LUMOS & ASSOCIATES

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ASCENTÉ

Geotechnical Review
November 7, 2017

Geotechnical Issues:

1. **Faulting:** Two faults were verified during our field investigation. Refer to Plates 2.1, 2.3 and Appendix I. 50 foot offsets are recommended for both of these faults (Fault Trench 1 and 5 and RS Line 5).
2. **Rippability:** One location indicated the site rock would not be rippable with a Cat D10 Dozer. Refer to Plate 2.2 and Appendix K (RS Line 3). Trenching will also be affected.
3. **Clays:** Clays were encountered in one exploration location (TP-9 from 2'-5'). Refer to Appendix A. Typical three (3) foot and one (1) foot over-excavations are recommended for foundations and roadway subgrades, if encountered.
4. **Low "R" Values:** Pavement design was based on "R"-value of 18. With a result 3" of AC on 8" of Aggregate Base. The minimum required for local roads is 3" of AC over 6" of Aggregate Base. This assumes an R-value of 30. Refer to Appendix G for Calculation.
5. **Rock Quality:** One core sample was tested for Abrasion (42% Loss) and specific gravity/absorption (2.236/5.5%). These results do not meet requirements for Rip Rap or Class C drain rock. Refer to Plate F-3.
6. **Fill Depths:** Fills of up to 25 to 30 feet are anticipated. To mitigate the potential settlement associated with fills of this height, we recommend an elevated compaction (97%), a relatively low bearing capacity (1,500 psf), and "Benching"/"Keying" of fills. Additionally, relatively tight specifications for particle size (12" max for common fill and 8" max for structural fill), and lift thicknesses are recommended 18" max for common fill and 12" max for structural fill. Refer to the General Site Grading Section of the report.

GEOTECHNICAL INVESTIGATION REPORT

for

ASCENTÉ

Washoe County, Nevada

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GEOTECHNICAL INVESTIGATION REPORT

ASCENTÉ
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INTRODUCTION

This report presents the results of Lumos & Associates, Inc.'s Geotechnical Investigation for the proposed construction of the Ascenté Subdivision in Washoe County, Nevada. A vicinity map is included as Plate 1 and a site plan is included as Plate 2.

It is our understanding that the project will consist of new single family residences with a one or two story wood framed structure supported by conventional spread footings, associated curb and gutter/sidewalks, residential roadways, retaining walls, and landscaped areas. Structural loads for the buildings are assumed to be two (2) to three (3) kips per lineal foot and 15 to 20 kips for isolated column loads. It is our understanding that the site will be constructed within 30 feet of existing elevations. Therefore, cut and fill depths were assumed to be approximately the same.

The purpose of our investigation was to characterize the site geology and soil conditions, describe the native soils and determine their engineering properties as they relate to the proposed construction. The investigation was also intended to identify possible adverse geologic, soil, and/or water table conditions. However, this study did not include an environmental assessment or an evaluation for soil and/or groundwater contamination at the site.

This report concludes with recommendations for site grading, foundations, footing area preparation, slope stability, utility installation, asphalt concrete, and Portland cement concrete. In addition, information such as logs of all exploratory test pits, borings/corings, fault trenches, refraction seismic investigation, laboratory test data, allowable soil bearing capacities, estimated total and differential settlements based on static loads, lateral earth pressures, and International Building Code (IBC) seismic site class designation are provided in this report.

The recommendations contained herein have been prepared based on our understanding of the proposed construction, as outlined above. Re-evaluation of the recommendations presented in this report should be conducted after the final site grading and construction plans are completed, if there are any variations from the assumptions described herein.

It is possible that subsurface discontinuities may exist between and beyond exploration points. Such discontinuities are beyond the evaluation of the Engineer at this time. No guarantee of the consistency of site geology and sub-surface conditions is implied or intended.

GEOLOGIC SETTING

The proposed project is located in the southern foothills of the Truckee Meadows, a broad basin bounded on the west by the tall granite peaks of the Sierra Nevada Mountains, and on the east by the lower volcanic peaks of the Virginia Range. Younger volcanic rocks confine the valley on the north and south. Faults separate the valley from the surrounding mountains, which is typical of the Basin and Range geomorphic province. Sediments have filled the valley from a number of tributaries and ancestral lakes during the Quaternary period (2 million years to the present). The dominant sediment source has been, and continues to be, the Truckee River and its ancestral counterparts. Stream deposits were particularly voluminous during the past 2 million years after glacial periods. Since the end of the last glacial periods, some 10,000 years ago, arid erosional forces combined with faulting have been the predominant processes to shape the region. These processes have created large alluvial fans that surround the Truckee Meadows basin.

The surface geology of the project area has been mapped by Tabor and Ellen, (1975). The mapping indicates that multiple deposits underlie the site:

1. Qfb - alluvial fans that are pebbly to bouldery sand in steep-sided fans.
2. Qgo2 - partly sorted sand, silt, and boulders deposited by glacial outwash streams with granitic boulders partly to thoroughly rotten where buried.
3. Qsh/Qsg - Steamboat Hills Rhyolite and associated deposits that are white, glassy to strongly devitrified biotite rhyolite in pumiceous dome and overlying rubble (Qsh) or coarse-grained angular granule conglomerate of rhyolite pumice and metamorphic rock (Qsg).
4. Tkf - Kate Peak Formation that is hornblende-pyroxene andesite flows with minor breccia.

SEISMIC CONSIDERATIONS

Washoe County, similar to many areas in Nevada, is located near active faults that are capable of producing significant earthquakes. This area can be described as an area that may experience major damage due to earthquakes having intensities of VII or more when evaluated using the Modified Mercalli Intensity Scale of 1931 (Plate 3).

The Washoe County area is located within the Sierra Nevada-Great Basin seismic belt and several major earthquakes with magnitudes greater than 6.0 (Plate 4) have occurred historically within several miles of the site.

According to the Washoe City Folio Geologic Map by Tabor and Ellen, (1975) (Plate 5), there are mapped faults surrounding the property. There are potentially active faults mapped just west of the site. However, according to this map, no active faults are shown to cross this site. Fred Saunders, consulting geologist, was employed by Lumos to perform a field geological survey of the site, specifically as it was related to faulting. Mr. Saunders mapped potential faults within the site, and are noted in Appendix I. The potential faults within the site were then investigated. Lumos utilized an excavator and cut approximate 60-100 foot long trenches perpendicular to and bisecting the potential faults mapped by Mr. Saunders. Fault trench 1 did not intersect the fault. The trench extended east to well outside of the area to be developed on the site. Evidence of a potential fault was observed in the far eastern end of the trench. Therefore, a fifty foot offset is recommended from this mapped fault. Fault trenches 2, 3, and 4 were designed to intercept the mapped fault along the western edge of the property. Our observations indicate that this mapped fault does not enter the Ascenté Site. A Refraction Seismic Line (RS Line 4) was also performed in this area by Gasch Geophysical Services, Inc. These results indicate a "possible fault zone". However, according to Fred Saunders, his interpretation of the data does not indicate that this is a possible fault zone. His review of this data is also included in Appendix I. Fault trench 5, based on information provided by Mr. Saunders, intersected a fault. Structures should not be built within 50 feet either side of this fault. A Refraction Seismic line (RS Line 5) performed in this area affirms this finding.

Liquefaction is the phenomena where loose saturated granular soils lose their shear strength when subjected to cyclic loading, and become unstable. Large earthquakes as described above may provide that type of cyclic loading. Loose sands and silty sands under saturated conditions are the most susceptible to this phenomenon. These soils conditions and characteristics were not encountered during our field investigation. Therefore, the potential for liquefaction on site is considered very low.

2012/15 IBC Design: The mapped maximum considered earthquake spectral response acceleration at short periods (S_S) is 2.322g corresponding to a 0.2 second spectral response acceleration at five percent (5%) of critical damping and for a Site Class B (IBC 1613.3.1(1)). The mapped maximum considered earthquake spectral response acceleration at a 1-second period (S_1) is 0.813g corresponding to a 1.0 second spectral response acceleration at five percent (5%) of critical damping and for a Site Class B (IBC 1613.3.1 (2)). According to section 1613.3.2, when the soil properties are not known in sufficient detail to a depth of 100 feet, site Class D shall be assumed. Therefore, the spectral response accelerations must be adjusted for Site Class effects. The site coefficient for spectral response accelerations adjustment at short periods (F_a) is 1.0 (IBC Table 1613.3.3(1)). The site class effect for spectral response accelerations adjustment at 1-second periods (F_V) is 1.5 (IBC Table 1613.3.3(2)). The maximum considered earthquake spectral response acceleration parameter for short periods (S_{MS}) is 2.322g and for 1-second periods (S_{M1}) is 1.219g. This corresponds to design spectral response acceleration parameters of 1.548g for short periods (S_{DS}) and of 0.813g for 1-second periods (S_{D1}).

It is emphasized that the above values are the minimum requirements intended to maintain public safety during strong ground shaking. These minimum requirements are meant to safeguard against loss of life and major structural failures. However, they are not intended to prevent damage or insure the functionality of the structure during and/or after a large seismic event.

In conclusion, seismic concerns for this site are not unlike other sites in the Reno area. Due to the proximity of the site to a number of faults that are considered active, as noted above, strong seismic shaking should be anticipated during the life of the proposed structure.

SITE CONDITIONS AND FIELD EXPLORATION

At the time of our investigation the site is undeveloped with the exception of a minimally maintained access road to an existing water tank. Additionally, there are numerous dirt roads throughout the site. The site was vegetated with large sagebrush and grasses. The site generally sloped downwards from east to west and north to south.

The current field investigation included a site reconnaissance and subsurface exploration. During the site reconnaissance, surface conditions were noted and the locations of exploratory borings, test pits, fault trenches, core holes, Refraction Seismic lines, and infiltration tests were determined using survey techniques.

Eight (8) exploratory borings were drilled utilizing hollow-stem auger or flight auger drilling methods throughout the site to a maximum depth of forty-one and one-half (41.5) feet below-existing-grade (b.e.g.), five (5) exploratory borings were drilled utilizing a combination of hollow-stem auger and core hole drilling methods to a maximum depth of forty (40) feet b.e.g., twenty (20) exploratory test pits were excavated to a maximum depth of thirteen (13) feet b.e.g., five (5) fault trenches were excavated on the site to maximum depth of eight (8) feet b.e.g., seven (7) Refraction Seismic lines were completed, and three (3) infiltration tests were also performed on the site. The locations of the exploratory borings, test pits, fault trenches, core holes, Refraction Seismic lines, and infiltration tests within the site are shown on Plates 2.1 through 2.3. The subsurface soils were continuously logged and visually classified in the field by our Geotechnician in accordance with the Unified Soil Classification System (USCS). Representative soil/bedrock samples were collected at each soil strata change in the test pits and fault trenches, at five (5) foot intervals within the exploratory borings, and at five (5) foot intervals (or where the core barrel jammed) within the core holes. The samples were subsequently transported to our Carson City and Reno geotechnical laboratories for testing and additional analysis.

The subsurface soils encountered consisted generally of silty and clayey sands and gravels to the depth explored. A fat clay was encountered in test pit 9 from two (2) feet to five (5) feet. Groundwater was not encountered at the time of our investigation. However, seasonal fluctuations in the groundwater table should be anticipated.

Additionally, three areas have been mapped as containing a "saturated water regime". These areas are mapped and labeled PEMB in Attachment/Figure 5 of 9 from the report prepared by geosUAS Inc. Refer to Appendix L.

FIELD AND LABORATORY TEST DATA

Laboratory tests performed on representative samples included sieve analysis (including fines), Atterberg limits, expansion index, proctor, direct shear, R-value, soluble sulfate, pH, and resistivity. Additionally, an abrasion test and a specific gravity/absorption test was performed on a core sample. Much of this data is displayed on the "logs" to facilitate correlation. Field descriptions presented on the logs have been modified, where appropriate, to reflect laboratory test results. The logs of the fault trenches are included in Appendix A Sierra Village as Plates A-1 through A-3 and Appendix A Donner Village as Plates A-4 and A-5. A key to the fault trench logs is included as Plate A-6. The logs of the test pits are included in Appendix B Sierra as Plates B-10 through B-14, B-19, B-20, Appendix B Tioga Village as Plates B-8, B-9, B-17, and B-18, and Appendix A Donner Village as Plates B-1 through B-7, B-15, and B-16. A key to the test pit logs is included as Plate B-21. The logs of the borings/corings are included in Appendix C Sierra Village as Plates C-1 and C-2, Appendix C Tioga Village as Plates C-6 through C-13, and Appendix C Donner Village as Plates C-3 through C-5. A key to the boring/coring logs is included as Plate C-14. Additionally, three (3) infiltration tests were performed on site and the results can be seen in Appendix J of this report. All the field investigation locations are shown on Plates 2.1 through 2.3.

Individual laboratory test results for the fault trench samples are presented in Appendix D as Plates D-1 through D-3, test results for the test pit samples are presented in Appendix E as Plates E-1 through E-6, and test results for the boring/coring samples are presented in Appendix F as Plates F-1 through F-3. Laboratory testing was performed per ASTM standards, except when test procedures are briefly described and no ASTM standard is specifically referenced in the report. Atterberg limits were determined using the dry method of preparation.

Analytical Testing: Silver State Analytical Laboratories, Reno, Nevada, conducted this testing. The testing included soluble sulfates. Test results are included (on Silver State letterhead) in Plates E-6. The results indicate no special type of cement is necessary for concrete in direct contact with site soils, however, Type II cement should be utilized. The results also indicate the site soils are corrosive toward metal, therefore, corrosion protective measures should be implemented.

The results of the Refraction Seismic Investigation are included in Appendix K of this report. The results indicate, at the locations investigated, that the site rock materials will be "rippable" based on the Cat D10R Rippability Performance Chart, with the following exception: At the southwest end of RS Line 3. This area is proposed for a cut of 20-25 feet below ground surface. Based on the data, the material is "rippable" to a depth of approximately 10-15 feet below the existing ground surface at this location.

The abrasion and specific gravity/absorption test results indicate the site bedrock does not meet the SSPWC requirements for Class C backfill or Rip Rap.

The soil/bedrock samples obtained during this investigation will be held in our laboratory for 30 days from the date of this report. The samples may be retained longer at an additional cost to the client or obtained from this office upon request.

DISCUSSION AND RECOMMENDATIONS

General

From a Geotechnical viewpoint, the site is considered suitable for the proposed improvements when prepared as recommended, here in. The following recommendations are based upon the construction and our understanding and assumptions of the proposed improvements, as outlined in the introduction of this report, and based on our findings during the field exploration phase of this project. If changes in the construction project are proposed, they should be presented to Lumos & Associates, Inc. Geotechnical Department, so that the recommendations provided herein can be reviewed and modified as necessary. As a minimum, final construction drawings should be submitted to the Lumos Geotechnical Department for review prior to actual construction and verification that our recommendations have been implemented.

General Site Grading

All soils with organics, clays, and any loose or otherwise disturbed or unstable native soils within the proposed improvement areas should be removed. Organic material encountered during excavations, should be stockpiled in a designated area on site or "screened" for later use on slopes for landscaping. Clays, if encountered, may be incorporated into deeper fill sections.

All unsuitable materials such as vegetation, etc, currently on-site should be removed before grading begins. Clearing and grubbing is expected to require six (6) inches to one (1) foot of removal. The onsite clays (CH soils) are unsuitable to provide direct structural support due to their volume change potential and low R-value. The clays may be used as common fill. Common fill is defined as fill outside of structural fill zones. Structural fill zones are located within one (1) foot of pavement and/or hardscape improvements subgrade and within three (3) feet of foundations. Clays were encountered in test pit 9. However, clay could be encountered elsewhere within the site.

Due to the volume change potential and/or relative weak nature of the on-site clays (CH), if encountered, we recommend a minimum of one (1) foot of separation between exterior concrete improvements and asphalt pavement sections and the clays. Removals shall extend horizontally beyond the edge of exterior concrete improvements and asphalt pavement section a minimum of one (1) foot. We recommend potholing be done during construction to insure these minimum separation requirements are met. Additionally, we recommend three (3) feet of separation between building foundations and the clays. Removals shall extend a minimum of three (3) feet outside of the foundation envelope.

Exposed excavation surfaces to support any of the proposed improvements should be observed and approved by a Lumos representative. Upon re-compaction and prior to placing any base, the re-compacted surface should be proof-rolled to identify any possible yielding surfaces. Proof-rolling should be conducted with a heavy rubber-tire loader with a fully loaded bucket, or a fully loaded water truck, and observed and approved by a Lumos representative.

Unstable conditions due to yielding and/or pumping soils may be encountered on site. However, the exposed soils may yield or pump under heavy equipment loads or where vibratory equipment draws up water. If yielding or pumping conditions are encountered, the soils should be scarified in place, allowed to dry as necessary and re-compacted, where applicable. Alternatively, the unsuitable or saturated soil should be removed, the exposed surface leveled and compacted/tamped as much as practical without causing further pumping, and covered (including the sides) with geotextile stabilizing fabric (Mirafi HP370 or other equivalent). The fabric should then be covered with at least 12 inches of 4 to 8 inch **angular rock fill** with enough fines to fill the inter-rock pore spaces. Placement should be by end dumping. No traffic or other action should be allowed over the fabric, which may cause it to deflect/deform prior to cobble placement. Test sections should be used to determine the minimum thickness and/or number of layers required for stabilization.

Stabilization should be evaluated by proof-rolling standards commensurate with the equipment used, and approved by a Lumos representative. The placement of the stabilizing rock-fill may require additional over-excavation to maintain appropriate grading elevations. A filter fabric (Mirafi 180N or equal) should also be placed over the cobble rock fill to prevent piping of fines from covering soils into the stabilizing rock matrix.

All fill soils shall not contain more than two percent (2%) of organics nor contain any roots larger than one (1) inch in diameter.

Common fill shall be defined as fill not within one (1) foot of finished subgrade elevation for pavements and/or hardscape improvements and not within three (3) feet of bottom of footing elevation. Common fill may consist of site clays and gravels, provided 12 inch and larger particles are removed. The common fill shall be placed in 18 inch maximum loose lifts, moisture conditioned to at within two percent (2%) of optimum moisture content and compacted to at least ninety-seven percent (97%) of the ASTM D1557 standard. Structural fill shall be defined as fill soils within one (1) foot of finished subgrade elevation for pavements and/or hardscape improvements and within three (3) feet of bottom of footing elevation. Properly compacted **structural fill** soils to be used on site should consist of non-expansive materials (LL less than 38 and/or a PI less than 13 and/or Expansion Index less than 20), should be free of contaminants, or natural rock larger than eight (8) inches in largest dimension. All structural fill soils shall also be non-corrosive and have a water soluble sulfate content of less than 0.1% and a minimum "R"-Value of 30. Structural fill soils shall also meet the following gradation requirements (Table 1):

TABLE 1
STRUCTURAL FILL GRADATION

Sieve Size	% Passing
8"	100
¾"	70-100
#40	15-60
#200	10-30

Structural fill soils that do not meet the above requirements may be approved at the discretion of the Geotechnical Engineer. It is anticipated site sands and gravels will be suitable for reuse as structural fill, provided oversize (+8") particles are removed.

Import structural fill soils if needed for this project and should be tested and approved prior to being placed or delivered on-site (**seven day advanced notice**).

Prior to placement of common and/or structural fill, the site subgrade shall be scarified to a depth of 12 inches, moisture conditioned to within two percent (2%) of optimum moisture content and recompacted to a minimum of ninety-seven percent (97%) relative compaction as determined by the ASTM D1557 Standard.

Structural fill should be placed only on compacted sub-grade or on compacted fill in loose lifts not exceeding 12 inches, moisture conditioned to within two percent (2%) of optimum moisture, and compacted to at least ninety-seven percent (97%) relative compaction as determined by the ASTM D1557 Standard. Differential fill across any individual house pad shall not exceed five (5) feet.

We are anticipating that many on-site materials encountered during mass grading (including after screening the oversized material) will have greater than 30%, by weight, particles larger than ¾". Therefore, these materials will be considered rock fill. Rock fill placement shall be continuously observed by Lumos Geotechnical personnel. Rock fill shall be placed in a manner that there is no occurrence of nesting of the larger particle size material. Lift thickness, moisture conditioning and proof rolling shall be completed to the satisfaction of the Geotechnical Engineer. Rock fill shall not be placed within three (3) feet laterally from and below bottom of footings, nor one (1) foot laterally from and below bottom of concrete improvements and asphalt paving.

Due to oversize materials, soils classifications, and low RQD of bedrock encountered, we estimate a shrinkage factor of 13% to 17% may be encountered during mass grading of the site materials.

Due to the relatively steep terrain of the site, Lumos is recommending that all fill placed be "benched" and "keyed" into existing slopes steeper than 5:1 (H:V). This will require the contractor to cut into the native ground or "bench" the fill a horizontal distance of at least one equipment width for every lift of fill placed. The benches shall be negatively graded into the slope a minimum of five percent (5%). Refer to Appendix M.

Additionally, the fill area adjacent to the toe of an existing slope shall be "keyed" in. This key will be a minimum of eight (8) feet wide and two (2) feet deep. Construction of the keys, benches, and fills should be continuously observed by Lumos Geotechnical personnel.

Fill material should not be placed, spread or compacted while the ground is frozen or during unfavorable weather conditions. When site grading is interrupted by heavy rain or snow, grading or filling operations should not resume until a Lumos representative approves the moisture content and density conditions of the subgrade or previously placed fill.

Landscape areas should be cleared of all objectionable material. In cut areas, no other work is necessary except grading to proper elevation. In landscape areas, fill should be placed in loose lifts not exceeding eight inches, moisture conditioned to within two percent (2%) of optimum moisture content and compacted to at least ninety-seven percent (97%) relative compaction (ASTM D1557) to prevent erosion.

Water should not be allowed to pond on pavements or adjacent to structures, and measures should be taken to reduce surface water infiltration into the subgrade soils. A representative of Lumos should be present during site grading operations to ensure any unforeseen or concealed conditions within the site are identified and properly mitigated, and to test and observe earthwork construction. This testing and observation is an integral part of our service as acceptance of earthwork construction and is dependent upon compaction and stability of the subgrade soils. The soils engineer may reject any material that does not meet engineering characteristics, compaction, and stability requirements. Further, recommendations of this report are based upon the assumption that earthwork construction will conform to recommendations set forth in this section of the report.

FOUNDATION DESIGN CRITERIA

Conventional spread footings founded on suitable subgrade and/or a minimum of 36 inches of structural fill (moisture conditioned and compacted as previously discussed in this report) may be used to support the proposed structures within the project site.

Spread footings: Footings should have a minimum embedment of 24 inches below lowest adjacent grade for frost protection. Footings founded on suitable subgrade and/or structural fill may be designed for a net allowable bearing pressure of 1,500 pounds-per-square-foot (psf).

If fill is placed to bring building pads to grade, no footings should be founded within a distance of at least one third of the total height of fill (H/3) placed from the face of the slope or equal to the depth of compacted fill below the bottom of footing, whichever is greater. Refer to Appendix N. In drainage areas, no footings should be located or founded above a 1:1 (horizontal:vertical) plane drawn up from the toe of slopes, outside edge of drainage conduits or drainage ditches, to avoid loss of bearing strength of supporting soils. No drainage or water diverting conduits other than associated utilities should be allowed underneath building footprints.

Footing Settlements: The maximum anticipated settlements, caused by static loading, for continuous or isolated spread footings, bearing on suitable subgrade and/or structural fill, and designed for a 1,500 psf bearing pressure is estimated at one (1) inch or less. Differential settlements are generally expected to be half of the total settlements. Settlements in granular soils are primarily expected to occur shortly after dead and sustained live loads are applied. Settlements in fine grained soils will occur over a much longer period of time.

Lateral Loading: Resistance to lateral loads can be provided by friction acting at the base of foundations and by lateral earth resistance. A coefficient of friction of 0.40 may be assumed at the base of spread footings supported by suitable subgrade and/or structural fill. An allowable passive earth resistance of 250 psf per foot of depth starting six (6) inches below lowest adjacent grade may be used for the sides of spread footings poured against suitable subgrade and/or structural fill. Passive resistance should not exceed 1,500 psf. The at-rest lateral earth pressure can be calculated utilizing an equivalent fluid pressure of 65 pounds-per-cubic-foot (pcf).

Dynamic Factors: Vertical and lateral bearing values indicated above are for total dead-load and frequently applied live loads. If normal code requirements are applied for design, the above vertical bearing values may be increased by thirty-three percent (33%) for short duration loading due to wind or seismic forces. The additional Dynamic Lateral earth pressure can be calculated utilizing the following equation.

Dynamic Lateral Force = $30H^2$

H = height of wall

This force should be assumed to act at a height of 0.6H above the bottom of the wall.

RETAINING WALLS

Retaining structures over three (3) feet in height, if used, will require local code compliance and shall be engineered based on parameters described in this section of the report. Retaining structures should be designed to resist the appropriate lateral earth pressures. Cantilevered walls, which are able to deflect at least 0.01 radians, can be designed using an equivalent fluid (backfill) unit weight of 45 pounds-per-cubic-foot (pcf). However, if the wall is fixed against rotation, the wall should be designed using an equivalent fluid (backfill) unit weight of 65 pcf. These design parameters are based upon the assumption that walls retain only level backfill and no hydrostatic pressures will be present. Any other surcharge pressures should be added to the above recommended lateral earth pressures. Retaining walls should be backfilled with free draining granular material that extends vertically to the bottom of the stem and laterally at least six (6) inches beyond the face of the stem (wall) and wrapped with a Mirafi 140 N or equivalent non-woven filter fabric. Weep holes should be provided on the walls at regular intervals, or a slotted drainpipe placed at the bottom of the wall (bottom of granular material) to relieve any possible build-up of hydrostatic pressure. Backfill material within two (2) feet of the wall should be compacted with hand-held equipment. The backfill material shall be moisture conditioned to within two percent (2%) of optimum moisture content and compacted to at least ninety-two percent (92%) relative compaction per the ASTM D1557 standard.

CONCRETE SLAB DESIGN

Interior concrete slabs should be underlain with at least six (6) inches of Type 2, Class B Aggregate Base, compacted to a minimum of ninety-five percent (95%), and supported on suitable subgrade and/or structural fill. A vapor barrier should be provided for all interior concrete slabs where floor moisture is undesirable. The vapor barrier should be a synthetic plastic sheeting at least ten (10) mils thick and meets the requirements of ASTM E1745 for Class A vapor retarder materials. The vapor retarder shall be installed per the manufactures recommendations.

Slab thickness design should be based on a Modulus of Subgrade Reaction equal two hundred (200) pounds-per-cubic-inch (pci) for construction on suitable subgrade and/or structural fill. Reinforcement of concrete slabs should be as specified by the Project Structural Engineer.

Exterior concrete slabs on grade for vehicular traffic and driveways should be underlain with at least six (6) inches of Type 2, Class B aggregate base. All subgrade, common fill, and structural fill shall be prepared and placed as described in the "General Site Grading" section of this report, while the aggregate base material shall be compacted to at least ninety-five percent (95%) of the ASTM D1557 standard.

ASPHALT CONCRETE PAVEMENT DESIGN

Suitable subgrade and/or structural fill in areas to be paved shall be moisture conditioned to within two percent (2%) of optimum moisture, and compacted to at least ninety-seven percent (97%) of the ASTM D1557 standard. If native clayey (CH) (and/or low "R"-value) soils are encountered they shall be overexcavated to a depth of at least one (1) foot below finished subgrade elevation. The soils exposed by overexcavation shall be scarified to a depth of at least 12 inches, moisture conditioned to within two percent (2%) of optimum moisture, and compacted to at least ninety-seven percent (97%). One (1) foot of structural fill shall then be placed, moisture conditioned to with two percent (2%) of optimum moisture and compacted to at least ninety-seven percent (97%). An alternative to overexcavation and replacement may be to lime treat the clay soils and/or the low "R"-value soils. Clayey soils are known for low "R" values including clayey sands (SC) and clayey gravels (GC). Aggregate base should consist of Type 2, Class B material and meet the requirements of the Standard Specifications for Public Works Construction (SPPWC) and be compacted to a minimum of ninety-five percent (95%). The minimum pavement structural sections for this project were based on a TI = 5 (residential roadways), and are provided in Table 2.

TABLE 2
RECOMMENDED ASPHALT PAVEMENT SECTION

Pavement Design	Minimum Asphalt Pavement Thickness	Minimum Aggregate Base Thickness	Minimum Structural Fill Thickness (if CH and/or Low R-Value Soils Encountered)
T.I. = 5	**3"**	**8"**	**12"**

Calculations included in Appendix C.

In all areas of the project, asphalt concrete should be a 50 blow Marshall mix with PG64-28NV, and target 4% air voids. Type 2 asphalt aggregate per the "Orange Book" standards shall be utilized. Asphalt concrete, in any case, should be compacted to between ninety-two percent **(92%)** and ninety-seven percent **(97%)** of the Rice theoretical maximum density. A mix design shall be submitted to the Geotechnical Engineer for review and approval a minimum of **seven (7) days prior to paving**.

A chip seal is recommended, to increase surface friction on Ascenté Crest Trail, and other roads with a grade steeper than 8%. The chip seal shall meet the requirements of the SSPWC for a Type 2 chip seal. Additionally, the chip seal should be redone on a regular maintenance schedule, for example on an every five (5) year basis or sooner as needed.

CORROSION AND CHEMICAL ATTACK

On-site soils have a negligible water soluble sulfate content of less than 0.10% (<0.01% actual). No specific type of cement is required for concrete in direct contact with on-site soils, as required by the International Building Code. However, Type II cement (meeting ASTM C150) is recommended for concrete in direct contact with on-site soils.

All exterior concrete should have between 4.5 and 7.5 percent entrained air, a maximum water-cement ratio of 0.45, and comply with all other ACI recommendations for concrete placed in areas subject to freezing. A minimum compression strength of 4,000 psi is recommended for all external concrete. All interior concrete should also be placed pursuant to ACI recommendations.

Native soils have a pH ranging from 6.64 to 6.79 and a resistivity ranging from 3,150 to 8,410 ohm-cm under saturated conditions. This indicates a corrosive potential for ferrous metals in contact with these soils. Corrosion mitigation measures, such as protective coatings, wrappings, and cathodic protection are therefore recommended. If protective coatings are used, the type and quantity will depend on the kind of steel and specific construction application. Steel and wire concrete reinforcement cover of at least three (3) inches where cast against soil, unformed, is recommended.

SLOPE STABILITY AND EROSION CONTROL

The results of our exploration and testing confirm that 2:1 (Horizontal: Vertical) maximum slopes will be stable for on-site materials both in cut and fill. All slopes shall incorporate a brow ditch to direct surface drainage away from the slope face. Slopes steeper than 2:1 will require stabilization, such as retaining walls.

The potential for dust generation is high at this project. Dust control will be mandatory on this project in order to comply with air quality standards. The contractor shall be responsible for submitting a dust control plan and securing any required permits.

Stabilization of all slopes and areas disturbed by construction will be required to prevent erosion and to control dust. Stabilization may consist of rip-rap, revegetation, or dust pallative, depending on the inclination of the slope.

In order to minimize storm water discharge from this site, best management practices should be implemented.

UTILITY EXCAVATIONS

On-site soils are anticipated to be excavatable with conventional construction equipment. The on-site bedrock encountered in RS Line 3 was very hard and slightly altered/weathered. Special excavation techniques may be required in these types of materials. Compliance with OSHA regulations should be enforced for Type B soils. Excavated soils may be suitable for backfill of utility trenches (if particles larger than four (4) inches are removed). Trench backfill shall meet the requirements of Class E backfill in the SSPWC. On-site soils encountered during our field exploration do not meet the minimum requirements for bedding sand and should be imported, where required. Bedding sand and trench backfill shall be moisture conditioned to within two percent (2%) of optimum and compacted to a minimum of **ninety-two percent (92%)** of the ASTM D1557 standard.

MOISTURE PROTECTION, EROSION AND DRAINAGE

The finish surfaces around all structures should slope away from the foundations and toward appropriate drop inlets or other surface drainage devices. It is recommended that within ten (10) feet of any structure a minimum slope of five percent (5%) be used for soil subgrade and a minimum of one percent (1%) be used for pavement. These grades should be maintained for the life of the structures.

If saturated soils are encountered at or near the building sites (such as near the PEMB mapped sites), foundation drains should be utilized to insure foundation supporting soils do not become saturated. These drains should be designed by a civil engineer, if needed.

Landscaping and downspouts should be planned to prevent discharge adjacent to buildings. Instead, water flow should be conveyed and re-routed to discharge areas away from any improvements.

Three infiltration tests were performed across the site. The locations of the tests can be seen in Plates 2.1-2.3. The results of the tests are included in Appendix J.

CONSTRUCTION SPECIFICATIONS

All work shall be governed by the Standard Specifications and Standard Details for Public Works Construction (SSPWC), as distributed by the Washoe County, except as modified herein.

LIMITATIONS

This report has been prepared in accordance with the currently accepted engineering practices in Northern Nevada and Northern California. The analysis and recommendations in this report are based upon exploration performed at the locations shown on the site plan, the proposed improvements as described in the Introduction section of this report and upon the property in its condition as of the date of this report. Lumos makes no guarantee as to the continuity of conditions as subsurface variations may occur between or beyond exploration points and over time. Any subsurface variations encountered during construction should be immediately reported to Lumos so that, if necessary, Lumos' recommendations may be modified.

This report has been prepared for and provided directly to NNV1 Partners, LLC ("The Client"), and any and all use of this report is expressly limited to the exclusive use of the Client. The Client is responsible for determining who, if anyone, shall be provided this report, including any designers and subcontractors whose work is related to this project. Should the Client decide to provide this report to any other individual or entity, Lumos shall not be held liable for any use by those individuals or entities to whom this report is provided. The Client agrees to indemnify, defend and hold harmless Lumos, its agents and employees from any claims resulting from unauthorized users.

If this report is utilized in the preparation of an Engineer's Estimate of Probable Construction Costs, then the preparer of the estimate acknowledges that the report recommendations are based on the subsurface conditions found at the specific locations investigated on site; that subsurface conditions may vary outside these locations; and that no guaranty or warranty, express or implied, is made that the conditions encountered are representative of the entire site. The preparer of the estimate agrees to indemnify, defend and hold harmless Lumos & Associates, its agents and employees from any and all claims, causes of action or liability arising from any claims resulting from the use of the report in the preparation of an Engineer's Cost Estimate.

This report is not intended for, nor should be utilized for, bidding purposes. If it is utilized for bidding purposes, Client acknowledges that the report recommendations are based on the subsurface conditions found at the specific locations investigated on site; that subsurface conditions may vary outside these locations; and that no guaranty or warranty, express or implied, is made that the conditions encountered are representative of the entire site. The Client agrees to indemnify, defend and hold harmless Lumos & Associates, Inc., its agents and employees from any and all claims, causes or action or liability arising from any claims resulting from the use of the report for bidding purposes.

As explained above, subsurface variations may exist and as such, beyond the express findings located in this report, no warranties express, or implied, are made by this report. No affirmation of fact, including but not limited to statements regarding suitability for use of performance shall be deemed to be a warranty or guaranty for any purpose.

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