SOUTHERN CALIFORNIA PUBLIC POWER AUTHORITY

ATTACHMENT E

Geotechnical Report Checklist

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I. Project Information

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2. Study date	cover
3. Consultant project identification number	cover
4. Company name and address, and name and phone number of who prepared the report	cover
5. Preparer's name, seal, and signature	cover letter
6. Client name	cover

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*The items identified in sections I. through IV. shall be provided in all geotechnical reports. Reports not containing this information will be returned for correction.

**The items identified in sections V. through X. are to be provided as appropriate for the specific project.

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1. INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the proposed Hyperloop Base Site Structures project located at Apex, North Las Vegas, Nevada. The location of the Base Site is indicated on Figure 1. The purpose of our evaluation was to assess geotechnically related considerations pertaining to the project site and to provide recommendations for design and construction of proposed improvements based on the findings of our subsurface explorations, results of our laboratory testing from previous studies performed near the site and pertinent studies performed by others. This report presents the conclusions regarding the subsurface soil conditions at the Base Site and foundations, and geotechnical recommendations for construction of this project.

Ninyo & Moore previously performed geotechnical borings at the site. Our services for the previous study included performance of the soil borings and preparation of the referenced report (Ninyo & Moore, 2016). The boring logs from the previous Base Site report were used for this study and are included in Appendix A. Ninyo & Moore has also previously performed geotechnical studies associated with the other Hyperloop projects adjacent to or near the subject site. The results of those studies were used to the extent possible for this study.

GRL Engineers, Inc. performed a dynamic pile measurements and thermal profiling study, which included preparation of the referenced report (GRL, 2016). In addition, GEOVision performed a borehole geophysics study at boring location B-1 and a seismic survey on the Base Site, which included preparation of the referenced reports (GEOVision 2016a and 2016b). The results of those three studies were reviewed and used to the extent possible for this study.

2. SCOPE OF SERVICES

The scope of our services included the following:

- Review of pertinent background data listed in the References section of this report. The data reviewed included previous geotechnical reports adjacent to and/or near the subject project, studies by others, in-house geotechnical and soils data, and published geologic maps and literature.

- Reviewing the boring logs and the results of the laboratory test data from the previous Ninyo & Moore studies adjacent to and/or near the subject project site.
- Logging the excavation and observing the construction of three 42-inch diameter drilled shaft foundations with lengths of 15, 20 and 30 feet at the Base Site. The drilled shafts were constructed for load testing.
- Observing the load testing operations performed by GRL Engineering.
- Performance of two field resistivity tests (Wenner four-pin method) in the substation area of the site. Soil resistivity was measured at approximate "a" spacings of 2, 5, 10, 20, 30 and 40 feet. Resistivity tests along two perpendicular traverses were performed at the test locations.
- Compilation and analysis of the accumulated data.
- Preparation of this geotechnical evaluation report presenting our findings, conclusions, and recommendations regarding the subject project.

3. PROJECT DESCRIPTION

We understand that the subject site is approximately 18 acres in size. The site includes Lot 21A, which is the western portion of the site (about 12 acres or two-thirds of the site) and Lot 21B, which is the eastern portion of the site (about 6 acres). The western portion of the site, which is approximately 5 acres in size will be developed with structures. A NV Energy substation with its associated structures will be constructed at the southwest corner of the overall site. A preparation building and an office building north and east of the substation site are also planned. The preparation building will be associated with the Hyperloop Development Loop (DevLoop) project. The substation site will include conventional foundations and deep foundations for supporting structures, and concrete pads for supporting equipment. The anticipated loads on the deep foundations are 4.1 kips axial, 5.7 kips lateral and 112.8 kip-ft moment. The preparation building and other structures associated with the Base Site will be supported by conventional spread footings with concrete slab-on-grade floors. We also understand that the Base Site project will include an unpaved access roadway along the southern perimeter of the site and approximately 60-foot wide drainage ditches along the northern and western perimeters of the site. We anticipate that the project will include some concrete flatwork, retaining walls and roadway or parking areas paved with aggregate base (unpaved roadway/parking).

4. GENERAL SITE CONDITIONS

Based on our observations during our previous field activities, the project site area was undeveloped. Silverhawk Generating Station was located to the south of the subject site. The ground surface was covered with relatively dense native desert vegetation. The topography at the site was moderately undulatory and generally sloped downward toward the southeast. Several ephemeral (dry) washes extended through the site that were a few feet deep and several feet wide.

Indications of underground utilities were not observed at the site during our field activities. However, underground utilities may be present in the site vicinity.

5. GEOLOGY

Based on our field observations, subsurface exploration, and review of referenced geologic and soils data, the subject site is underlain primarily by Quaternary-age alluvium (native soil). Ninyo & Moore's findings regarding the geologic setting, potential geologic hazards, ground motions, and liquefaction at the subject site are provided in the following sections.

5.1. Geologic Setting

The proposed project site is located in the Hidden Valley, which is part of the Basin and Range geomorphic province. Based on our review of referenced geologic data, this area is typically underlain by thick Paleozoic and Mesozoic sedimentary rock and Quaternary alluvium.

Surficial soils in the vicinity of the proposed project were predominantly derived from local bedrock sources in the Las Vegas Range to the west and the Arrow Canyon Range to the east. These bedrock sources are composed primarily of limestone and dolomite.

5.2. Potential Geologic Hazards

Ninyo & Moore's geotechnical study included an evaluation of the possible presence of geologic hazards, such as faults and ground fissures, in the site area. This evaluation included review of published geologic and soils maps and literature, and other data listed in the References section of this report.

Based on our review of referenced geologic data and our field observations, no bedrock or tectonic faults are known to transect the alluvium deposits at the subject site. No apparent indications of faulting or ground fissures, which are sometimes associated with faults in the project area, were observed at the site during our previous geologic field reconnaissance. However, Dohrenwend and others (1991) mapped the Dry Lake Range fault zone, which consists of a few roughly north-south trending tectonic normal faults that extend along the base of the west side of the Dry Lake Range. At its nearest point, one of these faults is located approximately 12 miles southeast of the subject site. Referenced geologic reports indicate that the Dry Lake Range fault zone is active and that the fault zone has the potential to generate earthquakes with moment magnitudes up to approximately 6.7. Other active tectonic faults are located approximately 10 miles north of the subject site in the Arrow Canyon Range and approximately 17 miles west of the site in the Sheep Range. Ninyo & Moore's review of the referenced geologic and seismic data indicates that these faults are Quaternary in age and may or may not be active.

5.3. Ground Motions

Using the referenced United States Geological Survey database (USGS, 2016a), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the subject site, where the middle is located at approximately 36.42056 degrees north latitude and -114.96012 degrees west longitude. Based on the subsurface soils encountered, results of the referenced seismic survey (GEOVision, 2016b) and the referenced International Building Code (ICC, 2012) a Seismic Site Class C is appropriate for the subject site and the parameters in the following table are characteristic of the site for design purposes.

Table 1 – Seismic Design Parameters

Parameters	Value		Reference (ICC, 2012)
	Short Period	Long Period	
Mapped Maximum Considered Earthquake Spectral Response Acceleration, S_S and S_1	0.58g	0.18g	Figure 1613.3.1 and referenced database (USGS, 2015a)
Site Coefficient, F_a and F_v	1.17	1.62	Table 1613.3.3
Maximum Considered Earthquake Spectral Response Acceleration Adjusted for Site Class Effects, S_{MS} and S_{M1}	0.68g	0.30g	Equations 16-37 and 16-38
Design Spectral Response Acceleration, S_{DS} and S_{D1}	0.45g	0.20g	Equations 16-39 and 16-40

5.4. Drainage and Surface Water

Numerous, relatively small, braided, ephemeral swales traverse the Base Site Structures site. These swales were generally up to approximately 5 feet deep and up to approximately 100 feet wide. The swales traversing the subject site are typically dry. However, during heavy rains some of these swales are known to transport significant amounts of water and are prone to flash flooding.

5.5. Liquefaction Potential

Liquefaction is a phenomenon in which loose, saturated soils lose shear strength under short-term (dynamic) loading conditions. Ground shaking of sufficient duration results in the loss of grain-to-grain contact in potentially liquefiable soils due to a rapid increase in pore water pressure, causing the soil to behave as a fluid for a short period of time. To be potentially liquefiable, a soil is typically cohesionless with a grain-size distribution generally consisting of sand and silt. It is generally loose to medium dense, saturated, and subjected to sufficient magnitude and duration of ground shaking.

An in-depth evaluation of the potential for liquefaction at the site was outside the scope of this geotechnical evaluation. General findings regarding liquefaction are provided in Section 7 of this report.

6. FIELD EXPLORATION AND SUBSURFACE CONDITIONS

Ninyo & Moore's previous subsurface exploration at the subject project site was performed from January 26 through January 28, 2016. These explorations consisted of drilling, logging, and sampling small-diameter exploratory borings. The borings were advanced to depths ranging from approximately 70 to 120 feet with a truck-mounted CME-75 drill rig utilizing hollow-stem drilling equipment. The borings were logged by Ninyo & Moore personnel that meet the requirements of Section 1803.6.11 of the Southern Nevada Amendments to the 2012 International Building Code (SNBO, 2012). The estimated elevation of the borings was obtained in the field by a hand-held GPS unit. The boring elevations should be considered approximate.

Ninyo & Moore observed the excavation and construction (by others) of three 42-inch diameter drilled shaft foundations (test shafts) with lengths of 15, 20 and 30 feet. Following construction of the shafts on March 9, 2016, Ninyo & Moore observed the load testing operations performed on March 18, 2016. Each test shaft was axially loaded up to approximately 2,000 kips, which resulted in zero to a negligible amount of vertical movement being detected. We understand that the test shafts were laterally loaded later up to approximately 117 kips, which reportedly resulted in a negligible amount of lateral movement/deflection. The estimated elevation of the test shaft excavations was obtained in the field by a hand-held GPS unit. The test shaft elevations should be considered approximate.

The boring logs (Borings B-1, B-2 and B-3) from the Base Site geotechnical report (Ninyo & Moore, 2016a) are presented in Appendix A. The logs of the test shaft excavations (TS-1, TS-2 and TS-3) are presented in Appendix B. The boring and test shaft elevations are provided on the boring logs in Appendix A and Appendix B. The approximate locations of the borings and test shafts are shown on Figure 2.

Field electrical resistivity tests were performed by Ninyo & Moore personnel at two locations within the area of the proposed NV Energy substation to evaluate corrosivity of the in-situ soils at the subject site. Resistivity of the subgrade soils was measured to nominal depths of 2, 5, 10, 20, 30 and 40 feet below the existing ground surface. The approximate locations of our field resistivity tests are shown on Figure 2. The test results and a description of the equipment and testing procedures utilized are presented in Appendix D.

6.1. Subsurface Soils

Native soil (alluvium) at the site consists primarily of very dense, poorly graded gravel with silt and sand, silty gravel with sand and silty sand with gravel. The subsoils also have interbedded layers of slightly to strongly cemented soils that are a few inches thick.

Layers of moderately hard to hard, moderately to strongly cemented soil (caliche) were encountered in the previous exploratory borings. Caliche is a naturally occurring cemented soil with rock-like characteristics. The following describes typical properties of caliche encountered in southern Nevada.

- Generally occurs in layers a few inches to several feet thick.
- Layers typically vary significantly in thickness, degree of cementation, and hardness over relatively short distances.
- Varies in composition from primarily fine-grained material to primarily coarse-grained material.
- Moderately hard, moderately cemented caliche can generally be gouged with a knife with difficulty and broken with a few hammer blows.
- Hard and very hard, strongly cemented caliche is difficult to scratch with a knife and breaks with difficulty with repeated hammer blows.
- Impedes earthwork operations, including grading and utility line trenching. Rock excavation methods are generally needed.

The following Table 2 describes the approximate depth, thickness, and hardness and degree of cementation of caliche layers encountered in the previous borings performed at the site.

Table 2 – Caliche Layers Encountered

Boring	Approximate Depth to Top of Layer (feet)*	Approximate Thickness of Layer (feet)	Hardness and Degree of Cementation
B-1	30.0	4.0	Moderately hard to hard, moderately to strongly cemented
	36.0	4.0	Moderately hard to hard, moderately to strongly cemented
	53.0	7.0	Moderately hard to hard, moderately to strongly cemented
	78.0	4.0	Moderately hard to hard, moderately to strongly cemented
B-2	---	<0.5	Moderately hard, moderately cemented layers a few inches thick
B-3	---	<0.5	Moderately hard to hard, moderately to strongly cemented layers a few inches thick

*Depth measured from ground surface adjacent to boring.

6.2. Groundwater

Groundwater was not encountered in our previous exploratory borings performed at the site, which were advanced up to approximately 120 feet below the existing ground surface. Seasonal fluctuations in groundwater levels and surface water flow may occur. These fluctuations may be due to variations in ground surface topography, subsurface geologic conditions, rainfall, irrigation, and other factors. Evaluation of factors associated with groundwater fluctuations was beyond the scope of this study.

7. FINDINGS AND CONCLUSIONS

Based on the findings of this study, there are no known geotechnical or geologic conditions that would preclude construction of the proposed structures at the site, provided the recommendations presented herein are implemented and appropriate construction practices are followed. Geotechnical design and construction considerations for the proposed project include the following:

- Drilled shafts, conventional foundations and structural slabs may be founded on medium dense to very dense, undisturbed native granular soil, caliche or on adequately compacted structural fill.

- Based on the anticipated subsurface soil conditions and our review of the referenced reports by GRL Engineers and GEOVison, drilled shafts may be designed using a skin friction of 8 kips per square foot for shafts 10 to 30 feet deep.

- Layers of moderately hard to very hard, moderately to strongly cemented caliche were encountered in our previous exploratory borings performed at and/or near the subject site. Grading, excavations, and other earthwork activities will be impeded due to the presence of these cemented soils. Rock excavation techniques should be anticipated during grading and excavation operations.

- Contractors for this project should anticipate that relatively large quantities of cobble- and boulder-size material will be generated during excavation operations for the project. These oversize materials will need to be crushed and processed prior to being used as structural fill and backfill, or exported from the project site.

- Based on the relatively dry and granular nature of native soils anticipated at the site and encountered in our previous exploratory borings, caving of the upper soils, particularly the non-cemented soils should be anticipated during grading and excavation operations.

- The findings of our previous studies indicate that the native soils should generally be suitable for use as structural fill and backfill material for the project. The excavated on-site soils may be used as structural fill and backfill provided they comply with the recommendations presented in Section 8.1.4.

- Due to the presence of cemented soils at the site, bulking of this material should be anticipated when this material is excavated, processed/crushed, and compacted. For planning purposes, up to approximately 10 percent bulking should be anticipated.

- The results of our resistivity and chemical tests indicate that the on-site soils are mildly to moderately corrosive to steel. Accordingly, we recommend that corrosion reduction methods be implemented for this project for steel in contact with on-site soils.

- Review of published geologic data and our field observations do not indicate the presence of adverse on-site geologic hazards, such as faults and ground fissures, which may affect proposed site development.

- Groundwater was not encountered in the previous borings to the total depths explored (approximately 120 feet) and is not anticipated to be a design or construction issue.

- In accordance with the referenced International Building Code, the seismic parameters provided in Table 1 are characteristic of the site and may be used in design of the proposed structures.
- Due to soil conditions encountered in the exploratory borings, it is our opinion that there is a low potential for liquefaction of subsurface soils.

8. RECOMMENDATIONS

The following recommendations are intended for incorporation into design and construction of the proposed Base Site structures.

8.1. Earthwork

The following subsections provide recommendations for earthwork, including site grading, structural fill and backfill, import soil, and temporary excavations.

8.1.1. Site Grading

Prior to grading, proposed structure areas should be cleared of any surface obstructions, debris, organics (including vegetation), and other deleterious material. Materials generated from clearing operations should be removed from the project site and disposed at a legal landfill site. Any undocumented fill and loose, and/or disturbed native soils should be removed from improvement areas, including concrete flatwork and roadway areas. These removed soils may be processed and stockpiled for later use as structural fill or backfill if they comply with the recommendations provided in this report.

After the previously described removals have been made, the exposed subgrade soils should be scarified to approximately 6 inches, moisture-conditioned to approximately optimum moisture content and compacted to 95 percent relative compaction, as evaluated by ASTM D 1557. Scarification may terminate on cemented soils, as evaluated by the geotechnical consultant. The project's geotechnical consultant should observe excavation bottoms and areas to receive fill at the time of grading to assess the suitability of the exposed soils and to evaluate whether removals down to more competent soils are needed. In addition, the project's geotechnical consultant should observe and test the placement of structural fill and observe any benching when filling in wash areas.

Surface preparations should extend 2 feet or more beyond the exterior edges of planned improvement areas, or to a lateral distance that is equivalent to the depth of compacted structural fill below the structure/improvement, whichever is greater.

Based on our observations during drilling of the borings and test shaft excavations at the site and the results of our geological review and our previous studies, the native soils should be suitable for use as structural fill and backfill material for the project. Soils excavated in areas of proposed project improvements may be re-used as structural fill and backfill provided they conform to recommendations provided in Section 8.1.4.

Some shrinkage should be anticipated when on-site non-cemented soils are excavated, processed, and compacted. For planning purposes, an estimated shrinkage factor of approximately 15 percent may be used for on-site non-cemented soils. Depending on finished grade elevations for the project, some importation of soils may be needed.

8.1.2. Caliche Considerations

Relatively thin layers of caliche or slightly cemented soils were encountered in our exploratory borings performed at the subject site. Due to its variable nature, additional layers of caliche may be present in subsurface soils between and beyond our borings and the test shaft locations at the subject site.

Rock excavation techniques such as use of heavy-duty drilled shaft excavation or ripping equipment, heavy-duty backhoe, headache ball, hoe-ram, and/or rock saw should be anticipated. The contractor should be aware of the potential for (and take adequate precautions to reduce the potential for) vibrational damage to adjacent or nearby structures, and take appropriate precautions, when using heavy impact equipment during removal of caliche.

Oversize materials may be generated during excavation of any cemented soils encountered at the subject site. These materials will need to be crushed prior to use as structural fill and backfill, or removed from the site and disposed of in a suitable manner. Bulking of this material should be anticipated when it is excavated, processed/crushed, and compacted. For planning purposes, up to approximately 10 percent bulking should be anticipated.

8.1.3. Fill on Slopes

When placing fill on slopes, particularly in wash areas, steeper than 5:1 (horizontal:vertical), topsoil, slope wash, colluvium, and other materials deemed unsuitable shall be removed. Near-horizontal keys and near-vertical benches shall be excavated into sound dense/firm native soils, caliche or bedrock. Keying and benching shall be performed. Compacted fill shall not be placed in an area subsequent to keying and benching until the area has been observed by the geotechnical consultant. Where the natural gradient of a slope is less than 5:1, benching is generally not recommended. However, fill shall not be placed on compressible or otherwise unsuitable materials left on the slope face.

8.1.4. Structural Fill and Backfill

Structural fill and backfill soils should not contain significant amounts of organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 6 inches and 3 inches nominal diameter, respectively. These soils should have a low solubility potential of 1.0 percent or less, as evaluated by Technical Guideline TG-19-2007 (CCDB, 2007), and a swell potential less than 4 percent, as evaluated by the test method outlined in Section 1803.5.3.2 of the referenced Southern Nevada Amendments to the 2012 International Building Code (SNBO, 2012).

Soils used as structural fill and backfill should be moisture-conditioned to approximately optimum moisture content and placed and compacted in uniform horizontal lifts to a relative compaction of 95 percent, as evaluated by the ASTM D 1557. The optimal lift thickness of fill will depend on the type of soil and compaction equipment used, but should generally not exceed approximately 12 inches in loose thickness. Placement and compaction of structural fill should be performed in accordance with the referenced IBC and amendments or the Uniform Standard Specifications for Public Works Construction, Off-Site Improvements (USSPWC), where applicable.

Earthwork operations should be observed and compaction of structural fill and backfill materials should be tested by the project's geotechnical consultant. Typically, one field test should be performed per lift for each approximately 500 cubic yards of fill placement in structural areas. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

8.1.5. Import Soil

Import soil should consist of coarse-grained material (50 percent or more retained on the No. 200 sieve) with a low solubility potential of 1.0 percent or less, as evaluated by Technical Guideline TG-19-2007 (CCDB, 2007), a low sulfate content (less than 0.1 percent), and a low swell potential (less than 4 percent), as evaluated by the test method outlined in Section 1803.5.3.2 of the referenced Southern Nevada Amendments to the 2012 International Building Code (SNBO, 2012). Import soil should not contain significant amounts of organic matter, debris, other deleterious matter, or rocks or hard chunks larger than approximately 4 inches nominal diameter. We further recommend that proposed import material be evaluated by the project's geotechnical consultant at the borrow source for its suitability prior to importation to the project site. Import soil should be moisture-conditioned and placed and compacted in accordance with the recommendations set forth in the previous section.

8.1.6. Temporary Excavations

Temporary slope surfaces should be kept moist to retard raveling and sloughing. Water should not be allowed to flow over the top of excavations in an uncontrolled manner. Stockpiled material and/or equipment should be kept back from the top of excavations a distance equivalent to the depth of the excavation or more. Workers should be protected from falling debris, sloughing, and raveling in accordance with Occupational Safety and Health Administration (OSHA) regulations (OSHA, 2005). Temporary excavations should be observed by the project's geotechnical consultant so that appropriate additional recommendations may be provided based on the actual field conditions. Temporary excavations are time sensitive and failures are possible.

Adequate surface drainage should be provided to reduce the potential for ponding and infiltration of water into the subgrade materials. We suggest that the roadway areas have a surface gradient of 1 percent or more. In addition, surface runoff from surrounding areas should be intercepted, collected, and not permitted to infiltrate the subgrade and any base. We recommend that perimeter swales, edge drains, or combination of these drainage devices be constructed to reduce the adverse effects of surface water runoff.

8.2. Structure Foundations

The following subsections provide recommendations for drilled shaft foundations and conventional spread foundations planned for support of the proposed Base Site Structures and associated improvements.

8.2.1. Drilled Shafts Foundations

We understand that a drilled shaft foundation system may be used for support of some of the NV Energy structures associated with the substation. The following sections present information relative to drilled shafts, as well as construction considerations for drilled shafts.

8.2.1.1. Analysis

Based on our review of the referenced GRL Engineers report (2016) and our observations of the load tests it appears that a skin friction of 8 kips per square foot may be used in the design of drilled shafts 10 to 30 feet deep for the project. The anticipated loads of 4.1 kips axial, 5.7 kips lateral and 112.8 kip-ft moment should adequately be supported by drilled shafts with a diameter of 24 inches or more and a depth of 10 feet or more. Ninyo & Moore estimates that drilled shafts, designed and constructed as indicated herein, should undergo settlements of up to approximately 3/4 inch.

For axial loading, drilled shafts should be spaced three or more shaft diameters center-to-center. Group-effects of relatively closely spaced drilled shafts (spaced less than approximately three shaft diameters center-to-center) were not considered in our analysis. If closely spaced drilled shafts are used, group-effects should be evaluated.

For lateral loading, drilled shafts in a group may be considered to act individually when the center-to-center spacing is greater than 3D (where D is the diameter of the shaft) in the direction normal to loading and greater than 6D in the direction parallel to loading. If closely spaced drilled shafts are used, group-effects should be evaluated, as appropriate.

It should also be noted that internal reaction loads were not evaluated with respect to structural capacity of construction materials. Drilled shafts should be designed in accordance with the recommendations of a qualified structural engineer.

8.2.1.2. Construction Considerations

The bottom and sidewalls of each drilled shaft excavation should be evaluated in the field during construction by the geotechnical consultant. The geotechnical consultant should compare the encountered conditions with those assumed for design. If the encountered geotechnical conditions are significantly different than those used in design of the drilled shaft, our office should be notified and additional recommendations, if warranted, will be provided upon request.

No concrete should be placed until the dimension, bottom elevation, and the excavation of each shaft has been evaluated by the geotechnical consultant. Drilled shaft excavations should also be checked for plumbness during construction. The contractor should make provisions to provide for the integrity of the excavation and to make sure that the excavations are cleaned and straight, and that sloughed, loose, or soft soil is removed from the bottom of excavations prior to the placement of concrete. Drilled shaft excavation bottoms need to be clean and founded on competent soil. No completed shaft excavation should be allowed to remain open overnight. Additional general recommendations regarding drilled shaft construction are provided in Appendix E.

Temporary steel casing should be available on site and placed, if required, to stabilize loose or caving materials. Reinforcing steel and shaft concrete should be placed the same day the shaft excavation is drilled. Concrete compressive strength and steel reinforcement should be designed in accordance with recommendations of a qualified structural engineer.

Concrete should be placed in the drilled shaft excavation as soon as practicable after drilling and evaluation by the geotechnical consultant. Concrete should have an ultimate strength not less than that specified, and should be workable and plastic so that it may be placed without segregation. Concrete should be cast-in-place against undisturbed earth in the hole in such a manner to provide for the exclusion of appreciable amounts of foreign matter in the concrete. The shafts should be adequately reinforced for lateral and uplift loads, as recommended by the project structural engineer.

8.2.2. Conventional Spread Foundations

We understand that conventional spread foundations will be used to support structures and other improvements associated with the project.

Structure foundations consisting of spread footings should extend 12 inches or more below the lowest adjacent finished grade and bear on medium dense to very dense native granular soils or on adequately placed and compacted structural fill (reworked native or import soils), as described in Section 8.1.1 of this report. Structure footings should have a width of 12 inches or more. From a geotechnical standpoint, we recommend that footings be reinforced with two No. 4 or larger reinforcing bars, one placed near the top and one near the bottom of the footings. Additional reinforcement may be recommended by the structural engineer.

An allowable bearing capacity of 2,500 pounds per square foot (psf) may be used for conventional spread footings with an embedment depth of 12 inches below adjacent finished grade and a width of 12 inches. The allowable bearing capacity may be increased by 500 psf for each additional 1 foot of width and 1,000 psf for each additional 1 foot of embedment up to 4,000 psf. The allowable bearing capacity, which was developed considering a factor of safety of 2.5, may be increased by one-third for short duration loads, such as wind or seismic. Lateral resistance for footings is presented in Section 8.4. Seismic parameters for design of structures at the site are provided in Table 1 in Section 5.3. Foundations should be designed and constructed in accordance with the recommendations of a qualified structural engineer.

For any concrete structural slabs for supporting equipment, a modulus of subgrade reaction, k, of 400 pounds per square inch (psi) per inch may be used in design.

Due to the potential for damaging differential settlement, footings/structural slabs should not bear on both cemented soils (caliche) and non-cemented soils. If both cemented and non-cemented soils are present at the footing base, the cemented soils should be overexcavated 12 inches and replaced with compacted structural fill.

8.3. Settlement

Based on our evaluation of spread footing bearing capacity, we anticipate that settlement of foundations will be on the order of 1 inch or less. We estimate footing differential settlement of about 1/2-inch over a horizontal span of about 40 feet.

8.4. Lateral Earth Pressures

Retaining walls that are not restrained from movement at the top, having level granular backfill behind the wall, and are 12 feet or less high may be designed using an “active” lateral earth pressure as indicated on Figure 3. Retaining walls that are restrained from movement at the top, having level granular backfill behind the wall, and are 12 feet or less high may be designed using an “at-rest” lateral earth pressure as indicated on Figure 4. The locations of the resultant forces due to these lateral earth pressures are also provided on Figure 3 and Figure 4. As discussed, the values on Figure 3 and Figure 4 assume that retaining walls will have a height of approximately 12 feet or less.

The recommended lateral earth pressure values assume compaction within about 5 feet of the wall will be accomplished with relatively light compaction equipment and that very low to low expansive backfill will be placed behind the wall.

Ninyo & Moore evaluated “active” and “at-rest” dynamic lateral earth pressures due to seismic loading based on the referenced Southern Nevada Amendments to the 2012 International Building Code (SNBO, 2012). Ninyo & Moore recommends that retaining walls that are not restrained from movement at the top be designed using an “active” resultant force due to seismic loading as indicated on Figure 3. Retaining walls that are restrained from movement at the top should be designed using an “at-rest” resultant force due to seismic loading as indicated on Figure 4 for walls up to 12 feet high.

Retaining walls should also be designed to resist an “active” and “at-rest” surcharge pressure as shown on Figure 3 and Figure 4. The value for “q” represents the pressure induced by adjacent light loads, uniform slab, or traffic loads plus any adjacent footing loads.

Measures should be taken so that hydrostatic pressure does not build up behind retaining walls. Drainage measures, as indicated on Figure 5, should include free-draining granular backfill material and perforated drain pipes, or weepholes lined with polyvinyl chloride (PVC) pipe. Drain pipes should outlet away from structures and retaining walls should be waterproofed in accordance with the recommendations of a qualified civil engineer or architect.

For passive resistance to lateral loads, we recommend that a passive lateral earth pressure of 350 pounds per square foot per foot (psf/ft) be used up to a value of 3,500 psf. This value assumes that the ground surface is horizontal for a distance of 10 feet, or three times the height generating the passive pressure, whichever is more. We recommend that the upper 12 inches of soil not protected by pavement or a concrete slab be neglected when calculating passive resistance. For frictional resistance to lateral loads, we recommend that a coefficient of friction of 0.70 be used between soil and soil contacts and/or between soil and cast-against-grade concrete contacts. A coefficient of friction of 0.47 may be used between soil and formed concrete contacts. Passive and frictional resistances may be used in combination, provided the passive resistance does not exceed one-half of the total allowable resistance.

8.5. Concrete Slab-On-Grade Floors

Any concrete slab-on-grade floors should be designed by the project’s structural engineer based on anticipated loading conditions. Ninyo & Moore recommends that conventional concrete slab-on-grade floors for this project be founded on 4 inches of Type II Aggregate Base overlying a 6 inch thick zone of adequately placed and compacted structural fill. The structural fill thickness may include 6 inches of scarified and recompacted soils. Aggregate base underlying concrete slab-on-grade floors should be compacted to 90 percent of the laboratory maximum dry density (ASTM D1557).

Floor slabs should be 4 inches or more in thickness and reinforced with No. 3 steel reinforcing bars placed at 24 inches on-center both ways. Reinforcement of the slab should be placed at mid-height. We recommend that "chairs" be utilized to aid in the placement of the reinforcement. Increased slab thickness and reinforcement may be recommended by the structural engineer. As a means to reduce shrinkage cracks, we recommend that conventional slab-on-grade floors be provided with control joints in accordance with the recommendations of a qualified structural engineer. Recommendations regarding concrete utilized in construction of floor slabs are provided in a subsequent section of this report.

As an alternative to slab reinforcement with steel reinforcing bars, post-tensioned slabs designed by a qualified structural engineer may be considered. Geotechnical recommendations for design of post-tensioned slabs-on-grade will be provided by Ninyo & Moore upon request.

Ninyo & Moore recommends that a moisture barrier be provided by a membrane placed beneath concrete slab-on-grade floors, particularly in areas where moisture-sensitive flooring is to be used. The membrane should consist of visqueen 10 mils in thickness, or an appropriate equivalent. The visqueen should overlie the previously described compacted base material.

8.6. Exterior Concrete Flatwork

Exterior concrete flatwork, such as walkways and larger slabs, should be founded on 4 inches of Type II Aggregate Base overlying 6 inches or more of compacted structural fill. The structural fill thickness may include 6 inches of scarified and recompacted soils. Type II Aggregate Base should be compacted to 95 percent relative compaction, as evaluated by ASTM D 1557.

Concrete flatwork should be 4 inches thick. To reduce the potential for shrinkage cracks, the flatwork should be constructed with control joints spaced approximately 5 feet apart for walkways and approximately 10 feet on-center each way for larger slabs. Crack control joint spacing should be in accordance with recommendations of a qualified structural engineer. Reduced joint spacing may be recommended by the structural engineer.

Formation of shrinkage cracks in concrete slabs, and other cracks due to minor soil movement, may be further reduced by utilizing steel reinforcement, such as welded wire mesh. However, due to the inherent difficulty in positioning welded wire mesh in the middle of concrete flatwork, other crack control methods should be considered, such as placement in the concrete of No. 3 steel reinforcing bars at approximately 24 inches on-center each way. Reinforcement of the flatwork should be placed at approximately mid-height in the concrete utilizing "chairs."

Exterior concrete flatwork should be constructed in accordance with the recommendations of the project's civil or structural engineer and governing agency requirements. Recommendations regarding concrete utilized in construction of proposed improvements are provided in Section 8.9.

8.7. Pavement Sections for Unpaved Parking and Access Areas

To form a basis for design of pavement (aggregate base) for any on-site unpaved parking and access areas, we have assumed the following:

- A design Equivalent Single Axial Load (ESAL) value of 3,000, based on Traffic Index (TI) = 4.5 for automobile traffic; and an ESAL value of 16,000, based on TI = 5.5 for truck traffic are applicable.
- A reliability of 80 percent.
- A standard deviation of 0.45.
- An initial serviceability index of 4.2.
- A terminal serviceability index of 2.0.
- A subgrade resilient modulus (MR) of 26,300 pounds per square inch (psi) for an average R-value of 70 (based on soil classification).

Using these values, structural numbers associated with the proposed parking and access areas were calculated using design procedures in accordance with the American Association of State Highway and Transportation Officials method of designing flexible pavement (AASHTO, 1993) requirements. The following table presents recommended structural unpaved pavement sections placed over structural fill for on-site parking and access areas.

Table 3 – Recommended Unpaved Pavement Section Thickness

Traffic Type	Design ESAL	Pavement ($a_{asphalt}$ = 0.35)	Base (a_{base} = 0.12)	Subgrade	Structural Number Provided	Structural Number Needed
		Asphalt Concrete Thickness (Inches)	Type II Base Thickness (Inches)	Structural Fill Thickness (Inches)*		
Automobile	3,000	N/A	5.0	6.0	0.60	0.59
Truck	16,000	N/A	7.5	6.0	0.90	0.89

*Structural fill below the aggregate base may include 6 inches of scarified and recompacted native soil. Scarification may terminate where caliche is encountered, as evaluated in the field by the geotechnical consultant.

If the assumed traffic or design ESAL values are not considered appropriate, this office should be notified. In providing these recommendations for unpaved pavement sections, we have assumed that Type II Aggregate Base will conform to Section 704.03.04 of the referenced USSPWC. Type II Aggregate Base materials should be placed and compacted to 95 percent relative compaction, as evaluated by ASTM D 1557, and in accordance with Section 302 of the referenced USSPWC.

Ninyo & Moore recommends that Portland cement concrete pavement be utilized in heavy traffic or staging areas. Our experience indicates that heavy traffic can significantly shorten the useful life of pavement sections. We recommend that, in heavy traffic areas, 600 pounds per square inch (psi) flexural strength Portland cement concrete, 7 inches thick, be placed over 6 inches of compacted Type II Aggregate Base over 6 inches of adequately placed and compacted structural fill. We also recommend that a qualified structural engineer be consulted for appropriate reinforcement of concrete pavement.

We recommend that the mix design be made for the Portland cement concrete by an engineering company specializing in this type of work.

Adequate surface drainage should be provided to reduce the potential for ponding and infiltration of water into the surface base and subgrade materials. We suggest that the roadway/parking areas have a surface gradient of 1 percent or more. In addition, surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow onto or infiltrate the base and subgrade. We recommend that perimeter swales, edge drains, culverts, curbs and gutters, or combination of these drainage devices be constructed to reduce the adverse effects of surface water runoff.

8.8. Moisture Infiltration Reduction and Surface Drainage

Infiltration of water into subsurface soils can lead to soil movement and associated distress, and chemically and physically related deterioration of concrete structures. To reduce the potential for infiltration of moisture into subsurface soils at the site, we recommend the following:

- Positive drainage should be established and maintained away from proposed structures. Positive drainage may be established by providing a surface gradient of 2 percent away from structures for a distance of 10 feet measured perpendicular from structure perimeters, where possible.
- Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, and other drainage devices. Surface run-off should not be allowed to pond near structures.

8.9. Concrete and Corrosion Considerations

The corrosion potential of on-site soils to concrete and metal was previously evaluated in the laboratory using representative samples obtained from the nearby Hyperloop POAT, Phase 1 borings and at the site using field resistivity tests. The testing was performed to assess the effects of sulfate content on concrete and the resistivity on metal. Results of these tests are presented in Appendix C and Appendix D. Recommendations regarding concrete to be utilized in construction of proposed improvements and for buried metal pipes are provided in the following sections.

8.9.1. Concrete

The chemical tests previously performed on selected samples of nearby soils indicated sulfate contents ranging from 0.00 to 0.01 percent by weight. Based on review of the referenced International Building Code (ICC, 2012) and American Concrete Institute manual (ACI, 2005), the tested soil is considered negligibly deleterious to concrete. However, based on our previous professional experience in the project vicinity, we recommend that concrete in contact with on-site soils, along with any subsurface walls up to 12 inches above finished grade, contain Type V cement and have a design compressive strength of 4,000 pounds per square inch (psi). In accordance with Section 501 of the referenced USSPWC, concrete in contact with on-site soils should have a water-cement ratio of 0.45 by weight. In addition, it is recommended that reinforcing bars in cast-against-grade concrete, with the exception of exterior concrete flatwork, be covered by approximately 3 inches or more of concrete. Concrete should be placed with an approximate 4-inch slump and good densification procedures should be used during placement to reduce the potential for honeycombing. Concrete samples should be obtained as needed and the slump should be tested at the site by the project's geotechnical consultant. Structural concrete should be placed in accordance with American Concrete Institute (ACI, 2005) and project specifications.

8.9.2. Buried Metal Pipes

Laboratory resistivity test results performed previously on representative samples of nearby soils that are similar to the on-site soils indicated electrical resistivity values of approximately 4,762 and 5,882 Ohm-centimeters (Ohm-cm), which is considered to be moderately corrosive to buried metals. A soil resistivity value depends on various factors, including moisture content, salt content, and temperature.

In addition, field resistivity tests performed at the site indicate electrical resistivity values ranging from approximately 30,400 to 131,000 Ohm-cm, which is considered mildly corrosive to buried metals. It is our opinion that the relatively high resistivity values at the subject site may be due to coarse-grained nature of the soils and low moisture content in the soil. We understand that others will evaluate corrosion concerns for this project and will provide recommendations for corrosion reduction methods, as needed. Ninyo & Moore recommends that corrosion reduction methods be implemented for this project for buried metal pipes. These corrosion reduction methods may include utilization of protective coatings, pipe sleeving, and/or appropriate cathodic protection as recommended by a qualified corrosion engineer. Where permitted by jurisdictional building codes, the use of plastic pipes for buried utilities should also be considered.

8.10. Moisture Infiltration Reduction and Surface Drainage

Infiltration of water into subsurface soils can lead to soil movement and associated distress, and chemically and physically related deterioration of concrete structures. To reduce the potential for infiltration of moisture into subsurface soils at the site, we recommend the following:

- Positive drainage should be established and maintained away from structures. Positive drainage may be established by providing a surface gradient of 2 percent away from structures for a distance of 10 feet measured perpendicular from structure perimeters, where possible.
- Adequate surface drainage should be provided to channel surface water away from on-site structures and to a suitable outlet. Adequate surface drainage may be enhanced by utilization of graded swales, area drains, culverts, and other drainage devices. Surface or storm water run-off should not be allowed to pond near structures.

8.11. Observation and Testing

A qualified geotechnical consultant should perform appropriate observation and testing services during grading and construction operations. These services should include observation of removal of soft, loose, or otherwise unsuitable soils, evaluation of subgrade conditions where soil removals are performed, and performance of observation and testing services during placement and compaction of structural fill and backfill soils. The geotechnical consultant should also perform observation and testing services during placement of concrete, mortar, grout, asphalt concrete, and steel reinforcement. Special inspections should be performed as indicated in Table 1705.6 of the referenced Southern Nevada Amendments to the 2012 International Building Code (SNBO, 2012). Based on the results of our laboratory testing and our understanding of the subject project, it is our opinion that the level of special inspection, as indicated in Table 1705.6, should be 4a.

8.12. Pre-Construction Meeting

We recommend that a pre-construction meeting be held. The owner or the owner's representative, the architect, the civil engineer, the contractor, and the geotechnical consultant should be in attendance to discuss the plans and the project.

9. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

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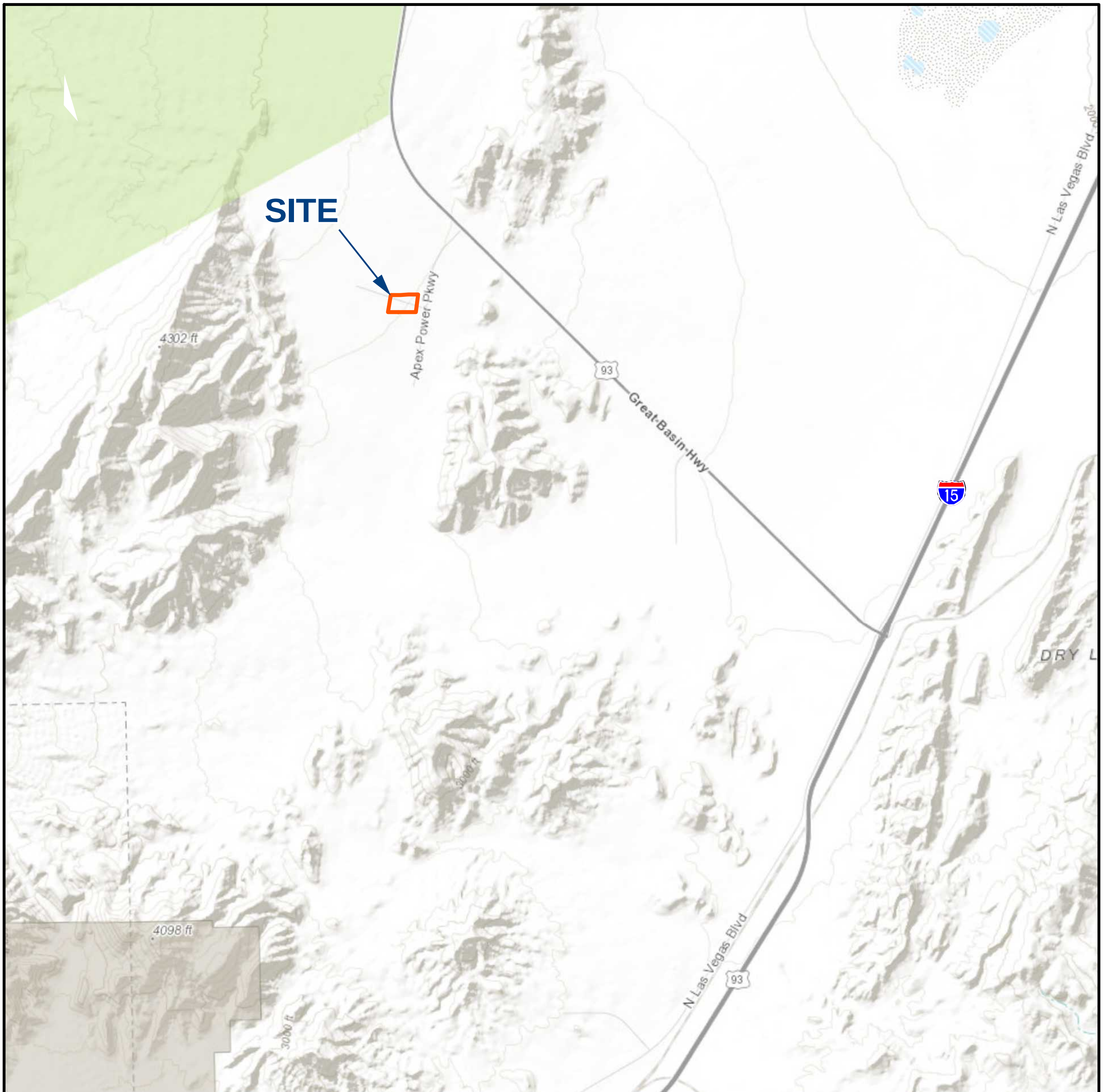
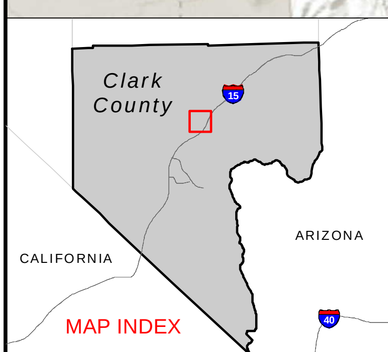


SOURCE: ESRI WORLD TOPO, 2016



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SCALE IN FEET

0 3,000 6,000 12,000

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore

PROJECT NO.	DATE
303983004	4/16

SITE LOCATION

HYPERLOOP BASE SITE STRUCTURES
APEX, NORTH LAS VEGAS, NEVADA

FIGURE 1

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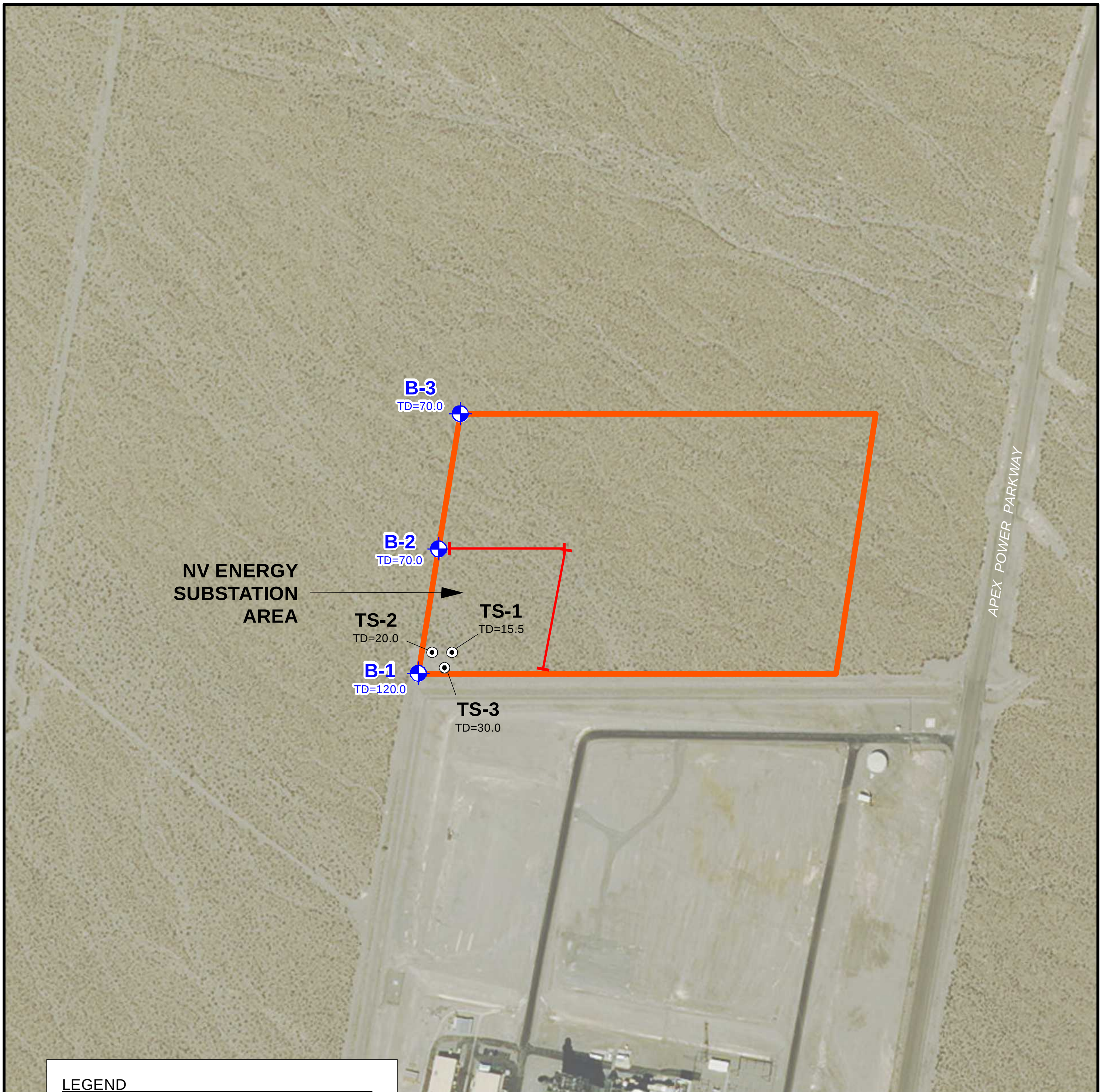

LEGEND

SITE BOUNDARY

B-3 TD=70.0 — BORING, TD=TOTAL DEPTH IN FEET

TS-3 TD=30.0 — TEST SHAFT, TD=TOTAL DEPTH IN FEET

FIELD RESISTIVITY TEST

SOURCE: Aerial Imagery - ESRI, i-cubed, USDA FSA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGP.

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SCALE IN FEET

0 200 400 800

NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE

Ninyo & Moore

BORING LOCATIONS		FIGURE
PROJECT NO.	DATE	
303983004	4/16	2

HYPERLOOP BASE SITE STRUCTURES
APEX, NORTH LAS VEGAS, NEVADA

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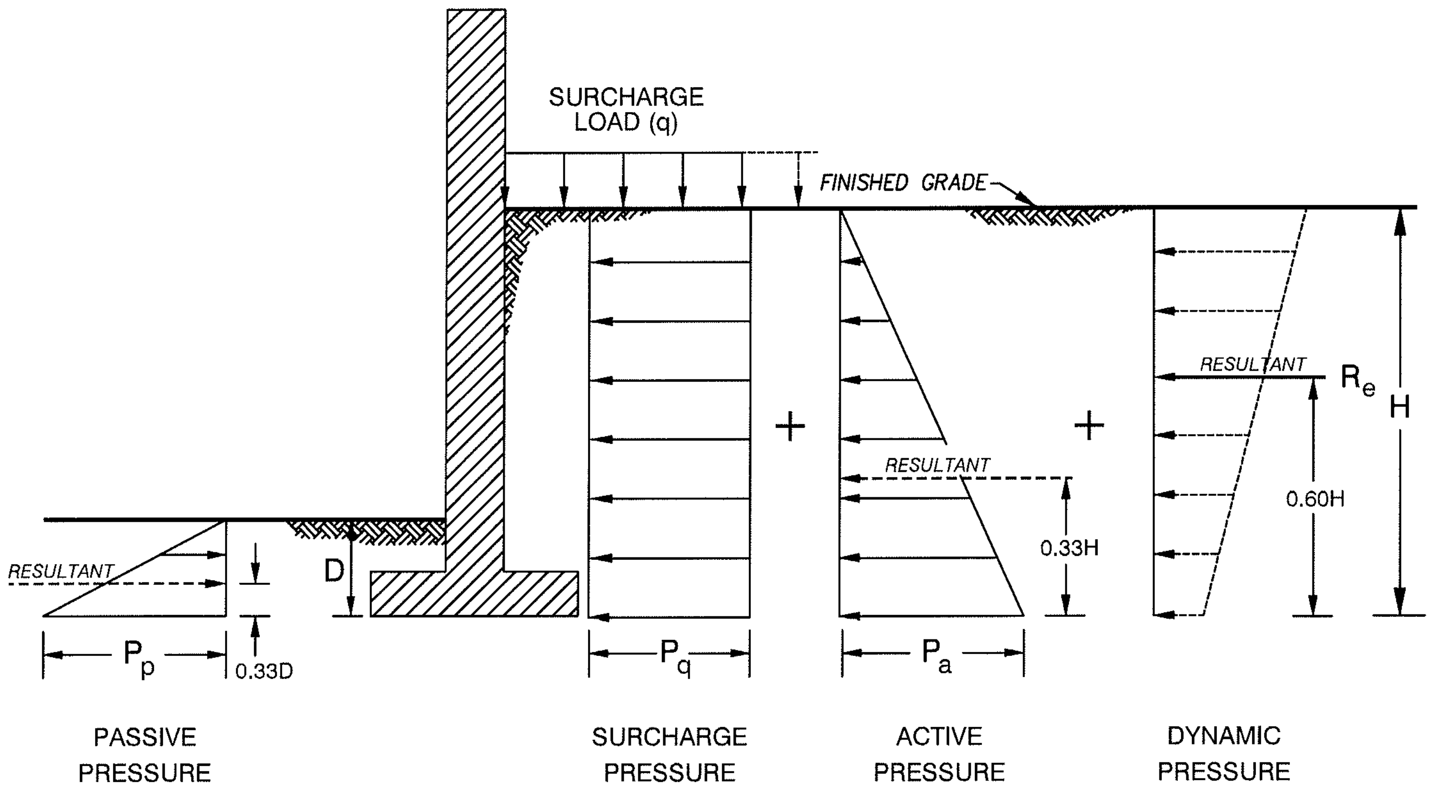


NOTES:

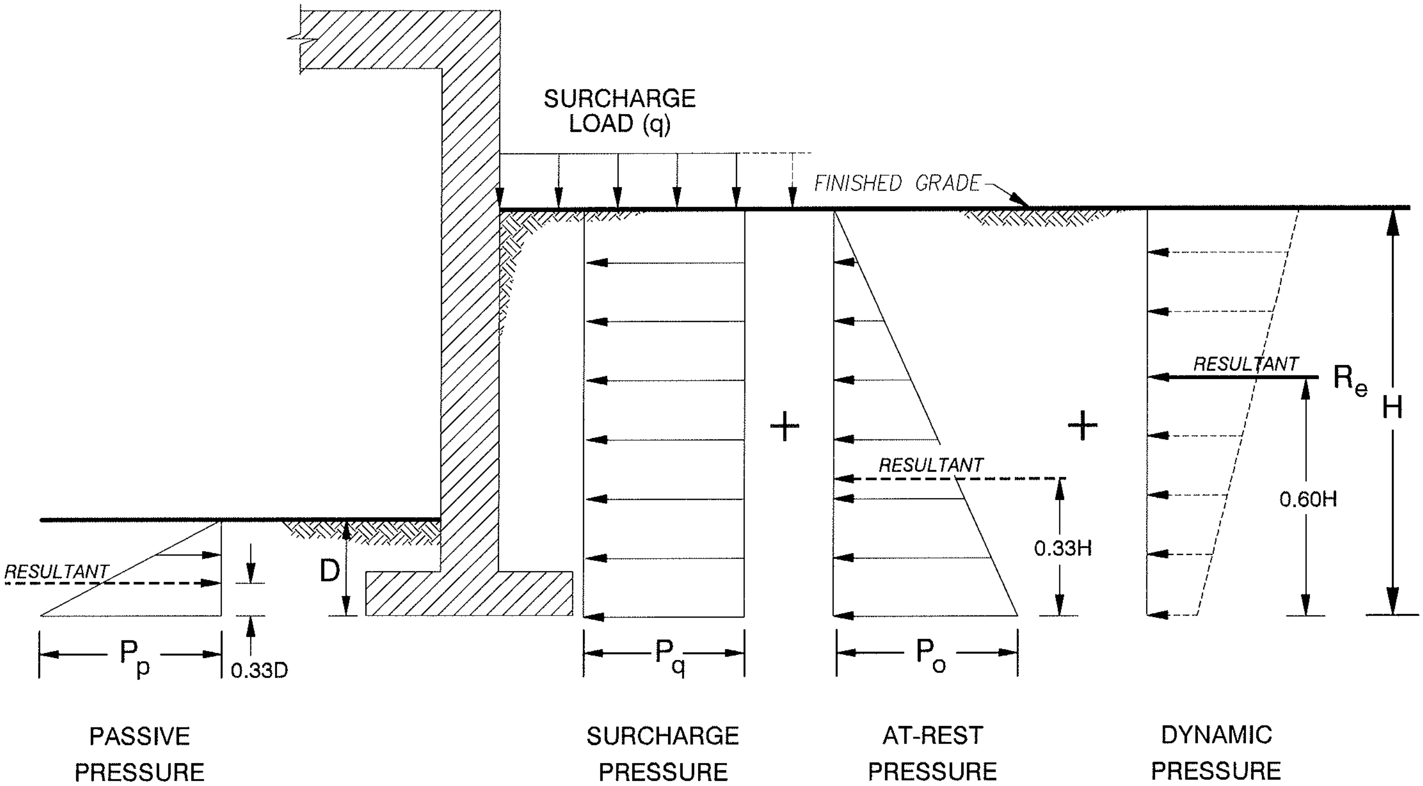
1. ASSUMES NO HYDROSTATIC PRESSURE BUILD-UP BEHIND THE RETAINING WALL
2. ASSUMES LEVEL, GRANULAR BACKFILL MATERIALS
3. DRAINS AS RECOMMENDED IN THE RETAINING WALL DRAINAGE DETAIL SHOULD BE INSTALLED BEHIND THE RETAINING WALL
4. DYNAMIC LATERAL EARTH PRESSURE RESULTANT IS BASED ON THE REFERENCED SOUTHERN NEVADA AMENDMENTS TO THE 2012 IBC (SNBO,2012)
5. H AND D ARE IN FEET
6. SETBACK SHOULD BE IN ACCORDANCE WITH SECTION 1808.7 OF THE 2012 IBC

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure
P_p	350 **D** psf
P_q	0.26 **q** psf
P_a	33 **H** psf
Resultant	Force Per Unit Width of Wall
R_e	$9H^2$ lbs/ft

NOT TO SCALE

Ninyo & Moore		LATERAL EARTH PRESSURES FOR YIELDING RETAINING WALLS	FIGURE
PROJECT NO.	DATE	HYPERLOOP BASE SITE STRUCTURES APEX NORTH LAS VEGAS, NEVADA	3
303983004	4/16		



NOTES:

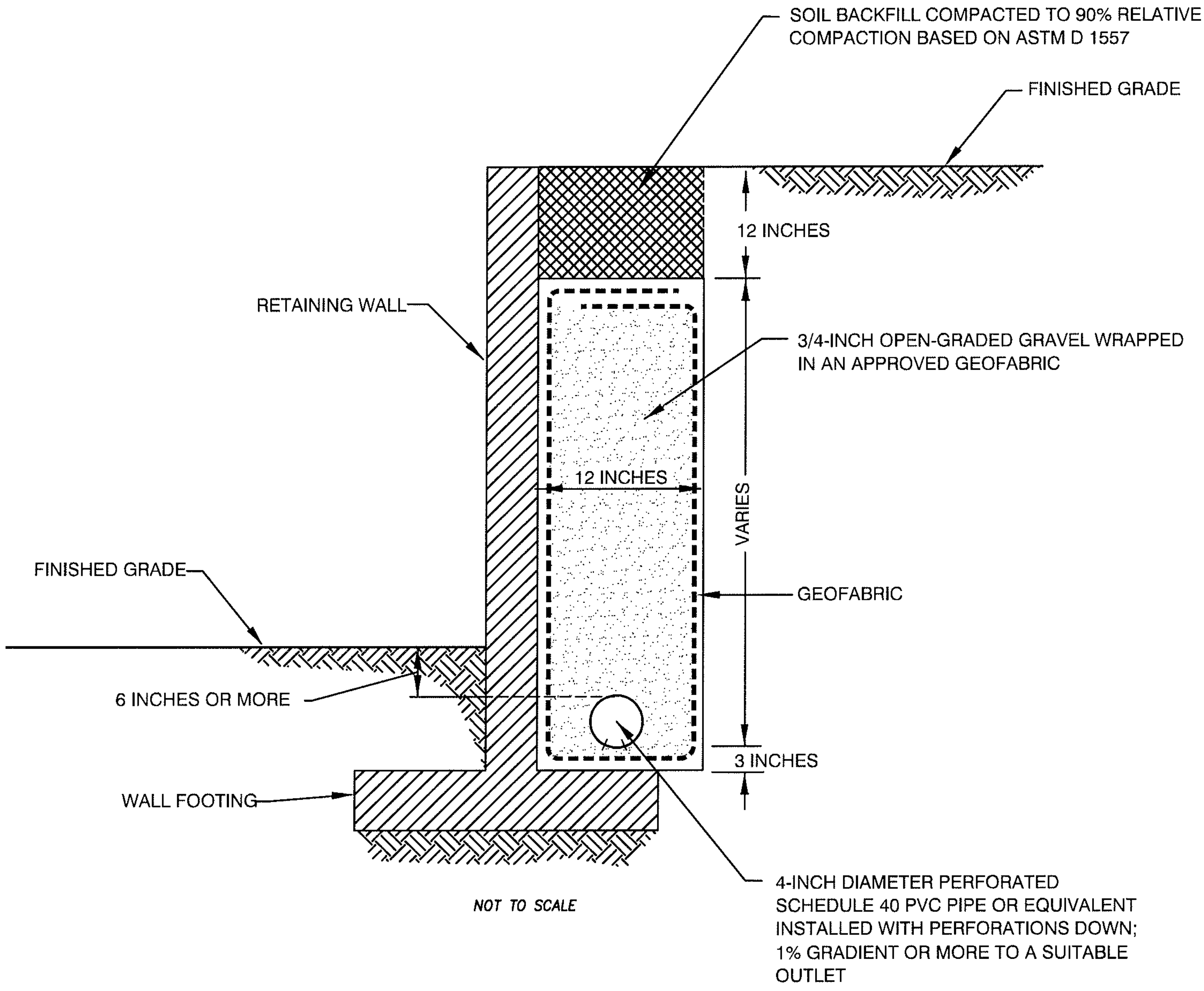
1. ASSUMES NO HYDROSTATIC PRESSURE BUILD-UP BEHIND THE RETAINING WALL
2. ASSUMES LEVEL, GRANULAR BACKFILL MATERIALS
3. DRAINS AS RECOMMENDED IN THE RETAINING WALL DRAINAGE DETAIL SHOULD BE INSTALLED BEHIND THE RETAINING WALL
4. DYNAMIC LATERAL EARTH PRESSURE RESULTANT IS BASED ON THE REFERENCED SOUTHERN NEVADA AMENDMENTS TO THE 2012 IBC (SNBO, 2012)
5. H AND D ARE IN FEET
6. SETBACK SHOULD BE IN ACCORDANCE WITH SECTION 1808.7 OF THE 2012 IBC

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure
P_p	350 **D** psf
P_q	0.41 **q** psf
P_o	50 **H** psf
Resultant	Force Per Unit Width of Wall
R_e	22 $\mathbf{H}^2$ lbs/ft

NOT TO SCALE

Ninyo & Moore	LATERAL EARTH PRESSURES FOR RESTRAINED RETAINING WALLS	FIGURE
PROJECT NO. 303983004	DATE 4/16	HYPERLOOP BASE SITE STRUCTURES APEX NORTH LAS VEGAS, NEVADA	4



NOTES: AS AN ALTERNATIVE, AN APPROVED GEOCOMPOSITE DRAIN SYSTEM MAY BE USED.

AS AN ALTERNATIVE TO USE OF 4" DIAMETER PVC BACKDRAINAGE PIPES, WEEP HOLES CAN BE CORED THROUGH THE WALL AND LINED WITH PVC PIPE. WEEP HOLES SHOULD BE 3" DIAMETER AND PLACED APPROXIMATELY 3" ABOVE THE LOWEST ADJACENT FINISHED GRADE AT APPROXIMATELY 10' ON-CENTER.

Ninyo & Moore		RETAINING WALL DRAINAGE DETAIL	FIGURE
PROJECT NO.	DATE	HYPERLOOP BASE SITE STRUCTURES APEX NORTH LAS VEGAS, NEVADA	5
303983004	4/16		

APPENDIX A

PREVIOUS BORING LOGS FROM HYPERLOOP BASE SITE

This appendix includes the boring logs for borings B-1, B-2, and B-3 from the previous Ninyo & Moore study performed at the Hyperloop Base Site (Ninyo & Moore Project No. 303983004). The approximate location of the borings is shown on Figure 2 of the report.

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GM	NATIVE SOIL: Light brown, moist, medium dense to dense, silty GRAVEL with sand.
							GP-GM	Light brown, moist, medium dense to dense, poorly graded GRAVEL with silt and sand.
5			30/6" 50/5"					Very dense.
10			30/6" 50/3"					Decrease in silt and sand.
15			50/4"					Slightly cemented.
20								

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 1 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20			50/2"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt, sand, and cobbles; slightly cemented.
								A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
30			50/1"					Light brown, moist, moderately hard to hard, CALICHE; moderately to strongly cemented.
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
35								A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
								Light brown, moist, moderately hard to hard, CALICHE; moderately to strongly cemented.
40								

DATE DRILLED 1/27/16 BORING NO. B-1
GROUND ELEVATION 2,616'± MSL SHEET 2 OF 7
METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig
DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"
SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40			50/2"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
								A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
45								With cobbles.
50			50/1"					
								Light brown, moist, moderately hard to hard, CALICHE; moderately to strongly cemented.
55								
60								

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 3 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-3

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60							GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly to moderately cemented.
								With cobbles.
65								
								A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
70								
75								
								Light brown, moist, moderately hard to very hard, CALICHE; moderately to strongly cemented.
80								

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 4 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-4

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 5 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Depth (feet)	Classification U.S.C.S.	Description/Interpretation
80		NATIVE SOIL (Continued): Light brown, moist, moderately hard to very hard, CALICHE; moderately to strongly cemented.
	GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt, sand, and cobbles; slightly cemented.
85		
90		A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
95		
100		

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-5

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
100							GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt, sand, and cobbles; slightly cemented.
105								
								A few moderately hard to hard, moderately to strongly cemented caliche layers, a few inches thick.
110								
115								
120								

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 6 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.

DATE DRILLED 1/27/16 BORING NO. B-1

GROUND ELEVATION 2,616'± MSL SHEET 7 OF 7

METHOD OF DRILLING Mayhew 1000 mud-rotary drill rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

DESCRIPTION/INTERPRETATION

120

Total depth = 120.0 feet.
Groundwater was not encountered during drilling.
Backfilled on 1/29/16.

NOTE:
Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

The ground elevation shown above is an estimation only. It is based on our interpretation of published maps and other documents reviewed for the purpose of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

125

The borehole was grouted with a bentonite and cement slurry and cased with a 3-inch diameter PVC pipe after drilling. The PVC pipe was capped at the bottom and filled with water up to the top for P-S logging procedures performed by others.

130

135

140

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-7

DATE DRILLED	1/26/16
BORING NO.	B-2
GROUND ELEVATION	2,627'± MSL
SHEET	1 OF 4
METHOD OF DRILLING	CME 75 Hollow Stem Auger Drill Rig
DRIVE WEIGHT	140 lbs (auto trip hammer)
DROP	30"
SAMPLED BY	RPM
LOGGED BY	RPM
REVIEWED BY	BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0		X	7/6" 10/6" 21/6"				SM	NATIVE SOIL: Light brown, moist, medium dense, silty SAND with gravel.
							GM	Light brown, moist, medium dense, silty GRAVEL with sand.
		X	16/6" 23/6" 23/6"					Very dense.
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
5		X	12/6" 28/6" 40/6"					Dense; with cobbles.
		X	20/6" 34/6" 32/6"					Very dense.
							GM	Light brown, moist, very dense, silty GRAVEL with sand.
	X	X	29/6" 50/6"					Slightly cemented.
10	X	X	23/6" 39/6" 32/6"					
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
15		X	18/6" 43/6" 50/3"					
								Slightly cemented.
20								

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-8

DATE DRILLED	1/26/16	BORING NO.	B-2
GROUND ELEVATION	2,627'± MSL	SHEET 2 OF 4	
METHOD OF DRILLING	CME 75 Hollow Stem Auger Drill Rig		
DRIVE WEIGHT	140 lbs (auto trip hammer)	DROP	30"
SAMPLED BY RPM	LOGGED BY RPM	REVIEWED BY	BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20			50/4"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
25			50/5"					
30			32/6" 50/3"					A few moderately hard, moderately cemented caliche layers a few inches thick.
35			50/3"					Decrease in silt and sand.
40								

DATE DRILLED 1/26/16	BORING NO. B-2	
GROUND ELEVATION 2,627'± MSL	SHEET 3	OF 4
METHOD OF DRILLING CME 75 Hollow Stem Auger Drill Rig		
DRIVE WEIGHT 140 lbs (auto trip hammer)	DROP 30"	
SAMPLED BY RPM	LOGGED BY RPM	REVIEWED BY BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40			50/3"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
45			50/5"					With cobbles.
50			19/6" 37/6" 34/6"				SM	Light brown, moist, very dense, silty SAND with gravel.
							GM	Light brown, moist, very dense, silty GRAVEL with sand.
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
55			50/2"					
60								

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-10

DATE DRILLED	1/26/16	BORING NO.	B-2
GROUND ELEVATION	2,627'± MSL	SHEET	4 OF 4
METHOD OF DRILLING	CME 75 Hollow Stem Auger Drill Rig		
DRIVE WEIGHT	140 lbs (auto trip hammer)	DROP	30"
SAMPLED BY	RPM	LOGGED BY	RPM
REVIEWED BY	BDB		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60			50/2"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
								With cobbles.
65			50/3"					
70			50/4"					Total depth = 70.3 feet. Groundwater was not encountered during drilling. Backfilled on 1/26/16. NOTE: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretation of published maps and other documents reviewed for the purpose of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
75								
80								

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-11

DATE DRILLED 1/28/16 BORING NO. B-3

GROUND ELEVATION 2,634'± MSL SHEET 1 OF 4

METHOD OF DRILLING CME 75 Hollow Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0			6/6" 6/6" 14/6"				SM	NATIVE SOIL: Light brown, moist, medium dense, silty SAND with gravel.
			11/6" 20/6" 22/6"				GM	Light brown, moist, very dense, silty GRAVEL with sand.
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
5			24/6" 33/6" 50/5"					Slightly cemented.
			31/6" 50/5"					
								A silty sand layer a few inches thick.
			17/6" 37/6" 50/5"				GM	Light brown, moist, very dense, silty GRAVEL with sand.
10			32/6" 29/6" 26/6"					
							GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand.
15			50/3"					Slightly cemented.
							GM	Light brown, moist, very dense, silty GRAVEL with sand; slightly cemented.
20								

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-12

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20			24/6" 50/3"				GM	NATIVE SOIL (Continued): Light brown, moist, very dense, silty GRAVEL with sand and cobbles; slightly cemented.
25			50/4"				GP-GM	Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
30			37/6" 50/3"					A few moderately hard to hard, moderately to strongly cemented layers of caliche, a few inches thick.
35			50/2"					
40								

DATE DRILLED 1/28/16 BORING NO. B-3

GROUND ELEVATION 2,634'± MSL SHEET 2 OF 4

METHOD OF DRILLING CME 75 Hollow Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-13

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40			50/5"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented.
45			50/4"					With cobbles.
								A few moderately hard to hard, moderately to strongly cemented layers of caliche, a few inches thick.
50			50/5"					
55			50/2"					
60								

DATE DRILLED 1/28/16 BORING NO. B-3

GROUND ELEVATION 2,634'± MSL SHEET 3 OF 4

METHOD OF DRILLING CME 75 Hollow Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-14

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
60			42/6" 50/2"				GP-GM	NATIVE SOIL (Continued): Light brown, moist, very dense, poorly graded GRAVEL with silt and sand; slightly cemented; a few moderately hard to hard, moderately to strongly cemented layers of caliche, a few inches thick.
65			50/4"					
70			50/2"					Total depth = 70.2 feet. Groundwater was not encountered during drilling. Backfilled on 1/28/16.
								NOTE: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
								The ground elevation shown above is an estimation only. It is based on our interpretation of published maps and other documents reviewed for the purpose of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
75								
80								

DATE DRILLED 1/28/16 BORING NO. B-3

GROUND ELEVATION 2,634'± MSL SHEET 4 OF 4

METHOD OF DRILLING CME 75 Hollow Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs (auto trip hammer) DROP 30"

SAMPLED BY RPM LOGGED BY RPM REVIEWED BY BDB

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE BORINGS
APEX, NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	2/16	A-15

APPENDIX B

LOGS OF LOAD TEST DRILLED SHAFT EXCAVATIONS

This appendix includes the logs of load test drilled shaft excavations TS-1 through TS-3 previously performed at the site. The approximate location of the drilled shafts is shown on Figure 2 of the report.

DATE DRILLED	3-9-16	BORING NO.	TS-1
GROUND ELEVATION	2615' ± MSL	SHEET	1 OF 1
METHOD OF DRILLING	42" Diameter Solid Flight Auger		
DRIVE WEIGHT	NA	DROP	NA
SAMPLED BY	BOM	LOGGED BY	BOM
REVIEWED BY	BLO		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GP-GM	NATIVE SOIL: Brown, dry, medium dense to dense, poorly graded GRAVEL with sand, silt, and cobbles up to approximately 6 inches diameter; gravel is sub-rounded to sub-angular, composed primarily of limestone/dolostone; cohesionless.
								Increase in sand content.
5								
								Dense to very dense.
10								
								Very dense; slightly cemented layer several inches thick.
15								
								Total Depth = 15.5 feet. Groundwater not encountered. Note: Groundwater, though not encountered at the time of drilling, may rise to higher level due to seasonal variations in precipitation and several other factors as discussed in the report. Start Time: 0900 Total Depth Time: 0925 Ground surface cleared and grubbed prior to drilling. Lat 36.41989 / Long -114.96102
20								

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE STRUCTURES
APEX/NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	4/16	B-1

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GP-GM	NATIVE SOIL: Brown, dry, medium dense to dense, poorly graded GRAVEL with silt, sand, and cobbles up to 10 inches diameter; gravel is sub-rounded to sub-angular composed of limestone/ dolostone; cohesionless.
								Increase in sand content.
5								
10								Dense to very dense.
15								
								Very dense.
20								

DATE DRILLED 3-9-16 BORING NO. TS-2

GROUND ELEVATION 2615' ± MSL SHEET 1 OF 2

METHOD OF DRILLING 42" Diameter Solid Flight Auger

DRIVE WEIGHT NA DROP NA

SAMPLED BY BOM LOGGED BY REVIEWED BY BLO

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE STRUCTURES
APEX/NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	4/16	B-2

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.
20							
25							
30							
35							
40							

DATE DRILLED 3-9-16 BORING NO. TS-2

GROUND ELEVATION 2615' ± MSL SHEET 2 OF 2

METHOD OF DRILLING 42" Diameter Solid Flight Auger

DRIVE WEIGHT NA DROP NA

SAMPLED BY BOM LOGGED BY REVIEWED BY BLO

DESCRIPTION/INTERPRETATION

Total Depth = 20.0 feet.
Groundwater not encountered.

Note: Groundwater, though not encountered at the time of drilling, may rise to higher level due to seasonal variations in precipitation and several other factors as discussed in the report.

Start Time: 0939
Total Depth Time: 1015
Ground surface cleared and grubbed prior to drilling.
Lat. 36.41989 / Long -114.96181

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE STRUCTURES
APEX/NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	4/16	B-3

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							GP-GM	NATIVE SOIL: Brown, dry, medium dense to dense, poorly graded GRAVEL with silt, sand, and cobbles up to approximately 10 inches diameter; gravel is sub-rounded to sub-angular composed primarily of limestone/dolostone; cohesionless.
								Increase in sand content.
								Dense to very dense.
5								
10								
15								Very dense; a few thin slightly cemented layers.
							GM	Brown, dry, very dense, silty GRAVEL with sand and cobbles; cobbles to approximately 6 inches diameter.
20								

DATE DRILLED 3-9-16 BORING NO. TS-3

GROUND ELEVATION 2615' ± MSL SHEET 1 OF 2

METHOD OF DRILLING 42" Diameter Solid Flight Auger

DRIVE WEIGHT NA DROP NA

SAMPLED BY BOM LOGGED BY ______ REVIEWED BY BLO

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE STRUCTURES
APEX/NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	4/16	B-4

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
20							GM	NATIVE SOIL: (Continued) Brown, dry, very dense, silty GRAVEL with sand and cobbles; cobbles to 6 inches diameter; gravel composed primarily of sub-rounded to sub-angular limestone/dolostone; cohesionless.
25								
							GP-GM	Brown, dry, very dense, poorly graded GRAVEL with silt, sand, and cobbles up to 8 inches diameter; gravel composed primarily of sub-rounded to sub- angular limestone/ dolostone; cohesionless.
30								
								Total Depth = 31.0 feet. Groundwater not encountered. Note: Groundwater, though not encountered at the time of drilling, may rise to higher level due to seasonal variations in precipitation and several other factors as discussed in the report. Start Time: 1202 Total Depth Time: 1243 Ground surface cleared and grubbed prior to drilling. Lat. 36.41971 / Long -114.96182
35								
40								

DATE DRILLED 3-9-16 BORING NO. TS-3

GROUND ELEVATION 2615' ± MSL SHEET 2 OF 2

METHOD OF DRILLING 42" Diameter Solid Flight Auger

DRIVE WEIGHT NA DROP NA

SAMPLED BY BOM LOGGED BY ______ REVIEWED BY BLO

Ninyo & Moore

BORING LOG

HYPERLOOP BASE SITE STRUCTURES
APEX/NORTH LAS VEGAS, NEVADA

PROJECT NO.	DATE	FIGURE
303983004	4/16	B-5

APPENDIX C

CHEMICAL TEST RESULTS FROM PREVIOUS STUDY

The results of chemical tests performed for the Hyperloop POAT 1 project are provided in this appendix.

SilverState Analytical Laboratories

LABORATORY REPORT

DATE: December 22, 2015

LABORATORY NO: 15-7256-1

CLIENT: Ninyo & Moore
6700 Paradise Road, Suite E
Las Vegas, NV 89119

PAGE: 1 of 1

CLIENT PROJECT: 303983001 ND

CLIENT PO #:

ANALYST: SW/LB/ET

Sampled By: Client
Date Sampled: --
Time Sampled: --

Date Received: 12/17/15
Time Received: 1000

Sample ID: B-7 @ 1.0-5.0'

Analysis	Result	Unit	Method
Sodium	<0.01	%	ASTM D2791
Water Soluble Sulfate (SO_4)	0.01	%	SM4500E
Total Available Water Soluble Sodium Sulfate (Na_2SO_4)	<0.01	%	Calculation
Total Salts (Solubility)	0.02	%	SM2540B
Soluble Soil Chlorides	15.8	mg/kg	SM4500Cl^-D
pH	8.12	S.U.	SM9045C
Redox	249	mV	SM2580B
Resistivity	5882	Ω-cm	NDOT T235B

NOTES: The results for each constituent denote the percentage (%) for that particular element which is soluble in a 1:5 (soil to water) extraction ratio and corrected for dilution.

REVIEWED BY: [signature] for

John Sloan
Laboratory Director
EPA: NV00930

3626 East Sunset Road, Suite 100 Las Vegas, NV 89120
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SilverState
Analytical Laboratories

LABORATORY REPORT

DATE: December 22, 2015

LABORATORY NO: 15-7256-2

CLIENT: Ninyo & Moore
6700 Paradise Road, Suite E
Las Vegas, NV 89119

PAGE: 1 of 1

CLIENT PROJECT: 303983001 ND

CLIENT PO #:

ANALYST: SW/LB/ET

Sampled By: Client
Date Sampled: --
Time Sampled: --

Date Received: 12/17/15
Time Received: 1000

Sample ID: B-9 @ 0.0-3.0'

Analysis	Result	Unit	Method
Sodium	<0.01	%	ASTM D2791
Water Soluble Sulfate (SO_4)	<0.01	%	SM4500E
Total Available Water Soluble Sodium Sulfate (Na_2SO_4)	<0.01	%	Calculation
Total Salts (Solubility)	0.01	%	SM2540B
Soluble Soil Chlorides	22.5	mg/kg	SM4500Cl$^-$D
pH	8.48	S.U.	SM9045C
Redox	204	mV	SM2580B
Resistivity	4762	Ω-cm	NDOT T235B

NOTES: The results for each constituent denote the percentage (%) for that particular element which is soluble in a 1:5 (soil to water) extraction ratio and corrected for dilution.

REVIEWED BY:

John Sloan
Laboratory Director
EPA: NV00930

APPENDIX D

FIELD RESISTIVITY TEST RESULTS

Field resistivity tests were performed at two locations at the subject site. A MiniRes Soil Resistance Meter and Wenner 4-pin arrangement were utilized to obtain electrical resistivity measurements at current and potential electrode intervals ("A" spacing) of 2, 5, 10, 20, 30 and 40 feet. Resistance values were recorded and used to calculate apparent resistivity in Ohm-centimeters (Ohm-cm). The approximate locations of the field resistivity tests are shown on Figure 2.

The field resistivity tests were conducted by a geologist trained and experienced in resistivity surveys. The test results are presented on the following table:

Field Resistivity Test Results

Location (orientation)	Spacing (feet)	Resistance (Ohms)		Apparent Resistivity (Ohm-cm)	
R-1 (E-W)	2	185	213	71,100	81,400
	5	127	131	122,100	125,800
	10	65	68	123,700	131,000
	20	16	17	60,500	64,300
	30	7.5	8.0	43,100	46,000
	40	7.7	8.2	59,200	62,800
R-2 (E-W)	2	169	161	64,700	61,500
	5	125	117	119,400	112,300
	10	57	57	109,700	108,200
	20	14	13	52,100	50,600
	30	5.6	5.3	32,200	30,400
	40	7.2	7.0	55,200	53,600

APPENDIX E

GENERAL DRILLED SHAFT RECOMMENDATIONS

Ninyo & Moore recommends that the following items regarding the installation of drilled shafts be incorporated into the project specifications.

1. All drilled shaft installation and concrete placement should be observed and documented by qualified geotechnical personnel.

2. Holes should be drilled or bored in such a manner as to provide a full-sized shaft, diameter and length specified on the project drawings or in the specifications.

3. Before and after placement of reinforcement cages and prior to placing concrete, the diameter, depth and bearing stratum of each borehole should be evaluated by the geotechnical consultant.

4. Concrete should be placed in the shaft by means of an “elephant trunk,” pump pipe, tremie pipe, or other approved means. Under no circumstances should concrete be allowed to free fall against shaft reinforcing.

5. If the bearing stratum is deemed as not capable of providing sufficient bearing support by the geotechnical consultant, the shaft length may need to be extended.

6. All loose material and slough should be removed from drilled shafts prior to concrete placement. Excavate shaft bottoms to a level plane, as approved by the geotechnical consultant. If caving occurs or “slough” from the surface falls into the borehole after placement of reinforcement cage, the reinforcement cage should be removed, the bottom cleaned out and reinforcement cage reinserted. If groundwater is encountered, it should be removed for concrete placement, or tremie placement methods as described below, should be used.

7. When groundwater is encountered, tremie concrete placement methods, as described below, may be used.

   a. Drilled shafts should be cleaned with a clean-out bucket or other approved method, immediately prior to concrete placement.

   b. The tremie or pump pipe should have watertight joints.

   c. During the initial concrete placement, the concrete tremie or pump pipe should be extended through the water to the bottom of the drilled shaft, prior to concrete placement.

d. During placement of concrete, the bottom of the pipe should be maintained below the top of the concrete at all times. If the seal is lost, the pipe should be reinserted and the operation restarted.

e. Sufficient embedment of the tremie or pump pipe in concrete should be maintained throughout concrete placement to reduce the re-entry of water potential. The embedment depth should be 5 or more feet.

f. The first placed portion of concrete flow that comes to the top of the shaft should be wasted, as evaluated by the geotechnical consultant.

g. Under no circumstances should concrete be allowed to free fall through water.

8. The placement of concrete for each drilled shaft should be completed in one placement prior to commencing the placement of concrete in another.

9. Quantities of concrete placed for each drilled shaft should be provided to the representative of the Owner.

10. Concrete should have an ultimate compressive strength of not less than that provided for in the specifications and should be workable and plastic so that it may be placed without segregation.

11. Concrete should be cast-in-place against undisturbed earth in the holes in such a manner as to provide for the exclusion of appreciable amounts of foreign matter in the concrete. Concrete should not be dropped vertically into drilled shaft excavations more than 5 feet unless an approved tremie (elephant trunk) or other similar appropriate method is used to reduce the potential for concrete striking the sides of the excavation.

Drilled shaft spacing should be evaluated by the geotechnical consultant at the time of construction. In order to reduce the potential for blowout between drilled shafts, it may be needed to place concrete and allow it to harden for 8 or more hours, prior to drilling adjacent shafts.