STATEMENT OF WORK (SOW)

Task Order No: FA4861-23-F-0203 (RKMF 23-0064)
Construct Addition and Repair for 328 WPS, BLDG. 47

APPENDIX F

Geotechnical Evaluation Report, 328 WPS Building 47

KALARCHITECTS ARCHITECTURE + ENGINEERING | PLANNING + INTERIOR DESIGN | CONSTRUCTION MANAGEMENT
Ninyo & Moore Geotechnical & Environmental Sciences Consultants
VOE
O'Connor Construction Management, Inc.

Geotechnical Evaluation
328 WPS Building 47
Holloman Avenue and Grissom Avenue
Nellis Air Force Base, Nevada

KAL Architects
12 J Mauchly | Irvine, California 92618

March 21, 2024 | Project No.305106001

Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

Ninyo & Moore
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35+ YEARS

Geotechnical Evaluation

328 WPS Building 47

Holloman Avenue and Grissom Avenue

Nellis Air Force Base, Nevada

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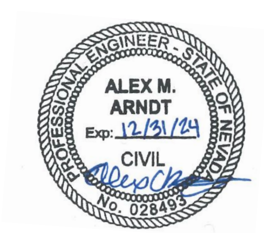

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1 INTRODUCTION

In accordance with your request, Ninyo & Moore has performed a geotechnical evaluation for the proposed 328 WPS Building 47 project located in Nellis Air Force Base (NAFB), Nevada. The location of the site is indicated on Figure 1. The purposes of our geotechnical study were to evaluate the subsurface soil conditions at the project site and to provide design and construction recommendations regarding geotechnical aspects of the project. This report presents the findings of our subsurface exploration, conclusions regarding subsurface conditions at the subject site, and geotechnical recommendations for design and construction of this project.

2 SCOPE OF SERVICES

The scope of our geotechnical services included the following:

- Review of pertinent background data, including in-house geotechnical data, project statement of work (SOW), aerial photographs, and published geologic maps, soils data, and literature.
- Coordination and mobilization for subsurface exploration, including clearance of existing utilities at the site conducted through Underground Service Alert (USA) and NAFB personnel.
- Acquisition of an NAFB excavation permit
- Drilling, logging, and sampling of three exploratory borings, which were advanced to depths of 16.5 feet. The borings were performed to evaluate subsurface soil conditions at the site and to obtain soil samples for laboratory testing.
- Performance of laboratory tests on selected soil samples obtained from the exploratory boring to evaluate in-place dry density and moisture content, particle size gradation, plasticity, swell potential, and chemical considerations including soluble sulfate and chloride, sodium sulfate (chemical heave), and solubility.
- Compilation and analysis of 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 project will consist of partial demolition, renovation, and expansion of the existing NAFB Building 47 to meet the needs of the 328th Weapons Squadron (328 WPS). The single-story expansion to the existing Building 47 will be up to approximately 20,000 square feet including restrooms/maternity room, break/storage/locker rooms, multiple large offices, 100-person auditorium, planning/simulator rooms and a conference room. Other improvements will include replacement of on-site water, sewer, electric, and communication service lines.

Improvements to on-site parking areas are anticipated including new asphalt and concrete pavements. Expansion of the parking lot area for Building 47 is anticipated to include elimination of a segment of Holloman Avenue. Replacement of deteriorated pavement northwest of Building 47's mechanical yard will also be part of the project. We assume structural loads for the project will be low to moderate on the order of 50 kips maximum for columns and 2 kips per lineal foot maximum for walls.

4 GENERAL SITE CONDITIONS

The project site is located on the northeastern portion of Nellis Air Force Base, on the northern corner of Holloman Avenue and Grissom Avenue. The site is bounded by England Avenue to the east, Holloman Avenue to the south, Grissom Avenue to the west, and Devlin Drive to the north. At the time of our fieldwork, the project site included an existing single-story building, asphalt paved parking areas, a back maintenance yard secured by a masonry block wall and gate, and undeveloped rock-mulch/landscape areas. The existing topography at the site was relatively flat and is generally the same grade as the adjacent roadways.

Indications of underground utilities, including water and electrical lines were observed on-site. Other underground utilities associated with NAFB may also be present at the site.

5 GEOLOGY AND SUBSURFACE CONDITIONS

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

5.1 Geologic Setting

The site is located at the foot of Sunrise Mountain in the northeast portion of Las Vegas Valley, which lies within the Basin and Range physiographic province. The Las Vegas Valley is a naturally formed structural basin as a result of block faulting, a fundamental characteristic of the Basin and Range physiographic province.

Las Vegas Valley extends in a northwest-southeast direction and drains generally toward the southeast through Las Vegas Wash into Lake Mead. Bordering the alluvium-filled valley are relatively steep mountain ranges including the Spring Mountains to the west; the Desert, Sheep, and Las Vegas ranges to the north; the McCullough Range to the south; and Sunrise Mountain, Frenchman Mountain, and River Mountains to the east.

Las Vegas Valley is underlain at depth by Proterozoic-age igneous and metamorphic basement rock, which is overlain by thick layers of Paleozoic- and Mesozoic-age sedimentary rock, and Tertiary-age volcanic rock. The lower lying areas of Las Vegas Valley generally contain relatively fine-grained deposits formed in former lake, marsh or stream floodplain environments during prehistoric times when the climate was appreciably wetter than today or in recent playa (dry lake) environments. Extending outward into the valley from the bordering mountain fronts, are sloping alluvial fans, comprised primarily of poorly sorted gravel and sand deposits with cobbles and boulders. Coarse-grained and fine-grained deposits generally inter-finger at their interface. Basin-fill sediments are up to about 5,000 feet thick in some areas of the valley.

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. Faults in the vicinity of the site include seismic (Class A) and subsidence-related (Class B) faults. Class A fault refers to a fault where geologic evidence demonstrates a Quaternary-active fault of tectonic origin (USGS, 2024). Class B fault refers to a fault where available geologic evidence is not strong enough to consider the fault of tectonic origin or to extend deep enough to be a source of significant earthquakes (USGS, 2024). Ground fissures, generally believed to be caused by erosion and differential stress resulting from regional subsidence due to withdrawal of groundwater, are known to occur near subsidence-related faults in southern Nevada (NBMG, 2001). There are no geologic hazards including faults and fissures anticipated to impact development of the site. The nearest mapped faults and fissure zone are summarized in the following table.

Table 1 – Nearest Geologic Hazard

Hazard	Description
Nearest Seismic Fault (Class A)	Frenchman Mountain fault approximately 2.6 miles east of the site
Nearest Subsidence-Related Fault (Class B)	Approximately 1.3 miles southwest of the site
Nearest Subsidence-Related Fissure Zone	Approximately 4.8 miles west of the site

Ninyo & Moore reviewed the referenced Clark County Soil Guidelines Map (GISMO, 2024a). This map indicates important aspects of near-surface soils and geologic features in the Las Vegas Valley. Review of the Clark County Soil Guidelines Map indicates that the project site is generally located within a Special Geotechnical Consideration Area including solubility, clay swell, corrosion, gypsum salt, expansive or hydro-collapsible potential. The results of the borings and laboratory tests presented herein generally corroborate the Clark County Soil Guidelines Map.

Ninyo & Moore reviewed the referenced Clark County Expansive Soil Guidelines Map (GISMO, 2024b). This map shows areas of the Las Vegas Valley where previous geotechnical studies have indicated the presence of low, moderate, high, and critical expansion potential. Based on review of this map, the subject site is expected in an area prone to low to moderate expansion potential. However, the results of the borings and laboratory tests presented in this report indicate that on-site soils have a high to critical expansion potential.

5.3 Ground Motions

Using the American Society of Civil Engineers 7 Hazard Tool (ASCE, 2016), estimated maximum considered earthquake spectral response accelerations for short (0.2 second) and long (1.0 second) periods were obtained for the subject site, which is located at approximately 36.24055 degrees north latitude and 115.04082 degrees west longitude. Based on the referenced International Building Code (ICC, 2018), the parameters in the following table are characteristic of the subject site for design purposes.

Table 2 – Seismic Design Criteria

Site Coefficients and Spectral Response Acceleration Parameters	Values
Risk Category	II
Site Class	D
Site Coefficient, F_a	1.321
Site Coefficient, F_v	2.211
Mapped Spectral Response Acceleration at 0.2-second Period, S_s	0.598 g
Mapped Spectral Response Acceleration at 1.0-second Period, S_1	0.194 g
Spectral Response Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	0.791 g
Spectral Response Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.430 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.527 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.287 g
Seismic Design Category	D

5.4 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 non-plastic silt. It is generally loose to medium dense, saturated, and subjected to sufficient magnitude and duration of ground shaking.

Liquefaction typically takes place within the upper 50 feet of the subsurface. Based on a publicly available groundwater monitoring well data within about 800 feet of the site (well log number 66574) groundwater is anticipated to be located deeper than 50 feet below ground surface (NDWR, 2024). Liquefaction hazard is considered low based on a screening analysis of publicly available well data showing no appreciable saturated soils within the upper 50 feet of the subsurface.

6 FIELD EXPLORATION, LABORATORY TESTING, AND SUBSURFACE CONDITIONS

Ninyo & Moore’s subsurface exploration of the project site was performed on February 23 and March 7, 2024. The exploration consisted of drilling, logging, and sampling of three small-diameter exploratory borings (B-1 through B-3). The borings were advanced to depths of 16.5 feet with a truck-mounted CME-75 drill rig and a track-mounted CME-55 drill rig each utilizing 8-inch diameter hollow-stem augers. The borings were logged by Ninyo & Moore personnel who meet the requirements of Section 1803.6.5 of the Southern Nevada Amendments to the 2018 International Building code (SNBO, 2019). The purpose of the borings was to evaluate subsurface conditions at the subject site, as well as to collect bulk and relatively undisturbed soil samples for laboratory testing. The elevations of the borings based on Mean Sea Level (MSL) were estimated from Google Earth Pro (Google, 2024). Accordingly, the boring elevations recorded on the boring logs in Appendix A should be considered approximate. The approximate locations of the borings are shown on Figure 2.

Laboratory tests were performed on representative soil samples collected from the borings to evaluate in-place dry density and moisture content, particle size gradation, plasticity, swell potential, soluble sulfate content and chloride content, sodium sulfate content, and solubility. The laboratory test results and descriptions of testing procedures utilized are presented in Appendix B and C.

6.1 Subsurface Soils Encountered

Generalized descriptions of the subsurface soils (fill and native soils) encountered in the borings are provided in the following sections.

6.1.1 Fill

Fill material, up to approximately ½-foot thick, was encountered in our borings. The encountered fill material consisted primarily of loose, poorly graded gravel (landscape gravel) or loose to medium dense, clayey sand. The existing fill should be considered uncontrolled fill and unsuitable in its present condition for the support of improvements.

6.1.2 Native Soil

Native soil was encountered beneath the noted fill and extended to the total depths of our exploratory borings (approximately 16.5 feet). The native soils consisted primarily of loose to very dense, clayey sand with varying amounts of gravel and firm to very stiff sandy lean and fat clay. Some native soils were observed to contain potentially water-soluble gypsum.

A layer of moderately hard to very hard, moderately to strongly cemented soil (caliche) was encountered in our exploratory borings. Caliche is a naturally occurring cemented soil with rock-like characteristics. The following describes typical properties of caliche encountered in southern Nevada.

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.
- Moderately hard caliche can generally be gouged with a knife with difficulty and broken with a few hammer blows.
- Hard and very hard caliche is difficult to scratch with a knife and breaks with difficulty with repeated hammer blows.
- May impede earthwork operations, including grading and utility line trenching. Rock excavation methods may be needed.

The following table describes the approximate depth, thickness, hardness and degree of cementation of caliche layers encountered in the borings.

Table 3 – Caliche Layers Encountered

Boring	Depth * (feet)	Thickness (feet)	Hardness
B-3	9.0	1.0	Moderately hard, moderately cemented

Note: *Depth measured from ground surface adjacent to boring.

Laboratory tests were performed on representative samples of subsurface soils obtained from the exploratory borings. Results of these tests are summarized in the following table.

Table 4 – Summary of Laboratory Test Results

Test Type	Test Results	Remarks
Atterberg Limits Liquid Limit Plastic Limit Plasticity Index	 26 to 76 17 to 25 9 to 51	Medium to high plasticity
Swell Potential	9 to 13 percent	High to critical swell potential
Chloride Content	0.024 and 0.026 percent	Below threshold to be considered corrosive to buried steel pipe
Sodium Sulfate Content	0.076 and 0.25 percent	Below threshold where soil is considered prone to chemical heave
Sulfate Content	0.066 and 0.44 percent	Severe sulfate exposure class (S2)
Sodium Content	0.025 and 0.079 percent	--
Total Salts (Solubility)	0.17 and 0.72 percent	Low solubility potential

6.2 Groundwater

Groundwater was not encountered in our exploratory borings, which were advanced to a maximum depth of 16.5 feet. Based on a publicly available groundwater monitoring well data (well log number 66574) groundwater is anticipated to be deeper than 50 feet below ground surface. Local and/or 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

There are no known geotechnical or geologic conditions that would preclude development of the site, provided the appropriate geotechnical recommendations are implemented. It is Ninyo & Moore's opinion that the following geotechnical and geologic factors should be considered in planning and development of the site:

- The native soils exhibit high to critical expansion potential upon wetting. Consequently, existing soils should be over-excavated beneath footings, slabs-on-grade, and aggregate base supporting pavements and replaced with Select Granular Material.

- Excavated native soil is generally not anticipated to meet the criteria for Select Granular Material due to its content of silt and clay sized particles and plasticity. Select Granular Material should be imported, or granular material should be imported and blended with excavated native soil to meet the criteria for Select Granular Material.

- Care should be exercised by the project contractor to avoid undermining of, and loss of lateral support for, the existing building's footing during overexcavation of subsurface soils. We recommend that the existing building be monitored for possible movement during project construction operations. If movement is detected, remedial measures should be implemented as soon as practicable, and the project's geotechnical engineer should be consulted for possible supplemental recommendations.

- A layer of moderately hard, moderately cemented caliche was encountered in one of our exploratory borings. Due to its variable nature, additional or shallower or thicker layers of caliche may be present in subsurface soils between or beyond our exploratory boring locations. Grading, excavations, and other earthwork activities will be impeded where these cemented soils are encountered. Rock excavation techniques should be anticipated during grading and excavation operations where these cemented soils are encountered.

- Spread footings should be founded on an over-excavated zone of compacted Select Granular Material.

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

- In accordance with the referenced International Building Code (ICC, 2018), the seismic parameters provided in Table 2 in Section 5.3 are characteristic of the site and may be used in design of the proposed buildings.

- Groundwater was not encountered in the borings to the maximum depth explored of 16.5 feet and is not anticipated to be a design or construction issue.

- Due to an anticipated depth to groundwater (approximately 55 feet below ground surface), no appreciable saturated soils are anticipated within the upper 50 feet of the subsurface and liquefaction hazard may be considered low.

8 RECOMMENDATIONS

Geotechnical recommendations for design and construction of proposed site improvements are provided in the following sections.

8.1 Earthwork

The following subsections provide recommendations for earthwork, including demolition, site grading, caliche considerations, select granular fill material, and temporary excavations.

8.1.1 Demolition

We understand that the subject project will include demolition of some existing improvements, including concrete flatwork, asphalt pavements, and landscape areas. Remnants from demolished improvements should be removed from the site. The contractor should take adequate precautions during demolition of any earthwork activities at the site to reduce the potential for damage to any known or undocumented utilities at the site. Existing utilities should be located, marked, and removed from structural areas or properly abandoned prior to demolition/earthwork operations. The project's geotechnical consultant should observe demolition activities to evaluate if demolished structural materials and utilities are adequately removed, and that resulting excavation are adequately backfilled, as described in the following section.

8.1.2 Site Grading

Prior to grading, proposed structure and improvement areas should be cleared of any surface obstructions, debris, organics (including shrubs, vegetation, and tree roots), and other deleterious material (such as debris from demolition of existing improvements). Materials generated from clearing operations should be removed from the project site for disposal. We recommend that the full depth of all existing uncontrolled fill be removed from proposed structure and improvement areas.

The native soils exhibit high to critical expansion potential upon wetting. To reduce the potential for future soil-related movement and possible associated damage, we recommend that near-surface native soils in areas of proposed structures and improvements be over-excavated and replaced with imported Select Granular Material. The following table summarizes recommended over-excavation depths needed to provide an adequate layer of Select Granular material beneath proposed project improvements.

Table 5 – Summary of Recommended Over-Excavation Depths

Proposed Improvement	Recommended Over-Excavation Depth*
Spread footings	24 inches below bottom of footing or 12 inches below existing grade, whichever extends lower in elevation
Concrete slab-on-grade	18 inches below aggregate base supporting slab or 12 inches below existing grade, whichever extends lower in elevation
Pavements and exterior concrete flatwork	18 inches below aggregate base supporting pavement or 12 inches below existing grade, whichever extends lower in elevation

Note:
*Over-excavation depth shown does not include 6-inch minimum scarification, moisture-conditioning and re-compaction of native subgrade to receive Select Granular Material. Over-excavation depth shown does not necessarily include removal of uncontrolled fill. Where uncontrolled fill is present, over-excavation should be continued to remove all uncontrolled fill.

Building pad preparation should extend 10 feet or more beyond the exterior edges of building foundations, where practicable. For unpaved surfaces adjacent to the building, the top approximately 12 inches of fill material placed on the Select Granular Material should consist of the generally fine-grained native soil intended to provide a relatively impervious surface to minimize the potential for rainfall wetting the soils beneath the building post-construction. Where utility trenches extend both inside and outside the building pad and utility trenches are backfilled with pervious Select Granular Material or similar pervious backfill, an impervious plug of controlled low strength material (CLSM) should be provided where the utility trench crosses the building perimeter to hinder infiltration of surface water under the foundation and floor slab soils.

After the over-excavation described above has been made, the exposed native soil should be scarified to approximately 6 inches, moisture-conditioned to approximately optimum moisture content, and compacted to 92 percent or more relative compaction, as evaluated using modified compaction effort per ASTM D1557. 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 material and to evaluate if excavations down to more competent soils are needed. In addition, the project's geotechnical consultant should observe and test the placement of structural fill.

The proposed improvements may include new foundations adjacent to the existing foundations. Excavations should not undermine existing foundations and should not extend below a plane that extends downward and outward from the bottom edge of existing foundations on a 1:1 (horizontal:vertical) slope. Alternatively, the soils beneath the foundations of the existing structure should be appropriately shored during excavation activities. In areas where new foundations are constructed parallel to existing foundations, and/or where the 1:1 excavation criteria cannot be met, the excavations should be performed in relatively small, independent stages to reduce the potential for undermining of existing footings. Staged excavations should not remain open for extended periods of time and should be adequately backfilled with structural fill prior to subsequent excavations. The geotechnical consultant should observe the exposed soils during excavations along the base of existing footings to assess the suitability and stability of the exposed soil.

The project's contractor should take precautions to avoid damage to existing structures during earthwork and construction operations. These precautions may include monitoring of the existing building and other site improvements for movement, cracking, etc. Precautionary measures should be reviewed and approved by the owner's representative.

8.1.3 Caliche Considerations

A layer of moderately hard to very hard, moderately to strongly cemented soil (caliche) was encountered in our exploratory borings. Due to its variable nature, additional, thicker or shallower layers of caliche may be encountered in areas between and beyond our boring locations during excavation operations for the project.

Special excavation techniques including heavy-duty ripper, heavy-duty hoe-ram, heavy-duty trencher or similar equipment should be anticipated to be necessary for excavation where caliche is encountered especially for deeper utility excavations.

8.1.4 Select Granular Material

Based on the findings of our subsurface evaluation and laboratory test results, excavated native soil is generally not anticipated to meet the criteria for Select Granular Material due to its content of silt and clay sized particles and plasticity. Select Granular Material should be imported, or granular material should be imported and blended with excavated native soil to meet the criteria for Select Granular Material recommended to be placed in over-excavations directly beneath improvements. However, for unpaved areas within at least 10 feet or more beyond the exterior edges of building foundations, the top approximately 12 inches of structural fill placed above Select Granular Material should consist of the generally fine-grained native soil intended to provide a relatively impervious surface to minimize the potential for rainfall wetting the soils beneath the building post-construction. The following table summarized the recommended fill material and compaction for various improvement areas.

Table 6 – Summary of Recommended Fill Material and Compaction

Improvement Area	Recommended Fill Material	Recommended Compaction*
Spread footing	Select Granular Material	At least 95 percent relative compaction near optimum moisture content, plus or minus 2 percent
Slab-on-grade	Select Granular Material	At least 95 percent relative compaction near optimum moisture content, plus or minus 2 percent
Pavement and exterior concrete flatwork	Select Granular Material	At least 95 percent relative compaction near optimum moisture content, plus or minus 2 percent
Top 12 inches in unpaved areas within 10 feet of exterior edges of building foundations	On-Site Borrow	At least 92 percent relative compaction at least optimum moisture content
Retaining wall backfill	Select Granular Material	At least 95 percent relative compaction near optimum moisture content, plus or minus 2 percent

Note: *As determined using the modified compaction effort per ASTM D1557.

The recommended fill materials should meet the material property requirements provided in the following table. All imported soil should meet the criteria for Select Granular Fill provided in the table below.

Table 7 – Fill Material Property Requirements	
Fill Material	**Property Requirements**
Select Granular Fill*	Maximum particle size of 2 inches nominal dimension (ASTM D6913) Less than 35 percent passing the No. 200 sieve (ASTM D1140) Liquid limit less than 35 (ASTM D4318) Plasticity index less than 12 (ASTM D4318) Expansion index of 20 or less (ASTM D4829) California Bearing Ratio of at least 20 (ASTM D1883)
On-Site Borrow**	Maximum particle size of 4 inches nominal dimension (visual observation) At least 35 percent passing the No. 200 sieve (ASTM D1140)

Notes:
* Imported to meet the property requirements, or imported and blended with on-site borrow to meet the property requirements.
**Excavated on-site soil processed to remove over-sized material larger than 4 inches nominal dimension.

Fill materials should be placed in maximum 8-inch loose lifts and moisture conditioned and compacted as recommended in Table 6. Earthwork operations should be observed and compaction of structural fill materials should be tested by the project's geotechnical consultant. Typically, one field test should be performed per lift for each approximately 2,500 square feet of fill placement in the building area and 15,000 square feet of fill placement in pavement areas. Additional field tests may also be performed in structural and non-structural areas at the discretion of the geotechnical consultant.

8.1.5 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 regulations (OSHA, 2016). 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.

8.2 Structure Foundations

Structure foundations consisting of spread footings should be designed using the parameters provided in the following table.

Table 8 – Foundation Design Parameters	
Parameter	**Description / Value**
Recommended Bearing Stratum	Over-excavated zone of compacted Select Granular Fill
Minimum Footing Width	18 inches (continuous) 24 inches (isolated)
Minimum Footing Embedment Depth	24 inches
Allowable Bearing Pressure *	2,000 psf
Allowable Sliding Resistance (Coefficient of Friction)	0.37
Allowable Lateral Bearing Pressure	250 psf/ft
Settlement	1 inch or less (total) ½ inch or less (differential)

Note:
*May be increased by 600 psf for each additional foot of embedment and 300 psf for each additional foot of width, up to a maximum of 3,500 psf. Included a factor of safety of at least 3. May be increased by one-third for short-duration loads, such as wind or seismic, provided by reducing the factor of safety for short-duration and infrequent loads.

Foundations should be designed and constructed in accordance with the recommendations of a qualified structural engineer.

8.3 Lateral Earth Pressures

Retaining walls that are not restrained from movement at the top and having level backfill behind the wall may be designed using an "active" lateral earth pressure as indicated on Figure 3. Retaining walls that are restrained from movement at the top and having level backfill behind the wall 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. The value for "q" represents the pressure induced by adjacent surcharge loads including traffic loads or adjacent footing loads. These lateral earth pressure values assume compaction within about 5 feet of the wall will be accomplished with relatively light compaction equipment. These values also assume that retaining walls will have a height of approximately 10 feet or less.

The Seismic Design Category is D, and due to the seismic demand and risk category of the proposed structures, retaining walls should be designed to include seismic earth pressures as shown on Figure 3 and Figure 4.

Backfill placed behind retaining walls should have no more than 30 percent passing the No. 200 sieve and an Expansion index of 20 or less or a swell potential of 4 percent or less, as evaluated by the test method outlined in Section 1803.5.3.2 of the referenced Southern Nevada Amendments to the 2018 International Building Code (SNBO, 2019).

Measures should be taken so that hydrostatic pressure does not build up behind retaining walls. Drainage measures, as indicated on Figure 5, should include open-graded gravel and perforated drain pipe or weep holes lined with polyvinyl chloride (PVC) pipe. Drain pipes should outlet away from structures and retaining walls. Retaining walls should be damp-proofed in accordance with the recommendations of a qualified civil engineer or architect.

8.4 Concrete Slab-On-Grade Floors

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 at least 6 inches of Type II Aggregate Base overlying at least 18 inches of compacted Select Granular Fill. Type II Aggregate Base should meet Section 704.03.04 of the referenced Uniform Standard Specifications (RTC, 2024). Aggregate base underlying concrete slab-on-grade floors should be compacted to at least 95 percent relative compaction, as evaluated using modified compaction effort per ASTM D1557.

Floor slabs should be 6 inches or more in thickness and reinforced with No. 3 steel reinforcing bars placed at 18 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 be at least 15 mils in thickness. The membrane should overlie the compacted aggregate base material. Concrete in contact with soils including slab-on-grade floors should be designed for durability to resist severe sulfate exposure class S2 per Section 8.7.

8.5 Exterior Concrete Flatwork

Exterior concrete flatwork, such as walkways, should be at least 4 inches thick and provided with control joints and steel reinforcing in accordance with recommendations of a qualified structural engineer. Ninyo & Moore recommends that exterior concrete flatwork for this project be founded on at least 4 inches of Type II Aggregate Base overlying at least 18 inches of compacted Select Granular Fill. Type II Aggregate Base should meet Section 704.03.04 of the referenced Uniform Standard Specifications (RTC, 2024). Aggregate base underlying exterior concrete flatwork should be compacted to at least 95 percent relative compaction, as evaluated using modified compaction effort per ASTM D1557.

Concrete in contact with soils including exterior concrete flatwork should be designed for durability to resist severe sulfate exposure class S2 per Section 8.7.

8.6 Pavements

The on-site pavements and associated traffic provided in the following table are anticipated for the project.

Table 9 – Pavements and Anticipated Traffic

Pavement Type	Traffic / Area	Equivalent Passes *
Light-duty asphalt	Up to 25 privately-owned-vehicles (POVs) per day / parking lot	182,500
Heavy-duty asphalt	Up to 1 P-23 crash fire trucks per day / drive aisle	7,300
Concrete	Up to 1 single-unit garbage trucks per day / trash dumpster enclosure	7,300

Note: *Based on 20-year design life.

Pavement designs were performed in accordance with the Unified Facilities Criteria (DoD, 2016) using the program PCASE2.09.06 (USACE, 2019). Pavement design calculations are provided in Appendix D. The following table presents the recommended structural pavement sections for the various pavement types.

Table 10 – Recommended Pavement Section Thickness

Pavement Type	Design CBR *	Design k-value**	Asphalt Concrete Thickness (Inches)	Portland Cement Concrete Thickness (Inches)	Aggregate Base Thickness (Inches)	Select Granular Fill Thickness
Light-duty asphalt	10	--	4	--	6***	18
Heavy-duty asphalt	10	--	4	--	6***	18
Concrete	--	250 pci	--	6	6	18

Notes:
- * Estimated CBR based on laboratory classification tests.
- ** Refers to modulus of subgrade reaction. Applicable for top of Select Granular Fill.
- *** Adopted as the minimum thickness.

Type II Aggregate Base should meet Section 704.03.04 of the referenced Uniform Standard Specifications (RTC, 2024). Aggregate base underlying pavements should be compacted to at least 100 percent relative compaction, as evaluated using modified compaction effort per ASTM D1557.

Adequate surface drainage should be provided to reduce the potential for ponding and infiltration of water into the pavement and subgrade materials. Surface runoff from surrounding areas should be intercepted, collected, and not permitted to flow onto the pavement or infiltrate the aggregate base and subgrade. We recommend that perimeter swales, curbs and gutters, or combination of these drainage devices be provided to reduce the adverse effects of surface water runoff.

8.7 Concrete and Corrosion Considerations

Laboratory testing was performed to assess the effects of sulfate on concrete. Results of these tests are presented in Appendix C. The tested on-site soil is considered to have severe (S2) sulfate exposure class (ACI, 2014). We recommend that concrete in contact with soil including spread footings, slab-on-grade floors, and exterior flatwork should be proportioned for durability to resist severe sulfate exposure including the following:

- Containing Type V sulfate resistant cement;
- Having a maximum water-to-cement ratio of 0.45; and
- Having a minimum 28-day strength of 4,500 psi.

Laboratory testing was performed to assess the effects of chloride on buried steel pipe. Results of these tests are presented in Appendix C. Corrosion reduction methods should be considered for this project for buried steel pipe. A corrosion engineer should be consulted to design or select appropriate corrosion protection. Where permitted by applicable building code, the use of plastic pipe should be considered.

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 the proposed buildings. Positive drainage should be established by providing a surface gradient of at least 5 percent within unpaved surfaces and 2 percent within paved surfaces away from the building for a distance of at least 10 feet measured perpendicular from the building perimeter, or to a drainage swale intend to convey rainwater off the site.

- Adequate surface drainage should be provided to channel surface water away from the buildings to a suitable outlet such as a storm drain or the street. 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 the building.

- Building roof drains should have downspouts tightlined to an appropriate outlet, such as a storm drain or the street. If tightlining of the downspouts is not practicable, they should discharge 5 feet or more away from the building or onto concrete flatwork or asphalt that slopes away from the structure. Downspouts should not be allowed to discharge onto the ground surface adjacent to building foundations.

- Ninyo & Moore recommends that low-water use (drip irrigated) landscaping be utilized on site, particularly within 10 feet of the buildings.

- Irrigation heads should be oriented so that they spray away from the buildings.

8.9 Observation and Testing

A qualified geotechnical consultant should perform appropriate observation, testing, and inspection services during grading and construction operations. These services should include performance of observation and testing services during placement and compaction of structural fill and backfill soils. The geotechnical consultant should also perform observation, testing, and inspection services during placement of concrete, mortar, grout, asphalt concrete, and steel reinforcement. Special inspections of soils should be performed as indicated in Table 1705.6 of the referenced Southern Nevada Amendments to the 2018 International Building Code (SNBO, 2019). 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 of soils should be continuous type 4b as indicated in Table 1705.6.

8.10 Plan Review

The recommendations presented in this report are based on preliminary design information for the proposed project, as provided by KAL Architects, and on the findings of our geotechnical evaluation. When finished, project plans and specifications should be reviewed by the geotechnical consultant prior to submitting the plans and specifications for permitting and bid. Additional field exploration and laboratory testing may be needed upon review of the project design plans.

8.11 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.

10 REFERENCES

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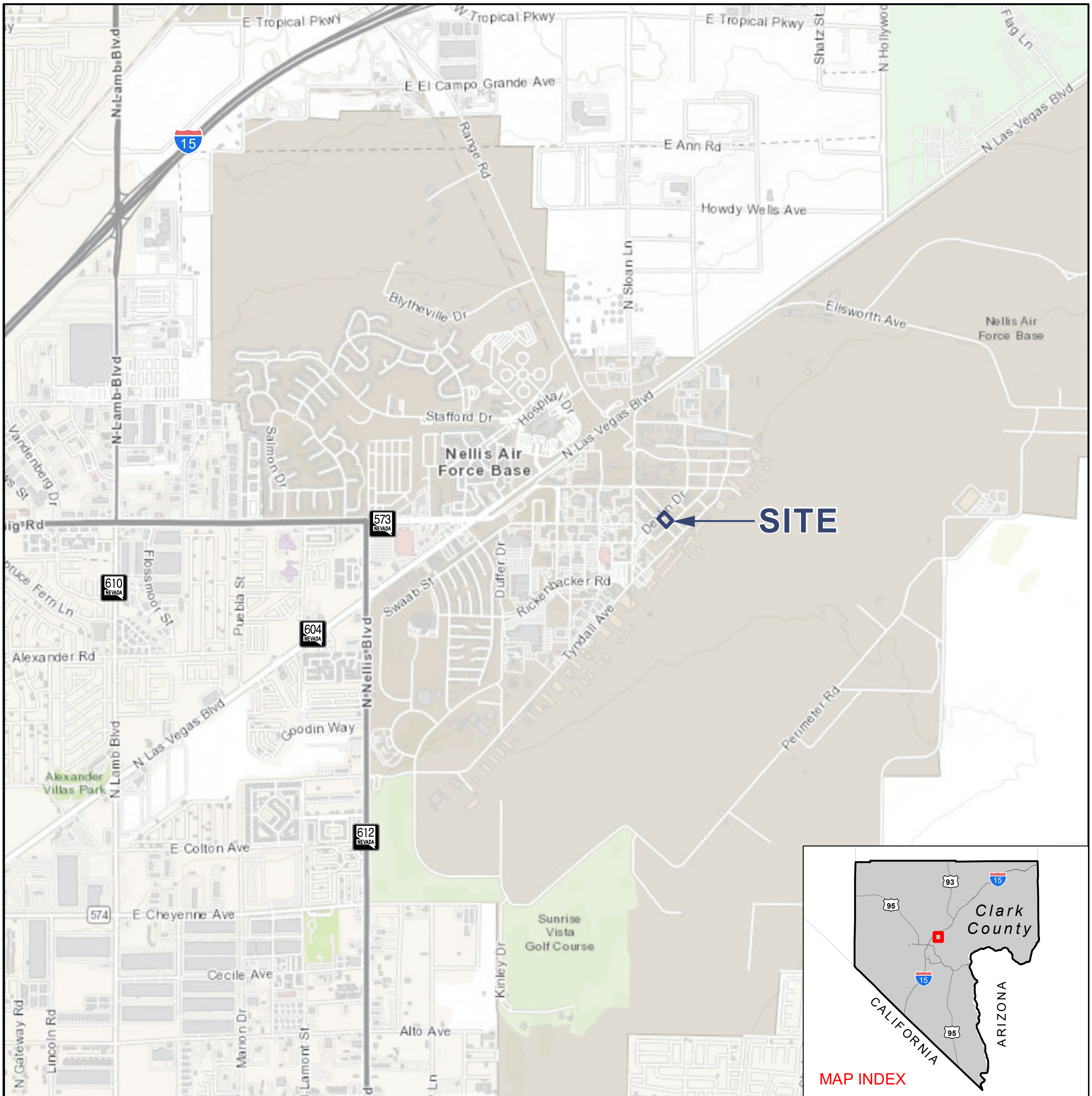
FIGURES



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NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: ESRI WORLD TOPO, 2024

N

FEET

0 3,000 6,000

FIGURE 1

SITE LOCATION

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE
NELLIS AIRFORCE BASE, NORTH LAS VEGAS, NEVADA

305106001 | 3/24

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NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE. | SOURCE: GOOGLE EARTH, 2024

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FIGURE 2

BORING LOCATIONS

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE
NELLIS AIRFORCE BASE, NORTH LAS VEGAS, NEVADA

305106001 | 3/24

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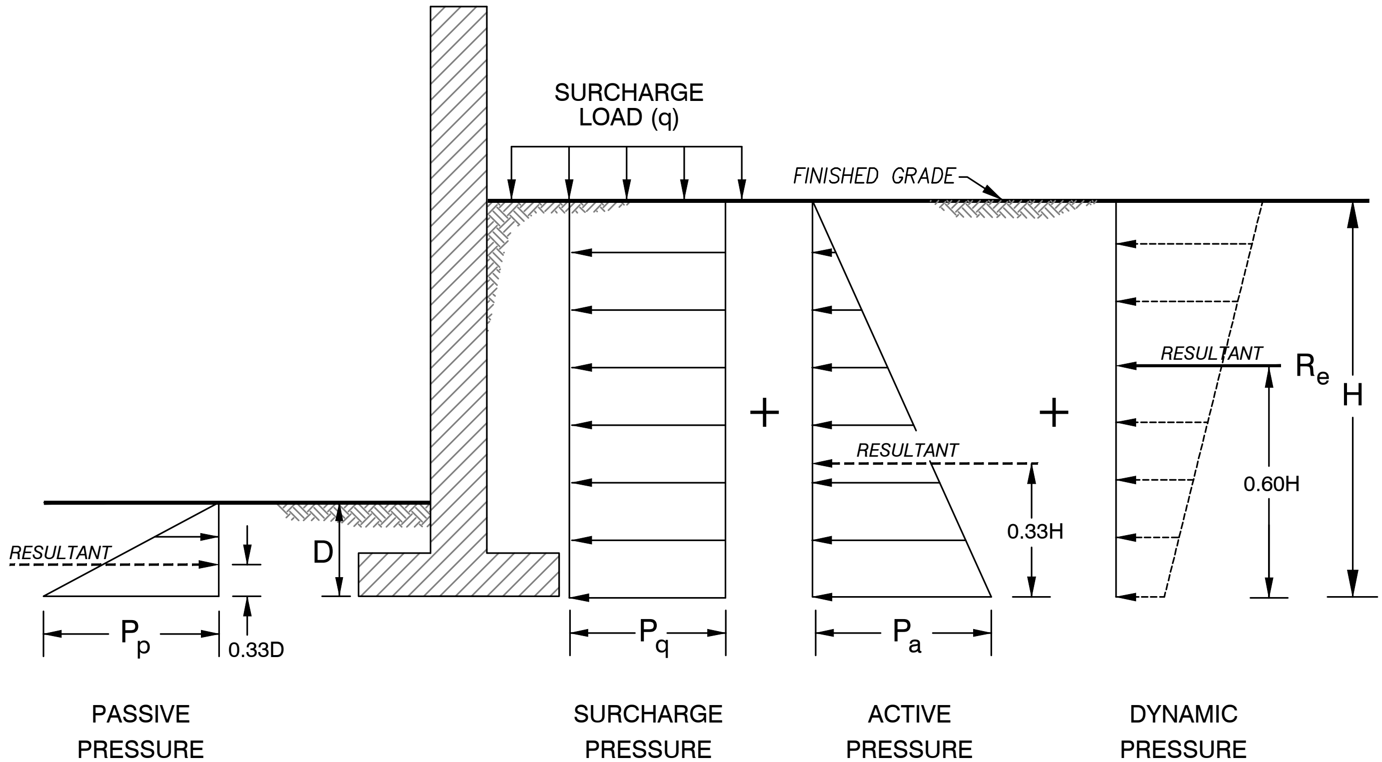

NOTES:

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 2018 IBC (SNBO, 2019)
5. H AND D ARE IN FEET
6. SETBACK SHOULD BE IN ACCORDANCE WITH SECTION 1808.7 OF THE 2018 IBC

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure
P_p	250 **D** psf
P_q	0.31 **q** psf
P_a	37 **H** psf
Resultant	Force Per Unit Width of Wall
R_e	13 $\mathbf{H}^2$ lbs/ft

NOT TO SCALE

FIGURE 3

LATERAL EARTH PRESSURES FOR YIELDING RETAINING WALLS

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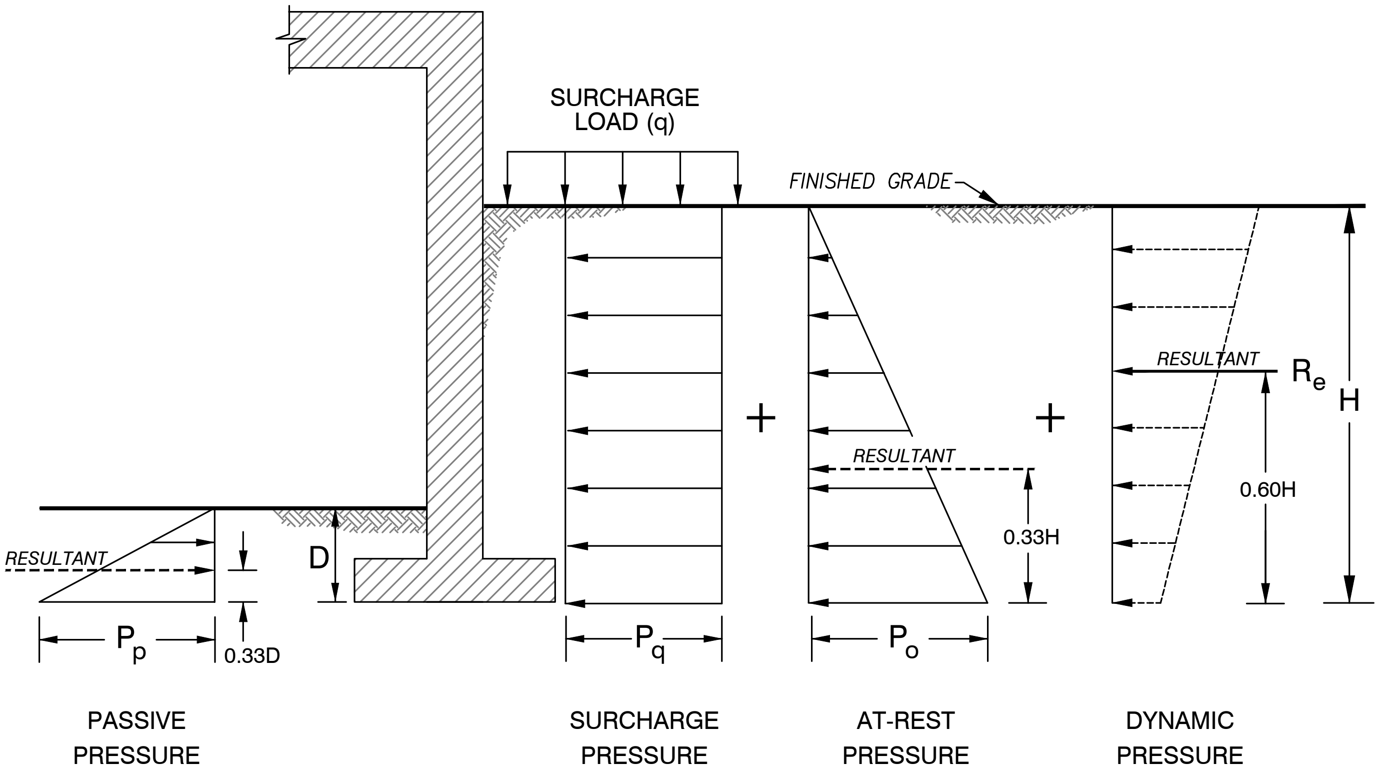

NOTES:

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 2018 IBC (SNBO, 2018)
5. H AND D ARE IN FEET
6. SETBACK SHOULD BE IN ACCORDANCE WITH SECTION 1808.7 OF THE 2018 IBC

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Lateral Earth Pressure	Equivalent Fluid Pressure
P_p	250 **D** psf
P_q	0.47 **q** psf
P_o	57 **H** psf
Resultant	Force Per Unit Width of Wall
R_e	23 $\mathbf{H}^2$ lbs/ft

NOT TO SCALE

4 304158001 D-LEPR.DWG

FIGURE 4

LATERAL EARTH PRESSURES FOR RESTRAINED RETAINING WALLS

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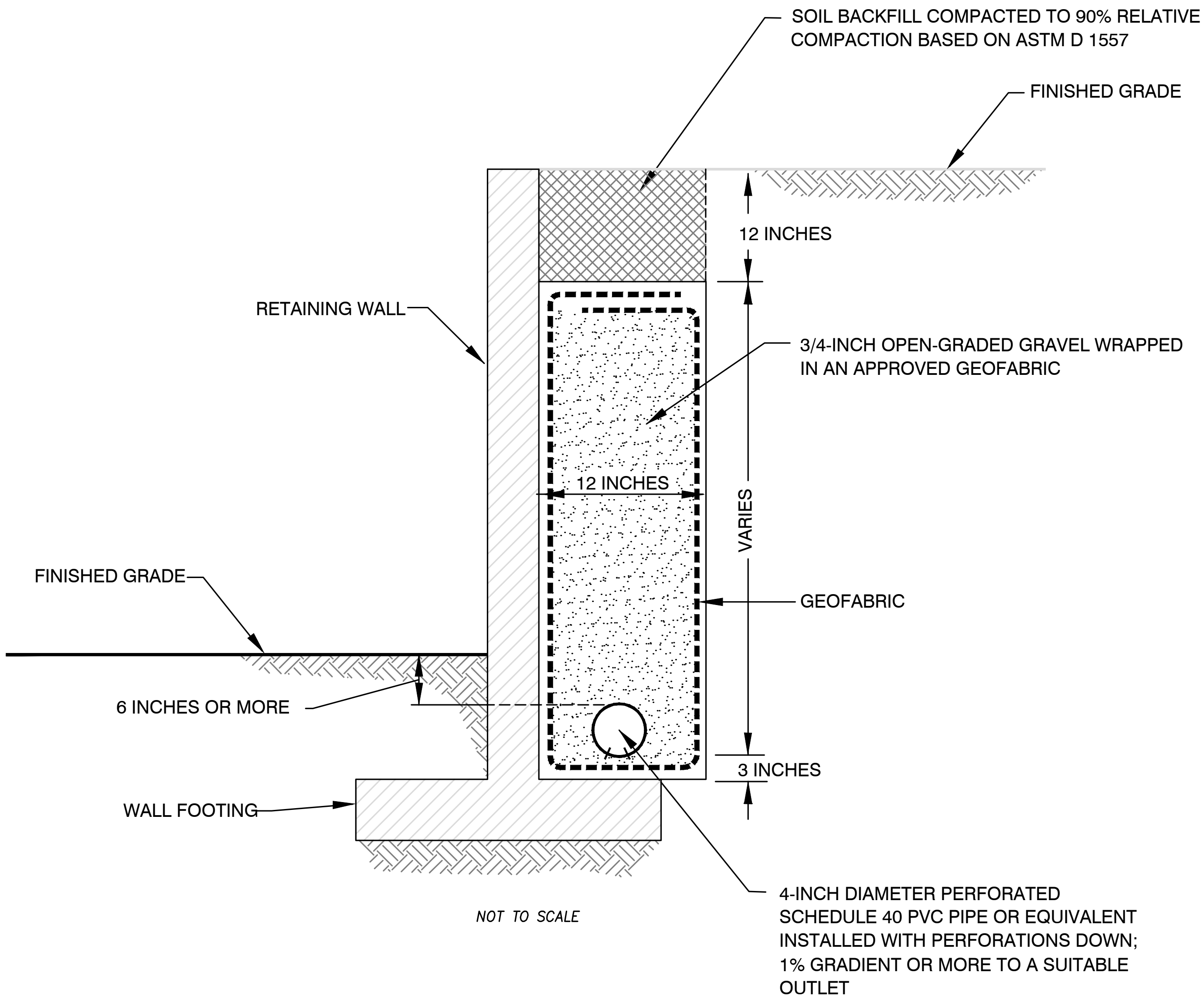

NOTES: AS AN ALTERNATIVE, AN APPROVED GEOCOMPOSITE DRAIN SYSTEM MAY BE USED.

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.

RETAINING WALL DD D-RW.DWG

FIGURE 5

RETAINING WALL DRAINAGE DETAIL

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NELLIS AIR FORCE BASE, NEVADA

305106001 | 3/24

APPENDIX A

Exploratory Boring Logs

APPENDIX A

EXPLORATORY BORING LOGS

Field Procedure for the Collection of Disturbed Samples
Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples
Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test (SPT) Sampler
Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-⅜ inches. The sampler was driven into the ground with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D1586 and the blow counts were recorded. Soil samples were observed and removed from the sampler, bagged, sealed, and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples
Relatively undisturbed soil samples were obtained in the field using a modified split barrel drive sampler. The sampler, with an external diameter of 3 inches, was lined with 1-inch long, thin brass rings with inside diameters of 2-½ inches. The sample barrel was driven into the ground with the weight of a hammer in general accordance with ASTM D3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows during driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

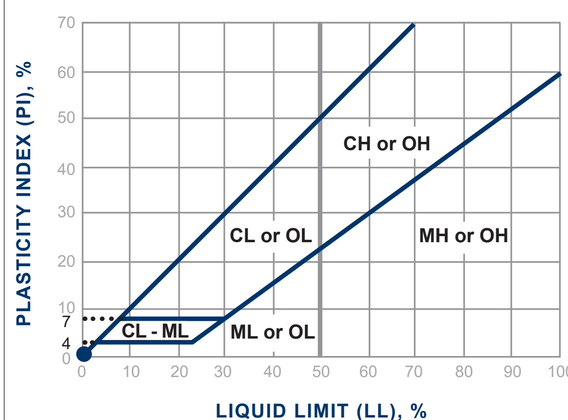
Soil Classification Chart Per ASTM D 2488

Primary Divisions			Group Symbol	Group Name
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

Grain Size

Description		Sieve Size	Grain Size	Approximate Size
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

Plasticity Chart



Apparent Density - Coarse-Grained Soil

Apparent Density	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

Consistency - Fine-Grained Soil

Consistency	Spooling Cable or Cathead		Automatic Trip Hammer	
	SPT (blows/foot)	Modified Split Barrel (blows/foot)	SPT (blows/foot)	Modified Split Barrel (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

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USCS METHOD OF SOIL CLASSIFICATION

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0								Bulk sample.
								Modified split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler.
								Sample retained by others.
								Standard Penetration Test (SPT).
5								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
								Seepage.
10								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
							CL	Dashed line denotes material change.
15								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

DATE DRILLED 2/23/24 BORING NO. B-1

GROUND ELEVATION 1,870' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY CAC LOGGED BY CAC REVIEWED BY BLO

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SC	NATIVE SOIL: Light brown, dry, loose, clayey SAND, with gravel.
								Moist, medium dense.
			4/6" 4/6" 6/6"	5.2				
5			5/6" 6/6" 9/6"	13.5	82.8		CL	Light brown, moist, stiff, sandy lean CLAY.
10								Firm.
			9/6" 7/6" 1/6"	9.2				
15			6/6" 8/6" 27/6"	17.3	74.4			Very stiff.
20								Total Depth = 16.5 feet. Groundwater not encountered during drilling. Backfilled on 2/23/24.

Total Depth = 16.5 feet.
Groundwater not encountered during drilling.
Backfilled on 2/23/24.

Notes:
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 interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DATE DRILLED	3/7/24	BORING NO.	B-2
GROUND ELEVATION	1,872' ± (MSL)	SHEET 1 OF 1	
METHOD OF DRILLING	CME-75 Hollow-Stem Auger Drill Rig		
DRIVE WEIGHT	140 lbs. (Auto. Trip)	DROP	30"
SAMPLED BY	CAC	LOGGED BY CAC	REVIEWED BY BLO

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	X						GP	FILL: Brown, dry, loose, poorly graded GRAVEL (landscape gravel).
	X						SC	NATIVE SOIL: Light brown, dry, medium dense, clayey SAND.
	X	X	7/6" 15/6" 14/6"					
5		X	7/6" 6/6" 11/6"					Moist.
10		X	16/6" 5/6" 5/6"					Loose; moderately gypsiferous.
15		X	10/6" 50/5"					Very dense.
20								

Total Depth = 15.9 feet.
Groundwater not encountered during drilling.
Backfilled on 3/7/24.

Notes:
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 interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.

DATE DRILLED 2/23/24 BORING NO. B-3

GROUND ELEVATION 1,870' ± (MSL) SHEET 1 OF 1

METHOD OF DRILLING CME-75 Hollow-Stem Auger Drill Rig

DRIVE WEIGHT 140 lbs. (Auto. Trip) DROP 30"

SAMPLED BY CAC LOGGED BY CAC REVIEWED BY BLO

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	X						SC	FILL: Light brown, dry, loose to medium dense, clayey SAND ; overlain by 1 inch of landscape gravel.
	X			7.6			CL	NATIVE SOIL: Light brown, moist, stiff, sandy lean CLAY.
	X	X	5/6" 6/6" 7/6"					
5		X	7/6" 6/6" 8/6"	23.2	92.3		CH	Light brown, moist, stiff, sandy fat CLAY.
								Light brown, dry, moderatey hard, CALICHE; moderately cemented.
10		X	41/6" 18/6" 12/6"	11.5			SC	Brown, moist, medium dense, clayey SAND.
15		X	5/6" 19/6" 32/6"	13.9	93.2			
								Total Depth = 16.5 feet. Groundwater not encountered during drilling. Backfilled on 2/23/24. Notes: 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 interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
20								

FIGURE A-3

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328 WPS B47
NELLIS AIR FORCE BASE, NEVADA

APPENDIX B

Laboratory Testing

APPENDIX B

LABORATORY TESTING

Classification
Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

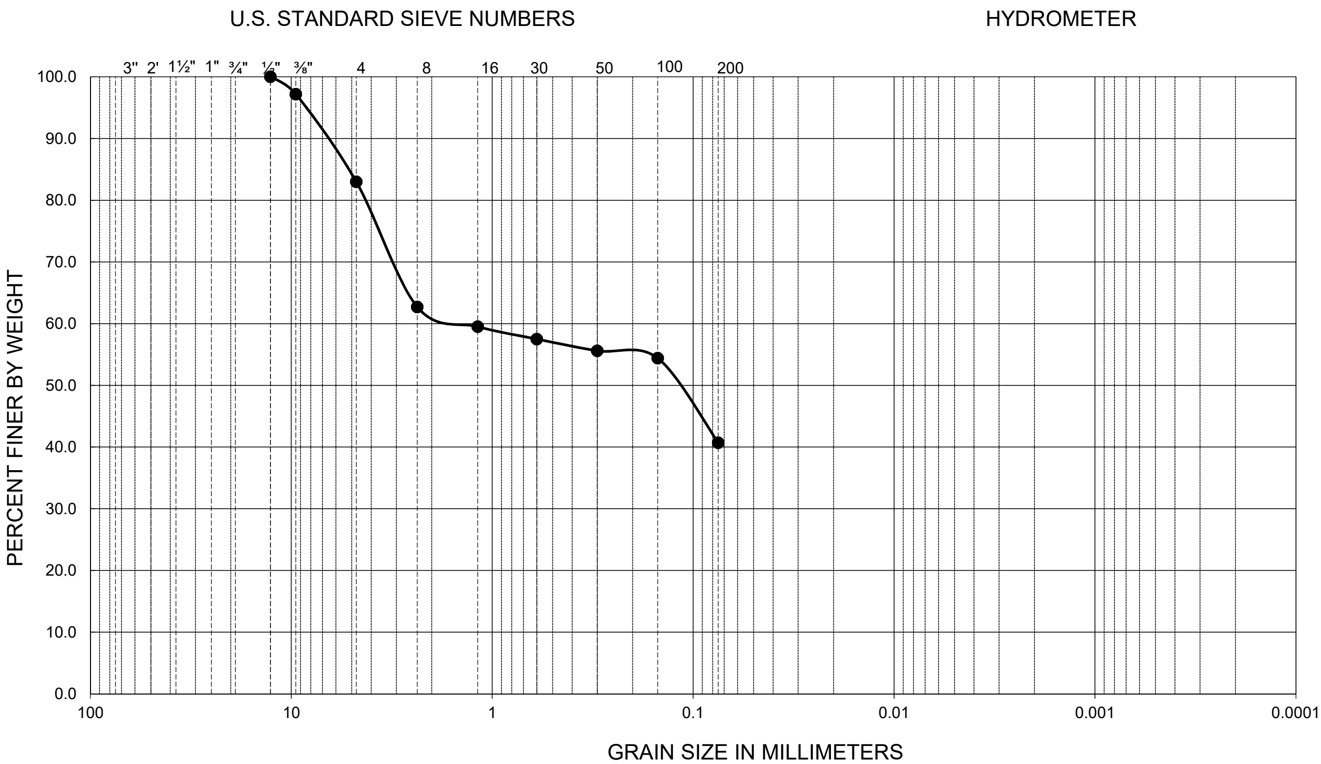
In Place Moisture and Density
The moisture content and dry density of ring-lined samples obtained from the exploratory borings were evaluated in general accordance with ASTM D2216 and ASTM D2937, respectively. The test results are presented on the boring logs in Appendix A.

Gradation Analysis
Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D422. The test results were utilized in evaluating the soil classifications in accordance with the USCS. The grain-size distribution curves are shown on Figures B-1 and Figure B-2.

Atterberg Limits
Tests were performed on selected representative soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D4318. The test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classifications are shown on Figure B-3.

Swell Tests
The swell potential of selected relatively undisturbed samples was evaluated. The samples were dried in a 60-degree centigrade oven for 8 hours or more and were loaded with a surcharge of 60 pounds per square foot before inundation with tap water, in general accordance with test criteria specified in Section 1803.5.3.2 of the referenced Southern Nevada Amendments to the 2018 International Building Code (SNBO, 2019). Readings of volumetric swell were recorded until completion of primary swell. The results of these tests are summarized on Figure B-4

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	2.5-4.0	26	17	9	--	--	1.31	--	--	40.7	SC

Material Percent by Weight			Soil Type
Gravel	Sand	Fines	Clayey SAND with gravel
17.0	42.3	40.7	

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

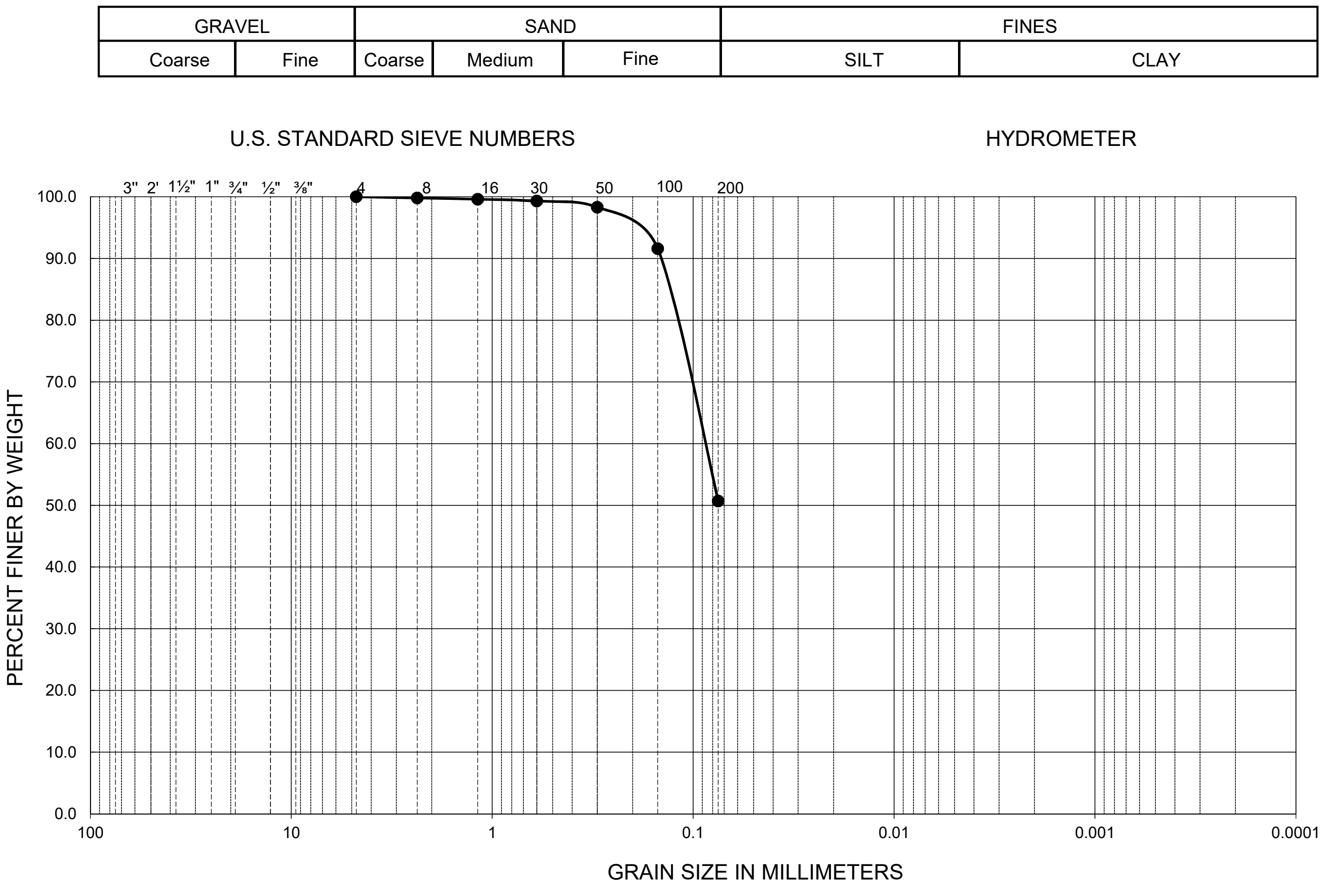
FIGURE B-1

GRADATION TEST RESULTS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE, NELLIS AIR FORCE BASE, NEVADA

305106001 | 3/2024



Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-3	5.0-6.5	76	25	51	--	--	0.09	--	--	50.7	CH

Material Percent by Weight			Soil Type
Gravel	Sand	Fines	Sandy fat CLAY
0.0	49.3	50.7	

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

FIGURE B-2

GRADATION TEST RESULTS

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE, NELLIS AIR FORCE BASE, NEVADA

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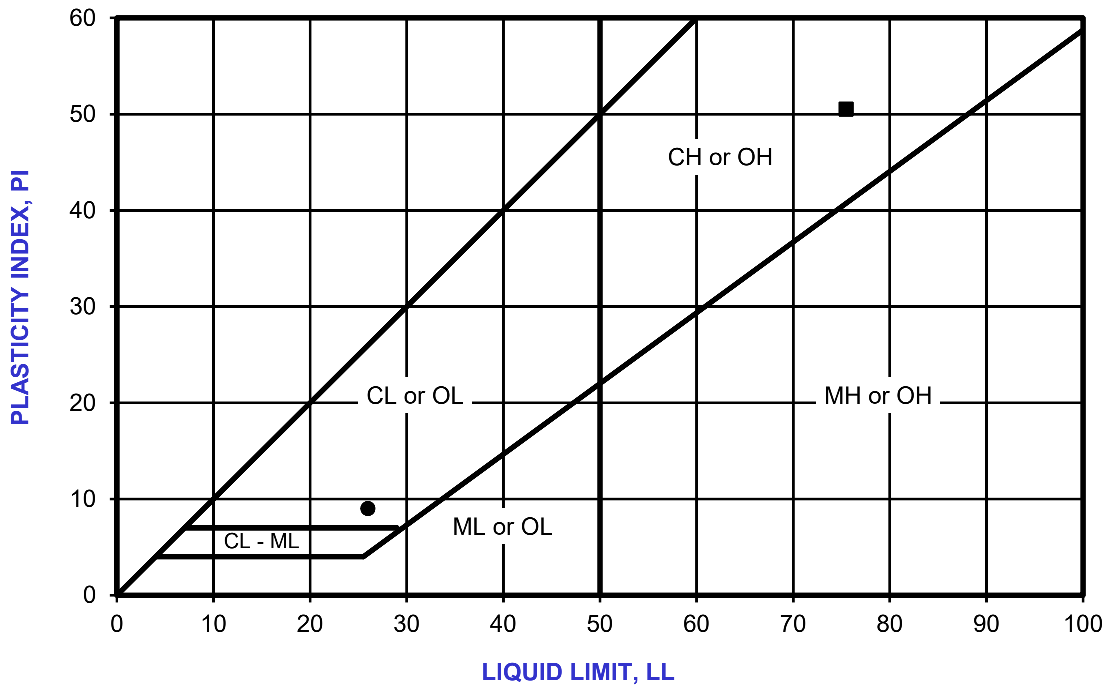
SYMBOL	LOCATION	DEPTH (ft)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS
●	B-1	2.5-4.0	26	17	9	CL	SC
■	B-3	5.0-6.5	76	25	51	CH	CH

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH D 4318

FIGURE B-3

Ninyo & Moore
Geotechnical & Environmental Sciences Consultants

ATTERBERG LIMITS TEST RESULTS

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE, NELLIS AIR FORCE BASE, NEVADA

SAMPLE LOCATION	SAMPLE DEPTH (ft)	IN-PLACE MOISTURE (percent)	IN-PLACE DRY DENSITY (pcf)	FINAL MOISTURE (percent)	SURCHARGE (PSF)	SWELL POTENTIAL (percent)	EXPANSION POTENTIAL
B-1	5.0-6.5	10.4	88.1	36.4	60	11	High
B-1	15.0-16.5	18.2	70.8	50.4	60	9	High
B-3	5.0-6.5	14.9	102.3	24.9	60	13	Critical
B-3	15.0-16.5	29.3	69.1	52.5	60	10	High

* Negative number indicates collapse.

PERFORMED IN GENERAL ACCORDANCE WITH SECTION 1803.5.3.2 OF THE SOUTHERN NEVADA BUILDING CODE AMENDMENTS

RESULTS INTERPRETED IN ACCORDANCE WITH TABLE 1808.6.1.1 OF THE SOUTHERN NEVADA BUILDING CODE AMENDMENTS

FIGURE B-4

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SWELL POTENTIAL TEST RESULTS

328 WPS B47
HOLLOMAN AVENUE AND GRISSOM AVENUE, NELLIS AIR FORCE BASE, NEVADA

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APPENDIX C

Chemical Test Results

APPENDIX C

CHEMICAL TEST RESULTS

The results of chemical tests performed are provided in this appendix.

Veritas Laboratories
Truth in Quality, Truth in Service
6245 Harrison Drive, Suite 4, Las Vegas, NV 89120

(702) 321-8315 Phone
(702) 597-2098 Fax
Email: veritaslabs@msn.com

CLIENT COMPANY NAME: Ninyo and Moore
CLIENT PROJECT NAME: **Nellis AFB B47**
CLIENT PROJECT NUMBER: 305106001
VERITAS LAB ORDER ID: V24C100

ANALYTICAL RESULTS

CLIENT SAMPLE ID: **B-1 @ 0'-5'** DATE/TIME SAMPLED: 2/23/24 0:00
VERITAS SAMPLE ID: V24C100-01 DATE/TIME RECEIVED: 3/8/24 15:00

Matrix: Soil

Analysis: Soil Solubility/Corrosion Parameters

PARAMETER	RESULT	UNITS	METHOD	DATE ANALYZED
Soluble Sodium	**0.025**	%	EPA 6010B	3/11/24
Soluble Sulfate	**0.066**	%	SM 4500-SO4 E	3/11/24
Total Soluble Sodium Sulfate	**0.076**	%	Calculation	3/11/24
Soluble Chloride	**0.024**	%	SM 4500-Cl E	3/11/24
Total Soluble Salts (Solubility)	**0.17**	%	SM 2540C	3/11/24

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Truth in Quality, Truth in Service
6245 Harrison Drive, Suite 4, Las Vegas, NV 89120
(702) 321-8315 Phone
(702) 597-2098 Fax
Email: veritaslabs@msn.com

CLIENT COMPANY NAME: Ninyo and Moore
CLIENT PROJECT NAME: **Nellis AFB B47**
CLIENT PROJECT NUMBER: 305106001
VERITAS LAB ORDER ID: V24C100

ANALYTICAL RESULTS

CLIENT SAMPLE ID: **B-3 @ 0'-5'**
VERITAS SAMPLE ID: V24C100-02
DATE/TIME SAMPLED: 2/23/24 0:00
DATE/TIME RECEIVED: 3/8/24 15:00

Matrix: Soil

Analysis: Soil Solubility/Corrosion Parameters

PARAMETER	RESULT	UNITS	METHOD	DATE ANALYZED
Soluble Sodium	**0.079**	%	EPA 6010B	3/11/24
Soluble Sulfate	**0.44**	%	SM 4500-SO4 E	3/11/24
Total Soluble Sodium Sulfate	**0.25**	%	Calculation	3/11/24
Soluble Chloride	**0.026**	%	SM 4500-Cl E	3/11/24
Total Soluble Salts (Solubility)	**0.72**	%	SM 2540C	3/11/24

APPENDIX D

PCASE Pavement Design Results

APPENDIX D

PCASE PAVEMENT DESIGN RESULTS

The results of PCASE pavement designs are provided in this appendix.

Pavement Design Report
U.S. Army Corps of Engineers
PCASE Version 2.09.06
Date : 3/20/2024

Design Name :	AR-PASSENGER
Design Type :	Roads
Pavement Type :	Flexible
Road Type :	Parking Area
Terrain Type :	Flat
Analysis Type :	CBR
Depth of Frost (in) :	0
Wander Width (in) :	33.35

Layer Information

Layer Type	Material Type	Frost Code	Moisture Content	Dry Unit Weight (lb/ft^3)	Analysis (lb/ft^3)	Non frost Design Thickness (in)	Reduced Subgrade Strength (in)	Limited Subgrade Penetration (in)	CBR Strength
AC	AC	NFS	0	145	Compute	4	0	0	0
BASE	UCS	NFS	5	135	Manual	6	0	0	80
SELFIL	COHLFILL	NFS	5	120	Manual	18	0	0	20
SUBG	COHCUT	NFS	18	100	Manual	0	0	0	10

Traffic Information

Pattern Name	**CAR-PASSENGER**		
Vehicles	**Weight (lb)**	**Passes per Life Span"**	**Equivalent Passes**
CAR - PASSENGER	3000	182500	182500
CAR - PASSENGER	3000		182500

Estimated AASHTO Equivalent Single Axle Loads	24808839

Pavement Design Report
U.S. Army Corps of Engineers
PCASE Version 2.09.06
Date : 3/20/2024

Design Name :	FIRE TRUCK
Design Type :	Roads
Pavement Type :	Flexible
Road Type :	Parking Area
Terrain Type :	Flat
Analysis Type :	CBR
Depth of Frost (in) :	0
Wander Width (in) :	33.35

Layer Information

Layer Type	Material Type	Frost Code	Moisture Content	Dry Unit Weight (lb/ft^3)	Analysis (lb/ft^3)	Non frost Design Thickness (in)	Reduced Subgrade Strength (in)	Limited Subgrade Penetration (in)	CBR Strength
AC	AC	NFS	0	145	Compute	4	0	0	0
BASE	UCS	NFS	5	135	Manual	6	0	0	80
SELFIL	COHLFILL	NFS	5	120	Manual	18	0	0	20
SUBG	COHCUT	NFS	18	100	Manual	0	0	0	10

Traffic Information

Pattern Name	**FIRE TRUCK**		
Vehicles	**Weight (lb)**	**Passes per Life Span"**	**Equivalent Passes**
P-23 CRASH TRUCK (FIRE TR	77880	7300	7300
P-23 CRASH TRUCK (FIRE TRUCK)	77880		7300

Estimated AASHTO Equivalent Single Axle Loads	111238374

Pavement Thickness Report
U.S. Army Corps of Engineers
PCASE Version 2.09.06
Date : 3/20/2024

Design Name :	SH ENCLOSURE
Design Type :	Roads
Pavement Type :	Rigid
Road Type :	Road
Terrain Type :	Flat
Analysis Type :	K
Depth of Frost (in) :	0
Wander Width (in) :	33.35
% Load Transfer :	0
Effective K (pci) :	297
Reduced Sub Effective K (pci) :	0
Joint Spacing :	10 to 15 ft
Dowel Spacing :	12.00 in
Dowel Length :	16.00 in
Dowel Diameter:	.75 in

Layer Information

Layer Type	Material Type	Frost Code	Moisture Content	Dry Unit Weight (lb/ft^3)	Flexural Strength (lb/ft^3)	CbCr (psi)	% Steel	Analysis	Non frost Design Thickness (in)	Reduced Subgrade Strength (in)	Limited Subgrade Penetratio (in)	K Strength (pci)
PCC	NA	NFS	0	145	530	0	0	Compute	6	0	0	0
BASE	BASCA	NFS	5	135	0	0	0	Manual	6	0	0	0
SUBG	COHLFILL	NFS	18	120	0	0	0	Manual	0	0	0	250

Traffic Information

Pattern Name	**GARBAGE TRUCK**		
Vehicles	**Weight (lb)**	**Passes per Life Span"**	**Equivalent**
TRUCK, 3 AXLE	35000	7300	7300
TRUCK, 3 AXLE	35000		7300

6700 Paradise Road, Suite E | Las Vegas, Nevada 89119 | p. 702.433.0330

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