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Geotechnical Investigation
Lot 70R – Summit Eden Phase 1C Development
8492 East Spring Park
Weber County, Utah

GeoStrata Job No. 594-004

July 11, 2018

Prepared for:

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APPENDICES

1.0 EXECUTIVE SUMMARY

This report presents the results of a geotechnical investigation conducted for the proposed residential structure to be constructed on Lot 70R of the Summit Eden Phase 1C development located in Weber County, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the site and to provide recommendations for general site grading and the design and construction of foundations, slab-on-grades, and exterior concrete flatwork.

Based on the results of our geotechnical laboratory testing, it is our opinion that the site is suitable for the proposed development provided that the recommendations contained in this report are incorporated into the design and construction of the project.

Subsurface soils were investigated through the advancement of a single exploratory trench excavated to a depth ranging from of 5½ to 9 feet below the existing site grade. Two soil profiles exposed in our trench were logged as test pits, TP-1 and TP-2. The soils encountered within our test pits at the site generally consisted of 6-inches of sandy topsoil overlying sediments that have been mapped as consisting of the Tertiary Wasatch Formation. Where observed, these sediments consisted of dense, moist, red-brown Silty GRAVEL (GM) with sand, Poorly Graded GRAVEL (GP-GM) with silt, sand, cobbles and boulders, and Poorly Graded SAND (SP-SM) with silt. Gravels, cobbles and boulders were typically subrounded to rounded, and had a maximum observed diameter of approximately 7 inches. Considering the rounded nature of the cobbles, it is considered possible that these sediments actually represent a unit of alluvial deposits. Groundwater was not encountered in any of the test pits completed for this investigation, and is not expected to impact the development, although strategic site grading should be implemented in order to account for potential perched groundwater units during spring months.

The foundation for the proposed structure may consist of conventional strip footings founded entirely on undisturbed native soils or entirely on bedrock (if exposed). If footing excavations expose a combination of soil and bedrock, the bedrock should be over-excavated at least 18 inches to allow placement of 18 inches of structural fill to limit the potential for differential settlement. We recommend that a GeoStrata representative observe all foundation soils in footing excavations prior to placing reinforcing steel or concrete. Conventional continuous/spread footings may be proportioned using a maximum net allowable bearing pressure of **1,700 pounds per square foot (psf)** for dead plus live load conditions.

Due to the possibility of moisture reaching the foundation elements during spring runoff, it is recommended that a foundation drain be constructed around the proposed residence.

NOTE: The scope of services provided within this report are limited to the assessment of the subsurface conditions at the subject site. The executive summary is provided solely for purposes of overview and is not intended to replace the report of which it is part and should not be used separately from the report.

2.0 INTRODUCTION

2.1 PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical investigation conducted for the proposed residential structure to be constructed on Lot 70R of the Summit Eden Phase 1C located at approximately 8492 East Spring Park in Weber County, Utah. The purposes of this investigation were to assess the nature and engineering properties of the subsurface soils at the site and to provide recommendations for general site grading and the design and construction of foundations, slab-on-grades, and exterior concrete flatwork.

The scope of work completed for this study included a site reconnaissance, subsurface exploration, soil sampling, laboratory testing, engineering analyses, and preparation of this report. Our services were performed in accordance with our proposal, dated September 9, 2016 and your signed authorization.

The recommendations contained in this report are subject to the limitations presented in the "Limitations" section of this report (Section 7.1).

2.2 PROJECT DESCRIPTION

The subject lot is located at approximately 8492 East Spring Park, approximately 600 feet east of the intersection of Copper Crest Drive and Summit Pass Drive in unincorporated Weber County, Utah (see Plate A-1, *Site Vicinity Map*). Our understanding of the proposed development is based on information provided by the client. We understand that the development will consist of the construction of a single family residential structure with associated driveway and landscaping on the lot, which has a total area of approximately 0.064 acres. Construction plans were not available for review at the time report was prepared; however, we anticipate that the proposed structure will consist of one to two story wood-framed building with a basement founded on conventional strip footings.

It should also be noted that GeoStrata is concurrently completing a geologic hazards assessment for the subject lot. The results of that study will be summarized in a separate report.

3.0 METHODS OF STUDY

3.1 LITERATURE REVIEW

In preparation of this report, we have reviewed geologic hazards maps created by the Utah Geologic Survey (UGS) for Weber County. These maps include surficial geologic maps completed by Coogan and others (2001) for the Ogden 30’ by 60’ Quadrangle. Based on our review of these maps, the subject site is underlain by bedrock composed of the Tertiary-aged Wasatch Formation, although numerous young landslides are mapped in areas adjacent to the subject lot. As such, a slope stability analysis is included as part of this investigation.

3.2 FIELD INVESTIGATION

As a part of this investigation, subsurface soil conditions were explored by excavating a trench across the full width of the property. This trench extended to depths ranging from 5½ feet to 9 feet in depth. Two locations along the profile of the trench were logged as test pits for the purposes of this geotechnical investigation, although a full log of the trench was completed as part of our geologic hazards assessment. The approximate locations of the explorations are shown on the *Exploration Location Map*, Plate A-2 in Appendix A. Subsurface soil conditions as encountered in the explorations were logged at the time of our investigation by qualified personnel and are presented on the enclosed Test Pit Logs, Plates B-1 and B-2 in Appendix B. A *Key to Soil Symbols and Terminology* is presented on Plate B-3.

The trench was excavated with a trackhoe. Bulk soil samples were obtained in the test pit explorations which were transported to our laboratory for testing to evaluate engineering properties of the various earth materials observed. Due to the granular nature of the exposed soils, it was not feasible to obtain relatively ‘undisturbed” soil samples. The soils were classified according to the *Unified Soil Classification System* (USCS) by the Geotechnical Engineer. Classifications for the individual soil units are shown on the attached Test Pit Logs.

3.3 LABORATORY INVESTIGATION

Geotechnical laboratory tests were conducted on selected soil samples obtained during our field investigation. The laboratory testing program was designed to evaluate the engineering characteristics of onsite earth materials. Laboratory tests conducted during this investigation include:

- Grain Size Distribution Analysis (ASTM D422)
- Atterberg Limits Test (ASTM D4318)
- Direct Shear Test (ASTM D3080)

The results of laboratory tests are presented on the test pit logs in Appendix B (Plates B-1 and B-2), the Lab Summary Report (Plate C-1), on the test result plates presented in Appendix C (Plates C-2 to C-4) and the slope stability analysis in Appendix D (Plates D-1 and D-2).

3.4 ENGINEERING ANALYSIS

Engineering analyses were performed using soil data obtained from the laboratory test results and empirical correlations from material density, depositional characteristics and classification. Appropriate factors of safety were applied to the results consistent with industry standards and the accepted standard of care.

Excavation stability was evaluated based on the field conditions encountered, laboratory test results, and soil type. Occupational Safety and Health (OSHA) minimum requirements are typically prescribed unless conditions warrant further flattening of excavation walls.

4.0 GENERALIZED SITE CONDITIONS

4.1 SURFACE CONDITIONS

The site is in a relatively natural state and is currently heavily vegetated with brush and grasses. The lot slopes upward moderately to the north at an approximate 4H:1V slope. The property sits at an elevation ranging from 8,560 to 8,600 feet above sea level with a total topographic relief of approximately 40 feet. No structures or other improvements were observed on the subject property at the time of our investigation.

4.2 SUBSURFACE CONDITIONS

As previously discussed, the subsurface soil conditions were explored at the site by excavating a trench across the subject lot. The test trench extended to depths ranging from 5½ to 9 feet below existing site grade. The soils encountered in the test pit explorations were visually classified and logged during our field investigation and are included on the test pit logs in Appendix B (Plates B-1 and B-2). The subsurface conditions encountered during our investigation are discussed below.

4.2.1 Soils

Based on our observations, the subject site is overlain by approximately 6-inches of sandy topsoil. Underlying the topsoil, we encountered units that are mapped consisting of highly- to completely-weathered exposures of the Tertiary-aged Wasatch Formation, however occasional cobbles and boulders with a sub-rounded to rounded nature were observed throughout this unit. This suggests that the material encountered may consist of an alluvial deposit. This unit persisted for the full depth of our investigation.

Topsoil: Generally consists of dark brown Silty SAND (SM) with gravel, cobbles, and boulders. This unit has an organic appearance and texture with roots throughout. Topsoil was encountered along the full profile exposed during our trenching activities and is anticipated to overlie the majority of the site.

Tertiary-aged Wasatch Formation: Where observed, this unit consisted of granular material, and could represent either highly- to completely-weathered bedrock unit or an alluvial unit. From an engineering perspective, this unit consists of a dense, moist, red-brown to brown Silty GRAVEL

(GM) with sand, Poorly Graded GRAVEL (GP-GM), with silt, cobble, and boulders, and Poorly Graded SAND (SP-SM) with silt and gravel. In general, the gravel, cobbles and boulders were subrounded to rounded, and had a maximum observed diameter of approximately 7-inches. The Wasatch Formation in this area is mapped by Coogan and others (2001) as consisting of "brown-red siltstone, sandstone, mudstone, and conglomerate with minor grey limestone and marlstone". These deposits persisted to the full depth of our investigation.

The stratification lines shown on the enclosed test pit logs represent the approximate boundary between soil types (Plates B-1 and B-2). The actual in-situ transition may be gradual. Due to the nature and depositional characteristics of the native soils, care should be taken in interpolating subsurface conditions between and beyond the exploration locations.

4.2.2 Groundwater

Groundwater was not encountered in any of the test pits excavated as part of our investigation, and is anticipated to be relatively deep: however, due to the alpine location of the subject lot, localized near perched groundwater may occur during the spring months. Fluctuations in the groundwater level should be expected over time.

5.0 GEOLOGIC CONDITIONS

5.1 GEOLOGIC SETTING

The site is located at an elevation ranging from approximately 8,560 to 8,600 feet above mean sea level within the James-Sharp Mountain area located at the southern part of the Bear River Range, Utah, which itself is located in the Middle Rocky Mountain province. James Peak is a structural high between the Cache Valley graben to the north and the Ogden Valley graben to the south. Sharp Mountain, on the other hand, is within the main part of the Bear River Range. The Bear River Range is formed from Paleozoic rocks that are broadly and gently folded. A major syncline and major anticline, trending north-northeast to northeast, were identified in the 30-minute Logan Quadrangle. Ogden Valley and the surrounding areas are underlain by rocks that range in age from Precambrian to Quaternary. The Precambrian rocks are mainly metasedimentary. Carbonate rocks predominate in the Paleozoic sequence, whereas deposits of Cenozoic age are predominately alluvial in origin. At its highest stage of about 5,090 feet (Blau, 1975) Pleistocene Lake Bonneville extended into Ogden Valley through Ogden Canyon. Unconsolidated lacustrine sediments undoubtedly were deposited in the valley.

Additional information concerning the geologic nature and condition of the subject property may be found in our Geologic Hazards Assessment concurrently being completed by GeoStrata.

6.0 ENGINEERING CONCLUSIONS AND RECOMMENDATIONS

6.1 GENERAL CONCLUSIONS

Based on the geotechnical soils testing results, it is our opinion that the soils at the subject site are suitable for the proposed construction provided that the recommendations contained in this report are complied with. The recommendations presented in this report are based on our understanding of the proposed project, the subsurface conditions observed during field exploration, the results of laboratory testing, and our engineering analyses. If subsurface conditions other than those described herein are encountered in conjunction with construction, and/or if design and layout changes are initiated, we must be informed so that the recommendations herein can be reviewed and revised as changes or conditions may require.

6.2 EARTHWORK

Prior to the placement of foundations, general site grading is recommended to provide proper support for foundations, exterior concrete flatwork, and concrete slab-on-grade. Site grading is also recommended to provide proper drainage and moisture control on the subject property and to aid in preventing differential settlement of foundations as a result of variations in subgrade moisture conditions.

6.2.1 General Site Preparation and Grading

In areas beneath footings and concrete flat work, topsoil should be stripped and stockpiled for use in landscape areas or disposal. Debris, undocumented fill, vegetation, roots (including tree roots), loose, soft or other deleterious materials should also be removed and replaced with structural fill. If over-excavation is required, the excavation should extend a minimum of one foot laterally for every foot of depth of over-excavation. Excavations should extend laterally at least two feet beyond flatwork, pavements, and slabs-on-grade. If materials are encountered that are not represented in the test pit logs or may present a concern, GeoStrata should be notified so observations and further recommendations as required can be made. The exposed native soils should then be proof-rolled with heavy rubber-tired equipment. If soft soils are observed, they should be stabilized in accordance with our recommendations in the Soft Soil Stabilization Section (Section 6.2.3); if loose soils are observed, they should be compacted as recommended in Section 6.2.4.

6.2.2 Excavation Stability

Based on Occupational Safety and Health Administration (OSHA) guidelines for excavation safety, trenches with vertical walls up to 5 feet in depth may be occupied, however, the presence of fill soils, loose soils, or wet soils may require that the walls be flattened to maintain safe working conditions. When the trench is deeper than 5 feet, we recommend a trench-shield or shoring be used as a protective system to workers in the trench. Based on our soil observations, laboratory testing, and OSHA guidelines, native soils at the site classify as Type C soils. Deeper excavations, if required, should be constructed with side slopes no steeper than one and one and one half horizontal to one vertical (1.5H:1V). If wet conditions are encountered, side slopes should be further flattened to maintain slope stability. Alternatively, shoring or trench boxes may be used to improve safe work conditions in trenches. The contractor is ultimately responsible for trench and site safety. Pertinent OSHA requirements should be met to provide a safe work environment. If site specific conditions arise that require engineering analysis in accordance with OSHA regulations, GeoStrata can respond and provide recommendations as needed.

We recommend that a GeoStrata representative be on-site during all excavations to assess the exposed foundation soils. We also recommend that the Geotechnical Engineer be allowed to review the grading plans when they are prepared in order to evaluate their compatibility with these recommendations.

6.2.3 Soft Soil Stabilization

Although not anticipated, soft or pumping soils may be exposed in excavations at the site. Once exposed, all subgrade surfaces beneath proposed structure, pavements, and flat work concrete should be proof rolled with heavy wheeled-construction equipment. If soft or pumping soils are encountered, these soils should be stabilized prior to construction of footings. Stabilization of the subgrade soils can be accomplished using a clean, coarse angular material worked into the soft subgrade. We recommend the material be greater than 2-inch diameter, but less than 6 inches. A locally available pit-run gravel may be suitable but should contain a high percentage of particles larger than 2 inches and have less than 7 percent fines (material passing the No. 200 sieve). A pit-run gravel may not be as effective as a coarse, angular material in stabilizing the soft soils and may require more material and greater effort. The stabilization material should be worked (pushed) into the soft subgrade soils until a firm relatively unyielding surface is established. Once a firm, relatively unyielding surface is achieved, the area may be brought to final design grade using structural fill.

In large areas of soft subgrade soils, stabilization of the subgrade may not be practical using the method outlined above. In these areas it may be more economical to place a woven geotextile fabric against the soft soils covered by 18 inches of coarse, sub-rounded to rounded material over the woven geotextile. An inexpensive non-woven geotextile “filter” fabric should also be placed over the top of the coarse, sub-rounded to rounded fill prior to placing structural fill or pavement section soils to reduce infiltration of fines from above. The woven geotextile should be Amoco 2004 or prior approved equivalent. The filter fabric should consist of an Amoco 4506, Amoco 4508, or equivalent as approved by the Geotechnical Engineer.

6.2.4 Structural Fill and Compaction

All fill placed for the support of the structure or flatwork concrete should consist of structural fill. Structural fill may consist of native, granular soils provided it is first screened to remove debris, vegetation, and material exceeding 4-inches in nominal diameter. Alternatively, structural fill may consist of an imported granular soil with maximum fines content (minus No.200 mesh sieve) of 30 percent. All structural fill should be free of vegetation and debris and contain no materials larger than 3-inches in nominal size. All structural fill soils should be approved by the Geotechnical Engineer prior to placement. Clay and silt particles in imported structural fill should have a liquid limit less than 35 and a plasticity index less than 15 based on the Atterberg Limit’s test (ASTM D-4318). The contractor should have confidence that the anticipated method of compaction will be suitable for the type of structural fill used. The contractor should anticipate testing all soils used as structural fill frequently to assess the maximum dry density, fines content, and moisture content, etc.

All structural fill should be placed in maximum 6-inch loose lifts if compacted by small hand-operated compaction equipment, maximum 8-inch loose lifts if compacted by light-duty rollers, and maximum 12-inch loose lifts if compacted by heavy duty compaction equipment that is capable of efficiently compacting the entire thickness of the lift. We recommend that all structural fill be compacted on a horizontal plane, unless otherwise approved by the geotechnical engineer. Structural fill with an overall thickness of 6 feet or less should be compacted to at least 95% of the maximum dry density (MDD), as determined by ASTM D-1557 (modified proctor). The moisture content should be within 3% of the optimum moisture content (OMC) at the time of placement and compaction. Also, prior to placing any fill, the excavations should be observed by the geotechnical engineer to observe that any unsuitable materials or loose soils have been removed. In addition, proper grading should precede placement of fill, as described in the *General Site Preparation and Grading* subsection of this report (Section 6.2.1).

Fill soils placed for subgrade below exterior flat work should be within 3% of the OMC when placed and compacted to at least 95% of the MDD as determined by ASTM D-1557. All utility trenches backfilled below the proposed structure, pavements, and flatwork concrete, should be backfilled with structural fill that is within 3% of the OMC when placed and compacted to at least 95% of the MDD as determined by ASTM D-1557. All other trenches, in landscape areas, should be backfilled and compacted to at least 90% of the MDD (ASTM D-1557).

The gradation, placement, moisture, and compaction recommendations contained in this section meet our minimum requirements but may not meet the requirements of other governing agencies such as city, county, or state entities. If their requirements exceed our recommendations, their specifications should override those presented in this report.

6.3 FOUNDATIONS

Due to the type of investigation performed, soil strength and stiffness parameters were estimated using conservative values to estimate the bearing capacity and settlement. The foundation for the proposed structure may consist of conventional strip footings founded entirely on undisturbed native soils or entirely on bedrock. If footing excavations expose a combination of soil and bedrock, the bedrock should be over-excavated at least 18 inches to allow placement of 18 inches of structural fill to limit the potential for differential settlement. Strip footings should be a minimum of 20-inches wide and exterior shallow footings should be embedded at least 36-inches below final grade for frost protection and confinement. Interior footings not subject to frost should be embedded at least 18 inches below final grade to provide confinement. To provide adequate support and confinement, we recommend that footings be place at least 15 feet, measured horizontally, from the face of existing or fill slopes at the site.

Conventional strip footings founded entirely on native soils or on properly compacted structural fill may be proportioned for a maximum net allowable bearing capacity of **1,700 psf**. The net allowable bearing capacity may be increased (typically by one-third) for temporary loading conditions such as transient wind and seismic loads. All footing excavations should be observed by the Geotechnical Engineer prior to footing placement.

Settlements of properly designed and constructed conventional footings, founded as described above, are anticipated to be less than 1 inch. Differential settlements should be on the order of half the total settlement over 30 feet.

6.4 SLOPE STABILITY

The global stability of Lot 70R was modeled using the SLIDE computer application and the Janbu's Corrected Method of analysis. Calculations for stability were developed by searching for the minimum factor of safety for a circular-type and user-defined slope parallel failure surfaces. Homogenous earth materials and arcuate failure surfaces were assumed. The profile for the lot was obtained from ARC GIS data. A surcharge of approximately 1,700 psf was applied to our model within the anticipated vicinity of the residence. Slope stability was performed for the static and pseudo-static conditions. The pseudo-static assessment used one half of the peak ground acceleration of 0.35g as presented in Section 6.1 of our Geologic Hazards Assessment Report. Groundwater is presumed to be relatively deep and was not incorporated into the model.

Our slope stability model consists of two soil layers parallel to the surface profile. The first layer is a 1-foot thick unit of topsoil mantling the property, which is underlain by a unit of highly- to completely-weathered bedrock/alluvial deposits. The following strength parameters were applied to our model;

Soil Strength Parameters

Soil Type	Friction Angle (phi) (degrees)	Cohesion (psf)
Topsoil*	30	100
Bedrock/Alluvium**	26	260

* assumed value

** laboratory obtained value

The strength parameters for the bedrock/alluvial deposits was increased to consist of a friction angle of 34 degrees and a cohesion of 50 psf to account for the fact that the material consisted of approximately 63% gravel, which was screened from our sample prior to testing. As such, it is considered likely that the results of our direct shear testing significantly underestimate the actual strength of the soils present at the site. Groundwater was not encountered during our field investigations and is anticipated to be located at a relatively great depth. As such, groundwater was not incorporated into our slope stability modeling. Slopes with factors of safety of 1.5 and

1.0 for static and pseudo-static conditions, respectively, are considered stable. The analyses performed for this report indicated that the site has a static factor of safety of 2.5 and a pseudo static factor of safety of 1.56.

6.5 FOUNDATION DRAINAGE

Due to the possibility of moisture reaching the foundation elements during spring runoff, it is recommended that a foundation drain be constructed around any subgrade walls. The foundation drain should consist of a 4-inch perforated pipe placed at or below the footing elevation. The pipe should be covered with at least 12 inches of free draining gravel (containing less than 5 percent passing the No 4 sieve) and be graded to a free gravity out fall or to a pumped sump. A separator fabric, such as Mirafi 140N, should separate the free draining gravel and native soil (i.e. the separator fabric should be placed between the gravel and the native soils at the bottom of the gravel, the side of the gravel where the gravel does not lie against the concrete footing or foundation and at the top of the gravel). We recommend that the gravel extend up the foundation wall to within 3 feet of the final ground surface. As an alternative, the gravel extending up the foundation wall may be replaced with a prefabricated drain panel, such as Ecodrain-E.

6.6 CONCRETE SLAB-ON-GRADE CONSTRUCTION

Concrete slabs-on-grade should be constructed over at least 4 inches of compacted gravel overlying undisturbed native soil or a zone of structural fill that is at least 12 inches thick. Disturbed native soils should be compacted to at least 95% of the MDD as determined by ASTM D-1557 (modified proctor) prior to placement of gravel. The gravel should consist of road base or clean drain rock with a ¾-inch maximum particle size and no more than 12 percent fines passing the No. 200 mesh sieve. The gravel layer should be compacted to at least 95 percent of the MDD of modified proctor or until tight and relatively unyielding if the material is non-proctorable. The maximum load on the floor slab should not exceed 300 psf; greater loads would require additional subgrade preparation and additional structural fill. All concrete slabs should be designed to minimize cracking as a result of shrinkage. Consideration should be given to reinforcing the slab with welded wire, re-bar, or fiber mesh.

6.7 EARTH PRESSURES AND LATERAL RESISTANCE

Lateral forces imposed upon conventional foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footing and the supporting soils. In determining the frictional resistance against concrete, a coefficient of friction of 0.44 for native granular soils should be used.

Ultimate lateral earth pressures from natural soils and *granular* backfill acting against retaining walls and buried structures may be computed from the lateral pressure coefficients or equivalent fluid densities presented in the following table:

Condition	**Lateral Pressure Coefficient**	**Equivalent Fluid Density (pounds per cubic foot)**
Active*	0.25	31
At-rest**	0.44	53
Passive*	8.95	1074
Seismic Active***	0.31	37
Seismic Passive***	-2.45	-294

* Based on Coulomb's equation
** Based on Jaky
*** Based on Mononobe-Okabe Equation

These coefficients and densities assume level, granular backfill with no buildup of hydrostatic pressures. The force of the water should be added to the presented values if hydrostatic pressures are anticipated. If sloping backfill is present, we recommend the geotechnical engineer be consulted to provide more accurate lateral pressure parameters once the design geometry is established.

Walls and structures allowed to rotate slightly should use the active condition. If the element is constrained against rotation, the at-rest condition should be used. These values should be used with an appropriate factor of safety against overturning and sliding. A value of 1.5 is typically used. Additionally, if passive resistance is calculated in conjunction with frictional resistance, the passive resistance should be reduced by ½.

For seismic analyses, the *active* and *passive* earth pressure coefficient provided in the table is based on the Mononobe-Okabe pseudo-static approach and only accounts for the dynamic horizontal thrust produced by ground motion. Hence, the resulting dynamic thrust pressure *should be added* to the static pressure to determine the total pressure on the wall. The pressure distribution of the dynamic horizontal thrust may be closely approximated as an inverted triangle with stress decreasing with depth and the resultant acting at a distance approximately 0.6 times the loaded height of the structure, measured upward from the bottom of the structure.

The coefficients shown assume a vertical wall face. Hydrostatic and surcharge loadings, if any, should be added. Over-compaction behind walls should be avoided. Resisting passive earth pressure from soils subject to frost or heave, or otherwise above prescribed minimum depths of embedment, should usually be neglected in design.

6.8 MOISTURE PROTECTION AND SURFACE DRAINAGE

Precautions should be taken during and after construction to minimize the potential for saturation of foundation soils. Over wetting the soils prior to or during construction may result in increased softening and pumping, causing equipment mobility problems and difficulty in achieving compaction.

Infiltrate of moisture in the vicinity of structures should be minimized. We recommend that roof runoff devices be installed to direct all runoff a minimum of 10 feet away from structures. The grade within 10 feet of the structures should be sloped a minimum of 5% away from the structure in accordance with the IBC, 2015.

7.0 CLOSURE

7.1 LIMITATIONS

The recommendations contained in this report are based on our limited field exploration, laboratory testing, and understanding of the proposed construction. The subsurface data used in the preparation of this report were obtained from the explorations made for this investigation. It is possible that variations in the soil and groundwater conditions could exist between the points explored. The nature and extent of variations may not be evident until construction occurs. If any conditions are encountered at this site that are different from those described in this report, we should be immediately notified so that we may make any necessary revisions to recommendations contained in this report. In addition, if the scope of the proposed construction changes from that described in this report, GeoStrata should be notified.

This report was prepared in accordance with the generally accepted standard of practice at the time the report was written. No warranty, expressed or implied, is made.

It is the Client's responsibility to see that all parties to the project including the Designer, Contractor, Subcontractors, etc. are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the Contractor's option and risk.

7.2 ADDITIONAL SERVICES

The recommendations made in this report are based on the assumption that an adequate program of tests and observations will be made during construction. GeoStrata staff should be on site to verify compliance with these recommendations. These tests and observations should include, but not necessarily be limited to, the following.

- Observations and testing during site preparation, earthwork and structural fill placement.
- Observation of foundation soils to assess their suitability for footing placement.
- Observation of soft/loose soils over-excavation.
- Observation of temporary excavations and shoring.
- Consultation as may be required during construction.
- Quality control and observation of concrete placement.

We also recommend that project plans and specifications be reviewed by us to verify compatibility with our conclusions and recommendations. Additional information concerning the scope and cost of these services can be obtained from our office.

We appreciate the opportunity to be of service on this project. Should you have any questions regarding the report or wish to discuss additional services, please do not hesitate to contact us at your convenience at (801) 501-0583.

8.0 REFERENCES CITED

Black, B.D., McDonald, G.N., and Hecker, S., compilers, 1999, Fault number 2378, *James Peak fault*, in Quaternary fault and fold database of the United States: U.S. Geological Survey

Blau, Jan, 1975 Geology of southern part of the James Peak quadrangle, Utah. Thesis Report Pages16-18.

Bryant, B., 1992, Geologic and Structures Map of the Salt Lake City 1X2 Quadrangle, Utah and Wyoming: U.S. Geological Survey Map I-1997, Scale !:125,000.

Coogan, J.C., King, J.K., 2001, Progress Report Geologic Map of the Ogden 30' by 60' Quadrangle, Utah and Wyoming, Year 3 of 3, Utah Geological Survey, Open File Report 380.

Federal Emergency Management Agency [FEMA], 1997, *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures,* FEMA 302, Washington, D.C.

Frankel, A., Mueller, C., Barnard, T., Perkins, D., Leyendecker, E.V., Dickman, N., Hanson, S., and Hopper, M., 1996, *National Seismic-hazard Maps: Documentation*, U.S. Geological Survey Open-File Report 96-532, June.

Harty, K.M., 1992, Landslide Map of the Salt Lake City 30' X 60' Quadrangle, Utah Geological Survey, Open File Report 236, Scale 1:100,000.

Hecker, S., 1993, Quaternary Tectonics of Utah with Emphasis on Earthquake-Hazard Characterization: Utah Geological Survey Bulletin 127, 157p.

Hintze, L. F., 1980, Geologic Map of Utah: Utah Geological and Mineral Survey Map-A-1, scale 1:500,000.

Hintze, L.F. 1993, Geologic History of Utah, Brigham Young University Studies, Special Publication 7, 202p.

Hintze, L.F., Willis, G.C., Laes, D.Y.M., 2000, Digital Geologic Map of Utah, Utah Geological Survey.

International Building Code [IBC], 2006, International Code Council, Inc.

King, J.K, Yonkee, W.A., Coogan, J.C., 2008, Interim Geologic Map of the Snow Basin Quadrangle and Part of the Huntsville Quadrangle, Davis, Morgan, and Weber Counties, Utah. Utah Geological Survey, Open File Report 536.

McCalpin, J.P., Foreman, S.L., Lowe, M. 1994, Reevaluation of Holocene faulting at the Kaysville site, Weber segment of the Wasatch fault zone, Utah, Tectonics, American Geophysical Union Publication, Vol. 13, No. 1, Pages 1-16

Stokes, W.L., 1986, Geology of Utah, Utah Museum of Natural History, University of Utah and Utah Geological and Mineral Survey, Department of Natural Resources: Occasional paper number 6.

Utah Department of Public Safety, 2009, Natural Hazard Pre-Disaster Mitigation Plan Part X, Morgan County

GeoStrata

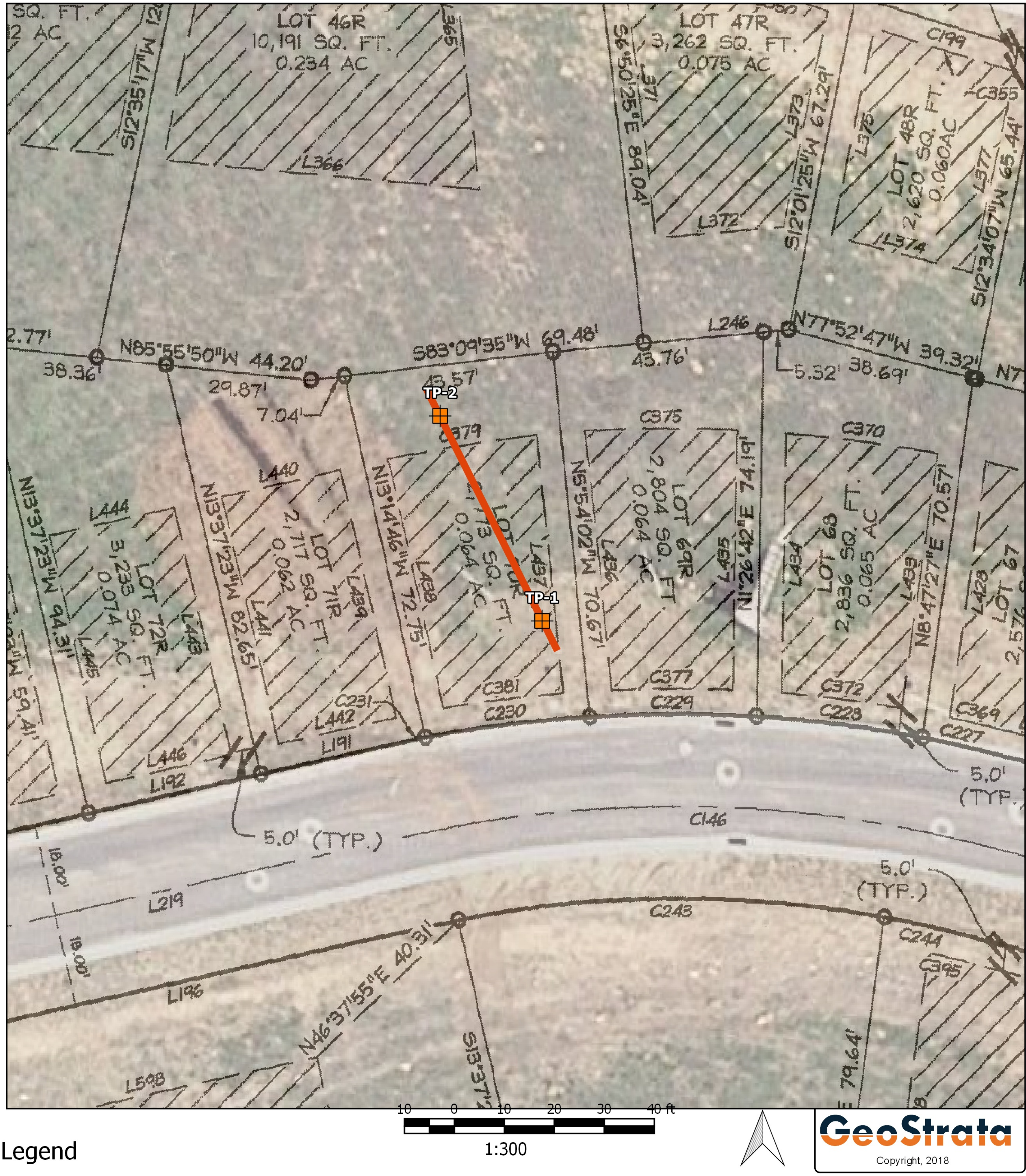
Legend

🟥 Appriximate Site Boundary

Scandinavian Homes
Powder Mountain Lot 70
Eden, Utah
Project Number: 594-004

Exploration Location Map

Plate A-1



GeoStrata

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Legend

⊞ Approximate Test Pit Location

▬ Approximate Trench Location

Scandinavian Homes
Powder Mountain Lot 70
Eden, Utah
Project Number: 594-004

Exploration Location Map

Plate A-2

DATE		
STARTED:	7/2/18	
COMPLETED:	7/2/18	
BACKFILLED:	7/2/18	

Summit Eden Phase 1C-Lot 70R
8492 East Spring Park
Weber County, Utah
Project Number 594-004

GeoStrata Rep: A. Peay
Rig Type: Trackhoe

TEST PIT NO:
TP-1
Sheet 1 of 1

LOCATION
NORTHING EASTING ELEVATION

DEPTH (FEET)	SAMPLES	WATER LEVEL	UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
0				TOPSOIL; Silty SAND with gravel - brown, moist, organics and roots up to 1 inch in diameter extending to 3 feet below the existing site grade					
			GM	Silty GRAVEL with sand - dense to very dense, reddish-brown, moist, organics and large roots throughout with pinhole or root cast structures, gravels are sub-rounded to rounded up to 5 inches in diameter					
	▯		GP-GM	Poorly Graded GRAVEL with silt, cobbles and boulders - dense to very dense, reddish-brown, moist, organics throughout, sub-rounded to rounded cobbles and boulders up to 1½ feet in diameter		2.6	11.3	NP	NP
5			SP-SM	Poorly Graded SAND with silt - dense, reddish brown, moist, occasional gravels less then ¼ inch in diameter					
				Bottom of Test Pit @ 5.5 Feet					

Depth scale: METERS 0, 1, 2, 3; FEET 0, 5

Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content ● — Liquid Limit
10 20 30 40 50 60 70 80 90

SAMPLE TYPE
- ▯ - GRAB SAMPLE
- ☒ - 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- ▼ - MEASURED
- ▽ - ESTIMATED

NOTES:
South end of trench

Plate
B-1

DATE	
STARTED:	7/2/18
COMPLETED:	7/2/18
BACKFILLED:	7/2/18

Summit Eden Phase 1C-Lot 70R
8492 East Spring Park
Weber County, Utah

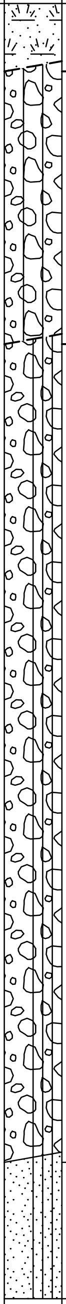
Project Number 594-004

GeoStrata Rep: A. Peay
Rig Type: Trackhoe

TEST PIT NO:
TP-2
Sheet 1 of 1

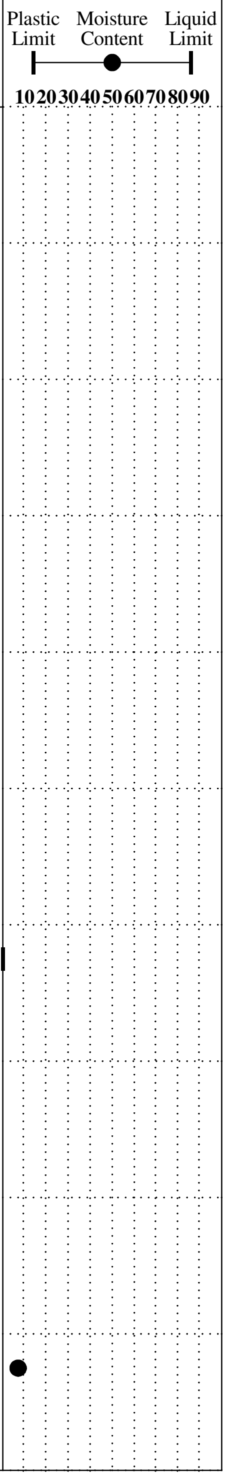
LOCATION
NORTHING
EASTING
ELEVATION

DEPTH: METERS 0, 1, 2, 3; FEET 0, 5



UNIFIED SOIL CLASSIFICATION	MATERIAL DESCRIPTION	Dry Density(pcf)	Moisture Content %	Percent minus 200	Liquid Limit	Plasticity Index
	TOPSOIL; Silty SAND with gravel - brown, moist, organics and roots up to 1 inch in diameter extending to 3 feet below the existing site grade					
GM	Silty GRAVEL with sand - dense to very dense, reddish-brown, moist, organics and large roots throughout with pinhole or root cast structures, occasional sub-rounded to rounded cobbles up to 6 inches in diameter					
GP-GM	Poorly Graded GRAVEL with silt and cobbles - dense to very dense, reddish-brown, moist, organics throughout, sub-rounded to rounded cobbles up to 7 inches in diameter			13.9	NP	NP
SP-SM	Poorly Graded SAND with silt - dense, reddish brown, moist, occasional gravels less then ¼ inch in diameter	113.0	7.0			
	Bottom of Test Pit @ 9.5 Feet					

Moisture Content and Atterberg Limits



GeoStrata

SAMPLE TYPE
- ▯ - GRAB SAMPLE
- ☒ - 3" O.D. THIN-WALLED HAND SAMPLER

WATER LEVEL
- ▼ - MEASURED
- ▽ - ESTIMATED

NOTES:
North end of trench

Plate

B-2

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			USCS SYMBOL		TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	GRAVELS (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVELS WITH LITTLE OR NO FINES	▨	GW	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			▨	GP	POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	▨	GM	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
			▨	GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH LITTLE OR NO FINES	░	SW	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			░	SP	POORLY-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	░	SM	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
			▨	SC	CLAYEY SANDS SAND-GRAVEL-CLAY MIXTURES
FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid limit less than 50)		▥	ML	INORGANIC SILTS & VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, CLAYEY SILTS WITH SLIGHT PLASTICITY
			■	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			▤	OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid limit greater than 50)		▥	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
			■	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			▨	OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY
HIGHLY ORGANIC SOILS			⁂	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

LOG KEY SYMBOLS

⊕ BORING SAMPLE LOCATION

⧗ TEST-PIT SAMPLE LOCATION

▼ WATER LEVEL (level after completion)

▽ WATER LEVEL (level where first encountered)

CEMENTATION

DESCRIPTION	DESCRIPTION
WEAKELY	CRUMBLES OR BREAKS WITH HANDLING OR SLIGHT FINGER PRESSURE
MODERATELY	CRUMBLES OR BREAKS WITH CONSIDERABLE FINGER PRESSURE
STRONGLY	WILL NOT CRUMBLE OR BREAK WITH FINGER PRESSURE

OTHER TESTS KEY

C	CONSOLIDATION	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	DS	DIRECT SHEAR
UC	UNCONFINED COMPRESSION	T	TRIAXIAL
S	SOLUBILITY	R	RESISTIVITY
O	ORGANIC CONTENT	RV	R-VALUE
CBR	CALIFORNIA BEARING RATIO	SU	SOLUBLE SULFATES
COMP	MOISTURE/DENSITY RELATIONSHIP	PM	PERMEABILITY
CI	CALIFORNIA IMPACT	-200	% FINER THAN #200
COL	COLLAPSE POTENTIAL	Gs	SPECIFIC GRAVITY
SS	SHRINK SWELL	SL	SWELL LOAD

MODIFIERS

DESCRIPTION	%
TRACE	<5
SOME	5 - 12
WITH	>12

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
DRY	ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH
MOIST	DAMP BUT NO VISIBLE WATER
WET	VISIBLE FREE WATER, USUALLY SOIL BELOW WATER TABLE

STRATIFICATION

DESCRIPTION	THICKNESS	DESCRIPTION	THICKNESS
SEAM	1/16 - 1/2"	OCCASIONAL	ONE OR LESS PER FOOT OF THICKNESS
LAYER	1/2 - 12"	FREQUENT	MORE THAN ONE PER FOOT OF THICKNESS

GENERAL NOTES

1. Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual.
2. No warranty is provided as to the continuity of soil conditions between individual sample locations.
3. Logs represent general soil conditions observed at the point of exploration on the date indicated.
4. In general, Unified Soil Classification designations presented on the logs were evaluated by visual methods only. Therefore, actual designations (based on laboratory tests) may vary.

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT (blows/ft)	MODIFIED CA. SAMPLER (blows/ft)	CALIFORNIA SAMPLER (blows/ft)	RELATIVE DENSITY (%)	FIELD TEST
VERY LOOSE	<4	<4	<5	0 - 15	EASILY PENETRATED WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
LOOSE	4 - 10	5 - 12	5 - 15	15 - 35	DIFFICULT TO PENETRATE WITH 1/2-INCH REINFORCING ROD PUSHED BY HAND
MEDIUM DENSE	10 - 30	12 - 35	15 - 40	35 - 65	EASILY PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
DENSE	30 - 50	35 - 60	40 - 70	65 - 85	DIFFICULT TO PENETRATED A FOOT WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER
VERY DENSE	>50	>60	>70	85 - 100	PENETRATED ONLY A FEW INCHES WITH 1/2-INCH REINFORCING ROD DRIVEN WITH 5-LB HAMMER

CONSISTENCY - FINE-GRAINED SOIL

		TORVANE	POCKET PENETROMETER	FIELD TEST
CONSISTENCY	SPT (blows/ft)	UNTRAINED SHEAR STRENGTH (tsf)	UNCONFINED COMPRESSIVE STRENGTH (tsf)	
VERY SOFT	<2	<0.125	<0.25	EASILY PENETRATED SEVERAL INCHES BY THUMB. EXUDES BETWEEN THUMB AND FINGERS WHEN SQUEEZED BY HAND.
SOFT	2 - 4	0.125 - 0.25	0.25 - 0.5	EASILY PENETRATED ONE INCH BY THUMB. MOLDED BY LIGHT FINGER PRESSURE.
MEDIUM STIFF	4 - 8	0.25 - 0.5	0.5 - 1.0	PENETRATED OVER 1/2 INCH BY THUMB WITH MODERATE EFFORT. MOLDED BY STRONG FINGER PRESSURE.
STIFF	8 - 15	0.5 - 1.0	1.0 - 2.0	INDENTED ABOUT 1/2 INCH BY THUMB BUT PENETRATED ONLY WITH GREAT EFFORT.
VERY STIFF	15 - 30	1.0 - 2.0	2.0 - 4.0	READILY INDENTED BY THUMBNAIL.
HARD	>30	>2.0	>4.0	INDENTED WITH DIFFICULTY BY THUMBNAIL.

GeoStrata

Soil Symbols Description Key

Lot 70 – Summit Eden Phase 1C
8492 East Spring Park
Weber County, Utah
Project Number: 594-004

Plate

B-3

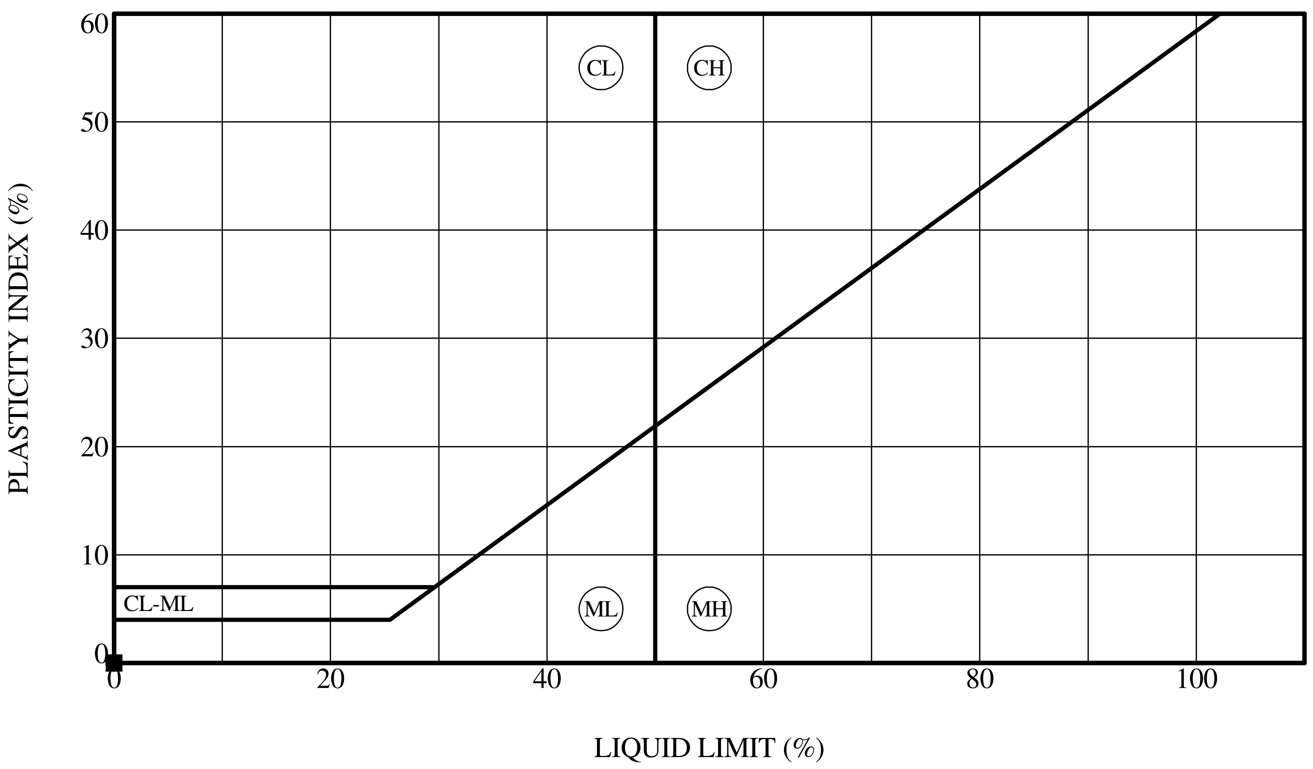
Test Pit No.	Sample Depth (feet)	USCS Soil Classification	Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg		Direct Shear	
					Gravel (%)	Sand (%)	Fines (%)	LL	PI	Apparent Cohesion (psf)	Internal Friction (°)
TP-1	4.5	GP-GM	2.6		80.3	8.4	11.3	NP	NP		
TP-2	6	GP-GM						NP	NP		
TP-2	9	GP-GM	7	113	62.7	23.4	13.9	NP	NP	260	26

GeoStrata

Lab Summary Report

Scandinavian Homes
Summit Eden Phase 1C – Lot 70R
8492 East Springs Park
Weber County, Utah
Project Number: 594-004

Plate
C - 1



Sample Location		Depth (ft)	LL (%)	PL (%)	PI (%)	Fines (%)	Classification
●	**TP-1**	**4.5**	**NP**	**NP**	**NP**	**11.3**	**Poorly Graded GRAVEL with silt**
☒	**TP-2**	**6.0**	**NP**	**NP**	**NP**	**13.9**	**Poorly Graded GRAVEL with silt**

GeoStrata

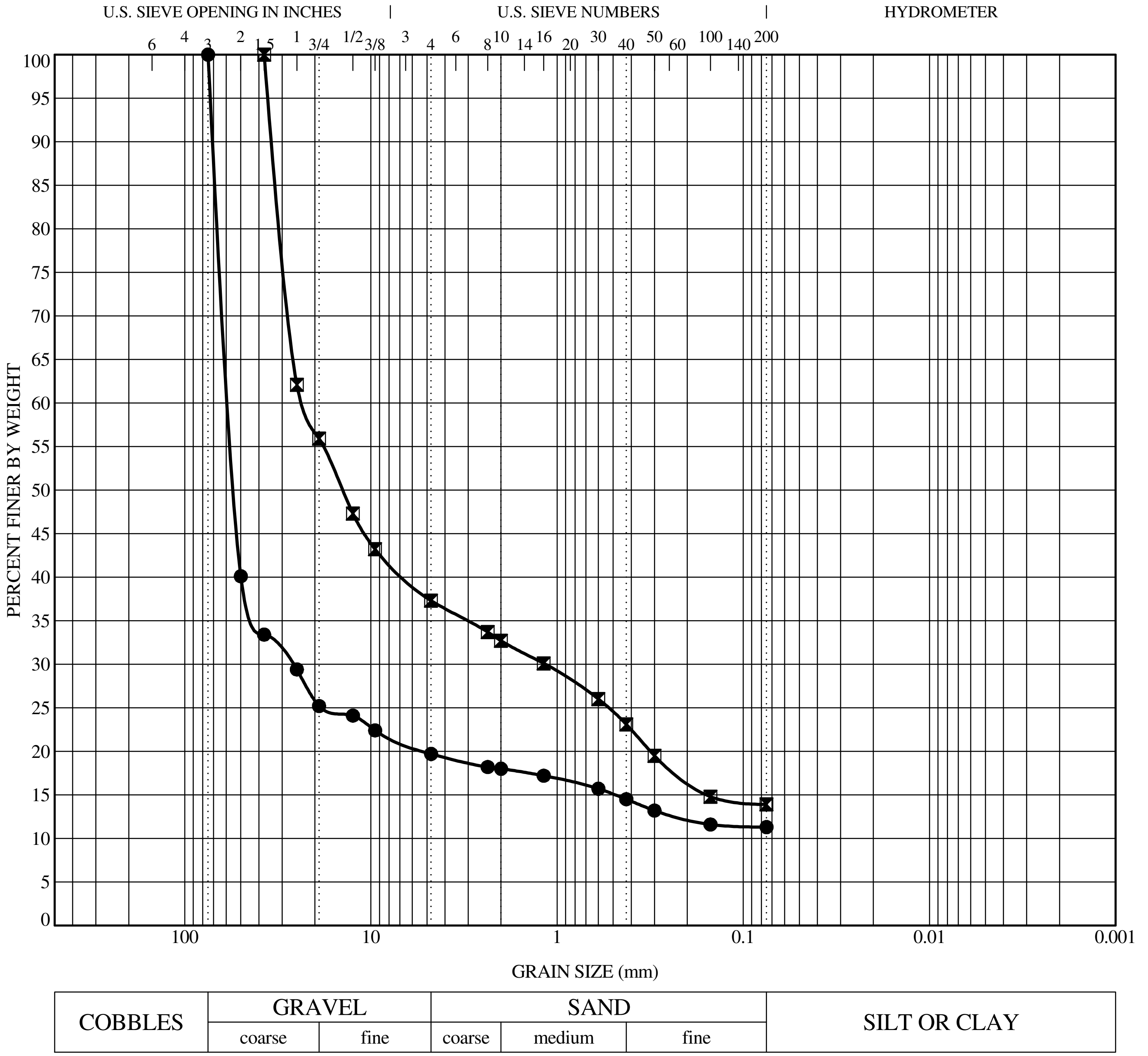
ATTERBERG LIMITS' RESULTS - ASTM D 4318

Summit Eden Phase 1C-Lot 70R
8492 East Spring Park
Weber County, Utah
Project Number: 594-004

Plate

C - 2

C_ATTERBERG TRENCH LOGS.GPJ GEOSTRATA.GDT 7/11/18



	Sample Location	Depth	Classification	LL	PL	PI	Cc	Cu
●	**TP-1**	**4.5**	**Poorly Graded GRAVEL with silt**	**NP**	**NP**	**NP**	**3316.18**	**15377.03**
☒	**TP-2**	**6.0**	**Poorly Graded GRAVEL with silt**	**NP**	**NP**	**NP**		

	Sample Loctaion	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**TP-1**	**4.5**	**75**	**57.21**	**26.568**		**80.3**	**8.4**	**11.3**	
☒	**TP-2**	**6.0**	**37.5**	**22.781**	**1.161**		**62.7**	**23.4**	**13.9**	

GeoStrata

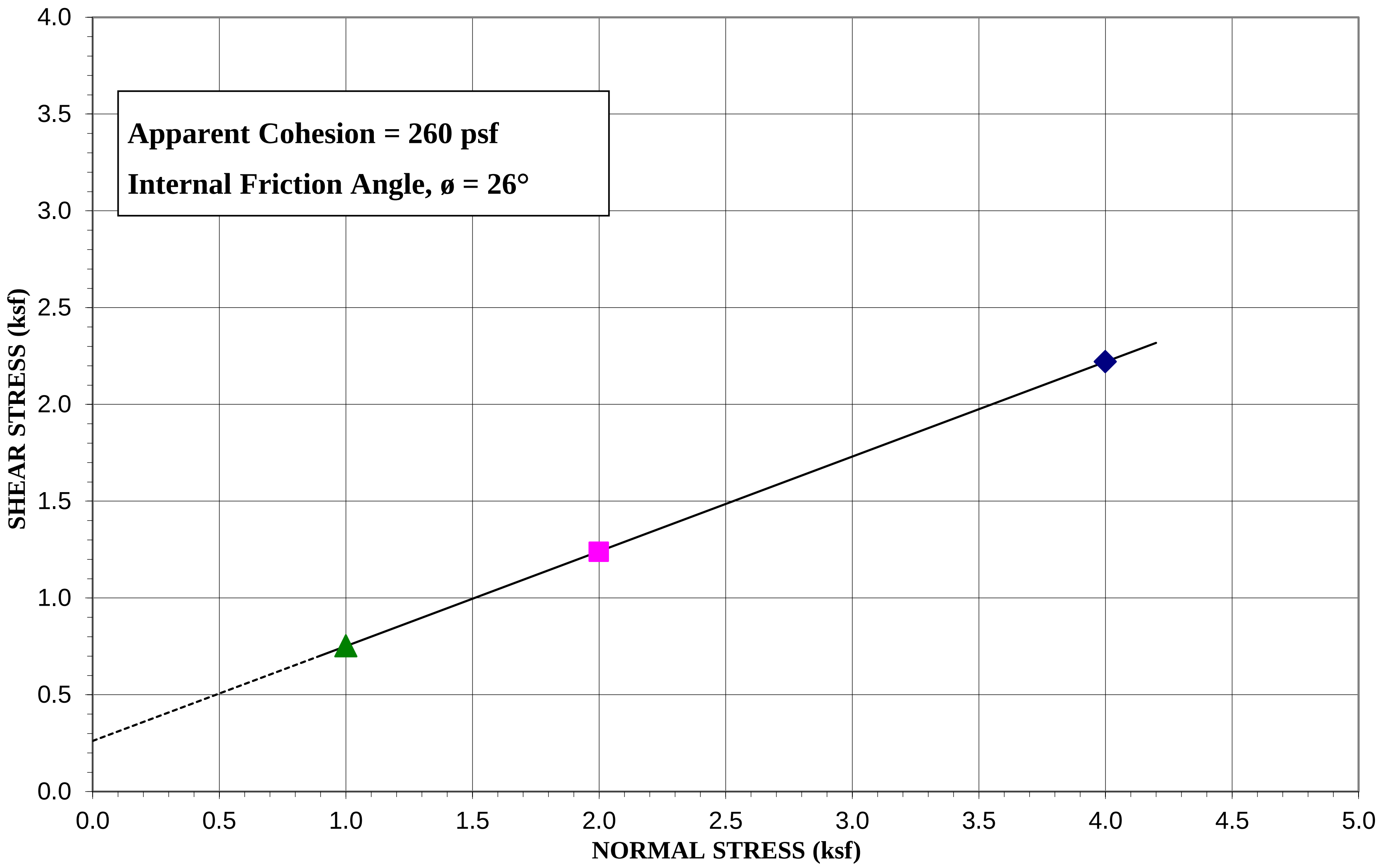
GRAIN SIZE DISTRIBUTION - ASTM D422

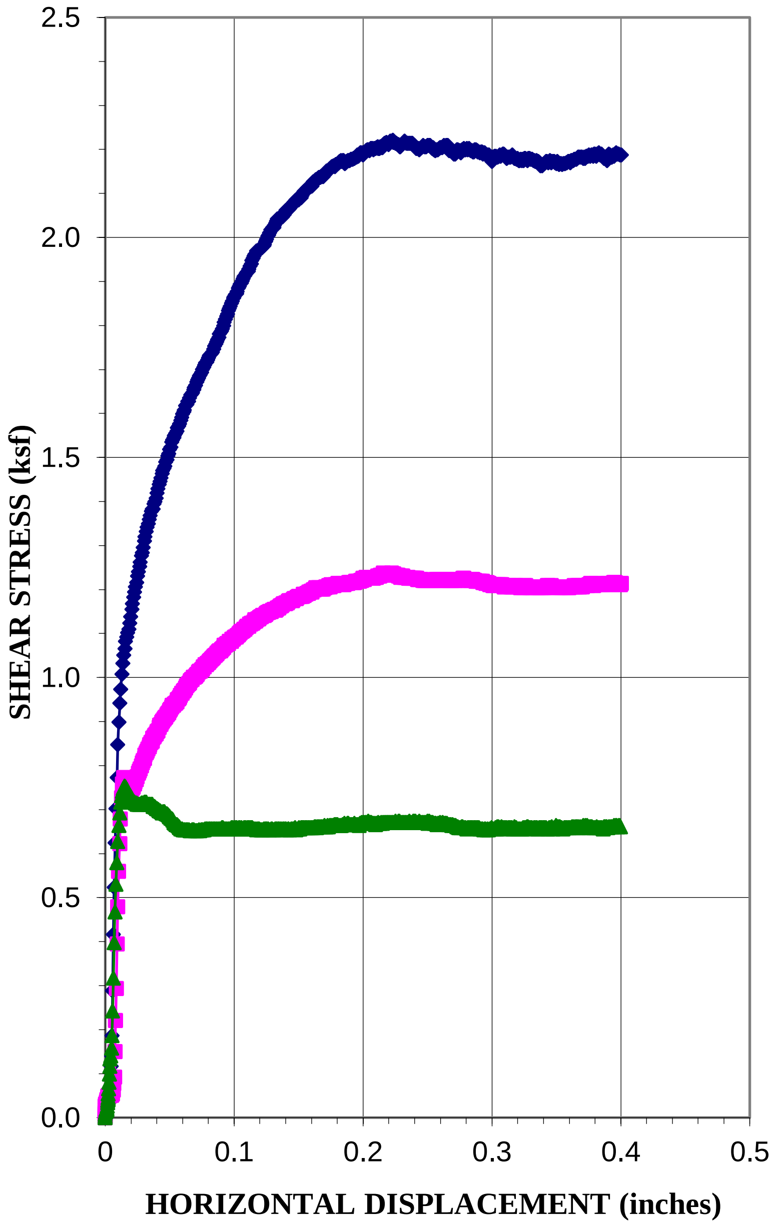
Summit Eden Phase 1C-Lot 70R
8492 East Spring Park
Weber County, Utah
Project Number: 594-004

Plate

C - 3

DIRECT SHEAR TEST





Sample Location:	TP-2 @ 9 ft
Type of Test:	Consolidated Drained/Saturated

Test No. (Symbol)	**1 (◆)**	**2 (■)**	**3 (▲)**
Sample Type	Remolded		
Initial Height, in.	0.984	0.982	0.989
Diameter, in.	2.5	2.5	2.5
Dry Density Before, pcf	115.7	115.2	113.4
Dry Density After, pcf	117.6	117.2	115.4
Moisture % Before	5.9	7.5	7.9
Moisture % After	13.9	14.4	14.7
Saturation, % Before	36.3	45.9	45.6
Saturation, % After	90.5	92.7	90.0
Normal Load, ksf	4.0	2.0	1.0
Shear Stress, ksf	2.22	1.24	0.75
Strain Rate	IN/MIN		

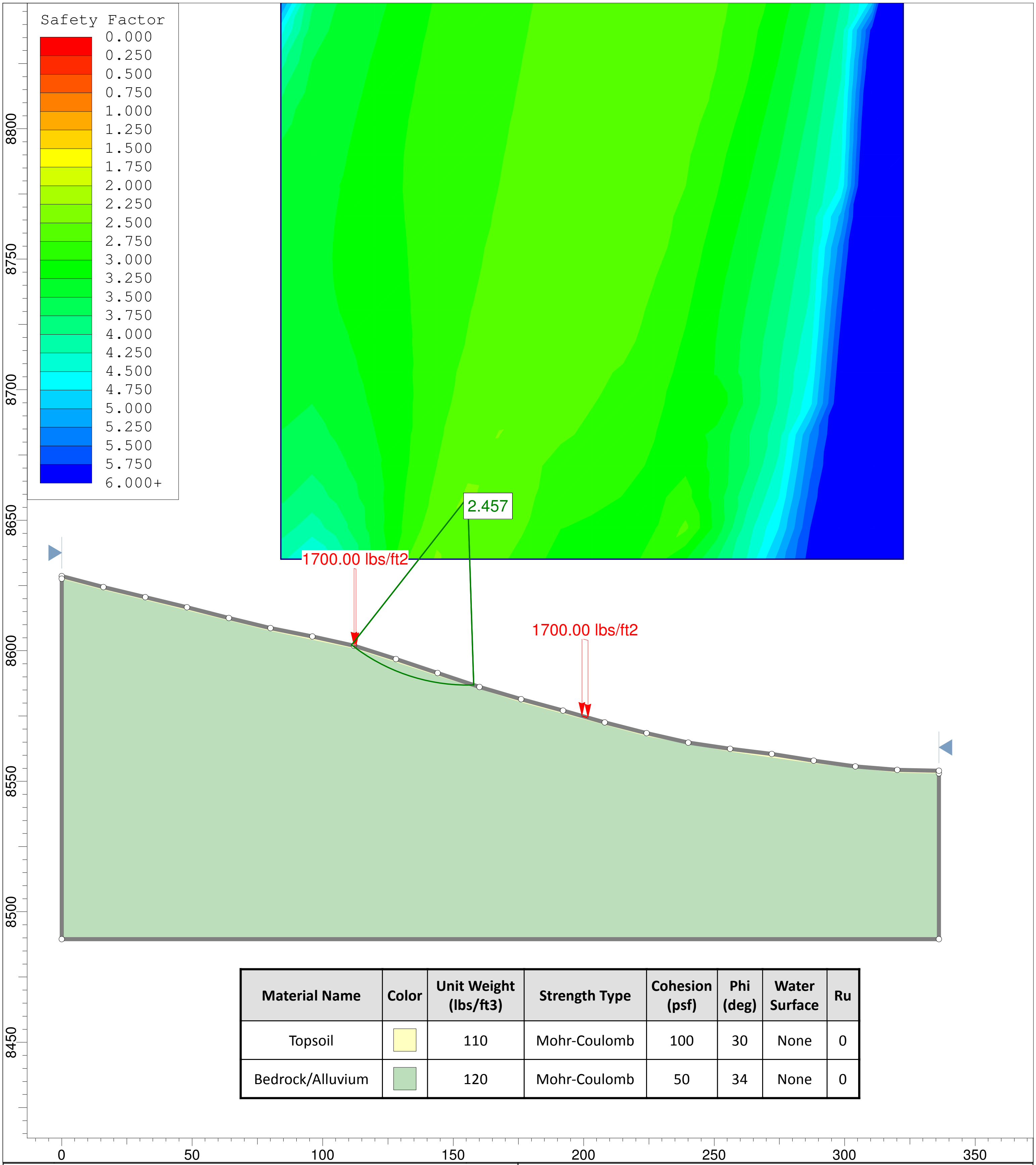
Sample Properties	
Cohesion, psf	260
Friction Angle, ϕ	26
Liquid Limit, %	NP
Plasticity Index, %	NP
Percent Gravel	62.7
Percent Sand	23.4
Percent Passing No. 200 sieve	13.9
Classification	GP-GM

PROJECT: Summit Eden Phase 1C- Lot 70R

PROJECT NO.: 594-004

GeoStrata

Plate
C-4



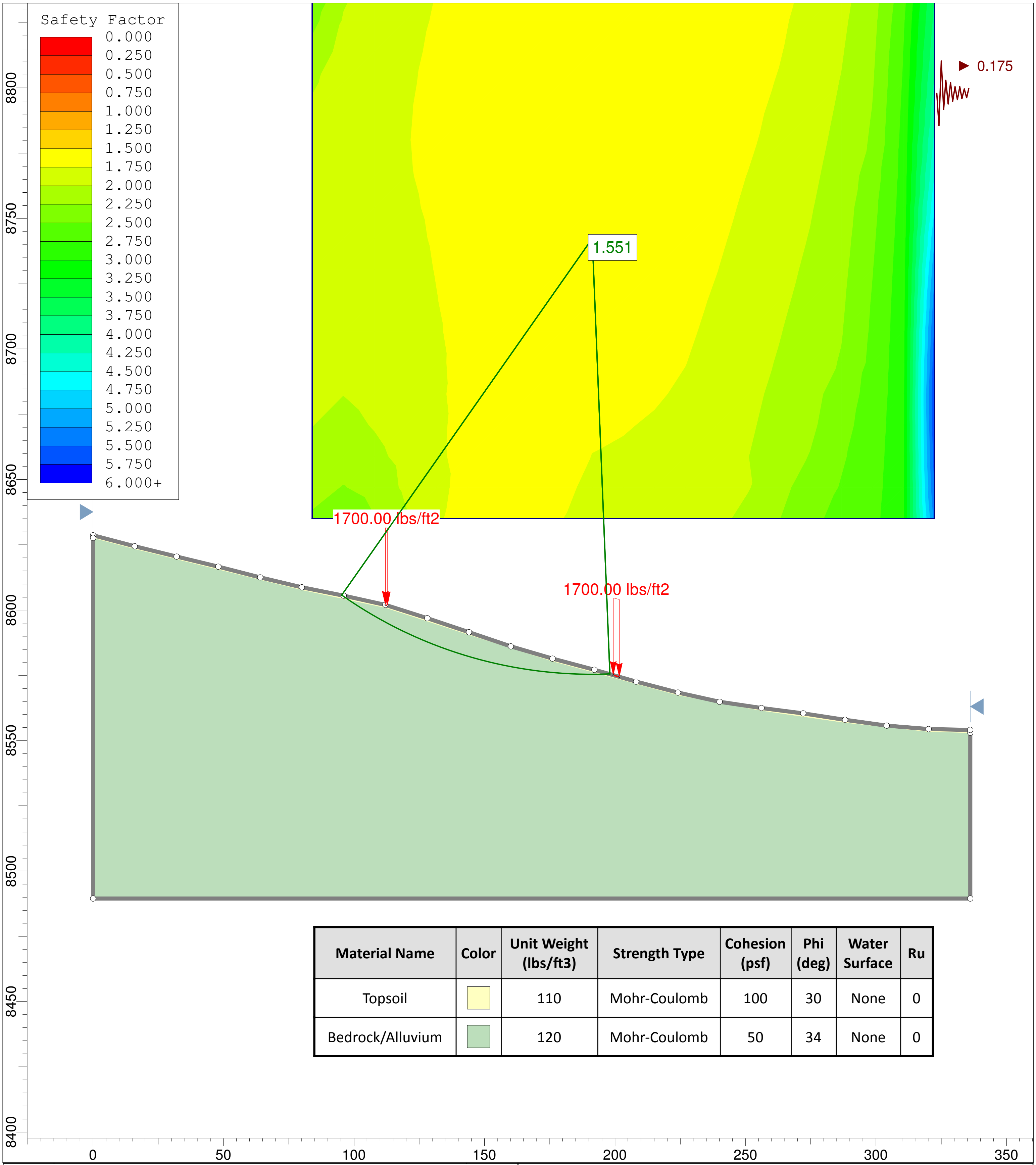
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Topsoil	🟨	110	Mohr-Coulomb	100	30	None	0
Bedrock/Alluvium	🟩	120	Mohr-Coulomb	50	34	None	0

GeoStrata

Lot 70R - Static Slope Stability

Lot 70R - Summit Eden Phase 1C
8492 East Spring Park
Weber County, Utah
GeoStrata Project No. 594-004

Plate D-1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Topsoil	🟨	110	Mohr-Coulomb	100	30	None	0
Bedrock/Alluvium	🟩	120	Mohr-Coulomb	50	34	None	0

GeoStrata

Lot 70R - PStatic Slope Stability

Lot 70R - Summit Eden Phase 1C
8492 East Spring Park
Weber County, Utah
GeoStrata Project no. 594-004

Plate D-2