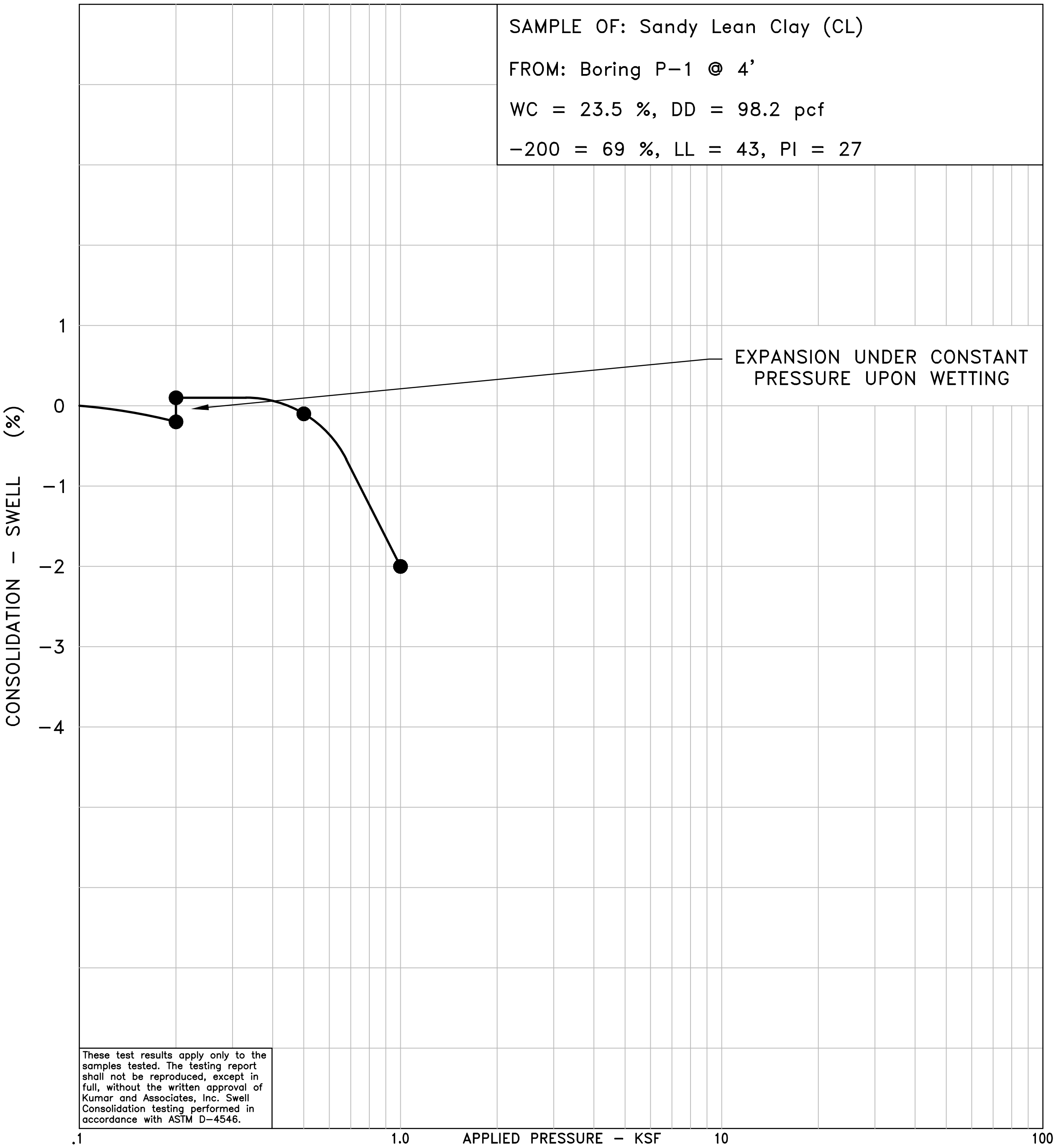




21−1−303	Kumar & Associates	SWELL−CONSOLIDATION TEST RESULTS	Fig. 3



21-1-303	Kumar & Associates	SWELL-CONSOLIDATION TEST RESULT	Fig. 4

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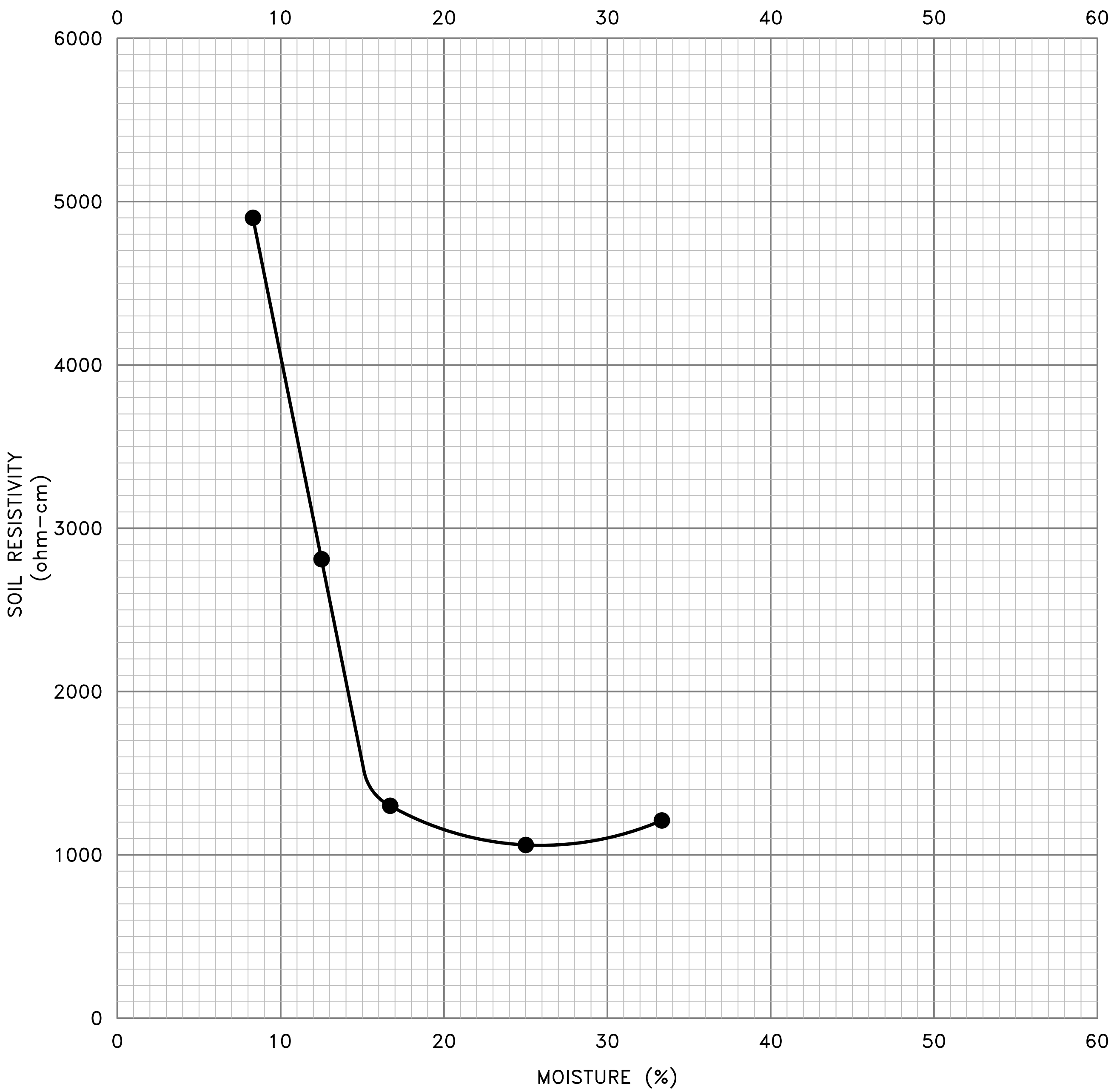

CURVE SYMBOL	SAMPLE IDENTIFICATION	SOIL OR BEDROCK TYPE	MINIMUM RESISTIVITY (ohm-cm)	RESISTIVITY AT IN SITU MOISTURE CONTENT (ohm-cm)
●	PERC-1 @ 4'	Sandy Lean Clay (CL)	1,060	1,160

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21-1-303	Kumar & Associates	LABORATORY RESISTIVITY RESULTS	Fig. 5

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NO.: 21-1-303
PROJECT NAME: AFC Urgent Care, East Colfax Avenue and Macon Street, Aurora, Colorado
DATE SAMPLED: 04/13/21
DATE RECEIVED: 04/13/21

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	Minimum Electrical Resistivity (ohm-cm)	pH	AASHTO CLASSIFICATION (group index)	SOIL OR BEDROCK TYPE
BORING	DEPTH (feet)					LIQUID LIMIT (%)	PLASTICITY INDEX (%)					
1	4	04/14/21	23.3	98.3	90	38	21	0.06			A-6 (19)	Fill: Lean Clay (CL)
2	1	04/14/21	26.0	96.0	89	39	23				A-6 (20)	Fill: Lean Clay (CL)
2	19	04/14/21	36.8	79.9	72	78	34	0.69				Claystone Bedrock
P-1	4	04/14/21	23.5	98.2	69	43	27				A-7-6 (16)	Sandy Lean Clay (CL)
P-2	1	04/14/21	24.4	99.7	70	33	24				A-6 (13)	Fill: Sandy Lean Clay (CL)
PERC-1	4	04/14/21	19.7	106.6	65	34	22		1,060	8.22	A-6 (11)	Sandy Lean Clay (CL)