Geotechnical Engineering
Exploration and Analysis

Proposed Holzer Residence
124 Summit Tower Circle
Asheville, North Carolina

Prepared for:

Joe Holzer
Asheville, North Carolina

Prepared by:

Gentry Geotechnical Engineering, PLLC.
Asheville, North Carolina

March 29, 2021
Gentry Project Number 21G-0084-01

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March 29, 2021

Joe Holzer
90 Summit Tower Circle
Asheville, North Carolina 28804

Subject: **Geotechnical Engineering Exploration and Analysis**
Proposed Holzer Residence
124 Summit Tower Circle
Asheville, North Carolina
Gentry Project No. 21G-0084-01
Gentry NC Engineering License No. P-1170

Dear Mr. Holzer:

As requested, Gentry Geotechnical Engineering, PLLC (Gentry) conducted a *Geotechnical Engineering Exploration and Analyses* for the proposed Holzer residence located at 124 Summit Tower Circle in Asheville, North Carolina. The accompanying report describes the services that were conducted for the project and it provides geotechnical-related findings, conclusions and recommendations that were derived from those services.

We sincerely appreciate the opportunity to provide geotechnical consulting services for the proposed project. Please contact the undersigned if there are questions concerning the report or if we may be of further service.

Respectfully submitted,

GENTRY GEOTECHNICAL ENGINEERING, PLLC

William T. Gentry III
Mar 29 2021 3:22 PM

Brian P. Moretti
Project Manager

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Principal Engineer
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NORTH CAROLINA PROFESSIONAL SEAL 033927 ENGINEER WILLIAM THOMAS GENTRY III

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GEOTECHNICAL ENGINEERING EXPLORATION AND ANALYSES

PROPOSED HOLZER RESIDENCE
124 SUMMIT TOWER CIRCLE
ASHEVILLE, NORTH CAROLINA
GENTRY PROJECT NUMBER 21G-0084-01

1.0 SCOPE OF SERVICES

This report provides the results of the *Geotechnical Engineering Exploration and Analyses* that Gentry Geotechnical Engineering, PLLC ("*Gentry")* conducted regarding the proposed development. The *Geotechnical Engineering Exploration and Analyses* included several separate, but related, service areas referenced hereafter as the Geotechnical Subsurface Exploration Program, Geotechnical Laboratory Services, and Geotechnical Engineering Services. The scope of each service area was narrow and limited, as directed by our client and in consideration of the proposed project. The scope of each service area is briefly explained later.

Geotechnical-related recommendations for design and construction of the foundation, floor slabs, basement and site retaining walls for the proposed residence are provided in this report. Site preparation recommendations are also given; however, those recommendations are only preliminary since the means and methods of site preparation will largely depend on factors that were unknown when this report was prepared. Those factors include the weather before and during construction, subsurface conditions that are exposed during construction, and finalized details of the proposed development.

2.0 SITE DESCRIPTION

We have reviewed a topographic survey of the site, provided to us by the client, and discussed the preliminary layout of the house footprint. Based on visual observations and a review of the topography shown on the site survey and on the Buncombe County GIS website, the slope across the proposed residence ranges from about 2.8H: 1V (Horizontal: Vertical) or 35.7 percent to 2.3H: 1V or 42.9 percent. The location for the residence is surrounded by mountainous, wooded property. Summit Tower Circle is located to the south and wooded property is located along the north and east sides of the property. A neighboring residence is located to the west.

Based on our review of the Buncombe County GIS Stability Index Map (SIN), the proposed residence is located predominately within Stable (Low Hazard) with occasional Moderately Stable (Moderate Hazard) Zones located along the east side of the property. The proposed residence will not be located within a potential debris flow pathway. The Buncombe County Steep Slope Ordinance requires *a geotechnical analysis for home sites on a 35% or greater slope or in an area designated as high or moderate hazard*.

3.0 PROJECT DESCRIPTION

It is understood that the proposed residence will consist of a two-story structure over a crawlspace with an approximate footprint of 2,400 square feet in plan area with an attached garage. The type of construction is unknown at this time. We have assumed conventional wood frame and wood-truss system over reinforced concrete or masonry block bearing walls. The structure is anticipated to be supported by bearing walls and/or columns with maximum loads estimated at 2,000 pounds per lineal foot for walls and 25 kips for columns. The basement floor or garage floor is expected to support a maximum 100 pounds per square foot live load.

4.0 GEOTECHNICAL SUBSURFACE EXPLORATION PROGRAM

The scope of the Geotechnical Subsurface Exploration Program included evaluating the subsurface conditions by performing four test pits (TP-1, TP-2, TP-3 and TP-4) at the site on March 10, 2021. The test pits were performed near the four corners of the proposed residence. The approximate house corners were staked at the time of our site visit. The test pit locations were chosen in the field and the approximate locations are shown on the attached *Test Pit Location Plan*.

The ground elevations at the test pits were determined as part of the Geotechnical Subsurface Exploration Program by estimating the ground surface elevations shown on the topographic survey. The test pit elevations are noted on the *Records of Subsurface Exploration*, which are logs of the test pits. The test pit elevations are considered accurate within about two feet.

The test pits were excavated to depths of between 3 and 8 feet, the maximum depths explored. Dynamic cone penetrometer (DCP) testing was performed routinely in the test pits to provide quantitative data about the soil strength and density. The dynamic cone penetrometer is an instrument composed of a conical point driven with blows from a 15-pound hammer falling 20 inches. The point is driven into the soil in three increments of 1-3/4 inches. The number of hammer blows required to drive each increment is recorded. The average number of blows of the final two increments is an index to soil strength and bearing capacity.

At certain depths, samples of the excavated soils were collected from the test pits. Immediately after sampling, soil samples were transferred to zip lock bags that were labeled at the site for identification. At completion of the field exploration, the test pits were backfilled and compacted in lifts with the bucket of the mini-excavator.

5.0 GEOTECHNICAL LABORATORY SERVICES

Samples that were retained at the site were classified by a geotechnical engineer using the descriptive terms and particle-size criteria, and by using the Unified Soil Classification System (ASTM D 2488-75) as a general guide. The classifications are shown on the *Records of Subsurface Exploration*, along with horizontal lines that show supposed depths of material change. Field-related information pertaining to the test borings is also shown on the *Records of Subsurface Exploration*. A select sample was tested for moisture content and percent fines to aid in soil classification and estimating engineering properties and is outlined below in Table 1.

TABLE 1 - LABORATORY TEST RESULTS				
Test Pit No.	**Depth (ft)**	**Percent Finer than No. 200 Sieve (%)**	**Moisture Content (%)**	**USCS Soil Classification**
TP-1	2-4	43.1	23.7	SM

6.0 SITE GEOLOGY

The project site is located in the Blue Ridge Physiographic Province. The bedrock in this region is a complex crystalline formation that has been faulted and contorted by past tectonic movements. The rock has weathered to residual soils which form the mantle for the hillsides and hilltops.

The typical residual soil profile in areas not disturbed by erosion or the activities of man consists of clayey soils near the surface where weathering is more advanced, underlain by sandy silts and silty sands.

The boundary between soil and rock is not sharply defined, and there often is a transitional zone, termed "partially weathered rock," overlying the parent bedrock. Partially weathered rock is defined, for engineering purposes, as residual material with standard penetration resistances in excess of 100 blows per foot (bpf). Weathering is facilitated by fractures, joints, and the presence of less resistant rock types. Consequently, the profile of the partially weathered rock and hard rock is quite irregular and erratic, even over short horizontal distances. Also, it is not unusual to find lenses and boulders of hard rock and/or zones of partially weathered rock within the soil mantle well above the general bedrock level.

7.0 MATERIAL CONDITIONS

Since material sampling at the test pits was discontinuous, it was necessary for *Gentry* to suppose conditions between sample intervals. The supposed conditions at the test pits are briefly discussed in this section and are described in detail on the *Records of Subsurface Exploration*. Also, the conclusions and recommendations in this report are based on the supposed conditions.

7.1. Surface Materials

The surface materials consisted of 4 to 6 inches of silty sand topsoil and root mat.

7.2. Residual Soil and Partially Weathered Rock (PWR)

Below the surface materials, the subsurface soils generally consisted of firm, brown to tan, moist, silty sand with partially weathered rock (PWR) fragments to depths of 3 to 8 feet. The firm silty sand encountered was classified as residual soils and had DCP values of 25 or better. Mini-excavator refusal occurred in TP-2 on PWR at a depth of 8 feet and refusal occurred on rock in TP-1 at 7 feet, in TP-3 at 3 feet and in TP-4 at 4 feet.

8.0 GROUNDWATER CONDITIONS

No ground water was encountered within the depths explored when the Geotechnical Subsurface Exploration Program was conducted. It should be noted that ground water levels may fluctuate several feet with seasonal and rainfall variations and with changes in the water level in adjacent drainage features. Normally, the highest ground-water levels occur in late winter and spring and the lowest levels occur in late summer and fall.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1. Slope Stability Considerations

Site grading in mountainous areas such as at this site can have a significant impact on the stability of natural and manmade slopes. As mentioned previously, the slope across the proposed residence ranges from about 2.8H: 1V (Horizontal: Vertical) or 35.7 percent to 2.3H: 1V or 42.9 percent.

The proposed residence will be constructed across the natural slope. It is understood that the proposed residence will be supported by a crawlspace foundation. A site reconnaissance did not observe any signs of slope instability (i.e., scarps, tension cracks, bulges or recurved trees) within the proposed construction limits and for a distance of about 50 feet in all directions. Although we did not observe evidence of slope instability in the site area, care should be taken to minimize disturbance of the existing slope. Site grading within the planned residential area should be limited to excavation as required to achieve the planned finished grade elevations.

A preliminary global stability analysis indicated the natural slope to be stable. The analysis used estimated soil strength parameters based on the subsurface conditions encountered and our experience with similar materials. Based on our observations of the slope and the soil conditions encountered at the test pits, shallow foundations with sufficient embedment into residual soils should be used to support the proposed residences.

Based on our observations and the subsurface conditions encountered at our test pit locations, the risk of instability of the natural slope appears to be reasonable with the recommended design measures, site preparation and testing during construction.

9.2. Building Foundation Recommendations

Based on the assumed structural loads and the soil test pit findings, a foundation designed using a 3,000 psf maximum, net, allowable soil bearing capacity is recommended for the proposed residence. A higher net allowable soil bearing capacity could be approved by *Gentry* if needed but would require field verification after initial site grading is performed. Strip footing pads are recommended to be at least 18 inches wide and isolated column pads are recommended to be at least 24 inches wide for geotechnical considerations, regardless of the calculated foundation bearing stress. Foundation basement walls or stem walls are assumed to be built of reinforced cast-in-place concrete or a reinforced masonry wall system. Columns are assumed to be built of reinforced concrete footings and pedestals above the ground surface. It is understood that specific foundation details including footing dimensions, reinforcing, and other parameters will be constructed per the most recent edition of the North Carolina State Residential Code.

It is understood that the North Carolina State Residential Code requires a minimum 12-inch foundation depth. However, it is our opinion that foundations have a minimum 24-inch foundation depth for stability and frost action concerns. Therefore, footings for foundation walls and columns of the proposed structure are recommended to bear at least 24 inches below the finished ground grade. The foundation analysis was conducted assuming that the foundations will bear at about 24 inches below the exterior ground surface. **The top of footings must bear at least 5 feet horizontally from a slope face. This includes footings bearing near the crest of a slope or within the slope itself. This may result in the footings bearing deeper than the recommended minimum embedment depth to provide 5 feet horizontally from a slope face.**

Foundation excavations are recommended to be dug with a smooth-edge backhoe bucket to develop a relatively undisturbed bearing grade. A toothed bucket will likely disturb foundation-bearing soil more than a smooth-edge bucket, thereby making soil at the excavation base more susceptible to saturation and instability, especially during adverse weather. It is critical that contractors protect foundation support soil and foundation construction materials (concrete, reinforcing, etc.). In addition, engineered fill is recommended to be placed and compacted in benched excavations along foundation walls immediately after the foundation walls are capable of supporting lateral pressures from backfill, compaction, and compaction equipment.

Earth-formed footing construction techniques will likely be feasible considering that silty sand residual soil or PWR was above the estimated foundation bearing elevations at the test pits.

Foundation Support Soil Requirements

Footing pads are recommended to be directly and entirely supported by suitable-bearing residual soil. Based on the recommended 3,000 psf bearing capacity, a DCP value of 8 is recommended. It is recommended that the strength characteristics of the soil or PWR within the entire foundation influence zone (determined by *Gentry* during construction) meet or exceed the recommended values, unless *Gentry* approves lesser values.

It is recommended that *Gentry* evaluate foundation support soil using appropriate means and methods immediately before foundation construction. The purpose of the recommended evaluation is to confirm that the foundation will be properly supported and confirm that the support soil is similar to the conditions described on the *Records of Subsurface Exploration*. In the event that another firm performs the recommended foundation elevation, *Gentry* must be notified if the composition or strength characteristics of foundation support soil differ from those shown on the *Records of Subsurface Exploration*.

Soil that is within a foundation influence zone but does not meet the recommended allowable bearing capacity (described above), or is otherwise unsuitable, is recommended to be replaced. Unsuitable bearing material could be replaced with engineered fill, such as No. 57 stone. It is recommended that *Gentry* provide specific recommendations pertaining to soil over-excavation and replacement at the time of construction including the need for wrapping the stone in a geotextile fabric. As an option to soil replacement, strip footings could be stepped or thickened to extend through unsuitable bearing materials. It is recommended that a structural engineer or architect provide specific details of stepped or thickened footings when required.

Estimated Foundation Settlement

The post-construction total and differential settlements of foundations designed and constructed based on this report are estimated to be a maximum of about 1 and 1/2 inch, respectively. The post-construction angular distortion is estimated to be a maximum of about 1/480 across a distance of 20 feet or more.

9.3. Floor Slab Recommendations

With proper sub-grade preparation, it is expected that site soil will be suitable for floor slab support. Over-excavation of unsuitable bearing soil might, however, be necessary to develop a suitable floor slab sub-grade. Engineered fill that is selected, placed, and compacted according to this report could also support a concrete slab. It is understood that specific foundation details including footing dimensions, reinforcing, and other parameters will be constructed per the most recent edition of the North Carolina State Residential Code.

A minimum 4-inch-thick base course is recommended to be directly below the floor slab to serve as a capillary break and help develop uniform support. It is recommended that the base course consist of free-draining aggregate. **Also, it is recommended that *Gentry* test and approve the subgrade soils, any backfill soils required to achieve final subgrade elevation and the base course aggregate before it is placed.** Depending on aggregate gradation, a geotextile might need to be below the base course.

A minimum 10-mil vapor retarder is recommended to be directly below the base course throughout the entire floor area. If the base course has sharp, angular aggregate, protecting the retarder with a geotextile (or by other means) is recommended. Also, it is recommended that a structural engineer or architect specify the vapor retarder location with careful consideration of concrete curing and the effects of moisture on future flooring materials.

Estimated Floor Slab Settlement

The post-construction total and differential settlements of an isolated floor slab constructed in accordance with this report are estimated to be a maximum of about ½ and ⅓-inch, respectively.

9.4. Retaining Wall Recommendations

We understand that basement foundation walls for the proposed residence will be required. Cast-in-place concrete or concrete masonry unit cantilever retaining walls for the residence should be designed as "restrained" retaining walls based on "at-rest" earth pressure, plus any surcharges near the walls as described below, if the walls are expected to be part of the residence and lateral movement is not acceptable. Cast-in-place concrete or CMU (concrete masonry unit) cantilever walls that are not attached to the residence and that can accept some lateral movement may be designed based on “active” earth pressures, plus any surcharges. Based on the geotechnical test pits and our experience with similar soil conditions, an allowable bearing pressure of 3,000 pounds per square foot (psf) may be used for footings. Foundation support soil requirements of the retaining walls should be performed as previously discussed.

Table 2 presents the recommended soil related design parameters for stem walls or site retaining walls with a level back slope behind the walls (i.e. β=0 degrees). *Gentry* should be contacted if an alternate retaining wall system is used for alternate recommendations or if a different sloped backfill surface is planned.

TABLE 2 – RECOMMENDATIONS FOR SOIL PROPERTIES AND LATERAL EARTH PRESSURES

				Active earth pressures		At-rest earth pressures		Passive earth pressures	
Material	**Unit Weight (pcf)**	**Friction Angle, Φ' (degrees)**	**f_s**	**Equiv. fluid pressure (pcf)**	**K_a**	**Equiv. fluid pressure (pcf)**	**K_o**	**Equiv. fluid pressure (pcf)**	**K_p(1)**
On-site silty SAND Residual Soils	125	33	0.40	37	0.29	58	0.46	425(1)	3.4
Clean washed stone (No. 57)(2)	100	40	0.5	22	0.22	36	0.36	460 (1)	4.6

(1) The passive earth pressure coefficient should be divided by a safety factor of 2 to limit the amount of lateral deformation required to mobilize the passive resistance.
(2) In order for this coefficient to be used, the soil wedge within an angle of 45 degrees from the base of the wall to about 2 feet below the finished exterior grade should be excavated and replaced with compacted clean washed stone.

The compacted mass unit weight of the backfill soil presented in the previous table should be used with the earth pressure coefficients to calculate lateral earth pressures. Lateral pressure arising from surcharge loading should be added to the above soil earth pressures to determine the total lateral pressures which the walls must resist. In addition, transient loads imposed on the walls by construction equipment during backfilling should be taken into consideration during design and construction. Excessively heavy grading equipment should not be allowed within about 5 feet horizontally of the walls.

Surface water should be rerouted around the walls and not allowed to flow over or pond behind the walls. In addition, to reduce the potential for the infiltration of surface water in the backfill, the upper 24 inches of backfill should consist of relatively impervious soils (i.e., clayey or silty soils) as backfill. This soil should be compacted to a minimum of 95 percent of its standard Proctor maximum dry density within plus or minus three percentage points of the optimum moisture content in accordance with ASTM D 698.

We recommend that positive, unblocked gravity drainage be provided from behind the walls. A perforated, rigid conduit within free draining crushed stone backfill at the base of the wall can be used to help provide the drainage required. A layer of nonwoven geotextile filter fabric should wrap entirely around the crushed stone backfill. If drainage is not provided, the walls should be designed to accommodate hydrostatic pressures that could develop.

9.5. <u>Generalized Site Preparation Recommendations</u>

This section deals with site preparation including preparation of foundation and engineered fill areas. The means and methods of site preparation will greatly depend on the weather conditions before and during construction, the subsurface conditions that are exposed during earthwork operations, and the finalized details of the proposed development. Therefore, only generalized site preparation recommendations are given.

Clearing, Grubbing and Stripping

Surface vegetation, trees and bushes (including root-balls), topsoil with adverse organic content, and otherwise unsuitable bearing materials are recommended to be removed from the proposed building footprint, pavement area, and other structural areas. Clearing, grubbing and stripping should extend at least several feet beyond proposed development areas, where feasible.

When the test pits were excavated, the topsoil at the test pit locations was between about 4 and 6 inches thick, with an average thickness of about 6 inches. Those topsoil thicknesses could be used on a preliminary basis to estimate topsoil stripping quantities. However, since topsoil may be thinner or thicker away from the test borings, the actual stripping quantity may be more or less than estimated. It might be beneficial to stockpile stripped topsoil on the site for later use in landscape areas.

Subgrade Evaluation and Fill Placement

After the recommended clearing, grubbing, and stripping as needed, the sub-grade is recommended to be evaluated by visual observations and probing since site constraints will not allow for typical proof-rolling to help locate unstable soil. It is recommended that *Gentry* evaluate the sub-grade stability based on those observations.

Soil that shows signs of instability is recommended to be replaced with engineered fill. Unsuitable soil could also be mechanically stabilized with coarse aggregate and/or geosynthetics (geogrids, geotextiles, etc.). It is recommended that *Gentry* provide specific soil improvement recommendations based on the conditions during construction.

The site is recommended to be raised, where necessary, to the planned finished grade with engineered fill immediately after the sub-grade is confirmed to be stable and suitable to support the proposed site improvements. Engineered fill should have a maximum liquid limit of 50, maximum plasticity index of 25, a maximum fines content of 50 percent, a maximum organic content of 5 percent and be free of deleterious or otherwise unsuitable material. Engineered fill is recommended to be placed in uniform, relatively thin layers (lifts). It is recommended that engineered fill slopes be placed no steeper than 2H:1V and be properly benched into the existing residual soils. **Any fill slopes steeper than 2H:1V should be designed by a Professional Engineer and possibly reinforced with geogrid.** Each layer of engineered fill is recommended to be compacted to at least 95 percent of the fill material's maximum dry density within 3 percent of the optimum moisture content as determined by *The Standard Proctor Compaction test (ASTM D698)*.

Engineered fill that does not meet the density and water content requirements is recommended to be replaced or scarified to a sufficient depth (likely 6 to 12 inches, or more), moisture-conditioned, and compacted to the required density. A subsequent lift of fill should only be placed after *Gentry* confirms that the previous lift was properly placed and compacted. Sub-grade soil may need to be recompacted immediately before construction since equipment traffic and adverse weather may reduce soil stability.

Use of Site Soil as Engineered Fill

Site soil that does not contain adverse organic content, or other deleterious materials or fines content greater than 50 percent, could be used as engineered fill. If construction is during adverse weather (discussed in the following section), drying site soil will likely not be feasible.

In that case, aggregate fill (or other fill material with a low water-sensitivity) will likely need to be imported to the site.

Surface Water Management

Control of surface water from driveway areas and roof drainage is very important for this site. Surface water that erodes slopes could cause instability or undermine footings. All structures should incorporate gutters with downspouts that are connected to a pipe system that will convey water to storm drains or offsite. Routine maintenance should include inspecting, cleaning and repairing the gutters, downspouts and other stormwater handling systems as needed to ensure they remain operable. Inspections and cleanings should be performed at least annually.
If conveyance of surface water into municipal storm drains is not possible, the surface water should be directed well away from the structure and maintained in a distributed flow onto the natural slope. Surface water should not be directed below the ground surface.

9.6. Generalized Construction Considerations

Adverse Weather

Site soil is moisture sensitive and will become unstable when exposed to adverse weather such as rain, snow, and freezing temperatures. Therefore, it might be necessary to remove or stabilize the upper 6 to 12 inches (or more) of soil due to adverse weather, which commonly occurs during late fall, winter, and early spring. At least some over-excavation and/or stabilization of unstable soil should be expected if construction is during or after adverse weather. Based on the test pits, extensive over-excavation is not expected to be needed if construction is during and after favorable, dry weather. Because site preparation is weather dependant, bids for site preparation, and other earthwork activities, are recommended to be based on the time of year that construction will be conducted.

In an effort to protect soil from adverse weather, the site surface is recommended to be smoothly graded and contoured during construction to divert surface water away from construction areas. Foundation construction should begin immediately after suitable support is confirmed.

Difficult Excavation

During the subsurface exploration, PWR or hard rock was encountered at depths ranging from 3 to 8 feet. Mini-excavator refusal occurred on PWR in TP-2 at 8 feet and mini-excavator refusal occurred on hard rock in TP-1 at 7 feet, in TP-3 at 3 feet and in TP-4 at 4 feet. Although refusal occurred with the mini-excavator, we believe that conventional construction equipment such as trackhoes will be capable of excavating to the depths required for the typical shallow foundations anticipated for this project.

Heavy, tracked excavating equipment with single tooth ripping tools will likely be required to remove hard rock or in confined trenches such as utilities. The ease of excavation of PWR or hard rock cannot be specifically quantified and depends on the quality of grading equipment, skill of the equipment operators and geologic structure of the material itself, such as the direction of bedding, planes of weakness and spacing between discontinuities.

Dewatering

Groundwater was not encountered during or at completion of the test pits. Some dewatering might be needed during construction due to precipitation or if perched water is encountered. Water that accumulates in construction areas is recommended to be removed from excavations and other construction areas, along with unstable soil as soon as possible. Filtered sump pumps, drawing water from sump pits excavated in the bottom of construction trenches, will likely be adequate to remove water that collects in shallow excavations. Excavated sump pits should be fully-lined with a geotextile and filled with open-graded, free-draining aggregate.

Cut and Fill Slopes

Confined excavations are recommended to be made in accordance with current OSHA excavation and trench safety standards, and other applicable requirements. Sides of excavations might need to be sloped or braced to maintain or develop a safe work environment. Temporary shoring must be designed according to applicable regulatory requirements. Contractors are responsible for excavation safety.

For slopes which are not confined, our test pits, tests on similar soils and our experience, the following ratios (horizontal: vertical) shown in Table 3 are recommended for slopes without surcharge at the top.

TABLE 3 – RECOMMENDATIONS FOR CUT AND FILL SLOPE RATIOS		
Type of Material	**Temporary Slopes**	**Permanent Slopes**
Structural Fill	1:1 (Cut)	2:1
Residual Soil-Cut	1:1	1.5:1
Partially Weathered Rock-Cut	0.5:1	1:1
Unweathered Rock-Cut	0.25:1 to vertical	0.25:1 to vertical

The outer edge of structural fill should extend at least 5 ft beyond paved areas before sloping. Fill slopes should initially be constructed beyond the design slope edge due to the difficulty of compacting the edge of slopes. The fill could then be cut back leaving the exposed face well compacted. Fill slopes should be adequately compacted in accordance with the recommendations of this report. Cut and fill slope surfaces should be protected from erosion by grassing or other means. Permanent slopes of 3:1 or flatter would be desirable for mowing.

9.7. Recommended Construction Materials Testing Services

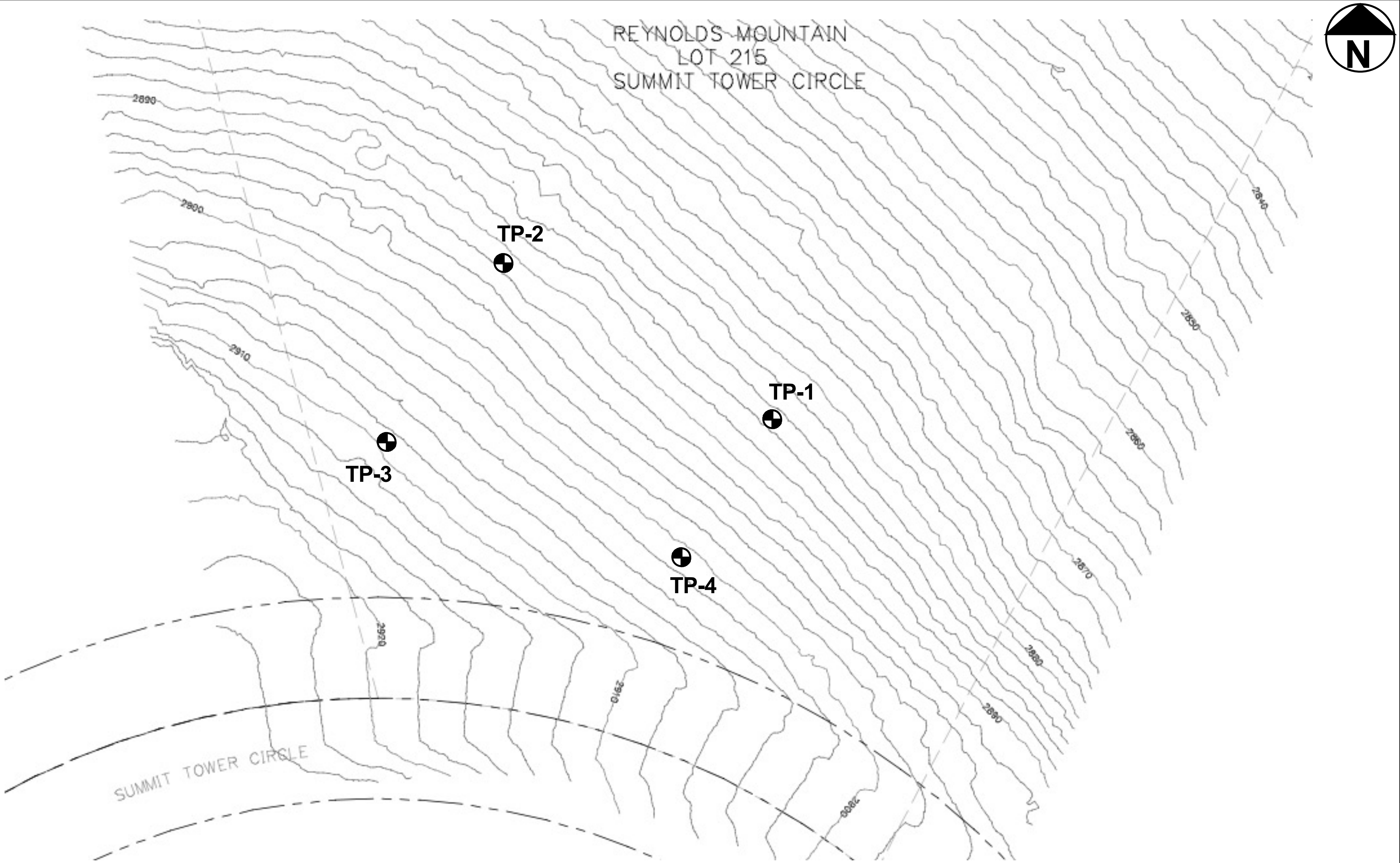
This report was prepared assuming that *Gentry* will perform Construction Materials Testing ("CMT") services during construction of the proposed development. In general, CMT services are recommended to at least include observation and testing of: foundation, retaining walls, grading, compaction; concrete and other construction materials. It might be necessary for *Gentry* to provide supplemental geotechnical recommendations based on the results of CMT services and provided specific details of the project.

9.8. Basis of Report

This report is based on our short form agreement (*Gentry Proposal No. 21P-060*) dated March 3, 2021 and authorized by your signature on March 3, 2021. The actual services for the project varied somewhat from those described in the proposal because of the conditions that were encountered while performing the services and in consideration of the proposed project.

This report is strictly based on the project description given earlier in this report. *Gentry* must be notified if any part of the project description is not accurate so that this report can be amended, if needed. This report is based on the assumption that the structure will be designed and constructed according to the building code that governs construction at the site.

The conclusions and recommendations in this report are based on supposed subsurface conditions as shown on the *Records of Subsurface Exploration*. *Gentry* must be notified if the subsurface conditions that are encountered during construction of the proposed development differ from those shown on the *Records of Subsurface Exploration* because this report will likely need to be revised.



Note 1: Site plan approximated by stakes at the site

Note 2: Not to scale

Test Pit Location Plan **Proposed Holzer Residence** **124 Summit Tower Circle** **Asheville, North Carolina**	GENTRY GEOTECHNICAL ENGINEERING, PLLC.		
	Approximate Test Pit Locations	Date: March 10, 2021	Project No.: 21G-0084-01

GENTRY GEOTECHNICAL ENGINEERING, PLLC

Record of Subsurface Exploration

Test Pit: TP-1

Project Name: Holzer Residence | Elevation: 2,885 ft | March 10, 2021

124 Summit Tower Circle, Reynolds Mountain Lot 215, Asheville, NC

Location: East Corner of Residence - See Test Pit Location Plan | Project No. 21G-0084-01

Technician: KB. Equipment: Excavator: Bobcat E42 Mini Excavator and DCP. Weather: 58F, partly cloudy

Description	Depth feet	Sample type	DCP	Remarks
4 inches of silty sand topsoil and rootmat				DCP = Dynamic Cone Penetrometer
Firm, brown-tan, moist, micaceous, silty, SAND (Residual) with PWR fragments		Grab	25/1.25"	
		Grab		
		Grab	25/.5"	
	5	Grab		
		Grab	25/.25"	
		Grab		
Test pit terminated at 7 feet due to refusal on rock. No groundwater encountered.				
	10			
	15			
	20			
	25			

GENTRY GEOTECHNICAL ENGINEERING, PLLC

Record of Subsurface Exploration

Test Pit: TP-2

Project Name: Holzer Residence

Elevation: 2,892 ft

March 10, 2021

124 Summit Tower Circle, Reynolds Mountain Lot 215, Asheville, NC

Location: Northwest Corner of Residence - See Test Pit Location Plan

Project No. 21G-0084-01

Technician: KB. Equipment: Excavator: Bobcat E42 Mini Excavator and DCP. Weather: 58F, partly cloudy

Description	Depth feet	Sample type	DCP	Remarks
6 inches of silty sand topsoil and rootmat				DCP = Dynamic Cone Penetrometer
Firm, brown-tan, moist, micaceous, silty, SAND (Residual) with PWR fragments		Grab	25/1.5"	
		Grab		
		Grab	15	
	5	Grab		
		Grab	25/.5"	
		Grab		
		Grab	25/.25"	
Test pit terminated at 8 feet due to refusal on partially weathered rock.				
No groundwater encountered	10			
	15			
	20			
	25			

GENTRY GEOTECHNICAL ENGINEERING, PLLC
Record of Subsurface Exploration

Test Pit: TP-3

Project Name: Holzer Residence — Elevation: 2,909 ft — March 10, 2021

124 Summit Tower Circle, Reynolds Mountain Lot 215, Asheville, NC

Location: West Corner of Residence - See Test Pit Location Plan — Project No. 21G-0084-01

Technician: KB. Equipment: Excavator: Bobcat E42 Mini Excavator and DCP. Weather: 58F, partly cloudy

Description	Depth feet	Sample type	DCP	Remarks
6 inches of silty sand topsoil and rootmat				DCP = Dynamic Cone Penetrometer
Firm, brown-tan, moist, micaceous, silty, SAND (Residual) with PWR fragments		Grab	25/.25"	
		Grab		
Test pit terminated at 3 feet due to refusal on rock.				
No groundwater encountered	5			
	10			
	15			
	20			
	25			

GENTRY GEOTECHNICAL ENGINEERING, PLLC
Record of Subsurface Exploration

Test Pit: TP-4

Project Name: Holzer Residence — Elevation: 2,901 ft — March 10, 2021

124 Summit Tower Circle, Reynolds Mountain Lot 215, Asheville, NC

Location: Southeast Corner of Residence - See Test Pit Location Plan — Project No. 21G-0084-01

Technician: KB. Equipment: Excavator: Bobcat E42 Mini Excavator and DCP. Weather: 58F, partly cloudy

Description	Depth feet	Sample type	DCP	Remarks
6 inches of silty sand topsoil and rootmat				DCP = Dynamic Cone Penetrometer
Firm, brown-tan, moist, micaceous, silty, SAND (Residual) with PWR fragments			25/1.5"	
			25/.5"	
Test pit terminated at 4 feet due to refusal on rock.	5			
No groundwater encountered				
	10			
	15			
	20			
	25			

Drilling and Sampling Abbreviations:

Sample/Drilling:
SS-Split Spoon Sampler
ST-Shelby Tube Sampler
RC-Rock Core: NX, BX, AX
HSA-Hollow Stem Auger

In-Situ Tests:
SPT-Standard Penetration Test
PMT-Pressuremeter Test
VS-Vane Shear
DCP-Dynamic Cone Penetrometer
Q_p-Estimated Unconfined Compressive Strength using Pocket Penetrometer
Q_u-Estimated Unconfined Compressive Strength using strain-controlled axial load device.

Correlation of Penetration Resistances to Soil Properties:

Relative Density -Sands, Silts
More than 50% retained onto the No. 200 sieve

SPT-N Value	Relative Density
0-4	Very Loose
5-10	Loose
11-20	Firm
21-30	Very Firm
31-50	Dense
over 50	Very Dense

Consistency Cohesive Soils
More than 50% passing the No. 200 seive

Unconfined Compressive Strength Q_p tsf	SPT-N Value	Consistency
under 0.25	0-2	Very Soft
0.25-0.50	3-4	Soft
0.50-1.00	5-8	Firm
1.00-2.00	9-15	Stiff
2.00-4.00	16-30	Very Stiff
4.00-8.00	31-50	Hard
over 8.00	over 50	Very Hard

Gradation Description and Terminology:

Major Component of Sample	Size Range	Description of Minor Components	Percent of Dry Weight
Boulders	Over 12 inches	Trace	1-9
Cobbles	12 inches to 3 inches	Little	10-19
Gravel	3 inches to No. 4 sieve	Some	20-34
Coarse	*3 inches to 3/4 inches*	And	35-50
Fine	*3/4 inches to No. 4 sieve*		
Sand	No. 4 sieve to No. 200 sieve		
Coarse	*No. 4 sieve to No. 10 sieve*		
Medium	*No. 10 seive to No. 40 sieve*		
Fine	*No. 40 seive to No. 200 sieve*		
Silt/Clay	Passing No. 200 seive		

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REFERENCE NOTES FOR BORING LOGS