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Geotechnical Evaluation Report

Les Schwab Tire Center

Sliceroo Drive and South Red Sky Drive

Parker, Colorado

VIVID Project No.: D23-1-321

VIVID Engineering Group

April 4, 2023

Report prepared for:

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GEOTECHNICAL EVALUATION REPORT
Les Schwab Tire Center
Sliceroo Drive and South Red Sky Drive
Parker, Colorado
VIVID Project No.: D23-1-321

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1.0 INTRODUCTION

1.1 GENERAL

This report presents the results of a geotechnical investigation performed for a proposed Les Schwab Tire Center to be constructed southeast of the intersection of Sliceroo Drive and South Red Sky Drive on Pad 8 of the commercial development in Parker, Colorado. An attached Vicinity Map (Figure 1) shows the general location of the project. Our investigation was performed for Les Schwab and was authorized by Mr. Eric Rouse.

This report includes our recommendations relating to the geotechnical aspects of project design and construction. The conclusions and recommendations stated in this report are based upon the subsurface conditions found at the locations of our exploratory borings at the time our exploration was performed. They also are subject to the provisions stated in the report section titled **Additional Services & Limitations**. Our findings, conclusions, and recommendations should not be extrapolated to other areas or used for other projects without our prior review. Furthermore, they should not be used if the site has been altered, or if a prolonged period has elapsed since the date of the report, without VIVID's prior review to determine if they remain valid.

1.2 PROJECT DESCRIPTION

We understand the proposed project consists of the construction of a new approximately 9,540 square foot one-story Tire Center building located southeast of the intersection of Sliceroo Drive and South Red Sky Drive on Pad 8 of the commercial development in Parker, Colorado. Additional improvements to the site associated with this structure include paved parking and drive lanes, concrete flatwork, and landscaping. A detention pond will not be required for this site.

The proposed grading plans were not available at the time of preparation of this report. For estimating purposes, we have assumed that, in general, planned overlot grading cuts and fills to achieve finish site grades will be minimal (i.e. approximately 1 to 3 feet or less). This does not include deeper excavations that will be required for foundations, utilities, etc., that will likely range from approximately 3 to 12 feet or so in depth unless deep foundation elements (i.e. drilled piers) are required.

If significant cuts or fills are anticipated for general site grading, or if the proposed construction varies from that presented above, this report should be reviewed for possible modification of our scope of services and recommendations.

The loading conditions for buildings of this type provided in the Les Schwab Geotechnical Criteria, dated July 1, 2022, are anticipated to be on the order of 3 to 8 kips per lineal foot for the exterior walls and on the order of 20 to 80 kips or less for isolated columns. Floor slab loading is anticipated to be approximately 100 to 150 pounds per square foot. Vehicle lifts will be surface mounted to thickened slabs so there will not be any below grade pits. Movement tolerances for the building are limited to ¾ inch of differential movement across the building and total movement of 1 inch.

1.3 PURPOSE AND SCOPE

The purpose of our investigation was to explore and evaluate subsurface conditions at various locations on the site and, based upon the conditions found, develop recommendations relating to the geotechnical aspects of project design and construction. Our conclusions and recommendations in this report are based upon analysis of the data from our field exploration, laboratory tests, and our experience with similar soil and geologic conditions in the area.

VIVID's scope of services included:

- A visual reconnaissance to observe surface and geologic conditions at the project site and locating the exploratory borings;
- Notification of the Colorado 811 one-call center to identify underground utility lines at the boring locations prior to our drilling;
- The drilling of seven exploratory borings at various locations on the property, which were selected based upon the proposed site layout, location of existing structures and utilities;
- Laboratory testing of selected samples obtained during the field exploration to evaluate relevant physical and engineering properties of the soil;
- Evaluation and engineering analysis of the field and laboratory data collected to develop our geotechnical conclusions and recommendations; and
- Preparation of this report, which includes a description of the proposed project, a description of the surface and subsurface site conditions found during our investigation, our conclusions and recommendations as to foundation and floor slab design and construction, pavement design for the proposed paved areas, other related geotechnical issues, and appendices which summarize our field and laboratory investigations.

2.0 FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

A field exploration was performed on January 13, 2023 and included drilling seven exploratory borings at the approximate locations indicated on the attached Field Exploration Plan (Figure 2). Borings B-1 through B-5 were drilled in the approximate footprint of the proposed building and were advanced to depths of approximately 20 to 30 feet each below the existing ground surface. Borings P-1 and P-2 were drilled within the proposed parking lot areas to a depth of approximately 10 feet each below the existing ground surface.

The borings were advanced using a CME 550 track-mounted drill rig equipped with 4-inch diameter, continuous-flight, solid-stem auger. Samples were attempted with a California-type sampler (2.0-inch I.D./2.5-inch O.D.) and by bulk methods. Penetration tests were obtained at the various sample depths as well.

Appendix A to this report includes logs describing the subsurface conditions. The lines defining boundaries between soil types on the logs are based upon drill behavior and interpolation between samples and are therefore approximate. Transition between soil types may be abrupt or may be gradual.

2.2 GEOTECHNICAL LABORATORY TESTING

Laboratory tests were performed on selected soil samples to estimate their relative engineering properties. Tests were performed in general accordance with the following methods of ASTM or other recognized standards-setting bodies, and local practice:

- Description and Identification of Soils (Visual-Manual Procedure)
- Moisture Content and Unit Weight of Soils
- Sieve Analysis
- Atterberg Limits
- Swell/Settlement Test
- R-Value

Results of the geotechnical laboratory tests are presented in the report text, where applicable, and included in Appendix B of this report. Selected test results are also shown on the boring logs in Appendix A.

2.3 ANALYTICAL LABORATORY TESTING

Analytical testing for soil corrosivity was performed on a selected sample and included the following tests:

- pH
- Resistivity
- Redox Potential
- Water-soluble Sulfates
- Water-soluble Chlorides
- Sulfides

Results of the analytical laboratory tests are presented in the report text, where applicable, and included in Appendix C of this report.

3.0 SITE CONDITIONS

3.1 SURFACE

At the time of our exploration, the subject site consisted of an open lot covered with snow. The site is a "Pad Ready" vacant site with recently constructed roadway and stubbed utilities. The site was relatively flat and gently slopes downward from east to west with a difference in elevation of approximately 4 feet. The site was bounded by a residential development to the east, Sliceroo Drive and undeveloped commercial sites to the west and south, and commercial development to the north.

Based upon past aerial photographs, it appears as though the site was initially rough graded between 2004 and 2005. Prior to development, a drainage ditch appeared to be present at the site orientated in the northeast-southwest direction. In addition, Arapahoe Canal was present within the commercial development, west of the subject lot orientated in the north-south direction. These drainage features appear to be removed/filled over during the initial rough grading of the commercial area and the construction of Hess Road and Chambers Road.

3.2 GEOLOGY

Prior to drilling, the site geology was evaluated by reviewing available geologic information including the USGS Geologic Map of the Greater Denver Area, Front Range Urban Corridor, Colorado (Trimble and Machette, 1979). Mapping indicates the site consists of older alluvium deposits underlain by sandstone and claystone of the Dawson Formation. The field exploration for this site was consistent with the geologic mapping.

Based upon mapping of the Potentially Swelling Soil and Rock in the Front Range Urban Corridor (Trimble, D.E., and Machette, M.N. 1979), the site is within an area consisting of "Moderate to High Swell Potential" materials. Potentially expansive materials mapped in this area include several bedrock formations and colluvium deposits of variable thickness.

3.3 SEISMICITY

Based upon the geologic setting, subsurface soil conditions, and low seismic activity in this region, liquefaction is not expected to be a hazard at the site. Based on correlation of blow count data (N-values) from the borings advanced during this evaluation, the subsurface soil profiles correspond with Site Class D of the 2015 International Building Code (IBC). The intermediate design acceleration values from IBC are presented below.

Table 1
Design Acceleration for Short Periods

S_S	F_a
0.176	1.6

S_S = The mapped spectral accelerations for short periods (ATC/USGS Seismic Design Web Services, 2022)

F_a = Site coefficient from Table 1613.3.3(1), 2015 IBC

Table 2
Design Acceleration for 1-Second Period

S_1	F_V
0.058	2.4

S_1 = The mapped spectral accelerations for 1-second period (ATC/Seismic Design Web Services, 2022)

F_v = Site coefficient from Table 1613.3.3(2), 2015 IBC

3.4 SUBSURFACE

VIVID explored the subsurface conditions by drilling, logging, and sampling seven exploratory borings at the proposed site as shown on Figure 2. These borings were drilled to depths ranging from approximately 10 to 30 feet below the existing ground surface The general profile encountered in our borings consisted of the following:

Fill

Fill comprising of sand with various amounts of clay and lean to fat clay with various amounts of sand was encountered from the ground surface to depths ranging from approximately 10 to 12 feet below the existing ground surface. The fill was generally brown, dark brown, gray, white, reddish-brown, orange-brown, and pink, slightly moist to moist, and field penetration testing (blow counts) indicating the fill materials were loose to medium dense in relative density and stiff to very stiff in consistency. Swell/settlement testing performed on samples of the clay soils indicated low swell potential of approximately 0.4 to 2.7 percent when wetted under surcharge pressures of approximately 200 to 1,000 psf.

Clay

Deposits comprising of lean clay and fat clay with various amounts of sand was encountered below the fill at depths ranging from approximately 10 to 27 feet below the existing ground surface. The clay was generally brown, dark brown, and gray, slightly moist to moist, with field penetration testing (blow counts) indicating the clay materials were stiff to very stiff in consistency.

Sand

Deposits comprising of poorly graded sand with varying amounts of clay were encountered below the clay soils in Borings B-1 and B-5 at depth ranging from 18 to 30 feet below the existing ground surface. The sand was generally white and orange-brown, slightly moist, and field penetration testing (blow counts) indicating the sand materials were medium dense to very dense in relative density.

Claystone

Claystone was encountered generally in the southern portion of the site in Borings B-3, B-4 and B-5 at depths ranging from approximately 18 to 23 feet below the existing ground surface extending to the maximum explored depth of approximately 30 feet below the existing ground surface. The claystone was generally gray and dark brown, slightly moist, and hard.

The boring logs in Appendix A should be reviewed for more detailed descriptions of the subsurface conditions at each of the boring locations explored.

3.4.1 Groundwater

Groundwater was not encountered in the borings during drilling. Based upon a review of the USGS Depth to the Water Table (1976-1977) in the Greater Denver Area, Front Range Urban Corridor, (Hiller, Schneider and Hutchinson, 1983), mapping indicates the groundwater is primarily in the Dawson Aquifer, generally more than 20 feet and commonly greater than 100 feet below the existing ground surface. Groundwater levels are dependent on seasonal precipitation, irrigation practices, land use, and runoff conditions. As such, it is likely that the groundwater level in the area may fluctuate during dryer and wetter seasons of the year.

Based on our experience in the area, groundwater can generally be perched on top of less permeable clay soil deposits and on top of bedrock. Perched conditions will fluctuate significantly with changes in rainfall/snow and runoff. Seepage within more permeable joints and fractures within the bedrock units should be expected at random locations and times as well. It should be noted that groundwater and soil moisture conditions within the area will vary depending on the water level in nearby waterways, rainfall, well pumping, irrigation practices, and/or runoff conditions. Accordingly, the soil moisture and groundwater data in this report pertain only to the locations and times at which exploration was performed. They can be extrapolated to other locations and times only with caution. It should be noted that VIVID has not performed a hydrologic study to verify the seasonal high-water level.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 GEOTECHNICAL FEASIBILITY OF PROPOSED CONSTRUCTION

VIVID found generally poor subsurface conditions during this investigation that would indicate that development of the site essentially as planned involves a greater risk of low performance of the structures than is typically acceptable without some type of mitigation. The main geotechnical issue is the presence of undocumented fill materials present at the site. Even with diligent efforts to minimize risk, increased maintenance and repair can be expected, especially for site elements such as pavements, flatwork, etc. where more exhaustive mitigation methods are generally cost prohibitive. However, as long as the recommendations in this report are incorporated in the design and construction of the project, the effects of the poor soil subgrade can be minimized.

The proposed structure may be supported by shallow foundations, provided the undocumented fill materials are removed and replaced and the owner can accept the potential risk of differential foundation movement as discussed in this report. If some foundation movement cannot be tolerated, then the structures should be supported on a deep foundation system.

If movement of the foundations is not desired, the structures may be supported on a deep foundation such as drilled piers. We can provide design parameters and recommendations for drilled pier construction, if desired

Under no circumstances may the structure be established on the existing non-engineered (undocumented) fills. With proper preparation, the existing non-engineered fill materials, may be used as structural fill, provided any deleterious materials are removed.

If the owner is willing to risk some pavement movement, pavement distress and "bird bathing" and possible premature pavement failure, then portions of the undocumented fill materials may be left in-place. As minimum preparation to the pavement subgrade, we recommend the upper 12 inches of the undocumented fill materials are over-excavated and the underlying undocumented fill materials are scarified to a depth of 8 inches, moisture conditioned, and recompacted prior to the placement, moisture conditioning, and compaction of the remaining 12 inches of pavement subgrade. In addition, we recommend the pavement subgrade pass a proof-rolled with a heavily loaded pneumatic-tired vehicle (such as a fully-loaded dump truck or similar weight equipment). Any areas with excessive rutting or movement should be stabilized.

Our geotechnical design and construction recommendations for site preparation, foundations, floor systems, pavements, and other related construction topics are provided in the following sections.

4.2 CONSTRUCTION CONSIDERATIONS

4.2.1 General

All site preparation and earthwork operations should be performed in accordance with applicable codes, safety regulations and other local, State, or Federal guidelines.

4.2.2 Site Preparation and Grading

Initial site work should consist of removing all undocumented fill materials and other deleterious materials from all areas to be filled and areas to be cut. All material should be removed for offsite disposal in accordance with local laws and regulations or, if appropriate, stockpiled in proposed landscaped areas for future use. Excavations to remove existing site features must be backfilled and properly compacted. Areas to receive fill should be evaluated by the geotechnical engineer prior to the placement of any fill materials.

After performing the required excavations and prior to the placement of any compacted fill and/or structural elements, processing of the subgrade should be performed. This should include scarifying the subgrade to a depth of at least 8 inches and compacting as recommended in Section 4.2.6 of this report. All fill materials should be placed on a horizontal plane and placed in loose lifts not to exceed 8 inches in thickness, unless otherwise accepted by the geotechnical engineer. **It should be noted that existing clay soils are approaching and exceeding the soil's plastic limit in many cases, therefore unstable subgrade conditions are possible. To address unstable subgrade conditions, techniques can vary from scarification, drying and re-compaction, to stabilization with rock and/or geogrid and aggregate materials.**

To address any unstable subgrade conditions, if encountered, techniques can vary from scarification, drying and re-compaction, to stabilization with rock and/or geogrid and aggregate materials. In addition, lower ground pressure equipment can be utilized to perform earthwork operations and install fill and pavement elements. This will help limit damage to the subgrade and reduce the required amount of stabilization. Consideration should also be given to the time of year for construction to minimize potential for precipitation during earthwork activities. Spring and early summer can produce periods of higher precipitation.

4.2.3 Excavation Characteristics

Proposed site grading plans were not provided to us prior to compilation of this report. However, we anticipate localized cuts and fills for general grading will be on the order of about 1 to 3 feet. We anticipate that excavation of the on-site overburden soils can be performed with conventional heavy-duty earthmoving equipment. Excavations penetrating the bedrock are not anticipated.

All excavations must comply with applicable local, State, and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods, and sequencing of construction operations. VIVID's recommendations for excavation support are intended for the Client's use in planning the project, and in no way relieve the Contractor of its responsibility to construct, support, and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that VIVID is assuming responsibility for either construction site safety or the Contractor's activities.

We believe that the soils on this site will classify as Type C materials using OSHA criteria. OSHA requires that unsupported cuts in Type C materials be laid back to ratios no steeper than 1½:1 (horizontal to vertical). In general, we believe that these slope ratios will be temporarily stable under unsaturated conditions. If groundwater seepage occurs, flatter slopes will be required. Please note that the actual determination of soil type and allowable sloping must be made in the field by an OSHA-qualified "competent person."

4.2.4 Fill Materials

One, or a combination of moisture treated (on-site soils) and granular structural fill (imported to site), will be required for this project. Specific recommendations in regard to depth of structural fill is presented in the following sections of this report for foundations, floor slabs, pavements, etc.

Site Grading Fill:

On-site soils and existing fill materials may be used for general site grading, provided deleterious materials are removed and these materials are properly processed (i.e., large pieces broken down to a soil-like consistency with particle sizes of less than three inches), moisture-conditioned, and compacted. If imported site grading fill is required at this site, it should consist of a non-expansive, granular material with a maximum particle size of 2 inches, a liquid limit of less than 30 percent, and a plasticity index of less than 6 percent. The fill should have between about 10 and 30 percent passing the No. 200 sieve. A sample of any imported site grading fill material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site.

Imported Structural Fill:

On-site soils and existing fill materials may be re-used as structural fill, provided delirious materials are removed. Imported structural fill, if required, at this site should consist of materials with fines content greater than 30 percent (pass the No. 200 sieve), Liquid Limit of 30 or less, Plasticity Index of 15 or less, and an expansion potential of 1.0 percent or less (under a surcharge load of 200 psf). A sample of any imported structural fill material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site. Specific recommendations regarding depth of structural fill is presented in the following sections of this report for foundations, floor slabs, etc.

Pavement Aggregate Base Course:

Aggregate Base Course (ABC) below pavements should consist of materials meeting CDOT Class 5 or 6 aggregate base course specifications, as described in Section 703.03 of the 2022 CDOT Standard Specifications for Road and Bridge Construction. A sample of any imported aggregate base course material should be submitted to our office for approval and testing at least 1 week prior to stockpiling at the site.

Fill should be compacted according to the recommendations in Section 4.2.6 of this report. We recommend that a qualified representative of VIVID visit the site during excavation and during placement of the structural fill to verify the soils exposed in the excavations are consistent with those encountered during our subsurface exploration and that proper foundation subgrade preparation and placement is performed.

4.2.5 Utility Trench Backfill

Backfill material should comprise granular structural fill and be essentially free of plant matter, organic soil, debris, trash, other deleterious matter and rock particles larger than 3 inches. However, backfill material in the "pipe zone" (from the trench floor to 1 foot above the top of pipe) should not contain rock particles larger than 1 inch. Strictly observe any requirements specified by the utility agency for bedding and pipe-zone fill. In general, backfill above the pipe zone in utility trenches should be placed in lifts of 6 to 8 inches, and compacted using power equipment designed for trench work. Backfill in the pipe zone should be placed in lifts of 8-inches or less and compacted with hand-held equipment. Compact trench backfill as recommended in Section 4.2.6 of this report.

4.2.6 Compaction Requirements

Fill materials should be placed in horizontal lifts compatible with the type of compaction equipment being used, moisture conditioned, and compacted in accordance with the following criteria:

Table 3
Compaction Specifications

FILL LOCATION [2]	MATERIAL TYPE	PERCENT COMPACTION[1]	MOISTURE CONTENT
Subgrade Preparation (all areas)	On-site Clay Soils (8 inches Scarified, Moisture Treated, Re-compacted)	95 minimum of ASTM D 698	0 to +4 % of optimum
General Site Grading Fill	On-site Clay Soils/Imported Site Grading Fill (see Section 4.2.4)	95 minimum of ASTM D 698	0 to +4 % of optimum
Structural Fill	Imported Clayey Sand and Clay soils (see Section 4.2.4)	95 minimum of ASTM D 698	0 to +4 % of optimum
Pavement Section Aggregate Base Course	Imported CDOT Class 5 or 6 ABC (see Section 4.2.4)	95 minimum of ASTM D 1557	± 2 % of optimum
Exterior Flatwork Areas	Imported Clayey Sand and Clay soils (see Section 4.2.4)	95 minimum of ASTM D 698	0 to +4 % of optimum
Utility Trenches	(see Section 4.2.5)	95 minimum of ASTM D 698	0 to +4 % of optimum

1) In non-structural or landscaped areas, the compaction specification may be reduced to 90 percent.
2) Where two or more "Fill Locations" coincide, the more stringent specification should be used.

Fill should be placed in level lifts not exceeding 8 inches in loose thickness and compacted to the specified percent compaction to produce a firm and unyielding surface. If field density tests indicate the required percent compaction has not been obtained, the fill material should be reconditioned as necessary and re-compacted to the required percent compaction before placing any additional material.

4.2.7 Construction in Wet or Cold Weather

During construction, grade the site such that surface water can drain readily away from the building and pavement areas. Promptly pump out or otherwise remove any water that may accumulate in excavations or on subgrade surfaces and allow these areas to dry before resuming construction. The use of berms, ditches and similar means may be used to prevent stormwater from entering the work area and to convey any water off site efficiently.

If earthwork is performed during the winter months when freezing is a factor, no grading fill, structural fill, or other fill should be placed on frosted or frozen ground, nor should frozen material be placed as fill. Frozen ground should be allowed to thaw or be completely removed prior to placement of fill. A good practice is to cover the compacted fill with a "blanket" of loose fill to help prevent the compacted fill from freezing.

If the buildings are erected during cold weather, foundations, concrete slabs-on-grade, or other concrete elements should not be constructed on frozen soil. Frozen soil should be completely removed from beneath the concrete elements, or thawed, scarified, and recompacted. The amount of time passing between excavation or subgrade preparation and placing concrete should be minimized during freezing conditions to prevent the prepared soils from freezing. The use of blankets, soil cover or heating as required may be utilized to prevent the subgrade from freezing.

4.2.8 Construction Testing and Observation

Testing and construction observation should take place under the direction of VIVID to support that engineer's professional opinion as to whether the earthwork does or does not substantially conform to the recommendations in this report. Furthermore, the opinions and conclusions of a geotechnical report are based upon the interpretation of a limited amount of information obtained from the field exploration. It is therefore not uncommon to find that actual site conditions differ somewhat from those indicated in the report. The geotechnical engineer should remain involved throughout the project to evaluate such differing conditions as they appear, and to modify or add to the geotechnical recommendations as necessary.

4.2.9 Surface Drainage and Landscaping

Positive drainage away from the structures is essential to the performance of foundations and flatwork and should be provided during the life of the structures. Landscape areas within 10 feet of the structures should slope away at a minimum of 8 percent. Areas where pavements or slabs are constructed adjacent to the structures should slope away at a minimum grade of 2 percent. All downspouts from roof drains should be tight-lined to the on-site stormwater system or, at a minimum, cross all backfilled areas such that they discharge all water away from the backfill zone and the structures. Drainage should be created such that water is diverted off the site and away from backfill areas of adjacent buildings. Landscaping improvements requiring supplemental watering are not recommended adjacent to improved areas including foundations, pavements, or slabs.

4.2.10 Permanent Cut and Fill Slopes

If required, permanent cut and fill slopes exposing the materials encountered in our borings are anticipated to be stable at slope ratios as steep as 3:1 (horizontal to vertical) under dry conditions. We believe that slope ratios of 4:1 or flatter are more reliable if subjected to wetting, and present less of a maintenance problem. New slopes should be revegetated as soon as possible after completion to reduce erosion problems.

4.3 FOUNDATION RECOMMENDATIONS

4.3.1 Shallow Foundation Recommendations

If the owner is willing to accept the risk of some movement to the building and canopies, the proposed structures may be established on a shallow foundation system provided the undocumented fills are over-excavated and replaced with granular structural fill.

Provided the following recommendations are complied with, the proposed structure may be supported on a shallow spread footing foundation. We recommend conventional shallow foundation elements be designed with the following criteria:

- Under no circumstances may the footings be installed on non-engineered fill, topsoil, soft or disturbed soils, construction debris, frozen soil, moisture sensitive soils, or within ponded water. All undocumented fills should be removed and replaced prior to foundation construction. If bearing soils or structural fill upon which the footings are to be constructed become loose or disturbed, the subgrade should be recompacted to the requirements of structural fill or excavated to firmer, undisturbed soils and replaced with structural fill or CLSM.
- Foundations bearing upon properly compacted structural fill extending to prepared native soil subgrade should be designed for a maximum allowable soil bearing capacity of 3,000 psf. A one-third increase in bearing capacity is allowable for transient loads (e.g. wind loads). All foundations should be proportioned as much as practicable to minimize differential settlement.
- We estimated total movement for shallow foundations placed on soils as discussed above would be about 1 inch with potential differential movement about half of the total movement Foundation sizes should be determined by a structural engineer. However, as a minimum, we recommend isolated columns be supported on square pads of at least three feet wide. Continuous wall footings should be at least two feet in width.
- Exterior foundations must be protected from frost action. We recommend footings be protected with at least 36 inches of soil cover or that which is required by local building codes. Foundation components must not be placed on frozen soils.
- A soil unit weight of 110 pounds per cubic foot (pcf) for on-site soils or imported granular structural fill may be used for overturning resistance calculations for soils placed above foundations, if required.
- Lateral foundation loads can be resisted through a combination of friction at the interface between the bottom of the foundation and passive earth pressure resistance from compacted structural fill placed adjacent the foundation. An allowable sliding coefficient of 0.3 for foundation concrete placed directly on structural fill may be used for frictional resistance. For structural fill compacted adjacent the foundations, an equivalent fluid passive earth pressure of 350 pounds per cubic foot (pcf) may be used to calculate lateral earth pressure resistance. Due to the large amount of foundation movement required to mobilize the full passive earth pressure

provided we recommend applying a factor of safety of at least 2 to the passive earth pressure provided.

- A representative of VIVID should observe all foundation excavations prior to placement of fill and/or concrete. Additionally, the placement and compaction of structural fill should be observed and tested by a representative of our firm.
- A modulus of subgrade reaction, K_{V1}, of 100 pounds per cubic inch may be used for design of mat foundations. K_{V1} refers to a one-foot square plate and should be adjusted for actual foundation dimensions using the following equation (B is foundation width in feet):

$$K_V = K_{V1}\left(\frac{B+1}{2B}\right)^2$$

- The foundation subgrade should be protected from wetting and drying prior to and after concrete placement. Footings should be backfilled as soon as practical after concrete placement.
- .

4.4 FLOOR SYSTEMS

4.4.1 Slab-on-Grade Floor System

Slab-on-grade floor systems are considered acceptable provided any existing fill materials are removed and replaced with imported structural fill or properly compacted on-site soils, and the owner is willing to risk some slab movement. If floor movement cannot be tolerated, then a structurally support floor system is recommended.

The criteria presented below should be observed for design and construction of floor slabs on this site. The construction details should be considered when preparing the project documents.

- For concrete slab-on-grade design purposes, a modulus of subgrade reaction of 100 pounds per cubic inch (pci) can be used for properly compacted, structural fill, and compacted subgrade preparation as described above. Additional reinforcement can also be used to help resist damage due to differential movement of slabs.
- Floor slabs should be separated from all bearing walls and columns with expansion joints that allow unrestrained vertical movement. At door thresholds only, both interior and exterior slabs can be dowelled into the foundation stem wall to resist movement that can create a trip hazard or impede proper door operation.
- Floor slab control joints should be used to reduce damage due to shrinkage cracking. Control joint spacing is a function of slab thickness, aggregate size, slump and curing conditions. The requirements for concrete slab thickness, joint spacing and reinforcement should be established by the designer based on experience, recognized design guidelines and the intended slab use. Placement and curing conditions will have a strong impact on the final concrete slab integrity.
- Minimum 2-inch void space should be constructed above or below non-bearing partition walls placed on the floor slab. Partition walls should be isolated from suspended ceilings.
- Utility lines should be provided with flexible joints or oversized sleeves where they penetrate floor slabs to prevent breakage caused by differential movement.

4.4.2 Capillary Break or Moisture Barrier

If moisture sensitive flooring or adhesives will be utilized within the structures, a capillary break or moisture barrier should be constructed below slabs at this site. The placement of compacted granular fill materials (CDOT Class I Structure Backfill) within the upper 12 inches of soil below the slab is considered a capillary break unless this does not meet the flooring manufacturer recommendations.

4.5 EXTERIOR CONCRETE FLATWORK/SLABS-ON-GRADE

The project will include exterior concrete for walkways, sidewalks, driveways, etc. Some potential for differential movement and cracking is possible. While it is not likely that exterior slabs can be economically protected from distress, several techniques are available to reduce the expected long-term movement of the slab, including:

- Placement of a thick zone of imported, granular, non-expansive structural fill beneath slabs;
- At thresholds, thickened slabs can be doweled into the structure to avoid differential movement and trip hazards;
- Avoidance of watering adjacent to slabs, and
- Structural reinforcement of slabs.

Note that exterior slabs constructed directly adjacent the building structure shall be constructed on prepared subgrade the same as the interior floor slab per Section 4.4.1 of this report.

4.6 CORROSIVITY AND CONCRETE

4.6.1 Corrosion Potential

Laboratory testing was completed to provide data regarding corrosivity of onsite soils. Our scope of services does not include corrosion engineering and, therefore, a detailed analysis of the corrosion test results is not included. A qualified corrosion engineer should be retained to review the test results and design protective systems that may be required.

Laboratory chloride concentration, sulfate concentration, pH, and electrical resistivity tests were performed on samples of onsite materials obtained during our field investigation. The results of the tests are included in Appendix C to this report and are summarized below in Table 7.

Table 7
Summary of Laboratory Soil Corrosivity Testing

Boring No.	Sample Depth (ft)	Lithology	Water Soluble Chloride (%)	pH	Redox Potential (mV)	Resistivity (ohm-cm)	Water Soluble Sulfate (%)	Sulfide Content
B-2	0 - 5	Fill	0.002	7.8	213.1	1,000	0.001	Trace

Metal and concrete elements in contact with soil, whether part of a foundation system or part of a supported structure, are subject to degradation due to corrosion or chemical attack. Therefore, buried metal and concrete elements should be designed to resist corrosion and degradation based on accepted practices.

Based on the "10-point" method developed by the American Water Works Association (AWWA) in standard AWWA C105/A21.5, the corrosivity test results indicate that the onsite materials have corrosive potential based upon the low resistivity value alone. We also recommend that a corrosion engineer be consulted to recommend appropriate protective measures, if required.

4.6.2 Chemical Sulfate Susceptibility and Concrete Type

The degradation of concrete or cement grout can be caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds within the concrete, causing cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete or cement grout. The American Concrete Institute (ACI) in their publication Guide to Durable Concrete (ACI 201.2R-08) provides guidelines for this assessment.

The concentration of water-soluble sulfates measured on subsurface materials submitted for testing represents Class 0 exposure of sulfate attack on concrete exposed to the soils per CDOT Standard Specifications for Road and Bridge Construction, 2022, Section 601.04.

4.7 PAVEMENT RECOMMENDATIONS

4.7.1 General

Paved parking lots and access/drive lanes are proposed for the site. Our borings indicate the pavement subgrade soils will generally consist of existing variable density, low to moderately expansive clay materials. These types of soils are generally considered to provide poor support for pavements. Laboratory testing from samples obtained from the upper 10 feet of the borings correlate to a moderate subgrade support value (R-value) of 17. All subgrade preparation, fill, and aggregate base course shall be compacted as recommended in Sections 4.2.2, 4.2.4, and 4.2.6 of this report.

4.7.2 Traffic Values

No traffic estimates were available for our use at the time this report was written. Based on past experience with similar projects, we anticipate areas of the pavement will be subjected to "light" passenger vehicle traffic, while other areas will be subject to heavier delivery trucks, trash trucks, and maintenance vehicles. For our design we have assigned a 20-year, 18-kip Equivalent Single Axle Load (ESAL) of 50,000 for areas of "light duty" vehicle use only, and an ESAL of 125,000 where heavier traffic loads are anticipated.

If traffic estimates vary significantly from those assumed, we should be contacted to re-evaluate our recommendations. The following pavement sections were designed using the AASHTO design methods for flexible and rigid pavements.

Table 8
Pavement Section Thickness Recommendations

PAVEMENT AREA	PORTLAND CEMENT CONCRETE/ AGGREGATE BASE COURSE (INCHES)[1]	ASPHALT CONCRETE/ AGGREGATE BASE COURSE (INCHES)[1]
Light Duty Use	5/6	3.5/6
Heavy Duty Use	5.5/6	4.5/6

1) Overlying a properly prepared subgrade as described in Section 4.7.3.

Concrete pavements should be provided with adequate reinforcement based upon anticipated loads. Asphalt does not perform well where trucks perform tight turn maneuvers, therefore concrete should be considered for these areas. A concrete pad is recommended in front of trash dumpster locations to support the heavy front wheel loads of trash trucks.

4.7.3 Pavement Subgrade Preparation

Pavement subgrades are projected to exhibit poor pavement support characteristics, including the placement of undocumented fill materials. If the owner is willing to risk some pavement movement, pavement distress and "bird bathing" and possible premature pavement failure, then portions of the undocumented fill materials may be left in-place. As minimum preparation to the pavement subgrade, we recommend the upper 12 inches of the undocumented fill materials are over-excavated and the underlying undocumented fill materials are scarified to a depth of 8 inches, moisture conditioned and recompacted prior to the placement, moisture conditioning and compaction of the remaining 12 inches of pavement subgrade. .

The prepared subgrade should be proof-rolled with a heavily loaded pneumatic-tired vehicle (such as a fully-loaded dump truck or similar weight equipment) after subgrade preparation and prior to placement of the pavement section and structural fill, if required. Pavement design procedures assume a firm and stable subgrade. Areas that deform under heavy wheel loads are not stable and should be removed to firm material and replaced to achieve a stable subgrade prior to paving. Care should be taken to ensure areas around manholes or other utility protrusions are proof-rolled adequately.

Subgrade soils may be at risk of pumping during construction. This risk is increased if pavements are being constructed during adverse weather conditions (e.g., heavy precipitation). In this event, stabilization options can only be determined when the conditions are observed but may include deeper Aggregate Base Course sections in combination with additional geo-grid placement, structural fill, rock stabilization, or similar options.

4.7.4 Pavement Construction Considerations

Pavement construction must be completed in accordance with City of Parker specifications. The specifications contain requirements for the roadway materials (asphalt concrete and base course) and the construction practices used (compaction and material sampling). Of particular importance are those specifications directed towards embankment construction, subgrade compaction, base course compaction, and utility trench compaction. Prior to pavement construction, the prepared subgrade should be proof-rolled with heavy construction equipment. A fully loaded dump truck or water truck would be acceptable for this purpose. During proof-rolling, particular attention should be directed to the areas immediately adjacent to manholes, valves, catch basins, and other similar surface features. Areas which exhibit excessive deflection during proof-rolling should be over-excavated and stabilized as required. If soil is imported to the subject site for final grading, the soil materials must be of a character similar to those described in this report.

Proper drainage is of paramount importance in enhancing pavement performance. To avoid distress to pavement from wet subgrade soils, we recommend the maintenance of good drainage away from all pavements. Possible water sources include storm runoff, irrigation of landscaping adjacent the pavement and localized groundwater seepage, among others. Landscaping adjacent to the pavements should be avoided. Joints in the pavement or at asphalt/concrete interfaces should be sealed. Any cracks or openings in the finished pavement surface should be sealed and/or repaired as quickly as possible.

5.0 ADDITIONAL SERVICES & LIMITATIONS

5.1 ADDITIONAL SERVICES

Attached to this report is a document by the Geoprofessional Business Association (GBA) that summarizes limitations of geotechnical reports as well as additional services that are required to further confirm subgrade materials are consistent with that encountered at the specific boring locations presented in this report. This document should be read in its entirety before implementing design or construction activities. Examples of other services beyond completion of a geotechnical report are necessary or desirable to complete a project satisfactorily include:

- Review of design plans and specifications to verify that our recommendations were properly interpreted and implemented.
- Attendance at pre-bid and pre-construction meetings to highlight important items and clear up misunderstandings, ambiguities, or conflicts with design plans and specifications.
- Performance of construction observation and testing which allows verification that existing materials at locations beyond our borings are consistent with that presented in our report, construction is compliant with the requirements/recommendations, evaluation of changed conditions.

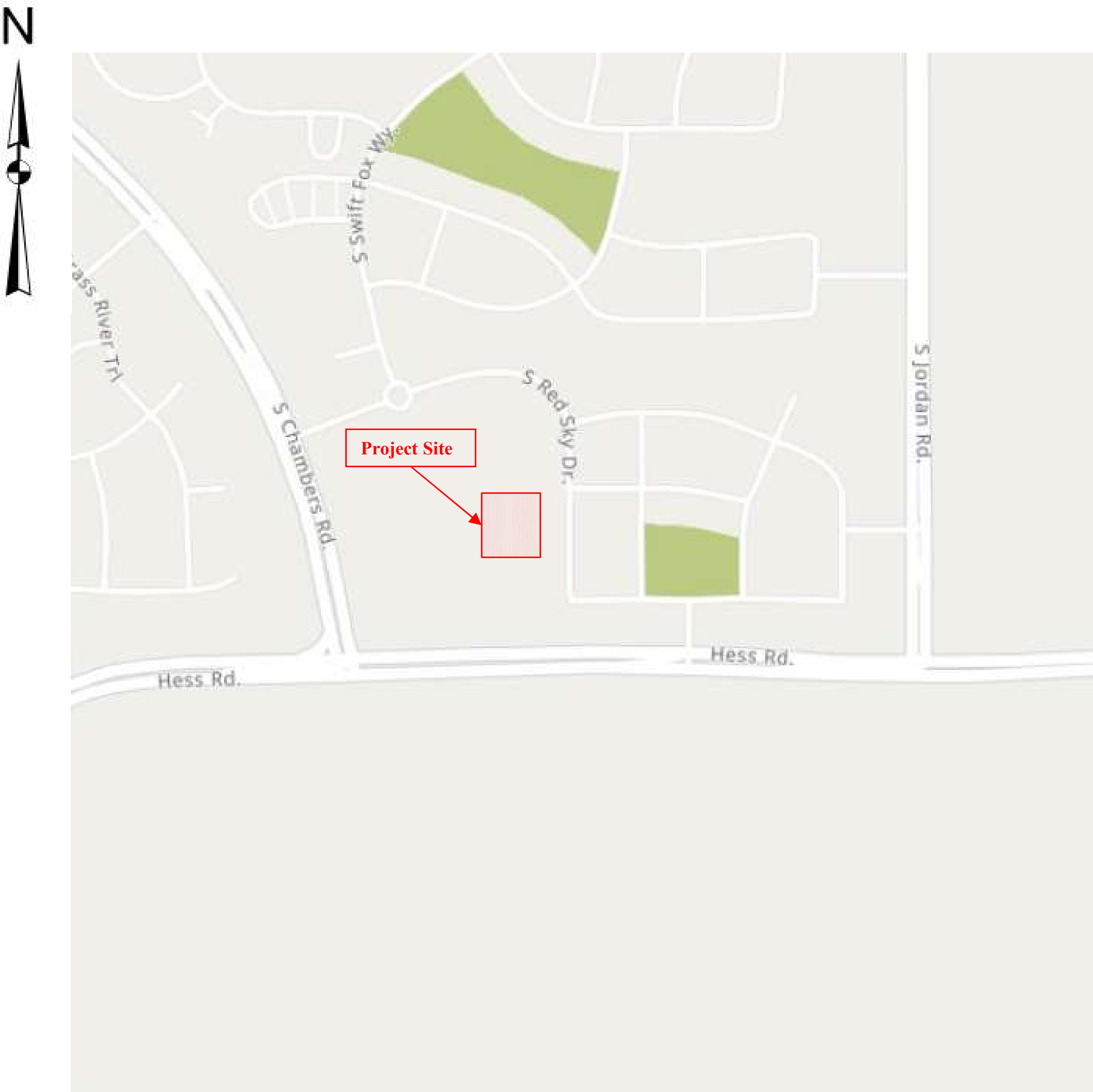
5.2 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of VIVID's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on a limited number of observations and data. It is possible that conditions could vary between or beyond the data evaluated. VIVID makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two (2) years from the date of the report.

The work performed was based on project information provided by Client. If Client does not retain VIVID to review any plans and specifications, including any revisions or modifications to the plans and specifications, VIVID assumes no responsibility for the suitability of our recommendations. In addition, if there are any changes in the field to the plans and specifications, Client must obtain written approval from VIVID's engineer that such changes do not affect our recommendations. Failure to do so will vitiate VIVID's recommendations.

Figures



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REFERENCE:
Base image obtained from www.mapquest.com, 2023

NOT TO SCALE

VIVID Engineering Group, Inc.
3885 Forest Street
Denver, CO 80207
303-994-5153

Project No. D23-1-321

Date: January 16, 2023

Drawn by: RJS

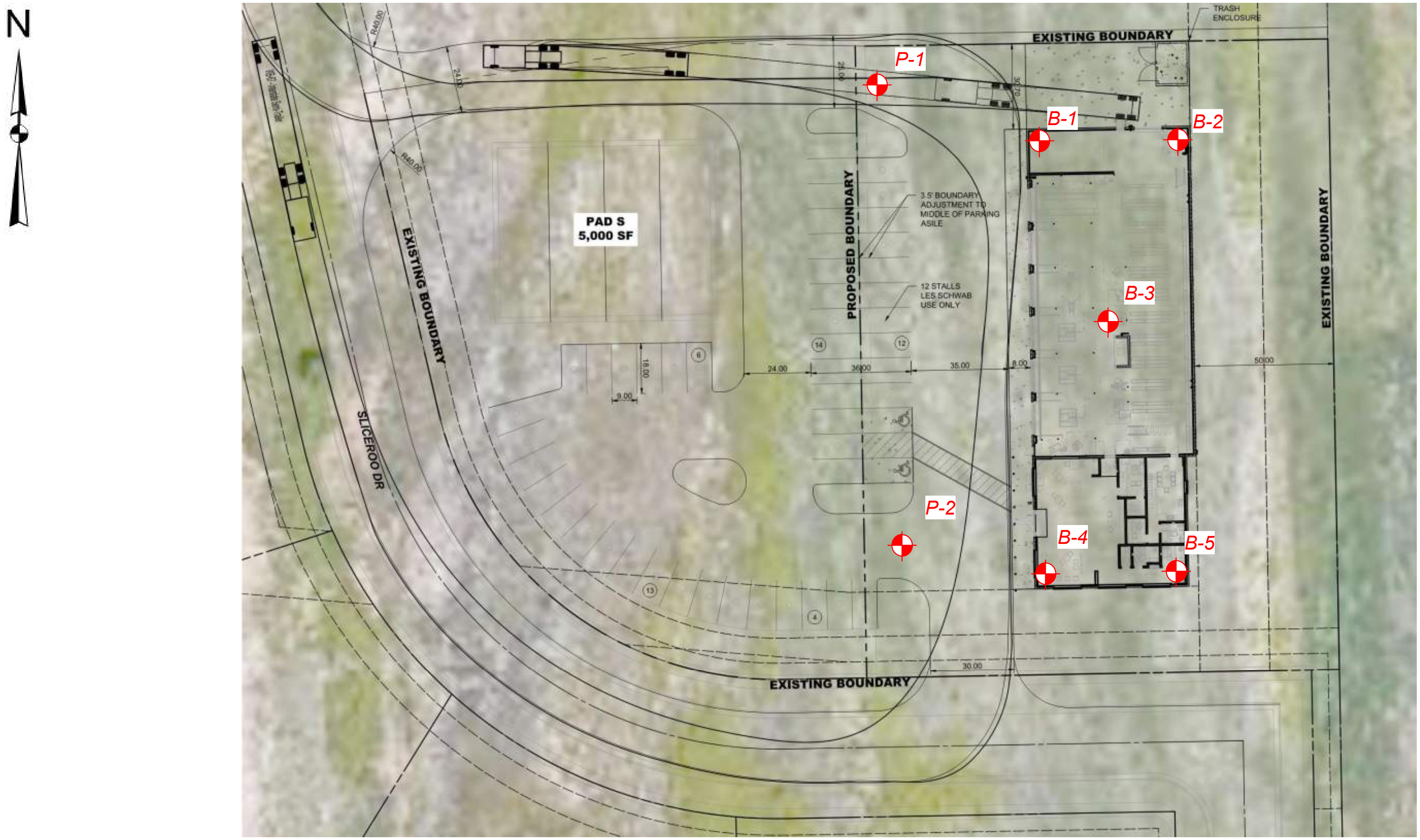
Reviewed by: TJN

VICINITY MAP

Les Schwab Tire Center
Sliceroo Drive and S. Red Sky Drive
Parker, Colorado

FIGURE

1



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REFERENCE:
Overall Site Plan
Provided By: Cushing Terrell
Dated: September 1, 2022

LEGEND

B-1 Soil Test Boring Location

GRAPHIC SCALE

0' 30' 60'

VIVID Engineering Group, Inc.
3885 Forest Street
Denver, CO 80207
303-994-5153

Project No. D23-1-321	**FIELD EXPLORATION PLAN**
Date: January 16, 2023	
Drawn by: TJN	Les Schwab Tire Center Sliceroo Drive and S. Red Sky Drive Parker, Colorado
Reviewed by: RJS	

FIGURE

2

Appendix A

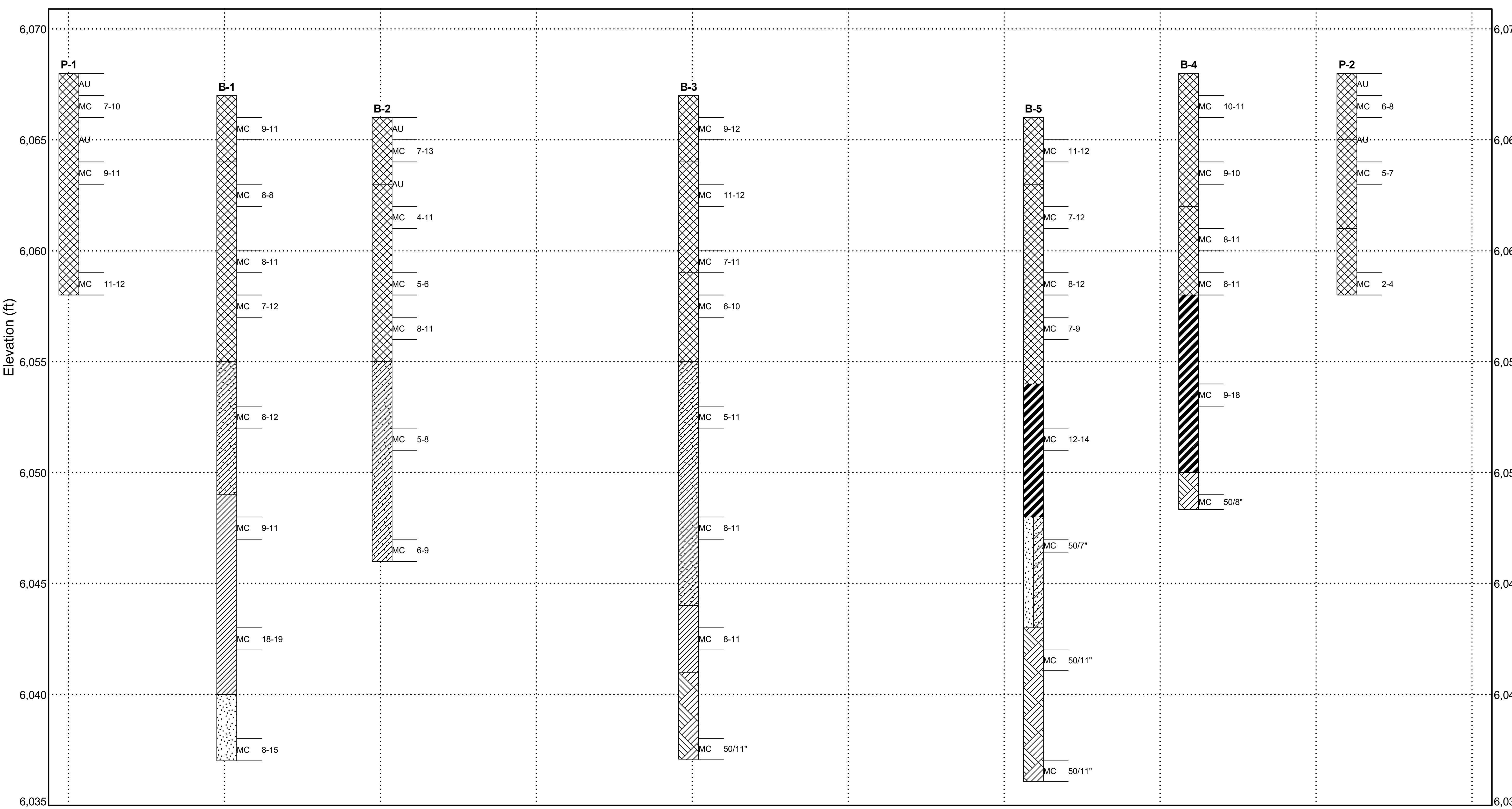
Log of Exploratory Borings

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

SUBSURFACE DIAGRAM

CLIENT Les Schwab
PROJECT NUMBER D23-1-321
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT LOCATION Parker, CO

Legend: FILL; SP USCS Poorly-graded Sand; SP-SC USCS Poorly-graded Sand with Clay; CLS USCS Low Plasticity Sandy Clay; CLAYSTONE; CL USCS Low Plasticity Clay; CH USCS High Plasticity Clay



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3885 Forest Street
Denver, CO 80207

KEY TO SYMBOLS

CLIENT Les Schwab

PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO

PROJECT NUMBER D23-1-321

PROJECT LOCATION Parker, CO

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

- CH: USCS High Plasticity Clay
- CL: USCS Low Plasticity Clay
- CLAYSTONE
- CLS: USCS Low Plasticity Sandy Clay
- FILL
- SP: USCS Poorly-graded Sand
- SP-SC: USCS Poorly-graded Sand with Clay

SAMPLER SYMBOLS

- Auger Cuttings
- 2" I.D. Modified California Sampler (MC)

ABBREVIATIONS

LL - LIQUID LIMIT (%)
PI - PLASTIC INDEX (%)
MC - MOISTURE CONTENT (%)
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
FINES- PERCENT PASSING NO. 200 SIEVE
UCS - UNCONFINED COMPRESSIVE STRENGTH

▽ Water Level at Time of Drilling, or as Shown
▼ Water Level at End of Drilling, or as Shown
▼ Water Level After 24 Hours, or as Shown

BORING NUMBER B-1

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6067 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0					FILL, Poorly Graded SAND with Clay, fine to coarse-grained, white and brown, slightly moist, medium dense
	MC	9-11	MC = 11.1% DD = 111.6 pcf		
					3.0 — 6064.0
					FILL, Sandy Lean Clay, brown, dark brown, and gray, moist, stiff to very stiff
5	MC	8-8	MC = 28.9% DD = 93.9 pcf Swell = 0.9% when wetted under 500 psf load		
	MC	8-11	MC = 19.3% DD = 107.7 pcf		
10	MC	7-12	MC = 17.7% DD = 117.2 pcf LL = 46 PL = 17 Fines = 58.0%		
					12.0 — 6055.0
					Sandy Lean Clay, brown, moist, very stiff
15	MC	8-12			
					18.0 — 6049.0
					Lean CLAY with Sand, dark brown, slightly moist, very stiff
20	MC	9-11	MC = 21.6% DD = 110.8 pcf		
25	MC	18-19			
					27.0 — 6040.0
					Poorly Graded SAND, fine to coarse-grained, white, slightly moist, medium dense
30	MC	8-15			30.0 — 6037.0

Bottom of borehole at 30.0 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER B-2

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6066 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0	AU				FILL, Sandy Lean CLAY, brown, slightly moist, very stiff
	MC	7-13	MC = 16.3% DD = 112.0 pcf		
	AU		Chloride = 0.002%, pH = 7.8, Redox Potential = 213.1 mv, Resistivity = 1000 ohm-cm, Sulfate = 0.001%, Sulfide = Trace		3.0 — 6063.0
					FILL, Sandy Lean CLAY, brown and dark brown, slightly moist to moist, stiff to very stiff
5	MC	4-11			
	MC	5-6	MC = 16.9% DD = 113.2 pcf Swell = 0.6% when wetted under 1,000 psf load		
10	MC	8-11			
					11.0 — 6055.0
					Sandy Lean CLAY, brown and dark brown, moist, stiff
15	MC	5-8	MC = 27.4% DD = 93.5 pcf		
20	MC	6-9			20.0 — 6046.0

Bottom of borehole at 20.0 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER B-3

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6067 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS
1-2	MC	9-12	
4-5	MC	11-12	MC = 25.3% DD = 98.6 pcf
7-8	MC	7-11	
9-10	MC	6-10	MC = 18.7% DD = 112.0 pcf Swell = 0.4% when wetted under 1,000 psf load
14-15	MC	5-11	
19-20	MC	8-11	MC = 23.5% DD = 99.0 pcf
24-25	MC	8-11	
29-29.9	MC	50/11"	MC = 32.7%

Depth (ft)	MATERIAL DESCRIPTION	Elevation (ft)
0.0 - 3.0	FILL, Sandy Lean CLAY, brown, slightly moist, very stiff	6064.0
3.0 - 8.0	FILL, Clayey SAND, fine to medium-grained, gray and reddish-brown, slightly moist, medium dense	6059.0
8.0 - 12.0	FILL, Sandy Lean CLAY, brown and dark brown, moist, stiff	6055.0
12.0 - 23.0	Sandy Lean CLAY, brown, dark brown, and gray, slightly moist to moist, stiff to very stiff	6044.0
23.0 - 26.0	Lean CLAY, gray, moist, very stiff	6041.0
26.0 - 29.9	Sandy CLAYSTONE, gray, moist, hard	6037.1

Bottom of borehole at 29.9 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER B-4

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6068 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	MATERIAL DESCRIPTION
0				FIILL, Lean CLAY with Sand, brown, slightly moist, very stiff
	MC	10-11	MC = 17.9% DD = 103.1 pcf	
5	MC	9-10		
6.0				(6062.0) FILL, Sandy Fat CLAY, brown and dark brown, slightly moist to moist, very stiff
	MC	8-11	MC = 24.3% DD = 100.9 pcf Swell = 0.5% when wetted under 1,000 psf load	
10	MC	8-11	MC = 24.9% DD = 93.9 pcf LL = 51 PL = 18 Fines = 53.0%	
10.0				(6058.0) Sandy Fat CLAY, dark brown, moist, very stiff
15	MC	9-18		
18.0				(6050.0) CLAYSTONE, gray, slightly moist, hard
19.7	MC	50/8"	MC = 28.7% DD = 88.0 pcf	(6048.3)

Bottom of borehole at 19.7 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER B-5

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6066 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0					FILL, Clayey SAND, fine to coarse-grained, brown to orange-brown, moist, medium dense
	MC	11-12			
3.0					6063.0
					FILL, Lean CLAY with Sand, brown and dark brown, slightly moist to moist, stiff to very stiff
5	MC	7-12	MC = 27.0% DD = 93.0 pcf		
	MC	8-12			
10	MC	7-9	MC = 15.7% DD = 117.8 pcf Swell = 1.6% when wetted under 1,000 psf load		
12.0					6054.0
					Fat CLAY with Sand, light brown to gray, moist, very stiff
15	MC	12-14	MC = 25.8% DD = 93.5 pcf LL = 77 PL = 31 Fines = 75.0%		
18.0					6048.0
					Poorly Graded SAND with Clay, fine to medium-grained, orange-brown, slightly moist, very dense
20	MC	50/7"			
23.0					6043.0
					CLAYSTONE, weathered, dark brown, moist, hard
25	MC	50/11"	MC = 29.3%		
	MC	50/11"			
29.9					6036.1

Bottom of borehole at 29.9 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER P-1

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6068 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0	AU				FILL, Clayey SAND, fine to coarse-grained, brown and dark brown, slightly moist to moist, medium dense
	MC	7-10	MC = 13.7%		
	AU		LL = 46 PL = 18 Fines = 47.0%		
5	MC	9-11	MC = 21.2% DD = 106.8 pcf Swell = 1.7% when wetted under 200 psf load		
10	MC	11-12			10.0 6058.0

Bottom of borehole at 10.0 feet.

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

BORING NUMBER P-2

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO
DATE STARTED 1/13/23 **COMPLETED** 1/13/23
GROUND ELEVATION 6068 ft **HOLE SIZE** 4 inches
DRILLING CONTRACTOR VINE (CME-550)
GROUND WATER LEVELS:
DRILLING METHOD 4" Solid Stem Auger
AT TIME OF DRILLING ---
LOGGED BY R. Schaffer **CHECKED BY** T. Nevin
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	SAMPLE TYPE NUMBER	BLOW COUNTS (N VALUE)	TESTS	GRAPHIC LOG	MATERIAL DESCRIPTION
0	AU		R-value @ 300 psi = 17		FILL, Sandy Lean CLAY with Gravel, fine to coarse-grained, brown and dark brown, slightly moist to moist, medium dense
	MC	6-8	MC = 14.4% DD = 116.2 pcf Swell = 2.7% when wetted under 200 psf load		
	AU		LL = 49 PL = 19 Fines = 53.0%		3.0 — 6065.0 FILL, Sandy Lean CLAY, brown, moist, stiff
5	MC	5-7	MC = 15.9% DD = 107.2 pcf		
					7.0 — 6061.0 FILL, Clayey SAND with Gravel, fine to coarse-grained, pink and brown, slightly moist, loose
10	MC	2-4			10.0 — 6058.0

Bottom of borehole at 10.0 feet.

Appendix B

Geotechnical Laboratory Test Results

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

SUMMARY OF LABORATORY RESULTS

CLIENT Les Schwab

PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO

PROJECT NUMBER D23-1-321

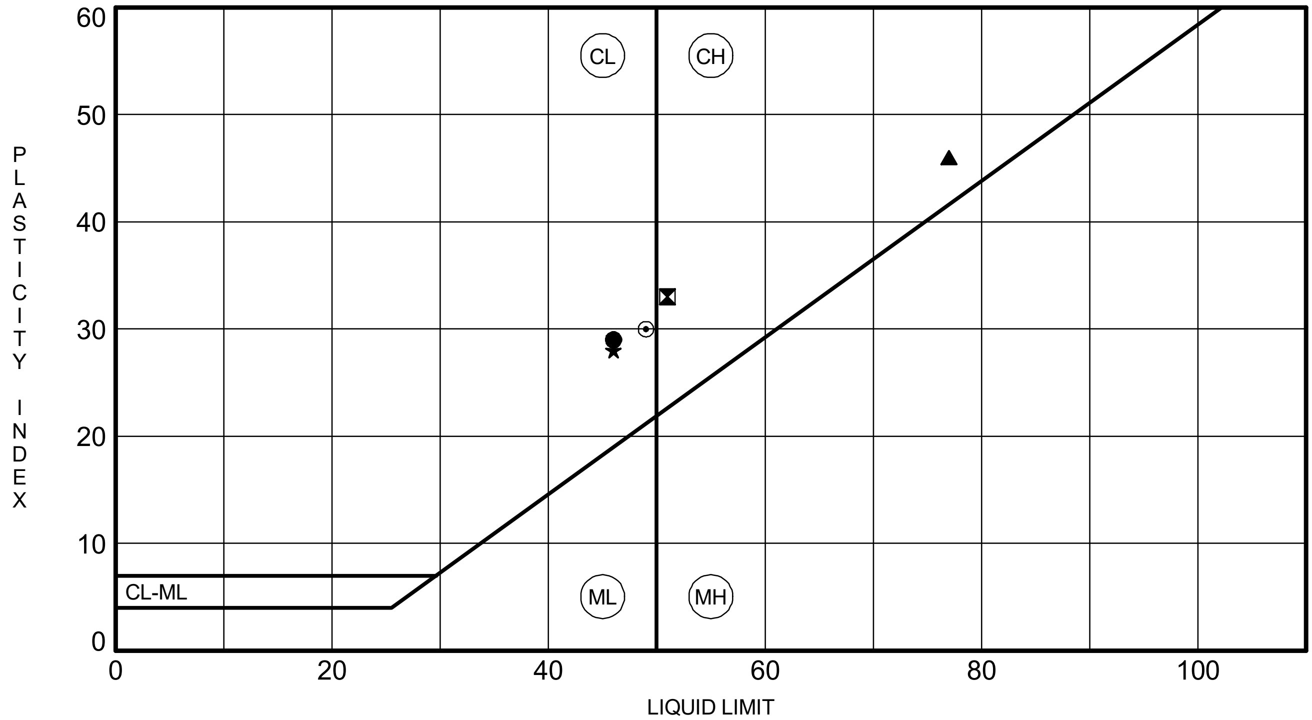
PROJECT LOCATION Parker, CO

Exploration ID	Approx. Sample Depth (ft)	Sample Description	Passing 3/4" Sieve (%)	Passing #4 Sieve (%)	Passing #200 Sieve (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Moisture Content (%)	Dry Density (pcf)
B-1	1.0								11.1	111.6
B-1	4.0								28.9	93.9
B-1	7.0								19.3	107.7
B-1	9.0	SANDY LEAN CLAY(CL)			58	46	17	29	17.7	117.2
B-1	19.0								21.6	110.8
B-2	1.0								16.3	112.0
B-2	7.0								16.9	113.2
B-2	14.0								27.4	93.5
B-3	4.0								25.3	98.6
B-3	9.0								18.7	112.0
B-3	19.0								23.5	99.0
B-3	29.0								32.7	
B-4	1.0								17.9	103.1
B-4	7.0								24.3	100.9
B-4	9.0	SANDY FAT CLAY(CH)			53	51	18	33	24.9	93.9
B-4	19.0								28.7	88.0
B-5	4.0								27.0	93.0
B-5	9.0								15.7	117.8
B-5	14.0	FAT CLAY with SAND(CH)			75	77	31	46	25.8	93.5
B-5	24.0								29.3	
P-1	1.0								13.7	
P-1	2.0	CLAYEY SAND(SC)			47	46	18	28		
P-1	4.0								21.2	106.8
P-2	1.0								14.4	116.2
P-2	2.0	SANDY LEAN CLAY(CL)			53	49	19	30		
P-2	4.0								15.9	107.2

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

ATTERBERG LIMITS' RESULTS

CLIENT Les Schwab
PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO
PROJECT NUMBER D23-1-321
PROJECT LOCATION Parker, CO



BOREHOLE	DEPTH	LL	PL	PI	Fines	Classification
● **B-1**	**9.0**	**46**	**17**	**29**	**58**	**SANDY LEAN CLAY(CL)**
⧗ **B-4**	**9.0**	**51**	**18**	**33**	**53**	**SANDY FAT CLAY(CH)**
▲ **B-5**	**14.0**	**77**	**31**	**46**	**75**	**FAT CLAY with SAND(CH)**
★ **P-1**	**2.0**	**46**	**18**	**28**	**47**	**CLAYEY SAND(SC)**
⊙ **P-2**	**2.0**	**49**	**19**	**30**	**53**	**SANDY LEAN CLAY(CL)**

Vivid Engineering Group
3885 Forest Street
Denver, CO 80207

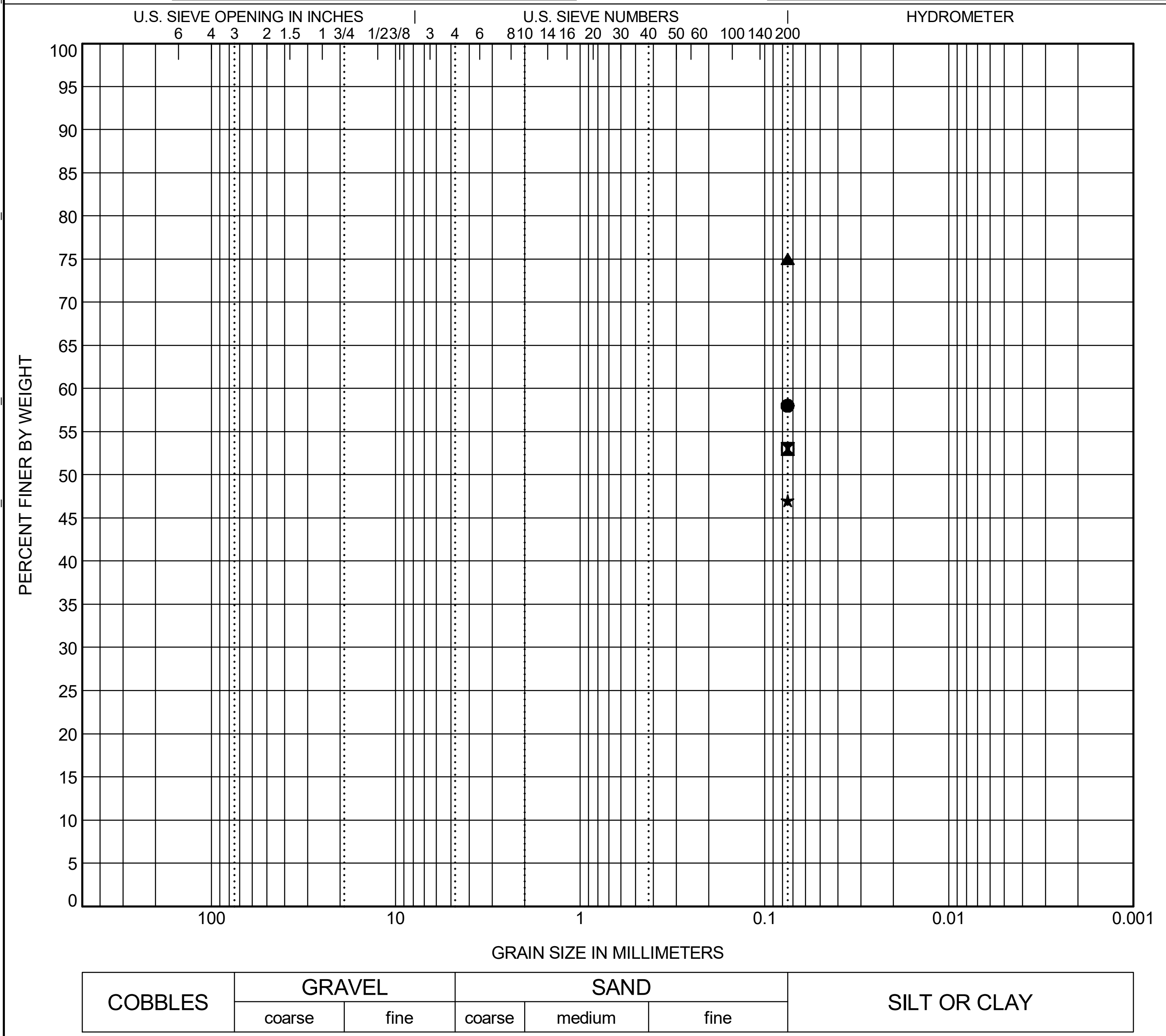
GRAIN SIZE DISTRIBUTION

CLIENT Les Schwab

PROJECT NAME Proposed Les Schwab Tire Center - Parker, CO

PROJECT NUMBER D23-1-321

PROJECT LOCATION Parker, CO

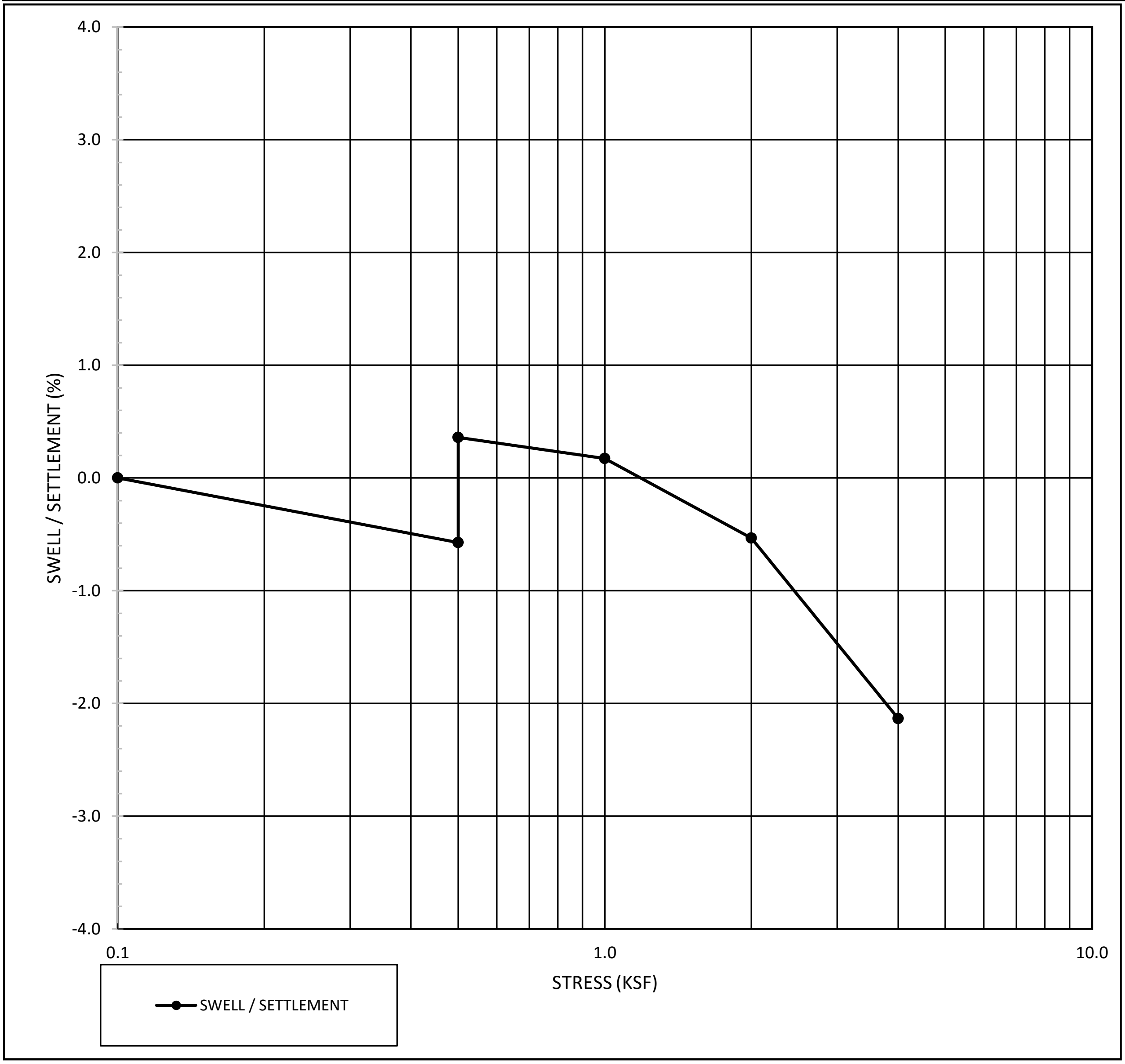


	BOREHOLE	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**9.0**	**SANDY LEAN CLAY(CL)**	**46**	**17**	**29**		
⧗	**B-4**	**9.0**	**SANDY FAT CLAY(CH)**	**51**	**18**	**33**		
▲	**B-5**	**14.0**	**FAT CLAY with SAND(CH)**	**77**	**31**	**46**		
★	**P-1**	**2.0**	**CLAYEY SAND(SC)**	**46**	**18**	**28**		
⊙	**P-2**	**2.0**	**SANDY LEAN CLAY(CL)**	**49**	**19**	**30**		

	BOREHOLE	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**9.0**	**0.075**						**58.0**	
⧗	**B-4**	**9.0**	**0.075**						**53.0**	
▲	**B-5**	**14.0**	**0.075**						**75.0**	
★	**P-1**	**2.0**	**0.075**						**47.0**	
⊙	**P-2**	**2.0**	**0.075**						**53.0**	

VIVID Engineering Group, Inc.

Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	B-1	**Sample Depth (ft)**	4
Sample Description:	Fill, Sandy Lean CLAY, brown and dark brown, moist		
		Swell @ Wetting Weight:	0.9 %

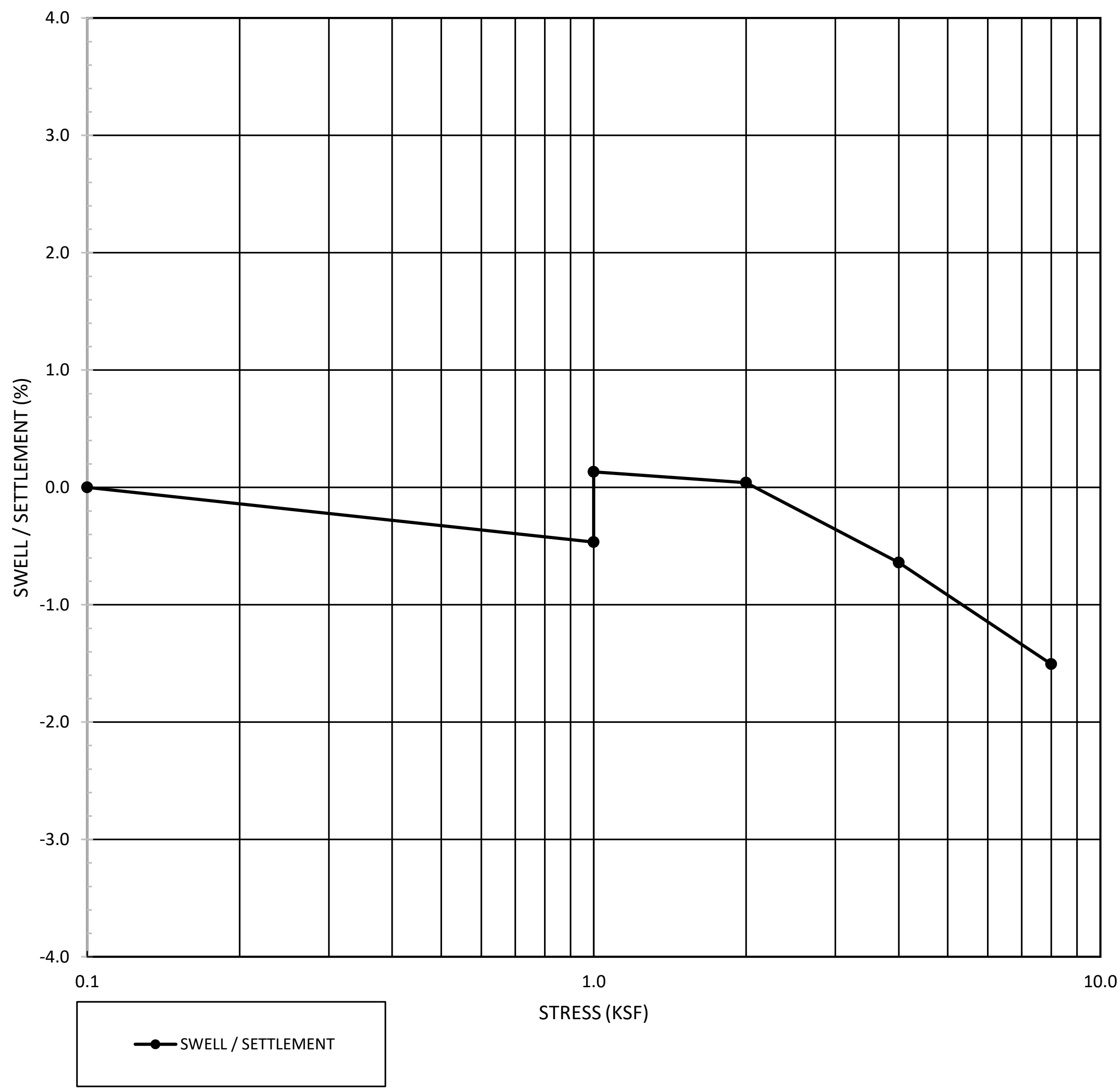


Initial Condition	
Moisture Content %	**28.9**
Dry Density (pcf)	**94.0**
Post-Swell Condition	
Moisture Content %	**29.4**

VIVID Engineering Group, Inc.

Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	B-2	**Sample Depth (ft)**	7
Sample Description:	Fill, Sandy Lean CLAY, brown and dark brown, moist		

Swell @ Wetting Weight: 0.6 %

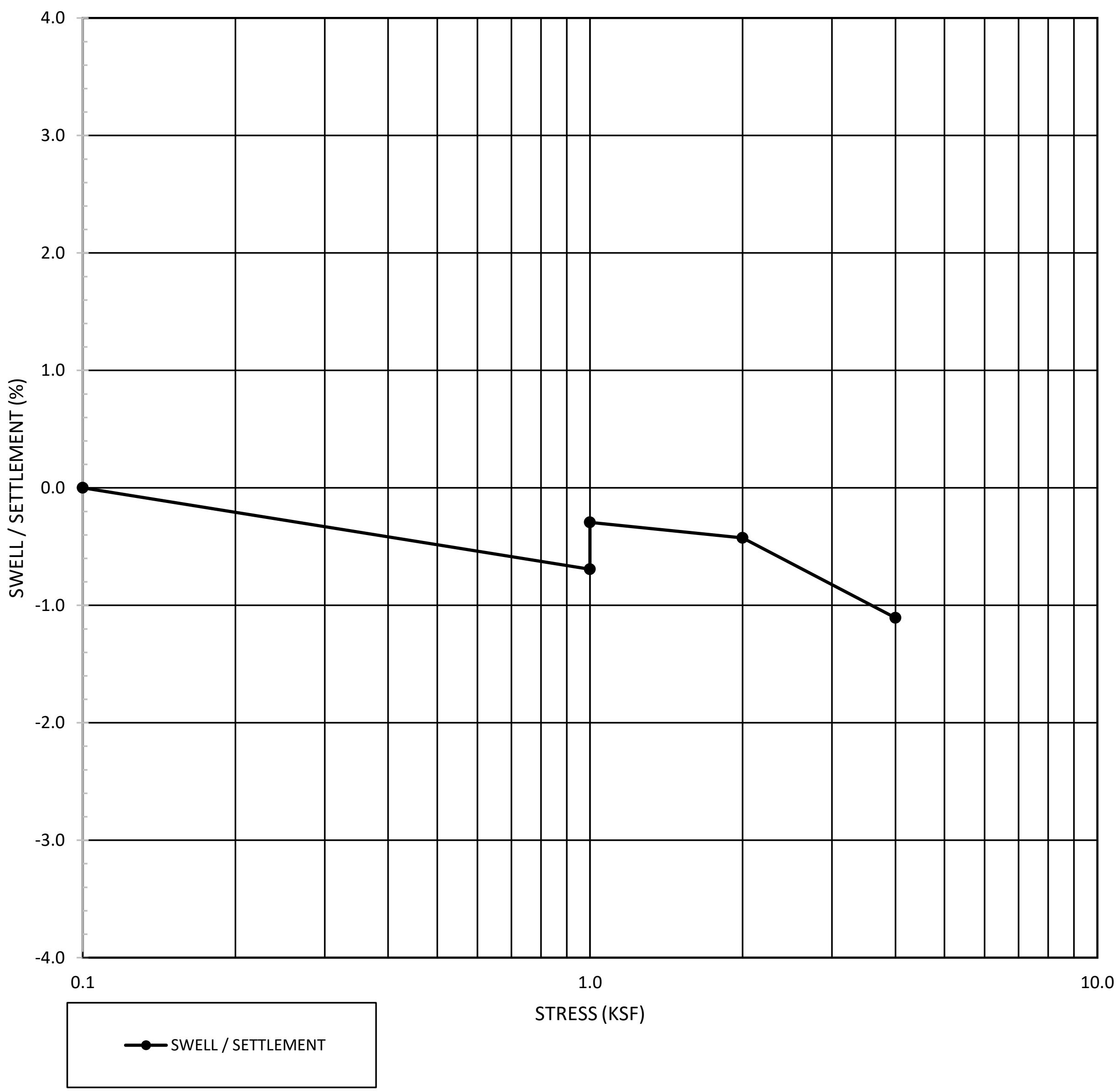


Initial Condition	
Moisture Content %	16.9
Dry Density (pcf)	113.2
Post-Swell Condition	
Moisture Content %	18.2

VIVID Engineering Group, Inc.

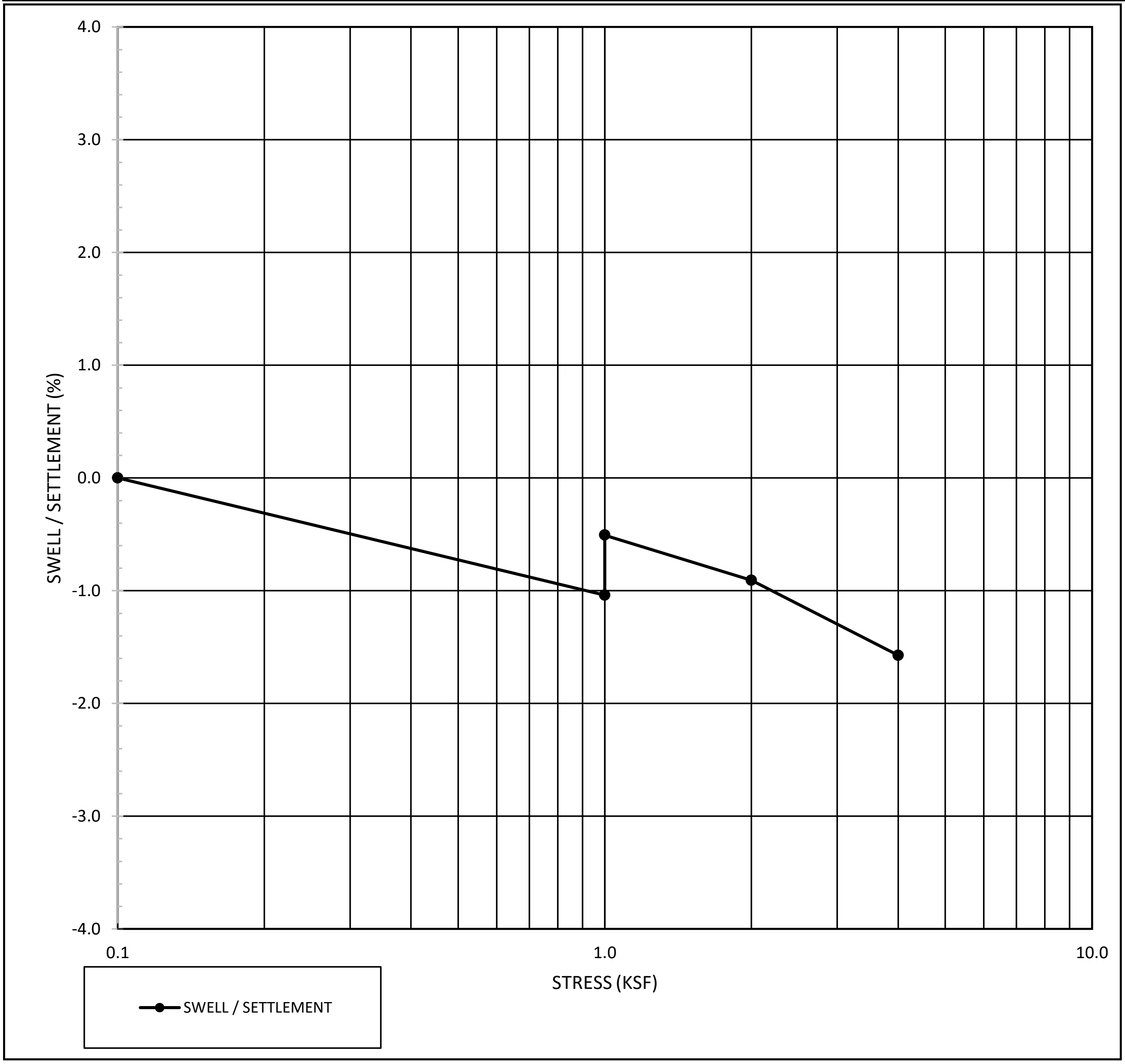
Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	B-3	**Sample Depth (ft)**	9
Sample Description:	Fill, Sandy Lean CLAY, brown and dark brown, moist		

	%
Swell @ Wetting Weight:	**0.4**



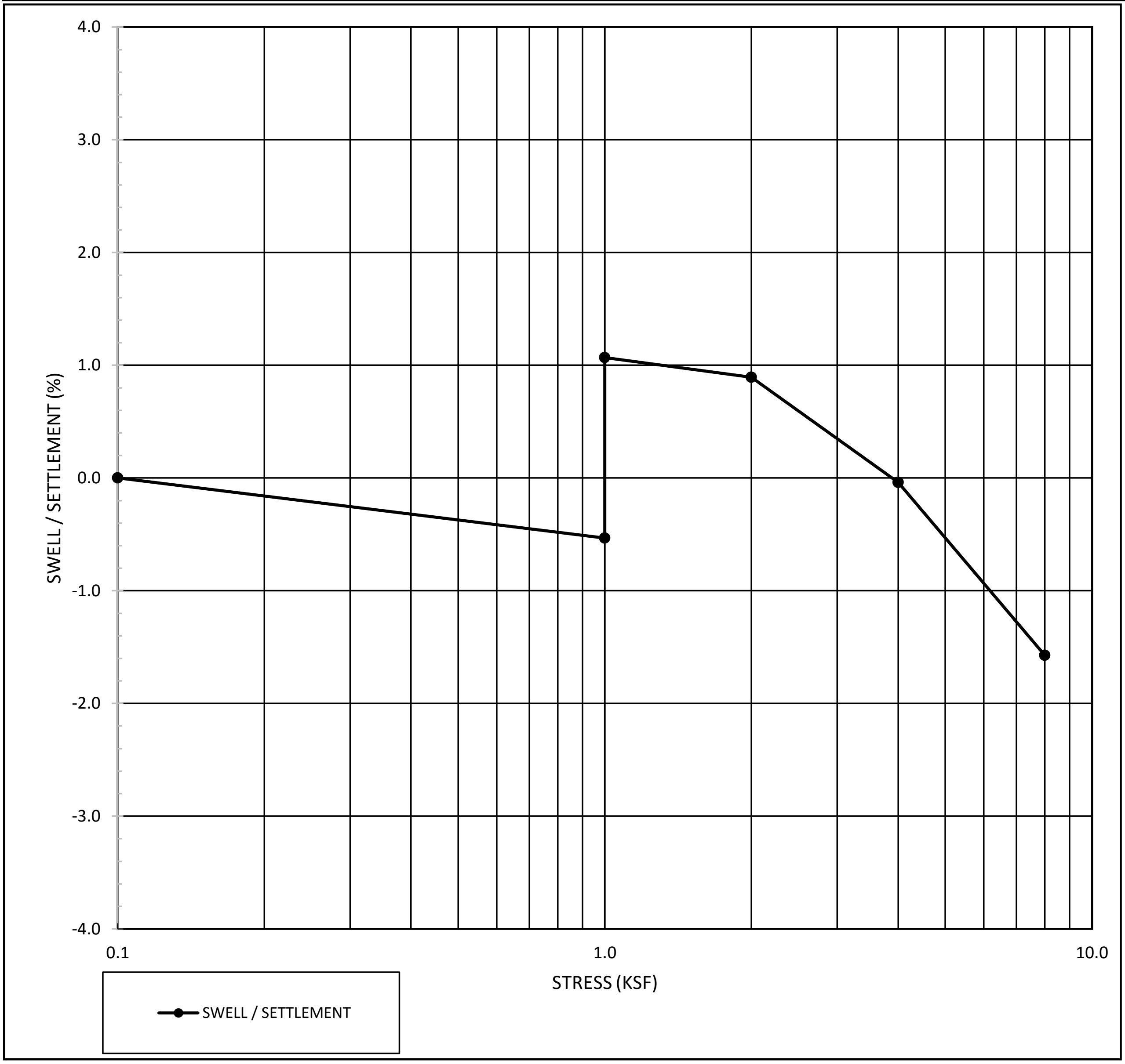
Initial Condition	
Moisture Content %	**18.7**
Dry Density (pcf)	**112.0**
Post-Swell Condition	
Moisture Content %	**19.4**

Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	B-4	**Sample Depth (ft)**	7
Sample Description:	Fill, Sandy Fat CLAY, brown and dark brown, moist		
Swell @ Wetting Weight:	0.5 %		



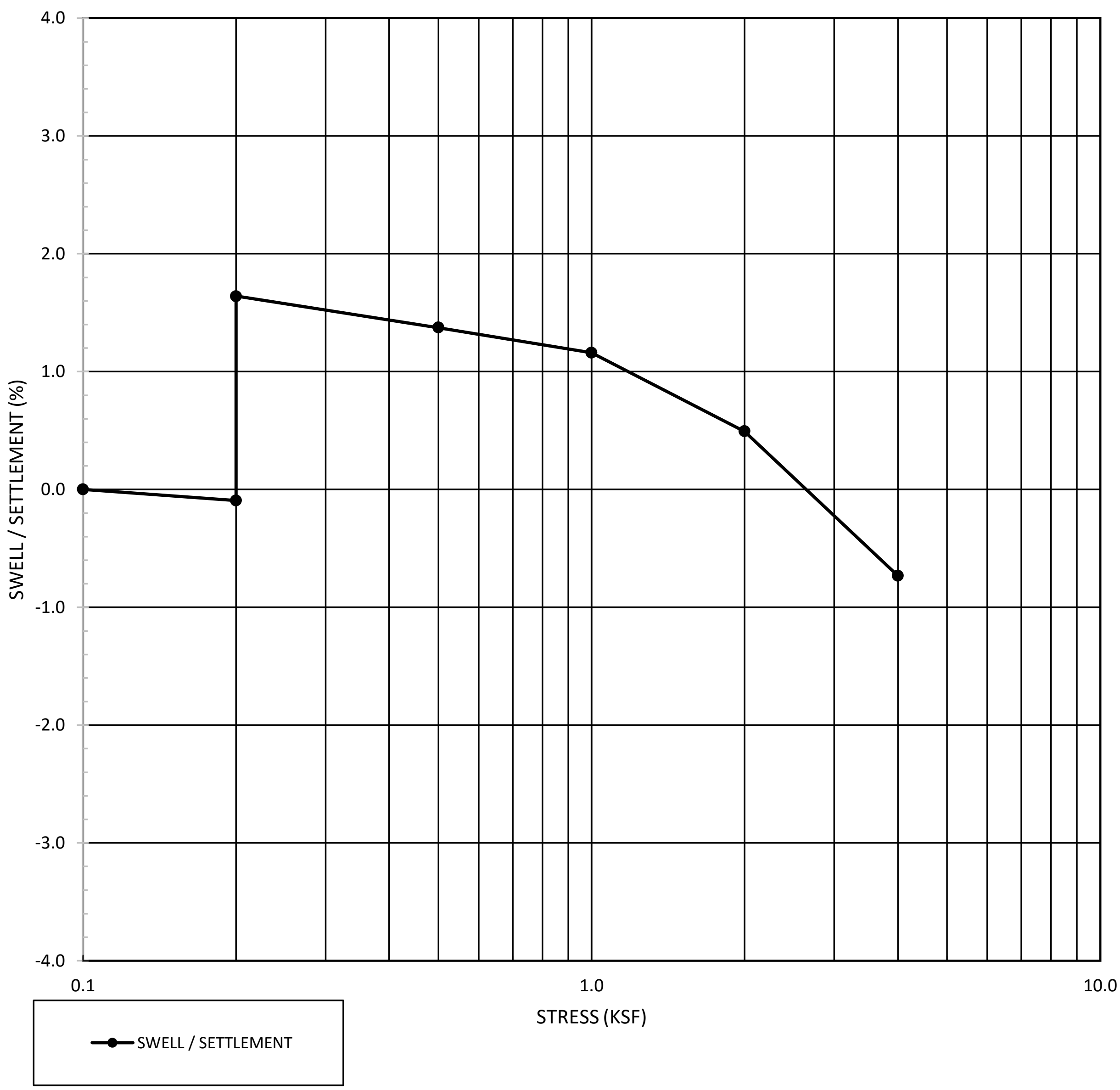
Initial Condition	
Moisture Content %	24.3
Dry Density (pcf)	100.9
Post-Swell Condition	
Moisture Content %	25.5

Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	B-5	**Sample Depth (ft)**	9
Sample Description:	Fill, Lean CLAY with Sand, brown and dark brown, moist		
Swell @ Wetting Weight:	1.6 %		



Initial Condition	
Moisture Content %	15.7
Dry Density (pcf)	117.8
Post-Swell Condition	
Moisture Content %	17.4

Project Name:	Les Schwab Tire Center - Parker	**Date**	1/20/2023
Project No.:	D23-1-321		
Boring ID.:	P-1	**Sample Depth (ft)**	4
Sample Description:	Fill, Clayey SAND, brown and dark brown, moist		
Swell @ Wetting Weight:	1.7 %		



Initial Condition	
Moisture Content %	21.2
Dry Density (pcf)	106.8
Post-Swell Condition	
Moisture Content %	21.8

Project Name: Les Schwab Tire Center - Parker

Date 1/20/2023

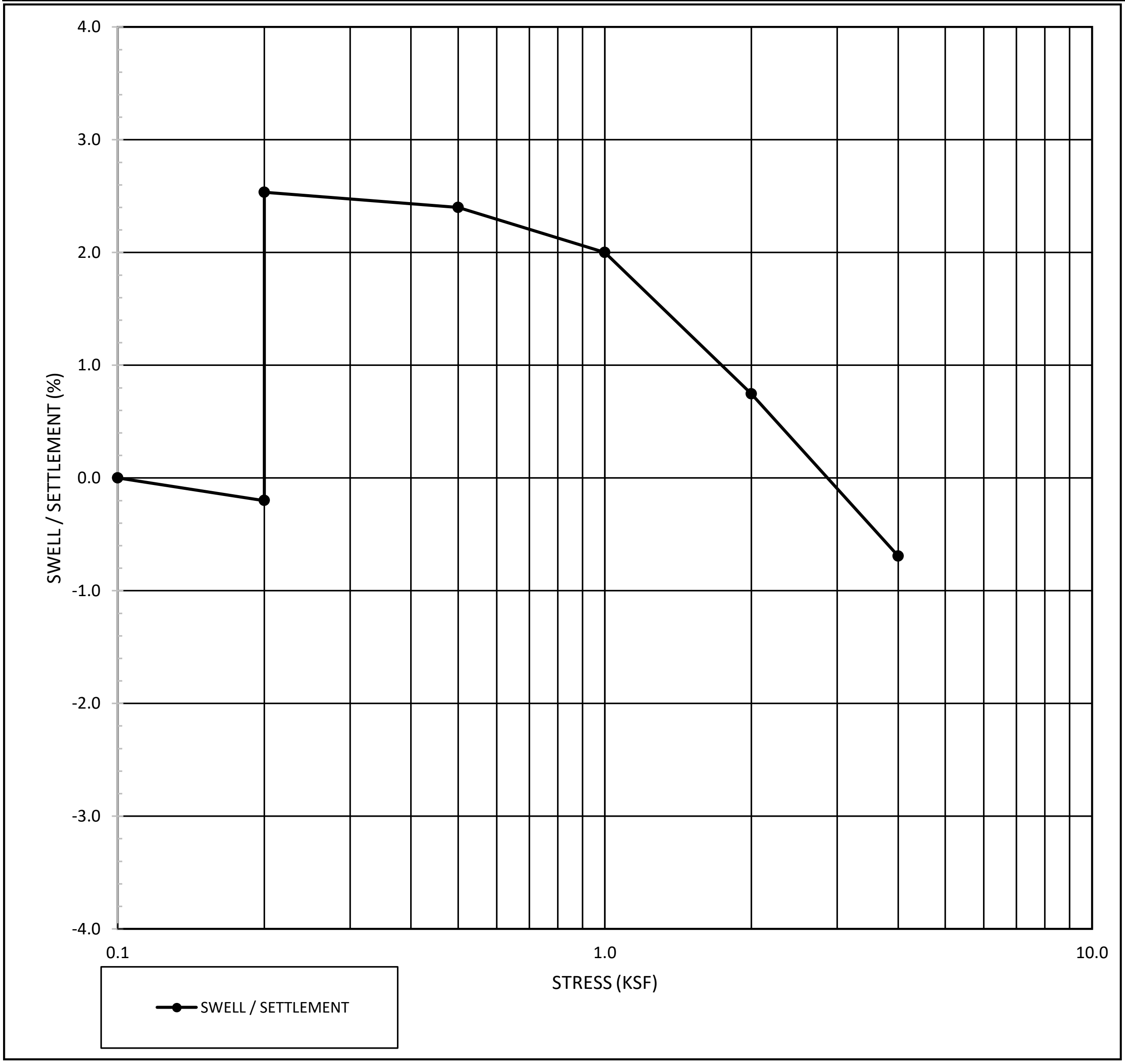
Project No.: D23-1-321

Boring ID.: P-2

Sample Depth (ft) 1

Sample Description: Fill, Sandy Lean CLAY with Gravel, brown and dark brown, moist

Swell @ Wetting Weight: 2.7 %



Initial Condition	
Moisture Content %	14.4
Dry Density (pcf)	116.1
Post-Swell Condition	
Moisture Content %	17.7

Appendix C

Analytical Laboratory Test Results

Corrosion Test Results

Project Name: Chambers Road and Hess Road
Tester: JH
Project No. D23-1-321
Date: 1/24/2023

Sample ID: B-2 @ 0-5' Bulk
Matrix: Soil

Test	Results		Method
Chloride - Water Soluble	0.002	%	AASHTO T291-91/ASTM D4327
pH	7.8	units	AASHTO T289-91
Redox Potential	213.1	mv	ASTM D1498
Electrical Resistivity	1000	ohm-cm	AASHTO T288-91
Sulfate - Water Soluble	0.001	%	CDOT CP-L 2103/ASTM D4327
Sulfide	Trace	-	AWWA C105

Appendix D

Site Photos

BORING B-1, LOOKING NORTHWEST

BORING B-2, LOOKING NORTHEAST

VIVID Engineering Group, Inc. 3885 Forest Street Denver, CO 80207 303-994-5153	Project No. D23-1-321 Date: January 25, 2023 Drawn by: RJS Reviewed by: TJN	**SITE PHOTOGRAPHS** Les Schwab Tire Center Sliceroo Drive and S. Red Sky Drive Parker, Colorado	**FIGURE** D-1

BORING B-3, LOOKING NORTHWEST

BORING B-4, LOOKING SOUTHWEST

VIVID Engineering Group, Inc.
3885 Forest Street
Denver, CO 80207
303-994-5153

Project No. D23-1-321	SITE PHOTOGRAPHS	FIGURE
Date: January 25, 2023		
Drawn by: RJS	Les Schwab Tire Center Sliceroo Drive and S. Red Sky Drive Parker, Colorado	D-2
Reviewed by: TJN		

BORING B-5, LOOKING SOUTHEAST

BORING P-1, LOOKING NORTHWEST

VIVID Engineering Group, Inc. **3885 Forest Street** **Denver, CO 80207** **303-994-5153**	Project No. D23-1-321 Date: January 25, 2023 Drawn by: RJS Reviewed by: TJN	**SITE PHOTOGRAPHS** Les Schwab Tire Center Sliceroo Drive and S. Red Sky Drive Parker, Colorado	**FIGURE** D-3

Appendix E

Important Information About This Geotechnical Engineering Report

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept* *responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

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