September 24, 2018

Josh Graham
Graham Custom Homes
PO Box 776338
Steamboat Springs, Colorado 80477

Re: Preliminary Geotechnical Recommendations
Proposed Residence
Lot 75, Tree Haus
Routt County, Colorado
Western Slope Geotech Project # 18-4055

Dear Josh,

Western Slope Geotech, Inc. (WSG- dba Soilogic) has prepared this preliminary geotechnical recommendations report you requested for the proposed residence to be constructed within Lot 75 of the Tree Haus Subdivision in Routt County, Colorado. The results of site observations and pertinent geotechnical engineering recommendations are included with this report.

PURPOSE AND SCOPE OF WORK

The purpose of this report is to describe current site conditions and proposed construction and provide preliminary geotechnical design and construction recommendations for the proposed barn structure and associated site improvements. WSG's scope of work included field observations of the proposed building site, review of preliminary building plans and the preparation of this report summarizing those observations and data and outlining our preliminary recommendations for foundation design and construction. The conclusions and recommendations outlined in this report are based on our understanding of proposed construction, results of field observations and WSG's experience with subsurface conditions and similar construction in the nearby area.

PROPOSED CONSTRUCTION

WSG understands proposed construction will include construction of a one to two-story wood frame structure over a full-depth walkout basement. An upper level garage will be supported by a structural floor system. We have assumed the lower level will be constructed with a concrete slab-on-grade floor system. Lower floor level is planned from

approximately 6 feet above to 10 feet below existing site grades. A site plan showing property boundaries and proposed construction is shown on Figure 1.

Based on our review of site grading plans, WSG also understands unretained fills up to 6 feet in height will be required to develop finish grades along the east side of the site. Retained fills up to 20 feet in height are also planned along the southwest corner of the building site and along Tree Haus Drive.

Foundation loads are expected to be relatively light, with continuous wall loads less than 3 kips per lineal foot and individual column loads less than 75 kips. If the assumed construction and loading conditions vary substantially from those assumed, WSG should be contacted to reevaluate the recommendations in this report.

SITE DESCRIPTION

The site is situated off the east side of Tree Haus Drive in Routt County, Colorado. The site was vacant, appeared to be undisturbed, and was well vegetated with grasses, weeds and deciduous brush in a mature aspen forest. Existing residences were present on adjacent properties to the north, south and east. An apparent 20-foot fill slope was present along the east side of Tree Haus Drive, and displayed an approximate 2(H) to 1(V) slope configuration. Obvious signs of recent slope instability within Lot 75 or Tree Haus Drive were not observed.

Site topography was fairly consistent and sloped steeply down to the east-southeast on the order of 33 percent, based on topography shown on the site plan provided. In addition, based on the site plan provided, it appears that a maximum elevation difference of approximately 16 feet exists across the proposed building site.

SUBSURFACE CONDITIONS

Based on WSG's knowledge of a previous geotechnical exploration conducted on nearby property to the south, we anticipate the subsurface conditions at the building site to generally consist of a layer of topsoil and organics over sandy lean clay and sandstone-siltstone bedrock of the Browns Park Formation.

Based on previous explorations and testing in this area, we anticipate sandy lean clay to be low to moderately plastic, stiff, moist and brown. Bedrock of the Browns Park Formation can be variable but typically consists of sandstone-siltstone that is low plastic, weathered

to medium hard, fine grained, non to lightly cemented, moist and light brown to tan. Based on WSG's experience with similar materials encountered during previous explorations on other nearby sites, sandy lean clay will likely classify as a CL soil in accordance with the Unified Soil Classification System (USCS), and bedrock materials will likely classify as SM to ML materials. Swell-consolidation testing will likely indicate both materials will possess a low swell potential under wetting and constant loading conditions. A test pit excavated during initial site work and/or an openhole inspection of the foundation excavation, material sampling, and testing will be summarized in a follow-up report to confirm subsurface conditions and material engineering properties.

Groundwater is not anticipated at this time, however, may be encountered in deeper foundation excavations. Groundwater levels will vary seasonally and over time based on weather conditions, site development, irrigation practices and other hydrologic conditions. Perched and/or trapped groundwater conditions may also be encountered at times throughout the year. Perched water is commonly encountered in soils overlying less permeable soil layers and/or bedrock.

ANALYSIS AND RECOMMENDATIONS

General

Based on our understanding of proposed construction, we assume structure foundations will be placed between 2 and 10 feet below existing site grades, and both sandy lean clay and sandstone-siltstone bedrock are anticipated at potential foundation bearing elevations.

Based on the anticipated subsurface conditions and WSG's experience with previous explorations in this area, WSG believes the anticipated sandy lean clay and or sandstone-siltstone bedrock will provide adequate support for lightly loaded foundations. Laboratory testing of both materials will likely indicate these materials are expected to display a low swell potential under relatively light loading and wetting conditions. It is WSG's opinion that total and differential foundation movements should be within tolerable limits provided the design, construction and maintenance recommendations contained herein are observed. These recommendations must be verified by WSG by openhole inspection and material testing.

Foundations

Based on WSG's experience, we recommend the proposed barn structure be supported by continuous spread footing and isolated pad foundations bearing on natural, undisturbed sandy lean clay and or sandstone-siltstone bedrock materials and designed and constructed as outlined below:

1. WSG recommends foundation footings be placed on undisturbed natural sandy lean clay and or bedrock materials and designed using a maximum net allowable soil bearing pressure of 2,500 psf. As a precaution and to resist uplift forces from expansive soils, we recommend footings be designed to maintain a minimum dead load pressure of 600 psf.
2. Footings exposed to freezing or frost conditions should be designed with adequate soil cover to prevent freezing. A cover depth of 48 inches is recognized by the local building authority as the minimum value for frost protection.
3. WSG recommends continuous footings have a minimum width of 12 inches and isolated pad foundations have a minimum width of 24 inches in order to facilitate construction and reduce the potential for development of eccentrically loaded conditions.
4. Foundation walls and grade beams should be designed to span an unsupported distance of 10 feet or the distance between pads.
5. Foundation resistance to lateral loads can be developed by passive pressure against footings and walls and sliding resistance between footings and floor slabs and the underlying soils. WSG recommends passive pressures be computed using an equivalent fluid pressure value of 250 pcf and friction resistance be calculated using a coefficient of friction of 0.30 times structural dead loads. The recommended passive equivalent fluid pressure value and coefficient of friction do not include a factor of safety.
6. WSG must be retained to observe foundation excavations to verify the subsurface conditions are consistent with those assumed and verify design values given above.

WSG estimates total and differential settlement of foundations designed and constructed as outlined above and resulting from the assumed structural loads will be less than 1 inch.

Interior Building Floor Slabs

WSG understands slab-on-grade construction will be used for the building lower level floor system. WSG believes slab-on-grade construction can be used for lower level floor system, provided the risk of differential slab movement is recognized and the design and construction precautions outlined below are observed.

1. Floor slabs should designed and constructed as floating slabs, separated from foundation walls, columns and plumbing intrusions by the use of blockouts, cellotex or another approved isolation material.

2. Interior partition walls should not bear on floor slabs, but should be hung from interior framing and constructed with a slip joint at the wall-to-slab connection. The slip joint should provide for a minimum of 1½ inches of vertical movement.

3. Floor slabs should be constructed with control joints located a maximum of 12 feet on center to control natural, unavoidable cracking associated with concrete shrinkage that commonly occurs during curing. Control joint locations should be carefully selected to intersect slab intrusions, corners and other locations where shrinkage cracking is common.

4. Underslab subgrade areas should be graded to drain to the building perimeter to prevent the accumulation of water. Topsoil and organic materials should be removed from all underslab areas prior to placement of fill materials.

5. Topsoil and/or organic material and any existing fill material should be completely removed from below all floor slab areas. WSG recommends at least 1 foot of the natural lean clay or bedrock be removed and replaced with properly compacted Low Volume Change (LVC) soils. After stripping and completing all cuts and prior to placement of any fill or floor slab concrete, WSG recommends the exposed subgrade be scarified to a depth of 6-inches, moisture conditioned to within +/-2% of optimum moisture content and compacted to at least 95% of the maximum standard Proctor density.

   Fill material used to bring underslab areas to grade should consist of either approved Low Volume Change (LVC) soils or imported non-expansive materials uniformly placed and compacted to at least 95% of the maximum standard Proctor density within ±2% of optimum moisture content (ASTM D698). The on-site

sandy lean clay or bedrock could be used beneath floor slabs, but will likely require moisture conditioning and processing prior to use. On-site or imported materials should be compacted to the minimum value indicated above with moisture contents ranging from +/-2%. Imported LVC materials (if required) should consist of a material with a liquid limit (LL) of less than 40 and plasticity index (PI) of less than 18. Essentially granular, non-expansive materials would also be considered LVC.

6. Floor slabs should be underlain by a minimum 6-inch layer of free draining gravel. The gravel layer will help provide uniform support and aid in underslab drainage.

The implementation of the above recommendations will not eliminate floor slab movement in the event that the underslab soils undergo significant moisture changes. WSG estimates floor slab movement of up to 1-inch and associated distress is possible. If this value is not acceptable, WSG recommends the use of structural floors supported above a crawl space or other void space.

Perimeter Drainage Systems

WSG recommends a perimeter drainage system be installed at the perimeter foundation of the structure. Properly constructed perimeter drainage systems enhance site drainage, help reduce the potential for development of hydrostatic pressures behind the below-grade walls and reduce the potential for water infiltration beneath footings and into underslab areas.

A perimeter drainage system should generally consist of a 4-inch perforated PVC drain pipe covered by a minimum of twelve (12) inches of free-draining gravel and covered with filter fabric (Mirafi 140N or equivalent) to prevent intrusion of fines. The high point of the drain pipe should be placed at approximate footing grade and run around the exterior of the perimeter foundation walls, constructed with a minimum 1% slope and discharge to a daylighted outfall. Multiple daylights are recommended for larger and more complex structures. Minimum burial depths of 24 inches are acceptable for at-grade floor slab areas. WSG can provide perimeter drainage system design and details upon request and after building plans are available.

Lateral Earth Pressures and Foundation Backfill

Lateral Earth Pressures: Foundation walls should be designed to resist lateral pressures associated with foundation backfill materials, existing site soils, topography and other surcharge loads. Materials affecting lateral pressures are located within the area extending from the base of the foundation wall upward at an approximate 1(H) to 1(V) angle. Recommended lateral earth pressure design values to be used in foundation wall design are provided in Table A shown below. All values presented assume drained conditions (no hydrostatic loads) and sufficient wall rotation is achieved for activation of active earth pressure conditions.

Table A

Design Pressure Condition	Equivalent Fluid Pressure (pcf)
Active	45
At-Rest	55
Passive	250

Variables that affect active lateral earth pressures include but are not limited to the classification and swell potential of the backfill soils, backfill compaction and geometry, wetting of the backfill soils, surcharge loads and point loads developed in the backfill materials. The recommended equivalent fluid pressure values do not include a factor of safety or an allowance for hydrostatic loading. Use of expansive soil backfill, excessive compaction of the wall backfill or surcharge loads placed adjacent to the foundation walls can add to the lateral earth pressures causing the equivalent fluid pressure values used in design to be exceeded.

Foundation Backfill: Backfill placed adjacent to below-grade walls should consist of LVC potential materials and relatively impervious soils free from organic matter, debris and other objectionable materials. The anticipated on-site natural sandy lean clay and bedrock materials should be suitable for use as wall backfill, but may require processing prior to placement. WSG recommends foundation backfill soils be uniformly placed in maximum 9-inch loose lifts, moisture conditioned to within +/-2% of optimum moisture content and compacted to at least 95% of the maximum standard Proctor dry density (ASTM D698).

Foundation wall backfill operations should be conducted only after proper bracing and support is provided. Structural engineer approval is recommended. Excessive lateral stresses resulting in displacement, distress and damage to foundation walls can occur when insufficient bracing is in place or heavy mechanical compaction equipment is used. Soilogic recommends compaction of unbalanced foundation wall backfill soils be completed using light mechanical or hand compaction equipment.

Exterior Flatwork

Any existing topsoil and vegetation and existing fill or other materials associated with the existing underground utilities should be stripped from proposed flatwork areas prior to fill or concrete placement. WSG recommends the exposed subgrade be scarified to a depth of 6-inches, moisture conditioned to within ±2% of optimum moisture content and compacted to at least 95% of the maximum standard Proctor density. WSG recommends fill supporting flatwork consist of approved granular materials or imported LVC fill materials uniformly placed in 9-inch loose lifts, moisture conditioned and compacted to the values indicated above with a limited risk of post-construction movement. The on-site lean clay soils could be used as fill beneath exterior flatwork.

Subgrade soils expected to receive exterior flatwork concrete should be evaluated closely evaluated immediately prior to concrete placement. If areas of disturbed, wet and softened, or dry subgrade soils are encountered at that time, reworking of those materials or removal/ replacement procedures may be required.

Drainage

Positive drainage is imperative for satisfactory long-term performance of the proposed structure foundations, floor slabs and associated site improvements. WSG recommends positive drainage be developed away from the structure during construction and maintained throughout the life of the site improvements. Twelve (12) inches of fall in the first 10 feet away from the building is recommended. Flatter slopes could be considered in hardscape areas. In the event that some settlement of the backfill soils occurs adjacent to the residence, the original grade and associated positive drainage outlined above should be immediately restored.

Care should be taken in the planning of landscaping to avoid features which could result in the fluctuation of the moisture content of the foundation bearing and/or flatwork subgrade

soils. We recommend watering systems be placed a minimum of 5 feet away from the perimeter of the structure and be designed to discharge away from all site improvements. Gutter systems should be considered to help reduce the potential for water ponding adjacent to the residence, with the gutter downspouts, roof drains or scuppers extended to discharge a minimum of 5 feet away from structural, flatwork and pavement elements. Water which is allowed to pond adjacent to the site improvements can result in unsatisfactory performance of those improvements over time. The use of area drain inlets and subsurface piping is recommended to aid in rapid runoff of surface water from areas of concentrated drainage and/or limited surface runoff capability.

SITE GRADING

WSG understands unretained fills up to 6 feet in height will be constructed for site development at the south and east sides of the building site. Retained fills up to 20 feet in height are anticipated at the southwest corner of the building site.

Existing slopes could become unstable as a result of proposed temporary and permanent grading activities. Design and construction considerations should be observed to limit or reduce the potential for slope instability. Although a slope stability analysis is beyond the scope of this report, some general guidelines are provided below, suitable for general site planning and design.

Based on our understanding of proposed construction, WSG recommends the following:

1. Unretained cuts and fills should be constructed to a 2(H) to 1(V) or flatter slope configuration. Flatter slopes are often desirable to help facilitate revegetation efforts.
2. WSG recommends site grading and drainage plans be prepared by an experienced professional engineer.
3. A construction sequencing plan should be developed for temporary excavations and required shoring, foundation construction, and backfilling prior to starting construction.
4. Excavation and backfilling activities should be conducted during periods of low precipitation and runoff to help reduce the potential for formation of perched water

tables and runoff water entering site cuts and fills. Excavation during spring and early summer when runoff levels are typically high is not recommended.

The presence of groundwater can reduce slope stability. If groundwater is encountered in excavations, excavation activities should cease immediately and WSG should be notified. Dewatering and additional stabilization measures may be required.

5. Fill materials supporting driveways or other settlement-sensitive landscaping features should consist of either on-site materials or approved imported materials. All fills should be uniformly placed and compacted in 9-inch loose lifts to at least 95% of the maximum standard Proctor density within 2% of optimum moisture content (ASTM D698). All fills should be benched or keyed into hillsides exceeding 25 percent grade using minimum 4-foot benches.

6. Proper drainage should be provided and maintained around all cuts, fills, buildings, and driveway surfaces. Special attention should be given to channeling or routing drainage around and away from site fills and retaining structures. Excessive or uncontrolled surface and subsurface drainage could lead to erosion and poor site fill performance and/or slope failure.

7. All disturbed areas should be protected from erosion by revegetation or other appropriate methods. Areas of concentrated drainage should be protected by use of rip rap or other appropriate methods.

8. Construction safety is the sole responsibility of the contractor. The contractor is responsible for determining the appropriate OSHA slope criteria for the soils conditions encountered and implementing it during construction. The contractor shall be responsible for all means, methods, techniques, sequencing, and operations during construction. All excavation activities should meet minimum OSHA, state or local trenching and excavation safety standards.

GENERAL COMMENTS

This report was prepared based upon WSG's experience with similar nearby sites and construction in this area. The subsurface conditions encountered may vary from those assumed. Therefore, WSG must be retained to conduct an openhole inspection on

foundation excavations and any necessary testing required to quantify foundation design parameters. Modifications to the assumed design values, and therefore foundation design may be required and could result in construction delays.

Variations in subsurface conditions can occur in relatively short distances away. This report does not reflect any variations which may occur across the site or away from the test pit locations. If variations in the subsurface conditions anticipated become evident, the geotechnical engineer should be notified immediately so that further evaluation can be completed and when warranted, alternative recommendations provided.

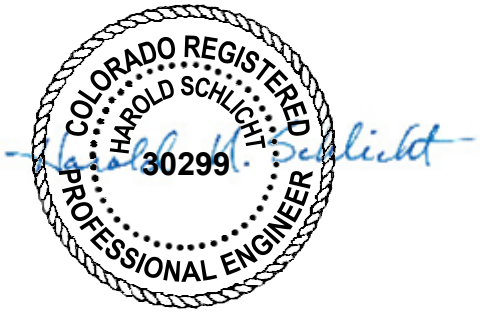
The scope of services for this project does not include either specifically or by implication any biological or environmental assessment of the site or identification or prevention of pollutants or hazardous materials or conditions. Other studies should be completed if concerns over the potential of such contamination or pollution exist.

WSG should be retained to review the plans and specifications so that comments can be made regarding the interpretation and implementation of our geotechnical recommendations in the design and specifications. Soilogic should also be retained to provide testing and observation services during construction to help evaluate compliance with project plans and specifications.

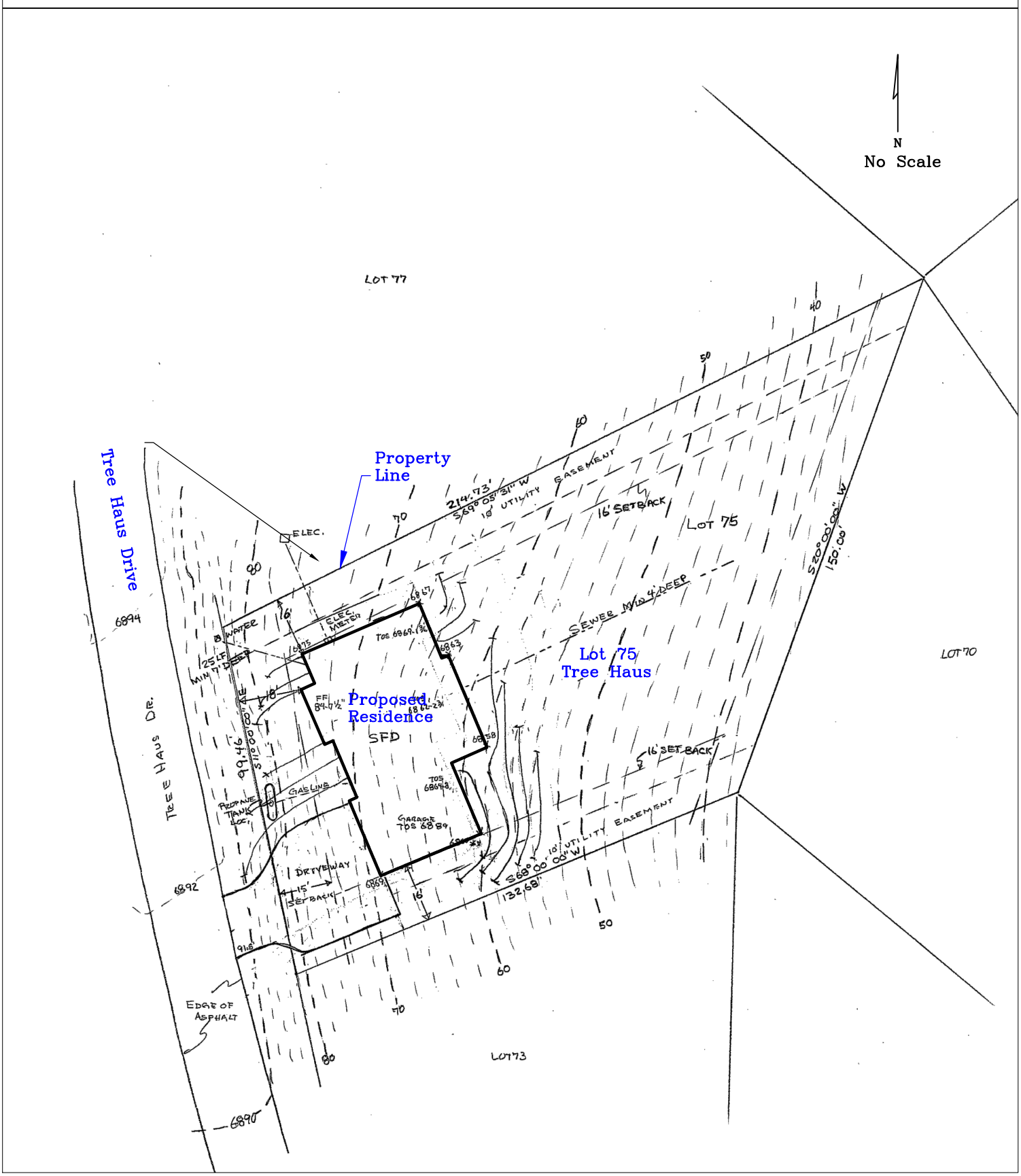
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with the generally accepted standard of care for the profession. No warranties express or implied, are made. The conclusions and recommendations contained in this report should not be considered valid in the event that any changes in the nature, design or location of the project as outlined in this report are planned, unless those changes are reviewed and the conclusions of this report modified and verified in writing by the geotechnical engineer.

WSG appreciates the opportunity to be of service to you on this project. If you have any questions concerning the enclosed information or if we can be of further service to you in any way, please do not hesitate to contact us.

Very Truly Yours,
Western Slope Geotech, Inc.



Harold Schlicht, P.E.
Principal Engineer



SITE PLAN

Project Name: Proposed Residence	SOILOGIC Steamboat Springs
Location: Lot 75, Tree Haus, Routt County, CO	Project No.: 18-4053 | Drawn/Checked:HS
	Date: 9/21/18 | Figure No.: 1