CMT ENGINEERING LABORATORIES

ENGINEERING • ENVIRONMENTAL (ESA I & II)
MATERIALS TESTING • SPECIAL INSPECTIONS
ORGANIC CHEMISTRY

**GEOTECHNICAL ENGINEERING SERVICES**

# Proposed Nordic Valley Ski Lift Expansion

About 3567 Nordic Valley Way
Eden, Weber County, Utah

Prepared For:
Nordic Valley Ski Resort
3567 Nordic Valley Way
Eden, Utah 84312

CMT Project No. 14998

September 3, 2020

September 3, 2020

Mr. Brandon Fessler
Nordic Valley Ski Resort
3567 Nordic Valley Way
Eden, Utah 84310

Subject: Geotechnical Engineering Services
Nordic Valley Ski Lift Expansion
About 3567 Nordic Valley Way
Eden, Weber County, Utah CMT Project Number: 14998

Mr. Fessler:

Submitted herewith is the report of our geotechnical engineering services for the subject site. This report contains the results of our findings and an engineering interpretation of these results with respect to the available project characteristics.

On July 22, 2020 a CMT Engineering Laboratories (CMT) engineer was on the property and visited the upper and lower terminal sites for the referenced high speed 6 ski lift to observe the foundation subgrade soil conditions as the contractor was in the process of forming them for concrete placement. An observation letter was subsequently provided on August 6, 2020.

In addition, an engineer from CMT observed and supervised the excavation and logging of 5 test pits along the planned lift alignment to depths of about 5.0 to 10.0 feet below the existing ground surface. Excavation depths were controlled by equipment limitations and existing slopes. Additionally, excavations for the lift terminals and tower locations were observed. Soil samples were obtained during the field operations and subsequently transported to our laboratory for further testing and observation.

A slope stability analysis was completed across 4 cross sections as shown on the attached Figure 3 Site Evaluation. Based on our analyses, the majority of the slopes met the stability requirements for both static and seismic conditions. Our analyses indicates that portions of the existing slopes with about 15 feet of soil overlying bedrock and having slopes as steep or steeper that about 1.5 Horizontal to 1.0 vertical showed marginal stability under static conditions and do not meet the required factors of safety during a design seismic event, though the potential failure surfaces extend within areas outside the tower locations.

We appreciate the opportunity to work with you at this stage of the project. CMT offers a full range of Geotechnical Engineering, Geological, Material Testing, Special Inspection services, and Phase I and II Environmental Site Assessments. With 9 offices throughout Utah, Idaho, and Arizona, our staff is capable of efficiently serving your project needs. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 870-6730.

Sincerely,
**CMT Engineering Laboratories**

LICENSED PROFESSIONAL ENGINEER # 276476 BRYAN N. ROBERTS 9/02/2020 STATE OF UTAH

Bryan N. Roberts, P.E.
Senior Geotechnical Engineer

**Reviewed by:**

Andrew M. Harris, P.E.
Geotechnical Division Manager

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# 1.0 INTRODUCTION

## 1.1 General

CMT Engineering Laboratories (CMT) was retained to conduct geotechnical services for the Nordic Valley Ski Lift Expansion located at about 3567 Nordic Valley Way in Eden, Weber County, Utah as shown in the **Vicinity Map** below.


Vicinity Map

## 1.2 Objectives, Scope and Authorization

The objectives and scope of our study were planned in discussions between Mr. Brandon Fessler with the Nordic Valley Ski Resort and Mr. Andrew Harris of CMT Engineering Laboratories (CMT). In general, the objectives of this study were to generally define and evaluate the subsurface soil and groundwater conditions along the new lift alignment, provided general slope stability analysis, provided seismic design information and generally foundation, and earthwork recommendations to be utilized in the design and construction of new ski lift.

In accomplishing these objectives, our scope of work has included performing field observations and explorations, which consisted of observing and soil conditions and soil sampling at the upper and lower terminals, and the excavating/logging/ soil sampling of 5 test pits extending to depths of about 5.0 to 10.0 feet, performing laboratory testing on representative samples, and conducting an office program, which consisted of correlating available data, performing engineering analyses, and preparing this summary report. This scope of work was authorized by returning a signed copy of our proposal dated July 21, 2020 and executed on July 22, 2020.

## 1.3 Description of Proposed Construction

We understand that construction for the High Speed 6 Ski Lift is planned for the parcel. The proposed ski lift will consist of 13 towers and 2 terminals. The proposed High Speed 6 lift is an aerial lift that will span approximately 4,000 feet and will lift skiers approximately 1375 feet in elevation. Associated trails, access roadways, and snow making areas will also be constructed as part of the project. Maximum continuous wall loads for the terminals is anticipated to be on the order of about 1 to 3 kips per lineal foot. Isolated spot loads are anticipated to be between about 25 and 75 kips. A geologic reconnaissance study has previously been completed for the site by GCS Geoscience[1] and determined that the site is exposed to geologic hazards related to potential landslide and debris flow as well as steep slopes posing a risk to maintaining slope stability at the site.

## 1.4 Executive Summary

Extensive slope stability analyses were completed across 4 representative cross sections. It is anticipated that bedrock is relatively shallow. For our analysis the depth to bedrock was projected to be at a depth of about 15 to 20 feet, though steeper slope areas may potentially have bedrock shallower than 15 feet as the depth to bedrock is likely to control the slope angle in those areas. No groundwater was observed nor was there any saturated soil conditions observed within the completed test pits at the time of the study. However, a perched groundwater conditions was modeled along the top of the bedrock between the overlying gravel soil and the underlying bedrock to represent seasonal fluctuations in groundwater.

The slope in-line with the proposed lift generally appears to be no steeper than about two horizontal to one vertical (2H:1V) and often shallower. However, the proximity of the lift to adjacent steep slopes, particularly

[1] "Report Professional Geologist Site Reconnaissance and Review, Proposed Lift 5 and Snowmaking expansion, Parcel #22-029-0010, Nordic Valley Ski Resort, 3567 Nordic Valley Way, Eden, Weber County, Utah," GCS File No: 2020.11; April 2, 2020.

along the northeast, may pose issues with overall stability with respect to industry minimum factors of safety. Typically, the required minimum factors of safety are 1.5 for static conditions and 1.0 for seismic (pseudostatic) conditions.

Towers 5 through 9 are located within a geologic mapped “mass movement, block failure hazards zone” and have the steepest adjacent slopes along the proposed lift alignment.

The results of our analyses along the four cross-section would indicate that the cross sections C’C’ and D-D’, representative of towers 11 through 13, would meet the minimum slope stability requirements. Further towers 1 through 4 appear to be in similar stable locations.

At cross section B-B”, running through tower 10, our analyses indicated suitable factors of safety over the majority of the hillside, including the location of tower 10, with the exception of a steep portion of the cross sections downhill about 500 feet from tower 10, which may have moderately shallow failures during a design seismic event (see Figures 16 and 17 in the appendix for a graphical representation).

However, along cross section A-A’, running through tower 6, (also representative of towers 5 and 9) the slope is relatively steep with a section below the proposed tower as steep as about 41 degrees. Along this cross-section there are multiple calculated failure surfaces which indicate moderately stable conditions under static loading and potentially unstable conditions during the design seismic earthquake with potential slope movement within the area of the tower. Therefore, in order to increase stability and further protect the tower location from potential slope movement, it is recommended that the tower foundation extend to and embed about 2 feet into competent bedrock. Also, down slope of the tower (at about 25 feet horizontal distance from the tower) a concrete cut of trench wall (described later in this report) should be constructed which also extends to competent bedrock. If during foundation and cut trench construction the bedrock is deeper than about 15 to 20 feet below the surface CMT must be notified to provided further recommendations.

Based on our geotechnical engineering analyses, it is our opinion the exposed undisturbed natural gravel soils and bedrock are suitable for supporting the proposed foundations utilizing a maximum bearing pressure of 4,000 pounds per square foot and the tolerable settlements as discussed above. **It is recommended that tower foundations at locations 5, 6, and 9 shall extend down to bedrock**.

CMT must verify that all topsoil, deleterious material, disturbed soil, non-engineered fills, or other unsuitable soils have been removed and that suitable soils/bedrock have been encountered prior to placing site grading fills, and foundations.

In the following sections, detailed discussions pertaining to the site and subsurface descriptions, seismic setting, slope stability, earthwork, foundations, lateral resistance, and lateral pressure are provided.

## 2.0 FIELD EXPLORATION

In order to define and evaluate the subsurface soil and groundwater conditions at the site, 5 test pits were excavated to depth of about 5 to 10 feet below the surface. Excavation depths were controlled by the steepness of the existing slopes and the limits of the excavation equipment. Further field observations were completed with respect to the upper and lower terminal foundation areas and along the lift at the proposed support tower locations. Locations of the test pits are presented on **Figure 3, Site Evaluation**. The field exploration was performed under the supervision of an experienced member of our geotechnical staff.

Representative soil samples were collected within the test pits by obtaining disturbed "grab" samples. The samples were placed in sealed plastic bags and containers prior to transport to the laboratory.

The subsurface soils encountered in the test pits were logged and described in general accordance with ASTM[2] D-2488. Soil samples were collected as described above, and were classified in the field based upon visual and textural examination. These field classifications were supplemented by subsequent examination and testing of select samples in our laboratory. Graphical representations of the subsurface conditions encountered are presented on each individual test pit logs, **Figures 4 through 8**, included in the Appendix. A Key to Symbols defining the terms and symbols used on the logs, is provided as **Figure 9** in the Appendix.

The test pits were backfilled with excavated soils. The backfill was not placed in uniform lifts and compacted to a specific density and therefore must be considered as non-engineered backfill. Settlement of the backfill with time is likely to occur.

# 3.0 LABORATORY TESTING

## 3.1 General

Selected samples of the subsurface soils were subjected to various laboratory tests to assess pertinent engineering properties, as follows:

1. Moisture Content, ASTM D-2216, Percent moisture representative of field conditions
2. Atterberg Limits, ASTM D-4318, Plasticity and workability
3. Gradation Analysis, ASTM D-1140/C-117, Grain Size Analysis
4. Direct Shear Test, ASTM D-3080, Shear strength parameters

## 3.2 Lab Summary

Laboratory test results are presented on the test pit logs (**Figures 4 through 8**) and in the following Lab Summary table:

[2]American Society for Testing and Materials

**Lab Summary Table**

| Test Pit | Depth (feet) | Soil Class | Sample Type | Moisture Content (%) | Dry Denstiy (pcf) | Gradation | | | Atterberg Limits | | | Lab Vane Shear PSF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Grav | Sand | Fines | LL | PL | PI | |
| 1 | 4 | GP-GC | bag | 4.2 | | 73 | 19 | 7.8 | | | | |
| 2 | 4 | GP-GC | bag | 8.3 | | 74 | | | | | | |
| 2 | 8 | GP-GC | bag | 6.1 | | | | 8.9 | 36 | 21 | 15 | |
| 4 | 4 | GP-GC | bag | 4.5 | | 75 | 14 | 11 | | | | |
| 6 | 4 | GP-GC | bag | 5.2 | | 63 | 30 | 6.7 | | | | |
| 6 | 8 | GP-GC | bag | 8.5 | | 43 | 39 | 18 | | | | |

## 3.3 Direct Shear Test

To determine the shear strength of the soils encountered at the site, laboratory direct shear tests were performed on recovered samples from the finer portion of the existing soils.

Direct shear test samples were screened over the No. 4 sieve and remolded. During the direct shear test, the samples were evenly consolidated within the test ring, loaded, and saturated immediately after the load was applied. Loading was conducted at a slower rate to simulate saturated-drained condition. The results of the direct shear tests are presented in the following table below:

**Direct Shear Results**

| Sample Location | Sample Depth (feet) | Sample Type | Unified Soils Classification | Measured Apparent Cohesion (psf) | Measured Internal Friction Angle (degrees) |
|---|---|---|---|---|---|
| TP-2 | 4 | Screened and remolded | GP-GC | 197 | 38.8 |
| TP-6 | 4 | Screened and remolded | GP-GC | 80 | 36.1 |

# 4.0 GEOLOGIC & SEISMIC CONDITIONS

## 4.1 Geologic Setting

A professional Geologist Site Reconnaissance and Review was completed for the site property by GCS Geoscience, dated April 2, 2020 (GCS File No: 2020.11) outlining and discussing site mapping and observed, associated, geologic hazards.

## 4.3 Seismicity

### 4.3.1 Site Class

Utah has adopted the International Building Code (IBC) 2018, which determines the seismic hazard for a site based upon 2014 mapping of bedrock accelerations prepared by the United States Geologic Survey (USGS) and the soil site class. The USGS values are presented on maps incorporated into the IBC code and are also available based on latitude and longitude coordinates (grid points). For site class definitions, IBC 2018 Section 1613.2.2 refers to Chapter 20, Site Classification Procedure for Seismic Design, of ASCE[3] 7-16. Given the subsurface soils encountered at the site, including our projected shallow depth to massive bedrock within a depth of 100 feet, it is our opinion the site best fits Site Class C – Very Dense Soil and Soft Rock (with data), which we recommend for seismic structural design.

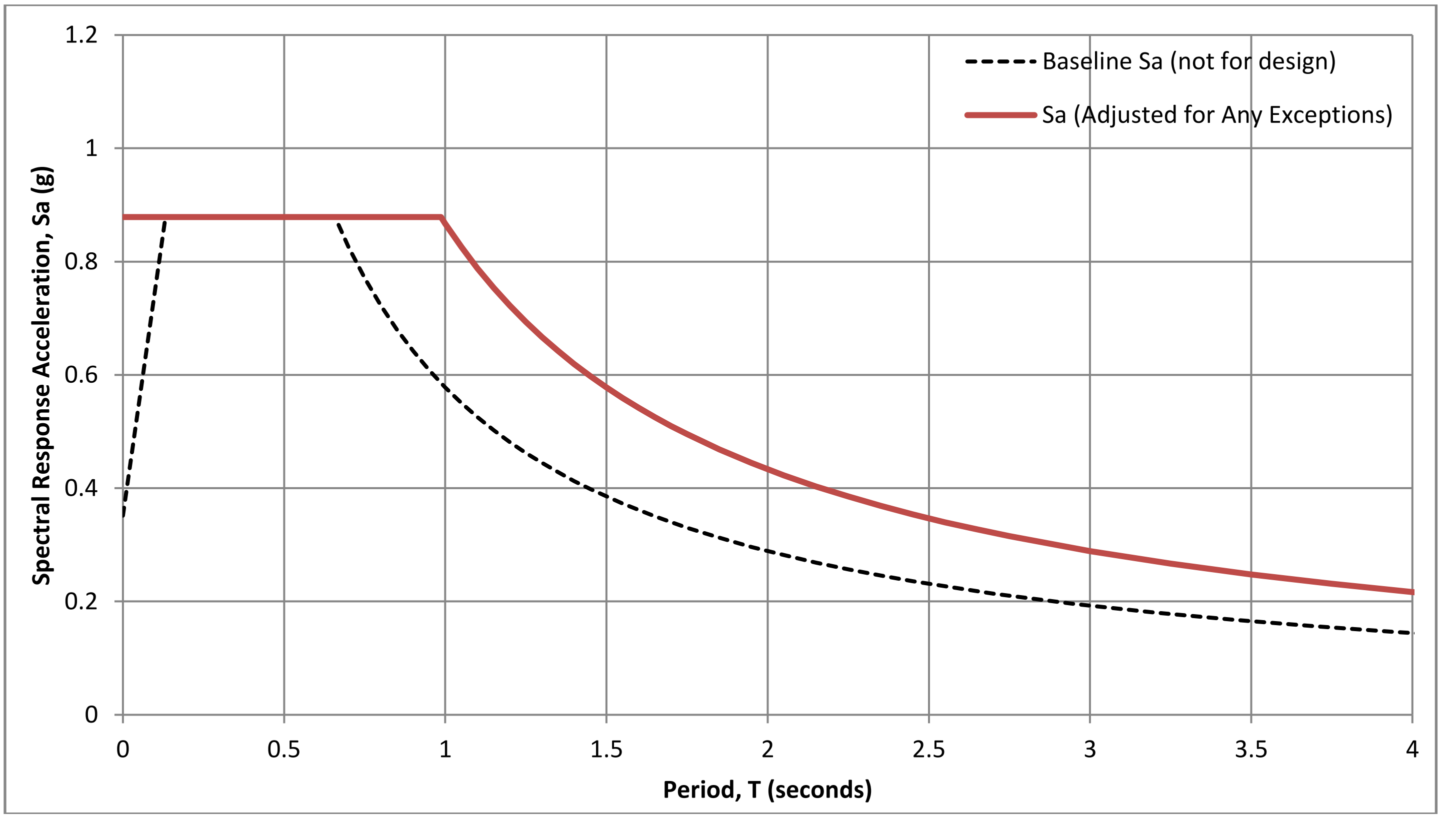
### 4.3.2 Ground Motions

The 2014 USGS mapping utilized by the IBC provides values of peak ground, short period and long period accelerations for the Site Class B/C boundary and the Maximum Considered Earthquake (MCE). This Site Class B/C boundary represents average bedrock values for the Western United States and must be corrected for local soil conditions. The following table summarizes the peak ground, short period and long period accelerations for the MCE event, and incorporates appropriate soil correction factors and any possible exceptions for a Site Class C soil profile at site grid coordinates of 41.29816 degrees north latitude and 111.868655 degrees west longitude (also see response spectrum below):

[3]American Society of Civil Engineers

| SPECTRAL ACCELERATION VALUE, T | SITE CLASS B/C BOUNDARY [mapped values] (g) | SITE COEFFICIENT | SITE CLASS C [adjusted for site class effects] (g) | MULTI-PLIER | DESIGN VALUES (g) |
|---|---|---|---|---|---|
| Peak Ground Acceleration | PGA = **0.491** | $F_{pga}$ = 1.200 | $PGA_M$ = 0.589 | 1.000 | $PGA_M$ = 0.589 |
| 0.2 Seconds (Long Period Acceleration) | $S_S$ = **1.095** | $F_a$ = 1.200 | $S_{MS}$ = 1.314 | 0.667 | $S_{DS}$ = 0.876 |
| | (exceptions, if any) | $F_a$ = (N/A) | $S_{MS}$ = (N/A) | 0.667 | $S_{DS}$ = (N/A) |
| 1.0 Second (Long Period Acceleration) | $S_1$ = **0.398** | $F_v$ = 1.500 | $S_{M1}$ = 0.597 | 0.667 | $S_{D1}$ = 0.398 |
| | (exceptions, if any) | $F_v$ = (N/A) | $S_{M1}$ = (N/A) | 0.667 | $S_{D1}$ = (N/A) |

NOTES:
1. $T_L$ = 8 seconds
2. Site Class: **C**
3. Have data to verify? **Yes**
**4. No Exceptions Needed**




# 5.0 SITE CONDITIONS

## 5.1 Surface Conditions

The expansion parcel consists of 347-acres of open, undeveloped, hills and valleys with general northeastern slopes which are marginally steep to steep. The Parcel is positioned between Lewis Peak on the west and floodplains on the north fork of the Ogden river to the east. The elevation across the expansion parcel ranges from about 5576 feet to 7126 feet as shown on Figures 1 and 3 in the appendix. A more in-depth description can be found in the referenced geologist site reconnaissance and review report.

## 5.2 Subsurface Soils

### 5.2.1 Upper and Lower Terminals

Upon request and prior to completing this study, an engineer from CMT Engineering Laboratories (CMT) visited the upper and lower terminal sites to observed the foundation subgrade soil conditions on Wednesday July 22, 2020.

Lower Terminal

At the time of the site visit the lower terminal foundation had been formed and reinforcing installed. The excavation consisted of one level extending roughly between 6 to 12 feet below surrounding grades and into undisturbed natural soils consisting of sandy fine and coarse gravel with some silt and cobbles (GP-GM) which was visually very dense, dry, and brown in color

Upper Terminal

At the time of the site visit the upper terminal foundation had been formed. The excavation consisted of one level extending about 1 to 12 feet below surrounding grades and into undisturbed natural soils consisting of clayey fine and coarse gravel with sand and cobbles (GC) which was visually very dense, slightly moist, and brown in color

### 5.2.2 Test Pits

Subsurface soils observed within the 5 test pits completed along the alignment generally encountered a layer of sandy TOPSOIL with gravel between about 1.0 to 1.5 feet thick underlain by sandy GRAVEL with some clay and cobbles extending to the full depth penetrated, about 5.0 to 10.0 feet. Test pit depth was controlled by moderately steep slopes and the limitations of the excavation equipment. Massive bedrock was not visibly encountered within the test pits depth but is projected to be within the upper 15 to 20 feet or less as much of the exposed gravel appeared to be a product of weathered bedrock and was generally highly fractured. The natural gravel soils were visibly dry to slightly moist, dense to very dense, and brown in color.

For a more descriptive interpretation of subsurface conditions, please refer to the bore hole and test pit logs, **Figures 4 through 8**, which graphically represent the subsurface conditions encountered. The lines designating the interface between soil types on the logs generally represent approximate boundaries - in situ, the transition between soil types may be gradual. A key to the symbols and terms on the logs is included as **Figure 9**.

## 5.3 Groundwater

Neither groundwater nor saturated soils were observed within the depths penetrated at the time of this study. Groundwater is anticipated to seasonally perch on or within the underlying bedrock.

## 5.4 Site Subsurface Variations

Based on the results of the subsurface explorations and our experience, variations in the continuity and nature of subsurface conditions should be anticipated. Due to the heterogeneous characteristics of natural soils, care should be taken in interpolating or extrapolating subsurface conditions between or beyond the exploratory locations.

In addition, once the subsurface explorations were completed the test pits were backfilled with the excavated soils but little effort was made to compact these soils. Therefore, the backfill must be considered as non-engineered fill and settlement of the backfill in the test pits over time should be anticipated. Caution must be exercised when constructing over these locations.

# 6.0 SLOPE STATILITY

## 6.1 General

In conjunction with our study, a slope stability analysis was conducted along 4 cross-sections labeled A-A', B-B', C-C', and D-D' located across select tower locations which we feel are representative of the related on site conditions (see **Figure 1 Site Map**, in the appendix). The slope grading was determined from available mapping, DEM, and LiDAR data. Due to the available excavation equipment limitations the test pits only extended to a maximum depth of about 10 feet below the surface. It is anticipated that bedrock is relatively shallow. For our analysis the depth to bedrock was projected to be at a depth of about 15 to 20 feet. No groundwater was observed nor was there any saturated soil conditions were observed within the completed test pits at the time of the study. However, a perched groundwater conditions was modeled along the top of the bedrock between the overlying gravel soil and the underlying bedrock. Towers 5 through 9 are located within a geologic mapped "mass movement, block failure hazards zone" and have the steepest adjacent slopes along the proposed lift alignment.

## 6.2 Input Parameters

Shear tests were completed on samples of the natural sandy gravel with cobble and trace to some clay encountered with our explorations. These soils were generally fractured and more highly fractured within the test pits completed along the steeper terrain. Due to particle size limits for the shear testing the samples were screened over a No 4 sieve and therefore the results are likely conservative of in-situ shear strengths. Accordingly, the following parameters were used for the stability analyses:

| Material | Internal Friction Angle (degrees) | Apparent Cohesion (psf) | Unit Weight (pcf)* |
|---|---|---|---|
| Highly fractured gravel | 38.8 | 175 | 130 |
| Less fractured gravel | 36.1 | 80 | 130 |
| PC concrete | 45 | 30000 | 145 |

To evaluate the slope stability under seismic (pseudostatic) conditions, the peak horizontal acceleration was queried for the site using site class C at 0.589*g* which was reduced by half at 0.2945*g* as the pseudostatic coefficients for the stability analysis.

## 6.3 Stability Analyses

We evaluated the global stability of the four cross sections provided on the above referenced site using the computer program *SLIDE* version 7.0. This program uses a limit equilibrium (Simplified Bishop) method for calculating factors of safety against sliding on an assumed failure surface and evaluates numerous potential failure surfaces, with the most critical failure surface identified as the one yielding the lowest factor of safety of those evaluated.

Groundwater water was included in the models representing a perched water conditions over bedrock at an assumed depth of bedrock at about 15 feet below the ground surface.

The slope in line with the proposed lift generally appears to be no steeper than about two horizontal to one vertical (2H:1V) and often shallower. However, the proximity of the lift to adjacent steep slopes, particularly along the northeast, may pose problems with overall stability with respect to industry minimum factors of safety. Typically, the required minimum factors of safety are 1.5 for static conditions and 1.0 for seismic (pseudostatic) conditions.

As discussed previously, 4 representative cross sections were analyzed as shown on Figure 3 **Site Evaluation,** provided in the appendix, and labeled:

A-A’: projecting through tower 6;
B-B’: projecting through tower 10;
C-C’: projecting through tower 11 and;
D-D’: projecting through tower 12.

The results of our analyses along the four cross-sections indicate that the cross sections C’C’ and D-D’, representative of towers 11 through 13, meet the minimum factors of safety for both static and seismic conditions. Further towers 1 through 4 appear to be sited in similar stable locations (see **Figures 15 through 20** in the appendix for a graphical representation).

At cross-section B-B", projecting through tower 10, our analysis indicated suitable factors of safety over the majority of the hillside, including the location of tower 10, with the exception of a steep portion of the cross sections downhill about 500 feet from tower 10, which may potentially experience moderately shallow slope failure during the design seismic event (see Figures 16 and 17 in the appendix for a graphical representation).

However, cross-section A-A', projecting through tower 6, the slope is relatively steep with a section below the proposed tower as steep as about 41 degrees. Along this cross-section, modeling indicates multiple calculated failure surfaces with a *static* safety factors of less than 1.5 and as low as 1.28. Under seismic conditions the factor of safety is less than 1.0 and would indicate potential slope failure extending through the area of the tower. Therefore, in order to increase stability and further protect the tower location from potential slope movement, it is recommended that the tower foundation extend to and embed a minimum of 2 feet into competent bedrock. Also, down slope of the tower location (at about 25 feet horizontal distance from the tower) a concrete cut of trench wall (described later in this report) must be constructed which also extends to competent bedrock (See **Figures 11 through 14** in the appendix for a graphical representation). If during foundation and cut trench construction the bedrock is deeper than about 15 to 20 feet below the surface CMT must be notified to provided further recommendations.

The results of our slope stability analyses with the lowest calculated factors of safety are summarized in the table below.

| Slope Cross Section | Condition | Seismic Coefficient | Lowest Factor of Safety (F.S.) | Minimum Allowable F.S. |
|---|---|---|---|---|
| A-A | Static-Current design | --- | 1.28 | 1.5 |
| A-A | Static-foundation extension to bedrock | --- | 1.28[1] | 1.5 |
| A-A | Static-foundation extension to bedrock and Cut off trench | --- | 1.353[1] | 1.5 |
| A-A | Seismic-foundation extension to bedrock | 0.2945 | <1.0[1] | 1.0 |
| A-A | Seismic -foundation extension to bedrock and Cut off trench | 0.2945 | | 1.0 |
| B-B | Static | --- | 1.495 | 1.5 |
| B-B | Seismic | 0.286[1] | <1.0[2] | 1.0 |
| C-C | Static | --- | 2.097 | 1.5 |
| C-C | Seismic | 0.2945 | 1.159 | 1.0 |
| D-D | Static | --- | 1.925 | 1.5 |
| D-D | Seismic | 0.295 | 1.075 | 1.0 |

1. Failure surfaces located downslope below tower 6.
2. Failure surfaces about 500 feet downslope and well isolated from tower 10.

* The lowest factor of safety was presented in the table above. However, numerous failure slices were calculated as shown on the attached figures in the appendix.

## 6.4 Permanent Cut and Fill Slopes

It is our understanding that moderate cut and fill grading will take place to construct associated trails, access roadways, and snow making areas. We recommend that the maximum permanent cut and fill slopes not exceed the following without further analysis and appropriate engineered retention.

Slopes up to 20 feet tall.

Maximum Cut slope: Two horizontal to one vertical (2H:1V)
Maximum Fill Slope: Two and one half horizontal to one vertical (2.5H:1V)

# 7.0 CUT OFF WALL

As discussed above, in order to improve slope stability for towers 5, 6 and 9, a concrete cut off wall is recommended to be constructed downslope of these towers (about 20 to 25 feet horizontal from tower foundation) and extend to bedrock. The cut off trenches should be about 2.0 to 3.0 feet wide, and 50 feet long centered in line with the tower foundation perpendicular to the slope direction. The trench shall be filled with Portland cement concrete with a minimum flexural strength of 300 pounds per square foot. Two inch diameter weep holes must be installed through the concrete block on a minimum four foot centers beginning about 2 feet up from the bottom of the trench in order to allow water to travel from the upslope gravel soil, passing through the wall, and down in the gravel soils below such that hydrostatic pressures behind the concrete filled trench are not allowed to build.

A construction alternative to an open trench wall may be to construct a series of drilled piers/shafts that extend down to bedrock forming the cut off trench. This may be constructed by stagger drilling, two/three -foot diameter piers along the alignment, installing minimum shrinkage steel reinforcement the full length and pouring similar concrete described above. Once sufficient set strength is achieved, additional drilled piers may be installed between prior installed piers such that the intended maximum spacing between the edge of piers is on the order of about 1.0 foot.

# 8.0 SITE PREPARATION AND GRADING

## 8.1 General

It is anticipated that initial site preparation will consist of removing surface vegetation, topsoil, and any other deleterious materials from beneath an area extending out at least 5 feet beyond new structures

It is anticipated that all foundations well bear on undisturbed natural gravel soil or on competent bedrock. If excessively soft or otherwise unsuitable soils are encountered beneath foundations, they must be totally removed and replaced with gravel structural fill.

A representative of CMT must verify that suitable natural soils have been encountered prior to placing site grading fills, and foundations.

Existing slopes shall not be steepened more than about two horizontal to one vertical (2.0H:1V) over more than about 5 vertical feet without proper engineering consideration and/or retention.

It is recommended that the ground surface be modified around the terminals and poles to provided adequate surface runoff around and away from these structures. We recommend a minimum slope of 6 to 8 inches in the first 10 feet away from the structure. This slope should be maintained throughout the lifetime of the structure. Other precautions that may become evident during construction.

## 8.2 Temporary Excavations

For granular (cohesionless) soils, construction excavations above the water table, not exceeding 4 feet, should be no steeper than about one-half horizontal to one vertical (0.5H:1V). Deeper, temporary excavations if granular cohesionless soils, above the water table should not be constructed steeper than one horizontal to one vertical (1H:1V) unless braced.

Excavations encountering saturated cohesionless soils as well as very clean (low fines content) cohesionless soils may be very difficult and require very flat side slopes and/or shoring, bracing and dewatering as these soils will tend to flow into the excavation.

All excavations must be inspected periodically by qualified personnel. If any signs of instability or excessive sloughing are noted, immediate remedial action must be initiated. All excavations should be made following OSHA safety guidelines.

Slope movements or even failure can occur if the slope soils are undermined or become saturated. Any retaining walls must be properly engineered to maintain stability of the slopes. Following grading at the site, the slope surface must be revegetated as soon as possible to limit erosion and potential undermining of the slope. The property owner and the owner’s representatives should be made aware of the risks involved should these or other conditions occur that could saturate or erode/undermine the slope soils.

## 8.3 Fill Material

Structural fill is defined as all fill which will ultimately be subjected to structural loadings, such as imposed by foundation and support slabs etc. Structural fill will be required as backfill over foundations and utilities, as site grading fill, and possibly as replacement fill below footings. All structural fill must be free of sod, rubbish, topsoil, frozen soil, and other deleterious materials.

Following are our recommendations for the various fill types we anticipate will be used at this site:

| Fill Material Type | Description/Recommended Specification |
|---|---|
| Structural Fill/Replacement Fill | Placed below structures, flatwork and pavement. sand/gravel mixture, with maximum particle size of 4 inches, a minimum 70% passing 3/4-inch sieve, a maximum 20% passing the No. 200 sieve, and a maximum Plasticity Index of 10. |

On-site granular soils may be used as structural fill if free of deleterious material and processed to meet the above criteria. All fill material should be approved by a CMT geotechnical engineer prior to placement.

## 8.4 Fill Placement and Compaction

The various types of compaction equipment available have their limitations as to the maximum lift thickness that can be compacted. For example, hand operated equipment is limited to lifts of about 4 inches and most "trench compactors" have a maximum, consistent compaction depth of about 6 inches. Large rollers, depending on soil and moisture conditions, can achieve compaction at 8 to 12 inches. The full thickness of each lift should be compacted to at least the following percentages of the maximum dry density as determined by ASTM D-1557 (or AASHTO[4] T-180) in accordance with the following recommendations:

| Location | Total Fill Thickness (feet) | Minimum Percentage of Maximum Dry Density |
|---|---|---|
| Beneath an area extending at least 5 feet beyond the perimeter of structures, and 2 feet beyond flatwork (applies to structural fill and site grading fill) | 0 to 5<br>5 to 10 | 95<br>98 |
| Site grading fill outside area defined above | 0 to 5<br>5 to 10 | 92<br>95 |
| Non-structural fill | 0 to 5<br>5 to 10 | 90<br>92 |

Structural fills greater than 10 feet thick are not anticipated at the site. For best compaction results, we recommend that the moisture content for structural fill/backfill be within 2% of optimum. Field density tests should be performed on each lift as necessary to verify that proper compaction is being achieved.

## 8.6 Subgrade Stabilization

If subgrade soils below structures are soft and or do not consist of the anticipated granular soils (sandy gravel), free of deleterious materials, CMT must be notified to provide further recommendations.

[4] American Association of State Highway and Transportation Officials

# 9.0 FOUNDATION RECOMMENDATIONS

The following recommendations have been developed on the basis of the previously described project characteristics, the subsurface conditions observed in the field, the laboratory test data, as well as common engineering practice. **Tower foundations at locations 5, 6, and 9 shall extend down to bedrock**. It is anticipated that bedrock would be encountered somewhere between about 10 and 20 feet below the surface. If bedrock is deeper, than 20 feet below the surface at these tower locations, CMT must be notified to provided additional recommendations.

## 9.1 Foundation Recommendations

It is our understanding that the terminal and tower foundations are generally designed with tolerable settlement of up to between 2 to 3 inches.

Based on our geotechnical engineering analyses, it is our opinion the exposed undisturbed natural gravel soils are suitable for supporting the proposed foundations utilizing a maximum bearing pressure of 4,000 pounds per square foot and the tolerable settlements as discussed above.

We recommend that final grading provided frost protection up to 40 inches. Design bearing pressure increase for seismic loading may be up to 30 percent.

We also recommend the following:

1. Continuous footing widths should be maintained at a minimum of 24 inches.
2. Spot footings should be a minimum of 30 inches wide.

## 9.2 Installation

Under no circumstances shall the footings be established upon non-engineered fills, loose or disturbed soils, topsoil, sod, rubbish, construction debris, other deleterious materials, frozen soils, or within ponded water. Further it is anticipated that all foundation will bear directly on natural gravel soils are on bedrock. If this is not the case CMT must be notified to provide further recommendations. **Tower foundations at locations 5, 6, and 9 shall extend down to bedrock**. This may be achieved by drilling and installing one large reinforced pier/shaft or multiple smaller piers below the planned spread footings having a minimum diameter of 12 inches. Where smaller piers are utilized below spread footings there shall be a minimum, one pier at every corner and one pier every 5 square feet within the interior footing portion, but no less than one at the center of the footing. The piers shall be structural tied to the overlying footing.

If unsuitable soils are encountered, they must be completely removed and replaced with compacted structural fill. The width of structural replacement fill below footings should be equal to the width of the footing plus one foot for each foot of fill thickness. For instance, if the footing width is 2 feet and the structural fill depth beneath the footing is 2 feet, the fill replacement width should be 4 feet, centered beneath the footing.

### 9.3 Lateral Resistance

Lateral loads imposed upon foundations due to wind or seismic forces may be resisted by the development of passive earth pressures and friction between the base of the footings and the supporting soils. In determining frictional resistance, a coefficient of 0.4 may be utilized for natural granular soils or imported granular structural fills. Passive resistance provided by properly placed and compacted granular structural fill above the water table may be considered equivalent to a fluid with a density of 300 pounds per cubic foot.

## 10.0 LATERAL EARTH PRESSURES

The lateral pressure parameters, as presented herein, are for backfills which will consist of suitable, drained on-site granular soil and which are relatively horizontal behind the wall.

The lateral pressures imposed upon subgrade facilities will, therefore, be basically dependent upon the relative rigidity and movement of the backfilled structure. For active walls, such as retaining walls which can move outward (away from the backfill), backfill may be considered equivalent to a fluid with a density of 35 pounds per cubic foot in computing lateral pressures. For more rigid walls (moderately yielding), backfill may be considered equivalent to a fluid with a density of 45 pounds per cubic foot. For very rigid non-yielding walls, backfill should be considered equivalent to a fluid with a density of at least 55 pounds per cubic foot. The above values assume that the fill within 4 feet of the wall will be compacted with hand-operated compacting equipment.

For seismic loading of retaining/below-grade walls, the following uniform lateral pressures, in pounds per square foot (psf), should be added based on wall depth and wall case.

| UNIFORM LATERAL PRESSURES | | | |
|---|---|---|---|
| WALL HEIGHT (FEET) | ACTIVE PRESSURE CASE (PSF) | MODERATELY YIELDING CASE (PSF) | AT REST/NON-YIELDING CASE (PSF) |
| 5 | 26 | 61 | 96 |
| 10 | 52 | 122 | 191 |

The given values for design are based on the natural granular soils in place behind walls. The values above may be linearly interpolated between heights given.

# 11.0 QUALITY CONTROL

We recommend that CMT be retained to as part of a comprehensive quality control testing and observation program for which we can offer discounted rates. With CMT onsite we can help facilitate implementation of our recommendations and address, in a timely manner, any subsurface conditions encountered which vary from those described in this report. Without such a program CMT cannot be responsible for application of our recommendations to subsurface conditions which may vary from those described herein. This program may include, but not necessarily be limited to, the following:

## 11.1 Field Observations

Observations should be completed during all phases of construction such as site preparation, foundation excavation, structural fill placement and concrete placement. Due to the variance in measured groundwater levels, it is recommended that the depth to groundwater be determined for each individual home, to determine design floor slab elevation, at the time of construction or just prior to construction if a land drain is not installed.

## 11.2 Fill Compaction

Compaction testing by CMT is required for all structural supporting fill materials. Maximum Dry Density (Modified Proctor, ASTM D-1557) tests should be requested by the contractor immediately after delivery of any fill materials. The maximum density information should then be used for field density tests on each lift as necessary to ensure that the required compaction is being achieved.

## 11.3 Excavations

All excavation procedures and processes should be observed by a geotechnical engineer from CMT or their representative. In addition, for the recommendations in this report to be valid, all backfill and structural fill placed in trenches and all pavements should be density tested by CMT. We recommend that freshly mixed concrete be tested by CMT in accordance with ASTM designations.

# 12.0 LIMITATIONS

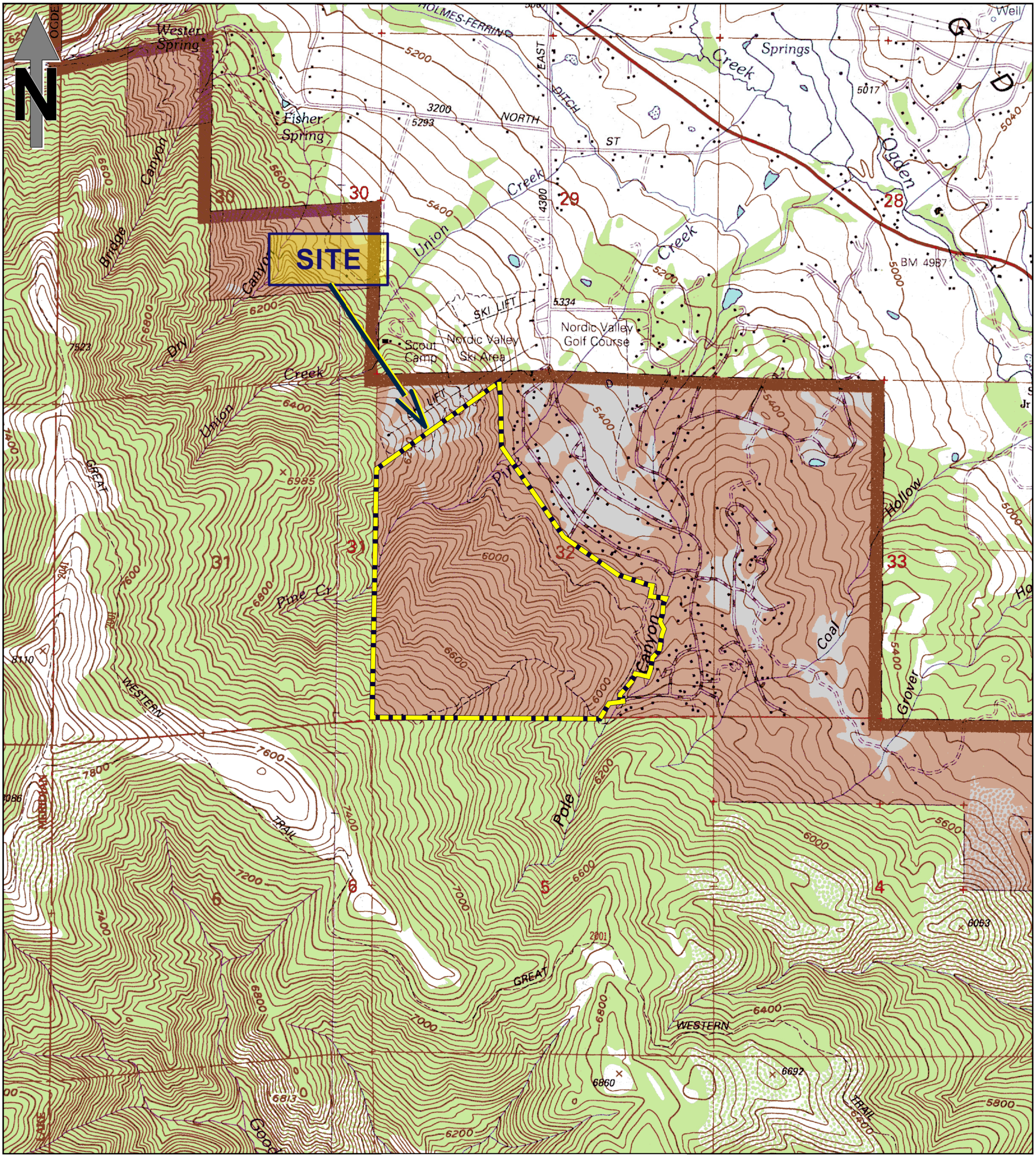
The recommendations provided herein were developed by evaluating the information obtained from the subsurface explorations and soils encountered therein. The exploration logs reflect the subsurface conditions only at the specific location at the particular time designated on the logs. Soil and ground water conditions may differ from conditions encountered at the actual exploration locations. The nature and extent of any variation in the explorations may not become evident until during the course of construction. If variations do appear, it may become necessary to re-evaluate the recommendations of this report after we have observed the variation.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties, either expressed or implied.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance or if you have any questions regarding this project, please do not hesitate to contact us at (801) 870-6730. To schedule materials testing, please call (801) 381-5141.

# APPENDIX

SUPPORTING
DOCUMENTATION




Base:
1998 USGS 7.5 Minute topographic maps titled "Huntsville, Utah" and North Ogden, Utah, from Utah AGRC; http://gis.utah.gov/

0 2000 4000 ft

1:24,000

**Nordic Valley High Speed Six Lift**

Nordic Valley Ski Resort

Eden, Weber County, Utah

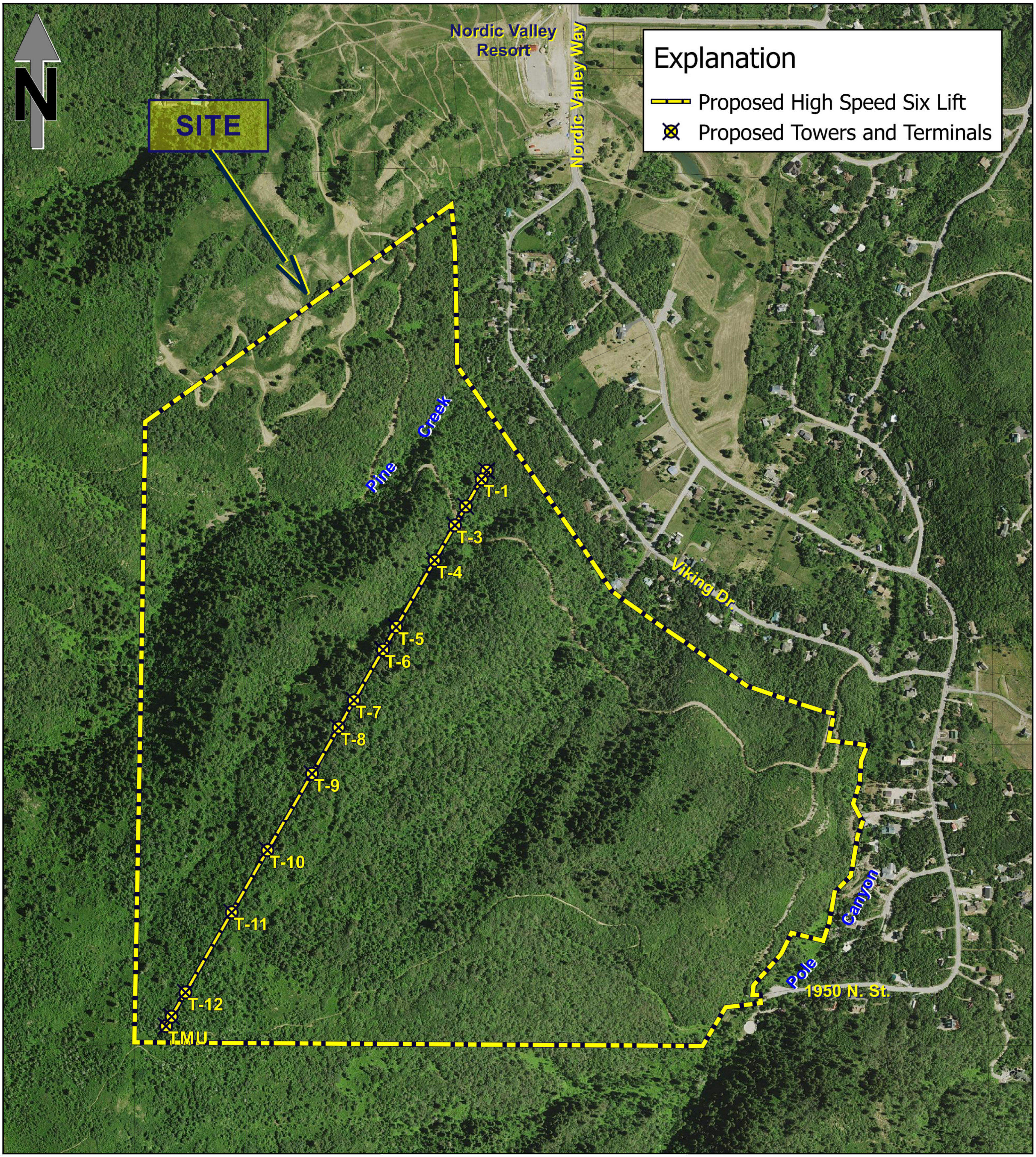
CMT ENGINEERING LABORATORIES

VICINITY MAP

| | |
|---|---|
| Date: | 11 Aug-20 |
| Job # | 14998 |

Figure

1

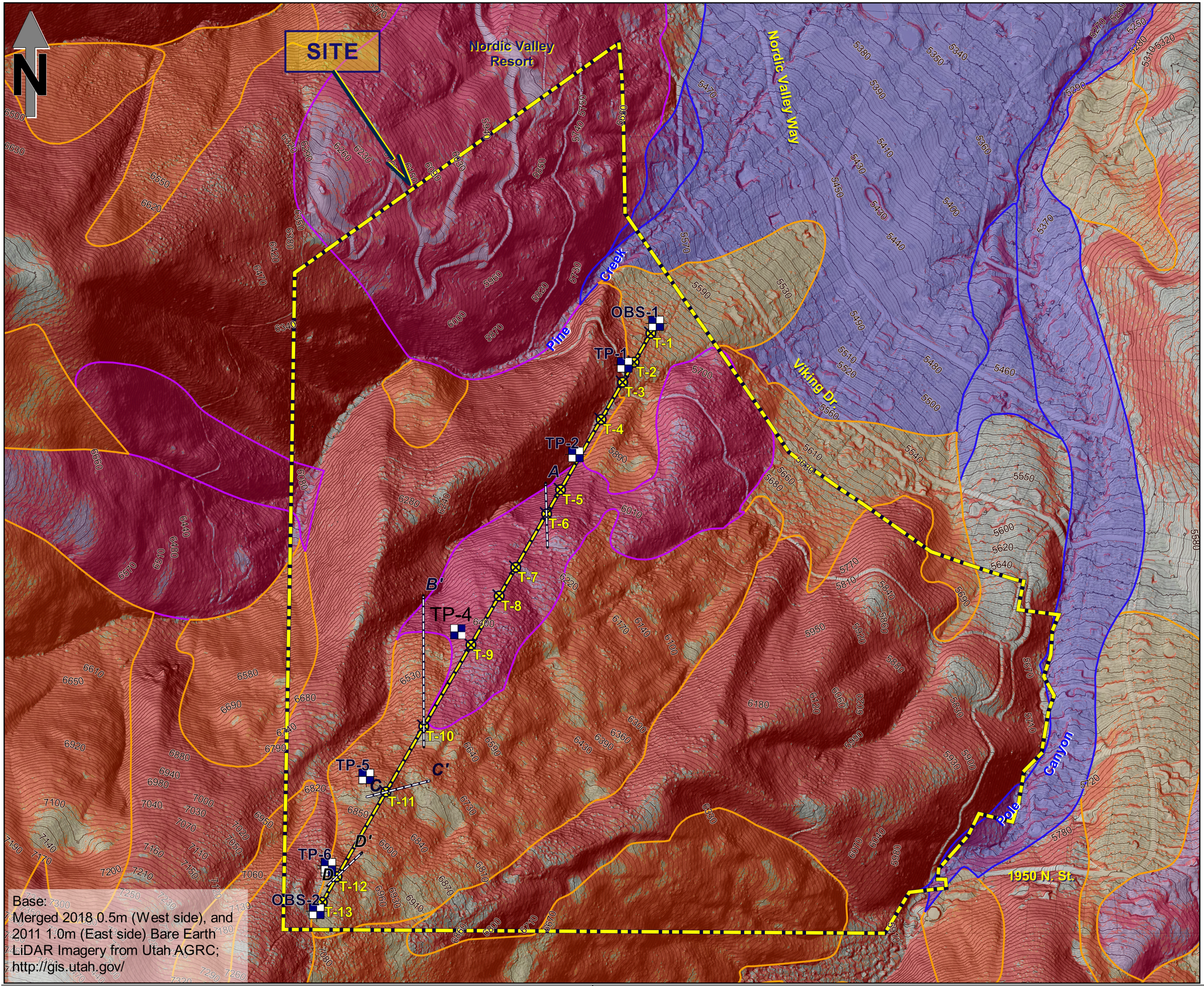



Base:
2014 1.0m NAIP Color Orthoimagery,
from Utah AGRC; http://gis.utah.gov/

0 800 1600 ft

1:9,600

| | | | |
|---|---|---|---|
| **Nordic Valley High Speed Six Lift**<br>Nordic Valley Ski Resort<br>Eden, Weber County, Utah | CMT ENGINEERING LABORATORIES<br>SITE PLAN | Date: 11 Aug-20<br>Job # 14998 | Figure<br>2 |




## Explanation

- Proposed High Speed Six Lift
- Proposed Towers and Terminals

Geologic Hazard Overlay*

- Alluvial Fan Debris Flow Processes Hazards
- Mass Movement, Slump, Soil Creep Hazards
- Mass Movement, Block Failure Hazards

*from 2020, GCS Geoscience Geologic Reconnaissance

Slope Gradients

- 25 to 30 Percent Slopes
- Greater than 30 Percent Slopes
- Index Contour
- Test Pits and Excavation Observation Locations
- Slope Stability Analysis Line

0 600 1200 ft

1:7,200

| CMT ENGINEERING LABORATORIES | Nordic Valley High Speed Six Lift<br>Nordic Valley Ski Resort<br>Eden, Weber County, Utah | SITE EVALUATION | Date: | 11 Aug-20 | Figure 3 |
|---|---|---|---|---|---|
| | | | Job # | 14998 | |

# Proposed Nordic Valley Lift Expansion

About 3567 Nordic Valley Way, Eden, Utah

# Test Pit Log

# TP-1

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 6'
Water Depth: (see Remarks)

Date: 7/28/20
Job #: 14998

| Depth (ft) | GRAPHIC LOG | Soil Description | Sample Type | Sample # | Moisture (%) | Dry Density(pcf) | Gradation: Gravel % | Gradation: Sand % | Gradation: Fines % | Atterberg: LL | Atterberg: PL | Atterberg: PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–6 | | Light Brown Fractured Rock (GP-GC) with trace to some silty clay and sand<br>dry, very dense | | | | | | | | | | |
| 4 | | | | 1 | 4.2 | | 73 | 19 | 7.8 | | | |
| 6 | | END AT 6' | | | | | | | | | | |

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Owner Provided
Logged By: Nate Pack



Figure: 4

# Proposed Nordic Valley Lift Expansion

## Test Pit Log — TP-2

About 3567 Nordic Valley Way, Eden, Utah

| | | | |
|---|---|---|---|
| Equipment: Rubber Tire Backhoe | Total Depth: 10' | Date: 7/28/20 | |
| Surface Elev. (approx): | Water Depth: (see Remarks) | Job #: 14998 | |

| Depth (ft) | GRAPHIC LOG | Soil Description | Sample Type | Sample # | Moisture (%) | Dry Density(pcf) | Gradation: Gravel % | Gradation: Sand % | Gradation: Fines % | Atterberg: LL | Atterberg: PL | Atterberg: PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | Brown Sandy GRAVEL (GP-GC) with clay, trace roots | | | | | | | | | | |
| 1 | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | Grades Dark Brown, highly fractured | | 2 | 8.3 | | 74 | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |
| 8 | | | | 3 | 6.1 | | | | 8.9 | 36 | 21 | 15 |
| 9 | | Grades Light Brown | | | | | | | | | | |
| 10 | | END AT 10' | | | | | | | | | | |
| 11 | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | |

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Owner Provided

Logged By: Nate Pack



Figure: 5

# Proposed Nordic Valley Lift Expansion

# Test Pit Log

# TP-4

About 3567 Nordic Valley Way, Eden, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 5'
Water Depth: (see Remarks)

Date: 7/28/20
Job #: 14998

| Depth (ft) | GRAPHIC LOG | Soil Description | Sample Type | Sample # | Moisture (%) | Dry Density(pcf) | Gradation: Gravel % | Gradation: Sand % | Gradation: Fines % | Atterberg: LL | Atterberg: PL | Atterberg: PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–5 | | Tan to Light Brown GRAVEL (GP-GC) with sand fractured cobbles, and some clay; dry, very dense | | | | | | | | | | |
| 4 | | | | 4 | 4.5 | | 75 | 14 | 11.4 | | | |
| 5 | | REFUSAL AT 5' Due to sloped conditions | | | | | | | | | | |

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Owner Provided
Logged By: Nate Pack



Figure: 6

# Proposed Nordic Valley Lift Expansion

# Test Pit Log

# TP-5

About 3567 Nordic Valley Way, Eden, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 7'
Water Depth: (see Remarks)

Date: 7/28/20
Job #: 14998

| Depth (ft) | GRAPHIC LOG | Soil Description | Sample Type | Sample # | Moisture (%) | Dry Density(pcf) | Gradation: Gravel % | Gradation: Sand % | Gradation: Fines % | Atterberg: LL | Atterberg: PL | Atterberg: PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | Brown to Dark Brown Topsoil; silty loam | | | | | | | | | | |
| 1 | | Tan to Light Brown Fractured Rock (GP-GC) with sand and some clay; dry, dense to very dense | | | | | | | | | | |
| 4 | | | | 5 | | | | | | | | |
| 7 | | END AT 7' | | | | | | | | | | |

Remarks: Groundwater not encountered during excavation.

CMT ENGINEERING LABORATORIES

Excavated By: Owner Provided
Logged By: Nate Pack



Figure: 7

# Proposed Nordic Valley Lift Expansion

## Test Pit Log

## TP-6

About 3567 Nordic Valley Way, Eden, Utah

Equipment: Rubber Tire Backhoe
Surface Elev. (approx):

Total Depth: 9'
Water Depth: (see Remarks)

Date: 7/28/20
Job #: 14998

| Depth (ft) | Soil Description | Sample Type | Sample # | Moisture (%) | Dry Density (pcf) | Gravel % | Sand % | Fines % | LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0–1.5 | Dark Brown Silty Topsoil | | | | | | | | | | |
| 1.5–9 | Light Brown Sandy Gravel (GP-GC) with cobbles and some clay; dry, dense to very dense | | | | | | | | | | |
| 4 | | ◣ | 6 | 5.2 | | 63 | 30 | 6.7 | | | |
| 8 | very dense | ◣ | 7 | 8.5 | | 43 | 39 | 17.7 | | | |
| 9 | END AT 9' | | | | | | | | | | |

Remarks: Groundwater not encountered during excavation.

Figure: 8

CMT ENGINEERING LABORATORIES

Excavated By: Owner Provided
Logged By: Nate Pack

# Proposed Nordic Valley Lift Expansion

About 3567 Nordic Valley Way, Eden, Utah

# Key to Symbols

Date: 7/28/20
Job #: 14998

| Depth (ft) ① | GRAPHIC LOG ② | Soil Description ③ | Sample Type ④ | Sample # ⑤ | Moisture (%) ⑥ | Dry Density(pcf) ⑦ | Gradation ⑧ Gravel % | Sand % | Fines % | Atterberg ⑨ LL | PL | PI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

## COLUMN DESCRIPTIONS

① **Depth (ft.):** Depth (feet) below the ground surface (including groundwater depth - see water symbol below).

② **Graphic Log:** Graphic depicting type of soil encountered (see ② below).

③ **Soil Description:** Description of soils encountered, including Unified Soil Classification Symbol (see below).

④ **Sample Type:** Type of soil sample collected at depth interval shown; sampler symbols are explained below-right.

⑤ **Sample #:** Consecutive numbering of soil samples collected during field exploration.

⑥ **Moisture (%):** Water content of soil sample measured in laboratory (percentage of dry weight of sample).

⑦ **Dry Density (pcf):** The dry density of a soil measured in laboratory (pounds per cubic foot).

⑧ **Gradation:** Percentages of Gravel, Sand and Fines (Silt/Clay), obtained from lab test results of soil passing the No. 4 and No. 200 sieves.

⑨ **Atterberg:** Individual descriptions of Atterberg Tests are as follows:

**LL = Liquid Limit (%):** Water content at which a soil changes from plastic to liquid behavior.

**PL = Plastic Limit (%):** Water content at which a soil changes from liquid to plastic behavior.

**PI = Plasticity Index (%):** Range of water content at which a soil exhibits plastic properties (= Liquid Limit - Plastic Limit).

| STRATIFICATION | |
|---|---|
| **Description** | **Thickness** |
| Seam | Up to ½ inch |
| Lense | Up to 12 inches |
| Layer | Greater than 12 in. |
| Occasional | 1 or less per foot |
| Frequent | More than 1 per foot |

| MODIFIERS |
|---|
| **Trace** |
| <5% |
| **Some** |
| 5-12% |
| **With** |
| > 12% |

| MOISTURE CONTENT |
|---|
| **Dry:** Absence of moisture, dusty, dry to the touch. |
| **Moist:** Damp / moist to the touch, but no visible water. |
| **Saturated:** Visible water, usually soil below groundwater. |

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

| MAJOR DIVISIONS | | | USCS SYMBOLS | ② | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE-GRAINED SOILS More than 50% of material is larger than No. 200 sieve size. | GRAVELS The coarse fraction retained on No. 4 sieve. | CLEAN GRAVELS (< 5% fines) | GW | | Well-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines |
| | | | GP | | Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or No Fines |
| | | GRAVELS WITH FINES ( ≥ 12% fines) | GM | | Silty Gravels, Gravel-Sand-Silt Mixtures |
| | | | GC | | Clayey Gravels, Gravel-Sand-Clay Mixtures |
| | SANDS The coarse fraction passing through No. 4 sieve. | CLEAN SANDS (< 5% fines) | SW | | Well-Graded Sands, Gravelly Sands, Little or No Fines |
| | | | SP | | Poorly-Graded Sands, Gravelly Sands, Little or No Fines |
| | | SANDS WITH FINES ( ≥ 12% fines) | SM | | Silty Sands, Sand-Silt Mixtures |
| | | | SC | | Clayey Sands, Sand-Clay Mixtures |
| FINE-GRAINED SOILS More than 50% of material is smaller than No. 200 sieve size. | SILTS AND CLAYS Liquid Limit less than 50% | | ML | | Inorganic Silts and Sandy Silts with No Plasticity or Clayey Silts with Slight Plasticity |
| | | | CL | | Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays |
| | | | OL | | Organic Silts and Organic Silty Clays of Low Plasticity |
| | SILTS AND CLAYS Liquid Limit greater than 50% | | MH | | Inorganic Silts, Micacious or Diatomacious Fine Sand or Silty Soils |
| | | | CH | | Inorganic Clays of High Plasticity, Fat Clays |
| | | | OH | | Organic Silts and Organic Clays of Medium to High Plasticity |
| HIGHLY ORGANIC SOILS | | | PT | | Peat, Soils with High Organic Contents |

**SAMPLER SYMBOLS**

- Block Sample
- Bulk/Bag Sample
- Modified California Sampler
- 3.5" OD, 2.42" ID D&M Sampler
- Rock Core
- Standard Penetration Split Spoon Sampler
- Thin Wall (Shelby Tube)

**WATER SYMBOL**

- Encountered Water Level
- Measured Water Level

(see Remarks on Logs)

Note: Dual Symbols are used to indicate borderline soil classifications (i.e. GP-GM, SC-SM, etc.).

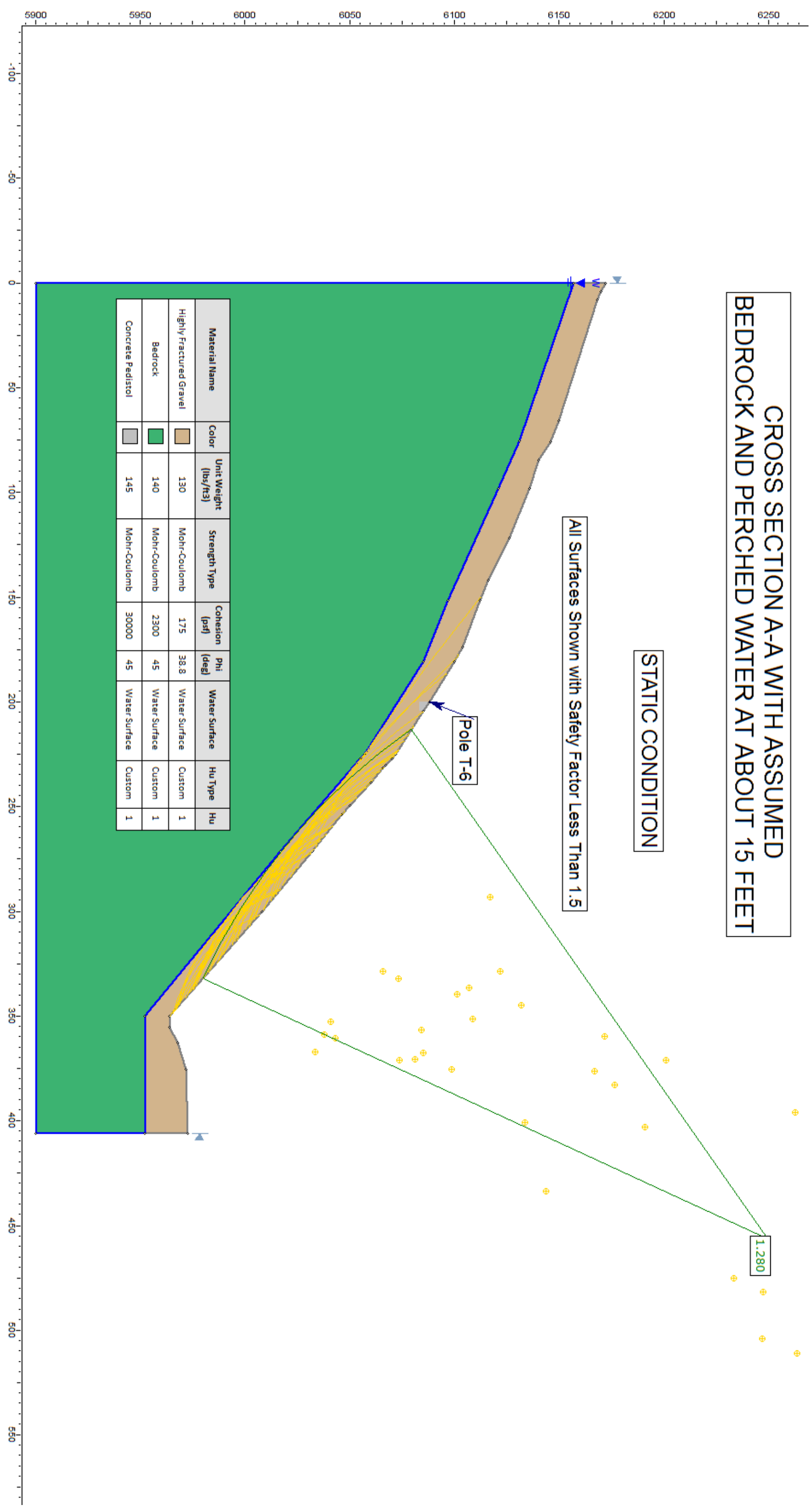
1. The results of laboratory tests on the samples collected are shown on the logs at the respective sample depths.
2. The subsurface conditions represented on the logs are for the locations specified. Caution should be exercised if interpolating between or extrapolating beyond the exploration locations.
3. The information presented on each log is subject to the limitations, conclusions, and recommendations presented in this report.

CMT ENGINEERING LABORATORIES

Figure: 9

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION
## Cross Section A-A (TOWER 6)
## (CURRENT PROPOSED DESIGN)
## STATIC




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Highly Fractured Gravel | | 130 | Mohr-Coulomb | 175 | 38.8 | Water Surface | Custom | 1 |
| Bedrock | | 140 | Mohr-Coulomb | 2300 | 45 | Water Surface | Custom | 1 |
| Concrete Pedistol | | 145 | Mohr-Coulomb | 30000 | 45 | Water Surface | Custom | 1 |

| | | |
|---|---|---|
| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 10 |

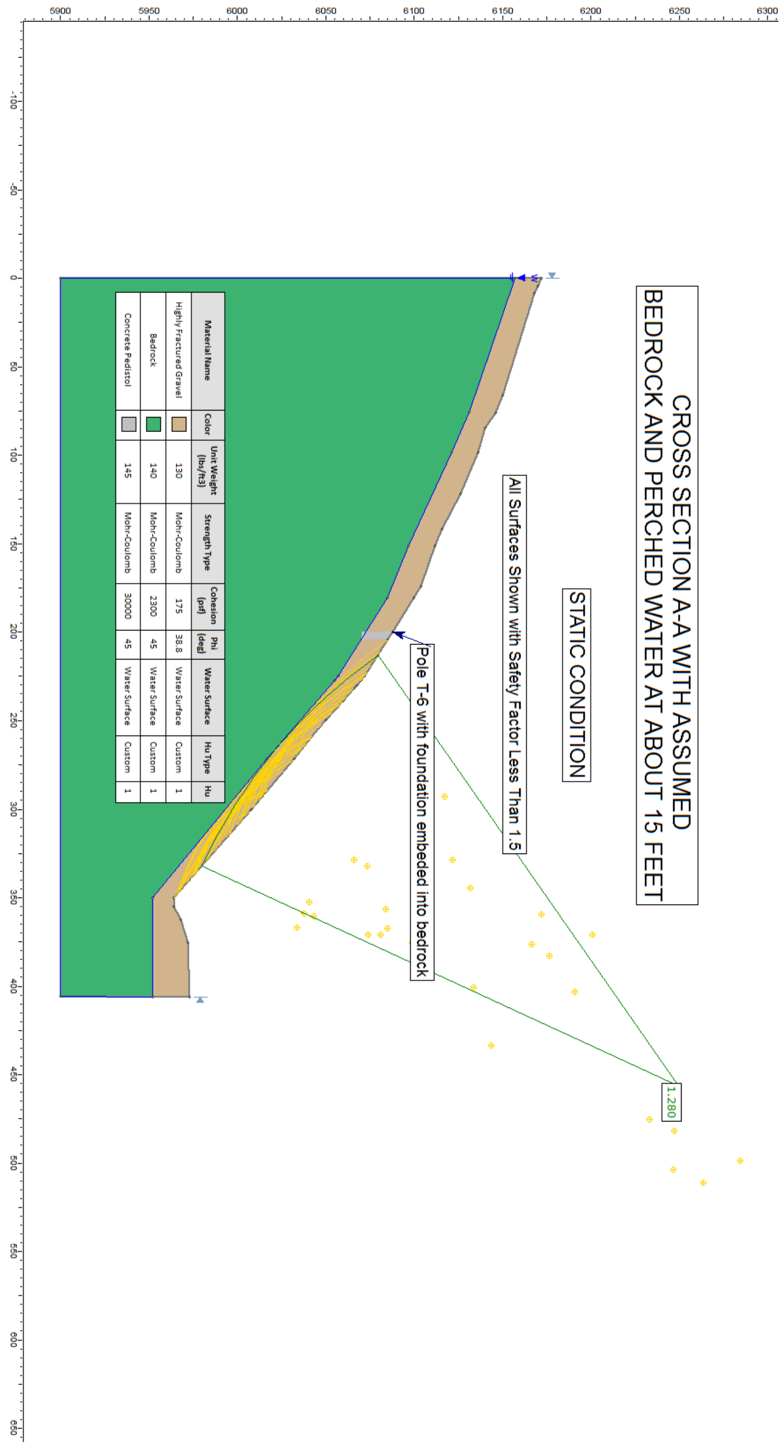
# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

## Cross Section A-A (TOWER 6)

## (TOWER FOUNDATION EXTENSION TO BEDROCK)

## STATIC




| PROJECT NO.: 14998 | NORDIC VALLEY LIFT 5 | FIGURE NO.: 11 |
|---|---|---|

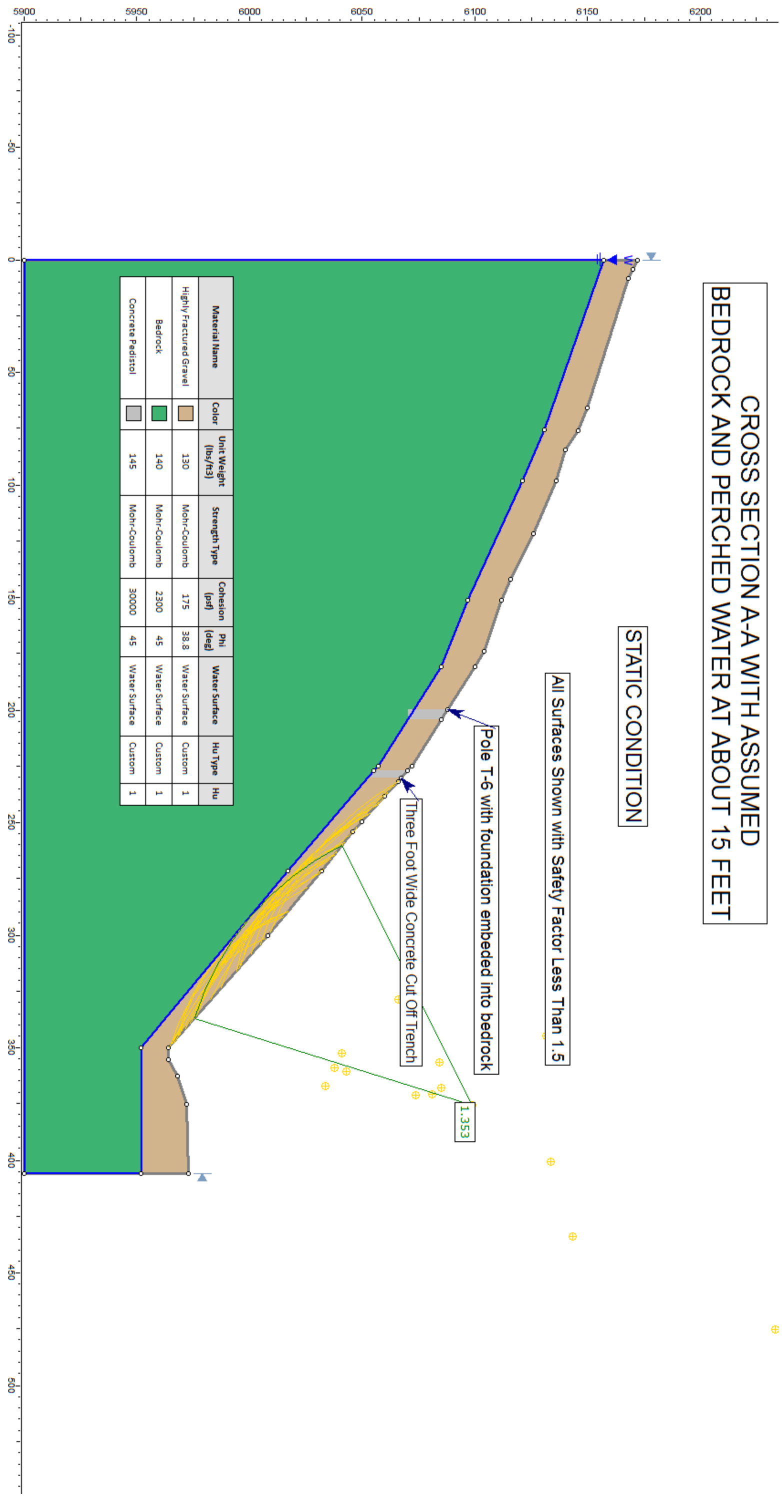
# STABILITY RESULTS

**NORDIC VALLEY LIFT EXPANSION**

**Cross Section A-A (TOWER 6)**

**(TOWER FOUNDATION & CUT OFF TRENCH EXTENSION TO BEDROCK)**

**STATIC**

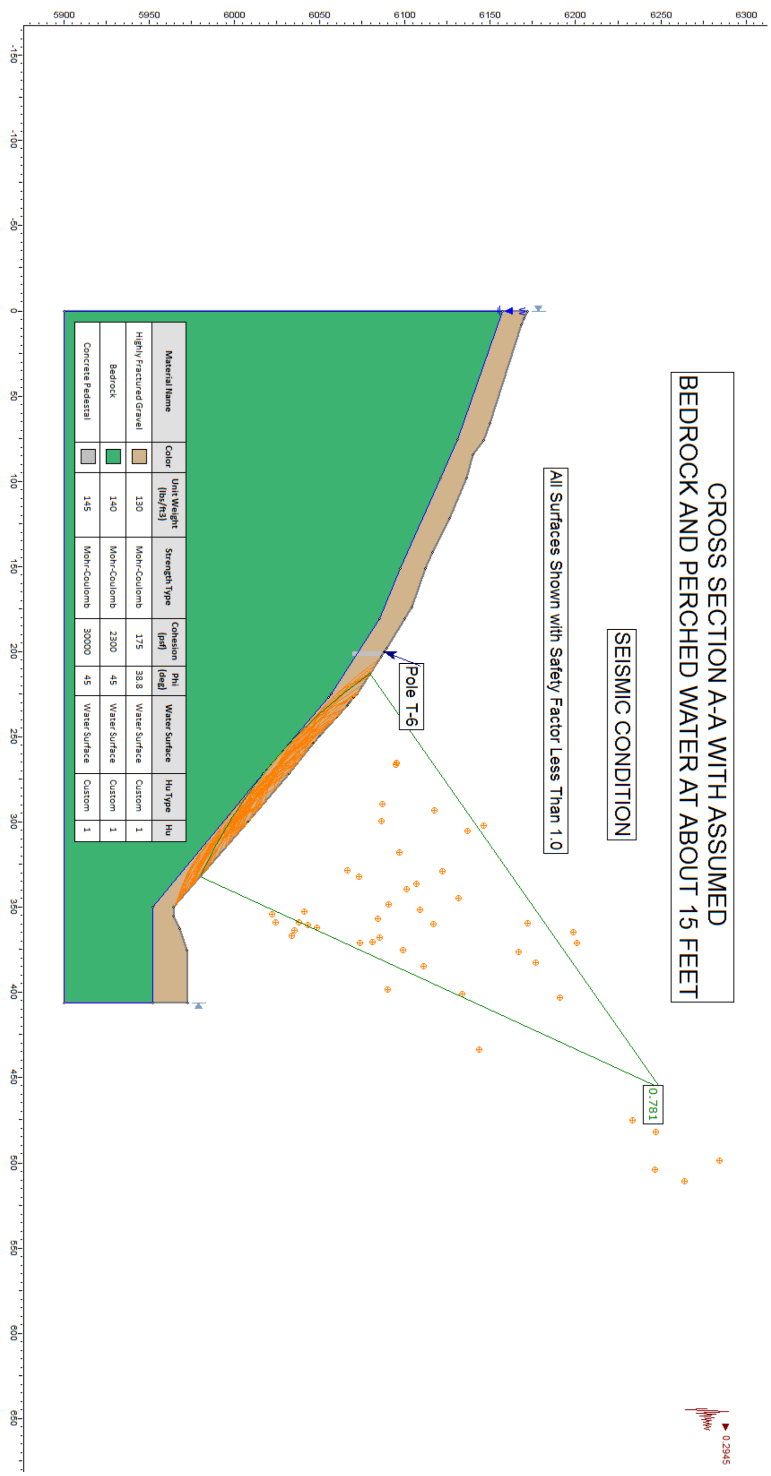



| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Highly Fractured Gravel | | 130 | Mohr-Coulomb | 175 | 38.8 | Water Surface | Custom | 1 |
| Bedrock | | 140 | Mohr-Coulomb | 2300 | 45 | Water Surface | Custom | 1 |
| Concrete Pedistol | | 145 | Mohr-Coulomb | 30000 | 45 | Water Surface | Custom | 1 |

| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 12 |
|---|---|---|

# STABILITY RESULTS

**NORDIC VALLEY LIFT EXPANSION**
**Cross Section A-A (TOWER 6)**
**(TOWER FOUNDATION EXTENSION TO BEDROCK)**
**SEISMIC**




| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 13 |
|---|---|---|

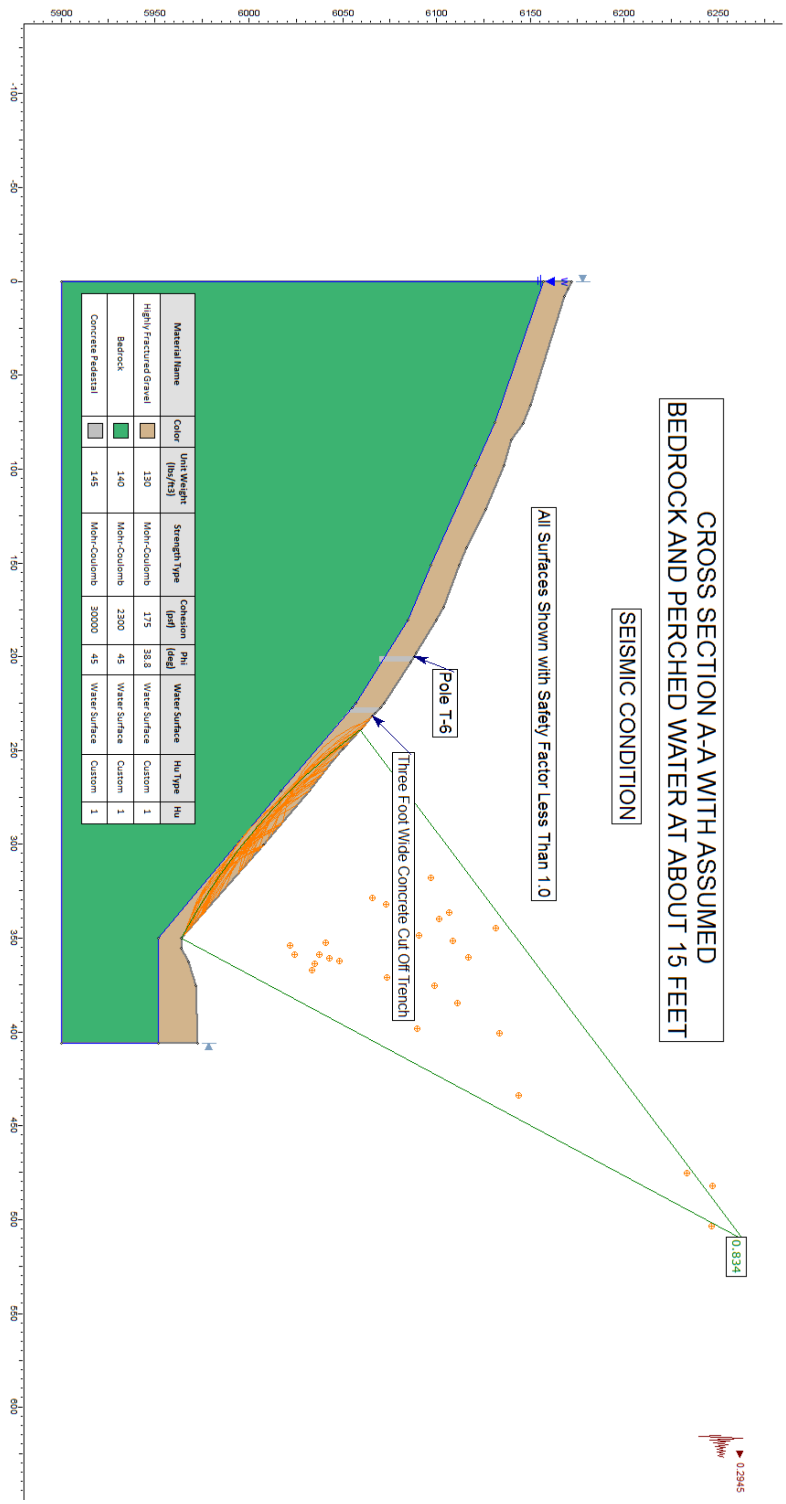
# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

## Cross Section A-A (TOWER 6)

## (TOWER FOUNDATION & CUT OFF TRENCH EXTENSION TO BEDROCK)

## SEISMIC




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Highly Fractured Gravel | | 130 | Mohr-Coulomb | 175 | 38.8 | Water Surface | Custom | 1 |
| Bedrock | | 140 | Mohr-Coulomb | 2300 | 45 | Water Surface | Custom | 1 |
| Concrete Pedestal | | 145 | Mohr-Coulomb | 30000 | 45 | Water Surface | Custom | 1 |

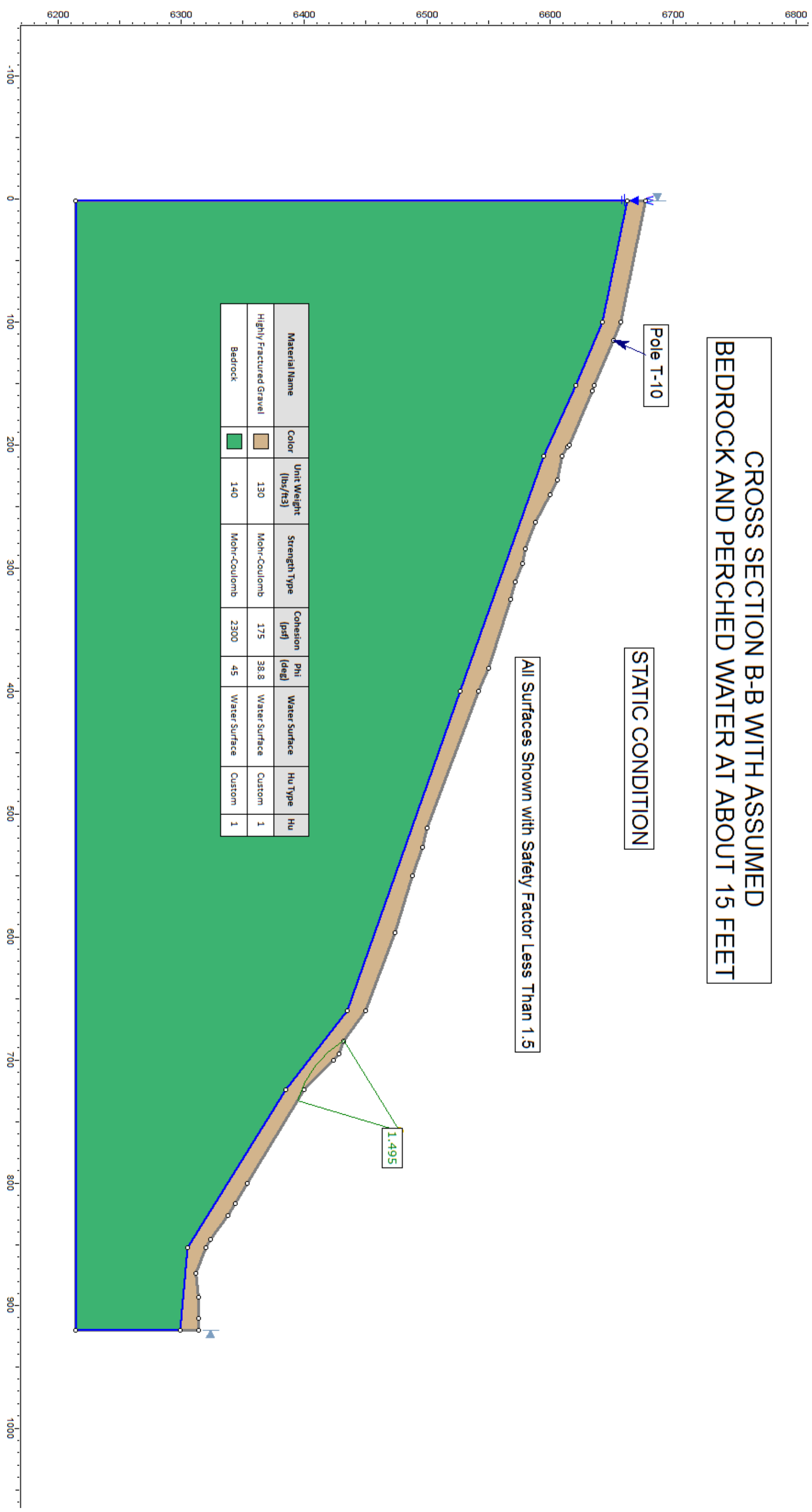
| | | |
|---|---|---|
| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 14 |

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

## Cross Section B-B (TOWER 10)

## STATIC



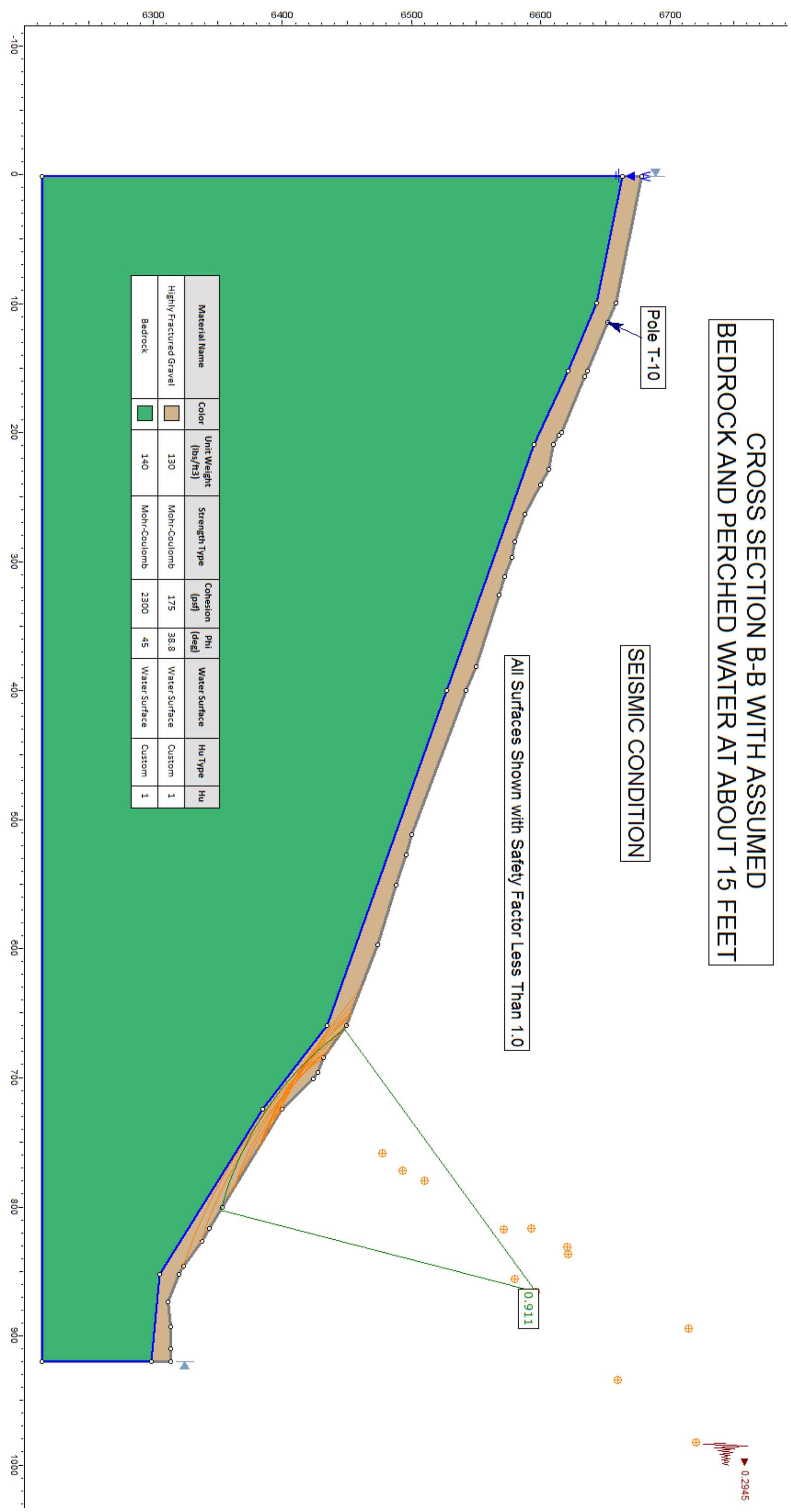

| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 15 |
|---|---|---|

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

### Cross Section B-B (TOWER 10)

### SEISMIC



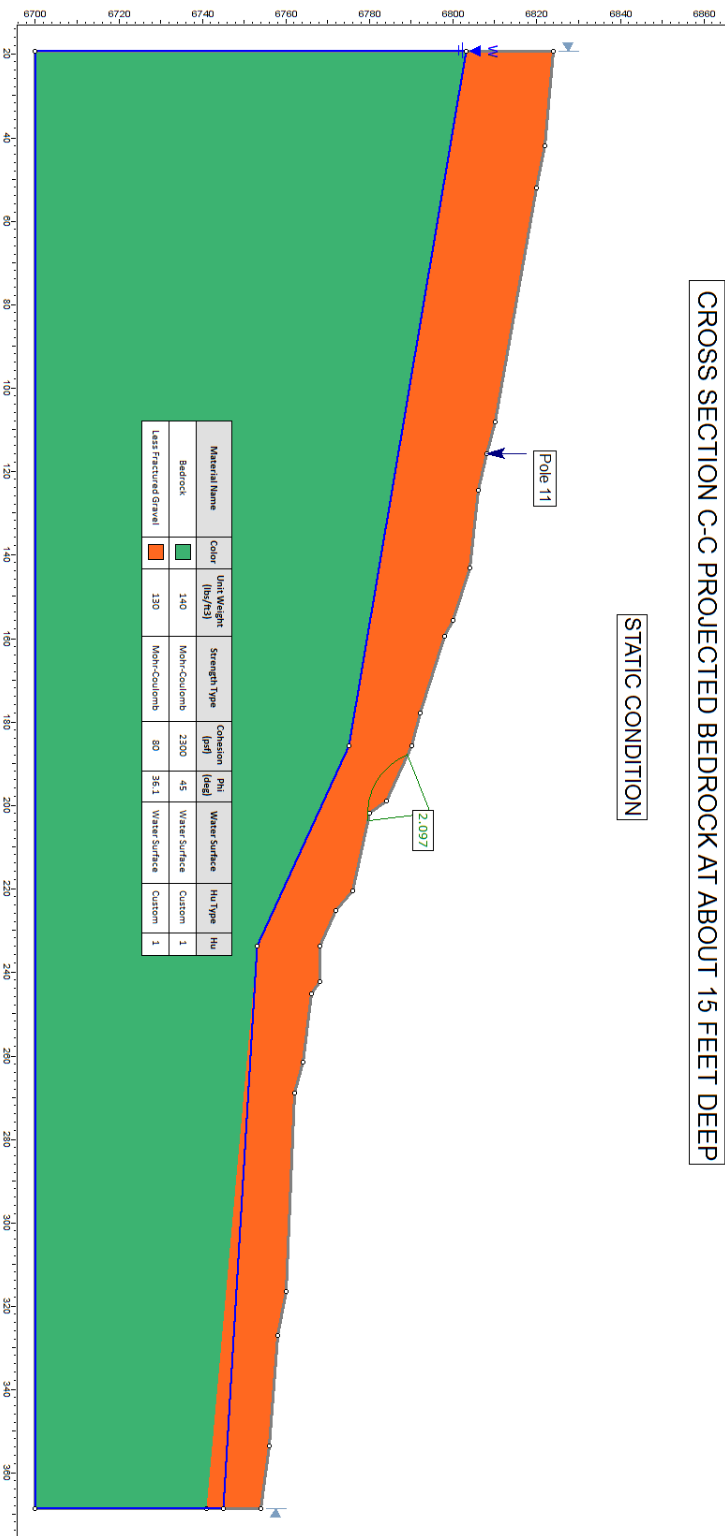

| PROJECT NO.: 14998 | NORDIC VALLEY LIFT 5 | FIGURE NO.: 16 |
|---|---|---|

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

## Cross Section C-C (TOWER 11)

## STATIC



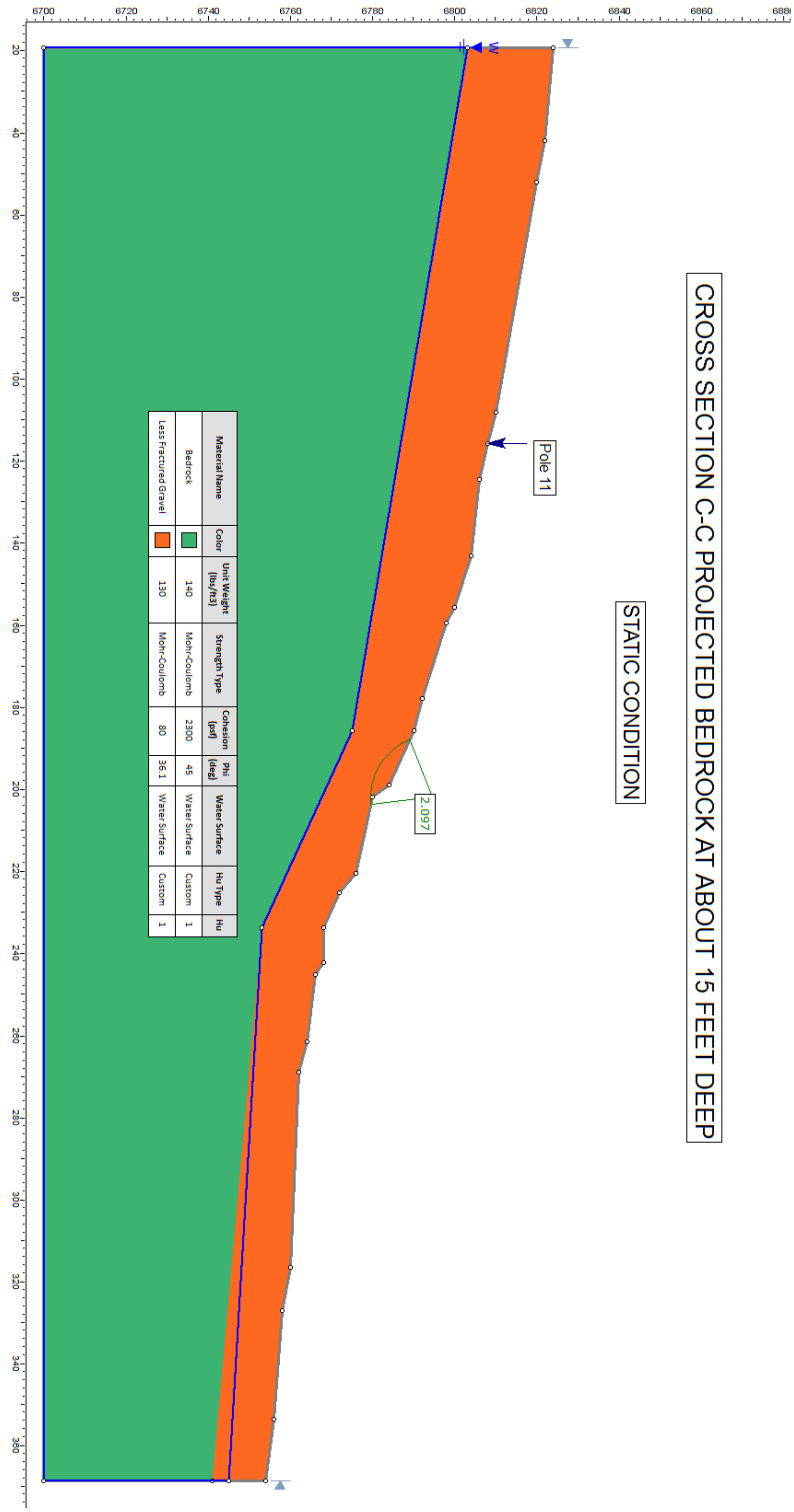

| PROJECT NO.: 14998 | NORDIC VALLEY LIFT 5 | FIGURE NO.: 17 |
|---|---|---|

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

## Cross Section C-C (TOWER 11)

## SEISMIC




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Bedrock | | 140 | Mohr-Coulomb | 2300 | 45 | Water Surface | Custom | 1 |
| Less Fractured Gravel | | 130 | Mohr-Coulomb | 80 | 36.1 | Water Surface | Custom | 1 |

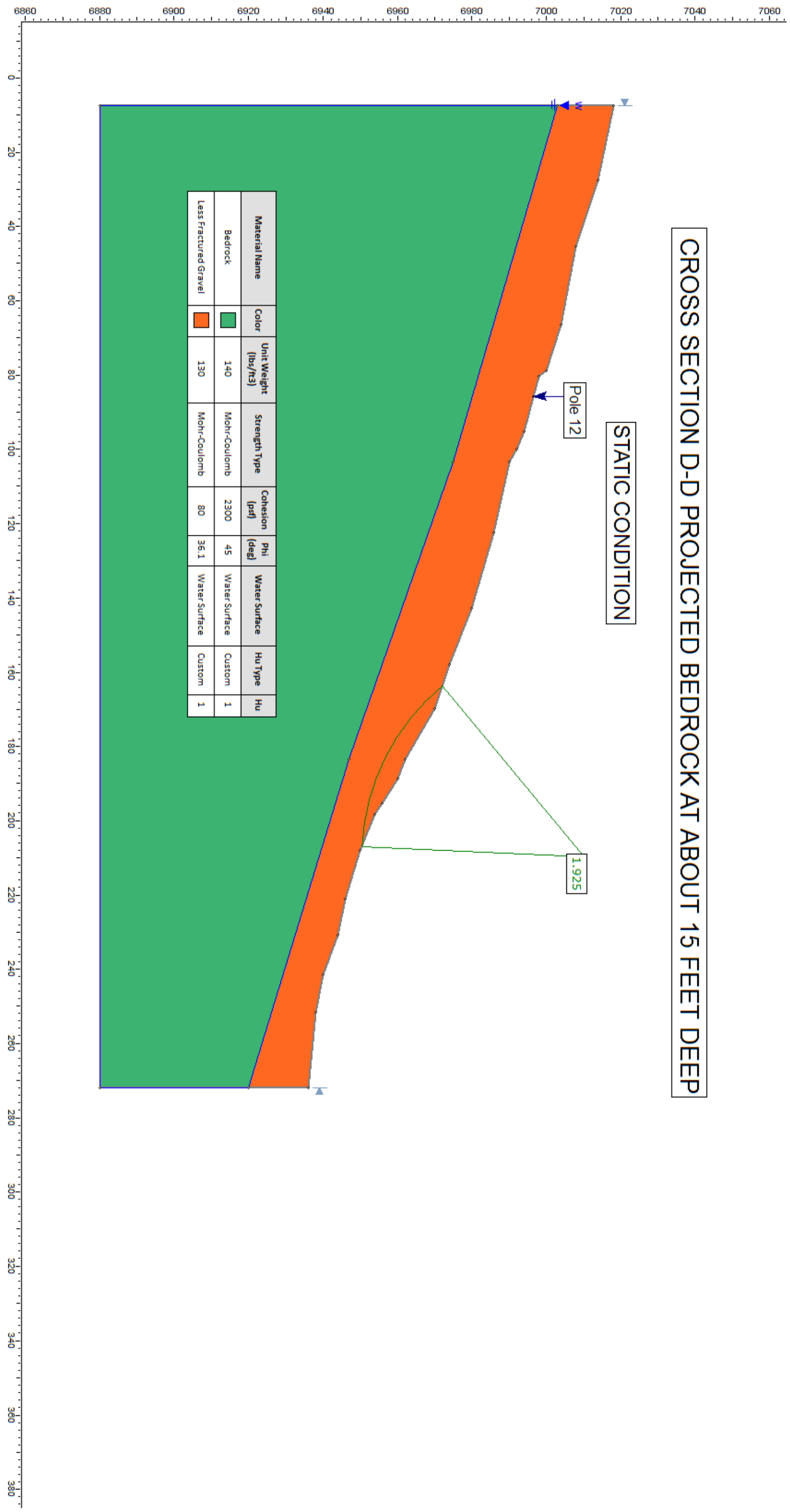
| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 18 |
|---|---|---|

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

### Cross Section D-D (TOWER 12)

### STATIC



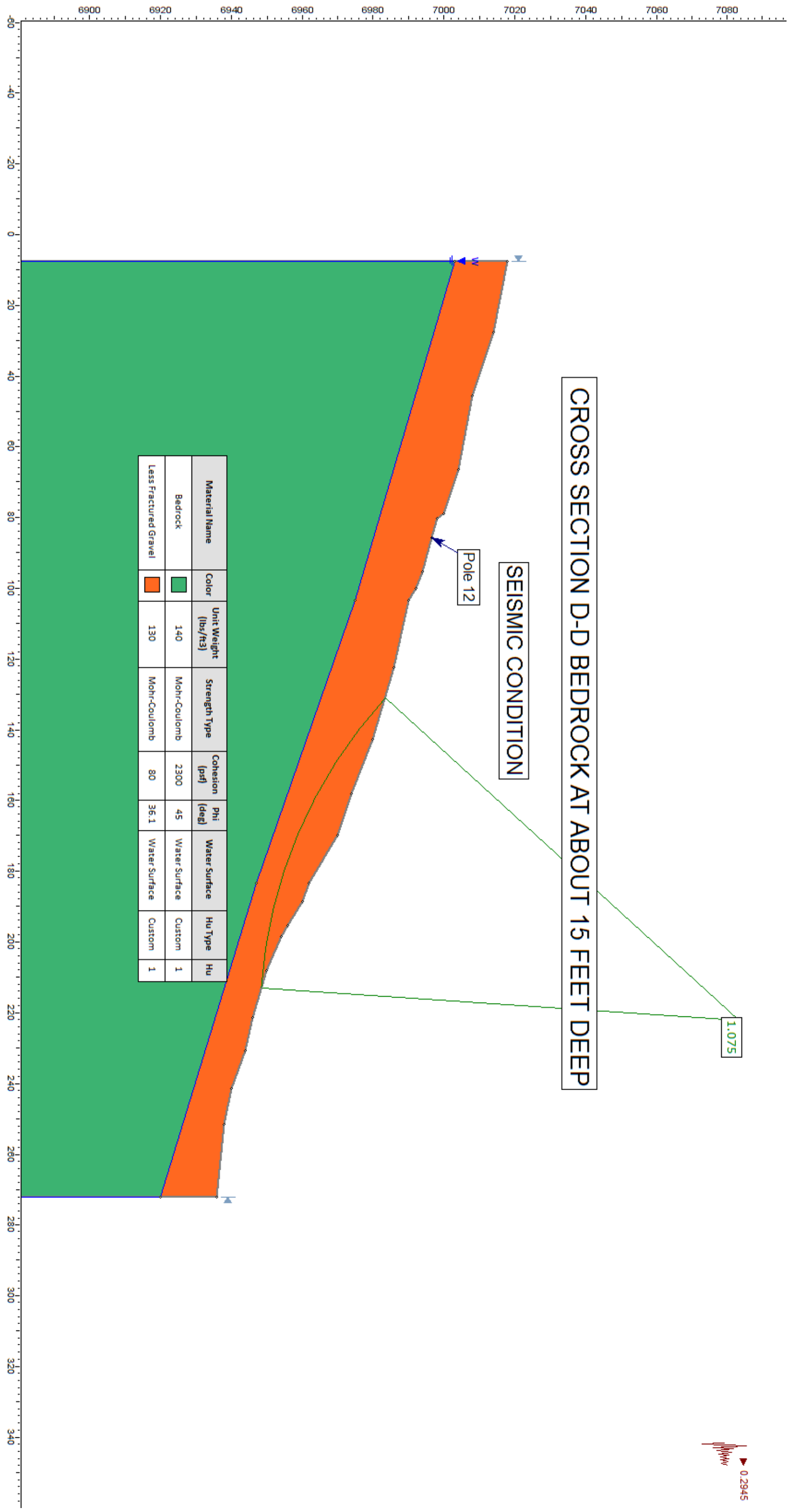

| | | |
|---|---|---|
| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 19 |

# STABILITY RESULTS

## NORDIC VALLEY LIFT EXPANSION

### Cross Section D-D (TOWER 12)

### SEISMIC




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Bedrock | | 140 | Mohr-Coulomb | 2300 | 45 | Water Surface | Custom | 1 |
| Less Fractured Gravel | | 130 | Mohr-Coulomb | 80 | 36.1 | Water Surface | Custom | 1 |

| | | |
|---|---|---|
| **PROJECT NO.:** 14998 | NORDIC VALLEY LIFT 5 | **FIGURE NO.:** 20 |