PRELIMINARY GEOTECHNICAL REPORT

Ward Lake Quarry Expansion
Lassen County, California

Hat Creek
Construction & Materials, Inc.

Submitted To:

Ms. Wendy Johnston
VESTRA RESOURCES, INC.
5300 Aviation Drive
City of Redding, CA 96002

VESTRA

Prepared by:
Bajada Geosciences, Inc.

Bajada Geosciences, Inc.

October 30, 2020
Project No. 2001.0107

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2001.0107

Ms. Wendy Johnston
VESTRA RESOURCES, INC.
5300 Aviation Drive
Redding, California 96048

Subject: **Preliminary Geotechnical Report**
Ward Lake Quarry Expansion
Lassen County, California

Dear Ms. Johnston:

Bajada Geosciences, Inc., is pleased to submit this preliminary geotechnical report to VESTRA Resources, Inc., for the expansion of Hat Creek Construction's Ward Lake Quarry located in Lassen County, California. This report is being submitted in accordance with our proposal dated February 25, 2020. This preliminary geotechnical report discusses field mapping and explorations performed, laboratory testing results, subsurface conditions encountered, and preliminary geotechnical analyses and recommendations associated with the study.

We appreciate the opportunity to perform this study. If you have any questions pertaining to this report, or if we may be of further service, please contact us at (530) 638-5263 at your earliest convenience.

Sincerely,
BAJADA GEOSCIENCES, INC.

James A. Bianchin, P.G., C.E.G.
Principal Engineering Geologist

Jon Everett, P.E., G.E.
Principal Geotechnical Engineer

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1 INTRODUCTION

BAJADA Geosciences, Inc. (BAJADA), is pleased to submit this preliminary geotechnical study to VESTRA Resources, Inc. (VESTRA), for the proposed expansion of Hat Creek Construction's (HCC) Ward Lake Quarry located in Lassen County, California. The location is shown on Plate 1 – Site Location Map. The following preliminary report discusses our understanding of the project, observations and measurements made within the proposed quarry expansion area, our analyses, and presents our preliminary opinions regarding slope stability at the proposed quarry.

1.1 PROJECT DESCRIPTION

We understand that Hat Creek Construction is proposing to expand their existing Ward Lake Quarry an additional approximately 84 acres. The proposed expansion area is located north of the existing quarry, as shown on Plate 2 – Proposed Quarry Expansion Area. The expansion area is currently fallow and has not been quarried in the past. However, we understand that portions of the expansion area have been explored by HCC using an Air-Track drill rig (an air-percussion drill rig) and we are in receipt of the logs from those explorations along with coordinates of where the explorations occurred. We understand that the materials to be extracted will be predominantly basaltic rock present on site. We also understand that proposed cut slope inclinations/bench slope widths and heights have not yet been established for the expansion area.

We understand that the quarried materials will be used as aggregate for construction and sand materials for various applications. In addition, we understand that these materials will also be used for batching of asphaltic concrete, Portland cement concrete, or other materials. It is anticipated that the materials within the quarry will be excavated using a combination of conventional ripping and hauling methods and through blasting and hauling. It is anticipated that overburden and highly weathered rock will be rippable using single- or double-shank rippers attached to bulldozers. With depth, as materials become harder and less weathered, it is anticipated that controlled blasting will be needed to excavate rock materials. Once ripped or blasted, it is anticipated that excavators will load haul trucks with excavated materials. We understand that overburden and topsoil will be stockpiled within the quarry for later use during reclamation. It is anticipated that these soils could be placed on excavated benches and slopes to help facilitate revegetation.

1.2 PROJECT LOCATION

The parcel on which the quarry expansion is to occur is located at APN 109-100-42-11. The approximate center of the proposed quarry expansion has the following latitude and longitude:

- Latitude: 40° 25' 23.7" (40.423237°)
- Longitude: -120° 24' 53.8" (-120.414953°)

It should be noted that no quarrying has been performed within the proposed expansion area; hence, there are no exposed volcanic rock faces that could be mapped and used for development of recommendations in this study. It should also be noted that drilling and geophysical explorations were not authorized as part of our scope of services for this study; however, BAJADA mapped selected available exposures within the existing quarry area and used those data in preparing this report. As such, this study should be considered preliminary in nature and should be supplemented with future studies to refine recommendations made, herein.

1.3 SCOPE OF SERVICES

Services performed for this study included:

- Reconnaissance of the site surface conditions;
- Review of pertinent, selected regional geological data;
- Observation of exposed geological conditions at the project site. Plate 3 – Geotechnical Map, presents the preliminary geological conditions mapped at the site;
- Collection of samples of surficially available on-site rock and soil materials within the existing quarry that were suitable for laboratory testing;
- Performance of laboratory testing on samples obtained from the site to estimate rock strength characteristics for use in stability analyses. Results of the laboratory testing are presented in Appendix A – Laboratory Testing;
- Performance of limit-equilibrium evaluations of the gross stability for the proposed highwall. Results of those evaluations are presented in Appendix B – Slope Stability Analyses;
- Preparation of this report, which includes:
    - A description of the proposed project;
    - A summary of our field observation and laboratory testing programs;
    - A description of site surface conditions encountered during our field investigation; and
    - Our preliminary opinion regarding slope stability.

1.4 FIELD EXPLORATION

Field exploration performed by Bajada for this study consisted of reconnaissance-level geologic mapping of the study area, field measurement of discontinuity data (fractures, joints, flow bands, bedding planes, etc.) and rock mass characteristics at selected locations within the existing quarry. Field exploration occurred on March 4, 2020.

Subsurface exploration was not authorized as part of our services.

1.5 PREVIOUS WORK PERFORMED

We know of no site specific geologic or geotechnical studies that have been performed at the site. We understand that HCC used an Air-Track drill rig to advance a number of exploratory holes on site to estimate material types and locations, and those logs were made available to us and are included in Appendix C – Air-Percussion Exploration Hole Data, of this report. Plate 4 – Air-Percussion Explorations, shows the approximate locations of where those explorations were performed.

Geological information has been previously published for the project region and is periodically referred to within this report. References for those data are presented in the References section (Section 8.0) of this report.

2 FINDINGS

2.1 SITE CONDITIONS

2.1.1 Surface Conditions

The proposed expansion site consists of a moderately inclined ridgeline that descends to the southwest and encompasses a relatively flat terrace at its base, as shown in Plate 2. The natural slopes descend at inclinations ranging from about 5 to 20 degrees. The terrace is inclined at about 0 to 5 degrees.

Both terrace and slope are fallow and covered with perennial and seasonal grasses and shrubs. Scattered, isolated trees are present locally across the site.

Drainage occurs as sheet flow to the southwest onto the terrace. Drainage on the terrace occurs as sheetflow towards the northwest into Balls Canyon, which eventually discharges into Willow Creek. Elevations within the proposed quarry expansion area range from about 4,200 to 4,540 feet (VESTRA, 2020).

2.1.2 Subsurface Conditions

Based on observations of the proposed expansion area and the highwall exposures within the active quarry, subsurface conditions consist of sedimentary soils within the terrace deposits and interlayered volcanic rock.

It is anticipated that the sediments within the terrace deposits will be a mixture of sand, silt, and clay with varying amounts of gravel. These materials were estimated to be at least 60 feet deep in explorations 69 and 70, which are shown on Plate 4.

Volcanic Rock was observed to consist of basalt, andesite, and lessor amounts of rhyolite. The basalt was observed within the existing quarry to be weak to hard (International Society of Rock Mechanics [ISRM] Grade R2 to R4), highly to slightly weathered (ISRM Grade II to IV), slightly to highly fractured, with clast shapes ranging from angular and prismatic to platy. The andesite and rhyolite were observed to be very weak to weak (ISRM Garde R1 to R2, completely to moderately weathered (ISRM Grade III to V), and were largely soil-like with cobble to boulder size spheroidally-shaped clasts of weak (ISRM Grade R2) andesite incorporated into the soil matrix. Thus, the andesite and rhyolite are considered block-in-matrix, or bimrock, layers. The volcanic rock materials were not fully penetrated by explorations shown on Plate 4 and are thought to extend deeper than the anticipated quarry excavations.

Four cross sections, A-A' through D-D', were prepared for this site and their locations are shown in plan view on Plate 3. The cross sections are presented as Plates 5.1 through 5.4 –

Geotechnical Cross Sections A-A' through D-D', respectively. Plate 6 – Fence Diagram, illustrates a pseudo three-dimensional perspective of the underlying earth materials.

2.2 GEOLOGIC CONDITIONS

2.2.1 Regional Geology

The project site is located on the margin of the Cascade Range and the Basin and Range geologic/geomorphic provinces of California. The Cascade Range province extends from the northern end of the Sierra Nevada north to the Canadian border. In the project vicinity the Cascade Range province is bounded to the west by the Klamath Mountain province, to the east by the Basin and Range province, to the south by the Sierra Nevada province, and to the north by the Cascade Range extending through Oregon and Washington.

The Cascade Range province consists of a north-northwest-trending, relatively linear belt of active and dormant strata and shield volcanoes. The regional geologic conditions are dominated by andesitic, rhyolitic and andesitic volcanic rocks mantled with surficial deposits consisting of pyroclastic rocks, lahar deposits, alluvium, and local lacustrine sediments (Hinds, 1952).

The Basin and Range province is characterized by interior drainage with lakes and playas, and the typical horst and graben structure (subparallel, fault-bounded ranges separated by down dropped basins). In these basins, moderate to extensive thicknesses of lacustrine (lake) and alluvial deposits are present. Death Valley, the lowest area in the United States (280 feet below sea level at Badwater), is one of these grabens.

2.2.2 Local Geologic Setting

As noted in Section 2.1.2, the site is underlain by Quaternary-age terrace deposits and Pleistocene-age volcanic rocks (Grose et al., 2013; Lydon et al, 1960). The terrace deposits are near-shore emergent lacustrine deposits associated with the ancestral Lake Lahontan, which covered most of the project region (Grose, et al., 2013). The volcanic rocks consist of interlayered basalt, andesite, and rhyolite tuff and flows labeled the Andesite Flows and Pyroclastics of Litchfield (Grose et al., 2013). The mapped relationships of regional geologic conditions are shown on Plate 7 – Regional Geologic Map. Local mapped geologic conditions are shown on Plate 3.

2.2.3 Groundwater

The depth to groundwater beneath the project area was estimated through searching existing groundwater databases and review of well completion logs for nearby sites. A search of regional groundwater data (DWR, 2020a) found one well located about 1.7 miles southeast of the site. Well 29N14E09D001M recorded water depths ranging from 31 to 51 feet between 1980 and 1993. No other relatively close wells on that database were found.

A search for well completion reports was performed through DWR (2020b). That search found one nearby well located about 4,000 feet southwest of the site. The well completion report for that well reported a static water level of 70.5 feet.

In addition, a search of the Geotracker database (Geotracker, 2020) did not indicate the presence of subsurface exploration or data close to the project site.

It is important to note that groundwater elevations at the proposed project location can, and most likely will, fluctuate over time. In general, the depth to groundwater varies throughout the year and from year to year. Intense and long duration precipitation or drought, modification of topography, and cultural land use changes can contribute to fluctuations in groundwater levels. Localized saturated conditions or perched groundwater conditions near the ground surface could be present during and following periods of heavy precipitation or if on-site sources contribute water.

3 GEOLOGICAL HAZARDS

3.1 FAULTING & SEISMICITY

3.1.1 Regulatory Seismic Setting

The State of California designates faults as Holocene-age or Pre-Holocene-age depending on the recency of movement that can be substantiated for a fault. Fault activity is rated as follows:

FAULT ACTIVITY RATINGS		
Fault Activity Rating	**Geologic Period of Last Rupture**	**Time Interval (Years)**
Holocene-Active	Holocene	Within last 11,000 Years[1]
Pre-Holocene	Quaternary & Older	>11,000 Years[1]
Age Undetermined	Unknown	Unknown

[1] – Holocene is defined as 11,700 years before present by the International Commission on Stratigraphy. The California State Mining and Geology Board, which administers the review and application of the Alquist-Priolo Earthquake Fault Zoning Act, currently recognizes the Holocene as 11,000 years before present.

The California Geologic Survey (CGS) evaluates the activity rating of a fault in fault evaluation reports (FERs). FERs compile available geologic and seismologic data and evaluate if a fault should be zoned as Holocene-active, pre-Holocene, or age undetermined. If an FER evaluates a fault as Holocene-active, then it is typically incorporated into a Special Studies Zone in accordance with the Alquist-Priolo Earthquake Fault Zoning Act (AP). AP Special Studies Zones require site-specific evaluation of fault location for structures for human occupancy and require a habitable structure setback if the fault is found traversing a project site.

The Holocene-active Honey Lake and Warm Springs Valley faults have been mapped in the project region, with the project site being north of the mapped trend of the Warm Springs Valley fault, as shown on Plate 8 – Regional Fault Map. Both the Honey Lake and Warm Springs faults exhibit right-lateral displacement and are significant faults within the Walker Lane fault zone (Wills, 1990). The Honey Lake fault is about 35 miles long and capable of generating a M_W 7.0 earthquake (USGS, 2020b). The Warm Springs Valley fault is about 24 miles long and capable of generating a M_W 6.8 earthquake (USGS, 2020b)

The Honey Lake fault is located about 7 miles southwest of the project site. The Warm Springs Valley fault is mapped about 13 miles south of the site. The State's fault location maps do not show the Warm Springs Valley fault projecting north of Honey Lake; however, lineations mapped from aerial photographs of the region and observed faulting within the existing quarry area project north through the quarry area and region with a trend that is coincident with the Warm Springs fault, as shown on Plate 9 – Interpreted Area Fault Map. The quarry site is not within a special studies zone associated with the AP.

3.1.2 CBC Seismic Design Recommendations

The following table presents 2019 California Building Code (CBC) criteria:

CBC SEISMIC DESIGN PARAMETERS		
California Building Code	**Parameter**	**CBC Designation**
Site Coordinates	Latitude	40.423237°
	Longitude	-120.414953°
Section 1613.5.3 Table 1613.5.3(1)	Site Coefficient, F_a	1.2
Section 1613.5.3 Table 1613.5.3(2)	Site Coefficient, F_v	1.5
Section 1613.5.1 Figure 1613.5	Site Class Designation	C
	Seismic Factor, Site Class B at 0.2 Seconds, S_s	0.808g
	Seismic Factor, Site Class B at 1.0 Seconds, S_1	0.286g
Section 1613.5.3	Site Specific Response Parameter for Site Class D at 0.2 Seconds, S_{MS}	0.970g
	Site Specific Response Parameter for Site Class D at 1.0 Seconds, S_{M1}	0.428g
Section 1613.5.4	$S_{DS}=2/3S_{MS}$	0.646g
	$S_{D1}=2/3S_{M1}$	0.286g
Per the 2019 CBC		

Because of the presence of weak to strong rock beneath the site, a Site Class C was used in the evaluation.

3.1.3 Probabilistic Estimates of Strong Ground motion

Probabilistic evaluations of horizontal strong ground motion that could affect the site were performed using attenuation evaluation methods provided by the U.S. Geological Survey (USGS, 2020a). The evaluations were performed using an estimated shear wave velocity in the upper 100 feet of the profile of 537 meters per second. Evaluations were performed for upper-bound (UBE) and design-basis (DBE) probabilistic exposures. The UBE corresponds to horizontal ground accelerations having a 10 percent probability of exceedance in a 100-year exposure period, with a statistical return period of 949 years. The DBE corresponds to horizontal ground accelerations having a 10 percent probability of exceedance in a 50-year, exposure period, with a statistical return period of 475 years. The results of these evaluations are presented in the following table:

PROBABILISTIC GROUND MOTION DATA				
Earthquake Level	Probabilistic Estimate Exposure Period (years)	Probability of Exceedance (%)	Return Period (years)	Estimated Peak Horizontal Ground Acceleration (g)
Upper-Bound Ground-Motion	100	10	949	0.296
Design-Basis Ground-Motion	50	10	475	0.215

It should be noted that although the seismic hazard models used for this study predict the probability of exceedance for various levels of acceleration in a given exposure period, the models are not able to account for the effect that the passage of time since past earthquakes has on future earthquake probability. Thus, while time may affect the incipient risk of earthquakes occurring, the UBE and DBE values are based on any 100-year and 50-year exposure period, respectively, regardless of how recently earthquakes have occurred.

3.2 LANDSLIDES
No existing, past, or incipient landslides were observed within the proposed quarry expansion area.

3.3 LIQUEFACTION AND LATERAL SPREADING
Liquefaction is described as the sudden loss of soil shear strength due to a rapid increase of soil pore water pressures caused by cyclic loading from a seismic event. In simple terms, it means that a liquefied soil acts more like a fluid than a solid when shaken during an earthquake. For liquefaction to occur, the following are needed:

- Granular soils (sand, silty sand, sandy silt, and some gravels);
- A high groundwater table; and
- A low density in the granular soils underlying the site.

If those criteria are present, then there is a potential that the soils could liquefy during a seismic event. The adverse effects of liquefaction include local and regional ground settlement, ground cracking and expulsion of water and sand, the partial or complete loss of bearing and confining forces used to support loads, amplification of seismic shaking, and lateral spreading. In general, the effects of liquefaction on the proposed project could include:

- Lateral spreading;
- Vertical settlement; and/or
- The soils surrounding lifelines can lose their strength and those lifelines can become damaged or severed.

Lateral spreading is defined as lateral earth movement of liquefied soils, or soil riding on a liquefied soil layer, down slope toward an unsupported slope face, such as a creek bank, or an inclined slope face. In general, lateral spreading has been observed on low to moderate gradient slopes but has been noted on slopes inclined as flat as one degree.

Most materials located within the proposed quarry area consist of volcanic rock materials and terrace deposits. The volcanic rock materials are not subject to liquefaction. The terrace deposits are thought to contain appreciable fines and groundwater is anticipated to be located at depths below 50 feet, per the exploratory holes advanced with the air-percussion drill rig (see Appendix C). Thus, terrace deposits are considered to have a low potential for liquefaction susceptibility.

3.4 NATURALLY OCCURRING ASBESTOS

3.4.1 Information Regarding Naturally Occurring Asbestos

Ultramafic rock, such as serpentinite, amphibolite, peridotite, dunite, pyroxenite, hornblendite, etc., can contain asbestiform minerals, which are fibrous, silica-rich crystals that can cause lung cancer, mesothelioma, asbestosis, and other health-related issues, if present. Typically, six minerals within ultramafic rocks are responsible for the primary, naturally occurring asbestiform concerns for health-related issues: chrysotile, tremolite, actinolite, anthophyllite, crocidolite, and amosite. These minerals may or may not be present in ultramafic rocks; thus, the presence of ultramafic rock does not automatically indicate that there is a health hazard. The presence of asbestiform minerals can sometimes be discerned in the field based on visual examination of rock exposures but, most often, must be confirmed using laboratory testing.

Naturally occurring asbestos can be hazardous to human health if it is disturbed, becomes airborne and is inhaled. If NOA is not disturbed and fibers are not released into the air, then it is typically not considered a health hazard. Inhalation is the primary exposure route of concern, because breathing asbestos fibers may cause them to become trapped in the lungs. Ingestion is another, albeit less common, pathway of concern, because swallowing asbestos fibers may also cause the fibers to be trapped in body tissues. Asbestos is not absorbed through the skin, so merely touching it does not pose a significant risk to human health. Asbestos fibers are not water soluble and do not move through groundwater to any appreciable extent. Based on studies of other insoluble particles of similar size, the expected migration rate of an asbestos fiber through soils by the forces of groundwater is approximately 1 to 10 centimeters (0.4 to 4 inches) per 3,000 to 40,000 years (New Hampshire DES, 2010). Thus, asbestos is not considered a groundwater contaminant.

As discussed in Section 2.1.2, the highwall should expose volcanic rocks consisting of basalt, andesite, and rhyolite, which are not rock types that typically are considered as generators of NOA. If fibrous rock, or differing rock materials, such as those mentioned above, are encountered during quarrying, we recommend that an assessment of the potential presence of NOA and its associated concentrations be performed.

3.4.2 Site Conditions

Volcanic rocks at the site are typically not considered asbestos bearing, since they do not meet the criteria noted above. Thus, testing was not performed to assess the potential presence of NOA. If such testing is desired, we would be pleased to assist in those services.

4 SLOPE STABILITY

4.1 GENERAL

The following section discusses slope stability evaluations performed for this project. Results of the stability analyses are included in Appendix B. The following section discusses methods used for stability analyses. All evaluations were performed in accordance with Blake et al. (2002) and CGS (2008), as discussed below.

4.2 DISCUSSION REGARDING FACTORS OF SAFETY

Evaluation of slope stability generally takes into consideration a number of soil and rock strength parameters, geologic conditions within the slope, hydrogeologic conditions, and surcharge and seismic loads that could affect the slope. Those parameters are typically modeled using limit-equilibrium methods (and less commonly using finite-element or finite-difference modeling) to estimate a slope inclination that meets or exceeds a target minimum factor of safety (FOS) against failure. The FOS is estimated by calculating the forces resisting slope failure divided by the forces causing slope failure. Thus, a FOS of greater than 1 implies a stable slope, a FOS of less than 1 a slope that is failing, and a FOS of 1, a slope that is creeping and/or on the verge of failure.

Conventional engineered cut or fill slopes typically utilize minimum slope stability FOS thresholds of 1.5 and 1.1 for static and pseudostatic (pseudo-earthquake forces) evaluations, respectively, for acceptable maximum slope inclinations (Blake et al., 2002, CGS, 2008). For open quarry slopes, the FOS for static conditions is often reduced to 1.25 because the risk to structures, people, and improvements is relatively low.

4.3 SURFACE SLOPE GEOMETRY

Surface topography used in our slope stability analyses is based upon topographic information collected for the proposed project (VESTRA, 2020).

4.4 SUBSURFACE PROFILE

Subsurface geological conditions for the proposed quarry expansion were estimated through observation and mapping of site conditions, review of air-percussion exploratory drill holes (see Appendix C), and observations from highwall exposures within the existing quarry. Cross sections presented as Plates 5.1 through 5.4 were developed across the site to depict anticipated subsurface conditions.

4.5 ENGINEERING PROPERTIES USED IN STABILITY ANALYSES

Soil shear strengths used in stability analyses are partially based upon direct shear data obtained from laboratory testing of a selected sample of completely weathered regolithic andesitic soil collected during this study. The shear strength obtained from that test is included in Appendix A and shown in the following tables:

DIRECT SHEAR TEST RESULTS		
Description	**Cohesion (psf)**	**Angle of Internal Friction (Ø)**
Regolithic andesitic soils	442	41.9°

Shear strength of the rock was estimated from laboratory unconfined compression tests (UCS) obtained from rock samples taken from exposures within the existing quarry during this study. Results of the unconfined compression tests are presented in Appendix A, and are as follows:

UNCONFINED COMPRESSION TEST RESULTS			
Sample	**Description**	**Compressive Strength**	
		psi	**Ksf**
1A	Basalt	6,180	889.9
2A	Andesite	5,780	832.3
2B	Andesite	5,710	822.2
3A	Basalt	10,260	1,477.4
3B	Basalt	17,200	2,476.8
	Average:	**9,026**	**1,299.7**

As noted above, the average UCS values for the rock tested from the quarry is 9,026 pounds per square inch (psi). Those intact rock strengths range from medium strong rock to very strong rock (ISRM Grade R3 to R5) with an average classification as strong rock (ISRM Grade R4).

The rock mass strength parameters were derived using the Hoek-Brown failure criterion (Marinos et al., 2005; Marinos et al., 2000). The overall strength of a rock mass is difficult to estimate because of scale issues. Methods of estimating rock mass strength based on the strength of intact rock materials and the lithology, rock mass quality and other factors are used to downgrade the measured intact rock strength to rock mass scale values. Once these strength properties have been estimated, they can be adjusted to account for the expected level of disturbance. Rock mass disturbance is typically caused by blast damage and vertical unloading, as well as strains resulting from stress changes in the quarry walls.

The Geological Strength Index (GSI) is based on the RMR rating system and was introduced by Hoek et al. (1995) to overcome issues with the RMR values for very poor-quality rock masses. For better quality rock masses (GSI>25), the value of GSI can be estimated from Bieniawski's RMR (1989) as GSI=RMR-5. This assumes a groundwater rating set to 15 (dry) and the adjustment for joint orientation set to 0 (very favorable). For this study, the GSI for basalt and andesite/ryholite have been estimated to be 60 and 55, respectively.

Hoek et al, (2002) recommends that the utilized rock mass strengths be downgraded to disturbed values to account for rock mass disturbance associated with heavy production blasting and vertical stress relief. He indicates that a disturbance factor of 0.7 would be appropriate for a mechanical excavation where no blasting damage is expected. A value of 1.0 is assumed for conventional production blasting. A good controlled production blasting strategy is expected to be between these extremes and consistent with a disturbance factor of 0.85. For this study a disturbance factor of 1.0 was used.

The following table presents a summary of the rock mass strength parameters for the anticipated rock that will be encountered within the quarry walls.

SUMMARY OF ROCK MASS STRENGTH PARAMETERS							
Basic Parameter	**Symbol**	**Unit**	**Values by Sample**				
			1A	**2A**	**2B**	**3A**	**3B**
		Rock Type:	Basalt	Andesite	Andesite	Basalt	Basalt
Unit Weight	Γ	pcf	165	165	165	165	165
Intact Unconfined Compressive Strength (UCS)	σ_{ci}	psi	6,180	5,780	5,710	10,260	17,200
Basic Rock Mass Rating (1989)	RMR	-	55	65	65	55	55
Geologic Strength Index	GSI	-	60	60	60	55	55
Petrographic Constant for Intact Rock	m_i	-	25	25	25	25	25
Disturbed Rock Mass (Disturbance Factor D=1.0)							
Hoek-Brown Constant for Rock Mass	m_b	-	1.436	1.436	1.436	0.703	0.703
Hoek-Brown Constant	S	-	0.0013	0.0013	0.0013	0.0002	0.0002
Friction angle of Rock Mass	Ø'	degrees	48.8	48.4	48.3	46.9	50.6
Cohesion of Rock Mass	C'	psf	9,102	8,828	8,780	8,105	10,170
Compressive Strength of Rock Mass	S_{cm}	ksf	31.15	29.13	28.78	21.84	36.61
Deformation Modulus	E_m	ksf	121,216	117,228	116,514	87,829	104,427

Thus, the following ranges for the angle of internal friction (Ø) and cohesion were estimated for the rock materials using the methods of Hoek et al. (2002):

DIRECT SHEAR TEST RESULTS		
Description	**Range for Cohesion (psf)**	**Range for Angle of Internal Friction (Ø)**
Basalt	9,102 to 15,314	48.8° to 55.6°
Andesite	6,364 to 6,395	42.6°

For basalt, we elected to use a cohesion (C) of 2,000 psf and Ø of 49° for the strength of those rock materials.

As previously noted, the andesite and rhyolite layers consist of soil with cobble- and boulder-size clasts interspersed within the soil mass forming a volcanic mélange, also known as bimrock. Strength evaluations of mélanges and bimrock materials, based on tests performed on groundmass, have shown the laboratory-determined strength values of the groundmass (matrix) to be lower than actual slope strength values because they do not account for the circuitous path around or through cobbles and boulders that shear planes must traverse in order for slope failure to occur (Lindquist, 1994; Medley, 2001).

A methodology for adjusting the angle of internal friction based on mélange characteristics is provided by Medley (2001). That procedure dictates that sufficient mechanical contrast has to be present between the block and matrix materials to realize an adjusted strength benefit. The following equation is used evaluate if that contrast is present:

$$\text{Contrast} = \frac{Tan(\text{Ø})\ of\ weakest\ block}{Tan(\text{Ø})\ of\ matrix}$$

If the contrast exceeds a value of 1.5, then appropriate conditions exist and benefit from that procedure might be realized. If the contrast is below 1.5, then failure surfaces are likely to pass through blocks and no benefit will be obtained. A Ø angle of 42.6° was obtained for the andesite block materials and a Ø angle of 41.9° was obtained for the matrix materials. The contrast ratio for those materials equates to 1.02. Thus, adjustment of strength values as described by Medley (2001) will not benefit this project.

Thus, based on the results of the aforementioned testing and evaluations, we have used the following strength values for materials anticipated to be exposed within highwall slopes:

STRENGTH VALUES USED IN EVALUATIONS		
Description	**Cohesion (psf)**	**Angle of Internal Friction (Ø)**
Basalt	2,000	49°
Andesite	440	42°

4.6 HYDROGEOLOGIC CONDITIONS

As noted in Section 2.2.3, groundwater is anticipated to be located below the bottom of the proposed quarry excavation. Thus, slope stability at the site was modeled with no piezometric surface influencing the stability.

4.7 PSEUDOSTATIC LOADING CRITERIA

To estimate the appropriate horizontal ground acceleration (pseudostatic loading) to use within our model, we used methods of Blake et al (2002) and CGS (2007). Using a probabilistic horizontal ground acceleration of 0.22g, which corresponds to a 475-year return period (10% chance of exceedance in 50 years; see Section 3.1.3), we could have reduced that value by 44 percent to obtain a pseudostatic acceleration of 0.09g and been within the standard of practice for these evaluations. However, to be conservative, we utilized a pseudo static acceleration of 0.15g within our model.

4.8 SLOPE STABILITY EVALUATIONS

BAJADA performed a number of slope stability evaluations to estimate the maximum safe slope inclination at the site. As discussed in Sections 2.1.2 and 2.2.2 and as shown on Plates 5.1 through 5.4 and Plate 6, the geologic conditions at the site consist of a layered rock and soil model. This model has competent, hard, fractured basalt flows sandwiched between weak rock and soil that contains cobble- and boulder-size clasts of harder andesite and rhyolite. Thus, the stability of the slope will not be governed by orientations and proliferations of discontinuity orientations of rock within the slope but more so by the stability of the soil interbeds.

Using this model, gross stability evaluations of slopes with varying inclinations and heights were performed. These evaluations consisted of limit-equilibrium analyses performed using the computer program SLIDE 2018 (Rocscience, 2020). Static and pseudostatic analyses results are presented in Appendix B of this report. Stability analyses evaluated the FOS values for highwall slopes ranging in height from 150 to 350 feet tall with slope angles varying from 45 to 60 degrees. The following table presents the results of those analyses:

RESULTS OF STABILITY ANALYSES

Slope Height (feet)	Slope Inclination (degrees)	Loading Condition	Factor of Safety	Acceptable FOS?
150	45	Static	1.55	Yes
		Pseudostatic	NP	NA
	50	Static	1.39	Yes
		Pseudostatic	NP	NA
	55	Static	1.26	Yes
		Pseudostatic	1.02	Yes
	60	Static	1.15	No
		Pseudostatic	NP	NA
200	45	Static	1.47	Yes
		Pseudostatic	NP	NA
	50	Static	1.31	Yes
		Pseudostatic	1.05	Yes
	55	Static	1.19	No
		Pseudostatic	NP	NA
250	45	Static	1.40	Yes
		Pseudostatic	NP	NA
	50	Static	1.25	Yes
		Pseudostatic	1.00	Yes
	55	Static	1.13	No
		Pseudostatic	NP	NA

RESULTS OF STABILITY ANALYSES				
Slope Height (feet)	**Slope Inclination (degrees)**	**Loading Condition**	**Factor of Safety**	**Acceptable FOS?**
300	45	Static	1.36	Yes
		Pseudostatic	1.07	Yes
	50	Static	1.19	No
		Pseudostatic	NP	NA
350	45	Static	1.31	Yes
		Pseudostatic	1.03	Yes
	50	Static	1.16	No
		Pseudostatic	NP	NA
NP – Not performed; NA – Not applicable				

Results of the stability analyses are presented graphically as a curve on Plate 10 – Slope Inclination Versus Height. It should be noted that the curve applies to both static (FOS ≥ 1.25) and pseudostatic (FOS ≥ 1.01) conditions.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 GENERAL

Based on the results of our investigation, it is our opinion that the site is suitable for development of the project provided recommendations presented, herein, are utilized during expansion of the quarry. Specific comments and recommendations regarding the geotechnical aspects of project design and construction are presented in the following sections.

5.1.1 Faulting

As previously noted, the project site is located about 7 miles from the closest State-mapped Holocene-active fault. However, as shown on Plate 9, it appears that possible northerly extensions of the Holocene-active Warm Springs Valley fault may project through the quarry area. It is our opinion that there is risk associated with rupture across the project site from this fault; however, since there are no habitable structures, the potential health risks are relatively low, especially with a relatively long recurrence interval for that fault.

5.1.2 Landslides

It is our opinion that the risk of natural landslides to adversely impact the project site is low. The risks of failure of man-made slopes associated with quarrying is discussed below.

5.1.3 Liquefaction

Based on our observations and the characteristics of materials exposed in the existing quarry during the investigation, it is our opinion that liquefaction and lateral spreading pose a low risk of adversely affecting the proposed quarry expansion project site.

5.1.4 Naturally Occurring Asbestos

Based on our observations at the existing quarry site, it is our opinion that rock materials associated with NOA are not present within the proposed quarry area.

5.2 QUARRY SLOPE DESIGN

The following sections discuss the maximum recommended slope inclinations, slope heights, and bench locations for the proposed disposal stockpile.

5.2.1 Slope Inclination & Height

As noted in Section 4.8, slopes ranging in height from 150 to 350 feet were evaluated to estimate the maximum slope inclination that would provide a minimum FOS value for static and pseudostatic conditions of 1.25 and 1.0, respectively, for those heights. The results are tabulated in Section 4.8 and presented on Plate 10. We recommend that highwall slope inclinations be designed no steeper than those inclinations noted on Plate 10 for the maximum proposed highwall height within the proposed expansion area.

5.2.2 Bench Recommendations

Conventional hard rock quarries have benches separated by near vertical bench faces to create a stepped geometry from top of slope to bottom of quarry. Because this site has relatively strong basalt flows separated by relatively weak andesite and rhyolite layers, conventional benching does not appear to be a viable alternative.

Instead, we recommend that the highwall be graded at an inclination noted in Section 4.8 and that benches to capture and divert drainage and to act as catchment for dislodged rocks, be constructed at vertical intervals across the highwall face. We recommend that benches be designed and constructed at no more than 50-foot vertical intervals. The benches should be a minimum of 12 feet wide, inclined into the slope, and constructed to drain to the margins of the highwall and/or to centralized collection areas that capture and convey drainage to the bottom of the cut slope. In addition, we recommend that a V-ditch or berm be constructed along the top of the highwall to divert water away from the highwall face.

5.3 OPERATIONAL CONSIDERATIONS

5.3.1 Controlled Blasting

Blasting disturbance is one of the controlling factors for rock mass strength and overall slope stability. Slope instabilities are often triggered by the progressive deterioration (raveling) of the wall face and this process is often initiated with the detachment of small rock blocks (key blocks) bounded by the rock mass discontinuities, The preservation of rock mass integrity during mining is critical to reduce the potential of these progressive failures and is required to achieve the steepest bench face angles possible.

Controlled blasting methods will facilitate steeper final quarry slopes by reducing face damage from blasting. Typical controlled blasting strategies utilize small diameter blast holes detonated as a pre-shear line in harder, massive rock (pre-splitting) or as a post-shear (cushion) line in weak or heavily fractured rock. In all cases, it is important that blast hole lengths be staggered so the bottom of the hole does not intercept the crest on the bench below. Otherwise, highly fragmented bench crests will develop leading to increased and possibly unacceptable backbreak.

Interim quarry slopes should incorporate some "controlled blasting" to maintain safety, but the requirements in this situation are less rigorous due to shorter operating life of these walls. The initial quarry can be developed with variable slopes and blast patterns to develop optimal blasting design for final quarry walls. Trial blasts are also recommended wherever there is a substantial change in rock mass characteristics, in order to evaluate and optimize blast performance.

5.3.2 Geotechnical Monitoring

Proactive geotechnical monitoring is recommended for all stages of quarry development. The monitoring program should be implemented as a staged approach and include geotechnical and tension crack observation and monitoring, as well as implementation of a surface displacement monitoring program.

Detailed geological mapping should be performed following creation of new benches but at a frequency no longer than quarterly to annually, depending on the rate of resource extraction and bench formation. Detailed information to be noted should include orientations, types, persistence, frequency, infilling, and condition of discontinuities exposed during mining operations. In addition, seepage volumes and relative changes in seepage volumes should be noted as those changes might indicate dilation of discontinuities and a change in the hydrogeologic environment.

Observations of tension cracks should be carried out along all newly formed benches. Detailed information to be noted should include the surveyed location, orientation, aperture, and both vertical and lateral extents of all tension cracks. The development of tension cracks should be very carefully observed. The frequency of observations should be commensurate with the rate of development of individual cracks. A map and database of tension crack information should be compiled and updated as new information becomes available. Areas of slope movement that are associated with development of tension cracks should also be monitored with survey and/or instrumentation, which can consist of time domain reflectometry (TDR), inclinometers, borehole and/or surface extensometers, tiltmeters, and piezometers.

6 FUTURE GEOTECHNICAL ASSESSMENTS

This preliminary report was prepared using limited data available from surficial rock exposures at the existing quarry site and data from the Air-Track drill holes advanced by HCC. Thus, it is preliminary in nature. Findings, conclusions, and recommendations made within this report should all be considered preliminary. Because of this, we recommend that future geotechnical assessment of the quarry be performed once rock exposures are made within the quarry highwall and/or once additional subsurface geotechnical exploration is authorized. Those future geotechnical assessments should collect additional discontinuity orientations, rock quality data, rock strength data, groundwater information, and evaluate whether recommendations made within this preliminary geotechnical report are valid or require amendment.

In addition, periodic on-going geotechnical assessment of the quarry geologic and geotechnical conditions should be performed, as discussed in Section 8.3.2 of this report.

7 CLOSURE

This preliminary report has been prepared in substantial accordance with the generally accepted geotechnical engineering and engineering geological practice, as it existed in the site area at the time our services were rendered. No other warranty, either express or implied, is made.

Preliminary conclusions contained in this report are based on the conditions encountered during our field observations and mapping, and are applicable only to those project features described herein (see Section 1.1). Subsurface exploration was not performed for completion of this study. Soil and rock deposits can vary in type, strength, and other geotechnical properties between points of observation and exploration. Additionally, groundwater and soil moisture conditions can also vary seasonally and for other reasons. Therefore, we do not and cannot have a complete knowledge of the subsurface conditions underlying the project site. The preliminary conclusions and recommendations presented in this report are based upon the findings at the points of observation, and interpolation and extrapolation of information between and beyond the points of observation, and are preliminary in nature and subject to confirmation based on the conditions revealed by construction. If conditions encountered during construction differ from those described in this report, or if the scope or nature of the proposed construction changes, we should be notified immediately to review and, if deemed necessary, conduct additional studies.

The scope of services provided by BAJADA for this project did not include the investigation and/or evaluation of toxic substances, or soil or groundwater contamination of any type. If such conditions are encountered during site development, additional studies may be required. Further, services provided by BAJADA for this project did not include the evaluation of the presence of critical environmental habitats or culturally sensitive areas.

This report may be used only by our client and their agents and only for the purposes stated herein, within a reasonable time from its issuance. Land use, site conditions, and other factors may change over time that may require additional studies. In the event significant time elapses between the issuance date of this report and full construction of the quarry, BAJADA shall be notified of such occurrence to review current conditions. Depending on that review, BAJADA may require that additional studies be conducted and that an updated or revised report is issued.

Any party other than our client who wishes to use all or any portion of this report shall notify BAJADA of such intended use. Based on the intended use as well as other site-related factors, BAJADA may require that additional studies be conducted and that an updated or revised report be issued. Failure to comply with any of the requirements outlined above by the client or any other party shall release BAJADA from any liability arising from the unauthorized use of this report.

We appreciate the opportunity to assist with this project. If you have any questions, please do not hesitate to contact our office.

8 REFERENCES

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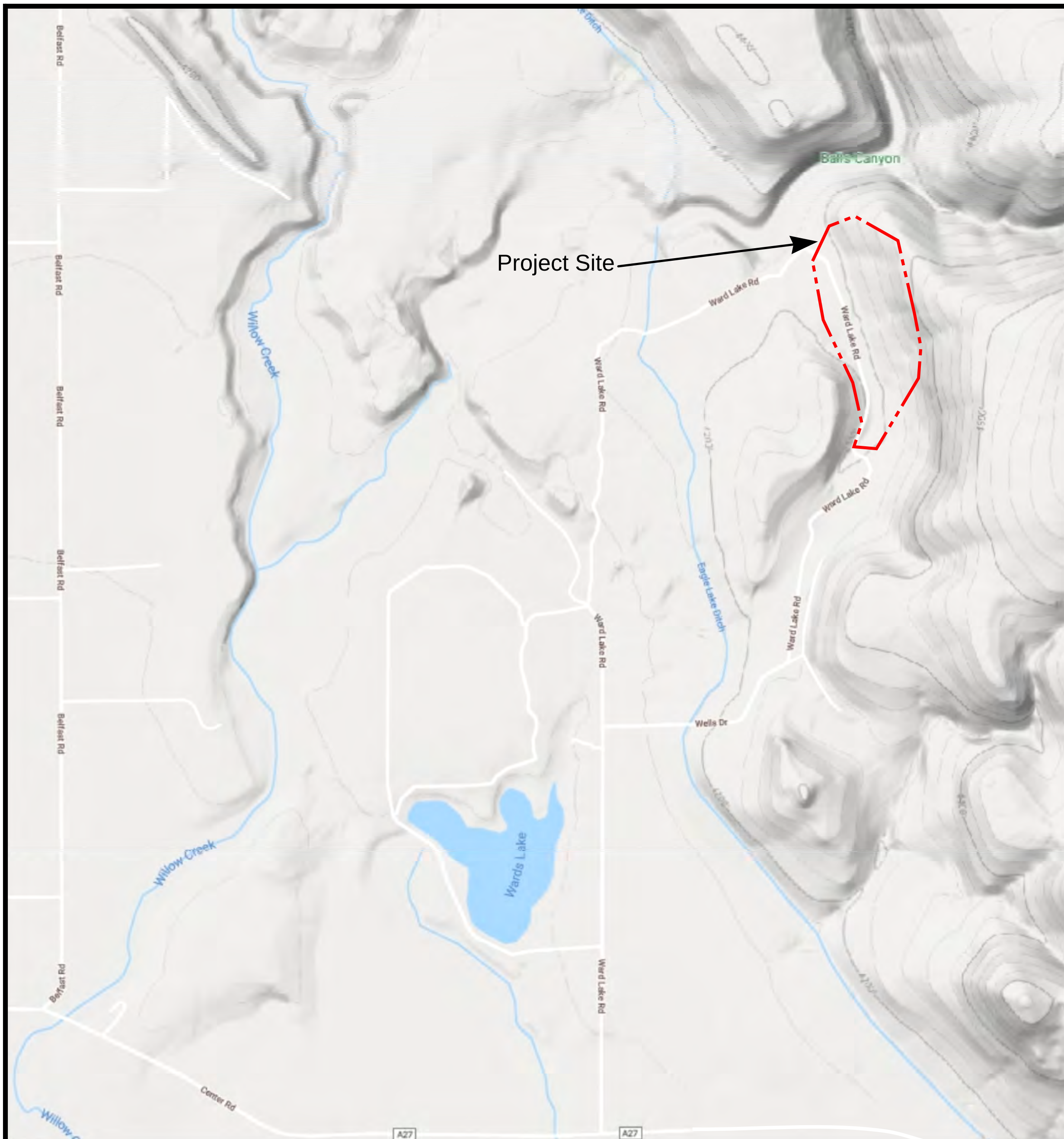
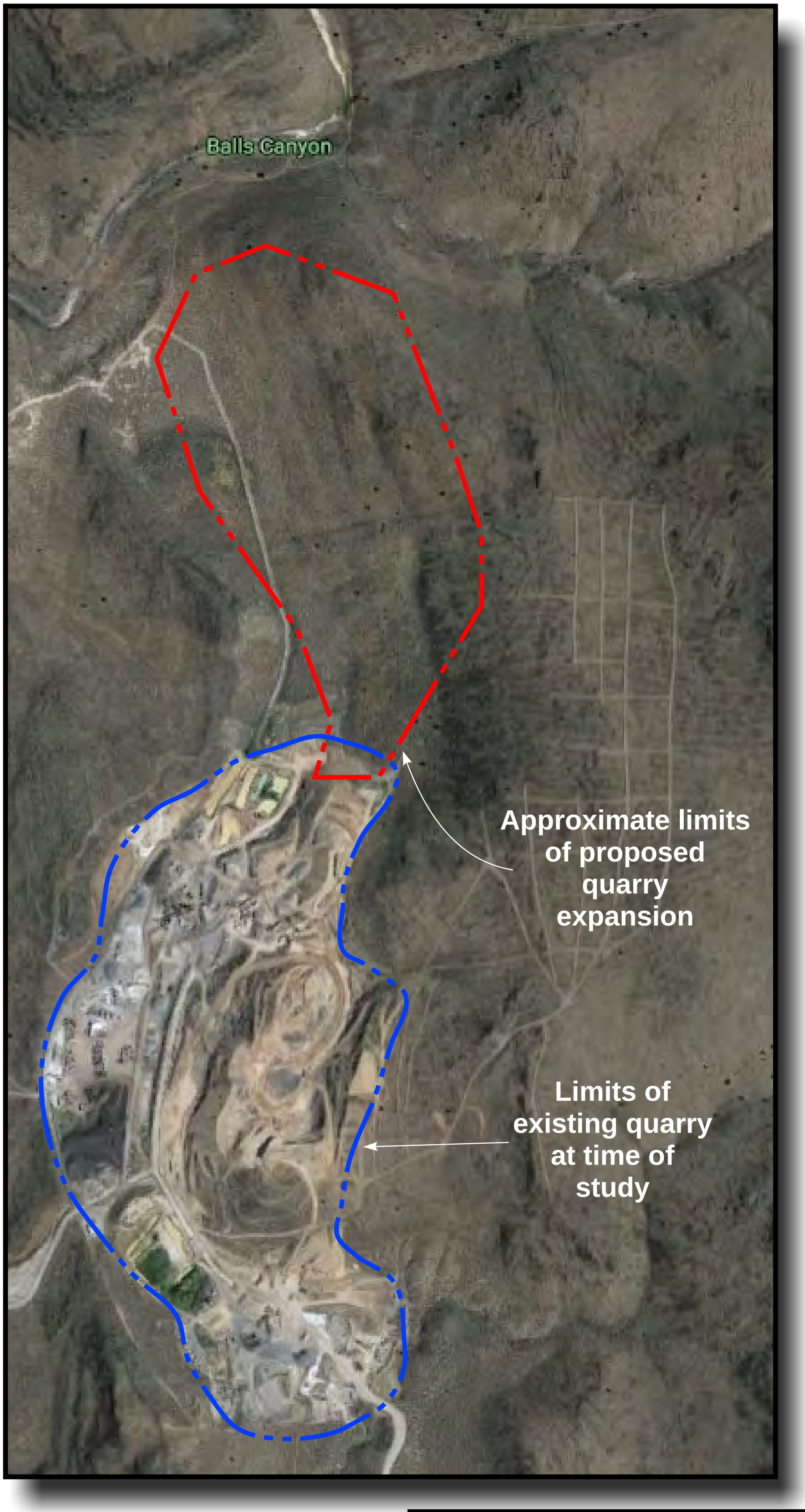


SITE LOCATION MAP

Ward Lake Quarry Expansion Preliminary Geotechnical Study Hat Creek Construction Company Lassen County, California	Plate No. 1
BAJADA Geosciences, Inc.	Project no. 2001.0107

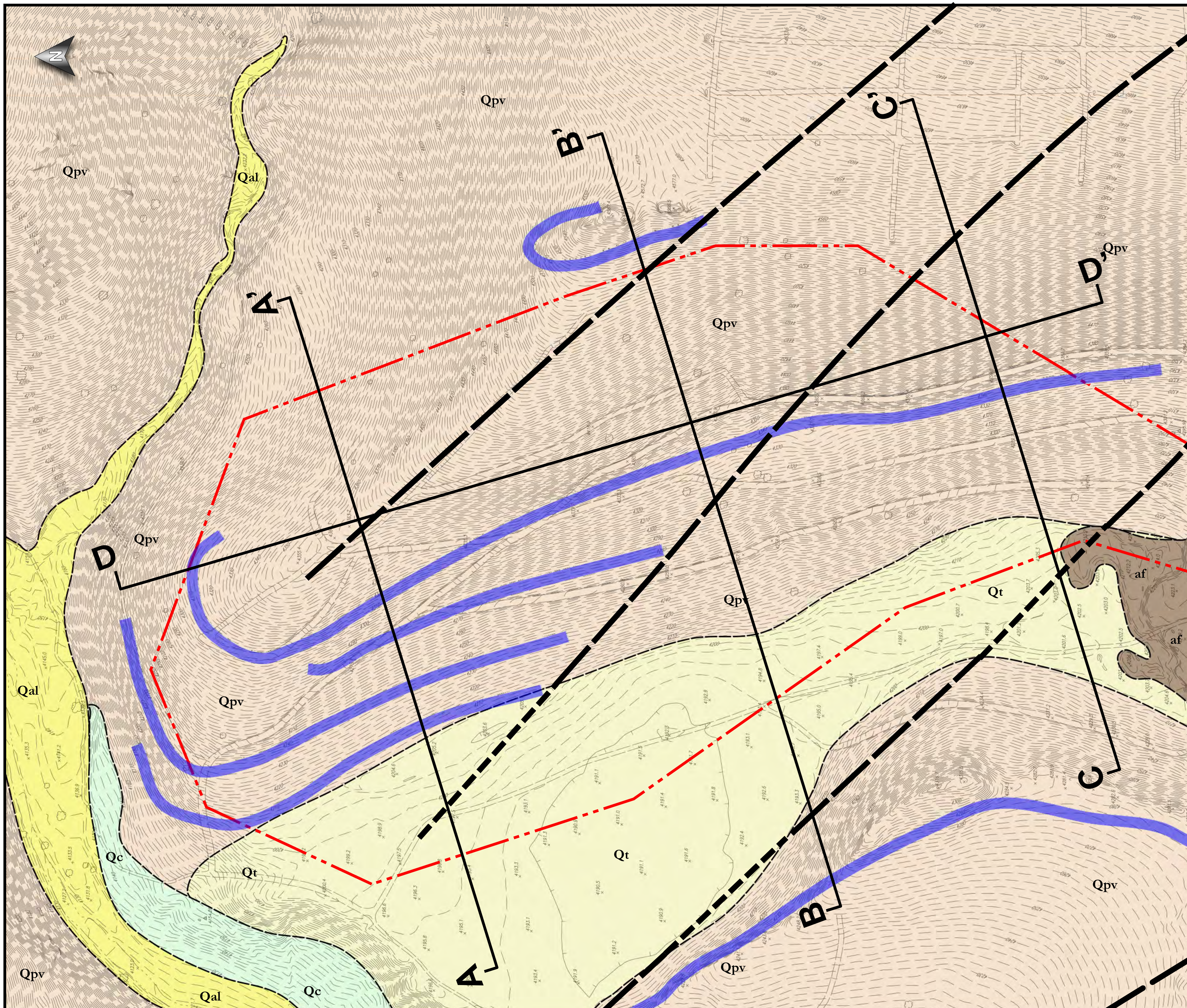
Base maps from Mapquest. Scale undetermined.



Base maps from Google Maps. Scale undetermined.

PROPOSED QUARRY EXPANSION AREA

Ward Lake Quarry Expansion Preliminary Geotechnical Study Hat Creek Construction Company Lassen County, California	Plate No. 2
BAJADA Geosciences, Inc.	Project no. 2001.0107



af	Artificial Fill/Stockpile
Qal	Alluvium
Qc	Colluvium
Qt	Terrace Deposits
Qpv	Volcanic Rock (Basalt & Andesite, with minor Rhyolite)

Geologic Contact, Dashed where approximate

Fault Dashed where approximate

D D' Geotechnical Cross Section
See Plate2 5.1 through 5.4 for Sections

Approximate Limits of Quarry Expansion

Approximate Limits of Resistant Strata Mapped From Aerial Photographs

0 150 300

Scale: 1"=300'
1:3,600
Contour Intervals: 2'

GEOTECHNICAL MAP

Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 3

Project no. 2001.0107

BAJADA Geosciences, Inc.

Topographic base map from VESTRA (2020)

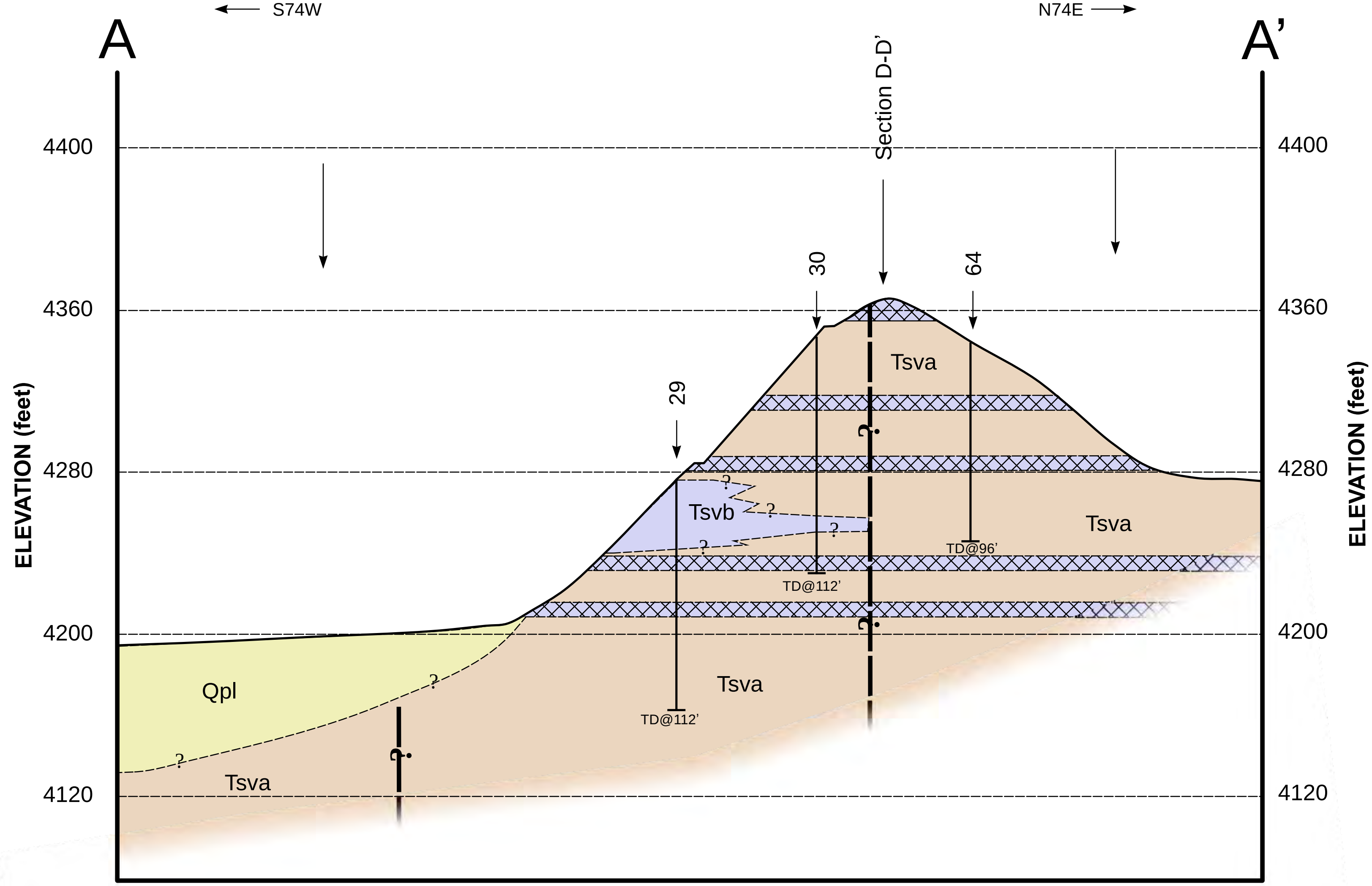
AIR-PERCUSSION EXPLORATIONS

Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

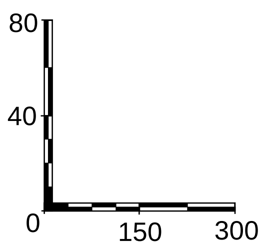
Plate No. 4

BAJADA Geosciences, Inc.

Project no. 2001.0107



Scale:
Horizontal:1"=300'
Vertical: 1"=80'
Vertical Exaggeration 3.75x



See Plate 5.4 for Legend

GEOTECHNICAL SECTION A-A'

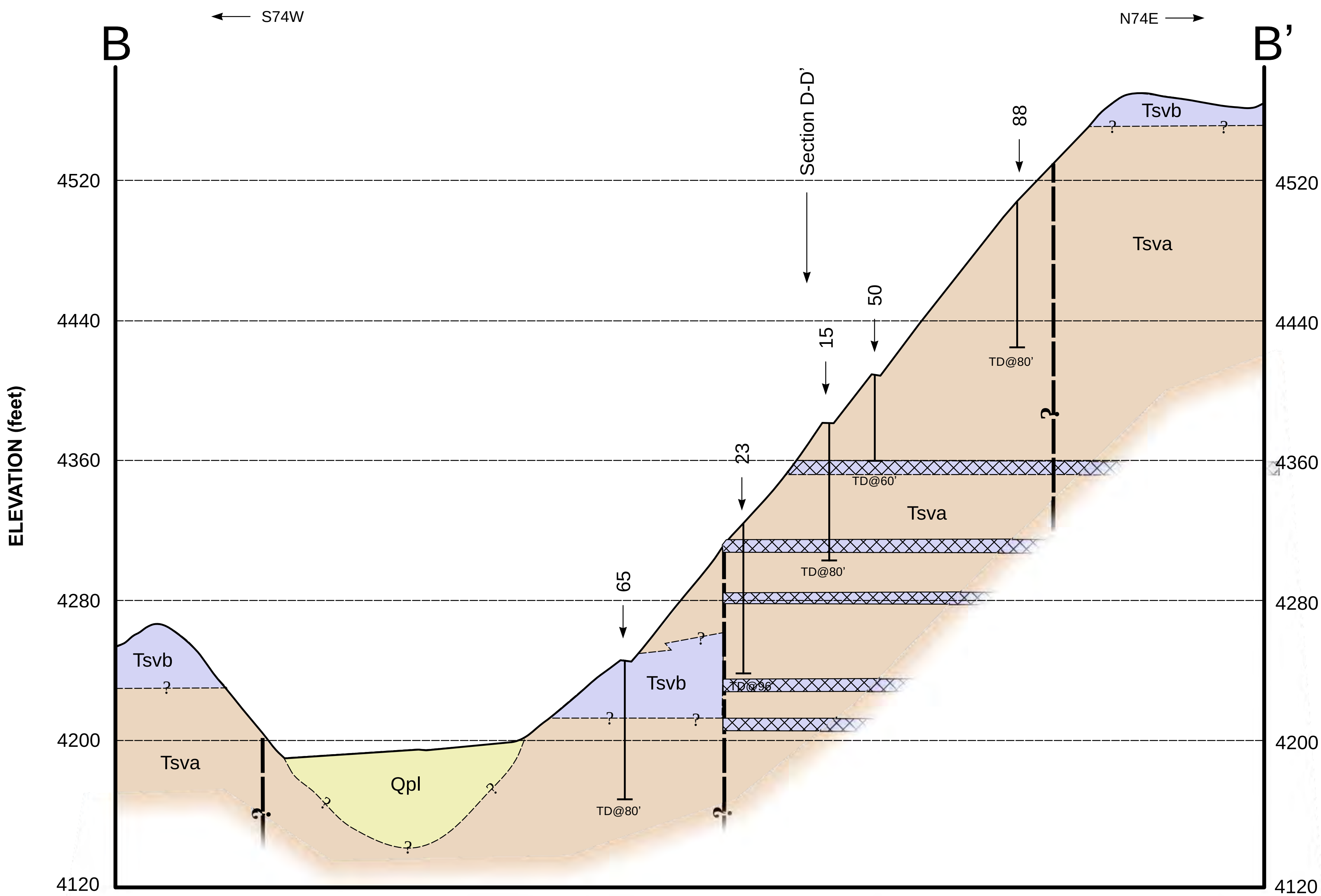
Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 5.1

BAJADA Geosciences, Inc.

Project no. 2001.0107

See Plate 3 for cross section location



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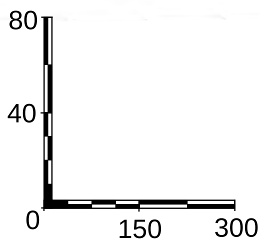
Vertical: 1"=80'
Vertical Exaggeration 3.75x



See Plate 5.4 for Legend

See Plate 3 for cross section location

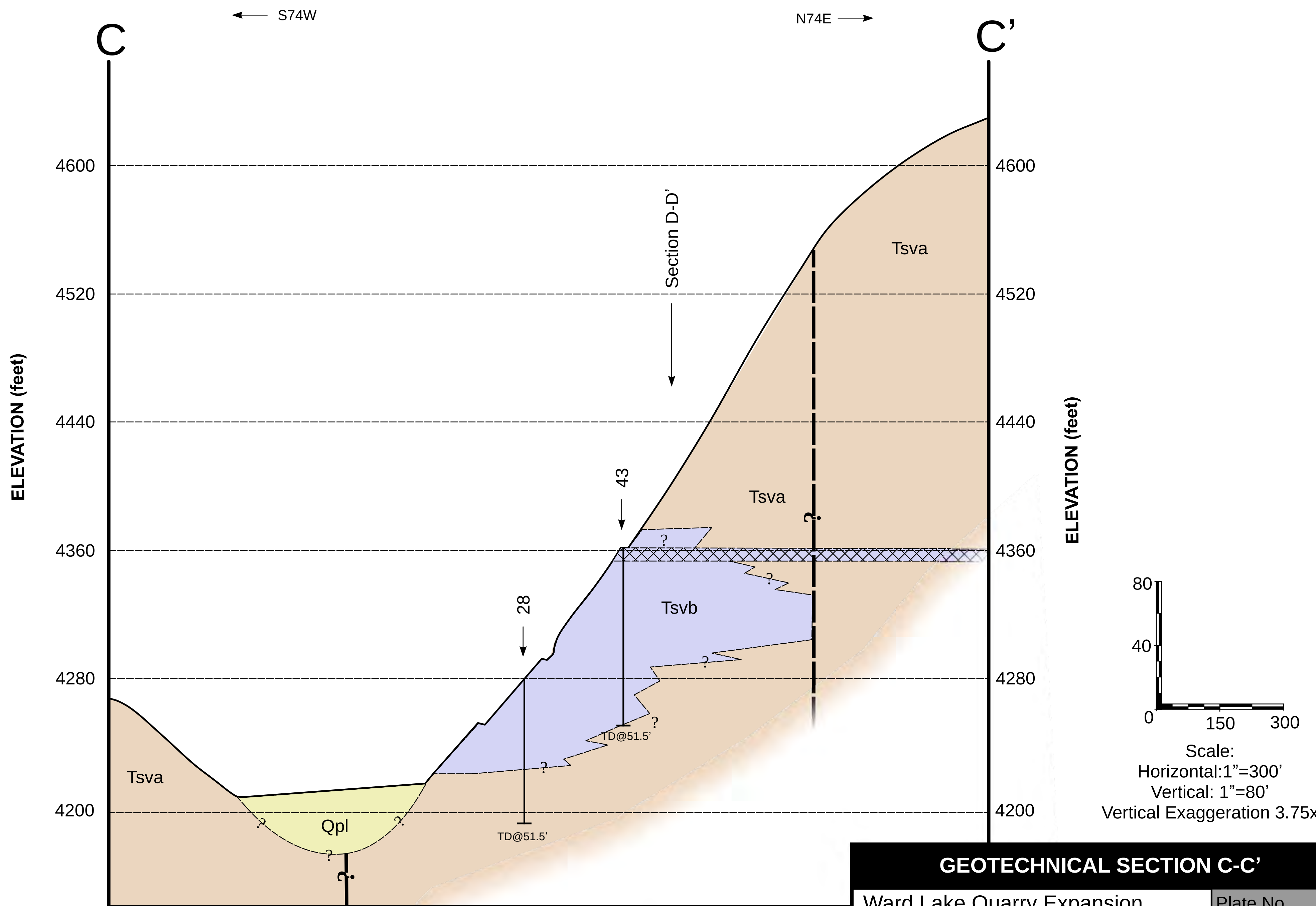
GEOTECHNICAL SECTION B-B'

Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 5.2

BAJADA Geosciences, Inc.

Project no. 2001.0107



See Plate 5.4 for Legend

GEOTECHNICAL SECTION C-C'

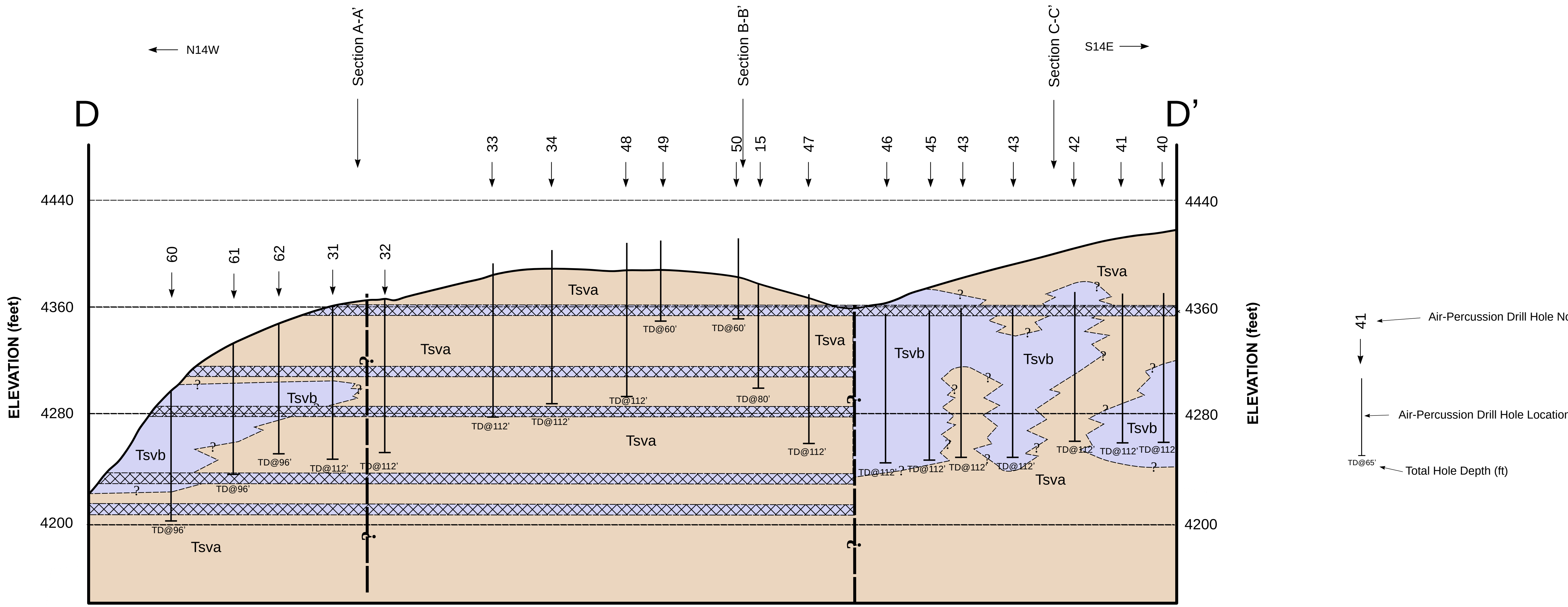
Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 5.3

BAJADA Geosciences, Inc.

Project no. 2001.0107

See Plate 3 for cross section location



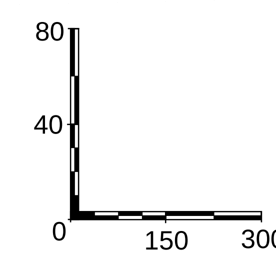
Mapped Based on HCC Air-Track Drill Hole Data

Qpl	Terrace Deposits
Tsvb	Basalt
Tsva	Andesite & Rhyolite

Stratification Line of Resistant Layer Visible on Aerial Photographs

------------? Geologic Contact, dashed and queried where uncertain

— — —? Fault, dashed and queried where uncertain



Scale:
Horizontal:1"=300'
Vertical: 1"=80'
Vertical Exaggeration 3.75x

GEOTECHNICAL SECTION D-D'

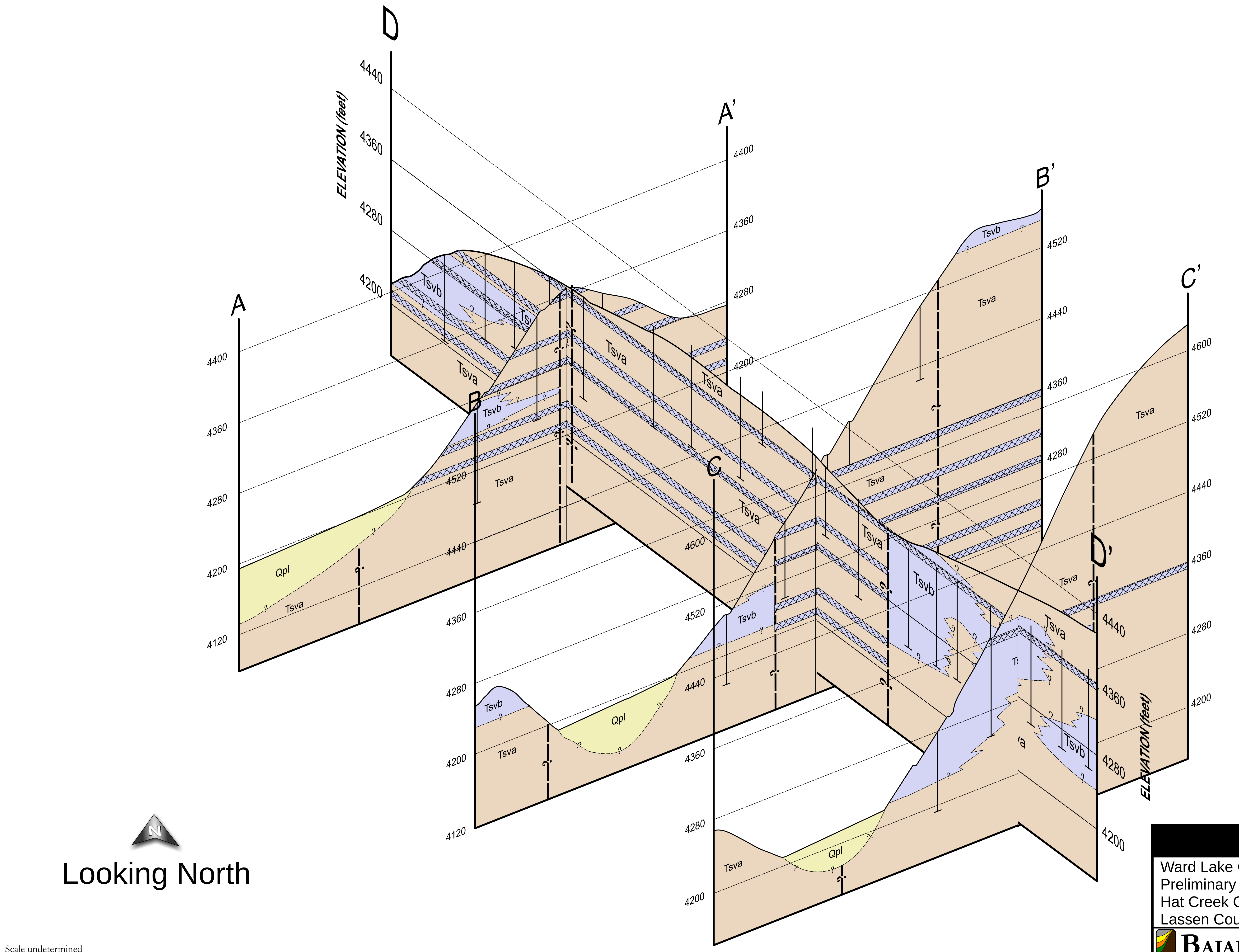
Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 5.4

BAJADA Geosciences, Inc.

Project no. 2001.0107

See Plate 3 for cross section location



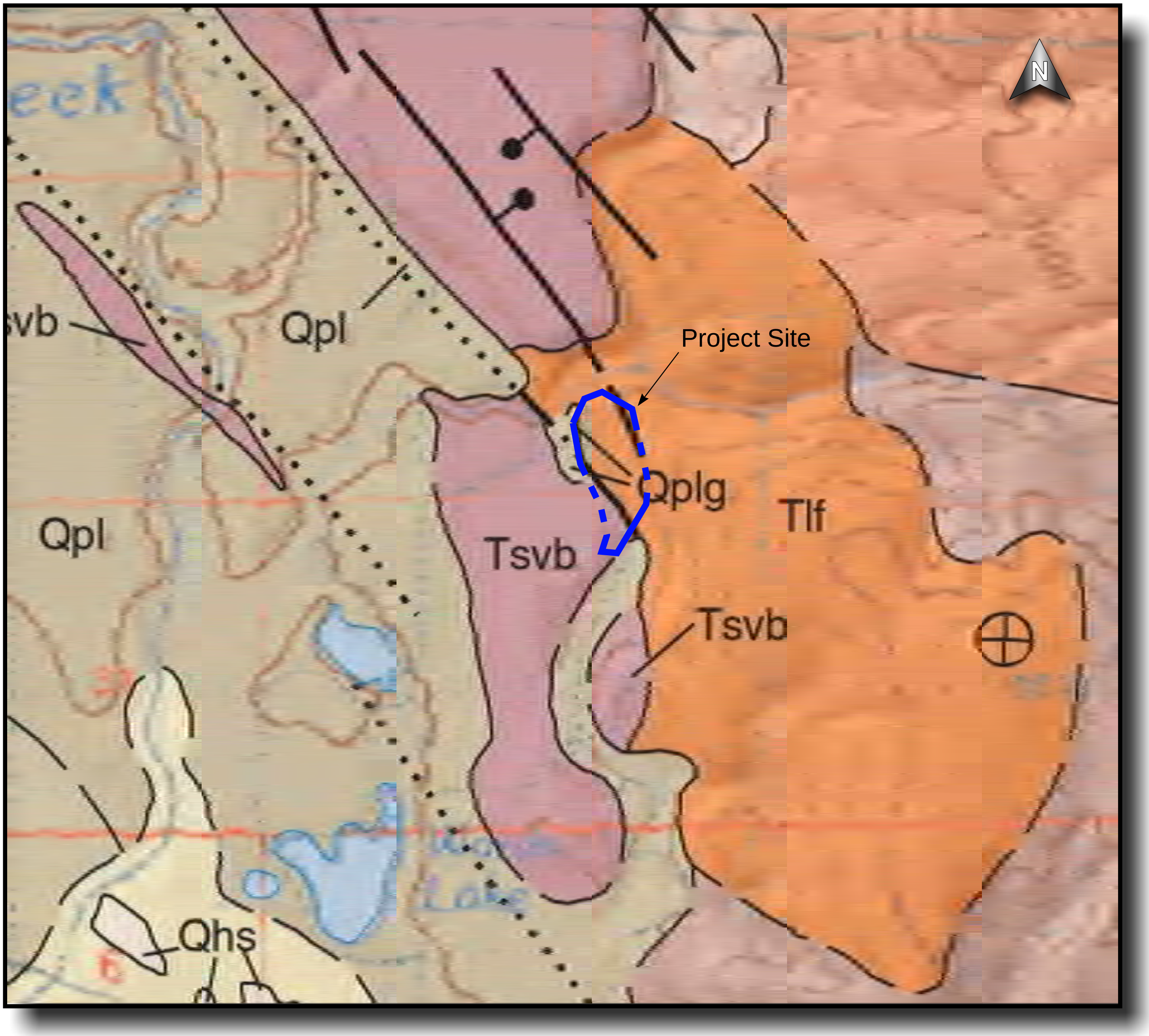
FENCE DIAGRAM

Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 6

BAJADA Geosciences, Inc.

Project no. 2001.0107



Qpl	Near-shore deposits of Lake Lahontan
Tsvb	Basalt of Secret Valley
Tlf	Andesite flows and pyroclastics of Litchfield
Tsma	Two-pyroxene andesite flows of Shaffer Mountain

Base map from Gross et al. (2013). Scale undetermined.

REGIONAL GEOLOGIC MAP

Ward Lake Quarry Expansion Preliminary Geotechnical Study Hat Creek Construction Company Lassen County, California	Plate No. 7
BAJADA Geosciences, Inc.	Project no. 2001.0107

Active	
Historic Displacement (last 200 years)	Holocene Displacement (last 11,700 years)
Potentially Active	**Inactive**
Late Quaternary Displacement (last 700,000 years)	Quaternary Fault (last 1.6 million years)

Map from USGS Interactive Fault Map

REGIONAL FAULT MAP

Ward Lake Quarry Expansion
Preliminary Geotechnical Study
Hat Creek Construction Company
Lassen County, California

Plate No. 8

BAJADA Geosciences, Inc.

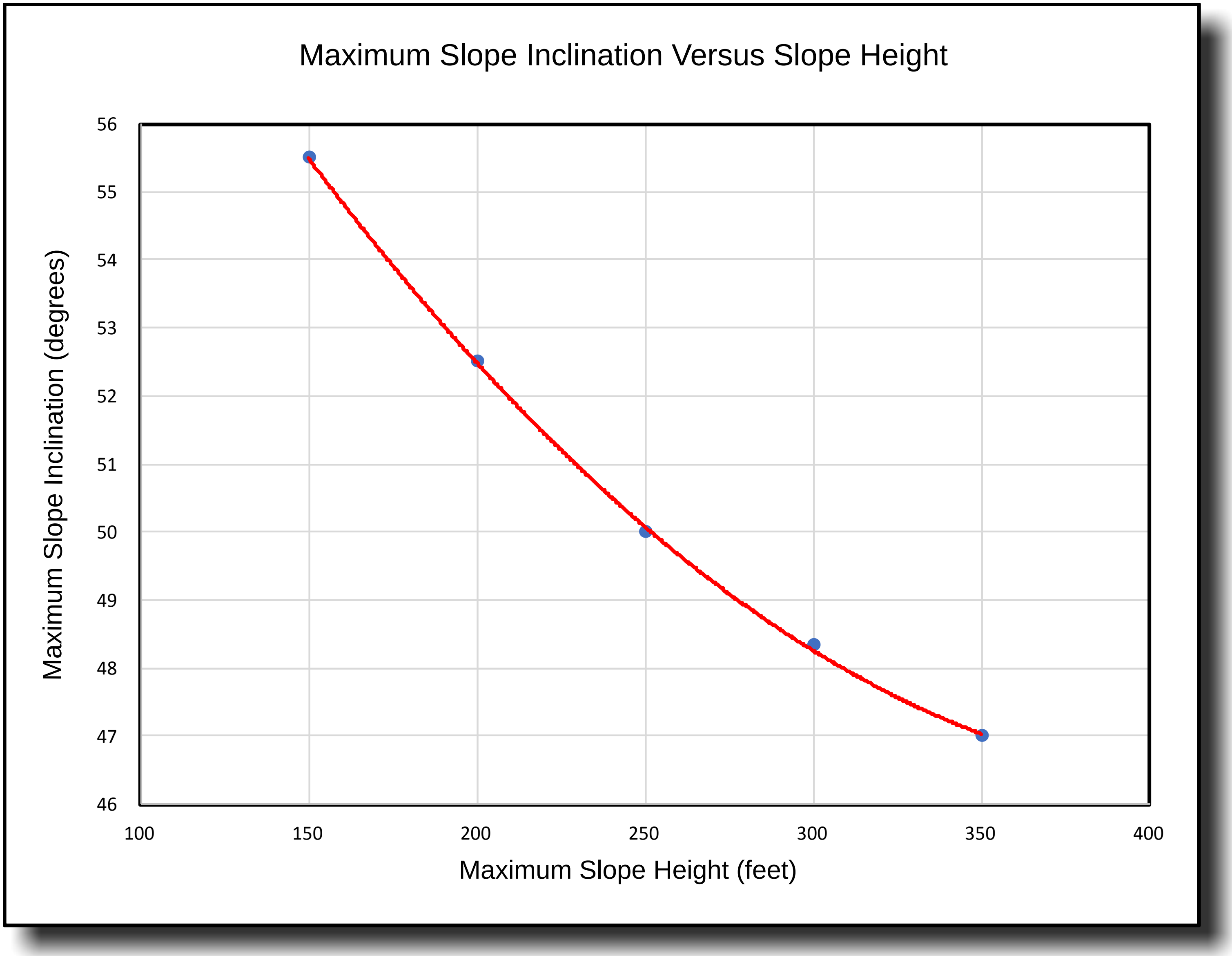
Project no. 2001.0107

Relatively distinct lineation probably indicative of a fault

Relatively distinct lineation possibly indicative of a fault

Base maps from Mapquest. Scale undetermined.

INTERPRETED AREA FAULT MAP	
Ward Lake Quarry Expansion Preliminary Geotechnical Study Hat Creek Construction Company Lassen County, California	Plate No. 9
BAJADA Geosciences, Inc.	Project no. 2001.0107



Note: curve satisfies both static (FOS ≥ 1.25) and pseudostatic (FOS ≥ 1.01) conditions.

SLOPE INCLINATION VERSUS HEIGHT

Ward Lake Quarry Expansion Preliminary Geotechnical Study Hat Creek Construction Company Lassen County, California	Plate No. 10
BAJADA Geosciences, Inc.	Project no. 2001.0107

APPENDIX A

Laboratory Testing

APPENDIX A
LABORATORY TESTING

Laboratory Analyses

Laboratory tests were performed on selected bulk soil samples to estimate engineering characteristics of the various earth materials encountered. Testing was performed under procedures described in one of the following references:

- ASTM Standards for Soil Testing, latest revision;
- Lambe, T. William, Soil Testing for Engineers, Wiley, New York, 1951;
- Laboratory Soils Testing, U.S. Army, Office of the Chief of Engineers, Engineering Manual No. 1110-2-1906, November 30, 1970.

Uniaxial Unconfined Compression Test

Uniaxial unconfined compression tests were performed on five rock samples obtained during field evaluations in accordance with standard test method ASTM D7012. The results of the tests are attached as the plate labeled Rock Core Compressive Strength Data.

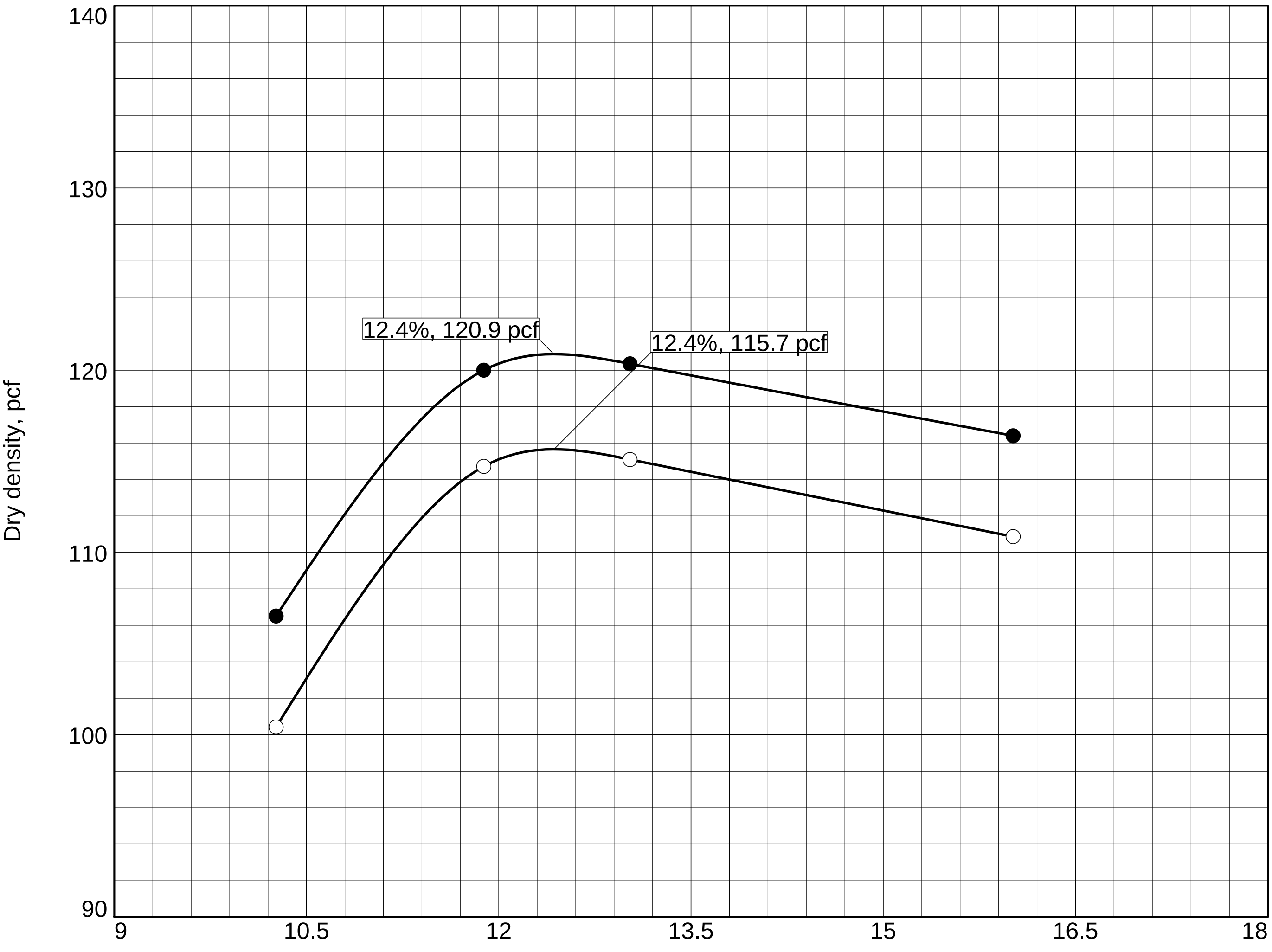
Direct Shear Tests

Direct shear tests were performed on one selected soil samples in accordance with standard test method ASTM D3080. The sample was remolded to 90-percent relative compaction at near optimum moisture content and tested. Results of that test is presented on the attached plate labeled *Consolidated Drained Direct Shear*.

Maximum Density & Optimum Moisture Content

Maximum density and optimum moisture content were evaluated on one selected bulk soil sample in accordance with standard test method ASTM D1557. Results of those tests are presented on the attached plate labeled *Compaction Test Report*.

COMPACTION TEST REPORT



Test specification: ASTM D1557-12 Method C (with uncorrected) Modified
ASTM D4718-15 Oversize Corr. Applied to Each Test Point

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
---	CL			2.60			15	

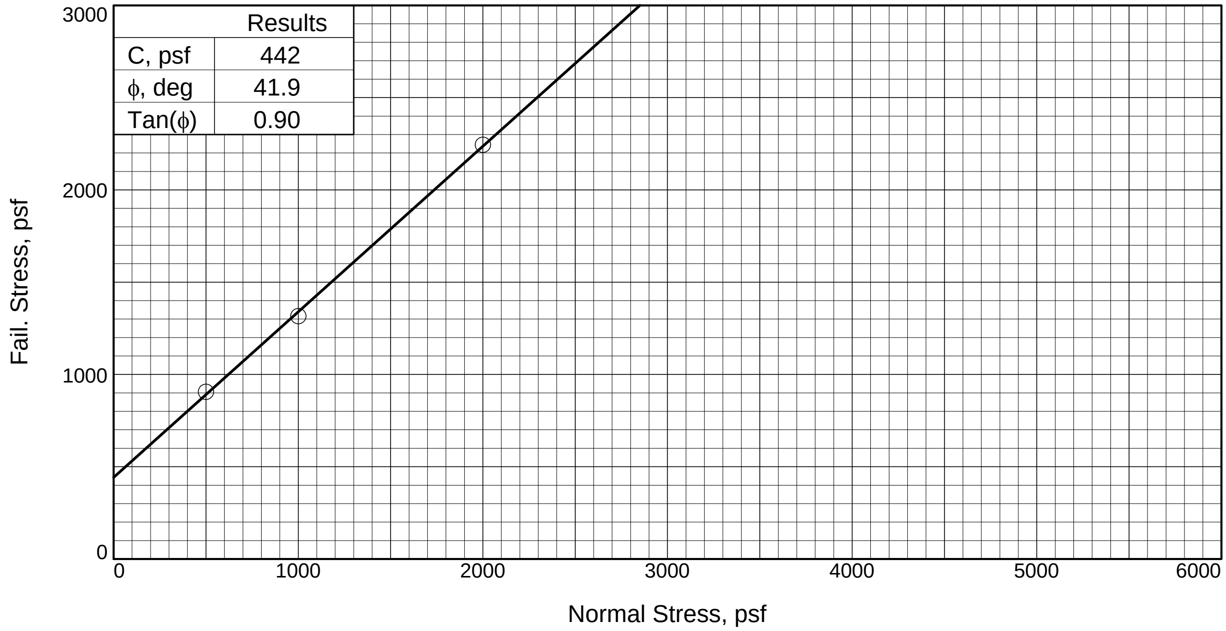
ROCK CORRECTED TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 120.9 pcf Optimum moisture = 12.4 %	Light Red Sandy Clay with Gravel (visual)

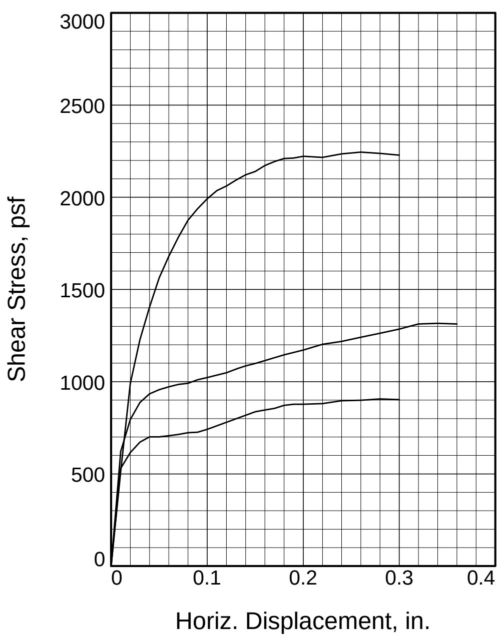
Project No. 3237 **Client:** BAJADA Geosciences, Inc.
Project: Ward Lake Quarry Expansion #2001.0107
Lassen County, California
○ **Location:** B1 **Sample Number:** 1

Remarks:
Curve #1
03/20/2020

Figure 0300-001

Tested By: Jack Bianchin





Sample No.		1	2	3
Initial	Water Content, %	12.4	12.4	12.4
	Dry Density, pcf	104.1	104.1	104.1
	Saturation, %	56.0	56.0	56.0
	Void Ratio	0.5892	0.5892	0.5892
	Diameter, in.	2.41	2.41	2.41
	Height, in.	1.00	1.00	1.00
At Test	Water Content, %	24.7	25.7	26.0
	Dry Density, pcf	103.2	98.5	92.9
	Saturation, %	108.6	100.1	88.5
	Void Ratio	0.6034	0.6798	0.7799
	Diameter, in.	2.41	2.41	2.41
	Height, in.	1.01	1.06	1.12
Normal Stress, psf		500	1000	2000
Fail. Stress, psf		906	1316	2244
Displacement, in.		0.28	0.34	0.26
Ult. Stress, psf				
Displacement, in.				
Strain rate, in./min.		0.002	0.002	0.002

Sample Type: remold

Description: Light Red Sandy Clay with Gravel (visual)

Specific Gravity= 2.65

Remarks: Material tested in accordance with ASTM D3080.
Sample remolded to 90% of maximum uncorrected at optimum moisture.

Figure 0300-002

Client: BAJADA Geosciences, Inc.

Project: Ward Lake Quarry Expansion #2001.0107
Lassen County, California

Location: B1

Sample Number: 1 **Depth:** ---

Proj. No.: 3237 **Date Sampled:** 03/11/20

Tested By: Cindy Gooden

Materials Testing, Inc.

8798 Airport Road
Redding, California 96002
(530) 222-1116, fax 222-1611

865 Cotting Lane, Suite A
Vacaville, California 95688
(707) 447-4025, fax 447-4143

Client:	BAJADA Geosciences, Inc. 28301 Inwood Road Shingletown, CA 96088	Date:	03/26/2020
		Client No:	3237-041
		Report No:	0100-003
Project:	Ward Lake Quarry Expansion #2001.0107	Page:	1 of 2
Location:	Lassen County, California		

ROCK CORE COMPRESSIVE STRENGTH DATA
(ASTM D7012 Method C)

Identification	1-A	2-A	2-B
Material	Basalt	Basalt	Basalt
Date Cut	03/19/20	03/20/20	03/20/20
Date Trimmed	03/19/20	03/23/20	03/23/20
Date Tested	03/24/20	03/24/20	03/24/20
Age in Days	5	5	5
Average Diameter, in	2.0	2.0	2.0
Average X-Section Area, in^2	3.14	3.14	3.14
As Received Length, in	5.5	9.3	9.8
L/D Factor	2.0	2.0	2.0
Maximum Load, lbs.	19,400	18,160	17,930
Compressive Strength, psi	**6,180**	**5,780**	**5,710**
Fracture Pattern, Type	Columnar	Columnar	Columnar

Notes: Specimens prepared in accordance with ASTM D4543.

Tested by Allante Blocker.

MTI
Materials Testing, Inc.
8798 Airport Road
Redding, California 96002
(530) 222-1116, fax 222-1611
865 Cotting Lane, Suite A
Vacaville, California 95688
(707) 447-4025, fax 447-4143

Client:	BAJADA Geosciences, Inc. 28301 Inwood Road Shingletown, CA 96088	Revised:	03/26/2020
		Client No:	3237-041
		Report No:	0100-003
Project:	Ward Lake Quarry Expansion #2001.0107	Page:	2 of 2
Location:	Lassen County, California		

ROCK CORE COMPRESSIVE STRENGTH DATA
(ASTM D7012 Method C)

Identification	3-A	3-B	
Material	Andesite	Andesite	
Date Cut	03/20/20	03/20/20	
Date Trimmed	03/23/20	03/24/20	
Date Tested	03/24/20		
Age in Days	5	4	
Average Diameter, in	2.0	2.0	
Average X-Section Area, in^2	3.14	3.14	
As Received Length, in	7.5	4.3	
L/D Factor	1.5*	1.0*	
Maximum Load, lbs.	32,210	54,020	
Compressive Strength, psi	**10,260**	**17,200**	
Fracture Pattern, Type	Columnar	Shear	

Notes: Specimens prepared in accordance with ASTM D4543.
*Specimens do not meet minimum L/D requirements

Tested by Allante Blocker.
The samples were tested according to the referenced standard test procedures and relate only to the items inspected or tested. Results are not transferable and shall not be reproduced, except in full, without written permission from MTI.

APPENDIX B

Slope Stability Analyses

APPENDIX B
SLOPE STABILITY ANALYSES

METHODS OF ANALYSIS

Computer-aided slope stability analyses were performed using the computer program SLIDE 2018. SLIDE 2018 was developed by Rocscience, Inc. (2020) and offers a wide variety of limit-equilibrium procedures. Those include the Modified Bishop, the Simplified and Corrected Janbu, Corps of Engineers #1 and #2, GLE/Morgenstern-Price, Lowe-Karafiath, and the Spencer methods. Those limit-equilibrium procedures are all "method of slices", but they differ from the Ordinary Method of Slices (Fellenius method – also included within SLIDE 2018) in:

1. The simplifying assumptions that have been made achieve static determinacy; and
2. The particular conditions of equilibrium that are satisfied.

SLIDE 2018 allows the use of any or all of the methods listed above because they better satisfy limit equilibrium conditions. A summary of the equilibrium conditions satisfied by each of these procedures and the type of failure surface for which each is useful is presented in the following table.

EQUILIBRIUM CONDITIONS SATISFIED BY PROCEDURES

Procedure of Analysis	Overall			Individual Slices			
	Moment	Vertical Force	Horizontal Force	Moment	Vertical Force	Horizont al Force	Slip Surface
Ordinary Method of Slices (Fellenius)	Yes	No	No	No	No	No	Circular Arc
Modified Bishop	Yes	(Yes)[1]	No	No	Yes	No	General Shape[2]
Simplified Janbu	No	(Yes)[1]	(Yes)[1]	No	Yes	Yes	General Shape
Spencer	Yes	(Yes)[1]	(Yes)[1]	Yes	Yes	Yes	General Shape

Per Wright (1969); (Yes)[1] - Parentheses indicate that this condition of equilibrium is implicitly satisfied as a result of the direct consideration of other equilibrium conditions; [2] – The original presentation of this procedure was for circular surfaces only.

Ordinary Method of Slices. From the above table, it is apparent that for circular failures, the Ordinary Method of Slices (Fellenius method) satisfies overall moment equilibrium, but does not satisfy individual slice moment equilibrium, or horizontal or vertical force equilibrium. Sherard et al. (1963), have suggested that the Fellenius method of slices might also be applied to non-circular surfaces; however, for noncircular surfaces that method would not, in general, satisfy any of the equilibrium conditions (Wright, 1969).

The Ordinary Method of Slices has been widely used by practicing engineers for many years because of its simplicity, but it has long been known to grossly underestimate (and in some cases overestimate) the factor of safety. Lambe and Whitman (1969) report that in some cases the Ordinary Method of Slices may underestimate the factor of safety by about 10 to 15 percent, but in other problems (particularly for noncircular slip surfaces) the error may be as much as 60 percent. With the development of high-speed computers, this approximate method has largely been replaced by more accurate methods that better satisfy equilibrium conditions. The Ordinary Method of Slices remains an acceptable method for performing hand-calculated estimates of slope stability for conditions where accurate solutions are not required.

Modified Bishop Method. The Modified Bishop Method assumes that the normal and weight forces act through a point on the center of the base of each slice and that there are no interslice shear forces. The resulting equation can be demonstrated to satisfy vertical force equilibrium as well as overall moment equilibrium for circular shear surfaces. The Modified Bishop Method is relatively simple to perform on a calculator, although the necessary iterations make it more suitable for use on a computer system. In spite of the necessary iterations, the Modified Bishop Method typically converges rapidly, therefore, it requires little computer time to perform.

Fredlund and Krahn (1977) have shown that the Modified Bishop Method typically estimates factors of safety that are typically within a few percent of those obtained from more rigorous methods that satisfy complete moment and force equilibrium.

Simplified Janbu Method. Although the simplifying assumption made in the Simplified Janbu Method is the same as that made for the Modified Bishop Method, the conditions of equilibrium that are satisfied are not the same. The Simplified Janbu Method satisfies vertical and horizontal force equilibrium for individual slices and for the overall shear surface while assuming that there are no interslice shear forces. An advantage of the Simplified Janbu Method is its suitability for the analysis of noncircular failure surfaces. While retaining a rapid computational speed, the Simplified Janbu Method yields factors of safety that are closer to those obtained by more rigorous methods (such as the Spencer Method) than those obtained from the Ordinary Method of Slices.

Spencer Method. The Spencer Method assumes that the normal forces are located at the center of the base of each slice and that all side forces are parallel. The result is an equation that satisfies complete moment and force equilibrium. Although the Spencer Method was directly applicable to a circular shear surface, the procedure may be readily extended to slip surfaces of a general shape (Wright, 1969).

Because of the complexity of the procedure, the Spencer Method is suitable only for computer-aided slope stability analyses. Although the Spencer Method typically yields a relatively accurate estimate of the factor of safety for a slope, its solution requires several iterations. Consequently, considerable time is needed to perform the analyses on a personal computer. Therefore, the Spencer Method is commonly used to refine the factor of safety for a critical failure plane that has been located by a search, which has used a more time-efficient method of analysis such as the Modified Bishop Method or Simplified Janbu procedure.

ANALYSES PERFORMED

Introduction. Analyses were performed to calculate the stability of the earth materials exposed in the slope. It is necessary to know the: 1) surface and subsurface geometry, 2) soil properties (unit weight and shear strength of the soil materials present), and 3) phreatic water level (groundwater) conditions.

Surface and Subsurface Geometry. Data for the surface geometry of the project area was derived from information presented by VESTRA (2020). Subsurface profiles were derived from air-percussion drilling performed by HCC at the site and interpretation of aerial photographs.

Engineering Properties. A summary and discussion of soil and rock mass strength values is presented in the text of the report.

Piezometric Water Level. The elevations of groundwater beneath the site are discussed in the text of the report.

Results of Analyses. The following table presents the conditions evaluated and results of the stability evaluations:

RESULTS OF STABILITY ANALYSES		
Slope Condition Evaluated	**Factor of Safety**	**File Name**
150-foot tall slope inclined at 55 degrees under static and dry conditions	1.26	150',dry,static,55deg
150-foot tall slope inclined at 55 degrees under pseudostatic and dry conditions	1.02	150',dry,PS,55deg
200-foot tall slope inclined at 50 degrees under static and dry conditions	1.31	200',dry,static,50deg
200-foot tall slope inclined at 50 degrees under pseudostatic and dry conditions	1.05	200',dry,PS,50deg
250-foot tall slope inclined at 50 degrees under static and dry conditions	1.25	250',dry,static,50deg
250-foot tall slope inclined at 50 degrees under pseudostatic and dry conditions	1.00	250',dry,PS,50deg
300-foot tall slope inclined at 45 degrees under static and dry conditions	1.36	300',dry,static,45deg
300-foot tall slope inclined at 45 degrees under pseudostatic and dry conditions	1.07	300',dry,PS,45deg
350-foot tall slope inclined at 45 degrees under static and dry conditions	1.31	350',dry,static,45deg
350-foot tall slope inclined at 45 degrees under pseudostatic and dry conditions	1.03	350',dry,PS,45deg

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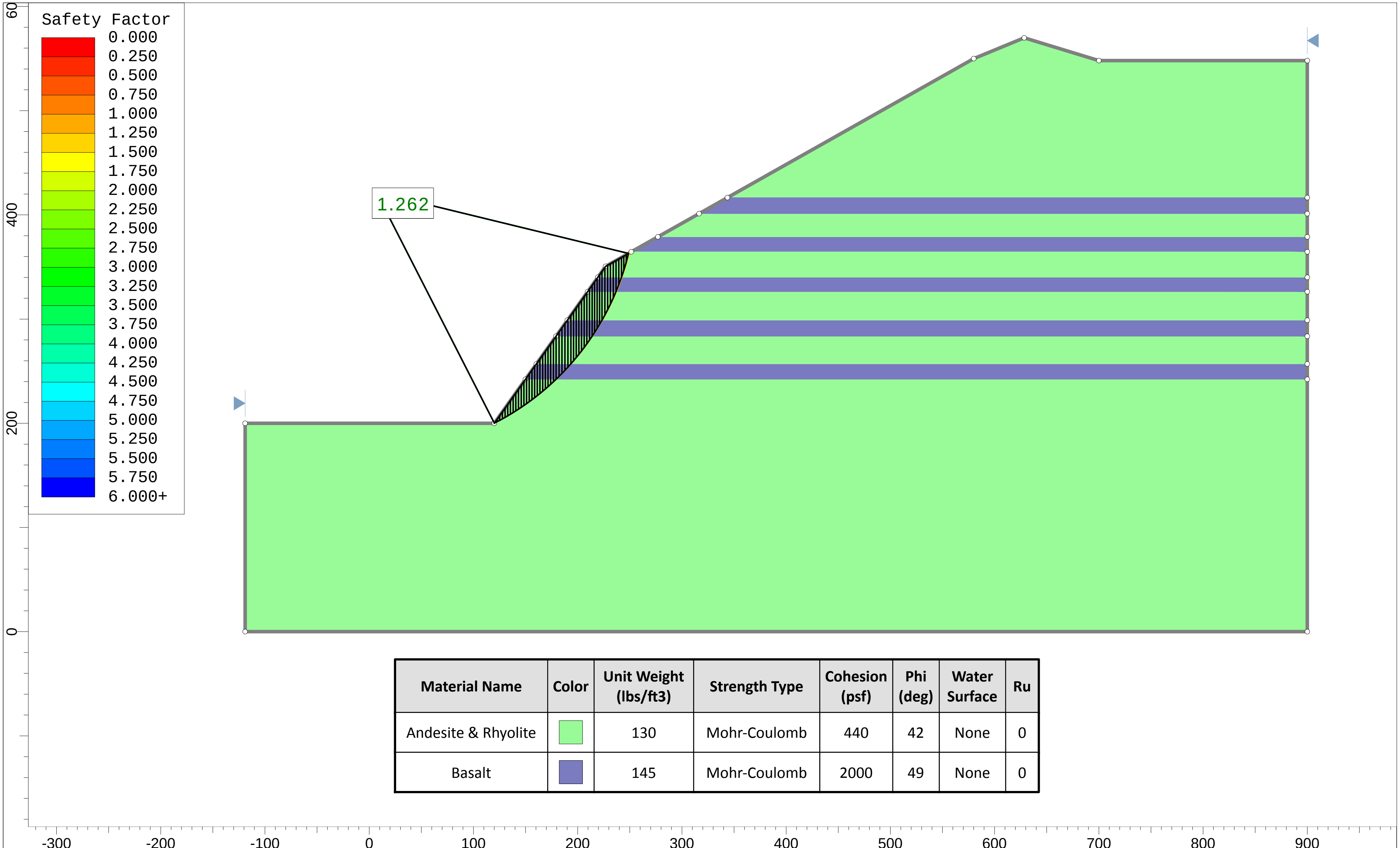


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

Bajada Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion
Analysis Description	150' Slope, dry, static, 55 degree gross slope inclination
Drawn By	J.Bianchin
Scale	1:1528
Company	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM
File Name	150',dry,ststic,55deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:04.239s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20

Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.261800
Center:	6.882, 421.822
Radius:	248.957
Left Slip Surface Endpoint:	120.054, 200.076
Right Slip Surface Endpoint:	248.789, 362.997
Resisting Moment:	1.32112e+08 lb-ft
Driving Moment:	1.04701e+08 lb-ft
Resisting Horizontal Force:	336914 lb
Driving Horizontal Force:	267010 lb
Total Slice Area:	4164.8 ft2
Surface Horizontal Width:	128.735 ft
Surface Average Height:	32.3517 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	9484
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.2618

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base	Base Material	Base Cohesion [psf]	Base Friction Angle	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress	Pore Pressure [psf]	Effective Normal Stress	Base Vertical Stress	Effective Vertical Stress

			[degrees]			[degrees]			[psf]		[psf]	[psf]	[psf]
1	2.57465	384.809	27.3719	Andesite & Rhyolite	440	42	494.77	624.301	204.687	0	204.687	460.843	460.843
2	2.57465	1148.01	28.0412	Andesite & Rhyolite	440	42	660.517	833.44	436.961	0	436.961	788.773	788.773
3	2.57465	1898.24	28.7147	Andesite & Rhyolite	440	42	817.242	1031.2	656.591	0	656.591	1104.29	1104.29
4	2.57465	2635.26	29.3925	Andesite & Rhyolite	440	42	965.204	1217.89	863.939	0	863.939	1407.64	1407.64
5	2.57465	3358.8	30.0749	Andesite & Rhyolite	440	42	1104.65	1393.84	1059.35	0	1059.35	1699.04	1699.04
6	2.57465	4068.58	30.7621	Andesite & Rhyolite	440	42	1235.8	1559.33	1243.14	0	1243.14	1978.72	1978.72
7	2.57465	4764.32	31.4542	Andesite & Rhyolite	440	42	1358.88	1714.63	1415.62	0	1415.62	2246.85	2246.85
8	2.57465	5445.7	32.1514	Andesite & Rhyolite	440	42	1474.09	1860.01	1577.08	0	1577.08	2503.62	2503.62
9	2.57465	6112.39	32.854	Andesite & Rhyolite	440	42	1581.63	1995.7	1727.78	0	1727.78	2749.18	2749.18
10	2.57465	6764.04	33.5623	Andesite & Rhyolite	440	42	1681.68	2121.94	1867.98	0	1867.98	2983.69	2983.69
11	2.57465	7400.28	34.2763	Andesite & Rhyolite	440	42	1774.41	2238.95	1997.94	0	1997.94	3207.28	3207.28
12	2.57465	8032.01	34.9965	Andesite & Rhyolite	440	42	1862.09	2349.58	2120.8	0	2120.8	3424.48	3424.48
13	2.57465	8751.36	35.7231	Andesite & Rhyolite	440	42	1961.65	2475.21	2260.33	0	2260.33	3671.12	3671.12
14	2.57465	9479.21	36.4564	Andesite & Rhyolite	440	42	2058.05	2596.85	2395.43	0	2395.43	3915.89	3915.89
15	2.57465	10189.9	37.1967	Andesite & Rhyolite	440	42	2146.76	2708.78	2519.74	0	2519.74	4149.02	4149.02
16	2.57465	10875.4	37.9443	Andesite & Rhyolite	440	42	2226.59	2809.51	2631.61	0	2631.61	4367.73	4367.73
17	2.57465	11441.5	38.6997	Andesite & Rhyolite	440	42	2281.94	2879.35	2709.18	0	2709.18	4537.33	4537.33
18	2.57465	11957.4	39.463	Andesite & Rhyolite	440	42	2325.49	2934.3	2770.2	0	2770.2	4684.67	4684.67
19	2.57465	12453.8	40.2349	Andesite & Rhyolite	440	42	2362.76	2981.33	2822.43	0	2822.43	4821.59	4821.59
20	2.57465	12930.3	41.0156	Andesite & Rhyolite	440	42	2393.83	3020.54	2865.98	0	2865.98	4948.05	4948.05
21	2.57465	13386	41.8058	Andesite & Rhyolite	440	42	2418.79	3052.03	2900.95	0	2900.95	5064.04	5064.04
22	2.57465	13820.1	42.6057	Andesite & Rhyolite	440	42	2437.71	3075.9	2927.45	0	2927.45	5169.49	5169.49
23	2.57465	14232	43.4161	Andesite & Rhyolite	440	42	2450.64	3092.22	2945.59	0	2945.59	5264.36	5264.36
24	2.838	16168.3	44.2802	Basalt	2000	49	4134.73	5217.2	2796.66	0	2796.66	6828.78	6828.78
25	2.838	16658.5	45.1998	Basalt	2000	49	4121.14	5200.06	2781.78	0	2781.78	6931.77	6931.77
26	2.838	17110.6	46.1345	Basalt	2000	49	4097.88	5170.71	2756.25	0	2756.25	7019.72	7019.72
27	2.838	17519.8	47.0854	Basalt	2000	49	4064.62	5128.74	2719.77	0	2719.77	7091.59	7091.59
28	2.838	17775.7	48.0536	Basalt	2000	49	4005.56	5054.21	2654.99	0	2654.99	7112	7112
29	2.55083	16167.3	48.9895	Andesite & Rhyolite	440	42	2394.45	3021.32	2866.86	0	2866.86	5620.34	5620.34
30	2.55083	16372.2	49.8925	Andesite & Rhyolite	440	42	2363.77	2982.6	2823.84	0	2823.84	5630.15	5630.15
31	2.55083	16544.6	50.8127	Andesite & Rhyolite	440	42	2327.38	2936.69	2772.86	0	2772.86	5627.8	5627.8
32	2.55083	16682.7	51.7514	Andesite & Rhyolite	440	42	2285.26	2883.54	2713.82	0	2713.82	5612.8	5612.8
33	2.55083	16784.2	52.71	Andesite & Rhyolite	440	42	2237.38	2823.13	2646.75	0	2646.75	5584.8	5584.8
34	2.55083	16846.6	53.6902	Andesite & Rhyolite	440	42	2183.71	2755.41	2571.51	0	2571.51	5543.22	5543.22
35	2.55083	16901.3	54.6938	Andesite & Rhyolite	440	42	2127.9	2684.98	2493.31	0	2493.31	5497.96	5497.96

36	2.55083	17008.7	55.7229	Andesite & Rhyolite	440	42	2076.18	2619.72	2420.82	0	2420.82	5467	5467
37	2.37625	15839.8	56.7427	Basalt	2000	49	3336.5	4209.99	1921.11	0	1921.11	7008.7	7008.7
38	2.37625	15721.8	57.7538	Basalt	2000	49	3232.03	4078.17	1806.53	0	1806.53	6929.73	6929.73
39	2.37625	15520.5	58.7941	Basalt	2000	49	3117.21	3933.3	1680.59	0	1680.59	6826.52	6826.52
40	2.37625	15179.5	59.8665	Basalt	2000	49	2986.34	3768.17	1537.04	0	1537.04	6681.83	6681.83
41	2.68205	16735.8	61.0488	Andesite & Rhyolite	440	42	1659.32	2093.73	1836.65	0	1836.65	4836.16	4836.16
42	2.68205	16087.1	62.3515	Andesite & Rhyolite	440	42	1535.37	1937.33	1662.96	0	1662.96	4593.8	4593.8
43	2.68205	14798.1	63.7135	Andesite & Rhyolite	440	42	1366.55	1724.31	1426.38	0	1426.38	4193.02	4193.02
44	2.68205	13370.1	65.1447	Andesite & Rhyolite	440	42	1196.38	1509.59	1187.9	0	1187.9	3770.55	3770.55
45	2.68205	11805.3	66.6579	Andesite & Rhyolite	440	42	1027.42	1296.4	951.125	0	951.125	3331.95	3331.95
46	2.62094	9739.19	68.2508	Basalt	2000	49	1808.56	2282.05	245.18	0	245.18	4778.57	4778.57
47	2.62094	7630.83	69.9443	Basalt	2000	49	1585.44	2000.5	0.437103	0	0.437103	4343.24	4343.24
48	2.25481	4798.48	71.6479	Andesite & Rhyolite	440	42	537.271	677.929	264.247	0	264.247	1883.86	1883.86
49	2.25481	3068.37	73.3791	Andesite & Rhyolite	440	42	418.567	528.148	97.898	0	97.898	1500.09	1500.09
50	2.25481	1073.94	75.3095	Andesite & Rhyolite	440	42	267.435	337.45	-113.894	0	-113.894	906.195	906.195

Query 1 (spencer) - Safety Factor: 1.2618

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.57465	384.809	27.3719	Andesite & Rhyolite	440	42	494.77	624.301	204.687	0	204.687	460.843	460.843
2	2.57465	1148.01	28.0412	Andesite & Rhyolite	440	42	660.517	833.44	436.961	0	436.961	788.773	788.773
3	2.57465	1898.24	28.7147	Andesite & Rhyolite	440	42	817.242	1031.2	656.591	0	656.591	1104.29	1104.29
4	2.57465	2635.26	29.3925	Andesite & Rhyolite	440	42	965.204	1217.89	863.939	0	863.939	1407.64	1407.64
5	2.57465	3358.8	30.0749	Andesite & Rhyolite	440	42	1104.65	1393.84	1059.35	0	1059.35	1699.04	1699.04
6	2.57465	4068.58	30.7621	Andesite & Rhyolite	440	42	1235.8	1559.33	1243.14	0	1243.14	1978.72	1978.72
7	2.57465	4764.32	31.4542	Andesite & Rhyolite	440	42	1358.88	1714.63	1415.62	0	1415.62	2246.85	2246.85
8	2.57465	5445.7	32.1514	Andesite & Rhyolite	440	42	1474.09	1860.01	1577.08	0	1577.08	2503.62	2503.62
9	2.57465	6112.39	32.854	Andesite & Rhyolite	440	42	1581.63	1995.7	1727.78	0	1727.78	2749.18	2749.18
10	2.57465	6764.04	33.5623	Andesite & Rhyolite	440	42	1681.68	2121.94	1867.98	0	1867.98	2983.69	2983.69
11	2.57465	7400.28	34.2763	Andesite & Rhyolite	440	42	1774.41	2238.95	1997.94	0	1997.94	3207.28	3207.28
12	2.57465	8032.01	34.9965	Andesite & Rhyolite	440	42	1862.09	2349.58	2120.8	0	2120.8	3424.48	3424.48
13	2.57465	8751.36	35.7231	Andesite & Rhyolite	440	42	1961.65	2475.21	2260.33	0	2260.33	3671.12	3671.12
14	2.57465	9479.21	36.4564	Andesite & Rhyolite	440	42	2058.05	2596.85	2395.43	0	2395.43	3915.89	3915.89
15	2.57465	10189.9	37.1967	Andesite & Rhyolite	440	42	2146.76	2708.78	2519.74	0	2519.74	4149.02	4149.02
16	2.57465	10875.4	37.9443	Andesite & Rhyolite	440	42	2226.59	2809.51	2631.61	0	2631.61	4367.73	4367.73
17	2.57465	11441.5	38.6997	Andesite & Rhyolite	440	42	2281.94	2879.35	2709.18	0	2709.18	4537.33	4537.33
18	2.57465	11957.4	39.463	Andesite & Rhyolite	440	42	2325.49	2934.3	2770.2	0	2770.2	4684.67	4684.67

19	2.57465	12453.8	40.2349	Andesite & Rhyolite	440	42	2362.76	2981.33	2822.43	0	2822.43	4821.59	4821.59
20	2.57465	12930.3	41.0156	Andesite & Rhyolite	440	42	2393.83	3020.54	2865.98	0	2865.98	4948.05	4948.05
21	2.57465	13386	41.8058	Andesite & Rhyolite	440	42	2418.79	3052.03	2900.95	0	2900.95	5064.04	5064.04
22	2.57465	13820.1	42.6057	Andesite & Rhyolite	440	42	2437.71	3075.9	2927.45	0	2927.45	5169.49	5169.49
23	2.57465	14232	43.4161	Andesite & Rhyolite	440	42	2450.64	3092.22	2945.59	0	2945.59	5264.36	5264.36
24	2.838	16168.3	44.2802	Basalt	2000	49	4134.73	5217.2	2796.66	0	2796.66	6828.78	6828.78
25	2.838	16658.5	45.1998	Basalt	2000	49	4121.14	5200.06	2781.78	0	2781.78	6931.77	6931.77
26	2.838	17110.6	46.1345	Basalt	2000	49	4097.88	5170.71	2756.25	0	2756.25	7019.72	7019.72
27	2.838	17519.8	47.0854	Basalt	2000	49	4064.62	5128.74	2719.77	0	2719.77	7091.59	7091.59
28	2.838	17775.7	48.0536	Basalt	2000	49	4005.56	5054.21	2654.99	0	2654.99	7112	7112
29	2.55083	16167.3	48.9895	Andesite & Rhyolite	440	42	2394.45	3021.32	2866.86	0	2866.86	5620.34	5620.34
30	2.55083	16372.2	49.8925	Andesite & Rhyolite	440	42	2363.77	2982.6	2823.84	0	2823.84	5630.15	5630.15
31	2.55083	16544.6	50.8127	Andesite & Rhyolite	440	42	2327.38	2936.69	2772.86	0	2772.86	5627.8	5627.8
32	2.55083	16682.7	51.7514	Andesite & Rhyolite	440	42	2285.26	2883.54	2713.82	0	2713.82	5612.8	5612.8
33	2.55083	16784.2	52.71	Andesite & Rhyolite	440	42	2237.38	2823.13	2646.75	0	2646.75	5584.8	5584.8
34	2.55083	16846.6	53.6902	Andesite & Rhyolite	440	42	2183.71	2755.41	2571.51	0	2571.51	5543.22	5543.22
35	2.55083	16901.3	54.6938	Andesite & Rhyolite	440	42	2127.9	2684.98	2493.31	0	2493.31	5497.96	5497.96
36	2.55083	17008.7	55.7229	Andesite & Rhyolite	440	42	2076.18	2619.72	2420.82	0	2420.82	5467	5467
37	2.37625	15839.8	56.7427	Basalt	2000	49	3336.5	4209.99	1921.11	0	1921.11	7008.7	7008.7
38	2.37625	15721.8	57.7538	Basalt	2000	49	3232.03	4078.17	1806.53	0	1806.53	6929.73	6929.73
39	2.37625	15520.5	58.7941	Basalt	2000	49	3117.21	3933.3	1680.59	0	1680.59	6826.52	6826.52
40	2.37625	15179.5	59.8665	Basalt	2000	49	2986.34	3768.17	1537.04	0	1537.04	6681.83	6681.83
41	2.68205	16735.8	61.0488	Andesite & Rhyolite	440	42	1659.32	2093.73	1836.65	0	1836.65	4836.16	4836.16
42	2.68205	16087.1	62.3515	Andesite & Rhyolite	440	42	1535.37	1937.33	1662.96	0	1662.96	4593.8	4593.8
43	2.68205	14798.1	63.7135	Andesite & Rhyolite	440	42	1366.55	1724.31	1426.38	0	1426.38	4193.02	4193.02
44	2.68205	13370.1	65.1447	Andesite & Rhyolite	440	42	1196.38	1509.59	1187.9	0	1187.9	3770.55	3770.55
45	2.68205	11805.3	66.6579	Andesite & Rhyolite	440	42	1027.42	1296.4	951.125	0	951.125	3331.95	3331.95
46	2.62094	9739.19	68.2508	Basalt	2000	49	1808.56	2282.05	245.18	0	245.18	4778.57	4778.57
47	2.62094	7630.83	69.9443	Basalt	2000	49	1585.44	2000.5	0.437103	0	0.437103	4343.24	4343.24
48	2.25481	4798.48	71.6479	Andesite & Rhyolite	440	42	537.271	677.929	264.247	0	264.247	1883.86	1883.86
49	2.25481	3068.37	73.3791	Andesite & Rhyolite	440	42	418.567	528.148	97.898	0	97.898	1500.09	1500.09
50	2.25481	1073.94	75.3095	Andesite & Rhyolite	440	42	267.435	337.45	-113.894	0	-113.894	906.195	906.195

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.2618

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	120.054	200.076	0	0	0
2	122.628	201.408	1003.28	802.628	38.6599
3	125.203	202.78	2107.69	1686.15	38.6598

4	127.777	204.19	3289.47	2631.57	38.6597
5	130.352	205.641	4525.98	3620.79	38.6599
6	132.927	207.132	5795.67	4636.53	38.6598
7	135.501	208.664	7077.97	5662.38	38.6598
8	138.076	210.239	8353.35	6682.68	38.6598
9	140.651	211.857	9603.19	7682.55	38.6598
10	143.225	213.52	10809.8	8647.86	38.6599
11	145.8	215.228	11956.5	9565.17	38.6597
12	148.375	216.983	13027.2	10421.8	38.6599
13	150.949	218.785	14007.1	11205.7	38.6599
14	153.524	220.637	14881.3	11905	38.6597
15	156.099	222.539	15633.1	12506.5	38.6599
16	158.673	224.493	16246.5	12997.2	38.6598
17	161.248	226.501	16706.4	13365.1	38.6598
18	163.823	228.563	17003.9	13603.1	38.6598
19	166.397	230.683	17130.2	13704.2	38.6599
20	168.972	232.861	17075.8	13660.7	38.6599
21	171.546	235.101	16832.2	13465.7	38.6597
22	174.121	237.403	16391.5	13113.2	38.6598
23	176.696	239.771	15746.7	12597.3	38.6597
24	179.27	242.207	14891.7	11913.4	38.6599
25	182.108	244.975	18907	15125.6	38.6598
26	184.946	247.833	22673.7	18138.9	38.6597
27	187.784	250.785	26185.8	20948.7	38.6599
28	190.622	253.838	29439.7	23551.7	38.6597
29	193.46	256.996	32443.6	25954.9	38.6598
30	196.011	259.929	30153	24122.4	38.6598
31	198.562	262.957	27641.5	22113.2	38.6598
32	201.113	266.086	24912.5	19930	38.6598
33	203.664	269.322	21970.6	17576.5	38.6598
34	206.215	272.672	18822.3	15057.8	38.6597
35	208.765	276.143	15476	12380.8	38.6598
36	211.316	279.745	11933.1	9546.46	38.6597
37	213.867	283.488	8178.34	6542.67	38.6598
38	216.243	287.111	9159.89	7327.91	38.6598
39	218.62	290.878	10049	8039.24	38.6599
40	220.996	294.8	10877	8701.59	38.6598
41	223.372	298.894	11693.7	9354.94	38.6597
42	226.054	303.742	7247.35	5797.88	38.6598
43	228.736	308.862	2858.76	2287	38.6597
44	231.418	314.292	-1214.69	-971.751	38.6598
45	234.1	320.082	-4877.94	-3902.35	38.6598
46	236.782	326.297	-8028.76	-6423.01	38.6598
47	239.403	332.867	-4890.94	-3912.75	38.6598
48	242.024	340.046	-731.348	-585.079	38.6598
49	244.279	346.843	-1313.88	-1051.1	38.6597
50	246.534	354.397	-1107.89	-886.31	38.6597
51	248.789	362.997	0	0	0

Query 1 (spencer) - Safety Factor: 1.2618

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	120.054	200.076	0	0	0
2	122.628	201.408	1003.28	802.628	38.6599
3	125.203	202.78	2107.69	1686.15	38.6598
4	127.777	204.19	3289.47	2631.57	38.6597
5	130.352	205.641	4525.98	3620.79	38.6599
6	132.927	207.132	5795.67	4636.53	38.6598
7	135.501	208.664	7077.97	5662.38	38.6598
8	138.076	210.239	8353.35	6682.68	38.6598
9	140.651	211.857	9603.19	7682.55	38.6598
10	143.225	213.52	10809.8	8647.86	38.6599

11	145.8	215.228	11956.5	9565.17	38.6597
12	148.375	216.983	13027.2	10421.8	38.6599
13	150.949	218.785	14007.1	11205.7	38.6599
14	153.524	220.637	14881.3	11905	38.6597
15	156.099	222.539	15633.1	12506.5	38.6599
16	158.673	224.493	16246.5	12997.2	38.6598
17	161.248	226.501	16706.4	13365.1	38.6598
18	163.823	228.563	17003.9	13603.1	38.6598
19	166.397	230.683	17130.2	13704.2	38.6599
20	168.972	232.861	17075.8	13660.7	38.6599
21	171.546	235.101	16832.2	13465.7	38.6597
22	174.121	237.403	16391.5	13113.2	38.6598
23	176.696	239.771	15746.7	12597.3	38.6597
24	179.27	242.207	14891.7	11913.4	38.6599
25	182.108	244.975	18907	15125.6	38.6598
26	184.946	247.833	22673.7	18138.9	38.6597
27	187.784	250.785	26185.8	20948.7	38.6599
28	190.622	253.838	29439.7	23551.7	38.6597
29	193.46	256.996	32443.6	25954.9	38.6598
30	196.011	259.929	30153	24122.4	38.6598
31	198.562	262.957	27641.5	22113.2	38.6598
32	201.113	266.086	24912.5	19930	38.6598
33	203.664	269.322	21970.6	17576.5	38.6598
34	206.215	272.672	18822.3	15057.8	38.6597
35	208.765	276.143	15476	12380.8	38.6598
36	211.316	279.745	11933.1	9546.46	38.6597
37	213.867	283.488	8178.34	6542.67	38.6598
38	216.243	287.111	9159.89	7327.91	38.6598
39	218.62	290.878	10049	8039.24	38.6599
40	220.996	294.8	10877	8701.59	38.6598
41	223.372	298.894	11693.7	9354.94	38.6597
42	226.054	303.742	7247.35	5797.88	38.6598
43	228.736	308.862	2858.76	2287	38.6597
44	231.418	314.292	-1214.69	-971.751	38.6598
45	234.1	320.082	-4877.94	-3902.35	38.6598
46	236.782	326.297	-8028.76	-6423.01	38.6598
47	239.403	332.867	-4890.94	-3912.75	38.6598
48	242.024	340.046	-731.348	-585.079	38.6598
49	244.279	346.843	-1313.88	-1051.1	38.6597
50	246.534	354.397	-1107.89	-886.31	38.6597
51	248.789	362.997	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882
900	401.213
900	416.559
900	548
700	548

628.434	569.928
580	550
343.655	416.559
316.475	401.213
276.924	378.882
251.485	364.52
226.69	350.52
219.266	340.046
209.52	326.297
190.097	298.894
179.177	283.488
160.399	256.996
149.917	242.207
120	200
-119.082	200

Material Boundary

X	Y
149.917	242.207
900	242.207

Material Boundary

X	Y
160.399	256.996
900	256.996

Material Boundary

X	Y
179.177	283.488
900	283.488

Material Boundary

X	Y
190.097	298.894
900	298.894

Material Boundary

X	Y
209.52	326.297
900	326.297

Material Boundary

X	Y
219.266	340.046
900	340.046

Material Boundary

X	Y
251.485	364.52
900	364.52

Material Boundary

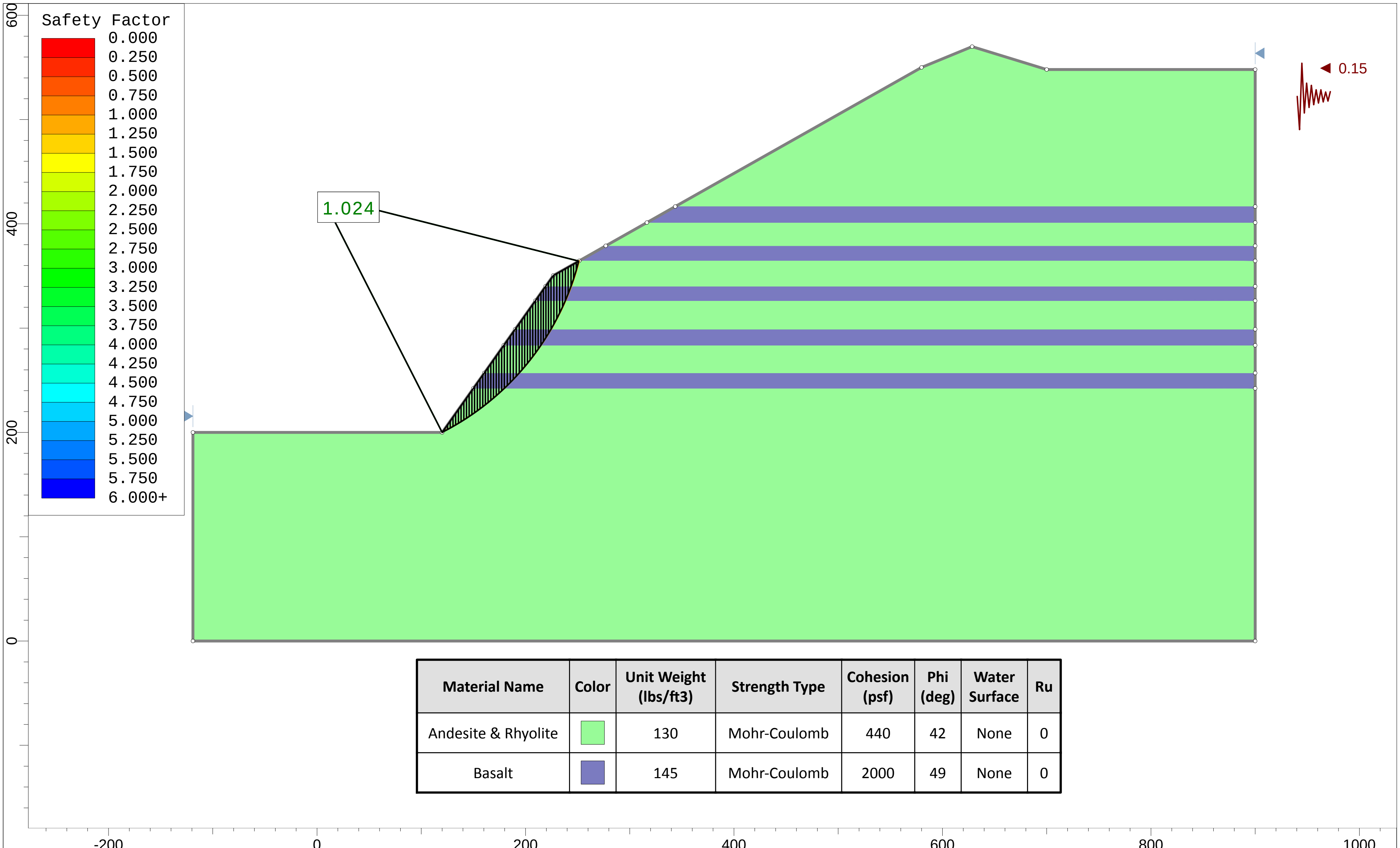
X	Y
276.924	378.882
900	378.882

Material Boundary

X	Y
316.475	401.213
900	401.213

Material Boundary

X	Y
343.655	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

Bajada Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion		
Analysis Description	150' Slope, dry, pseudostatic, 55 degree gross slope inclination		
Drawn By J.Bianchin	*Scale* 1:1528	*Company*	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM	*File Name*	150',dry,PS,55deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:03.724s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.15

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.023530
Center:	4.554, 426.537
Radius:	254.248
Left Slip Surface Endpoint:	120.011, 200.015
Right Slip Surface Endpoint:	251.063, 364.281
Resisting Moment:	1.25701e+08 lb-ft
Driving Moment:	1.22812e+08 lb-ft
Resisting Horizontal Force:	321801 lb
Driving Horizontal Force:	314404 lb
Total Slice Area:	4311.47 ft2
Surface Horizontal Width:	131.052 ft
Surface Average Height:	32.8989 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 10990
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.02353

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.59379	390.893	27.3366	Andesite & Rhyolite	440	42	1151.69	1178.79	820.51	0	820.51	1415.88	1415.88
2	2.59379	1166.26	27.9966	Andesite & Rhyolite	440	42	1350.59	1382.37	1046.61	0	1046.61	1764.63	1764.63
3	2.59379	1928.66	28.6607	Andesite & Rhyolite	440	42	1526.58	1562.5	1246.66	0	1246.66	2081.08	2081.08
4	2.59379	2677.85	29.329	Andesite & Rhyolite	440	42	1681.59	1721.16	1422.87	0	1422.87	2367.66	2367.66
5	2.59379	3413.57	30.0017	Andesite & Rhyolite	440	42	1817.47	1860.23	1577.32	0	1577.32	2626.71	2626.71
6	2.59379	4135.55	30.679	Andesite & Rhyolite	440	42	1935.85	1981.4	1711.9	0	1711.9	2860.37	2860.37
7	2.59379	4843.51	31.3611	Andesite & Rhyolite	440	42	2038.32	2086.28	1828.38	0	1828.38	3070.67	3070.67
8	2.59379	5537.13	32.0482	Andesite & Rhyolite	440	42	2126.28	2176.31	1928.37	0	1928.37	3259.5	3259.5
9	2.59379	6216.09	32.7405	Andesite & Rhyolite	440	42	2201.04	2252.83	2013.35	0	2013.35	3428.59	3428.59
10	2.59379	6880.06	33.4381	Andesite & Rhyolite	440	42	2263.81	2317.08	2084.71	0	2084.71	3579.58	3579.58
11	2.59379	7528.66	34.1415	Andesite & Rhyolite	440	42	2315.7	2370.19	2143.69	0	2143.69	3713.99	3713.99
12	2.59379	8177.27	34.8508	Andesite & Rhyolite	440	42	2360.73	2416.28	2194.88	0	2194.88	3838.73	3838.73
13	2.59379	8916.38	35.5662	Andesite & Rhyolite	440	42	2416.27	2473.12	2258.01	0	2258.01	3985.73	3985.73
14	2.59379	9658.88	36.2881	Andesite & Rhyolite	440	42	2465.42	2523.43	2313.88	0	2313.88	4124.12	4124.12
15	2.59379	10384.3	37.0167	Andesite & Rhyolite	440	42	2505.24	2564.19	2359.15	0	2359.15	4248.12	4248.12
16	2.59379	11079.2	37.7523	Andesite & Rhyolite	440	42	2534.4	2594.03	2392.29	0	2392.29	4354.79	4354.79
17	2.59379	11649.9	38.4954	Andesite & Rhyolite	440	42	2539.18	2598.93	2397.73	0	2397.73	4417.16	4417.16
18	2.59379	12178.8	39.2462	Andesite & Rhyolite	440	42	2534.71	2594.35	2392.65	0	2392.65	4463.32	4463.32
19	2.59379	12688.4	40.0051	Andesite & Rhyolite	440	42	2525.23	2584.65	2381.88	0	2381.88	4501.18	4501.18
20	2.59379	13178.2	40.7726	Andesite & Rhyolite	440	42	2511.11	2570.2	2365.82	0	2365.82	4531.27	4531.27
21	2.59379	13647.5	41.5491	Andesite & Rhyolite	440	42	2492.66	2551.31	2344.85	0	2344.85	4553.98	4553.98
22	2.59379	14095.4	42.3349	Andesite & Rhyolite	440	42	2470.13	2528.25	2319.24	0	2319.24	4569.64	4569.64
23	2.59379	14523.8	43.1308	Andesite & Rhyolite	440	42	2444.03	2501.54	2289.57	0	2289.57	4579.12	4579.12
24	2.8708	16597.8	43.9808	Basalt	2000	49	5713.38	5847.82	3344.85	0	3344.85	8858.5	8858.5
25	2.8708	17112	44.8869	Basalt	2000	49	5567.34	5698.34	3214.91	0	3214.91	8760.31	8760.31
26	2.8708	17588.2	45.8075	Basalt	2000	49	5419.29	5546.81	3083.2	0	3083.2	8657.45	8657.45
27	2.8708	18012.8	46.7436	Basalt	2000	49	5268.17	5392.13	2948.72	0	2948.72	8547.7	8547.7
28	2.8708	18267.6	47.6963	Basalt	2000	49	5099.73	5219.73	2798.87	0	2798.87	8402.67	8402.67
29	2.59009	16691.1	48.6183	Andesite & Rhyolite	440	42	2181.89	2233.23	1991.58	0	1991.58	4468.05	4468.05
30	2.59009	16915.9	49.5093	Andesite & Rhyolite	440	42	2126.77	2176.81	1928.93	0	1928.93	4419.87	4419.87
31	2.59009	17108.1	50.4167	Andesite & Rhyolite	440	42	2067.28	2115.92	1861.3	0	1861.3	4361.7	4361.7
32	2.59009	17266	51.342	Andesite & Rhyolite	440	42	2003.16	2050.29	1788.41	0	1788.41	4292.51	4292.51
33	2.59009	17387.4	52.2863	Andesite &	440	42	1934.1	1979.61	1709.91	0	1709.91	4211.1	4211.1

				Rhyolite								
34	2.59009	17469.9	53.2511	Andesite & Rhyolite	440	42	1859.79	1903.55	1625.44	0	1625.44	4116.1	4116.1
35	2.59009	17584.2	54.2383	Andesite & Rhyolite	440	42	1785.17	1827.18	1540.62	0	1540.62	4019.32	4019.32
36	2.59009	17722.5	55.2497	Andesite & Rhyolite	440	42	1708.57	1748.77	1453.53	0	1453.53	3916.39	3916.39
37	2.42425	16605.1	56.2534	Basalt	2000	49	3867.07	3958.06	1702.11	0	1702.11	7490.34	7490.34
38	2.42425	16506	57.2501	Basalt	2000	49	3735.02	3822.91	1584.63	0	1584.63	7391.4	7391.4
39	2.42425	16278.9	58.2745	Basalt	2000	49	3595.82	3680.43	1460.78	0	1460.78	7277.11	7277.11
40	2.42425	15949.1	59.3295	Basalt	2000	49	3453.3	3534.56	1333.97	0	1333.97	7156.81	7156.81
41	2.75373	17723.3	60.495	Andesite & Rhyolite	440	42	1191.76	1219.8	866.056	0	866.056	2972.05	2972.05
42	2.75373	16768.8	61.7812	Andesite & Rhyolite	440	42	1044.23	1068.8	698.352	0	698.352	2644.3	2644.3
43	2.75373	15434.3	63.1238	Andesite & Rhyolite	440	42	893.452	914.475	526.958	0	526.958	2289.87	2289.87
44	2.75373	13983.5	64.5318	Andesite & Rhyolite	440	42	754.077	771.82	368.523	0	368.523	1951.74	1951.74
45	2.75373	12397.3	66.0168	Andesite & Rhyolite	440	42	632.306	647.184	230.101	0	230.101	1651.4	1651.4
46	2.71541	10381.4	67.5825	Basalt	2000	49	2498.43	2557.22	484.383	0	484.383	6540.78	6540.78
47	2.71541	8215.86	69.2484	Basalt	2000	49	2411.11	2467.84	406.687	0	406.687	6770.16	6770.16
48	2.4746	5519.02	70.967	Andesite & Rhyolite	440	42	506.529	518.448	87.125	0	87.125	1555.44	1555.44
49	2.4746	3531.74	72.7631	Andesite & Rhyolite	440	42	594.045	608.023	186.609	0	186.609	2101.29	2101.29
50	2.4746	1236.78	74.7652	Andesite & Rhyolite	440	42	760.234	778.122	375.523	0	375.523	3166.95	3166.95

Query 1 (spencer) - Safety Factor: 1.02353

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.59379	390.893	27.3366	Andesite & Rhyolite	440	42	1151.69	1178.79	820.51	0	820.51	1415.88	1415.88
2	2.59379	1166.26	27.9966	Andesite & Rhyolite	440	42	1350.59	1382.37	1046.61	0	1046.61	1764.63	1764.63
3	2.59379	1928.66	28.6607	Andesite & Rhyolite	440	42	1526.58	1562.5	1246.66	0	1246.66	2081.08	2081.08
4	2.59379	2677.85	29.329	Andesite & Rhyolite	440	42	1681.59	1721.16	1422.87	0	1422.87	2367.66	2367.66
5	2.59379	3413.57	30.0017	Andesite & Rhyolite	440	42	1817.47	1860.23	1577.32	0	1577.32	2626.71	2626.71
6	2.59379	4135.55	30.679	Andesite & Rhyolite	440	42	1935.85	1981.4	1711.9	0	1711.9	2860.37	2860.37
7	2.59379	4843.51	31.3611	Andesite & Rhyolite	440	42	2038.32	2086.28	1828.38	0	1828.38	3070.67	3070.67
8	2.59379	5537.13	32.0482	Andesite & Rhyolite	440	42	2126.28	2176.31	1928.37	0	1928.37	3259.5	3259.5
9	2.59379	6216.09	32.7405	Andesite & Rhyolite	440	42	2201.04	2252.83	2013.35	0	2013.35	3428.59	3428.59
10	2.59379	6880.06	33.4381	Andesite & Rhyolite	440	42	2263.81	2317.08	2084.71	0	2084.71	3579.58	3579.58
11	2.59379	7528.66	34.1415	Andesite & Rhyolite	440	42	2315.7	2370.19	2143.69	0	2143.69	3713.99	3713.99
12	2.59379	8177.27	34.8508	Andesite & Rhyolite	440	42	2360.73	2416.28	2194.88	0	2194.88	3838.73	3838.73
13	2.59379	8916.38	35.5662	Andesite & Rhyolite	440	42	2416.27	2473.12	2258.01	0	2258.01	3985.73	3985.73
14	2.59379	9658.88	36.2881	Andesite & Rhyolite	440	42	2465.42	2523.43	2313.88	0	2313.88	4124.12	4124.12
15	2.59379	10384.3	37.0167	Andesite & Rhyolite	440	42	2505.24	2564.19	2359.15	0	2359.15	4248.12	4248.12

16	2.59379	11079.2	37.7523	Andesite & Rhyolite	440	42	2534.4	2594.03	2392.29	0	2392.29	4354.79	4354.79
17	2.59379	11649.9	38.4954	Andesite & Rhyolite	440	42	2539.18	2598.93	2397.73	0	2397.73	4417.16	4417.16
18	2.59379	12178.8	39.2462	Andesite & Rhyolite	440	42	2534.71	2594.35	2392.65	0	2392.65	4463.32	4463.32
19	2.59379	12688.4	40.0051	Andesite & Rhyolite	440	42	2525.23	2584.65	2381.88	0	2381.88	4501.18	4501.18
20	2.59379	13178.2	40.7726	Andesite & Rhyolite	440	42	2511.11	2570.2	2365.82	0	2365.82	4531.27	4531.27
21	2.59379	13647.5	41.5491	Andesite & Rhyolite	440	42	2492.66	2551.31	2344.85	0	2344.85	4553.98	4553.98
22	2.59379	14095.4	42.3349	Andesite & Rhyolite	440	42	2470.13	2528.25	2319.24	0	2319.24	4569.64	4569.64
23	2.59379	14523.8	43.1308	Andesite & Rhyolite	440	42	2444.03	2501.54	2289.57	0	2289.57	4579.12	4579.12
24	2.8708	16597.8	43.9808	Basalt	2000	49	5713.38	5847.82	3344.85	0	3344.85	8858.5	8858.5
25	2.8708	17112	44.8869	Basalt	2000	49	5567.34	5698.34	3214.91	0	3214.91	8760.31	8760.31
26	2.8708	17588.2	45.8075	Basalt	2000	49	5419.29	5546.81	3083.2	0	3083.2	8657.45	8657.45
27	2.8708	18012.8	46.7436	Basalt	2000	49	5268.17	5392.13	2948.72	0	2948.72	8547.7	8547.7
28	2.8708	18267.6	47.6963	Basalt	2000	49	5099.73	5219.73	2798.87	0	2798.87	8402.67	8402.67
29	2.59009	16691.1	48.6183	Andesite & Rhyolite	440	42	2181.89	2233.23	1991.58	0	1991.58	4468.05	4468.05
30	2.59009	16915.9	49.5093	Andesite & Rhyolite	440	42	2126.77	2176.81	1928.93	0	1928.93	4419.87	4419.87
31	2.59009	17108.1	50.4167	Andesite & Rhyolite	440	42	2067.28	2115.92	1861.3	0	1861.3	4361.7	4361.7
32	2.59009	17266	51.342	Andesite & Rhyolite	440	42	2003.16	2050.29	1788.41	0	1788.41	4292.51	4292.51
33	2.59009	17387.4	52.2863	Andesite & Rhyolite	440	42	1934.1	1979.61	1709.91	0	1709.91	4211.1	4211.1
34	2.59009	17469.9	53.2511	Andesite & Rhyolite	440	42	1859.79	1903.55	1625.44	0	1625.44	4116.1	4116.1
35	2.59009	17584.2	54.2383	Andesite & Rhyolite	440	42	1785.17	1827.18	1540.62	0	1540.62	4019.32	4019.32
36	2.59009	17722.5	55.2497	Andesite & Rhyolite	440	42	1708.57	1748.77	1453.53	0	1453.53	3916.39	3916.39
37	2.42425	16605.1	56.2534	Basalt	2000	49	3867.07	3958.06	1702.11	0	1702.11	7490.34	7490.34
38	2.42425	16506	57.2501	Basalt	2000	49	3735.02	3822.91	1584.63	0	1584.63	7391.4	7391.4
39	2.42425	16278.9	58.2745	Basalt	2000	49	3595.82	3680.43	1460.78	0	1460.78	7277.11	7277.11
40	2.42425	15949.1	59.3295	Basalt	2000	49	3453.3	3534.56	1333.97	0	1333.97	7156.81	7156.81
41	2.75373	17723.3	60.495	Andesite & Rhyolite	440	42	1191.76	1219.8	866.056	0	866.056	2972.05	2972.05
42	2.75373	16768.8	61.7812	Andesite & Rhyolite	440	42	1044.23	1068.8	698.352	0	698.352	2644.3	2644.3
43	2.75373	15434.3	63.1238	Andesite & Rhyolite	440	42	893.452	914.475	526.958	0	526.958	2289.87	2289.87
44	2.75373	13983.5	64.5318	Andesite & Rhyolite	440	42	754.077	771.82	368.523	0	368.523	1951.74	1951.74
45	2.75373	12397.3	66.0168	Andesite & Rhyolite	440	42	632.306	647.184	230.101	0	230.101	1651.4	1651.4
46	2.71541	10381.4	67.5825	Basalt	2000	49	2498.43	2557.22	484.383	0	484.383	6540.78	6540.78
47	2.71541	8215.86	69.2484	Basalt	2000	49	2411.11	2467.84	406.687	0	406.687	6770.16	6770.16
48	2.4746	5519.02	70.967	Andesite & Rhyolite	440	42	506.529	518.448	87.125	0	87.125	1555.44	1555.44
49	2.4746	3531.74	72.7631	Andesite & Rhyolite	440	42	594.045	608.023	186.609	0	186.609	2101.29	2101.29
50	2.4746	1236.78	74.7652	Andesite & Rhyolite	440	42	760.234	778.122	375.523	0	375.523	3166.95	3166.95

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.02353

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	120.011	200.015	0	0	0
2	122.605	201.356	1829.63	3476.29	62.2414
3	125.198	202.735	3716.03	7060.46	62.2415
4	127.792	204.153	5620.5	10678.9	62.2413
5	130.386	205.61	7508.73	14266.6	62.2415
6	132.98	207.108	9350.46	17765.9	62.2415
7	135.574	208.647	11119.1	21126.2	62.2414
8	138.167	210.227	12791.3	24303.4	62.2414
9	140.761	211.851	14346.7	27258.8	62.2415
10	143.355	213.519	15767.8	29958.9	62.2415
11	145.949	215.232	17039.4	32374.9	62.2415
12	148.543	216.991	18148.5	34482.2	62.2415
13	151.136	218.797	19083.4	36258.4	62.2414
14	153.73	220.651	19827.9	37673	62.2415
15	156.324	222.556	20369.6	38702.3	62.2415
16	158.918	224.512	20698.8	39327.6	62.2414
17	161.511	226.52	20808.3	39535.8	62.2415
18	164.105	228.583	20703.4	39336.5	62.2415
19	166.699	230.702	20383.9	38729.4	62.2415
20	169.293	232.879	19848.2	37711.6	62.2415
21	171.887	235.116	19095.6	36281.7	62.2415
22	174.48	237.414	18126.3	34440	62.2415
23	177.074	239.777	16941.1	32188.1	62.2415
24	179.668	242.207	15541.1	29528.1	62.2415
25	182.539	244.978	20193.3	38367.2	62.2414
26	185.41	247.837	24422.6	46403	62.2415
27	188.28	250.79	28244.1	53663.7	62.2414
28	191.151	253.841	31675.3	60183.1	62.2415
29	194.022	256.996	34752.2	66029.2	62.2415
30	196.612	259.935	32047.3	60889.9	62.2415
31	199.202	262.969	29169.1	55421.2	62.2414
32	201.792	266.102	26128.5	49644.1	62.2414
33	204.382	269.34	22938.5	43583.1	62.2414
34	206.972	272.689	19614.5	37267.6	62.2415
35	209.563	276.158	16174.8	30732.2	62.2415
36	212.153	279.754	12622.3	23982.3	62.2414
37	214.743	283.488	8964.19	17032	62.2415
38	217.167	287.116	9675.62	18383.7	62.2415
39	219.591	290.885	10285.6	19542.7	62.2415
40	222.015	294.806	10836.4	20589.1	62.2414
41	224.44	298.894	11366.2	21595.7	62.2414
42	227.193	303.76	7776.37	14775.1	62.2415
43	229.947	308.892	4554.03	8652.66	62.2415
44	232.701	314.326	1836.97	3490.25	62.2415
45	235.455	320.107	-313.838	-596.293	62.2415
46	238.208	326.297	-1855.82	-3526.06	62.2415
47	240.924	332.879	185.577	352.596	62.2414
48	243.639	340.046	2588.41	4917.98	62.2415
49	246.114	347.219	2389.54	4540.13	62.2415
50	248.588	355.195	1842.02	3499.84	62.2415
51	251.063	364.281	0	0	0

Query 1 (spencer) - Safety Factor: 1.02353

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	120.011	200.015	0	0	0
2	122.605	201.356	1829.63	3476.29	62.2414
3	125.198	202.735	3716.03	7060.46	62.2415

4	127.792	204.153	5620.5	10678.9	62.2413
5	130.386	205.61	7508.73	14266.6	62.2415
6	132.98	207.108	9350.46	17765.9	62.2415
7	135.574	208.647	11119.1	21126.2	62.2414
8	138.167	210.227	12791.3	24303.4	62.2414
9	140.761	211.851	14346.7	27258.8	62.2415
10	143.355	213.519	15767.8	29958.9	62.2415
11	145.949	215.232	17039.4	32374.9	62.2415
12	148.543	216.991	18148.5	34482.2	62.2415
13	151.136	218.797	19083.4	36258.4	62.2414
14	153.73	220.651	19827.9	37673	62.2415
15	156.324	222.556	20369.6	38702.3	62.2415
16	158.918	224.512	20698.8	39327.6	62.2414
17	161.511	226.52	20808.3	39535.8	62.2415
18	164.105	228.583	20703.4	39336.5	62.2415
19	166.699	230.702	20383.9	38729.4	62.2415
20	169.293	232.879	19848.2	37711.6	62.2415
21	171.887	235.116	19095.6	36281.7	62.2415
22	174.48	237.414	18126.3	34440	62.2415
23	177.074	239.777	16941.1	32188.1	62.2415
24	179.668	242.207	15541.1	29528.1	62.2415
25	182.539	244.978	20193.3	38367.2	62.2414
26	185.41	247.837	24422.6	46403	62.2415
27	188.28	250.79	28244.1	53663.7	62.2414
28	191.151	253.841	31675.3	60183.1	62.2415
29	194.022	256.996	34752.2	66029.2	62.2415
30	196.612	259.935	32047.3	60889.9	62.2415
31	199.202	262.969	29169.1	55421.2	62.2414
32	201.792	266.102	26128.5	49644.1	62.2414
33	204.382	269.34	22938.5	43583.1	62.2414
34	206.972	272.689	19614.5	37267.6	62.2415
35	209.563	276.158	16174.8	30732.2	62.2415
36	212.153	279.754	12622.3	23982.3	62.2414
37	214.743	283.488	8964.19	17032	62.2415
38	217.167	287.116	9675.62	18383.7	62.2415
39	219.591	290.885	10285.6	19542.7	62.2415
40	222.015	294.806	10836.4	20589.1	62.2414
41	224.44	298.894	11366.2	21595.7	62.2414
42	227.193	303.76	7776.37	14775.1	62.2415
43	229.947	308.892	4554.03	8652.66	62.2415
44	232.701	314.326	1836.97	3490.25	62.2415
45	235.455	320.107	-313.838	-596.293	62.2415
46	238.208	326.297	-1855.82	-3526.06	62.2415
47	240.924	332.879	185.577	352.596	62.2414
48	243.639	340.046	2588.41	4917.98	62.2415
49	246.114	347.219	2389.54	4540.13	62.2415
50	248.588	355.195	1842.02	3499.84	62.2415
51	251.063	364.281	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894

900	326.297
900	340.046
900	364.52
900	378.882
900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
343.655	416.559
316.475	401.213
276.924	378.882
251.485	364.52
226.69	350.52
219.266	340.046
209.52	326.297
190.097	298.894
179.177	283.488
160.399	256.996
149.917	242.207
120	200
-119.082	200

Material Boundary

X	Y
149.917	242.207
900	242.207

Material Boundary

X	Y
160.399	256.996
900	256.996

Material Boundary

X	Y
179.177	283.488
900	283.488

Material Boundary

X	Y
190.097	298.894
900	298.894

Material Boundary

X	Y
209.52	326.297
900	326.297

Material Boundary

X	Y
219.266	340.046
900	340.046

Material Boundary

X	Y
251.485	364.52
900	364.52

Material Boundary

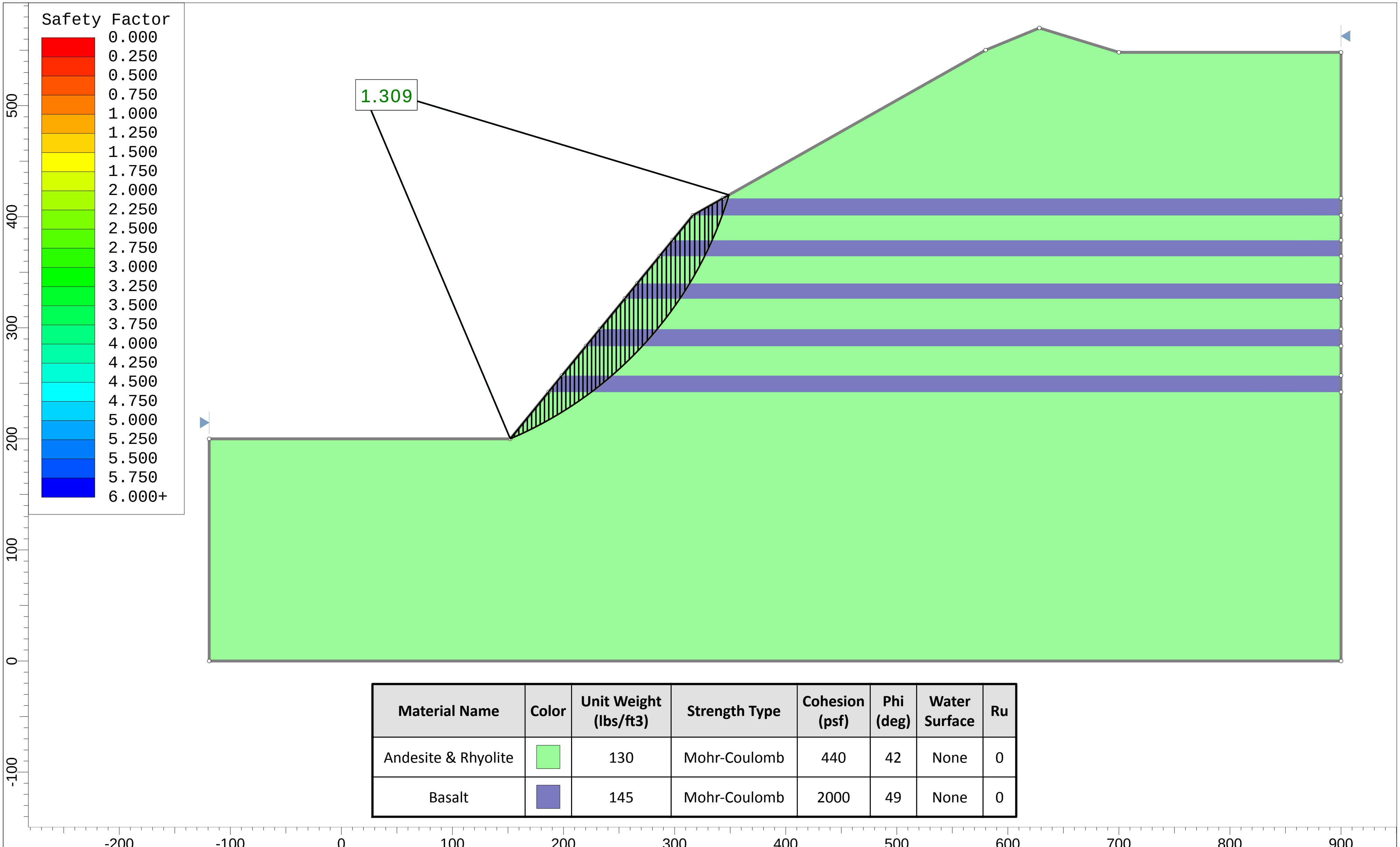
X	Y
276.924	378.882
900	378.882

Material Boundary

X	Y
316.475	401.213
900	401.213

Material Boundary

X	Y
343.655	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite	(green)	130	Mohr-Coulomb	440	42	None	0
Basalt	(purple)	145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion
Analysis Description	200' Slope, dry, static, 50 degree gross slope inclination
Drawn By	J.Bianchin
Scale	1:1434
Company	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM
File Name	200',dry,ststic,50deg.slim

Slide Analysis Information
Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version: 8.032

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type: Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10

Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.309350
Center:	16.553, 519.622
Radius:	347.122
Left Slip Surface Endpoint:	152.020, 200.025
Right Slip Surface Endpoint:	348.934, 419.540
Resisting Moment:	3.61389e+08 lb-ft
Driving Moment:	2.76007e+08 lb-ft
Resisting Horizontal Force:	708486 lb
Driving Horizontal Force:	541099 lb
Total Slice Area:	8280.15 ft2
Surface Horizontal Width:	196.914 ft
Surface Average Height:	42.0495 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	11154
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.30935

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]

1	3.85174	764.093	23.3167	Andesite & Rhyolite	440	42	545.969	714.865	305.268	0	305.268	540.588	540.588
2	3.85174	2278.35	24.0108	Andesite & Rhyolite	440	42	784.04	1026.58	651.466	0	651.466	1000.72	1000.72
3	3.85174	3764.53	24.7088	Andesite & Rhyolite	440	42	1008.29	1320.2	977.56	0	977.56	1441.51	1441.51
4	3.85174	5222.16	25.4106	Andesite & Rhyolite	440	42	1219.14	1596.28	1284.18	0	1284.18	1863.35	1863.35
5	3.85174	6650.74	26.1166	Andesite & Rhyolite	440	42	1417.02	1855.37	1571.93	0	1571.93	2266.62	2266.62
6	3.85174	8049.75	26.8268	Andesite & Rhyolite	440	42	1602.31	2097.98	1841.37	0	1841.37	2651.7	2651.7
7	3.85174	9418.64	27.5416	Andesite & Rhyolite	440	42	1775.39	2324.61	2093.07	0	2093.07	3018.92	3018.92
8	3.85174	10756.8	28.261	Andesite & Rhyolite	440	42	1936.63	2535.73	2327.55	0	2327.55	3368.62	3368.62
9	3.85174	12064	28.9853	Andesite & Rhyolite	440	42	2086.42	2731.86	2545.37	0	2545.37	3701.2	3701.2
10	3.85174	13487.7	29.7147	Andesite & Rhyolite	440	42	2245.54	2940.2	2776.76	0	2776.76	4058.36	4058.36
11	3.85174	15002.2	30.4495	Andesite & Rhyolite	440	42	2409.69	3155.13	3015.45	0	3015.45	4432.01	4432.01
12	3.85174	16483.2	31.1898	Andesite & Rhyolite	440	42	2561.82	3354.32	3236.69	0	3236.69	4787.56	4787.56
13	3.85174	17817.4	31.936	Andesite & Rhyolite	440	42	2687.64	3519.06	3419.64	0	3419.64	5094.89	5094.89
14	3.85174	18958.1	32.6883	Andesite & Rhyolite	440	42	2782.49	3643.25	3557.57	0	3557.57	5343.09	5343.09
15	3.85174	20061.8	33.447	Andesite & Rhyolite	440	42	2867.51	3754.57	3681.21	0	3681.21	5575.35	5575.35
16	3.85174	21128.6	34.2124	Andesite & Rhyolite	440	42	2943.1	3853.55	3791.13	0	3791.13	5792.18	5792.18
17	3.85174	22157.5	34.9848	Andesite & Rhyolite	440	42	3009.51	3940.5	3887.7	0	3887.7	5993.79	5993.79
18	3.85174	23158.8	35.7645	Andesite & Rhyolite	440	42	3068.27	4017.44	3973.16	0	3973.16	6183.17	6183.17
19	3.85174	24311.9	36.552	Andesite & Rhyolite	440	42	3140.27	4111.71	4077.83	0	4077.83	6405.92	6405.92
20	3.66655	24164.2	37.3283	Basalt	2000	49	5279.51	6912.72	4270.56	0	4270.56	8296.59	8296.59
21	3.66655	25041.6	38.0933	Basalt	2000	49	5307.31	6949.12	4302.21	0	4302.21	8462.67	8462.67
22	3.66655	25772.9	38.8664	Basalt	2000	49	5309	6951.34	4304.14	0	4304.14	8582.83	8582.83
23	3.66655	26318.5	39.6481	Basalt	2000	49	5280.51	6914.03	4271.7	0	4271.7	8647.59	8647.59
24	3.66655	26818.3	40.4387	Basalt	2000	49	5243.1	6865.05	4229.14	0	4229.14	8697.47	8697.47
25	3.92095	29279.5	41.2668	Andesite & Rhyolite	440	42	3239.87	4242.13	4222.7	0	4222.7	7065.67	7065.67
26	3.92095	29943.6	42.1337	Andesite & Rhyolite	440	42	3234.31	4234.85	4214.61	0	4214.61	7140.49	7140.49
27	3.92095	30552.4	43.0126	Andesite & Rhyolite	440	42	3221.16	4217.62	4195.46	0	4195.46	7200.56	7200.56
28	3.92095	31248.8	43.9043	Andesite & Rhyolite	440	42	3214.01	4208.27	4185.09	0	4185.09	7278.47	7278.47
29	3.92095	32021.5	44.8095	Andesite & Rhyolite	440	42	3211.29	4204.7	4181.11	0	4181.11	7371.12	7371.12
30	3.92095	32727.7	45.7292	Andesite & Rhyolite	440	42	3199.86	4189.74	4164.5	0	4164.5	7446.87	7446.87
31	3.92095	33190.6	46.6643	Andesite & Rhyolite	440	42	3164.93	4144	4113.71	0	4113.71	7468.06	7468.06
32	4.49179	38207.6	47.6865	Basalt	2000	49	4835.09	6330.83	3764.73	0	3764.73	9075.92	9075.92
33	4.49179	38138.6	48.8	Basalt	2000	49	4688.99	6139.53	3598.44	0	3598.44	8954.63	8954.63
34	4.49179	37937	49.9388	Basalt	2000	49	4532.62	5934.78	3420.45	0	3420.45	8810.51	8810.51
35	4.07983	34358.9	51.0504	Andesite & Rhyolite	440	42	2818.99	3691.05	3610.66	0	3610.66	7098.1	7098.1
36	4.07983	34544	52.1346	Andesite & Rhyolite	440	42	2755.63	3608.08	3518.5	0	3518.5	7062.67	7062.67
37	4.07983	34656.4	53.2459	Andesite & Rhyolite	440	42	2686.53	3517.61	3418.03	0	3418.03	7015.19	7015.19

38	4.07983	34589.9	54.3868	Andesite & Rhyolite	440	42	2604.9	3410.72	3299.32	0	3299.32	6936.03	6936.03
39	4.07983	34170.2	55.5604	Andesite & Rhyolite	440	42	2500.32	3273.8	3147.26	0	3147.26	6793.48	6793.48
40	4.3793	35804.4	56.8162	Basalt	2000	49	3681.46	4820.32	2451.66	0	2451.66	8081	8081
41	4.3793	34489.2	58.1617	Basalt	2000	49	3458.35	4528.19	2197.72	0	2197.72	7767.14	7767.14
42	4.49348	33923.1	59.5792	Andesite & Rhyolite	440	42	2055.9	2691.89	2500.98	0	2500.98	6002.27	6002.27
43	4.49348	31281.1	61.0785	Andesite & Rhyolite	440	42	1841.75	2411.5	2189.58	0	2189.58	5522.95	5522.95
44	4.49348	28021.1	62.6527	Andesite & Rhyolite	440	42	1607.07	2104.22	1848.31	0	1848.31	4955.65	4955.65
45	3.38384	18572	64.0993	Basalt	2000	49	2339.34	3063.01	924.057	0	924.057	5741.58	5741.58
46	3.38384	15985.8	65.4098	Basalt	2000	49	2075.48	2717.54	623.745	0	623.745	5159.04	5159.04
47	4.49572	17178.6	67.0318	Andesite & Rhyolite	440	42	955.454	1251.02	900.732	0	900.732	3155.12	3155.12
48	4.49572	12307.7	69.0189	Andesite & Rhyolite	440	42	702.696	920.075	533.177	0	533.177	2365.57	2365.57
49	5.1669	6422.28	71.3917	Basalt	2000	49	1079.2	1413.05	-510.228	0	-510.228	2695	2695
50	0.912136	146.191	72.9854	Andesite & Rhyolite	440	42	0	0	-551.133	0	-551.133	-551.133	-551.133

Query 1 (spencer) - Safety Factor: 1.30935

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.85174	764.093	23.3167	Andesite & Rhyolite	440	42	545.969	714.865	305.268	0	305.268	540.588	540.588
2	3.85174	2278.35	24.0108	Andesite & Rhyolite	440	42	784.04	1026.58	651.466	0	651.466	1000.72	1000.72
3	3.85174	3764.53	24.7088	Andesite & Rhyolite	440	42	1008.29	1320.2	977.56	0	977.56	1441.51	1441.51
4	3.85174	5222.16	25.4106	Andesite & Rhyolite	440	42	1219.14	1596.28	1284.18	0	1284.18	1863.35	1863.35
5	3.85174	6650.74	26.1166	Andesite & Rhyolite	440	42	1417.02	1855.37	1571.93	0	1571.93	2266.62	2266.62
6	3.85174	8049.75	26.8268	Andesite & Rhyolite	440	42	1602.31	2097.98	1841.37	0	1841.37	2651.7	2651.7
7	3.85174	9418.64	27.5416	Andesite & Rhyolite	440	42	1775.39	2324.61	2093.07	0	2093.07	3018.92	3018.92
8	3.85174	10756.8	28.261	Andesite & Rhyolite	440	42	1936.63	2535.73	2327.55	0	2327.55	3368.62	3368.62
9	3.85174	12064	28.9853	Andesite & Rhyolite	440	42	2086.42	2731.86	2545.37	0	2545.37	3701.2	3701.2
10	3.85174	13487.7	29.7147	Andesite & Rhyolite	440	42	2245.54	2940.2	2776.76	0	2776.76	4058.36	4058.36
11	3.85174	15002.2	30.4495	Andesite & Rhyolite	440	42	2409.69	3155.13	3015.45	0	3015.45	4432.01	4432.01
12	3.85174	16483.2	31.1898	Andesite & Rhyolite	440	42	2561.82	3354.32	3236.69	0	3236.69	4787.56	4787.56
13	3.85174	17817.4	31.936	Andesite & Rhyolite	440	42	2687.64	3519.06	3419.64	0	3419.64	5094.89	5094.89
14	3.85174	18958.1	32.6883	Andesite & Rhyolite	440	42	2782.49	3643.25	3557.57	0	3557.57	5343.09	5343.09
15	3.85174	20061.8	33.447	Andesite & Rhyolite	440	42	2867.51	3754.57	3681.21	0	3681.21	5575.35	5575.35
16	3.85174	21128.6	34.2124	Andesite & Rhyolite	440	42	2943.1	3853.55	3791.13	0	3791.13	5792.18	5792.18
17	3.85174	22157.5	34.9848	Andesite & Rhyolite	440	42	3009.51	3940.5	3887.7	0	3887.7	5993.79	5993.79
18	3.85174	23158.8	35.7645	Andesite & Rhyolite	440	42	3068.27	4017.44	3973.16	0	3973.16	6183.17	6183.17
19	3.85174	24311.9	36.552	Andesite & Rhyolite	440	42	3140.27	4111.71	4077.83	0	4077.83	6405.92	6405.92
20	3.66655	24164.2	37.3283	Basalt	2000	49	5279.51	6912.72	4270.56	0	4270.56	8296.59	8296.59

21	3.66655	25041.6	38.0933	Basalt	2000	49	5307.31	6949.12	4302.21	0	4302.21	8462.67	8462.67
22	3.66655	25772.9	38.8664	Basalt	2000	49	5309	6951.34	4304.14	0	4304.14	8582.83	8582.83
23	3.66655	26318.5	39.6481	Basalt	2000	49	5280.51	6914.03	4271.7	0	4271.7	8647.59	8647.59
24	3.66655	26818.3	40.4387	Basalt	2000	49	5243.1	6865.05	4229.14	0	4229.14	8697.47	8697.47
25	3.92095	29279.5	41.2668	Andesite & Rhyolite	440	42	3239.87	4242.13	4222.7	0	4222.7	7065.67	7065.67
26	3.92095	29943.6	42.1337	Andesite & Rhyolite	440	42	3234.31	4234.85	4214.61	0	4214.61	7140.49	7140.49
27	3.92095	30552.4	43.0126	Andesite & Rhyolite	440	42	3221.16	4217.62	4195.46	0	4195.46	7200.56	7200.56
28	3.92095	31248.8	43.9043	Andesite & Rhyolite	440	42	3214.01	4208.27	4185.09	0	4185.09	7278.47	7278.47
29	3.92095	32021.5	44.8095	Andesite & Rhyolite	440	42	3211.29	4204.7	4181.11	0	4181.11	7371.12	7371.12
30	3.92095	32727.7	45.7292	Andesite & Rhyolite	440	42	3199.86	4189.74	4164.5	0	4164.5	7446.87	7446.87
31	3.92095	33190.6	46.6643	Andesite & Rhyolite	440	42	3164.93	4144	4113.71	0	4113.71	7468.06	7468.06
32	4.49179	38207.6	47.6865	Basalt	2000	49	4835.09	6330.83	3764.73	0	3764.73	9075.92	9075.92
33	4.49179	38138.6	48.8	Basalt	2000	49	4688.99	6139.53	3598.44	0	3598.44	8954.63	8954.63
34	4.49179	37937	49.9388	Basalt	2000	49	4532.62	5934.78	3420.45	0	3420.45	8810.51	8810.51
35	4.07983	34358.9	51.0504	Andesite & Rhyolite	440	42	2818.99	3691.05	3610.66	0	3610.66	7098.1	7098.1
36	4.07983	34544	52.1346	Andesite & Rhyolite	440	42	2755.63	3608.08	3518.5	0	3518.5	7062.67	7062.67
37	4.07983	34656.4	53.2459	Andesite & Rhyolite	440	42	2686.53	3517.61	3418.03	0	3418.03	7015.19	7015.19
38	4.07983	34589.9	54.3868	Andesite & Rhyolite	440	42	2604.9	3410.72	3299.32	0	3299.32	6936.03	6936.03
39	4.07983	34170.2	55.5604	Andesite & Rhyolite	440	42	2500.32	3273.8	3147.26	0	3147.26	6793.48	6793.48
40	4.3793	35804.4	56.8162	Basalt	2000	49	3681.46	4820.32	2451.66	0	2451.66	8081	8081
41	4.3793	34489.2	58.1617	Basalt	2000	49	3458.35	4528.19	2197.72	0	2197.72	7767.14	7767.14
42	4.49348	33923.1	59.5792	Andesite & Rhyolite	440	42	2055.9	2691.89	2500.98	0	2500.98	6002.27	6002.27
43	4.49348	31281.1	61.0785	Andesite & Rhyolite	440	42	1841.75	2411.5	2189.58	0	2189.58	5522.95	5522.95
44	4.49348	28021.1	62.6527	Andesite & Rhyolite	440	42	1607.07	2104.22	1848.31	0	1848.31	4955.65	4955.65
45	3.38384	18572	64.0993	Basalt	2000	49	2339.34	3063.01	924.057	0	924.057	5741.58	5741.58
46	3.38384	15985.8	65.4098	Basalt	2000	49	2075.48	2717.54	623.745	0	623.745	5159.04	5159.04
47	4.49572	17178.6	67.0318	Andesite & Rhyolite	440	42	955.454	1251.02	900.732	0	900.732	3155.12	3155.12
48	4.49572	12307.7	69.0189	Andesite & Rhyolite	440	42	702.696	920.075	533.177	0	533.177	2365.57	2365.57
49	5.1669	6422.28	71.3917	Basalt	2000	49	1079.2	1413.05	-510.228	0	-510.228	2695	2695
50	0.912136	146.191	72.9854	Andesite & Rhyolite	440	42	0	0	-551.133	0	-551.133	-551.133	-551.133

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.30935

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	152.02	200.025	0	0	0
2	155.872	201.685	1589.57	1340.3	40.1371
3	159.724	203.4	3482.29	2936.21	40.137
4	163.575	205.173	5621.27	4739.76	40.137
5	167.427	207.003	7952.6	6705.5	40.137
6	171.279	208.891	10425.2	8790.37	40.1371
7	175.13	210.839	12990.8	10953.6	40.137
8	178.982	212.847	15603.5	13156.6	40.137

9	182.834	214.918	18220.3	15363	40.1369
10	186.686	217.052	20800.3	17538.5	40.1371
11	190.537	219.25	23318.4	19661.7	40.137
12	194.389	221.514	25743.1	21706.2	40.1371
13	198.241	223.846	28032.6	23636.6	40.137
14	202.093	226.247	30142.2	25415.5	40.1371
15	205.944	228.719	32033.1	27009.8	40.1371
16	209.796	231.263	33677.4	28396.3	40.1371
17	213.648	233.882	35049.6	29553.3	40.1371
18	217.5	236.577	36126	30460.9	40.1371
19	221.351	239.352	36884.4	31100.4	40.1371
20	225.203	242.207	37297.6	31448.8	40.1371
21	228.87	245.003	44654.2	37651.7	40.137
22	232.536	247.877	51687.3	43581.9	40.137
23	236.203	250.832	58373.5	49219.6	40.1371
24	239.869	253.871	64695.1	54549.8	40.137
25	243.536	256.996	70644.1	59566	40.1371
26	247.457	260.436	68779.2	57993.5	40.137
27	251.378	263.983	66471.8	56048	40.1371
28	255.299	267.641	63715.5	53723.9	40.1371
29	259.22	271.415	60484.6	50999.6	40.137
30	263.141	275.31	56751.2	47851.7	40.137
31	267.062	279.332	52508.7	44274.5	40.1371
32	270.983	283.488	47784.4	40291.1	40.1371
33	275.474	288.422	50859.3	42883.7	40.137
34	279.966	293.553	53392.1	45019.4	40.1371
35	284.458	298.894	55417.7	46727.3	40.137
36	288.538	303.941	48658.9	41028.4	40.137
37	292.618	309.189	41403.6	34910.8	40.137
38	296.697	314.651	33658.1	28380	40.1371
39	300.777	320.347	25460	21467.4	40.137
40	304.857	326.297	16904	14253.2	40.1371
41	309.236	332.993	16558.5	13961.9	40.1371
42	313.616	340.046	16156.8	13623.2	40.1371
43	318.109	347.699	6227.13	5250.62	40.1371
44	322.603	355.831	-3330.01	-2807.81	40.137
45	327.096	364.52	-12189.9	-10278.3	40.137
46	330.48	371.488	-10738	-9054.13	40.1371
47	333.864	378.882	-8348.99	-7039.74	40.1371
48	338.36	389.49	-13621.6	-11485.5	40.137
49	342.855	401.213	-16722.9	-14100.5	40.1371
50	348.022	416.559	-3334.41	-2811.52	40.137
51	348.934	419.54	0	0	0

Query 1 (spencer) - Safety Factor: 1.30935

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	152.02	200.025	0	0	0
2	155.872	201.685	1589.57	1340.3	40.1371
3	159.724	203.4	3482.29	2936.21	40.137
4	163.575	205.173	5621.27	4739.76	40.137
5	167.427	207.003	7952.6	6705.5	40.137
6	171.279	208.891	10425.2	8790.37	40.1371
7	175.13	210.839	12990.8	10953.6	40.137
8	178.982	212.847	15603.5	13156.6	40.137
9	182.834	214.918	18220.3	15363	40.1369
10	186.686	217.052	20800.3	17538.5	40.1371
11	190.537	219.25	23318.4	19661.7	40.137
12	194.389	221.514	25743.1	21706.2	40.1371
13	198.241	223.846	28032.6	23636.6	40.137
14	202.093	226.247	30142.2	25415.5	40.1371
15	205.944	228.719	32033.1	27009.8	40.1371

16	209.796	231.263	33677.4	28396.3	40.1371
17	213.648	233.882	35049.6	29553.3	40.1371
18	217.5	236.577	36126	30460.9	40.1371
19	221.351	239.352	36884.4	31100.4	40.1371
20	225.203	242.207	37297.6	31448.8	40.1371
21	228.87	245.003	44654.2	37651.7	40.137
22	232.536	247.877	51687.3	43581.9	40.137
23	236.203	250.832	58373.5	49219.6	40.1371
24	239.869	253.871	64695.1	54549.8	40.137
25	243.536	256.996	70644.1	59566	40.1371
26	247.457	260.436	68779.2	57993.5	40.137
27	251.378	263.983	66471.8	56048	40.1371
28	255.299	267.641	63715.5	53723.9	40.1371
29	259.22	271.415	60484.6	50999.6	40.137
30	263.141	275.31	56751.2	47851.7	40.137
31	267.062	279.332	52508.7	44274.5	40.1371
32	270.983	283.488	47784.4	40291.1	40.1371
33	275.474	288.422	50859.3	42883.7	40.137
34	279.966	293.553	53392.1	45019.4	40.1371
35	284.458	298.894	55417.7	46727.3	40.137
36	288.538	303.941	48658.9	41028.4	40.137
37	292.618	309.189	41403.6	34910.8	40.137
38	296.697	314.651	33658.1	28380	40.1371
39	300.777	320.347	25460	21467.4	40.137
40	304.857	326.297	16904	14253.2	40.1371
41	309.236	332.993	16558.5	13961.9	40.1371
42	313.616	340.046	16156.8	13623.2	40.1371
43	318.109	347.699	6227.13	5250.62	40.1371
44	322.603	355.831	-3330.01	-2807.81	40.137
45	327.096	364.52	-12189.9	-10278.3	40.137
46	330.48	371.488	-10738	-9054.13	40.1371
47	333.864	378.882	-8348.99	-7039.74	40.1371
48	338.36	389.49	-13621.6	-11485.5	40.137
49	342.855	401.213	-16722.9	-14100.5	40.1371
50	348.022	416.559	-3334.41	-2811.52	40.137
51	348.934	419.54	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882
900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
343.655	416.559
316.475	401.213
298.222	378.882

286.481	364.52
266.476	340.046
255.237	326.297
232.838	298.894
220.244	283.488
198.589	256.996
186.501	242.207
152	200
-119.082	200

Material Boundary

X	Y
186.501	242.207
900	242.207

Material Boundary

X	Y
198.589	256.996
900	256.996

Material Boundary

X	Y
220.244	283.488
900	283.488

Material Boundary

X	Y
232.838	298.894
900	298.894

Material Boundary

X	Y
255.237	326.297
900	326.297

Material Boundary

X	Y
266.476	340.046
900	340.046

Material Boundary

X	Y
286.481	364.52
900	364.52

Material Boundary

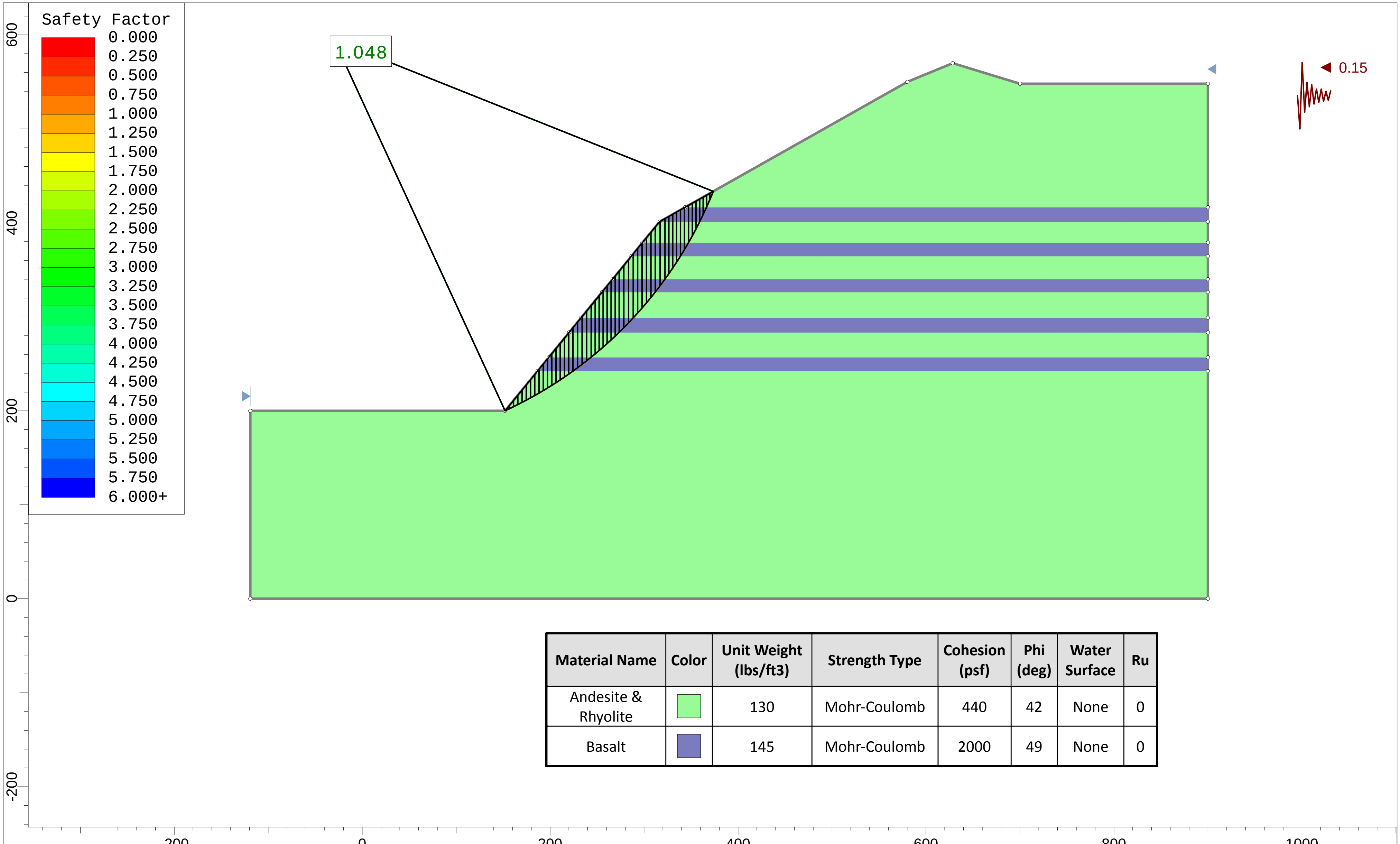
X	Y
298.222	378.882
900	378.882

Material Boundary

X	Y
316.475	401.213
900	401.213

Material Boundary

X	Y
343.655	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

Bajada Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion		
Analysis Description	200' Slope, dry, pseudostatic, 50 degree gross slope inclination		
Drawn By J.Bianchin	*Scale* 1:1695	*Company*	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM	*File Name*	200',dry,PS,50deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:04.56s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.15

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.047750
Center:	-29.731, 594.421
Radius:	434.259
Left Slip Surface Endpoint:	152.022, 200.027
Right Slip Surface Endpoint:	373.598, 433.465
Resisting Moment:	4.7909e+08 lb-ft
Driving Moment:	4.57258e+08 lb-ft
Resisting Horizontal Force:	781962 lb
Driving Horizontal Force:	746328 lb
Total Slice Area:	9774 ft2
Surface Horizontal Width:	221.576 ft
Surface Average Height:	44.1112 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 9810
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.04775

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.51672	1001.89	25.0711	Andesite & Rhyolite	440	42	1003.6	1051.52	679.163	0	679.163	1148.67	1148.67
2	4.51672	2986.96	25.7308	Andesite & Rhyolite	440	42	1328.11	1391.53	1056.78	0	1056.78	1696.84	1696.84
3	4.51672	4934.29	26.3942	Andesite & Rhyolite	440	42	1623.45	1700.97	1400.45	0	1400.45	2206.13	2206.13
4	4.51672	6843.24	27.0615	Andesite & Rhyolite	440	42	1891.21	1981.52	1712.03	0	1712.03	2678.21	2678.21
5	4.51672	8713.12	27.7327	Andesite & Rhyolite	440	42	2132.95	2234.8	1993.34	0	1993.34	3114.72	3114.72
6	4.51672	10543.2	28.4081	Andesite & Rhyolite	440	42	2350.13	2462.35	2246.04	0	2246.04	3517.18	3517.18
7	4.51672	12332.8	29.0878	Andesite & Rhyolite	440	42	2544.14	2665.62	2471.81	0	2471.81	3887.15	3887.15
8	4.51672	14106.1	29.7721	Andesite & Rhyolite	440	42	2719.87	2849.74	2676.29	0	2676.29	4232.21	4232.21
9	4.51672	16111.3	30.461	Andesite & Rhyolite	440	42	2912.03	3051.08	2899.9	0	2899.9	4612.55	4612.55
10	4.51672	18148.6	31.1549	Andesite & Rhyolite	440	42	3091.92	3239.56	3109.24	0	3109.24	4978.45	4978.45
11	4.51672	20052.8	31.8539	Andesite & Rhyolite	440	42	3239.04	3393.7	3280.41	0	3280.41	5292.92	5292.92
12	4.51672	21644.7	32.5582	Andesite & Rhyolite	440	42	3334.07	3493.27	3391	0	3391	5519.8	5519.8
13	4.51672	23172.5	33.2681	Andesite & Rhyolite	440	42	3411	3573.88	3480.53	0	3480.53	5718.43	5718.43
14	4.51672	24653.1	33.9838	Andesite & Rhyolite	440	42	3473.16	3639	3552.86	0	3552.86	5894.1	5894.1
15	4.51672	26085.3	34.7056	Andesite & Rhyolite	440	42	3521.5	3689.65	3609.09	0	3609.09	6048.01	6048.01
16	4.51672	27618	35.4338	Andesite & Rhyolite	440	42	3572.88	3743.49	3668.89	0	3668.89	6211.18	6211.18
17	4.83462	31319.5	36.1947	Basalt	2000	49	7617.23	7980.95	5199.15	0	5199.15	10773	10773
18	4.83462	32937.7	36.9892	Basalt	2000	49	7587.21	7949.5	5171.82	0	5171.82	10887	10887
19	4.83462	34191	37.7921	Basalt	2000	49	7498.59	7856.65	5091.11	0	5091.11	10906	10906
20	4.83462	35241.2	38.6038	Basalt	2000	49	7378.36	7730.68	4981.6	0	4981.6	10872.5	10872.5
21	4.25623	31944.5	39.3752	Andesite & Rhyolite	440	42	3569.89	3740.35	3665.42	0	3665.42	6595.17	6595.17
22	4.25623	32867.4	40.1055	Andesite & Rhyolite	440	42	3545.43	3714.72	3636.95	0	3636.95	6623.06	6623.06
23	4.25623	33751.1	40.8438	Andesite & Rhyolite	440	42	3515.67	3683.54	3602.31	0	3602.31	6641.65	6641.65
24	4.25623	34813.5	41.5904	Andesite & Rhyolite	440	42	3499.59	3666.7	3583.61	0	3583.61	6689.64	6689.64
25	4.25623	35908.7	42.3457	Andesite & Rhyolite	440	42	3484.06	3650.42	3565.54	0	3565.54	6740.87	6740.87
26	4.25623	36880.3	43.1102	Andesite & Rhyolite	440	42	3456.75	3621.81	3533.75	0	3533.75	6769.68	6769.68
27	4.25623	37549.1	43.8844	Andesite & Rhyolite	440	42	3405.17	3567.77	3473.74	0	3473.74	6748.83	6748.83
28	5.01251	44776.7	44.7395	Basalt	2000	49	6465.09	6773.8	4149.81	0	4149.81	10556.4	10556.4
29	5.01251	45102.3	45.6784	Basalt	2000	49	6251.17	6549.66	3954.96	0	3954.96	10355.9	10355.9
30	5.01251	45340.3	46.6332	Basalt	2000	49	6035.5	6323.7	3758.54	0	3758.54	10148.3	10148.3
31	4.68199	42937.2	47.5726	Andesite & Rhyolite	440	42	3074.99	3221.82	3089.53	0	3089.53	6453.84	6453.84
32	4.68199	43656.4	48.4965	Andesite & Rhyolite	440	42	3023.08	3167.43	3029.12	0	3029.12	6445.67	6445.67
33	4.68199	44101.6	49.4376	Andesite & Rhyolite	440	42	2957.87	3099.11	2953.24	0	2953.24	6408.84	6408.84
34	4.68199	44202.5	50.3971	Andesite &	440	42	2877.17	3014.55	2859.33	0	2859.33	6336.87	6336.87

				Rhyolite								
35	4.68199	44183.2	51.3765	Andesite & Rhyolite	440	42	2794.68	2928.13	2763.35	0	2763.35	6261.25	6261.25
36	5.17897	48420.8	52.4317	Basalt	2000	49	4924.52	5159.67	2746.66	0	2746.66	9148.61	9148.61
37	5.17897	46272.9	53.5674	Basalt	2000	49	4604.96	4824.85	2455.61	0	2455.61	8694.19	8694.19
38	4.11319	34674.5	54.6112	Andesite & Rhyolite	440	42	2338.81	2450.49	2232.87	0	2232.87	5525.27	5525.27
39	4.11319	32907.9	55.5596	Andesite & Rhyolite	440	42	2192.6	2297.3	2062.74	0	2062.74	5260.11	5260.11
40	4.11319	31025.9	56.5314	Andesite & Rhyolite	440	42	2046.96	2144.7	1893.26	0	1893.26	4989.56	4989.56
41	4.11319	29019.4	57.5289	Andesite & Rhyolite	440	42	1901.07	1991.85	1723.51	0	1723.51	4710.92	4710.92
42	4.29149	27765.3	58.5773	Basalt	2000	49	3285.44	3442.32	1253.79	0	1253.79	6631.42	6631.42
43	4.29149	24749.2	59.6812	Basalt	2000	49	3006.79	3150.36	999.995	0	999.995	6141.62	6141.62
44	3.97251	20168.9	60.7789	Andesite & Rhyolite	440	42	1385.32	1451.47	1123.35	0	1123.35	3599.94	3599.94
45	3.97251	17574.6	61.8716	Andesite & Rhyolite	440	42	1225.33	1283.84	937.18	0	937.18	3229.28	3229.28
46	3.97251	14800.6	63.0048	Andesite & Rhyolite	440	42	1058.39	1108.92	742.915	0	742.915	2820.54	2820.54
47	3.62662	10718.6	64.1305	Basalt	2000	49	2026.2	2122.95	106.88	0	106.88	4285.33	4285.33
48	3.62662	7649.13	65.2503	Basalt	2000	49	1777.23	1862.1	-119.878	0	-119.878	3735.29	3735.29
49	3.58231	4549.85	66.4124	Andesite & Rhyolite	440	42	490.183	513.589	81.7289	0	81.7289	1204.37	1204.37
50	3.58231	1555.2	67.6238	Andesite & Rhyolite	440	42	567.3	594.389	171.467	0	171.467	1549.46	1549.46

Query 1 (spencer) - Safety Factor: 1.04775

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.51672	1001.89	25.0711	Andesite & Rhyolite	440	42	1003.6	1051.52	679.163	0	679.163	1148.67	1148.67
2	4.51672	2986.96	25.7308	Andesite & Rhyolite	440	42	1328.11	1391.53	1056.78	0	1056.78	1696.84	1696.84
3	4.51672	4934.29	26.3942	Andesite & Rhyolite	440	42	1623.45	1700.97	1400.45	0	1400.45	2206.13	2206.13
4	4.51672	6843.24	27.0615	Andesite & Rhyolite	440	42	1891.21	1981.52	1712.03	0	1712.03	2678.21	2678.21
5	4.51672	8713.12	27.7327	Andesite & Rhyolite	440	42	2132.95	2234.8	1993.34	0	1993.34	3114.72	3114.72
6	4.51672	10543.2	28.4081	Andesite & Rhyolite	440	42	2350.13	2462.35	2246.04	0	2246.04	3517.18	3517.18
7	4.51672	12332.8	29.0878	Andesite & Rhyolite	440	42	2544.14	2665.62	2471.81	0	2471.81	3887.15	3887.15
8	4.51672	14106.1	29.7721	Andesite & Rhyolite	440	42	2719.87	2849.74	2676.29	0	2676.29	4232.21	4232.21
9	4.51672	16111.3	30.461	Andesite & Rhyolite	440	42	2912.03	3051.08	2899.9	0	2899.9	4612.55	4612.55
10	4.51672	18148.6	31.1549	Andesite & Rhyolite	440	42	3091.92	3239.56	3109.24	0	3109.24	4978.45	4978.45
11	4.51672	20052.8	31.8539	Andesite & Rhyolite	440	42	3239.04	3393.7	3280.41	0	3280.41	5292.92	5292.92
12	4.51672	21644.7	32.5582	Andesite & Rhyolite	440	42	3334.07	3493.27	3391	0	3391	5519.8	5519.8
13	4.51672	23172.5	33.2681	Andesite & Rhyolite	440	42	3411	3573.88	3480.53	0	3480.53	5718.43	5718.43
14	4.51672	24653.1	33.9838	Andesite & Rhyolite	440	42	3473.16	3639	3552.86	0	3552.86	5894.1	5894.1
15	4.51672	26085.3	34.7056	Andesite & Rhyolite	440	42	3521.5	3689.65	3609.09	0	3609.09	6048.01	6048.01
16	4.51672	27618	35.4338	Andesite & Rhyolite	440	42	3572.88	3743.49	3668.89	0	3668.89	6211.18	6211.18

17	4.83462	31319.5	36.1947	Basalt	2000	49	7617.23	7980.95	5199.15	0	5199.15	10773	10773
18	4.83462	32937.7	36.9892	Basalt	2000	49	7587.21	7949.5	5171.82	0	5171.82	10887	10887
19	4.83462	34191	37.7921	Basalt	2000	49	7498.59	7856.65	5091.11	0	5091.11	10906	10906
20	4.83462	35241.2	38.6038	Basalt	2000	49	7378.36	7730.68	4981.6	0	4981.6	10872.5	10872.5
21	4.25623	31944.5	39.3752	Andesite & Rhyolite	440	42	3569.89	3740.35	3665.42	0	3665.42	6595.17	6595.17
22	4.25623	32867.4	40.1055	Andesite & Rhyolite	440	42	3545.43	3714.72	3636.95	0	3636.95	6623.06	6623.06
23	4.25623	33751.1	40.8438	Andesite & Rhyolite	440	42	3515.67	3683.54	3602.31	0	3602.31	6641.65	6641.65
24	4.25623	34813.5	41.5904	Andesite & Rhyolite	440	42	3499.59	3666.7	3583.61	0	3583.61	6689.64	6689.64
25	4.25623	35908.7	42.3457	Andesite & Rhyolite	440	42	3484.06	3650.42	3565.54	0	3565.54	6740.87	6740.87
26	4.25623	36880.3	43.1102	Andesite & Rhyolite	440	42	3456.75	3621.81	3533.75	0	3533.75	6769.68	6769.68
27	4.25623	37549.1	43.8844	Andesite & Rhyolite	440	42	3405.17	3567.77	3473.74	0	3473.74	6748.83	6748.83
28	5.01251	44776.7	44.7395	Basalt	2000	49	6465.09	6773.8	4149.81	0	4149.81	10556.4	10556.4
29	5.01251	45102.3	45.6784	Basalt	2000	49	6251.17	6549.66	3954.96	0	3954.96	10355.9	10355.9
30	5.01251	45340.3	46.6332	Basalt	2000	49	6035.5	6323.7	3758.54	0	3758.54	10148.3	10148.3
31	4.68199	42937.2	47.5726	Andesite & Rhyolite	440	42	3074.99	3221.82	3089.53	0	3089.53	6453.84	6453.84
32	4.68199	43656.4	48.4965	Andesite & Rhyolite	440	42	3023.08	3167.43	3029.12	0	3029.12	6445.67	6445.67
33	4.68199	44101.6	49.4376	Andesite & Rhyolite	440	42	2957.87	3099.11	2953.24	0	2953.24	6408.84	6408.84
34	4.68199	44202.5	50.3971	Andesite & Rhyolite	440	42	2877.17	3014.55	2859.33	0	2859.33	6336.87	6336.87
35	4.68199	44183.2	51.3765	Andesite & Rhyolite	440	42	2794.68	2928.13	2763.35	0	2763.35	6261.25	6261.25
36	5.17897	48420.8	52.4317	Basalt	2000	49	4924.52	5159.67	2746.66	0	2746.66	9148.61	9148.61
37	5.17897	46272.9	53.5674	Basalt	2000	49	4604.96	4824.85	2455.61	0	2455.61	8694.19	8694.19
38	4.11319	34674.5	54.6112	Andesite & Rhyolite	440	42	2338.81	2450.49	2232.87	0	2232.87	5525.27	5525.27
39	4.11319	32907.9	55.5596	Andesite & Rhyolite	440	42	2192.6	2297.3	2062.74	0	2062.74	5260.11	5260.11
40	4.11319	31025.9	56.5314	Andesite & Rhyolite	440	42	2046.96	2144.7	1893.26	0	1893.26	4989.56	4989.56
41	4.11319	29019.4	57.5289	Andesite & Rhyolite	440	42	1901.07	1991.85	1723.51	0	1723.51	4710.92	4710.92
42	4.29149	27765.3	58.5773	Basalt	2000	49	3285.44	3442.32	1253.79	0	1253.79	6631.42	6631.42
43	4.29149	24749.2	59.6812	Basalt	2000	49	3006.79	3150.36	999.995	0	999.995	6141.62	6141.62
44	3.97251	20168.9	60.7789	Andesite & Rhyolite	440	42	1385.32	1451.47	1123.35	0	1123.35	3599.94	3599.94
45	3.97251	17574.6	61.8716	Andesite & Rhyolite	440	42	1225.33	1283.84	937.18	0	937.18	3229.28	3229.28
46	3.97251	14800.6	63.0048	Andesite & Rhyolite	440	42	1058.39	1108.92	742.915	0	742.915	2820.54	2820.54
47	3.62662	10718.6	64.1305	Basalt	2000	49	2026.2	2122.95	106.88	0	106.88	4285.33	4285.33
48	3.62662	7649.13	65.2503	Basalt	2000	49	1777.23	1862.1	-119.878	0	-119.878	3735.29	3735.29
49	3.58231	4549.85	66.4124	Andesite & Rhyolite	440	42	490.183	513.589	81.7289	0	81.7289	1204.37	1204.37
50	3.58231	1555.2	67.6238	Andesite & Rhyolite	440	42	567.3	594.389	171.467	0	171.467	1549.46	1549.46

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.04775

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	152.022	200.027	0	0	0

2	156.539	202.14	2934.44	4702.02	58.0325
3	161.055	204.317	6167.34	9882.28	58.0325
4	165.572	206.558	9599.38	15381.6	58.0325
5	170.089	208.866	13139.7	21054.4	58.0324
6	174.606	211.24	16705.2	26767.8	58.0326
7	179.122	213.683	20220.7	32400.8	58.0325
8	183.639	216.196	23617.6	37843.8	58.0325
9	188.156	218.78	26835.8	43000.5	58.0325
10	192.672	221.436	29830.4	47798.9	58.0325
11	197.189	224.167	32542.9	52145.3	58.0325
12	201.706	226.973	34916.2	55948.2	58.0325
13	206.223	229.857	36905.4	59135.6	58.0325
14	210.739	232.82	38477.3	61654.4	58.0325
15	215.256	235.865	39603.7	63459.2	58.0325
16	219.773	238.993	40260.3	64511.4	58.0325
17	224.289	242.207	40417.1	64762.6	58.0325
18	229.124	245.745	54045.4	86600	58.0325
19	233.959	249.387	66845.1	107110	58.0326
20	238.793	253.136	78777.1	126229	58.0325
21	243.628	256.996	89830.1	143940	58.0325
22	247.884	260.489	87385.1	140022	58.0325
23	252.14	264.073	84463.7	135341	58.0325
24	256.397	267.753	81066.1	129897	58.0325
25	260.653	271.531	77158.5	123635	58.0324
26	264.909	275.41	72727	116535	58.0326
27	269.165	279.394	67785.2	108616	58.0325
28	273.422	283.488	62383.7	99961	58.0325
29	278.434	288.455	67366.8	107946	58.0326
30	283.447	293.587	71545.1	114641	58.0326
31	288.459	298.894	74963.6	120118	58.0324
32	293.141	304.017	67052.1	107441	58.0324
33	297.823	309.308	58588.3	93879.4	58.0325
34	302.505	314.778	49627.8	79521.4	58.0325
35	307.187	320.437	40248.3	64492.1	58.0325
36	311.869	326.297	30473.9	48830.1	58.0325
37	317.048	333.03	30148.1	48308.1	58.0326
38	322.227	340.046	29757.8	47682.6	58.0325
39	326.34	345.836	21219.8	34001.7	58.0325
40	330.453	351.834	12903.6	20676.1	58.0324
41	334.567	358.056	4865.32	7795.97	58.0325
42	338.68	364.52	-2830.9	-4536.11	58.0325
43	342.971	371.544	-1744.28	-2794.96	58.0325
44	347.263	378.882	71.0074	113.779	58.0325
45	351.235	385.984	-5444.94	-8724.74	58.0325
46	355.208	393.415	-10191.8	-16330.9	58.0325
47	359.18	401.213	-14013	-22453.8	58.0325
48	362.807	408.692	-9093.21	-14570.6	58.0326
49	366.433	416.559	-2870.89	-4600.19	58.0325
50	370.016	424.763	-2473.02	-3962.66	58.0325
51	373.598	433.465	0	0	0

Query 1 (spencer) - Safety Factor: 1.04775

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	152.022	200.027	0	0	0
2	156.539	202.14	2934.44	4702.02	58.0325
3	161.055	204.317	6167.34	9882.28	58.0325
4	165.572	206.558	9599.38	15381.6	58.0325
5	170.089	208.866	13139.7	21054.4	58.0324
6	174.606	211.24	16705.2	26767.8	58.0326
7	179.122	213.683	20220.7	32400.8	58.0325

8	183.639	216.196	23617.6	37843.8	58.0325
9	188.156	218.78	26835.8	43000.5	58.0325
10	192.672	221.436	29830.4	47798.9	58.0325
11	197.189	224.167	32542.9	52145.3	58.0325
12	201.706	226.973	34916.2	55948.2	58.0325
13	206.223	229.857	36905.4	59135.6	58.0325
14	210.739	232.82	38477.3	61654.4	58.0325
15	215.256	235.865	39603.7	63459.2	58.0325
16	219.773	238.993	40260.3	64511.4	58.0325
17	224.289	242.207	40417.1	64762.6	58.0325
18	229.124	245.745	54045.4	86600	58.0325
19	233.959	249.387	66845.1	107110	58.0326
20	238.793	253.136	78777.1	126229	58.0325
21	243.628	256.996	89830.1	143940	58.0325
22	247.884	260.489	87385.1	140022	58.0325
23	252.14	264.073	84463.7	135341	58.0325
24	256.397	267.753	81066.1	129897	58.0325
25	260.653	271.531	77158.5	123635	58.0324
26	264.909	275.41	72727	116535	58.0326
27	269.165	279.394	67785.2	108616	58.0325
28	273.422	283.488	62383.7	99961	58.0325
29	278.434	288.455	67366.8	107946	58.0326
30	283.447	293.587	71545.1	114641	58.0326
31	288.459	298.894	74963.6	120118	58.0324
32	293.141	304.017	67052.1	107441	58.0324
33	297.823	309.308	58588.3	93879.4	58.0325
34	302.505	314.778	49627.8	79521.4	58.0325
35	307.187	320.437	40248.3	64492.1	58.0325
36	311.869	326.297	30473.9	48830.1	58.0325
37	317.048	333.03	30148.1	48308.1	58.0326
38	322.227	340.046	29757.8	47682.6	58.0325
39	326.34	345.836	21219.8	34001.7	58.0325
40	330.453	351.834	12903.6	20676.1	58.0324
41	334.567	358.056	4865.32	7795.97	58.0325
42	338.68	364.52	-2830.9	-4536.11	58.0325
43	342.971	371.544	-1744.28	-2794.96	58.0325
44	347.263	378.882	71.0074	113.779	58.0325
45	351.235	385.984	-5444.94	-8724.74	58.0325
46	355.208	393.415	-10191.8	-16330.9	58.0325
47	359.18	401.213	-14013	-22453.8	58.0325
48	362.807	408.692	-9093.21	-14570.6	58.0326
49	366.433	416.559	-2870.89	-4600.19	58.0325
50	370.016	424.763	-2473.02	-3962.66	58.0325
51	373.598	433.465	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882

900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
343.655	416.559
316.475	401.213
298.222	378.882
286.481	364.52
266.476	340.046
255.237	326.297
232.838	298.894
220.244	283.488
198.589	256.996
186.501	242.207
152	200
-119.082	200

Material Boundary

X	Y
186.501	242.207
900	242.207

Material Boundary

X	Y
198.589	256.996
900	256.996

Material Boundary

X	Y
220.244	283.488
900	283.488

Material Boundary

X	Y
232.838	298.894
900	298.894

Material Boundary

X	Y
255.237	326.297
900	326.297

Material Boundary

X	Y
266.476	340.046
900	340.046

Material Boundary

X	Y
286.481	364.52

900	364.52

Material Boundary

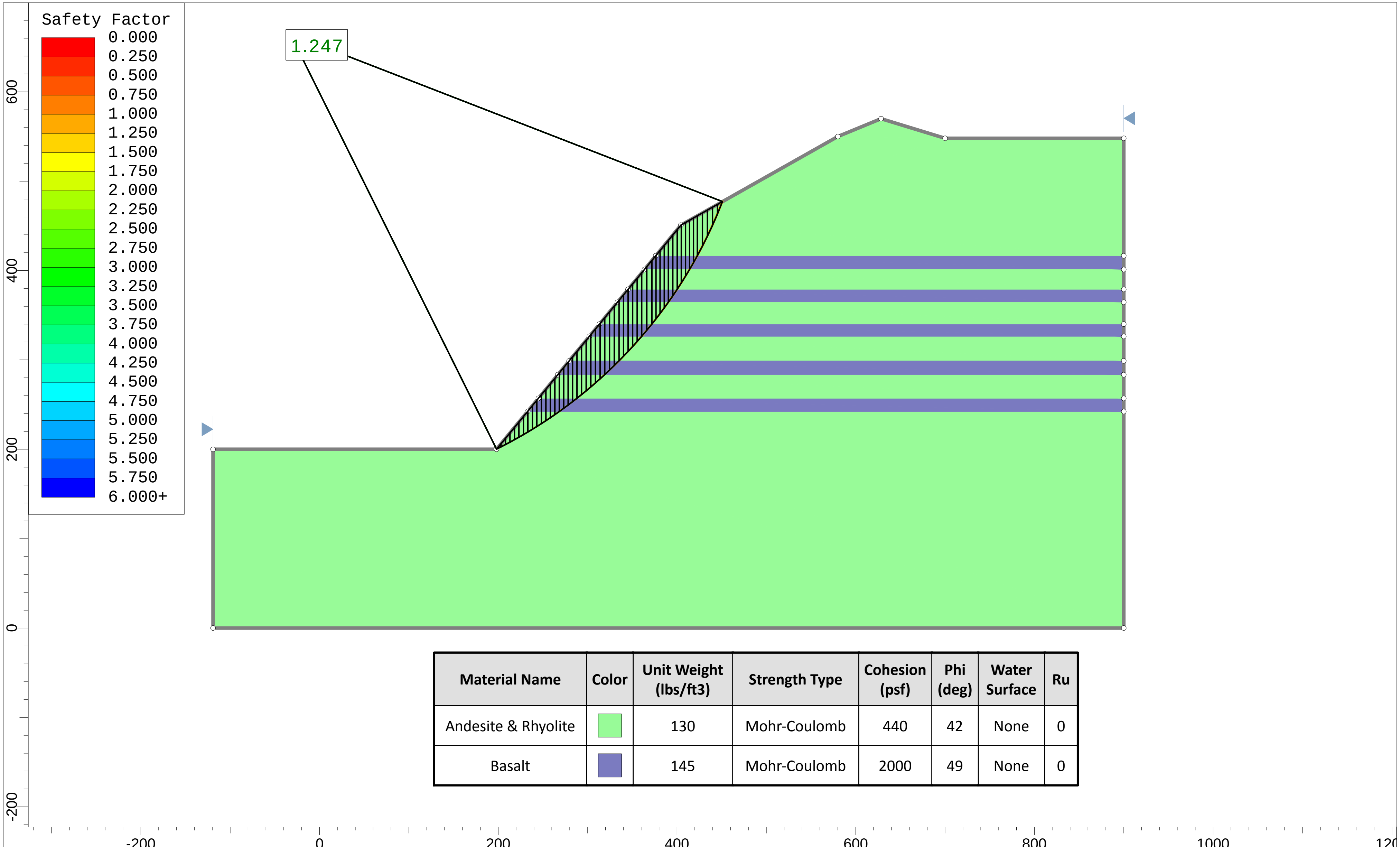
X	Y
298.222	378.882
900	378.882

Material Boundary

X	Y
316.475	401.213
900	401.213

Material Boundary

X	Y
343.655	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion		
Analysis Description	250' Slope, dry, static, 50 degree gross slope inclination		
Drawn By J.Bianchin	*Scale* 1:1782	*Company*	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM	*File Name*	250',dry,static,50deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:03.640s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.247020
Center:	-32.840, 664.766
Radius:	518.888
Left Slip Surface Endpoint:	198.075, 200.091
Right Slip Surface Endpoint:	450.934, 477.129
Resisting Moment:	7.46699e+08 lb-ft
Driving Moment:	5.98788e+08 lb-ft
Resisting Horizontal Force:	990284 lb
Driving Horizontal Force:	794122 lb
Total Slice Area:	11952.6 ft2
Surface Horizontal Width:	252.859 ft
Surface Average Height:	47.2699 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	10048
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.24702

Slice	Width	Weight	Angle	Base	Base	Base	Shear	Shear	Base	Pore	Effective	Base	Effective

Number	[ft]	[lbs]	of Slice Base [degrees]	Material	Cohesion [psf]	Friction Angle [degrees]	Stress [psf]	Strength [psf]	Normal Stress [psf]	Pressure [psf]	Normal Stress [psf]	Vertical Stress [psf]	Vertical Stress [psf]
1	5.01649	1164.19	26.7346	Andesite & Rhyolite	440	42	590.871	736.828	329.66	0	329.66	627.284	627.284
2	5.01649	3470.18	27.3566	Andesite & Rhyolite	440	42	864.239	1077.72	708.264	0	708.264	1155.41	1155.41
3	5.01649	5731.02	27.982	Andesite & Rhyolite	440	42	1121.67	1398.75	1064.8	0	1064.8	1660.75	1660.75
4	5.01649	7945.93	28.6111	Andesite & Rhyolite	440	42	1363.71	1700.57	1400	0	1400	2143.86	2143.86
5	5.01649	10114.1	29.244	Andesite & Rhyolite	440	42	1590.83	1983.8	1714.56	0	1714.56	2605.25	2605.25
6	5.01649	12234.6	29.8809	Andesite & Rhyolite	440	42	1803.53	2249.04	2009.14	0	2009.14	3045.41	3045.41
7	5.01649	14308.6	30.5218	Andesite & Rhyolite	440	42	2002.47	2497.12	2284.67	0	2284.67	3465.25	3465.25
8	5.01649	16601	31.167	Andesite & Rhyolite	440	42	2216.93	2764.55	2581.68	0	2581.68	3922.55	3922.55
9	5.01649	19031.8	31.8166	Andesite & Rhyolite	440	42	2437.23	3039.28	2886.8	0	2886.8	4398.93	4398.93
10	5.01649	21309	32.4709	Andesite & Rhyolite	440	42	2632.28	3282.5	3156.92	0	3156.92	4831.99	4831.99
11	5.01649	23202.2	33.1299	Andesite & Rhyolite	440	42	2779.59	3466.21	3360.94	0	3360.94	5175	5175
12	5.01649	25016.1	33.7939	Andesite & Rhyolite	440	42	2912.25	3631.63	3544.66	0	3544.66	5493.79	5493.79
13	5.01649	26774.9	34.4631	Andesite & Rhyolite	440	42	3033.21	3782.47	3712.19	0	3712.19	5793.98	5793.98
14	5.01649	28501.1	35.1377	Andesite & Rhyolite	440	42	3145.09	3921.99	3867.14	0	3867.14	6080.64	6080.64
15	4.93515	29856.3	35.8124	Basalt	2000	49	5589.57	6970.3	4320.63	0	4320.63	8353.78	8353.78
16	4.93515	31568.5	36.4873	Basalt	2000	49	5695.75	7102.72	4435.73	0	4435.73	8648.41	8648.41
17	4.93515	33088.3	37.1681	Basalt	2000	49	5771.09	7196.66	4517.39	0	4517.39	8892.82	8892.82
18	4.93515	34238.4	37.8551	Basalt	2000	49	5796.35	7228.16	4544.78	0	4544.78	9049.82	9049.82
19	5.17792	37230.2	38.5658	Andesite & Rhyolite	440	42	3531.05	4403.29	4401.69	0	4401.69	7217.04	7217.04
20	5.17792	38650.5	39.3009	Andesite & Rhyolite	440	42	3579.63	4463.87	4468.96	0	4468.96	7398.94	7398.94
21	5.17792	40021.1	40.0437	Andesite & Rhyolite	440	42	3619.95	4514.15	4524.8	0	4524.8	7567.01	7567.01
22	5.17792	41665.4	40.7948	Andesite & Rhyolite	440	42	3678.01	4586.55	4605.21	0	4605.21	7779.39	7779.39
23	5.17792	43337	41.5544	Andesite & Rhyolite	440	42	3733.23	4655.41	4681.69	0	4681.69	7990.89	7990.89
24	5.17792	44623.3	42.3231	Andesite & Rhyolite	440	42	3754.04	4681.36	4710.51	0	4710.51	8129.19	8129.19
25	5.32993	46796.1	43.1128	Basalt	2000	49	5919	7381.11	4677.73	0	4677.73	10219.1	10219.1
26	5.32993	47372.8	43.9245	Basalt	2000	49	5838.4	7280.6	4590.36	0	4590.36	10213.6	10213.6
27	5.32993	47864	44.7474	Basalt	2000	49	5749.16	7169.32	4493.62	0	4493.62	10192.3	10192.3
28	5.07091	46427.1	45.5616	Andesite & Rhyolite	440	42	3628.64	4524.99	4536.84	0	4536.84	8237.32	8237.32
29	5.07091	47501.2	46.3672	Andesite & Rhyolite	440	42	3622.68	4517.56	4528.59	0	4528.59	8328.42	8328.42
30	5.07091	48235.1	47.1849	Andesite & Rhyolite	440	42	3590.34	4477.22	4483.79	0	4483.79	8358.95	8358.95
31	5.07091	48636.8	48.0153	Andesite & Rhyolite	440	42	3533.7	4406.6	4405.36	0	4405.36	8332.05	8332.05
32	5.07091	48929.2	48.8594	Andesite & Rhyolite	440	42	3468.64	4325.46	4315.25	0	4315.25	8285.74	8285.74
33	5.71298	55101.4	49.7734	Basalt	2000	49	5263.94	6564.24	3967.63	0	3967.63	10190.8	10190.8
34	5.71298	55071.6	50.7604	Basalt	2000	49	5118	6382.25	3809.44	0	3809.44	10075.9	10075.9
35	4.61856	44629.5	51.6702	Andesite & Rhyolite	440	42	3200.1	3990.59	3943.34	0	3943.34	7991.04	7991.04
36	4.61856	44607	52.5002	Andesite &	440	42	3120.05	3890.77	3832.46	0	3832.46	7898.63	7898.63

				Rhyolite									
37	4.61856	44307.2	53.3462	Andesite & Rhyolite	440	42	3022.4	3768.99	3697.22	0	3697.22	7758.92	7758.92
38	4.61856	43891.2	54.2094	Andesite & Rhyolite	440	42	2918.01	3638.82	3552.65	0	3552.65	7599.98	7599.98
39	4.91603	45860.7	55.12	Basalt	2000	49	4418.33	5509.74	3050.97	0	3050.97	9389.22	9389.22
40	4.91603	44560.1	56.0811	Basalt	2000	49	4213.23	5253.98	2828.64	0	2828.64	9094.11	9094.11
41	4.64749	41000.5	57.0391	Andesite & Rhyolite	440	42	2494.13	3110.23	2965.59	0	2965.59	6811.96	6811.96
42	4.64749	38919.7	57.9948	Andesite & Rhyolite	440	42	2307.83	2877.91	2707.57	0	2707.57	6400.13	6400.13
43	4.64749	35924.3	58.9768	Andesite & Rhyolite	440	42	2082.36	2596.74	2395.3	0	2395.3	5857.76	5857.76
44	4.35017	30505.5	59.9544	Basalt	2000	49	3194.74	3983.91	1724.59	0	1724.59	7247.9	7247.9
45	4.35017	27054.6	60.9284	Basalt	2000	49	2897.2	3612.87	1402.05	0	1402.05	6613.37	6613.37
46	5.62013	29945.6	62.0855	Andesite & Rhyolite	440	42	1372.76	1711.86	1412.54	0	1412.54	4003.65	4003.65
47	5.62013	24281.3	63.4423	Andesite & Rhyolite	440	42	1113.71	1388.81	1053.76	0	1053.76	3281.89	3281.89
48	5.62013	18115.9	64.8669	Andesite & Rhyolite	440	42	862.066	1075.01	705.254	0	705.254	2542.81	2542.81
49	5.62013	11364.9	66.3717	Andesite & Rhyolite	440	42	621.11	774.536	371.54	0	371.54	1791.29	1791.29
50	5.62013	3915.56	67.9733	Andesite & Rhyolite	440	42	365.279	455.51	17.2257	0	17.2257	920.11	920.11

Query 1 (spencer) - Safety Factor: 1.24702

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.01649	1164.19	26.7346	Andesite & Rhyolite	440	42	590.871	736.828	329.66	0	329.66	627.284	627.284
2	5.01649	3470.18	27.3566	Andesite & Rhyolite	440	42	864.239	1077.72	708.264	0	708.264	1155.41	1155.41
3	5.01649	5731.02	27.982	Andesite & Rhyolite	440	42	1121.67	1398.75	1064.8	0	1064.8	1660.75	1660.75
4	5.01649	7945.93	28.6111	Andesite & Rhyolite	440	42	1363.71	1700.57	1400	0	1400	2143.86	2143.86
5	5.01649	10114.1	29.244	Andesite & Rhyolite	440	42	1590.83	1983.8	1714.56	0	1714.56	2605.25	2605.25
6	5.01649	12234.6	29.8809	Andesite & Rhyolite	440	42	1803.53	2249.04	2009.14	0	2009.14	3045.41	3045.41
7	5.01649	14308.6	30.5218	Andesite & Rhyolite	440	42	2002.47	2497.12	2284.67	0	2284.67	3465.25	3465.25
8	5.01649	16601	31.167	Andesite & Rhyolite	440	42	2216.93	2764.55	2581.68	0	2581.68	3922.55	3922.55
9	5.01649	19031.8	31.8166	Andesite & Rhyolite	440	42	2437.23	3039.28	2886.8	0	2886.8	4398.93	4398.93
10	5.01649	21309	32.4709	Andesite & Rhyolite	440	42	2632.28	3282.5	3156.92	0	3156.92	4831.99	4831.99
11	5.01649	23202.2	33.1299	Andesite & Rhyolite	440	42	2779.59	3466.21	3360.94	0	3360.94	5175	5175
12	5.01649	25016.1	33.7939	Andesite & Rhyolite	440	42	2912.25	3631.63	3544.66	0	3544.66	5493.79	5493.79
13	5.01649	26774.9	34.4631	Andesite & Rhyolite	440	42	3033.21	3782.47	3712.19	0	3712.19	5793.98	5793.98
14	5.01649	28501.1	35.1377	Andesite & Rhyolite	440	42	3145.09	3921.99	3867.14	0	3867.14	6080.64	6080.64
15	4.93515	29856.3	35.8124	Basalt	2000	49	5589.57	6970.3	4320.63	0	4320.63	8353.78	8353.78
16	4.93515	31568.5	36.4873	Basalt	2000	49	5695.75	7102.72	4435.73	0	4435.73	8648.41	8648.41
17	4.93515	33088.3	37.1681	Basalt	2000	49	5771.09	7196.66	4517.39	0	4517.39	8892.82	8892.82
18	4.93515	34238.4	37.8551	Basalt	2000	49	5796.35	7228.16	4544.78	0	4544.78	9049.82	9049.82
19	5.17792	37230.2	38.5658	Andesite & Rhyolite	440	42	3531.05	4403.29	4401.69	0	4401.69	7217.04	7217.04

20	5.17792	38650.5	39.3009	Andesite & Rhyolite	440	42	3579.63	4463.87	4468.96	0	4468.96	7398.94	7398.94
21	5.17792	40021.1	40.0437	Andesite & Rhyolite	440	42	3619.95	4514.15	4524.8	0	4524.8	7567.01	7567.01
22	5.17792	41665.4	40.7948	Andesite & Rhyolite	440	42	3678.01	4586.55	4605.21	0	4605.21	7779.39	7779.39
23	5.17792	43337	41.5544	Andesite & Rhyolite	440	42	3733.23	4655.41	4681.69	0	4681.69	7990.89	7990.89
24	5.17792	44623.3	42.3231	Andesite & Rhyolite	440	42	3754.04	4681.36	4710.51	0	4710.51	8129.19	8129.19
25	5.32993	46796.1	43.1128	Basalt	2000	49	5919	7381.11	4677.73	0	4677.73	10219.1	10219.1
26	5.32993	47372.8	43.9245	Basalt	2000	49	5838.4	7280.6	4590.36	0	4590.36	10213.6	10213.6
27	5.32993	47864	44.7474	Basalt	2000	49	5749.16	7169.32	4493.62	0	4493.62	10192.3	10192.3
28	5.07091	46427.1	45.5616	Andesite & Rhyolite	440	42	3628.64	4524.99	4536.84	0	4536.84	8237.32	8237.32
29	5.07091	47501.2	46.3672	Andesite & Rhyolite	440	42	3622.68	4517.56	4528.59	0	4528.59	8328.42	8328.42
30	5.07091	48235.1	47.1849	Andesite & Rhyolite	440	42	3590.34	4477.22	4483.79	0	4483.79	8358.95	8358.95
31	5.07091	48636.8	48.0153	Andesite & Rhyolite	440	42	3533.7	4406.6	4405.36	0	4405.36	8332.05	8332.05
32	5.07091	48929.2	48.8594	Andesite & Rhyolite	440	42	3468.64	4325.46	4315.25	0	4315.25	8285.74	8285.74
33	5.71298	55101.4	49.7734	Basalt	2000	49	5263.94	6564.24	3967.63	0	3967.63	10190.8	10190.8
34	5.71298	55071.6	50.7604	Basalt	2000	49	5118	6382.25	3809.44	0	3809.44	10075.9	10075.9
35	4.61856	44629.5	51.6702	Andesite & Rhyolite	440	42	3200.1	3990.59	3943.34	0	3943.34	7991.04	7991.04
36	4.61856	44607	52.5002	Andesite & Rhyolite	440	42	3120.05	3890.77	3832.46	0	3832.46	7898.63	7898.63
37	4.61856	44307.2	53.3462	Andesite & Rhyolite	440	42	3022.4	3768.99	3697.22	0	3697.22	7758.92	7758.92
38	4.61856	43891.2	54.2094	Andesite & Rhyolite	440	42	2918.01	3638.82	3552.65	0	3552.65	7599.98	7599.98
39	4.91603	45860.7	55.12	Basalt	2000	49	4418.33	5509.74	3050.97	0	3050.97	9389.22	9389.22
40	4.91603	44560.1	56.0811	Basalt	2000	49	4213.23	5253.98	2828.64	0	2828.64	9094.11	9094.11
41	4.64749	41000.5	57.0391	Andesite & Rhyolite	440	42	2494.13	3110.23	2965.59	0	2965.59	6811.96	6811.96
42	4.64749	38919.7	57.9948	Andesite & Rhyolite	440	42	2307.83	2877.91	2707.57	0	2707.57	6400.13	6400.13
43	4.64749	35924.3	58.9768	Andesite & Rhyolite	440	42	2082.36	2596.74	2395.3	0	2395.3	5857.76	5857.76
44	4.35017	30505.5	59.9544	Basalt	2000	49	3194.74	3983.91	1724.59	0	1724.59	7247.9	7247.9
45	4.35017	27054.6	60.9284	Basalt	2000	49	2897.2	3612.87	1402.05	0	1402.05	6613.37	6613.37
46	5.62013	29945.6	62.0855	Andesite & Rhyolite	440	42	1372.76	1711.86	1412.54	0	1412.54	4003.65	4003.65
47	5.62013	24281.3	63.4423	Andesite & Rhyolite	440	42	1113.71	1388.81	1053.76	0	1053.76	3281.89	3281.89
48	5.62013	18115.9	64.8669	Andesite & Rhyolite	440	42	862.066	1075.01	705.254	0	705.254	2542.81	2542.81
49	5.62013	11364.9	66.3717	Andesite & Rhyolite	440	42	621.11	774.536	371.54	0	371.54	1791.29	1791.29
50	5.62013	3915.56	67.9733	Andesite & Rhyolite	440	42	365.279	455.51	17.2257	0	17.2257	920.11	920.11

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.24702

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	198.075	200.091	0	0	0
2	203.091	202.618	2139.62	1990.74	42.9357
3	208.108	205.213	4649.26	4325.74	42.9356

4	213.124	207.878	7454.29	6935.59	42.9356
5	218.141	210.615	10484.1	9754.55	42.9355
6	223.157	213.424	13671.8	12720.4	42.9355
7	228.174	216.306	16954.1	15774.3	42.9355
8	233.19	219.263	20271.4	18860.8	42.9356
9	238.207	222.298	23591.4	21949.8	42.9356
10	243.223	225.41	26868.1	24998.5	42.9356
11	248.24	228.602	30033.1	27943.3	42.9356
12	253.256	231.876	33013.5	30716.2	42.9355
13	258.273	235.234	35763.6	33275	42.9356
14	263.289	238.677	38242.4	35581.3	42.9356
15	268.306	242.207	40411.9	37599.8	42.9355
16	273.241	245.768	52691	49024.5	42.9356
17	278.176	249.418	64690.3	60188.8	42.9356
18	283.111	253.16	76350.9	71038	42.9356
19	288.046	256.996	87606.6	81510.5	42.9356
20	293.224	261.124	87770.6	81663.1	42.9356
21	298.402	265.362	87418.6	81335.5	42.9355
22	303.58	269.714	86526.5	80505.5	42.9356
23	308.758	274.182	85046.7	79128.7	42.9356
24	313.936	278.772	82944.5	77172.8	42.9356
25	319.114	283.488	80226.8	74644.2	42.9356
26	324.444	288.478	88523.9	82364	42.9356
27	329.774	293.611	96167.1	89475.3	42.9356
28	335.104	298.894	103157	95979.2	42.9357
29	340.175	304.065	98149.4	91319.7	42.9356
30	345.245	309.384	92485.5	86049.9	42.9356
31	350.316	314.858	86203.5	80205	42.9356
32	355.387	320.492	79350.6	73829	42.9356
33	360.458	326.297	71942.1	66936	42.9356
34	366.171	333.051	75303.9	70063.8	42.9355
35	371.884	340.046	77980.2	72554	42.9356
36	376.503	345.888	69766.2	64911.5	42.9356
37	381.121	351.907	61149.9	56894.8	42.9356
38	385.74	358.114	52201.5	48569.1	42.9356
39	390.358	364.52	42959	39969.7	42.9356
40	395.274	371.572	43226	40218.1	42.9356
41	400.19	378.882	43318.8	40304.4	42.9355
42	404.838	386.05	33688.5	31344.3	42.9356
43	409.485	393.486	24311.3	22619.6	42.9356
44	414.133	401.213	15506.8	14427.8	42.9357
45	418.483	408.734	16474	15327.7	42.9357
46	422.833	416.559	18142.8	16880.3	42.9355
47	428.453	427.167	10895.7	10137.5	42.9355
48	434.074	438.411	5324.5	4954	42.9356
49	439.694	450.391	1734.64	1613.93	42.9355
50	445.314	463.237	462.34	430.168	42.9356
51	450.934	477.129	0	0	0

Query 1 (spencer) - Safety Factor: 1.24702

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	198.075	200.091	0	0	0
2	203.091	202.618	2139.62	1990.74	42.9357
3	208.108	205.213	4649.26	4325.74	42.9356
4	213.124	207.878	7454.29	6935.59	42.9356
5	218.141	210.615	10484.1	9754.55	42.9355
6	223.157	213.424	13671.8	12720.4	42.9355
7	228.174	216.306	16954.1	15774.3	42.9355
8	233.19	219.263	20271.4	18860.8	42.9356
9	238.207	222.298	23591.4	21949.8	42.9356

10	243.223	225.41	26868.1	24998.5	42.9356
11	248.24	228.602	30033.1	27943.3	42.9356
12	253.256	231.876	33013.5	30716.2	42.9355
13	258.273	235.234	35763.6	33275	42.9356
14	263.289	238.677	38242.4	35581.3	42.9356
15	268.306	242.207	40411.9	37599.8	42.9355
16	273.241	245.768	52691	49024.5	42.9356
17	278.176	249.418	64690.3	60188.8	42.9356
18	283.111	253.16	76350.9	71038	42.9356
19	288.046	256.996	87606.6	81510.5	42.9356
20	293.224	261.124	87770.6	81663.1	42.9356
21	298.402	265.362	87418.6	81335.5	42.9355
22	303.58	269.714	86526.5	80505.5	42.9356
23	308.758	274.182	85046.7	79128.7	42.9356
24	313.936	278.772	82944.5	77172.8	42.9356
25	319.114	283.488	80226.8	74644.2	42.9356
26	324.444	288.478	88523.9	82364	42.9356
27	329.774	293.611	96167.1	89475.3	42.9356
28	335.104	298.894	103157	95979.2	42.9357
29	340.175	304.065	98149.4	91319.7	42.9356
30	345.245	309.384	92485.5	86049.9	42.9356
31	350.316	314.858	86203.5	80205	42.9356
32	355.387	320.492	79350.6	73829	42.9356
33	360.458	326.297	71942.1	66936	42.9356
34	366.171	333.051	75303.9	70063.8	42.9355
35	371.884	340.046	77980.2	72554	42.9356
36	376.503	345.888	69766.2	64911.5	42.9356
37	381.121	351.907	61149.9	56894.8	42.9356
38	385.74	358.114	52201.5	48569.1	42.9356
39	390.358	364.52	42959	39969.7	42.9356
40	395.274	371.572	43226	40218.1	42.9356
41	400.19	378.882	43318.8	40304.4	42.9355
42	404.838	386.05	33688.5	31344.3	42.9356
43	409.485	393.486	24311.3	22619.6	42.9356
44	414.133	401.213	15506.8	14427.8	42.9357
45	418.483	408.734	16474	15327.7	42.9357
46	422.833	416.559	18142.8	16880.3	42.9355
47	428.453	427.167	10895.7	10137.5	42.9355
48	434.074	438.411	5324.5	4954	42.9356
49	439.694	450.391	1734.64	1613.93	42.9355
50	445.314	463.237	462.34	430.168	42.9356
51	450.934	477.129	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882
900	401.213
900	416.559

900	548
700	548
628.434	569.928
580	550
404.388	450.849
376.176	416.559
363.55	401.213
345.177	378.882
333.36	364.52
313.224	340.046
301.912	326.297
279.366	298.894
266.69	283.488
244.894	256.996
232.726	242.207
198	200
-119.082	200

Material Boundary

X	Y
232.726	242.207
900	242.207

Material Boundary

X	Y
244.894	256.996
900	256.996

Material Boundary

X	Y
266.69	283.488
900	283.488

Material Boundary

X	Y
279.366	298.894
900	298.894

Material Boundary

X	Y
301.912	326.297
900	326.297

Material Boundary

X	Y
313.224	340.046
900	340.046

Material Boundary

X	Y
333.36	364.52
900	364.52

Material Boundary

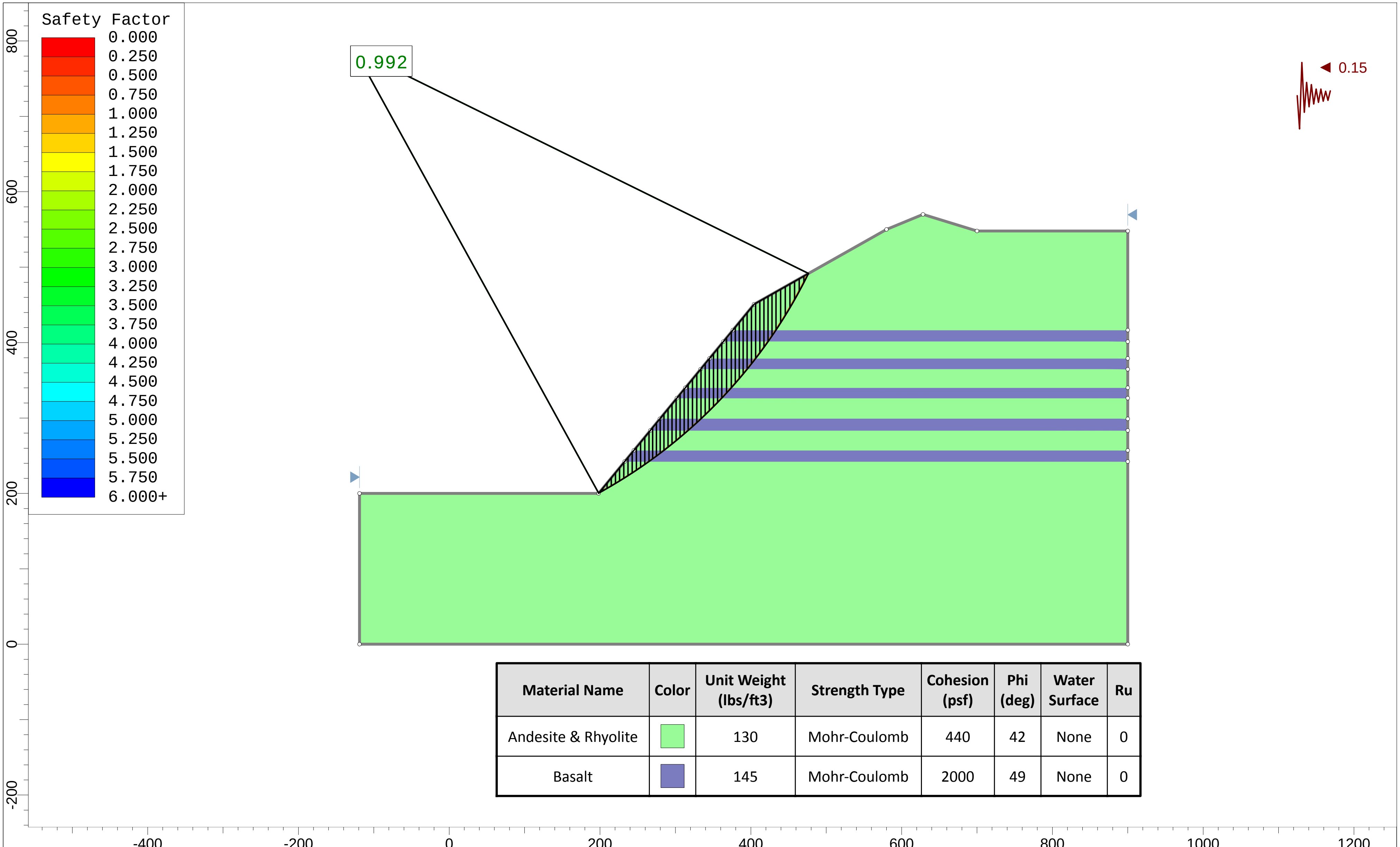
X	Y
345.177	378.882
900	378.882

Material Boundary

X	Y
363.55	401.213
900	401.213

Material Boundary

X	Y
376.176	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion
Analysis Description	250' Slope, dry, pseudostatic, 50 degree gross slope inclination
Drawn By	J.Bianchin
Scale	1:2113
Company	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM
File Name	250',dry,PS,50deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:04.779s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.15

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	0.992364
Center:	-125.329, 787.995
Radius:	670.922
Left Slip Surface Endpoint:	198.183, 200.223
Right Slip Surface Endpoint:	476.577, 491.607
Resisting Moment:	9.53963e+08 lb-ft
Driving Moment:	9.61304e+08 lb-ft
Resisting Horizontal Force:	1.00795e+06 lb
Driving Horizontal Force:	1.01571e+06 lb
Total Slice Area:	13200.6 ft2
Surface Horizontal Width:	278.394 ft
Surface Average Height:	47.417 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 10392
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 0.992364

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.55693	1322.38	29.1001	Andesite & Rhyolite	440	42	940.106	932.927	547.45	0	547.45	1070.71	1070.71
2	5.55693	3942.02	29.6446	Andesite & Rhyolite	440	42	1253.95	1244.38	893.353	0	893.353	1606.99	1606.99
3	5.55693	6511	30.1922	Andesite & Rhyolite	440	42	1544.44	1532.65	1213.51	0	1213.51	2112.12	2112.12
4	5.55693	9028.49	30.7428	Andesite & Rhyolite	440	42	1812.6	1798.76	1509.05	0	1509.05	2587.13	2587.13
5	5.55693	11493.6	31.2965	Andesite & Rhyolite	440	42	2059.39	2043.66	1781.04	0	1781.04	3033	3033
6	5.55693	13905.4	31.8536	Andesite & Rhyolite	440	42	2285.75	2268.3	2030.53	0	2030.53	3450.72	3450.72
7	5.55693	16435.9	32.414	Andesite & Rhyolite	440	42	2511.54	2492.36	2279.38	0	2279.38	3874.11	3874.11
8	5.55693	19288	32.9779	Andesite & Rhyolite	440	42	2757.79	2736.73	2550.78	0	2550.78	4340.19	4340.19
9	5.55693	21997.5	33.5454	Andesite & Rhyolite	440	42	2974.18	2951.47	2789.28	0	2789.28	4761.24	4761.24
10	5.55693	24232.4	34.1167	Andesite & Rhyolite	440	42	3129.01	3105.12	2959.91	0	2959.91	5079.74	5079.74
11	5.55693	26362.3	34.6919	Andesite & Rhyolite	440	42	3262.95	3238.03	3107.52	0	3107.52	5366.21	5366.21
12	5.55693	28432.3	35.2711	Andesite & Rhyolite	440	42	3381.54	3355.72	3238.24	0	3238.24	5629.95	5629.95
13	4.97447	27115.6	35.8237	Basalt	2000	49	7375.86	7319.54	4624.2	0	4624.2	9948.48	9948.48
14	4.97447	28831	36.3494	Basalt	2000	49	7474.93	7417.85	4709.67	0	4709.67	10210.5	10210.5
15	4.97447	30524.2	36.8787	Basalt	2000	49	7559.98	7502.25	4783.03	0	4783.03	10454.8	10454.8
16	4.97447	31904.7	37.4116	Basalt	2000	49	7591.06	7533.09	4809.84	0	4809.84	10616.1	10616.1
17	5.364	35844.9	37.9696	Andesite & Rhyolite	440	42	3752.28	3723.63	3646.84	0	3646.84	6575.24	6575.24
18	5.364	37441.1	38.553	Andesite & Rhyolite	440	42	3796.77	3767.78	3695.88	0	3695.88	6721.7	6721.7
19	5.364	38974.7	39.1412	Andesite & Rhyolite	440	42	3831.03	3801.78	3733.64	0	3733.64	6851.61	6851.61
20	5.364	40613.4	39.7343	Andesite & Rhyolite	440	42	3869.2	3839.65	3775.7	0	3775.7	6991.88	6991.88
21	5.364	42531.6	40.3326	Andesite & Rhyolite	440	42	3924.44	3894.47	3836.57	0	3836.57	7168.58	7168.58
22	5.364	44265.9	40.9363	Andesite & Rhyolite	440	42	3959.98	3929.74	3875.75	0	3875.75	7310.38	7310.38
23	5.66	47893	41.5624	Basalt	2000	49	7578.69	7520.82	4799.17	0	4799.17	11519	11519
24	5.66	48788.6	42.2117	Basalt	2000	49	7465.92	7408.91	4701.9	0	4701.9	11474.4	11474.4
25	5.66	49590.6	42.8678	Basalt	2000	49	7343.23	7287.16	4596.06	0	4596.06	11412.1	11412.1
26	5.50805	49479.1	43.5219	Andesite & Rhyolite	440	42	3834.44	3805.16	3737.39	0	3737.39	7378.93	7378.93
27	5.50805	51037.1	44.1742	Andesite & Rhyolite	440	42	3837.52	3808.22	3740.78	0	3740.78	7469.25	7469.25
28	5.50805	52253.6	44.8337	Andesite & Rhyolite	440	42	3816.38	3787.24	3717.48	0	3717.48	7511.78	7511.78
29	5.50805	53080.4	45.5009	Andesite & Rhyolite	440	42	3770.03	3741.24	3666.39	0	3666.39	7502.93	7502.93
30	5.50805	53812.6	46.1761	Andesite & Rhyolite	440	42	3718.06	3689.67	3609.13	0	3609.13	7483.06	7483.06
31	6.34038	62563.5	46.9121	Basalt	2000	49	6721.31	6669.99	4059.56	0	4059.56	11245.2	11245.2
32	6.34038	63288.7	47.7108	Basalt	2000	49	6558.56	6508.48	3919.16	0	3919.16	11129.6	11129.6
33	5.22788	52773.2	48.4497	Andesite & Rhyolite	440	42	3518.02	3491.16	3388.66	0	3388.66	7358.03	7358.03
34	5.22788	53071.8	49.1274	Andesite & Rhyolite	440	42	3451.64	3425.28	3315.49	0	3315.49	7304.01	7304.01
35	5.22788	53234.1	49.8144	Andesite &	440	42	3379.52	3353.71	3236.01	0	3236.01	7237.17	7237.17

				Rhyolite									
36	5.22788	53293.3	50.5114	Andesite & Rhyolite	440	42	3303.99	3278.76	3152.77	0	3152.77	7162.45	7162.45
37	5.68283	57568.7	51.2501	Basalt	2000	49	5766.79	5722.75	3236.14	0	3236.14	10421.4	10421.4
38	5.68283	56578.1	52.0322	Basalt	2000	49	5539.14	5496.84	3039.75	0	3039.75	10137.8	10137.8
39	5.48567	51931.6	52.8142	Andesite & Rhyolite	440	42	2881.67	2859.67	2687.32	0	2687.32	6485.74	6485.74
40	5.48567	48909.3	53.5964	Andesite & Rhyolite	440	42	2676.09	2655.66	2460.74	0	2460.74	6090.03	6090.03
41	5.48567	45733.8	54.3934	Andesite & Rhyolite	440	42	2472.58	2453.7	2236.44	0	2236.44	5689.27	5689.27
42	5.25568	40391.1	55.1889	Basalt	2000	49	4264.35	4231.79	1940.06	0	1940.06	8073.12	8073.12
43	5.25568	36571.2	55.9831	Basalt	2000	49	3941.73	3911.63	1661.75	0	1661.75	7501.9	7501.9
44	6.16894	38240.2	56.8662	Andesite & Rhyolite	440	42	1821.03	1807.12	1518.34	0	1518.34	4308.18	4308.18
45	6.16894	33309.1	57.843	Andesite & Rhyolite	440	42	1597.11	1584.91	1271.55	0	1271.55	3811.94	3811.94
46	6.16894	28075.7	58.8471	Andesite & Rhyolite	440	42	1372	1361.52	1023.45	0	1023.45	3293.1	3293.1
47	6.16894	22512.9	59.8812	Andesite & Rhyolite	440	42	1144.44	1135.7	772.651	0	772.651	2745.42	2745.42
48	6.16894	16589	60.9486	Andesite & Rhyolite	440	42	912.947	905.976	517.519	0	517.519	2161.04	2161.04
49	6.16894	10266.5	62.0532	Andesite & Rhyolite	440	42	675.775	670.615	256.124	0	256.124	1529.92	1529.92
50	6.16894	3500.22	63.1994	Andesite & Rhyolite	440	42	422.891	419.662	-22.5879	0	-22.5879	814.574	814.574

Query 1 (spencer) - Safety Factor: 0.992364

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.55693	1322.38	29.1001	Andesite & Rhyolite	440	42	940.106	932.927	547.45	0	547.45	1070.71	1070.71
2	5.55693	3942.02	29.6446	Andesite & Rhyolite	440	42	1253.95	1244.38	893.353	0	893.353	1606.99	1606.99
3	5.55693	6511	30.1922	Andesite & Rhyolite	440	42	1544.44	1532.65	1213.51	0	1213.51	2112.12	2112.12
4	5.55693	9028.49	30.7428	Andesite & Rhyolite	440	42	1812.6	1798.76	1509.05	0	1509.05	2587.13	2587.13
5	5.55693	11493.6	31.2965	Andesite & Rhyolite	440	42	2059.39	2043.66	1781.04	0	1781.04	3033	3033
6	5.55693	13905.4	31.8536	Andesite & Rhyolite	440	42	2285.75	2268.3	2030.53	0	2030.53	3450.72	3450.72
7	5.55693	16435.9	32.414	Andesite & Rhyolite	440	42	2511.54	2492.36	2279.38	0	2279.38	3874.11	3874.11
8	5.55693	19288	32.9779	Andesite & Rhyolite	440	42	2757.79	2736.73	2550.78	0	2550.78	4340.19	4340.19
9	5.55693	21997.5	33.5454	Andesite & Rhyolite	440	42	2974.18	2951.47	2789.28	0	2789.28	4761.24	4761.24
10	5.55693	24232.4	34.1167	Andesite & Rhyolite	440	42	3129.01	3105.12	2959.91	0	2959.91	5079.74	5079.74
11	5.55693	26362.3	34.6919	Andesite & Rhyolite	440	42	3262.95	3238.03	3107.52	0	3107.52	5366.21	5366.21
12	5.55693	28432.3	35.2711	Andesite & Rhyolite	440	42	3381.54	3355.72	3238.24	0	3238.24	5629.95	5629.95
13	4.97447	27115.6	35.8237	Basalt	2000	49	7375.86	7319.54	4624.2	0	4624.2	9948.48	9948.48
14	4.97447	28831	36.3494	Basalt	2000	49	7474.93	7417.85	4709.67	0	4709.67	10210.5	10210.5
15	4.97447	30524.2	36.8787	Basalt	2000	49	7559.98	7502.25	4783.03	0	4783.03	10454.8	10454.8
16	4.97447	31904.7	37.4116	Basalt	2000	49	7591.06	7533.09	4809.84	0	4809.84	10616.1	10616.1
17	5.364	35844.9	37.9696	Andesite & Rhyolite	440	42	3752.28	3723.63	3646.84	0	3646.84	6575.24	6575.24
18	5.364	37441.1	38.553	Andesite & Rhyolite	440	42	3796.77	3767.78	3695.88	0	3695.88	6721.7	6721.7

19	5.364	38974.7	39.1412	Andesite & Rhyolite	440	42	3831.03	3801.78	3733.64	0	3733.64	6851.61	6851.61
20	5.364	40613.4	39.7343	Andesite & Rhyolite	440	42	3869.2	3839.65	3775.7	0	3775.7	6991.88	6991.88
21	5.364	42531.6	40.3326	Andesite & Rhyolite	440	42	3924.44	3894.47	3836.57	0	3836.57	7168.58	7168.58
22	5.364	44265.9	40.9363	Andesite & Rhyolite	440	42	3959.98	3929.74	3875.75	0	3875.75	7310.38	7310.38
23	5.66	47893	41.5624	Basalt	2000	49	7578.69	7520.82	4799.17	0	4799.17	11519	11519
24	5.66	48788.6	42.2117	Basalt	2000	49	7465.92	7408.91	4701.9	0	4701.9	11474.4	11474.4
25	5.66	49590.6	42.8678	Basalt	2000	49	7343.23	7287.16	4596.06	0	4596.06	11412.1	11412.1
26	5.50805	49479.1	43.5219	Andesite & Rhyolite	440	42	3834.44	3805.16	3737.39	0	3737.39	7378.93	7378.93
27	5.50805	51037.1	44.1742	Andesite & Rhyolite	440	42	3837.52	3808.22	3740.78	0	3740.78	7469.25	7469.25
28	5.50805	52253.6	44.8337	Andesite & Rhyolite	440	42	3816.38	3787.24	3717.48	0	3717.48	7511.78	7511.78
29	5.50805	53080.4	45.5009	Andesite & Rhyolite	440	42	3770.03	3741.24	3666.39	0	3666.39	7502.93	7502.93
30	5.50805	53812.6	46.1761	Andesite & Rhyolite	440	42	3718.06	3689.67	3609.13	0	3609.13	7483.06	7483.06
31	6.34038	62563.5	46.9121	Basalt	2000	49	6721.31	6669.99	4059.56	0	4059.56	11245.2	11245.2
32	6.34038	63288.7	47.7108	Basalt	2000	49	6558.56	6508.48	3919.16	0	3919.16	11129.6	11129.6
33	5.22788	52773.2	48.4497	Andesite & Rhyolite	440	42	3518.02	3491.16	3388.66	0	3388.66	7358.03	7358.03
34	5.22788	53071.8	49.1274	Andesite & Rhyolite	440	42	3451.64	3425.28	3315.49	0	3315.49	7304.01	7304.01
35	5.22788	53234.1	49.8144	Andesite & Rhyolite	440	42	3379.52	3353.71	3236.01	0	3236.01	7237.17	7237.17
36	5.22788	53293.3	50.5114	Andesite & Rhyolite	440	42	3303.99	3278.76	3152.77	0	3152.77	7162.45	7162.45
37	5.68283	57568.7	51.2501	Basalt	2000	49	5766.79	5722.75	3236.14	0	3236.14	10421.4	10421.4
38	5.68283	56578.1	52.0322	Basalt	2000	49	5539.14	5496.84	3039.75	0	3039.75	10137.8	10137.8
39	5.48567	51931.6	52.8142	Andesite & Rhyolite	440	42	2881.67	2859.67	2687.32	0	2687.32	6485.74	6485.74
40	5.48567	48909.3	53.5964	Andesite & Rhyolite	440	42	2676.09	2655.66	2460.74	0	2460.74	6090.03	6090.03
41	5.48567	45733.8	54.3934	Andesite & Rhyolite	440	42	2472.58	2453.7	2236.44	0	2236.44	5689.27	5689.27
42	5.25568	40391.1	55.1889	Basalt	2000	49	4264.35	4231.79	1940.06	0	1940.06	8073.12	8073.12
43	5.25568	36571.2	55.9831	Basalt	2000	49	3941.73	3911.63	1661.75	0	1661.75	7501.9	7501.9
44	6.16894	38240.2	56.8662	Andesite & Rhyolite	440	42	1821.03	1807.12	1518.34	0	1518.34	4308.18	4308.18
45	6.16894	33309.1	57.843	Andesite & Rhyolite	440	42	1597.11	1584.91	1271.55	0	1271.55	3811.94	3811.94
46	6.16894	28075.7	58.8471	Andesite & Rhyolite	440	42	1372	1361.52	1023.45	0	1023.45	3293.1	3293.1
47	6.16894	22512.9	59.8812	Andesite & Rhyolite	440	42	1144.44	1135.7	772.651	0	772.651	2745.42	2745.42
48	6.16894	16589	60.9486	Andesite & Rhyolite	440	42	912.947	905.976	517.519	0	517.519	2161.04	2161.04
49	6.16894	10266.5	62.0532	Andesite & Rhyolite	440	42	675.775	670.615	256.124	0	256.124	1529.92	1529.92
50	6.16894	3500.22	63.1994	Andesite & Rhyolite	440	42	422.891	419.662	-22.5879	0	-22.5879	814.574	814.574

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 0.992364

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	198.183	200.223	0	0	0

2	203.74	203.315	3333.94	4993.49	56.2707
3	209.297	206.478	6887.45	10315.8	56.2705
4	214.854	209.711	10572	15834.5	56.2707
5	220.411	213.016	14305.4	21426.3	56.2707
6	225.968	216.394	18011.7	26977.4	56.2706
7	231.525	219.847	21620.4	32382.6	56.2708
8	237.082	223.376	25072.7	37553.3	56.2707
9	242.638	226.981	28311.3	42404	56.2707
10	248.195	230.666	31266.8	46830.6	56.2706
11	253.752	234.43	33881.2	50746.5	56.2707
12	259.309	238.277	36110.3	54085.1	56.2707
13	264.866	242.207	37914.3	56787.1	56.2707
14	269.841	245.798	53943.3	80794.9	56.2707
15	274.815	249.459	69571.9	104203	56.2707
16	279.79	253.191	84760	126951	56.2706
17	284.764	256.996	99445.3	148947	56.2707
18	290.128	261.182	98934.8	148182	56.2707
19	295.492	265.457	97890.9	146619	56.2707
20	300.856	269.822	96300.5	144236	56.2706
21	306.22	274.281	94133.8	140991	56.2706
22	311.584	278.835	91337.8	136803	56.2706
23	316.948	283.488	87913.6	131675	56.2707
24	322.608	288.506	99551.9	149106	56.2706
25	328.268	293.64	110361	165297	56.2708
26	333.928	298.894	120351	180259	56.2707
27	339.436	304.125	114505	171503	56.2707
28	344.944	309.477	107974	161720	56.2705
29	350.452	314.953	100805	150983	56.2706
30	355.96	320.558	93062.8	139387	56.2706
31	361.468	326.297	84763.2	126956	56.2706
32	367.809	333.075	90489	135532	56.2706
33	374.149	340.046	95271.9	142696	56.2707
34	379.377	345.945	85764.5	128456	56.2707
35	384.605	351.986	75824.3	113568	56.2707
36	389.833	358.175	65482.5	98078	56.2707
37	395.061	364.52	54763.4	82023.2	56.2706
38	400.743	371.6	55994.7	83867.4	56.2706
39	406.426	378.882	56858.7	85161.5	56.2707
40	411.912	386.113	45449.7	68073.4	56.2707
41	417.398	393.553	34490.5	51659.1	56.2707
42	422.883	401.213	24065.8	36045.1	56.2706
43	428.139	408.772	25760.8	38583.9	56.2707
44	433.395	416.559	28057.3	42023.6	56.2707
45	439.564	426.01	19208.5	28770	56.2707
46	445.732	435.822	11590.2	17359.6	56.2708
47	451.901	446.027	5400.58	8088.85	56.2707
48	458.07	456.661	869.215	1301.89	56.2707
49	464.239	467.767	-1733.01	-2595.66	56.2707
50	470.408	479.395	-2081.25	-3117.25	56.2707
51	476.577	491.607	0	0	0

Query 1 (spencer) - Safety Factor: 0.992364

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	198.183	200.223	0	0	0
2	203.74	203.315	3333.94	4993.49	56.2707
3	209.297	206.478	6887.45	10315.8	56.2705
4	214.854	209.711	10572	15834.5	56.2707
5	220.411	213.016	14305.4	21426.3	56.2707
6	225.968	216.394	18011.7	26977.4	56.2706
7	231.525	219.847	21620.4	32382.6	56.2708

8	237.082	223.376	25072.7	37553.3	56.2707
9	242.638	226.981	28311.3	42404	56.2707
10	248.195	230.666	31266.8	46830.6	56.2706
11	253.752	234.43	33881.2	50746.5	56.2707
12	259.309	238.277	36110.3	54085.1	56.2707
13	264.866	242.207	37914.3	56787.1	56.2707
14	269.841	245.798	53943.3	80794.9	56.2707
15	274.815	249.459	69571.9	104203	56.2707
16	279.79	253.191	84760	126951	56.2706
17	284.764	256.996	99445.3	148947	56.2707
18	290.128	261.182	98934.8	148182	56.2707
19	295.492	265.457	97890.9	146619	56.2707
20	300.856	269.822	96300.5	144236	56.2706
21	306.22	274.281	94133.8	140991	56.2706
22	311.584	278.835	91337.8	136803	56.2706
23	316.948	283.488	87913.6	131675	56.2707
24	322.608	288.506	99551.9	149106	56.2706
25	328.268	293.64	110361	165297	56.2708
26	333.928	298.894	120351	180259	56.2707
27	339.436	304.125	114505	171503	56.2707
28	344.944	309.477	107974	161720	56.2705
29	350.452	314.953	100805	150983	56.2706
30	355.96	320.558	93062.8	139387	56.2706
31	361.468	326.297	84763.2	126956	56.2706
32	367.809	333.075	90489	135532	56.2706
33	374.149	340.046	95271.9	142696	56.2707
34	379.377	345.945	85764.5	128456	56.2707
35	384.605	351.986	75824.3	113568	56.2707
36	389.833	358.175	65482.5	98078	56.2707
37	395.061	364.52	54763.4	82023.2	56.2706
38	400.743	371.6	55994.7	83867.4	56.2706
39	406.426	378.882	56858.7	85161.5	56.2707
40	411.912	386.113	45449.7	68073.4	56.2707
41	417.398	393.553	34490.5	51659.1	56.2707
42	422.883	401.213	24065.8	36045.1	56.2706
43	428.139	408.772	25760.8	38583.9	56.2707
44	433.395	416.559	28057.3	42023.6	56.2707
45	439.564	426.01	19208.5	28770	56.2707
46	445.732	435.822	11590.2	17359.6	56.2708
47	451.901	446.027	5400.58	8088.85	56.2707
48	458.07	456.661	869.215	1301.89	56.2707
49	464.239	467.767	-1733.01	-2595.66	56.2707
50	470.408	479.395	-2081.25	-3117.25	56.2707
51	476.577	491.607	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882

900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
404.388	450.849
376.176	416.559
363.55	401.213
345.177	378.882
333.36	364.52
313.224	340.046
301.912	326.297
279.366	298.894
266.69	283.488
244.894	256.996
232.726	242.207
198	200
-119.082	200

Material Boundary

X	Y
232.726	242.207
900	242.207

Material Boundary

X	Y
244.894	256.996
900	256.996

Material Boundary

X	Y
266.69	283.488
900	283.488

Material Boundary

X	Y
279.366	298.894
900	298.894

Material Boundary

X	Y
301.912	326.297
900	326.297

Material Boundary

X	Y
313.224	340.046
900	340.046

Material Boundary

X	Y

333.36	364.52
900	364.52

Material Boundary

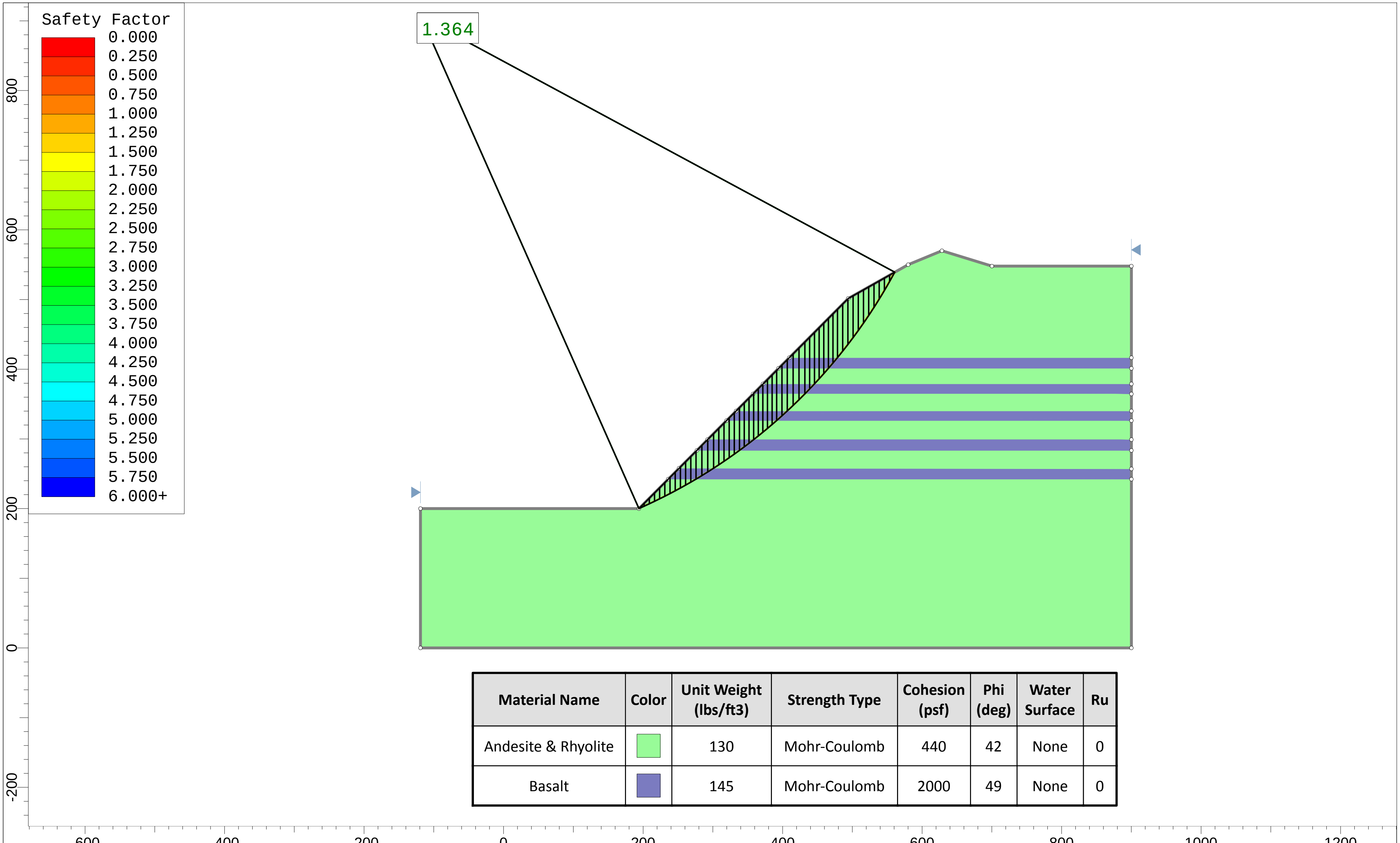
X	Y
345.177	378.882
900	378.882

Material Boundary

X	Y
363.55	401.213
900	401.213

Material Boundary

X	Y
376.176	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

Bajada Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion
Analysis Description	300' Slope, dry, static, 45 degree gross slope inclination
Drawn By	J.Bianchin
Scale	1:2284
Company	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM
File Name	300',dry,static,45deg.slim

Slide Analysis Information
Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:04.322s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.363560
Center:	-117.962, 905.410
Radius:	771.306
Left Slip Surface Endpoint:	194.014, 200.014
Right Slip Surface Endpoint:	560.859, 539.193
Resisting Moment:	1.71566e+09 lb-ft
Driving Moment:	1.25822e+09 lb-ft
Resisting Horizontal Force:	1.65724e+06 lb
Driving Horizontal Force:	1.21538e+06 lb
Total Slice Area:	18331.1 ft2
Surface Horizontal Width:	366.845 ft
Surface Average Height:	49.9696 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	9873
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.36356

Slice	Width	Weight	Angle	Base	Base	Base	Shear	Shear	Base	Pore	Effective	Base	Effective

Number	[ft]	[lbs]	of Slice Base [degrees]	Material	Cohesion [psf]	Friction Angle [degrees]	Stress [psf]	Strength [psf]	Normal Stress [psf]	Pressure [psf]	Normal Stress [psf]	Vertical Stress [psf]	Vertical Stress [psf]
1	7.43814	2000.16	24.1611	Andesite & Rhyolite	440	42	550.387	750.486	344.829	0	344.829	591.734	591.734
2	7.43814	5954.49	24.7682	Andesite & Rhyolite	440	42	851.709	1161.36	801.147	0	801.147	1194.12	1194.12
3	7.43814	9816.16	25.3782	Andesite & Rhyolite	440	42	1135.92	1548.9	1231.55	0	1231.55	1770.4	1770.4
4	7.43814	13583.8	25.9914	Andesite & Rhyolite	440	42	1403.53	1913.8	1636.82	0	1636.82	2321.1	2321.1
5	7.43814	17255.9	26.6077	Andesite & Rhyolite	440	42	1655.01	2256.71	2017.66	0	2017.66	2846.71	2846.71
6	7.43814	20883.3	27.2274	Andesite & Rhyolite	440	42	1894.63	2583.44	2380.54	0	2380.54	3355.39	3355.39
7	7.43814	25019.8	27.8506	Andesite & Rhyolite	440	42	2162.38	2948.53	2786.01	0	2786.01	3928.54	3928.54
8	7.43814	29204.2	28.4773	Andesite & Rhyolite	440	42	2424.18	3305.51	3182.48	0	3182.48	4497.46	4497.46
9	7.43814	32713.8	29.1078	Andesite & Rhyolite	440	42	2630.04	3586.22	3494.24	0	3494.24	4958.57	4958.57
10	7.43814	35882.4	29.7422	Andesite & Rhyolite	440	42	2805.22	3825.08	3759.52	0	3759.52	5362.32	5362.32
11	7.43814	38945	30.3806	Andesite & Rhyolite	440	42	2966.72	4045.3	4004.09	0	4004.09	5743.31	5743.31
12	8.42757	47753.6	31.0663	Basalt	2000	49	5313.63	7245.45	4559.8	0	4559.8	7760.93	7760.93
13	8.42757	51792.7	31.8001	Basalt	2000	49	5515.73	7521.03	4799.36	0	4799.36	8219.27	8219.27
14	8.42757	55092.3	32.5397	Basalt	2000	49	5652.53	7707.56	4961.51	0	4961.51	8568.07	8568.07
15	7.4259	50988.3	33.2408	Andesite & Rhyolite	440	42	3521.14	4801.29	4843.7	0	4843.7	7151.45	7151.45
16	7.4259	53433.4	33.9028	Andesite & Rhyolite	440	42	3614.26	4928.26	4984.71	0	4984.71	7413.65	7413.65
17	7.4259	55860.8	34.5701	Andesite & Rhyolite	440	42	3701.84	5047.68	5117.35	0	5117.35	7668.22	7668.22
18	7.4259	58787.9	35.2428	Andesite & Rhyolite	440	42	3814.57	5201.4	5288.08	0	5288.08	7983.23	7983.23
19	7.4259	61514.4	35.9211	Andesite & Rhyolite	440	42	3910.27	5331.89	5433	0	5433	8265.76	8265.76
20	6.76382	57517	36.5745	Basalt	2000	49	6177.15	8422.92	5583.36	0	5583.36	10166.6	10166.6
21	6.76382	58514.1	37.2027	Basalt	2000	49	6157.5	8396.12	5560.07	0	5560.07	10234.3	10234.3
22	6.76382	59400.8	37.8362	Basalt	2000	49	6127.5	8355.22	5524.5	0	5524.5	10283.7	10283.7
23	6.59051	59276.1	38.467	Andesite & Rhyolite	440	42	3961.43	5401.65	5510.47	0	5510.47	8657.81	8657.81
24	6.59051	61067.2	39.095	Andesite & Rhyolite	440	42	4008.93	5466.41	5582.4	0	5582.4	8839.78	8839.78
25	6.59051	62458	39.7287	Andesite & Rhyolite	440	42	4029.48	5494.44	5613.53	0	5613.53	8962.28	8962.28
26	6.59051	63385.9	40.3683	Andesite & Rhyolite	440	42	4020.61	5482.34	5600.09	0	5600.09	9018.05	9018.05
27	6.59051	64204	41.014	Andesite & Rhyolite	440	42	4003.9	5459.56	5574.78	0	5574.78	9057.04	9057.04
28	7.60811	74773.6	41.717	Basalt	2000	49	6045.12	8242.88	5426.85	0	5426.85	10816.1	10816.1
29	7.60811	75565.6	42.4787	Basalt	2000	49	5976.63	8149.5	5345.68	0	5345.68	10818.2	10818.2
30	8.39873	84416	43.2904	Andesite & Rhyolite	440	42	3893.49	5309.01	5407.58	0	5407.58	9075.39	9075.39
31	8.39873	84919.2	44.1538	Andesite & Rhyolite	440	42	3830.66	5223.33	5312.43	0	5312.43	9031.57	9031.57
32	8.39873	85091.8	45.0299	Andesite & Rhyolite	440	42	3753.51	5118.13	5195.59	0	5195.59	8953.02	8953.02
33	6.88424	69319	45.8384	Basalt	2000	49	5542.13	7557.03	4830.65	0	4830.65	10537.4	10537.4
34	6.88424	68341	46.5774	Basalt	2000	49	5379.95	7335.88	4638.41	0	4638.41	10323	10323
35	6.68715	65633.4	47.3157	Andesite & Rhyolite	440	42	3437.66	4687.46	4717.29	0	4717.29	8444.7	8444.7
36	6.68715	65088.7	48.0537	Andesite & Rhyolite	440	42	3346.42	4563.05	4579.11	0	4579.11	8302.7	8302.7

37	6.68715	64375.1	48.8023	Andesite & Rhyolite	440	42	3248.18	4429.09	4430.33	0	4430.33	8141	8141
38	6.45559	60937.9	49.549	Basalt	2000	49	4800.62	6545.93	3951.72	0	3951.72	9582.26	9582.26
39	6.45559	59199.3	50.2939	Basalt	2000	49	4610.58	6286.8	3726.46	0	3726.46	9278.72	9278.72
40	7.47418	66625.4	51.1114	Andesite & Rhyolite	440	42	2847.11	3882.2	3822.95	0	3822.95	7352.85	7352.85
41	7.47418	64772.1	52.0045	Andesite & Rhyolite	440	42	2708.37	3693.02	3612.84	0	3612.84	7079.96	7079.96
42	7.47418	61194.4	52.9159	Andesite & Rhyolite	440	42	2509.71	3422.14	3312.01	0	3312.01	6632.35	6632.35
43	7.47418	55526	53.8468	Andesite & Rhyolite	440	42	2243.49	3059.14	2908.85	0	2908.85	5979.46	5979.46
44	7.47418	49509.2	54.799	Andesite & Rhyolite	440	42	1976.17	2694.62	2504.01	0	2504.01	5305.3	5305.3
45	7.47418	43124.4	55.7742	Andesite & Rhyolite	440	42	1708.39	2329.49	2098.5	0	2098.5	4609.88	4609.88
46	7.47418	36343.3	56.7744	Andesite & Rhyolite	440	42	1440.75	1964.55	1693.18	0	1693.18	3892.73	3892.73
47	7.47418	29133.5	57.802	Andesite & Rhyolite	440	42	1173.93	1600.73	1289.12	0	1289.12	3153.45	3153.45
48	7.47418	21457.4	58.8598	Andesite & Rhyolite	440	42	908.824	1239.24	887.644	0	887.644	2391.83	2391.83
49	7.47418	13270.9	59.9511	Andesite & Rhyolite	440	42	646.486	881.522	490.36	0	490.36	1607.9	1607.9
50	7.47418	4522.07	61.0795	Andesite & Rhyolite	440	42	375.69	512.275	80.2701	0	80.2701	760.256	760.256

Query 1 (spencer) - Safety Factor: 1.36356

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	7.43814	2000.16	24.1611	Andesite & Rhyolite	440	42	550.387	750.486	344.829	0	344.829	591.734	591.734
2	7.43814	5954.49	24.7682	Andesite & Rhyolite	440	42	851.709	1161.36	801.147	0	801.147	1194.12	1194.12
3	7.43814	9816.16	25.3782	Andesite & Rhyolite	440	42	1135.92	1548.9	1231.55	0	1231.55	1770.4	1770.4
4	7.43814	13583.8	25.9914	Andesite & Rhyolite	440	42	1403.53	1913.8	1636.82	0	1636.82	2321.1	2321.1
5	7.43814	17255.9	26.6077	Andesite & Rhyolite	440	42	1655.01	2256.71	2017.66	0	2017.66	2846.71	2846.71
6	7.43814	20883.3	27.2274	Andesite & Rhyolite	440	42	1894.63	2583.44	2380.54	0	2380.54	3355.39	3355.39
7	7.43814	25019.8	27.8506	Andesite & Rhyolite	440	42	2162.38	2948.53	2786.01	0	2786.01	3928.54	3928.54
8	7.43814	29204.2	28.4773	Andesite & Rhyolite	440	42	2424.18	3305.51	3182.48	0	3182.48	4497.46	4497.46
9	7.43814	32713.8	29.1078	Andesite & Rhyolite	440	42	2630.04	3586.22	3494.24	0	3494.24	4958.57	4958.57
10	7.43814	35882.4	29.7422	Andesite & Rhyolite	440	42	2805.22	3825.08	3759.52	0	3759.52	5362.32	5362.32
11	7.43814	38945	30.3806	Andesite & Rhyolite	440	42	2966.72	4045.3	4004.09	0	4004.09	5743.31	5743.31
12	8.42757	47753.6	31.0663	Basalt	2000	49	5313.63	7245.45	4559.8	0	4559.8	7760.93	7760.93
13	8.42757	51792.7	31.8001	Basalt	2000	49	5515.73	7521.03	4799.36	0	4799.36	8219.27	8219.27
14	8.42757	55092.3	32.5397	Basalt	2000	49	5652.53	7707.56	4961.51	0	4961.51	8568.07	8568.07
15	7.4259	50988.3	33.2408	Andesite & Rhyolite	440	42	3521.14	4801.29	4843.7	0	4843.7	7151.45	7151.45
16	7.4259	53433.4	33.9028	Andesite & Rhyolite	440	42	3614.26	4928.26	4984.71	0	4984.71	7413.65	7413.65
17	7.4259	55860.8	34.5701	Andesite & Rhyolite	440	42	3701.84	5047.68	5117.35	0	5117.35	7668.22	7668.22
18	7.4259	58787.9	35.2428	Andesite & Rhyolite	440	42	3814.57	5201.4	5288.08	0	5288.08	7983.23	7983.23

19	7.4259	61514.4	35.9211	Andesite & Rhyolite	440	42	3910.27	5331.89	5433	0	5433	8265.76	8265.76
20	6.76382	57517	36.5745	Basalt	2000	49	6177.15	8422.92	5583.36	0	5583.36	10166.6	10166.6
21	6.76382	58514.1	37.2027	Basalt	2000	49	6157.5	8396.12	5560.07	0	5560.07	10234.3	10234.3
22	6.76382	59400.8	37.8362	Basalt	2000	49	6127.5	8355.22	5524.5	0	5524.5	10283.7	10283.7
23	6.59051	59276.1	38.467	Andesite & Rhyolite	440	42	3961.43	5401.65	5510.47	0	5510.47	8657.81	8657.81
24	6.59051	61067.2	39.095	Andesite & Rhyolite	440	42	4008.93	5466.41	5582.4	0	5582.4	8839.78	8839.78
25	6.59051	62458	39.7287	Andesite & Rhyolite	440	42	4029.48	5494.44	5613.53	0	5613.53	8962.28	8962.28
26	6.59051	63385.9	40.3683	Andesite & Rhyolite	440	42	4020.61	5482.34	5600.09	0	5600.09	9018.05	9018.05
27	6.59051	64204	41.014	Andesite & Rhyolite	440	42	4003.9	5459.56	5574.78	0	5574.78	9057.04	9057.04
28	7.60811	74773.6	41.717	Basalt	2000	49	6045.12	8242.88	5426.85	0	5426.85	10816.1	10816.1
29	7.60811	75565.6	42.4787	Basalt	2000	49	5976.63	8149.5	5345.68	0	5345.68	10818.2	10818.2
30	8.39873	84416	43.2904	Andesite & Rhyolite	440	42	3893.49	5309.01	5407.58	0	5407.58	9075.39	9075.39
31	8.39873	84919.2	44.1538	Andesite & Rhyolite	440	42	3830.66	5223.33	5312.43	0	5312.43	9031.57	9031.57
32	8.39873	85091.8	45.0299	Andesite & Rhyolite	440	42	3753.51	5118.13	5195.59	0	5195.59	8953.02	8953.02
33	6.88424	69319	45.8384	Basalt	2000	49	5542.13	7557.03	4830.65	0	4830.65	10537.4	10537.4
34	6.88424	68341	46.5774	Basalt	2000	49	5379.95	7335.88	4638.41	0	4638.41	10323	10323
35	6.68715	65633.4	47.3157	Andesite & Rhyolite	440	42	3437.66	4687.46	4717.29	0	4717.29	8444.7	8444.7
36	6.68715	65088.7	48.0537	Andesite & Rhyolite	440	42	3346.42	4563.05	4579.11	0	4579.11	8302.7	8302.7
37	6.68715	64375.1	48.8023	Andesite & Rhyolite	440	42	3248.18	4429.09	4430.33	0	4430.33	8141	8141
38	6.45559	60937.9	49.549	Basalt	2000	49	4800.62	6545.93	3951.72	0	3951.72	9582.26	9582.26
39	6.45559	59199.3	50.2939	Basalt	2000	49	4610.58	6286.8	3726.46	0	3726.46	9278.72	9278.72
40	7.47418	66625.4	51.1114	Andesite & Rhyolite	440	42	2847.11	3882.2	3822.95	0	3822.95	7352.85	7352.85
41	7.47418	64772.1	52.0045	Andesite & Rhyolite	440	42	2708.37	3693.02	3612.84	0	3612.84	7079.96	7079.96
42	7.47418	61194.4	52.9159	Andesite & Rhyolite	440	42	2509.71	3422.14	3312.01	0	3312.01	6632.35	6632.35
43	7.47418	55526	53.8468	Andesite & Rhyolite	440	42	2243.49	3059.14	2908.85	0	2908.85	5979.46	5979.46
44	7.47418	49509.2	54.799	Andesite & Rhyolite	440	42	1976.17	2694.62	2504.01	0	2504.01	5305.3	5305.3
45	7.47418	43124.4	55.7742	Andesite & Rhyolite	440	42	1708.39	2329.49	2098.5	0	2098.5	4609.88	4609.88
46	7.47418	36343.3	56.7744	Andesite & Rhyolite	440	42	1440.75	1964.55	1693.18	0	1693.18	3892.73	3892.73
47	7.47418	29133.5	57.802	Andesite & Rhyolite	440	42	1173.93	1600.73	1289.12	0	1289.12	3153.45	3153.45
48	7.47418	21457.4	58.8598	Andesite & Rhyolite	440	42	908.824	1239.24	887.644	0	887.644	2391.83	2391.83
49	7.47418	13270.9	59.9511	Andesite & Rhyolite	440	42	646.486	881.522	490.36	0	490.36	1607.9	1607.9
50	7.47418	4522.07	61.0795	Andesite & Rhyolite	440	42	375.69	512.275	80.2701	0	80.2701	760.256	760.256

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.36356

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	194.014	200.014	0	0	0

2	201.452	203.351	2949.33	2407.8	39.2278
3	208.89	206.783	6544.44	5342.81	39.2278
4	216.328	210.311	10660.7	8703.29	39.2279
5	223.766	213.937	15180.1	12392.9	39.2279
6	231.204	217.663	19990.8	16320.3	39.2279
7	238.643	221.491	24993.6	20404.5	39.2278
8	246.081	225.421	30152.4	24616.1	39.2278
9	253.519	229.455	35370.1	28875.7	39.2278
10	260.957	233.597	40491	33056.4	39.2278
11	268.395	237.847	45410	37072.3	39.2279
12	275.833	242.207	50049.7	40860	39.2278
13	284.261	247.284	71746.9	58573.4	39.2278
14	292.688	252.51	93222.1	76105.5	39.2278
15	301.116	257.887	114251	93273.5	39.2279
16	308.542	262.754	116864	95406.4	39.2278
17	315.968	267.744	118867	97041.4	39.2277
18	323.394	272.861	120211	98139.1	39.2279
19	330.82	278.108	120835	98648.4	39.2278
20	338.246	283.488	120688	98528.4	39.2278
21	345.009	288.506	134511	109813	39.2277
22	351.773	293.641	147673	120558	39.2277
23	358.537	298.894	160157	130751	39.2279
24	365.128	304.13	157451	128541	39.2278
25	371.718	309.485	154017	125738	39.2279
26	378.309	314.962	149867	122350	39.2279
27	384.899	320.565	145029	118400	39.2278
28	391.49	326.297	139502	113888	39.2278
29	399.098	333.08	148754	121441	39.2278
30	406.706	340.046	157053	128216	39.2277
31	415.105	347.958	147017	120023	39.2278
32	423.503	356.112	135919	110963	39.2279
33	431.902	364.52	123809	101076	39.2277
34	438.786	371.608	127776	104315	39.2278
35	445.67	378.882	131127	107051	39.2279
36	452.358	386.133	119946	97922.5	39.2278
37	459.045	393.574	108285	88402.5	39.2278
38	465.732	401.213	96193.6	78531.4	39.2278
39	472.188	408.785	97309.6	79442.5	39.2278
40	478.643	416.559	98148	80127	39.2278
41	486.117	425.826	84033.6	68604.1	39.2278
42	493.591	435.394	69738.6	56933.8	39.2278
43	501.066	445.282	55774.4	45533.6	39.2278
44	508.54	455.512	42810.9	34950.4	39.2279
45	516.014	466.107	31073.3	25367.9	39.2278
46	523.488	477.094	20804.4	16984.5	39.2278
47	530.962	488.505	12268.7	10016	39.2277
48	538.437	500.374	5754.38	4697.81	39.2278
49	545.911	512.745	1576.66	1287.17	39.2279
50	553.385	525.665	80.2719	65.5331	39.2278
51	560.859	539.193	0	0	0

Query 1 (spencer) - Safety Factor: 1.36356

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	194.014	200.014	0	0	0
2	201.452	203.351	2949.33	2407.8	39.2278
3	208.89	206.783	6544.44	5342.81	39.2278
4	216.328	210.311	10660.7	8703.29	39.2279
5	223.766	213.937	15180.1	12392.9	39.2279
6	231.204	217.663	19990.8	16320.3	39.2279
7	238.643	221.491	24993.6	20404.5	39.2278

8	246.081	225.421	30152.4	24616.1	39.2278
9	253.519	229.455	35370.1	28875.7	39.2278
10	260.957	233.597	40491	33056.4	39.2278
11	268.395	237.847	45410	37072.3	39.2279
12	275.833	242.207	50049.7	40860	39.2278
13	284.261	247.284	71746.9	58573.4	39.2278
14	292.688	252.51	93222.1	76105.5	39.2278
15	301.116	257.887	114251	93273.5	39.2279
16	308.542	262.754	116864	95406.4	39.2278
17	315.968	267.744	118867	97041.4	39.2277
18	323.394	272.861	120211	98139.1	39.2279
19	330.82	278.108	120835	98648.4	39.2278
20	338.246	283.488	120688	98528.4	39.2278
21	345.009	288.506	134511	109813	39.2277
22	351.773	293.641	147673	120558	39.2277
23	358.537	298.894	160157	130751	39.2279
24	365.128	304.13	157451	128541	39.2278
25	371.718	309.485	154017	125738	39.2279
26	378.309	314.962	149867	122350	39.2279
27	384.899	320.565	145029	118400	39.2278
28	391.49	326.297	139502	113888	39.2278
29	399.098	333.08	148754	121441	39.2278
30	406.706	340.046	157053	128216	39.2277
31	415.105	347.958	147017	120023	39.2278
32	423.503	356.112	135919	110963	39.2279
33	431.902	364.52	123809	101076	39.2277
34	438.786	371.608	127776	104315	39.2278
35	445.67	378.882	131127	107051	39.2279
36	452.358	386.133	119946	97922.5	39.2278
37	459.045	393.574	108285	88402.5	39.2278
38	465.732	401.213	96193.6	78531.4	39.2278
39	472.188	408.785	97309.6	79442.5	39.2278
40	478.643	416.559	98148	80127	39.2278
41	486.117	425.826	84033.6	68604.1	39.2278
42	493.591	435.394	69738.6	56933.8	39.2278
43	501.066	445.282	55774.4	45533.6	39.2278
44	508.54	455.512	42810.9	34950.4	39.2279
45	516.014	466.107	31073.3	25367.9	39.2278
46	523.488	477.094	20804.4	16984.5	39.2278
47	530.962	488.505	12268.7	10016	39.2277
48	538.437	500.374	5754.38	4697.81	39.2278
49	545.911	512.745	1576.66	1287.17	39.2279
50	553.385	525.665	80.2719	65.5331	39.2278
51	560.859	539.193	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882

900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
494.015	501.453
409.526	416.559
394.254	401.213
372.029	378.882
357.735	364.52
333.378	340.046
319.695	326.297
292.423	298.894
277.089	283.488
251.684	257.96
236.006	242.207
194	200
-119.082	200

Material Boundary

X	Y
236.006	242.207
900	242.207

Material Boundary

X	Y
251.684	257.96
900	256.996

Material Boundary

X	Y
277.089	283.488
900	283.488

Material Boundary

X	Y
292.423	298.894
900	298.894

Material Boundary

X	Y
319.695	326.297
900	326.297

Material Boundary

X	Y
333.378	340.046
900	340.046

Material Boundary

X	Y

357.735	364.52
900	364.52

Material Boundary

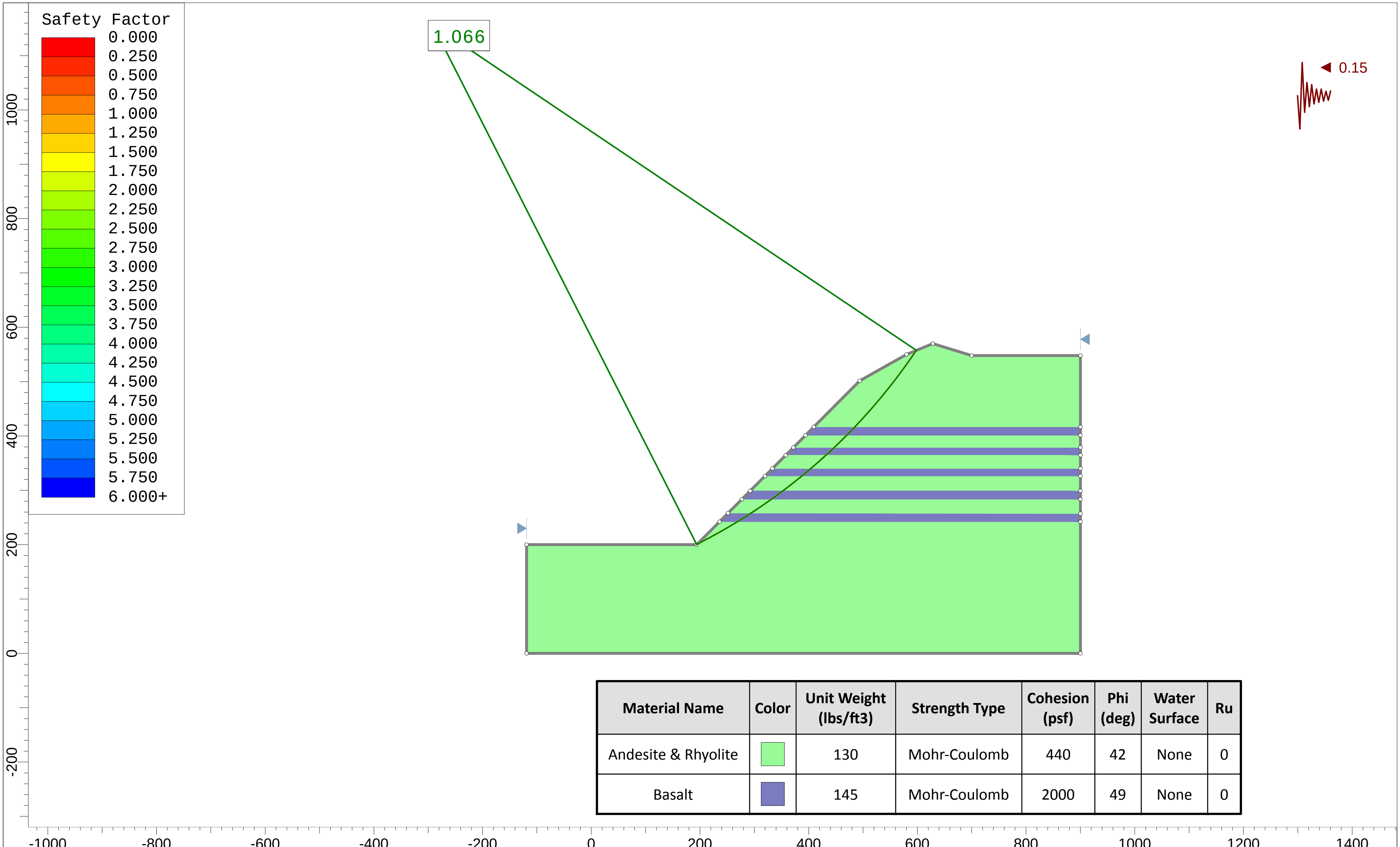
X	Y
372.029	378.882
900	378.882

Material Boundary

X	Y
394.254	401.213
900	401.213

Material Boundary

X	Y
409.526	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.

SLIDEINTERPRET 8.032

Project	Ward Lake Quarry Expansion		
Analysis Description	300' Slope, dry, pseudostatic, 45 degree gross slope inclination		
Drawn By J.Bianchin	*Scale* 1:2932	*Company*	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM	*File Name*	300',dry,PS,45deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:03.410s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.15

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.066260
Center:	-292.281, 1157.200
Radius:	1073.614
Left Slip Surface Endpoint:	194.057, 200.057
Right Slip Surface Endpoint:	598.229, 557.500
Resisting Moment:	2.32086e+09 lb-ft
Driving Moment:	2.17663e+09 lb-ft
Resisting Horizontal Force:	1.64096e+06 lb
Driving Horizontal Force:	1.53898e+06 lb
Total Slice Area:	19844.8 ft2
Surface Horizontal Width:	404.172 ft
Surface Average Height:	49.0998 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 10694
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.06626

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	8.36654	2234.73	27.1867	Andesite & Rhyolite	440	42	758.603	808.868	409.669	0	409.669	799.316	799.316
2	8.36654	6653.45	27.6898	Andesite & Rhyolite	440	42	1091.27	1163.58	803.615	0	803.615	1376.3	1376.3
3	8.36654	10970	28.1952	Andesite & Rhyolite	440	42	1403.53	1496.53	1173.4	0	1173.4	1925.81	1925.81
4	8.36654	15183	28.7031	Andesite & Rhyolite	440	42	1696.04	1808.42	1519.79	0	1519.79	2448.46	2448.46
5	8.36654	19290.9	29.2134	Andesite & Rhyolite	440	42	1969.44	2099.94	1843.54	0	1843.54	2944.83	2944.83
6	8.36654	23805	29.7263	Andesite & Rhyolite	440	42	2261.09	2410.91	2188.92	0	2188.92	3480	3480
7	8.36654	28746.2	30.2418	Andesite & Rhyolite	440	42	2571.09	2741.45	2556.01	0	2556.01	4054.93	4054.93
8	8.36654	32944	30.76	Andesite & Rhyolite	440	42	2817.31	3003.99	2847.6	0	2847.6	4524.39	4524.39
9	8.36654	36613.5	31.281	Andesite & Rhyolite	440	42	3017.57	3217.51	3084.74	0	3084.74	4918.07	4918.07
10	8.26496	39345.6	31.8017	Basalt	2000	49	6212.18	6623.8	4019.41	0	4019.41	7871.38	7871.38
11	8.26496	42641.3	32.3222	Basalt	2000	49	6406.5	6830.99	4199.51	0	4199.51	8253	8253
12	8.26496	46238.9	32.8457	Basalt	2000	49	6616.74	7055.17	4394.4	0	4394.4	8666.07	8666.07
13	7.4974	44649.8	33.3477	Andesite & Rhyolite	440	42	3648.28	3890.02	3831.63	0	3831.63	6232.46	6232.46
14	7.4974	47139.3	33.828	Andesite & Rhyolite	440	42	3761.67	4010.92	3965.9	0	3965.9	6486.79	6486.79
15	7.4974	49539.8	34.311	Andesite & Rhyolite	440	42	3863.96	4119.99	4087.04	0	4087.04	6723.95	6723.95
16	7.4974	51998.6	34.7968	Andesite & Rhyolite	440	42	3965.39	4228.14	4207.15	0	4207.15	6962.85	6962.85
17	7.4974	54993.4	35.2856	Andesite & Rhyolite	440	42	4097.06	4368.53	4363.07	0	4363.07	7262.4	7262.4
18	7.01003	53634.4	35.7612	Basalt	2000	49	7356.4	7843.83	5079.96	0	5079.96	10378	10378
19	7.01003	54900.5	36.2235	Basalt	2000	49	7358.35	7845.91	5081.77	0	5081.77	10471.9	10471.9
20	7.01003	56055.2	36.6887	Basalt	2000	49	7347.55	7834.4	5071.77	0	5071.77	10546.2	10546.2
21	8.73487	71857.4	37.2146	Andesite & Rhyolite	440	42	4251.56	4533.27	4546.03	0	4546.03	7774.85	7774.85
22	8.73487	75166.6	37.8023	Andesite & Rhyolite	440	42	4339.74	4627.29	4650.45	0	4650.45	8016.97	8016.97
23	8.73487	78152.8	38.3947	Andesite & Rhyolite	440	42	4406.04	4697.98	4728.97	0	4728.97	8220.48	8220.48
24	8.73487	80201.2	38.9919	Andesite & Rhyolite	440	42	4421.32	4714.28	4747.07	0	4747.07	8326.35	8326.35
25	8.23224	76882.5	39.5768	Basalt	2000	49	7426.15	7918.21	5144.62	0	5144.62	11283	11283
26	8.23224	78217.4	40.1492	Basalt	2000	49	7373.67	7862.25	5095.97	0	5095.97	11316	11316
27	9.24561	90064.7	40.7623	Andesite & Rhyolite	440	42	4400.02	4691.57	4721.85	0	4721.85	8514.8	8514.8
28	9.24561	91763.6	41.417	Andesite & Rhyolite	440	42	4380.54	4670.79	4698.77	0	4698.77	8563.04	8563.04
29	9.24561	93011.3	42.0784	Andesite & Rhyolite	440	42	4340.45	4628.05	4651.31	0	4651.31	8570.23	8570.23
30	7.7084	77925.8	42.6906	Basalt	2000	49	7076.74	7545.65	4820.76	0	4820.76	11348.8	11348.8
31	7.7084	77660.6	43.2528	Basalt	2000	49	6928.93	7388.04	4683.75	0	4683.75	11202.5	11202.5
32	7.60461	76615.3	43.8165	Andesite & Rhyolite	440	42	4111.81	4384.26	4380.54	0	4380.54	8325.9	8325.9
33	7.60461	76883.8	44.3816	Andesite & Rhyolite	440	42	4051.74	4320.21	4309.41	0	4309.41	8274.62	8274.62
34	7.60461	77006.3	44.9523	Andesite & Rhyolite	440	42	3985.42	4249.49	4230.87	0	4230.87	8209.65	8209.65
35	7.45891	75080.5	45.5231	Basalt	2000	49	6425.24	6850.98	4216.9	0	4216.9	10760.5	10760.5
36	7.45891	74049.2	46.0942	Basalt	2000	49	6246.17	6660.04	4050.91	0	4050.91	10540.3	10540.3

37	8.09086	79479.5	46.6959	Andesite & Rhyolite	440	42	3674.64	3918.12	3862.85	0	3862.85	7761.72	7761.72
38	8.09086	77447.9	47.3292	Andesite & Rhyolite	440	42	3522.27	3755.66	3682.42	0	3682.42	7503.38	7503.38
39	8.09086	72942.9	47.9702	Andesite & Rhyolite	440	42	3276.82	3493.94	3391.74	0	3391.74	7027.22	7027.22
40	8.09086	68197.3	48.6193	Andesite & Rhyolite	440	42	3030.26	3231.05	3099.78	0	3099.78	6539.27	6539.27
41	8.09086	63229.5	49.2768	Andesite & Rhyolite	440	42	2783.72	2968.17	2807.81	0	2807.81	6041.54	6041.54
42	8.09086	58030.7	49.9432	Andesite & Rhyolite	440	42	2537.18	2705.29	2515.86	0	2515.86	5533.47	5533.47
43	8.09086	52591.1	50.6189	Andesite & Rhyolite	440	42	2290.61	2442.39	2223.89	0	2223.89	5014.41	5014.41
44	8.09086	46900.3	51.3045	Andesite & Rhyolite	440	42	2044.02	2179.46	1931.87	0	1931.87	4483.64	4483.64
45	8.09086	40946.8	52.0005	Andesite & Rhyolite	440	42	1797.37	1916.46	1639.77	0	1639.77	3940.34	3940.34
46	8.09086	34718.2	52.7076	Andesite & Rhyolite	440	42	1550.58	1653.32	1347.53	0	1347.53	3383.51	3383.51
47	8.09086	28201.1	53.4262	Andesite & Rhyolite	440	42	1303.61	1389.98	1055.06	0	1055.06	2812.05	2812.05
48	8.09086	21338.8	54.1572	Andesite & Rhyolite	440	42	1055	1124.9	760.667	0	760.667	2221.16	2221.16
49	8.09086	13258.9	54.9014	Andesite & Rhyolite	440	42	777.492	829.009	432.038	0	432.038	1538.36	1538.36
50	8.09086	4477.48	55.6596	Andesite & Rhyolite	440	42	400.633	427.179	-14.2394	0	-14.2394	572.178	572.178

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.06626

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	194.057	200.057	0	0	0
2	202.423	204.354	4266.44	4648.67	47.455
3	210.79	208.745	8892.17	9688.81	47.455
4	219.156	213.23	13754.7	14987	47.4551
5	227.523	217.811	18739	20417.9	47.4551
6	235.889	222.49	23737.5	25864.1	47.455
7	244.256	227.267	28672.7	31241.5	47.455
8	252.622	232.145	33456.4	36453.7	47.455
9	260.989	237.124	37962.9	41364	47.455
10	269.355	242.207	42098.1	45869.6	47.455
11	277.62	247.332	67064.3	73072.6	47.455
12	285.885	252.561	91784.1	100007	47.455
13	294.15	257.897	116220	126632	47.455
14	301.648	262.831	118036	128611	47.4551
15	309.145	267.855	119310	129998	47.4548
16	316.643	272.972	120007	130758	47.4549
17	324.14	278.182	120088	130847	47.4551
18	331.637	283.488	119482	130186	47.4549
19	338.647	288.536	137482	149799	47.455
20	345.657	293.671	154859	168733	47.4551
21	352.667	298.894	171591	186964	47.455
22	361.402	305.528	167882	182923	47.4551
23	370.137	312.304	163094	177705	47.4549
24	378.872	319.226	157216	171301	47.455
25	387.607	326.297	150331	163799	47.455
26	395.839	333.102	165072	179861	47.4551
27	404.071	340.046	178799	194818	47.4551

28	413.317	348.016	168435	183525	47.455
29	422.563	356.172	156946	171006	47.4549
30	431.808	364.52	144393	157329	47.455
31	439.517	371.63	153107	166823	47.4549
32	447.225	378.882	161030	175457	47.4551
33	454.83	386.179	148918	162259	47.4549
34	462.434	393.621	136200	148402	47.455
35	470.039	401.213	122909	133920	47.4549
36	477.498	408.81	127654	139091	47.4551
37	484.957	416.559	131857	143670	47.455
38	493.047	425.144	116576	127020	47.455
39	501.138	433.921	101205	110272	47.455
40	509.229	442.897	86394.4	94134.4	47.455
41	517.32	452.081	72274.4	78749.4	47.455
42	525.411	461.479	58976.7	64260.4	47.455
43	533.502	471.102	46639.6	50818	47.455
44	541.593	480.959	35408.6	38580.8	47.455
45	549.683	491.06	25438	27717	47.455
46	557.774	501.416	16891.7	18405	47.455
47	565.865	512.039	9943.95	10834.8	47.4549
48	573.956	522.944	4781.23	5209.58	47.455
49	582.047	534.145	1616.89	1761.75	47.4551
50	590.138	545.657	959.837	1045.83	47.4551
51	598.229	557.5	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882
900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
494.015	501.453
409.526	416.559
394.254	401.213
372.029	378.882
357.735	364.52
333.378	340.046
319.695	326.297
292.423	298.894
277.089	283.488
251.684	257.96
236.006	242.207
194	200
-119.082	200

Material Boundary

X	Y
236.006	242.207
900	242.207

Material Boundary

X	Y
251.684	257.96
900	256.996

Material Boundary

X	Y
277.089	283.488
900	283.488

Material Boundary

X	Y
292.423	298.894
900	298.894

Material Boundary

X	Y
319.695	326.297
900	326.297

Material Boundary

X	Y
333.378	340.046
900	340.046

Material Boundary

X	Y
357.735	364.52
900	364.52

Material Boundary

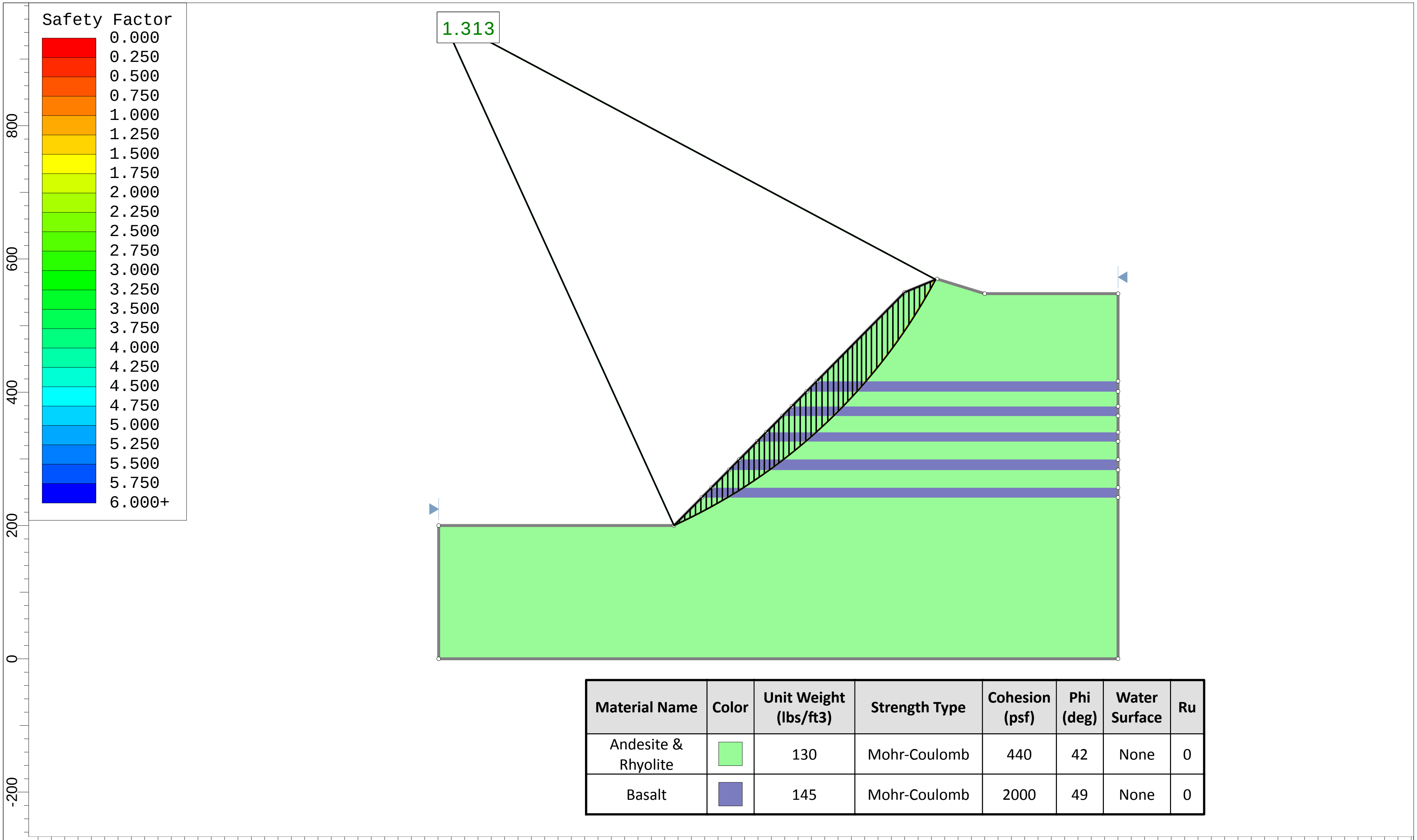
X	Y
372.029	378.882
900	378.882

Material Boundary

X	Y
394.254	401.213
900	401.213

Material Boundary

X	Y
409.526	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.	*Project*	Ward Lake Quarry Expansion	
	Analysis Description	350' Slope, dry, static, 45 degree gross slope inclination	
	Drawn By J.Bianchin	*Scale* 1:2418	*Company* Bajada Geosciences, Inc.
SLIDEINTERPRET 8.032	*Date* 4/3/2020, 2:25:57 PM		*File Name* 350',dry,static,45deg.slim

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:04.332s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.313020
Center:	-114.959, 964.180
Radius:	840.074
Left Slip Surface Endpoint:	234.022, 200.023
Right Slip Surface Endpoint:	626.414, 569.097
Resisting Moment:	2.06244e+09 lb-ft
Driving Moment:	1.57076e+09 lb-ft
Resisting Horizontal Force:	1.81601e+06 lb
Driving Horizontal Force:	1.38308e+06 lb
Total Slice Area:	20824.1 ft2
Surface Horizontal Width:	392.392 ft
Surface Average Height:	53.0696 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces:	9485
Number of Invalid Surfaces:	0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.31302

Slice	Width	Weight	Angle	Base	Base	Base	Shear	Shear	Base	Pore	Effective	Base	Effective

Number	[ft]	[lbs]	of Slice Base [degrees]	Material	Cohesion [psf]	Friction Angle [degrees]	Stress [psf]	Strength [psf]	Normal Stress [psf]	Pressure [psf]	Normal Stress [psf]	Vertical Stress [psf]	Vertical Stress [psf]
1	8.05296	2311.96	24.8482	Andesite & Rhyolite	440	42	582.428	764.739	360.659	0	360.659	630.374	630.374
2	8.05296	6881.4	25.455	Andesite & Rhyolite	440	42	913.31	1199.19	843.17	0	843.17	1277.92	1277.92
3	8.05296	11341	26.0649	Andesite & Rhyolite	440	42	1224.92	1608.35	1297.59	0	1297.59	1896.74	1896.74
4	8.05296	15689.2	26.6779	Andesite & Rhyolite	440	42	1517.86	1992.98	1724.76	0	1724.76	2487.43	2487.43
5	8.05296	19924	27.2943	Andesite & Rhyolite	440	42	1792.66	2353.8	2125.49	0	2125.49	3050.52	3050.52
6	8.05296	24375.7	27.9141	Andesite & Rhyolite	440	42	2072.76	2721.57	2533.94	0	2533.94	3632.06	3632.06
7	8.05296	29346.5	28.5375	Andesite & Rhyolite	440	42	2378.14	3122.55	2979.27	0	2979.27	4272.51	4272.51
8	8.05296	33715.9	29.1646	Andesite & Rhyolite	440	42	2632.5	3456.53	3350.2	0	3350.2	4819.32	4819.32
9	8.05296	37477.8	29.7955	Andesite & Rhyolite	440	42	2837.74	3726.01	3649.48	0	3649.48	5274.38	5274.38
10	8.05296	41116	30.4305	Andesite & Rhyolite	440	42	3027.25	3974.84	3925.83	0	3925.83	5704.07	5704.07
11	7.97887	44187.3	31.0666	Basalt	2000	49	5479.99	7195.34	4516.25	0	4516.25	7817.64	7817.64
12	7.97887	47863.6	31.7041	Basalt	2000	49	5691.9	7473.58	4758.11	0	4758.11	8274.06	8274.06
13	7.97887	51084.3	32.346	Basalt	2000	49	5856.54	7689.76	4946.03	0	4946.03	8654.97	8654.97
14	7.77516	52447	32.9841	Andesite & Rhyolite	440	42	3634.93	4772.73	4811.98	0	4811.98	7171.1	7171.1
15	7.77516	55233.9	33.6186	Andesite & Rhyolite	440	42	3748.28	4921.57	4977.29	0	4977.29	7469.4	7469.4
16	7.77516	57961.3	34.2578	Andesite & Rhyolite	440	42	3853	5059.06	5129.98	0	5129.98	7754.16	7754.16
17	7.77516	61234.8	34.9019	Andesite & Rhyolite	440	42	3985.19	5232.64	5322.76	0	5322.76	8103.07	8103.07
18	7.77516	64368.7	35.5511	Andesite & Rhyolite	440	42	4103.33	5387.76	5495.05	0	5495.05	8427.46	8427.46
19	6.87601	58614.3	36.1675	Basalt	2000	49	6520.68	8561.78	5704.07	0	5704.07	10470.8	10470.8
20	6.87601	59766.3	36.7506	Basalt	2000	49	6515.47	8554.94	5698.12	0	5698.12	10563.6	10563.6
21	6.87601	60823	37.3382	Basalt	2000	49	6500.43	8535.2	5680.96	0	5680.96	10639.8	10639.8
22	8.42543	76891.2	37.9977	Andesite & Rhyolite	440	42	4218.98	5539.61	5663.7	0	5663.7	8959.65	8959.65
23	8.42543	79876.3	38.7306	Andesite & Rhyolite	440	42	4289.55	5632.27	5766.6	0	5766.6	9206.95	9206.95
24	8.42543	81859.1	39.4711	Andesite & Rhyolite	440	42	4306.41	5654.4	5791.19	0	5791.19	9337.47	9337.47
25	8.42543	83492.4	40.2196	Andesite & Rhyolite	440	42	4303.45	5650.52	5786.87	0	5786.87	9426.09	9426.09
26	7.82334	78741.5	40.9491	Basalt	2000	49	6522.8	8564.57	5706.49	0	5706.49	11366.5	11366.5
27	7.82334	79909.2	41.6595	Basalt	2000	49	6475.02	8501.83	5651.95	0	5651.95	11412.8	11412.8
28	8.67662	89797.2	42.4174	Andesite & Rhyolite	440	42	4236.26	5562.3	5688.9	0	5688.9	9559.49	9559.49
29	8.67662	90631.2	43.2242	Andesite & Rhyolite	440	42	4185.3	5495.38	5614.57	0	5614.57	9548.15	9548.15
30	8.67662	91199.6	44.0419	Andesite & Rhyolite	440	42	4121.96	5412.21	5522.19	0	5522.19	9508.55	9508.55
31	7.14528	74964.5	44.7969	Basalt	2000	49	6086.19	7991.29	5208.14	0	5208.14	11251.3	11251.3
32	7.14528	74237.9	45.4879	Basalt	2000	49	5932.04	7788.89	5032.21	0	5032.21	11066.1	11066.1
33	6.97079	71930.7	46.1788	Andesite & Rhyolite	440	42	3833.7	5033.73	5101.86	0	5101.86	9096.64	9096.64
34	6.97079	71657.9	46.8698	Andesite & Rhyolite	440	42	3751.57	4925.88	4982.07	0	4982.07	8986.84	8986.84
35	6.97079	71220.9	47.5698	Andesite & Rhyolite	440	42	3662.06	4808.36	4851.55	0	4851.55	8857.78	8857.78
36	6.75987	68103.7	48.2685	Basalt	2000	49	5385.78	7071.64	4408.71	0	4408.71	10446.9	10446.9
37	6.75987	66592	48.966	Basalt	2000	49	5199.52	6827.08	4196.12	0	4196.12	10170.3	10170.3

38	8.02465	77390.9	49.7405	Andesite & Rhyolite	440	42	3277.15	4302.96	4290.25	0	4290.25	8160.08	8160.08
39	8.02465	75821.5	50.5951	Andesite & Rhyolite	440	42	3142.32	4125.93	4093.65	0	4093.65	7918.5	7918.5
40	8.02465	73939.2	51.4654	Andesite & Rhyolite	440	42	2998.42	3936.99	3883.8	0	3883.8	7648.67	7648.67
41	8.02465	71725.8	52.3527	Andesite & Rhyolite	440	42	2845.62	3736.35	3660.97	0	3660.97	7349.78	7349.78
42	8.02465	69161	53.2582	Andesite & Rhyolite	440	42	2684.11	3524.29	3425.45	0	3425.45	7020.99	7020.99
43	8.02465	66222.1	54.1833	Andesite & Rhyolite	440	42	2514.12	3301.09	3177.57	0	3177.57	6661.34	6661.34
44	8.02465	62883.6	55.1296	Andesite & Rhyolite	440	42	2335.91	3067.1	2917.7	0	2917.7	6269.84	6269.84
45	8.02465	57572.8	56.0989	Andesite & Rhyolite	440	42	2101.05	2758.72	2575.2	0	2575.2	5701.76	5701.76
46	8.02465	48437.3	57.0933	Andesite & Rhyolite	440	42	1759.25	2309.93	2076.77	0	2076.77	4795.45	4795.45
47	8.02465	38684.7	58.1151	Andesite & Rhyolite	440	42	1417.55	1861.27	1578.48	0	1578.48	3857.2	3857.2
48	8.02465	28388.2	59.1671	Andesite & Rhyolite	440	42	1080.68	1418.96	1087.24	0	1087.24	2897.74	2897.74
49	8.02465	17496	60.2525	Andesite & Rhyolite	440	42	749.937	984.682	604.931	0	604.931	1917.18	1917.18
50	8.02465	5947.02	61.3753	Andesite & Rhyolite	440	42	409.373	537.515	108.301	0	108.301	858.375	858.375

Query 1 (spencer) - Safety Factor: 1.31302

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	8.05296	2311.96	24.8482	Andesite & Rhyolite	440	42	582.428	764.739	360.659	0	360.659	630.374	630.374
2	8.05296	6881.4	25.455	Andesite & Rhyolite	440	42	913.31	1199.19	843.17	0	843.17	1277.92	1277.92
3	8.05296	11341	26.0649	Andesite & Rhyolite	440	42	1224.92	1608.35	1297.59	0	1297.59	1896.74	1896.74
4	8.05296	15689.2	26.6779	Andesite & Rhyolite	440	42	1517.86	1992.98	1724.76	0	1724.76	2487.43	2487.43
5	8.05296	19924	27.2943	Andesite & Rhyolite	440	42	1792.66	2353.8	2125.49	0	2125.49	3050.52	3050.52
6	8.05296	24375.7	27.9141	Andesite & Rhyolite	440	42	2072.76	2721.57	2533.94	0	2533.94	3632.06	3632.06
7	8.05296	29346.5	28.5375	Andesite & Rhyolite	440	42	2378.14	3122.55	2979.27	0	2979.27	4272.51	4272.51
8	8.05296	33715.9	29.1646	Andesite & Rhyolite	440	42	2632.5	3456.53	3350.2	0	3350.2	4819.32	4819.32
9	8.05296	37477.8	29.7955	Andesite & Rhyolite	440	42	2837.74	3726.01	3649.48	0	3649.48	5274.38	5274.38
10	8.05296	41116	30.4305	Andesite & Rhyolite	440	42	3027.25	3974.84	3925.83	0	3925.83	5704.07	5704.07
11	7.97887	44187.3	31.0666	Basalt	2000	49	5479.99	7195.34	4516.25	0	4516.25	7817.64	7817.64
12	7.97887	47863.6	31.7041	Basalt	2000	49	5691.9	7473.58	4758.11	0	4758.11	8274.06	8274.06
13	7.97887	51084.3	32.346	Basalt	2000	49	5856.54	7689.76	4946.03	0	4946.03	8654.97	8654.97
14	7.77516	52447	32.9841	Andesite & Rhyolite	440	42	3634.93	4772.73	4811.98	0	4811.98	7171.1	7171.1
15	7.77516	55233.9	33.6186	Andesite & Rhyolite	440	42	3748.28	4921.57	4977.29	0	4977.29	7469.4	7469.4
16	7.77516	57961.3	34.2578	Andesite & Rhyolite	440	42	3853	5059.06	5129.98	0	5129.98	7754.16	7754.16
17	7.77516	61234.8	34.9019	Andesite & Rhyolite	440	42	3985.19	5232.64	5322.76	0	5322.76	8103.07	8103.07
18	7.77516	64368.7	35.5511	Andesite & Rhyolite	440	42	4103.33	5387.76	5495.05	0	5495.05	8427.46	8427.46

19	6.87601	58614.3	36.1675	Basalt	2000	49	6520.68	8561.78	5704.07	0	5704.07	10470.8	10470.8
20	6.87601	59766.3	36.7506	Basalt	2000	49	6515.47	8554.94	5698.12	0	5698.12	10563.6	10563.6
21	6.87601	60823	37.3382	Basalt	2000	49	6500.43	8535.2	5680.96	0	5680.96	10639.8	10639.8
22	8.42543	76891.2	37.9977	Andesite & Rhyolite	440	42	4218.98	5539.61	5663.7	0	5663.7	8959.65	8959.65
23	8.42543	79876.3	38.7306	Andesite & Rhyolite	440	42	4289.55	5632.27	5766.6	0	5766.6	9206.95	9206.95
24	8.42543	81859.1	39.4711	Andesite & Rhyolite	440	42	4306.41	5654.4	5791.19	0	5791.19	9337.47	9337.47
25	8.42543	83492.4	40.2196	Andesite & Rhyolite	440	42	4303.45	5650.52	5786.87	0	5786.87	9426.09	9426.09
26	7.82334	78741.5	40.9491	Basalt	2000	49	6522.8	8564.57	5706.49	0	5706.49	11366.5	11366.5
27	7.82334	79909.2	41.6595	Basalt	2000	49	6475.02	8501.83	5651.95	0	5651.95	11412.8	11412.8
28	8.67662	89797.2	42.4174	Andesite & Rhyolite	440	42	4236.26	5562.3	5688.9	0	5688.9	9559.49	9559.49
29	8.67662	90631.2	43.2242	Andesite & Rhyolite	440	42	4185.3	5495.38	5614.57	0	5614.57	9548.15	9548.15
30	8.67662	91199.6	44.0419	Andesite & Rhyolite	440	42	4121.96	5412.21	5522.19	0	5522.19	9508.55	9508.55
31	7.14528	74964.5	44.7969	Basalt	2000	49	6086.19	7991.29	5208.14	0	5208.14	11251.3	11251.3
32	7.14528	74237.9	45.4879	Basalt	2000	49	5932.04	7788.89	5032.21	0	5032.21	11066.1	11066.1
33	6.97079	71930.7	46.1788	Andesite & Rhyolite	440	42	3833.7	5033.73	5101.86	0	5101.86	9096.64	9096.64
34	6.97079	71657.9	46.8698	Andesite & Rhyolite	440	42	3751.57	4925.88	4982.07	0	4982.07	8986.84	8986.84
35	6.97079	71220.9	47.5698	Andesite & Rhyolite	440	42	3662.06	4808.36	4851.55	0	4851.55	8857.78	8857.78
36	6.75987	68103.7	48.2685	Basalt	2000	49	5385.78	7071.64	4408.71	0	4408.71	10446.9	10446.9
37	6.75987	66592	48.966	Basalt	2000	49	5199.52	6827.08	4196.12	0	4196.12	10170.3	10170.3
38	8.02465	77390.9	49.7405	Andesite & Rhyolite	440	42	3277.15	4302.96	4290.25	0	4290.25	8160.08	8160.08
39	8.02465	75821.5	50.5951	Andesite & Rhyolite	440	42	3142.32	4125.93	4093.65	0	4093.65	7918.5	7918.5
40	8.02465	73939.2	51.4654	Andesite & Rhyolite	440	42	2998.42	3936.99	3883.8	0	3883.8	7648.67	7648.67
41	8.02465	71725.8	52.3527	Andesite & Rhyolite	440	42	2845.62	3736.35	3660.97	0	3660.97	7349.78	7349.78
42	8.02465	69161	53.2582	Andesite & Rhyolite	440	42	2684.11	3524.29	3425.45	0	3425.45	7020.99	7020.99
43	8.02465	66222.1	54.1833	Andesite & Rhyolite	440	42	2514.12	3301.09	3177.57	0	3177.57	6661.34	6661.34
44	8.02465	62883.6	55.1296	Andesite & Rhyolite	440	42	2335.91	3067.1	2917.7	0	2917.7	6269.84	6269.84
45	8.02465	57572.8	56.0989	Andesite & Rhyolite	440	42	2101.05	2758.72	2575.2	0	2575.2	5701.76	5701.76
46	8.02465	48437.3	57.0933	Andesite & Rhyolite	440	42	1759.25	2309.93	2076.77	0	2076.77	4795.45	4795.45
47	8.02465	38684.7	58.1151	Andesite & Rhyolite	440	42	1417.55	1861.27	1578.48	0	1578.48	3857.2	3857.2
48	8.02465	28388.2	59.1671	Andesite & Rhyolite	440	42	1080.68	1418.96	1087.24	0	1087.24	2897.74	2897.74
49	8.02465	17496	60.2525	Andesite & Rhyolite	440	42	749.937	984.682	604.931	0	604.931	1917.18	1917.18
50	8.02465	5947.02	61.3753	Andesite & Rhyolite	440	42	409.373	537.515	108.301	0	108.301	858.375	858.375

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.31302

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	234.022	200.023	0	0	0

2	242.075	203.752	3353.05	2773.14	39.5924
3	250.128	207.585	7487.93	6192.9	39.5925
4	258.181	211.524	12257.4	10137.5	39.5925
5	266.234	215.571	17521.9	14491.5	39.5925
6	274.287	219.726	23149.7	19146	39.5925
7	282.34	223.992	29058.4	24032.8	39.5925
8	290.393	228.372	35194.3	29107.5	39.5925
9	298.446	232.866	41372.6	34217.3	39.5925
10	306.499	237.477	47434.4	39230.7	39.5925
11	314.552	242.207	53282.3	44067.1	39.5924
12	322.531	247.014	75370	62334.8	39.5925
13	330.51	251.943	97409	80562.2	39.5925
14	338.489	256.996	119223	98603.2	39.5924
15	346.264	262.042	123249	101933	39.5924
16	354.039	267.211	126711	104797	39.5926
17	361.814	272.507	129553	107147	39.5925
18	369.589	277.931	131717	108936	39.5923
19	377.364	283.488	133141	110114	39.5924
20	384.24	288.514	149380	123544	39.5923
21	391.117	293.649	164996	136460	39.5925
22	397.993	298.894	179968	148843	39.5925
23	406.418	305.476	178295	147459	39.5925
24	414.843	312.234	175529	145171	39.5924
25	423.269	319.172	171691	141997	39.5924
26	431.694	326.297	166778	137934	39.5925
27	439.518	333.086	179154	148169	39.5924
28	447.341	340.046	190554	157598	39.5925
29	456.018	347.974	182272	150748	39.5924
30	464.694	356.128	172860	142964	39.5925
31	473.371	364.52	162346	134269	39.5926
32	480.516	371.614	168955	139734	39.5924
33	487.661	378.882	174837	144599	39.5925
34	494.632	386.146	164547	136089	39.5925
35	501.603	393.587	153669	127092	39.5925
36	508.574	401.213	142241	117640	39.5923
37	515.334	408.792	145296	120167	39.5924
38	522.093	416.559	147911	122330	39.5925
39	530.118	426.035	133598	110492	39.5924
40	538.143	435.803	118870	98311.9	39.5926
41	546.167	445.879	103839	85879.9	39.5924
42	554.192	456.281	88628.5	73300.3	39.5925
43	562.217	467.031	73381.2	60690	39.5925
44	570.241	478.15	58256.1	48180.8	39.5925
45	578.266	489.666	43432.6	35921	39.5925
46	586.291	501.607	29569.1	24455.1	39.5924
47	594.315	514.008	17955.8	14850.3	39.5924
48	602.34	526.908	8988.01	7433.54	39.5925
49	610.365	540.352	3057.67	2528.85	39.5925
50	618.389	554.394	591.369	489.092	39.5925
51	626.414	569.097	0	0	0

Query 1 (spencer) - Safety Factor: 1.31302

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	234.022	200.023	0	0	0
2	242.075	203.752	3353.05	2773.14	39.5924
3	250.128	207.585	7487.93	6192.9	39.5925
4	258.181	211.524	12257.4	10137.5	39.5925
5	266.234	215.571	17521.9	14491.5	39.5925
6	274.287	219.726	23149.7	19146	39.5925
7	282.34	223.992	29058.4	24032.8	39.5925

8	290.393	228.372	35194.3	29107.5	39.5925
9	298.446	232.866	41372.6	34217.3	39.5925
10	306.499	237.477	47434.4	39230.7	39.5925
11	314.552	242.207	53282.3	44067.1	39.5924
12	322.531	247.014	75370	62334.8	39.5925
13	330.51	251.943	97409	80562.2	39.5925
14	338.489	256.996	119223	98603.2	39.5924
15	346.264	262.042	123249	101933	39.5924
16	354.039	267.211	126711	104797	39.5926
17	361.814	272.507	129553	107147	39.5925
18	369.589	277.931	131717	108936	39.5923
19	377.364	283.488	133141	110114	39.5924
20	384.24	288.514	149380	123544	39.5923
21	391.117	293.649	164996	136460	39.5925
22	397.993	298.894	179968	148843	39.5925
23	406.418	305.476	178295	147459	39.5925
24	414.843	312.234	175529	145171	39.5924
25	423.269	319.172	171691	141997	39.5924
26	431.694	326.297	166778	137934	39.5925
27	439.518	333.086	179154	148169	39.5924
28	447.341	340.046	190554	157598	39.5925
29	456.018	347.974	182272	150748	39.5924
30	464.694	356.128	172860	142964	39.5925
31	473.371	364.52	162346	134269	39.5926
32	480.516	371.614	168955	139734	39.5924
33	487.661	378.882	174837	144599	39.5925
34	494.632	386.146	164547	136089	39.5925
35	501.603	393.587	153669	127092	39.5925
36	508.574	401.213	142241	117640	39.5923
37	515.334	408.792	145296	120167	39.5924
38	522.093	416.559	147911	122330	39.5925
39	530.118	426.035	133598	110492	39.5924
40	538.143	435.803	118870	98311.9	39.5926
41	546.167	445.879	103839	85879.9	39.5924
42	554.192	456.281	88628.5	73300.3	39.5925
43	562.217	467.031	73381.2	60690	39.5925
44	570.241	478.15	58256.1	48180.8	39.5925
45	578.266	489.666	43432.6	35921	39.5925
46	586.291	501.607	29569.1	24455.1	39.5924
47	594.315	514.008	17955.8	14850.3	39.5924
48	602.34	526.908	8988.01	7433.54	39.5925
49	610.365	540.352	3057.67	2528.85	39.5925
50	618.389	554.394	591.369	489.092	39.5925
51	626.414	569.097	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046
900	364.52
900	378.882

900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
448.084	416.559
432.914	401.213
410.838	378.882
396.639	364.52
372.445	340.046
358.854	326.297
331.764	298.894
316.534	283.488
290.344	256.996
275.725	242.207
234	200
-119.082	200

Material Boundary

X	Y
275.725	242.207
900	242.207

Material Boundary

X	Y
290.344	256.996
900	256.996

Material Boundary

X	Y
316.534	283.488
900	283.488

Material Boundary

X	Y
331.764	298.894
900	298.894

Material Boundary

X	Y
358.854	326.297
900	326.297

Material Boundary

X	Y
372.445	340.046
900	340.046

Material Boundary

X	Y
396.639	364.52

900	364.52

Material Boundary

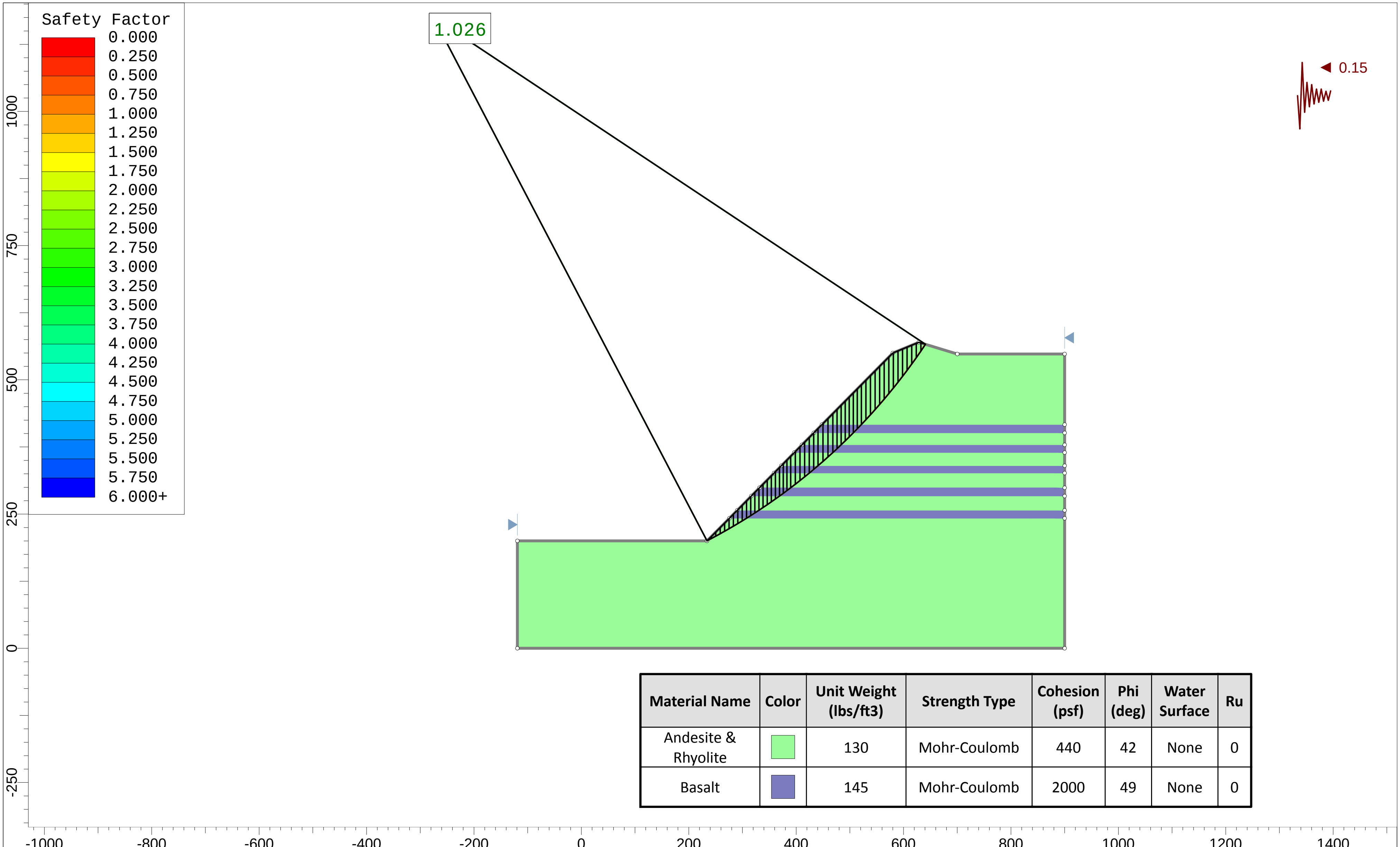
X	Y
410.838	378.882
900	378.882

Material Boundary

X	Y
432.914	401.213
900	401.213

Material Boundary

X	Y
448.084	416.559
900	416.559



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Andesite & Rhyolite		130	Mohr-Coulomb	440	42	None	0
Basalt		145	Mohr-Coulomb	2000	49	None	0

BAJADA Geosciences, Inc.

Project	Ward Lake Quarry Expansion		
Analysis Description	350' Slope, dry, pseudostatic, 45 degree gross slope inclination		
Drawn By J.Bianchin	*Scale* 1:2967	*Company*	Bajada Geosciences, Inc.
Date	4/3/2020, 2:25:57 PM	*File Name*	350',dry,PS,45deg.slim

SLIDEINTERPRET 8.032

Slide Analysis Information

Ward Lake Quarry Expansion

Project Summary

Slide Modeler Version:	8.032
Compute Time:	00h:00m:03.384s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search

Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.15

Materials

Property	Andesite & Rhyolite	Basalt
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	130	145
Cohesion [psf]	440	2000
Friction Angle [°]	42	49
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: spencer

FS	1.025820
Center:	-275.555, 1175.072
Radius:	1100.177
Left Slip Surface Endpoint:	234.022, 200.023
Right Slip Surface Endpoint:	640.747, 566.155
Resisting Moment:	2.4147e+09 lb-ft
Driving Moment:	2.35391e+09 lb-ft
Resisting Horizontal Force:	1.64514e+06 lb
Driving Horizontal Force:	1.60373e+06 lb
Total Slice Area:	20696 ft2
Surface Horizontal Width:	406.725 ft
Surface Average Height:	50.8846 ft

Valid/Invalid Surfaces

Method: spencer

Number of Valid Surfaces: 9884
Number of Invalid Surfaces: 0

Slice Data

Global Minimum Query (spencer) - Safety Factor: 1.02582

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	8.18328	2104.91	27.8333	Andesite & Rhyolite	440	42	783.573	803.805	404.046	0	404.046	817.76	817.76
2	8.18328	6267.6	28.3163	Andesite & Rhyolite	440	42	1114.22	1142.99	780.749	0	780.749	1381.11	1381.11
3	8.18328	10335.4	28.8016	Andesite & Rhyolite	440	42	1424.9	1461.69	1134.7	0	1134.7	1918.09	1918.09
4	8.18328	14306.9	29.289	Andesite & Rhyolite	440	42	1716.24	1760.55	1466.63	0	1466.63	2429.3	2429.3
5	8.18328	18180.8	29.7789	Andesite & Rhyolite	440	42	1988.86	2040.21	1777.21	0	1777.21	2915.27	2915.27
6	8.18328	22370.8	30.2711	Andesite & Rhyolite	440	42	2274.76	2333.49	2102.94	0	2102.94	3430.66	3430.66
7	8.18328	27049.6	30.7658	Andesite & Rhyolite	440	42	2585.73	2652.49	2457.22	0	2457.22	3996.53	3996.53
8	8.18328	31017.6	31.2631	Andesite & Rhyolite	440	42	2832.53	2905.67	2738.4	0	2738.4	4458.11	4458.11
9	8.18328	34486.1	31.763	Andesite & Rhyolite	440	42	3033.5	3111.82	2967.36	0	2967.36	4845.5	4845.5
10	7.67082	35105	32.2498	Basalt	2000	49	6311.33	6474.29	3889.44	0	3889.44	7871.56	7871.56
11	7.67082	37728.5	32.7234	Basalt	2000	49	6478.88	6646.16	4038.85	0	4038.85	8201.95	8201.95
12	7.67082	40815.7	33.1995	Basalt	2000	49	6683.63	6856.2	4221.43	0	4221.43	8594.99	8594.99
13	7.66569	43746.4	33.6781	Andesite & Rhyolite	440	42	3658.15	3752.6	3679.01	0	3679.01	6116.67	6116.67
14	7.66569	46345.6	34.1592	Andesite & Rhyolite	440	42	3780.22	3877.83	3818.09	0	3818.09	6383.2	6383.2
15	7.66569	48842.1	34.6431	Andesite & Rhyolite	440	42	3889.68	3990.11	3942.8	0	3942.8	6630.43	6630.43
16	7.66569	51290.2	35.1298	Andesite & Rhyolite	440	42	3990.68	4093.72	4057.86	0	4057.86	6865.66	6865.66
17	7.66569	54282.4	35.6194	Andesite & Rhyolite	440	42	4122.78	4229.23	4208.36	0	4208.36	7162.1	7162.1
18	6.93042	51389.5	36.0882	Basalt	2000	49	7488.7	7682.06	4939.34	0	4939.34	10397.8	10397.8
19	6.93042	52676.8	36.5362	Basalt	2000	49	7497.75	7691.34	4947.41	0	4947.41	10502.8	10502.8
20	6.93042	53790	36.9867	Basalt	2000	49	7487.4	7680.72	4938.18	0	4938.18	10577.6	10577.6
21	8.6551	69059.3	37.4967	Andesite & Rhyolite	440	42	4294.11	4404.98	4403.56	0	4403.56	7698.14	7698.14
22	8.6551	72143.2	38.067	Andesite & Rhyolite	440	42	4377.51	4490.54	4498.57	0	4498.57	7926.92	7926.92
23	8.6551	75240.1	38.6418	Andesite & Rhyolite	440	42	4456.11	4571.17	4588.13	0	4588.13	8150.72	8150.72
24	8.6551	77329.2	39.2213	Andesite & Rhyolite	440	42	4477.43	4593.04	4612.42	0	4612.42	8266.9	8266.9
25	8.17285	74277.5	39.7892	Basalt	2000	49	7579.17	7774.86	5020.01	0	5020.01	11332.3	11332.3
26	8.17285	75382.9	40.3454	Basalt	2000	49	7512.91	7706.89	4960.93	0	4960.93	11342.6	11342.6
27	9.19337	87083.9	40.9415	Andesite & Rhyolite	440	42	4452.3	4567.26	4583.79	0	4583.79	8446.14	8446.14
28	9.19337	88964.6	41.5784	Andesite & Rhyolite	440	42	4442.75	4557.46	4572.9	0	4572.9	8514.37	8514.37
29	9.19337	90220	42.2217	Andesite & Rhyolite	440	42	4403.7	4517.4	4528.41	0	4528.41	8524.48	8524.48
30	7.67626	75725.3	42.8175	Basalt	2000	49	7237.24	7424.11	4715.11	0	4715.11	11421	11421
31	7.67626	75480.8	43.3649	Basalt	2000	49	7087.67	7270.67	4581.73	0	4581.73	11276	11276
32	7.58265	74584	43.914	Andesite & Rhyolite	440	42	4173.79	4281.56	4266.49	0	4266.49	8284.98	8284.98
33	7.58265	74878.6	44.4647	Andesite & Rhyolite	440	42	4113.95	4220.17	4198.3	0	4198.3	8236.09	8236.09
34	7.58265	75031.5	45.0207	Andesite & Rhyolite	440	42	4047.71	4152.22	4122.84	0	4122.84	8173.48	8173.48
35	7.44672	73270.3	45.5771	Basalt	2000	49	6580.93	6750.85	4129.85	0	4129.85	10844.7	10844.7
36	7.44672	72277.7	46.1339	Basalt	2000	49	6399.14	6564.37	3967.74	0	3967.74	10625.3	10625.3

37	8.52881	81924.6	46.7378	Andesite & Rhyolite	440	42	3730.93	3827.26	3761.93	0	3761.93	7726.33	7726.33
38	8.52881	81326.2	47.3899	Andesite & Rhyolite	440	42	3630.86	3724.61	3647.93	0	3647.93	7595.06	7595.06
39	8.52881	80491.4	48.0502	Andesite & Rhyolite	440	42	3523.8	3614.78	3525.96	0	3525.96	7446.43	7446.43
40	8.52881	79411.1	48.719	Andesite & Rhyolite	440	42	3409.95	3497.99	3396.24	0	3396.24	7280.3	7280.3
41	8.52881	78075.3	49.3969	Andesite & Rhyolite	440	42	3289.5	3374.43	3259.01	0	3259.01	7096.51	7096.51
42	8.52881	76473.5	50.0842	Andesite & Rhyolite	440	42	3162.61	3244.27	3114.46	0	3114.46	6894.78	6894.78
43	8.52881	74551.3	50.7816	Andesite & Rhyolite	440	42	3027.97	3106.15	2961.06	0	2961.06	6671.28	6671.28
44	8.52881	68891	51.4895	Andesite & Rhyolite	440	42	2768.58	2840.06	2665.53	0	2665.53	6144.8	6144.8
45	8.52881	60742.6	52.2086	Andesite & Rhyolite	440	42	2435.15	2498.03	2285.68	0	2285.68	5426.03	5426.03
46	8.52881	52275.2	52.9395	Andesite & Rhyolite	440	42	2104.55	2158.89	1909.02	0	1909.02	4695.72	4695.72
47	8.52881	43472.7	53.683	Andesite & Rhyolite	440	42	1776.64	1822.51	1535.43	0	1535.43	3952.53	3952.53
48	8.52881	34317	54.4399	Andesite & Rhyolite	440	42	1451.29	1488.76	1164.76	0	1164.76	3194.88	3194.88
49	8.52881	24119.8	55.211	Andesite & Rhyolite	440	42	1107.88	1136.48	773.522	0	773.522	2368.2	2368.2
50	8.52881	8457.78	55.9974	Andesite & Rhyolite	440	42	475.811	488.096	53.4164	0	53.4164	758.766	758.766

Query 1 (spencer) - Safety Factor: 1.02582

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	8.18328	2104.91	27.8333	Andesite & Rhyolite	440	42	783.573	803.805	404.046	0	404.046	817.76	817.76
2	8.18328	6267.6	28.3163	Andesite & Rhyolite	440	42	1114.22	1142.99	780.749	0	780.749	1381.11	1381.11
3	8.18328	10335.4	28.8016	Andesite & Rhyolite	440	42	1424.9	1461.69	1134.7	0	1134.7	1918.09	1918.09
4	8.18328	14306.9	29.289	Andesite & Rhyolite	440	42	1716.24	1760.55	1466.63	0	1466.63	2429.3	2429.3
5	8.18328	18180.8	29.7789	Andesite & Rhyolite	440	42	1988.86	2040.21	1777.21	0	1777.21	2915.27	2915.27
6	8.18328	22370.8	30.2711	Andesite & Rhyolite	440	42	2274.76	2333.49	2102.94	0	2102.94	3430.66	3430.66
7	8.18328	27049.6	30.7658	Andesite & Rhyolite	440	42	2585.73	2652.49	2457.22	0	2457.22	3996.53	3996.53
8	8.18328	31017.6	31.2631	Andesite & Rhyolite	440	42	2832.53	2905.67	2738.4	0	2738.4	4458.11	4458.11
9	8.18328	34486.1	31.763	Andesite & Rhyolite	440	42	3033.5	3111.82	2967.36	0	2967.36	4845.5	4845.5
10	7.67082	35105	32.2498	Basalt	2000	49	6311.33	6474.29	3889.44	0	3889.44	7871.56	7871.56
11	7.67082	37728.5	32.7234	Basalt	2000	49	6478.88	6646.16	4038.85	0	4038.85	8201.95	8201.95
12	7.67082	40815.7	33.1995	Basalt	2000	49	6683.63	6856.2	4221.43	0	4221.43	8594.99	8594.99
13	7.66569	43746.4	33.6781	Andesite & Rhyolite	440	42	3658.15	3752.6	3679.01	0	3679.01	6116.67	6116.67
14	7.66569	46345.6	34.1592	Andesite & Rhyolite	440	42	3780.22	3877.83	3818.09	0	3818.09	6383.2	6383.2
15	7.66569	48842.1	34.6431	Andesite & Rhyolite	440	42	3889.68	3990.11	3942.8	0	3942.8	6630.43	6630.43
16	7.66569	51290.2	35.1298	Andesite & Rhyolite	440	42	3990.68	4093.72	4057.86	0	4057.86	6865.66	6865.66
17	7.66569	54282.4	35.6194	Andesite & Rhyolite	440	42	4122.78	4229.23	4208.36	0	4208.36	7162.1	7162.1

18	6.93042	51389.5	36.0882	Basalt	2000	49	7488.7	7682.06	4939.34	0	4939.34	10397.8	10397.8
19	6.93042	52676.8	36.5362	Basalt	2000	49	7497.75	7691.34	4947.41	0	4947.41	10502.8	10502.8
20	6.93042	53790	36.9867	Basalt	2000	49	7487.4	7680.72	4938.18	0	4938.18	10577.6	10577.6
21	8.6551	69059.3	37.4967	Andesite & Rhyolite	440	42	4294.11	4404.98	4403.56	0	4403.56	7698.14	7698.14
22	8.6551	72143.2	38.067	Andesite & Rhyolite	440	42	4377.51	4490.54	4498.57	0	4498.57	7926.92	7926.92
23	8.6551	75240.1	38.6418	Andesite & Rhyolite	440	42	4456.11	4571.17	4588.13	0	4588.13	8150.72	8150.72
24	8.6551	77329.2	39.2213	Andesite & Rhyolite	440	42	4477.43	4593.04	4612.42	0	4612.42	8266.9	8266.9
25	8.17285	74277.5	39.7892	Basalt	2000	49	7579.17	7774.86	5020.01	0	5020.01	11332.3	11332.3
26	8.17285	75382.9	40.3454	Basalt	2000	49	7512.91	7706.89	4960.93	0	4960.93	11342.6	11342.6
27	9.19337	87083.9	40.9415	Andesite & Rhyolite	440	42	4452.3	4567.26	4583.79	0	4583.79	8446.14	8446.14
28	9.19337	88964.6	41.5784	Andesite & Rhyolite	440	42	4442.75	4557.46	4572.9	0	4572.9	8514.37	8514.37
29	9.19337	90220	42.2217	Andesite & Rhyolite	440	42	4403.7	4517.4	4528.41	0	4528.41	8524.48	8524.48
30	7.67626	75725.3	42.8175	Basalt	2000	49	7237.24	7424.11	4715.11	0	4715.11	11421	11421
31	7.67626	75480.8	43.3649	Basalt	2000	49	7087.67	7270.67	4581.73	0	4581.73	11276	11276
32	7.58265	74584	43.914	Andesite & Rhyolite	440	42	4173.79	4281.56	4266.49	0	4266.49	8284.98	8284.98
33	7.58265	74878.6	44.4647	Andesite & Rhyolite	440	42	4113.95	4220.17	4198.3	0	4198.3	8236.09	8236.09
34	7.58265	75031.5	45.0207	Andesite & Rhyolite	440	42	4047.71	4152.22	4122.84	0	4122.84	8173.48	8173.48
35	7.44672	73270.3	45.5771	Basalt	2000	49	6580.93	6750.85	4129.85	0	4129.85	10844.7	10844.7
36	7.44672	72277.7	46.1339	Basalt	2000	49	6399.14	6564.37	3967.74	0	3967.74	10625.3	10625.3
37	8.52881	81924.6	46.7378	Andesite & Rhyolite	440	42	3730.93	3827.26	3761.93	0	3761.93	7726.33	7726.33
38	8.52881	81326.2	47.3899	Andesite & Rhyolite	440	42	3630.86	3724.61	3647.93	0	3647.93	7595.06	7595.06
39	8.52881	80491.4	48.0502	Andesite & Rhyolite	440	42	3523.8	3614.78	3525.96	0	3525.96	7446.43	7446.43
40	8.52881	79411.1	48.719	Andesite & Rhyolite	440	42	3409.95	3497.99	3396.24	0	3396.24	7280.3	7280.3
41	8.52881	78075.3	49.3969	Andesite & Rhyolite	440	42	3289.5	3374.43	3259.01	0	3259.01	7096.51	7096.51
42	8.52881	76473.5	50.0842	Andesite & Rhyolite	440	42	3162.61	3244.27	3114.46	0	3114.46	6894.78	6894.78
43	8.52881	74551.3	50.7816	Andesite & Rhyolite	440	42	3027.97	3106.15	2961.06	0	2961.06	6671.28	6671.28
44	8.52881	68891	51.4895	Andesite & Rhyolite	440	42	2768.58	2840.06	2665.53	0	2665.53	6144.8	6144.8
45	8.52881	60742.6	52.2086	Andesite & Rhyolite	440	42	2435.15	2498.03	2285.68	0	2285.68	5426.03	5426.03
46	8.52881	52275.2	52.9395	Andesite & Rhyolite	440	42	2104.55	2158.89	1909.02	0	1909.02	4695.72	4695.72
47	8.52881	43472.7	53.683	Andesite & Rhyolite	440	42	1776.64	1822.51	1535.43	0	1535.43	3952.53	3952.53
48	8.52881	34317	54.4399	Andesite & Rhyolite	440	42	1451.29	1488.76	1164.76	0	1164.76	3194.88	3194.88
49	8.52881	24119.8	55.211	Andesite & Rhyolite	440	42	1107.88	1136.48	773.522	0	773.522	2368.2	2368.2
50	8.52881	8457.78	55.9974	Andesite & Rhyolite	440	42	475.811	488.096	53.4164	0	53.4164	758.766	758.766

Interslice Data

Global Minimum Query (spencer) - Safety Factor: 1.02582

Slice Number	X coordinate	Y coordinate - Bottom	Interslice Normal Force	Interslice Shear Force	Interslice Force Angle

	[ft]	[ft]	[lbs]	[lbs]	[degrees]
1	234.022	200.023	0	0	0
2	242.206	204.343	4371.59	4809.32	47.7297
3	250.389	208.753	9136.59	10051.4	47.7296
4	258.572	213.252	14179.5	15599.3	47.7297
5	266.755	217.842	19391.5	21333.2	47.7297
6	274.939	222.524	24670.8	27141.1	47.7297
7	283.122	227.301	29946.3	32944.8	47.7297
8	291.305	232.172	35146.8	38666.1	47.7297
9	299.489	237.141	40143.8	44163.5	47.7297
10	307.672	242.207	44841.4	49331.4	47.7297
11	315.343	247.047	69321.8	76263.1	47.7297
12	323.014	251.976	93615.1	102989	47.7297
13	330.684	256.996	117739	129528	47.7296
14	338.35	262.104	120517	132585	47.7298
15	346.016	267.305	122777	135071	47.7298
16	353.681	272.602	124481	136946	47.7298
17	361.347	277.996	125593	138168	47.7296
18	369.013	283.488	126045	138666	47.7297
19	375.943	288.539	145454	160018	47.7296
20	382.874	293.674	164279	180728	47.7296
21	389.804	298.894	182493	200766	47.7297
22	398.459	305.535	180179	198221	47.7298
23	407.114	312.313	176876	194586	47.7296
24	415.769	319.233	172535	189811	47.7297
25	424.424	326.297	167231	183976	47.7297
26	432.597	333.104	184064	202495	47.7298
27	440.77	340.046	199919	219937	47.7297
28	449.964	348.021	191364	210526	47.7298
29	459.157	356.177	181700	199893	47.7296
30	468.35	364.52	171005	188128	47.7297
31	476.027	371.632	181846	200054	47.7296
32	483.703	378.882	191889	211103	47.7297
33	491.285	386.183	181305	199459	47.7297
34	498.868	393.625	170125	187159	47.7296
35	506.451	401.213	158377	174236	47.7298
36	513.897	408.812	165173	181712	47.7297
37	521.344	416.559	171399	188562	47.7298
38	529.873	425.622	156942	172657	47.7297
39	538.402	434.893	141988	156205	47.7296
40	546.931	444.382	126609	139286	47.7296
41	555.459	454.097	110881	121984	47.7298
42	563.988	464.046	94890.6	104392	47.7297
43	572.517	474.241	78729.9	86613.2	47.7297
44	581.046	484.692	62511.7	68771	47.7297
45	589.575	495.41	47297.9	52033.9	47.7297
46	598.103	506.408	33883.7	37276.5	47.7297
47	606.632	517.702	22491	24743	47.7297
48	615.161	529.305	13355.8	14693.2	47.7298
49	623.69	541.236	6730.15	7404.05	47.7297
50	632.219	553.512	3095.76	3405.74	47.7297
51	640.747	566.155	0	0	0

Query 1 (spencer) - Safety Factor: 1.02582

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	234.022	200.023	0	0	0
2	242.206	204.343	4371.59	4809.32	47.7297
3	250.389	208.753	9136.59	10051.4	47.7296
4	258.572	213.252	14179.5	15599.3	47.7297
5	266.755	217.842	19391.5	21333.2	47.7297

6	274.939	222.524	24670.8	27141.1	47.7297
7	283.122	227.301	29946.3	32944.8	47.7297
8	291.305	232.172	35146.8	38666.1	47.7297
9	299.489	237.141	40143.8	44163.5	47.7297
10	307.672	242.207	44841.4	49331.4	47.7297
11	315.343	247.047	69321.8	76263.1	47.7297
12	323.014	251.976	93615.1	102989	47.7297
13	330.684	256.996	117739	129528	47.7296
14	338.35	262.104	120517	132585	47.7298
15	346.016	267.305	122777	135071	47.7298
16	353.681	272.602	124481	136946	47.7298
17	361.347	277.996	125593	138168	47.7296
18	369.013	283.488	126045	138666	47.7297
19	375.943	288.539	145454	160018	47.7296
20	382.874	293.674	164279	180728	47.7296
21	389.804	298.894	182493	200766	47.7297
22	398.459	305.535	180179	198221	47.7298
23	407.114	312.313	176876	194586	47.7296
24	415.769	319.233	172535	189811	47.7297
25	424.424	326.297	167231	183976	47.7297
26	432.597	333.104	184064	202495	47.7298
27	440.77	340.046	199919	219937	47.7297
28	449.964	348.021	191364	210526	47.7298
29	459.157	356.177	181700	199893	47.7296
30	468.35	364.52	171005	188128	47.7297
31	476.027	371.632	181846	200054	47.7296
32	483.703	378.882	191889	211103	47.7297
33	491.285	386.183	181305	199459	47.7297
34	498.868	393.625	170125	187159	47.7296
35	506.451	401.213	158377	174236	47.7298
36	513.897	408.812	165173	181712	47.7297
37	521.344	416.559	171399	188562	47.7298
38	529.873	425.622	156942	172657	47.7297
39	538.402	434.893	141988	156205	47.7296
40	546.931	444.382	126609	139286	47.7296
41	555.459	454.097	110881	121984	47.7298
42	563.988	464.046	94890.6	104392	47.7297
43	572.517	474.241	78729.9	86613.2	47.7297
44	581.046	484.692	62511.7	68771	47.7297
45	589.575	495.41	47297.9	52033.9	47.7297
46	598.103	506.408	33883.7	37276.5	47.7297
47	606.632	517.702	22491	24743	47.7297
48	615.161	529.305	13355.8	14693.2	47.7298
49	623.69	541.236	6730.15	7404.05	47.7297
50	632.219	553.512	3095.76	3405.74	47.7297
51	640.747	566.155	0	0	0

Entity Information

External Boundary

X	Y
-119.082	0
900	0
900	242.207
900	256.996
900	283.488
900	298.894
900	326.297
900	340.046

900	364.52
900	378.882
900	401.213
900	416.559
900	548
700	548
628.434	569.928
580	550
448.084	416.559
432.914	401.213
410.838	378.882
396.639	364.52
372.445	340.046
358.854	326.297
331.764	298.894
316.534	283.488
290.344	256.996
275.725	242.207
234	200
-119.082	200

Material Boundary

X	Y
275.725	242.207
900	242.207

Material Boundary

X	Y
290.344	256.996
900	256.996

Material Boundary

X	Y
316.534	283.488
900	283.488

Material Boundary

X	Y
331.764	298.894
900	298.894

Material Boundary

X	Y
358.854	326.297
900	326.297

Material Boundary

X	Y
372.445	340.046
900	340.046

Material Boundary

X	Y
396.639	364.52
900	364.52

Material Boundary

X	Y
410.838	378.882
900	378.882

Material Boundary

X	Y
432.914	401.213
900	401.213

Material Boundary

X	Y
448.084	416.559
900	416.559

APPENDIX C

Air-Percussion Explorations

APPENDIX C
AIR-PERCUSSION EXPLORATIONS

Exploration at the project site was performed by Hat Creek Construction using air-percussion (Air-Track) methods. The drilling was performed between February 10 and February 24, 2020 by Precision Blasting out of Carson City, Nevada. A total of 90 air-percussion holes were advanced in the study area. A Bajada representative was not involved with development of the exploration plan nor was present on-site during drilling. Logs of the air-percussion drill holes were provided to Bajada after the exploration program was completed.

The logs of those air-percussion drill holes are attached to this appendix.

PO Box 3365
Carson City, NV 89702
Office 775.883.0303
Fax 775.883.8013
Cell 775.315.1257
Email don@nvblasting.com

CAL NEVADA PRECISION BLASTING

Drill Log

Date 2/10/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2157

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
1	112	4		X	Fill 4' soft red tan 6ft/min 4'-80' tan soft clay rock/ boulder mix 4.8-5.8ft/min 80'-112'
					TEST DRILLING
					East side of primary crusher lower road north end

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

CAL NEVADA PRECISION BLASTING

PO Box 3365
Carson City, NV 89702
Office 775.883.0303
Fax 775.883.8013
Cell 775.315.1257
Email don@nvblasting.com

Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2160.1

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
2	112	0		X	Soft red 6.4 ft/min 0'-14' brown rock 3.8 ft/min 14'-26' soft red/tan boulder mix 5.8ft/min
					26'-90' soft brown rock 4.2 ft/min 90'-112'
					TEST DRILL
					East side crusher primary lower road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2160.8

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
3	112	0		X	Tan/red boulder mix 4ft/min 0'-18' tan/brown boulder mix 4ft-7ft/min 18'-112'
					Test Drill
					East side primary lower beach mid point

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2161.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
4	112	4		X	4ft clay/rock fill soft brown rock boulder mix 5ft/min 4'-90' tan rock 7ft/min 90'-112'
					Test drilling
					East side primary south side lower road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2162.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
5	112	0		X	Soft brown rock 5ft/min 0'-38' 8ft/min 38'-100' soft tan rock 8ft/min 100'-112'
					Test drill
					East primary south side lower bench

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2163

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name ___________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
6	112	8		X	8ft dirt super soft brownish red rock 9ft/min 8'-77' soft tan rock 7ft/min 77'-112'
					Test drill
					East primary 2nd bench north

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2163.8

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
7	112	0		X	Brown clay rock mix 3ft-7ft/ min 0'-38' soft brown rock 7ft/min 38'-112'
					Test drill
					East primary 2nd road midway

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 5.5 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2165

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
8	112	0		X	Soft brown rock 8ft/min 0'-36' tan boulder mix 4ft-7ft/ min 36'-112'
					East primary perpendicular to 2nd road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2167

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
9	80	5		X	Clay rock mix 7ft/min 5'-40' soft tan boulder mix 8ft/min 40'-80'
					Test drill
					Location 3 south side pit mid bench north end

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/11/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2167.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
10	112	4		X	Clay rock mix 6ft/min 4'-38' soft tan boulder mix 9ft/min 38ft'-80' gray rock 3ft/min 80'-90'
					Rock clay mix 90'-112'
					Test drill
					Location 3 mid bench north side

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2169

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
11	96	3		X	0-8' soft dirt 7ft/min 8'-10' boulder 10'-48 Red/tan clay rock mix 6.5ft/min
					Tan clay mix 7ft/min 48'-96'

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2170

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
12	112	4		X	Tan dirt 8ft/min 0-32' tan boulder mix 4.8-6ft/min 32'-90' soft white sand 12ft/min 09'-96'
					Test drill
					North boundary near blm before fence next to lone tree

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2172

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 2 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
13	112	3		X	Red tan clay boulder mix 6ft/min 0-14' light grey rock 2-4ft/min 14'-33' tan rock 4-5ft/min 33
					Grey tan mix rock 3.5-4.5ft-min 43'-60' grey rock 1.2-3ft/min 60'-90'
					Tan rock clay mix 4-5ft/min 90'-102' tan grey rock mix 1.8-3ft/min 102'-112'
					Test drill
					New property upper road at y north end

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-153 Hour Meter 2173

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
14	112	2		X	Fill 2' grey rock1.9-3ft/min 2'-12' tan rock 5ft/min 12'-17' grey rock 1.5-2.8ft/min 17'-24'
					Grey tan mix 3.4-4.8ft/min 24'-34' grey rock 1.8-2.9ft/min 34'-46'
					4-6 ft/min tan clay rock mix 46'-72 grey rock 1.4-4ft/min 72'-112'
					Test hole
					New pit Upper road across from east tree

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2174

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
15	80	8		X	Clay dirt 8' red tan soft clay 7ft/min 8'-80'

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2175

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name ___________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
16	50	3		X	Dirt 3' red clay 3'-50'
					Test holes
					New pit upper road

Number of Holes 1
Total Footage 50
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2176

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
17	112	0		X	Fractured rock dirt mix 2.8-4.8ft/min 0-20' clay dirt rock mix 4-8ft/min 20'-84'
					Red rock clay boulder mix 9ft/min 84'-112'
					Test holes
					North end y where top and bottom road meet new pit

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2177

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name ________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
18	112	9		X	Rock dirt mix 2-4.5ft/min 9'-54' red rock dirt 7ft/min 54'-73' rock clay mix 73'-112'
					Test holes
					New pit bottom road north of y just before heading down hill toward river.

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/12/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2178

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
19	100	4		X	Dirt grey rock 4'-64' dirt clay mix 64'-80' tan rock mix 80'-100'

Number of Holes 1
Total Footage 100
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2179

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
20	112	0		X	Broken rock dirt mix 2-3.5ft/min 0-10' grey rock light dirt mix 2-4ft/min 10'-41'
					Dirt fractured grey/red rock mix 8-10ft/ min 41'-59' clay dirt boulder mix 5-9ft/min 59'-100'
					Soft dirt boulder mix 8-12ft/min 100'-112'
					Test hole
					New property lower road just before y intersection with upper road north end

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2181

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 2 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
21	112	2		X	Fractured rock dirt mix 2.5-5ft/min 2'-103' tan rock dirt mix 6-9ft/min 103'-112'
					Test hole
					New property lower road north end 2nd hole south of y

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2182

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
22	96	4			Red rock clay dirt mix 8ft/min 4'-16' dirt rock mix 4-6ft/min 16'-84' clay 84'-96'
					Test hole
					New pit lower road next to west tree

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2183

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #__________ Chuck Tender Name ____________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
23	92	5		X	Fill 5' grey rock dirt mix 1.3-3ft/min 5'-32' Dirt seam 11'-15' fractured rock dirt mix 4-6ft/min
					Clay boulder mix 59'-92
					Test hole
					New pit lower road close to wash on east side of mountain

Number of Holes 1
Total Footage 92
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2184

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
24	96	5		X	Dirt/clay 5' fractured rock dirt clay mix 4-6ft/min 5'-65' clay boulder mix 6-10ft/min 65'-96'
					Boulder 88'-92'
					Test hole
					New pit bottom road midway point

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2185

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
25	112	3		X	3' fill soft tan rock clay mix 8ft/min 3'-16' grey rock dirt mix 2-4ft/min 16'-37'
					Clay 37'-42' tan rock mix 3-4.6ft/min 42'-87' clay boulder mix 4-7ft/min87'-112'
					Test hole
					Lower road south end near hole to east

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2186

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
26	105	6		X	Fill/dirt 6' clay dirt boulder mix 5-8ft/min 6'-92' dirt clay mix 92'-105'

Number of Holes 1
Total Footage 105
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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872 LOCAL 872

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2187

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
27	112	4			Dirt rock mix 4.5-7ft/min 4'- 80' clay 80'-96' dirt boulder mix 4-6ft/min 96'-112'
					Clay seam 107'-112'
					Test hole
					New pit lower bench south end almost to old pit

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/13/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2188

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
28	90	7		X	Light tan rock boulder clay mix 6-9ft/min 7'-90' Boulders every 5-8ft about 3-5ft in size
					Test hole
					New pit lower road near lone small tree to west

Number of Holes 1
Total Footage 90
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2189

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
29	112	3		X	Grey rock dirt mix 1.5-3ft/min 3'-34' clay red rock mix 5-7ft/min 34'-42'
					Dirt tan rock mix 3.5-7ft/min 42'-80' dirt soft 12ft/min 80'-112'
					Test hole
					New pit north end y heading east entrance

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2191

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
30	112	4		X	Dirt clay boulder mix 4-9ft/min 4'-87" boulder 87-92' tan rock clay dirt mix 6-9ft/min 92'-112
					Test hole
					New pit north road midway to corner

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2192

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name ___________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
31	112	2		X	Grey rock dirt mix 2-4.5 2'-77' dirt tan rock 5-7ft/min 77'-80'
					Grey rock dirt mix 1.2-2..5ft/min 80'-102' soft tan grey rock dirt mix 5-9ft/min 102'-112'
					Test hole
					New pit farthest north top of hill next to intersection

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2193

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
32	112	3		X	Tan rock clay dirt mix 6.5-8ft/min 3'-112
					Test hole
					New pit middle road north end

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2193

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
33	112	3		X	Dirt tan rock boulder mix 6-8ft/min 3'-96' grey rock dirt mix 2-4ft/min 96'-112'
					Test hole
					New pit middle road north end knob

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/14/2020 Job Name Hat Creek Ward Lake 161-330 Driller Brandon Longe

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2195

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 2.5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer # ________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
34	112	1		X	Dirt clay boulder mix 6-9ft/min 1'-23' broken rock clay mix 2.8-5ft/min 23'-67'
					Red tan rock boulder mix6-7ft/min 67'-100' red rock 4-6ft/min 100'-112'
					Test hole
					New property middle road on ridge north end

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2197.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
35	112	5		X	Brown rock 1.7-3.2ft/min 6'-34' soft tan 4ft/min 34'-50' brown rock 2.2-3.4ft/min 50'-63'
					Soft tan 4.5ft/min 63'-112'
					New land north of primary south lower road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2198.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
36	112	3		X	Rock clay mix 4ft/min 3'-17' soft tan 5ft/min 17'-78' brown rock 2.2-3.1ft/min 78'-
					North primary south on lower road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2199

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
37	112	4		X	Brown rock 2.3-3.7ft/min 4'-40' soft brown 4-6.5ft/min 40'-80ft/min brown rock 1.9-3.4ft/min
					80'-112'
					North primary last hole lower road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2200.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 2 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
38	112	5		X	Rock clay mix 3-5ft/min 5'-22' soft brown 6ft/min 22'-112'
					New land upper road last hole to the south

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2201.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
39	112	4		X	Clay rock mix 3.5ft/min 4'-20' brown rock gray boulder mix 2.8-4.8ft/min 20'-112'
					New land upper road south side

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2202.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
40	112	3		X	Clay 3ft/min 3'-15' soft brown rock 4-6ft/min 15'-47' brown rock w/ gray 1.5-3.7ft/min
					47'-101' soft brown 4-6ft/min 101'-112'

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/17/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill D65-151 Hour Meter 2203.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
41	112	0		X	Brown rock 2.3-4.7ft/min 0'-37' soft clumpy brown 37'-46' brown rock 3.4-4ft/min 46'-80'
					Hard gray rock 1.2-2.4 ft/min 80'-112'
					New land upper road south side

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2206

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
42	112	4		X	Brown rock w/ gray boulders 1.7-3.5ft/min 4'-59' soft brown rock 5ft/min 59'-66' clumpy brow
					New land south side upper road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2207

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
43	112	7		X	Rock clay mix 3.7ft/min 7'-19' brown rock w/ gray boulders2.6-3.5ft/min 19'-112'
					New land middle upper road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2208

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
44	112	0		X	Brown rock w/ gray boulders 1.8-5.5ft/min 0-45' rock clay mix 45'-88' brown rock 2-3.5ft/mir
					88'-101' clay 101'-112'
					New land middle upper bench

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2209.2

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
45	112	7		X	Gray rock 1.8-3.2ft/min 7'-61' brown rock 2.7-4.2ft/min 61'-112'
					New land middle upper road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2210.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1.5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
46	112	0		X	Gray rock .7-2.1ft/min 0-89' brown rock 2.3-3.1ft/min 89'-
					New land upper bench north side

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/18/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2211.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
47	112	12		X	Clay rock mix 2.5ft/min 12-39' brown rock w/ gray boulders 1.2-3.9ft/min 39'-55'
					Clay rock mix 2.7-4.5ft/min 55'-75' wet clay 75'-80'
					New land north upper road

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2215.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
48	112	4		X	Light brown 6ft/min 4'-31' brown rock 3.2-4.5ft/min 31'-52' soft brown boulder mix6ft/min
					52'-112'
					New land upper road east

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2216

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
49	60	0		X	Soft brown boulder mix 6ft/min 0-21' rock clay mix 1ft/min 21'-60'
					New land east upper road

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2216.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ____ Standby Approved by ________ Hammer #________ Chuck Tender Name ______________ Hrs. ____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
50	60	0		X	Soft brown boulder mix 2.2-5.7ft/min 0-49' clay rock mix 1.3-2.4ft/min 49'-60'

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2217.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
51	48	48		X	Dirt and boulders
					New land road northwest towards river

Number of Holes 1
Total Footage 48
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2218.2

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
52	112	21		X	Soft brown rock clay mix 5.2-7.1ft/min 21'-112'
					New land northwest road towards river

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2219

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name ____________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
53	112	4		X	Brown rock w/ gray boulders 3.1-5ft/min 4'-20' gray rock .8-2.3ft/min 20'-80' brown rock
					2.1-3.2ft/min 80'-112'

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/19/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 6.75 Drill 65 Lite-152 Hour Meter 2220

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
54	112	3		X	Brown rock 3-4.5ft/min 3'-30' gray rock .7ft/min 30'-67' brown rock 2.7-4ft/min 67'-112'
					New land northwest road towards river

Number of Holes 1
Total Footage 112
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2225

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
55	96	13		X	Brown rock w/ gray boulders 2-4.7ft/min 13'-49' brown sandy rock 4.3-6.1ft/min 49'-96'
					New land lower road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2225.5

Type: Hammer ☒ Rotary ☐ Drilling Hrs. 1 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
56	80	7		X	Brown sandy rock 2-4ft/min 7'-31' gray rock 2.1-5.2ft/min 31'-96'

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2227

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
57	96	0		X	Brown rock with gray boulders 3.1-4.8ft/min 0-96ft

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2227.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
58	96	7		X	Soft brown rock w/ gray boulders 5.8-8.2ft/min 7'-76' brown rock 2.9-5ft/min 76'-96'
					New land horseshoe road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2228

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
59	96	0		X	Brown rock w/ gray boulders 4.3-6.1ft/min 0'-66' brown clay 66'-71' brown rock
					4.1-6.3ft/min 71'-96'
					New land horseshoe road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2228.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
60	96	5		X	Gray rock 3.5ft/min 5'-55" brown rock 2.1-5.2ft/min 55'-64' gray rock 2.7-3.8ft/min 64'-78'
					Super soft brown 7-11ft/min 78'-96'
					New land horseshoe road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2229.1

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
61	96	0		X	Brown/gray rock 2.7-5ft/min 0-43' clay 43'-59' brown rock w/gray boulders 3.5-6.4ft/min
					59'-73' super soft brown 9ft/min 73'-96'
					New land horseshoe road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2229.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
62	96	0		X	Soft brown 6.5-11ft/min 0-96'
					New land horseshoe road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill D65-151 Hour Meter 2230.2

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #__________ Chuck Tender Name ____________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
63	96	41		X	Soft brown 7ft/min 41'-96'
					New land northeast road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/20/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2230.9

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name ___________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
64	96	0		X	Gray/brown rock 3.5-5ft/min 0-96'
					New land northeast road

Number of Holes 1
Total Footage 96
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2232.8

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole: Yes	Water in Hole: No	Comments – seams, voids, material change, soft, hard, etc.
65	80	4		X	Fractured gray rock 3-5ft/min 4'-31' brown rock w/clay 4.4-6.7ft/min 31'-80'
					New land lowest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2233.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
66	80	7		X	Gray rock 3.2-4ft/min 7'-27' soft brown w/ boulders 3.4-8ft/min 27'-80'
					New land lowest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2234

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
67	80	5			Wet brown clay 5'-39' soft brown with gray boulders 7-12ft/min 39'-54' wet clay 54'-80'

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2234.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #__________ Chuck Tender Name ____________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
68	80	12		X	Soft brown w/ brown boulders 5.7-7.6ft/min 12'-72' red 12ft/min 72'-80'
					New land lowest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2235.8

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
69	60	0		X	Soft brown w/ boulders7ft-9ft/min 0-60'
					New land floor

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2236

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
70	60	60		X	Dirt

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2236.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer # _________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
71	60	60		X	Dirt w/ boulders 12ft/min 0-60'

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 00 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2236.7

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #__________ Chuck Tender Name ____________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
72	60	60		X	Dirt
					New land floor

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/21/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2237.2

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name __________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
73	40	40		X	Dirt w/ dark brown clay couldn't drill deeper
					New land floor

Number of Holes 1
Total Footage 40
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2238.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
74	64	41		X	Soft brown 11ft/min 41'-64'
					West side new land

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2238.8

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
75	64	21		X	Gray rock 3.1-4.4ft/min 21'-38' soft brown rock 6-9ft/min 38'-40' reddish brown 7-12ft/min
					40'-64'
					West side new land

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 0 Drill 65 Lite-152 Hour Meter 2239

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name ______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
76	65	10		X	Soft brown w/ gray boulder 5-8ft/min 10'-64'
					New land west side

Number of Holes 1
Total Footage 65
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2239.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
77	64	8			Powdery gray rock 3.5-4.9ft/min 8'-21' brown rock 4-5.2ft/min 21'-37' soft reddish brown
					6.8-8.9ft/min 37'-64'
					New land west side

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2240.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
78	64	0		X	Soft brown w/ boulder 7ft/min 0-54' reddish brown 9ft/min 54'-64'

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2240.7

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
79	64	0		X	Soft brown w/ boulders 5.9-7.8ft/min 0-30' brown rock w/ clay 3.7-6ft/min 30'-80'
					West side lower road

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2241.2

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
80	80	5		X	Fractured Brown rock w/ clay 4-6.3ft/min 5'-80'
					West side lower road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2241.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
81	80	0		X	Brown rock 4.7-6.2ft/min 0-60' brown rock with clay 3.6-5.2ft/min 60'-80'
					Lower road west side

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2242

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
82	64	0		X	Soft brown7-9ft/min 0-64'
					Lower road west side

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2243

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .75 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
83	80	0		X	Gray/brown rock 3.2-5.4 ft/min 0-55' soft brown 8ft/min 55'-80'
					New land north east road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2243.4

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. ______ Standby Approved by ____________ Hammer #_________ Chuck Tender Name ___________________ Hrs. ______

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
84	60	0		X	Soft brown 8ft/min 0-35' sand 17ft/min 35'-60'
					New land northeast road

Number of Holes 1
Total Footage 60
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2244

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
85	64	0		X	Super soft brown 11-17ft/min 0-64'
					New land highest road

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2244.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .25 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
86	64	0		X	Soft brown with gray boulders 5.9-7.6ft/min 0-64'
					New land highest road

Number of Holes 1
Total Footage 64
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2244.6

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
87	80	0		X	Soft brown with boulders 5.9-9.8ft/min 0-
					New land highest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2245.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name _______________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
89	80	5		X	Soft brown w/ boulders 4.7-10ft/min 5'-80'
					New land highest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2245.3

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by __________ Hammer #________ Chuck Tender Name ________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole: Yes	Water in Hole: No	Comments – seams, voids, material change, soft, hard, etc.
89	80	5		X	Soft brown w/ boulders 4.7-10ft/min 5'-80'
					New land highest road

Number of Holes 1
Total Footage 80
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

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Drill Log

Date 2/24/2020 Job Name Hat Creek Ward Lake 161-330 Driller Carter Nuckolls

Shot # 0 Burden 0 Spacing 0 Sub-Drill 0 Bit Size 5.5 Drill 65 Lite-152 Hour Meter 2245.7

Type: Hammer ☒ Rotary ☐ Drilling Hrs. .5 (*Drilling Hrs. = Pre-op, Drilling, Watering, Fueling, Post-op*)

Standby Hrs. _____ Standby Approved by ___________ Hammer #_________ Chuck Tender Name __________________ Hrs. _____

Hole	Depth	Overburden	Water in Hole		Comments – seams, voids, material change, soft, hard, etc.
			Yes	No	
90	50	10		X	Soft brown w/ clay 2.9-11.7ft/min 10'-41' wet brown clay 41'-50'
					New land highest road

Number of Holes 1
Total Footage 50
Total Yardage 00.00
Total Yardage Minus Sub-Drill 00.00

United States Department of Agriculture

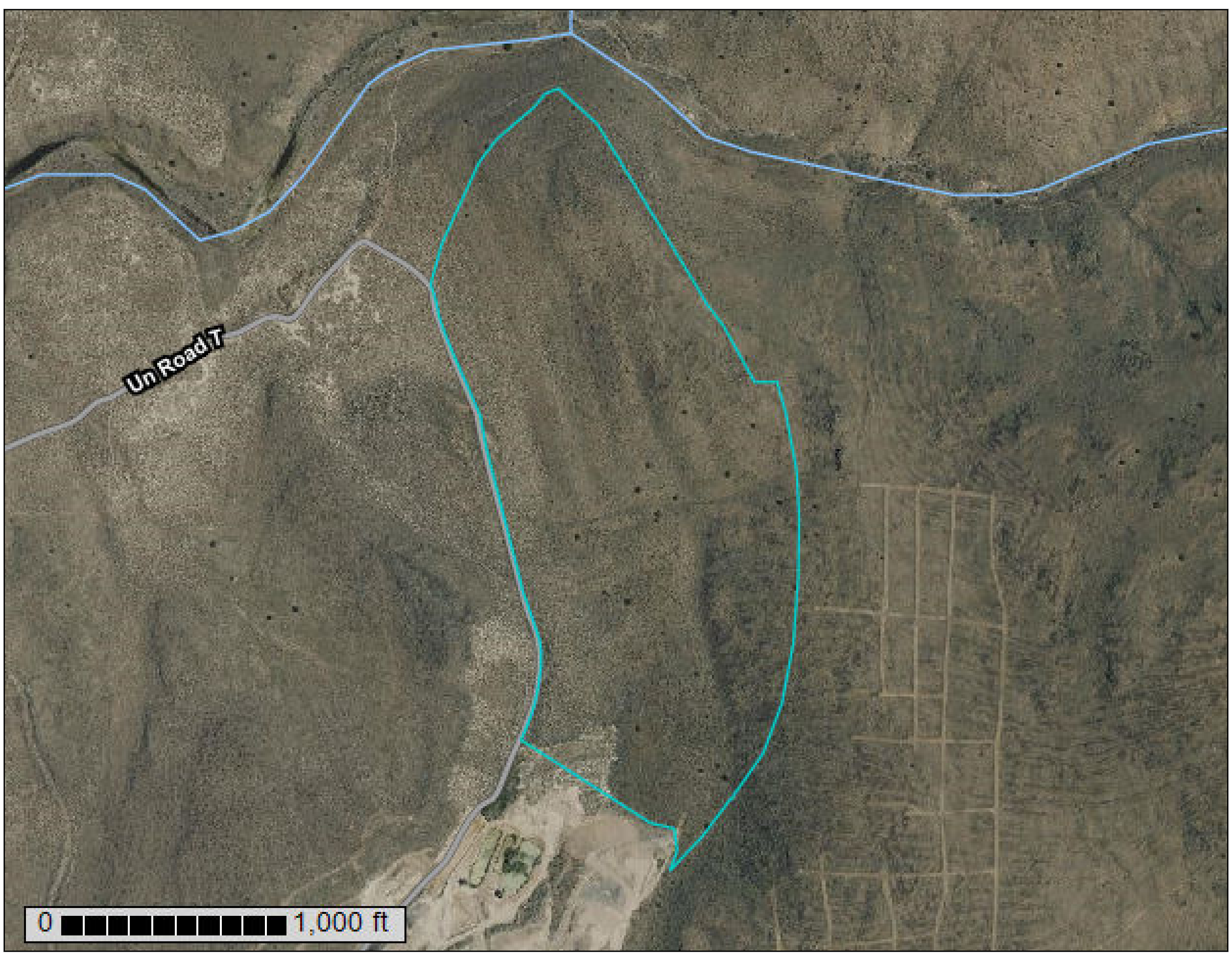
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Susanville Area, Parts of Lassen and Plumas Counties, California

Ward Lake Pit Expansion Area



October 19, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

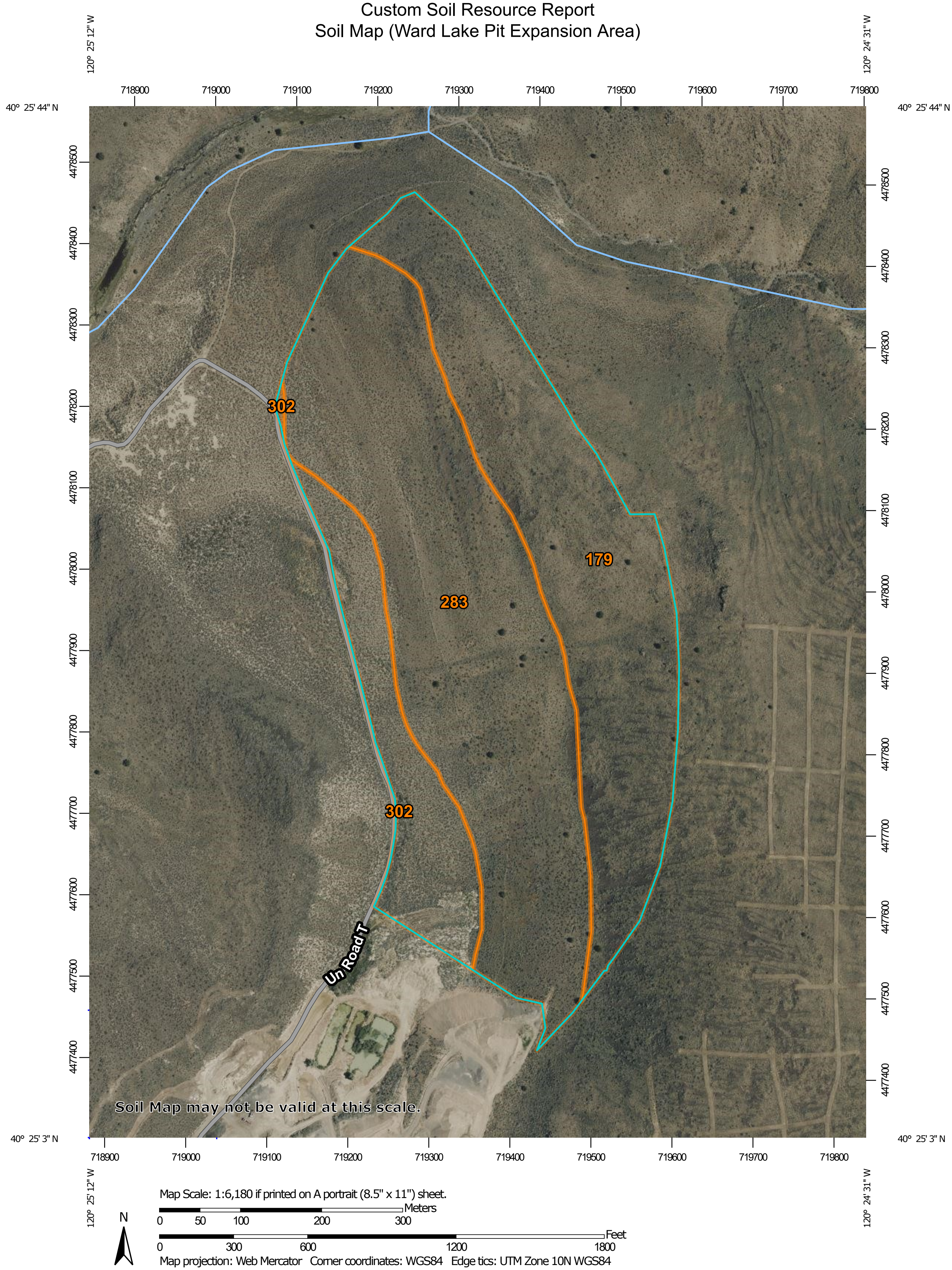
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map (Ward Lake Pit Expansion Area)



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Susanville Area, Parts of Lassen and Plumas Counties, California
Survey Area Data: Version 11, Jun 1, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 8, 2019—Jun 21, 2019

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Ward Lake Pit Expansion Area)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
179	Devada-Rock outcrop association, 2 to 50 percent slopes	28.0	36.0%
283	McConnel-Mottsville complex, 2 to 9 percent slopes	39.8	51.1%
302	Orhood very stony sandy loam, 5 to 15 percent slopes	10.0	12.9%
Totals for Area of Interest		**77.9**	**100.0%**

Map Unit Descriptions (Ward Lake Pit Expansion Area)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Susanville Area, Parts of Lassen and Plumas Counties, California

179—Devada-Rock outcrop association, 2 to 50 percent slopes

Map Unit Setting

National map unit symbol: jc76
Elevation: 4,400 to 5,600 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 45 to 48 degrees F
Frost-free period: 60 to 100 days
Farmland classification: Not prime farmland

Map Unit Composition

Devada and similar soils: 70 percent
Rock outcrop: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Devada

Setting

Landform: Mountains
Landform position (two-dimensional): Backslope
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Colluvium derived from andesite and basalt and residuum weathered from basalt or andesite

Typical profile

H1 - 0 to 7 inches: very cobbly loam
H2 - 7 to 15 inches: gravelly clay
H3 - 15 to 25 inches: unweathered bedrock

Properties and qualities

Slope: 2 to 50 percent
Surface area covered with cobbles, stones or boulders: 5.0 percent
Depth to restrictive feature: 12 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to low (0.00 to 0.01 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: R023XF081CA
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Mountains

Typical profile

H1 - 0 to 10 inches: unweathered bedrock

Properties and qualities

Slope: 2 to 50 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Runoff class: Very high

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Minor Components

Longcreek

Percent of map unit: 10 percent
Landform: Mountains
Landform position (two-dimensional): Backslope
Ecological site: R023XF082CA
Hydric soil rating: No

283—McConnel-Mottsville complex, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: jccv
Elevation: 4,000 to 5,610 feet
Mean annual precipitation: 6 to 12 inches
Mean annual air temperature: 45 to 52 degrees F
Frost-free period: 60 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Mcconnel and similar soils: 60 percent
Mottsville and similar soils: 25 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mcconnel

Setting

Landform: Fan remnants
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Alluvium derived from mixed rocks and lacustrine deposits

Typical profile

H1 - 0 to 10 inches: gravelly fine sandy loam
H2 - 10 to 60 inches: stratified extremely gravelly coarse sand to very gravelly sandy loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 4 percent
Maximum salinity: Very slightly saline to strongly saline (2.0 to 32.0 mmhos/cm)
Sodium adsorption ratio, maximum: 12.0
Available water capacity: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R026XF052CA - GRANITIC UPLAND 9-12" P.Z.
Hydric soil rating: No

Description of Mottsville

Setting

Landform: Fan remnants
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from granite

Typical profile

H1 - 0 to 17 inches: gravelly loamy coarse sand
H2 - 17 to 60 inches: stratified gravelly coarse sand to loamy sand

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e

Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R026XF051CA - GRANITIC FAN 9-12"
Hydric soil rating: No

Minor Components

Devada

Percent of map unit: 5 percent
Landform: Plateaus
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R023XF081CA
Hydric soil rating: No

Mcconnel

Percent of map unit: 4 percent
Landform: Fan remnants
Ecological site: R026XF052CA - GRANITIC UPLAND 9-12" P.Z.
Hydric soil rating: No

Zorravista

Percent of map unit: 3 percent
Landform: Dunes
Ecological site: R023XG049CA - SAND DUNES 6-9"
Hydric soil rating: No

Longcreek

Percent of map unit: 3 percent
Landform: Plateaus
Ecological site: R023XF082CA
Hydric soil rating: No

302—Orhood very stony sandy loam, 5 to 15 percent slopes

Map Unit Setting

National map unit symbol: jcds
Elevation: 4,100 to 6,000 feet
Mean annual precipitation: 9 to 16 inches
Mean annual air temperature: 44 to 52 degrees F
Frost-free period: 60 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Orhood and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Orhood

Setting

Landform: Mountains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Mountainbase
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Colluvium derived from volcanic rock and residuum weathered from volcanic rock

Typical profile

H1 - 0 to 4 inches: very stony sandy loam
H2 - 4 to 9 inches: very cobbly loam
H3 - 9 to 19 inches: very cobbly clay loam
H4 - 19 to 29 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 15 percent
Surface area covered with cobbles, stones or boulders: 15.0 percent
Depth to restrictive feature: 14 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: R021XE174CA - STONY LOAM 12-16"
Hydric soil rating: No

Minor Components

Incy

Percent of map unit: 8 percent
Landform: Dunes
Ecological site: R026XF022CA - GRANITIC SAND 9-12"
Hydric soil rating: No

Searles

Percent of map unit: 6 percent
Landform: Mountains
Landform position (two-dimensional): Backslope
Ecological site: R021XE179CA - WARM STONY LOAM 12-16"
Hydric soil rating: No

Puls

Percent of map unit: 6 percent
Landform: Plateaus
Down-slope shape: Linear
Across-slope shape: Linear

Ecological site: R021XE173CA - SHALLOW STONY LOAM 12-16"
Hydric soil rating: No

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BIOLOGICAL RESOURCES ASSESSMENT

WARD LAKE QUARRY PROPOSED MINE BOUNDARY EXPANSION
LASSEN COUNTY, CALIFORNIA

Prepared for

Hat Creek Construction & Materials, Inc.

Prepared by

VESTRA Resources Inc.
5300 Aviation Drive
Redding, California 96002

OCTOBER 2020

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FIGURES

APPENDICES

1.0 INTRODUCTION

This biological assessment evaluates the impact of a proposed Reclamation Plan Amendment to expand the mining boundary for the Ward Lake Quarry to include approximately 51 acres to the north of the already approved reclamation boundary

1.1 Project Location

The Ward Lake Quarry is located approximately three miles east of Ward Lake, off of Ward Lake Road, in Lassen County. The quarry is located in Section 32, Township 30 North, Range 14 East, MDBM. The latitude and longitude at the center of the project are 40.414478° and - 120.417222°. The general site location is shown on Figure 1.

1.2 Ownership

The project area includes an active mine operation area, area of proposed reclamation, area of proposed expansion, and buffer areas. TNT Enterprises owns approximately 682 acres in two parcels. Currently, mine operations occur on 138 acres of the property. The proposed Reclamation Plan Amendment would add an additional 51 acres of mine quarry area. The current processing and stockpile areas would remain. Previous quarry areas would be reclaimed. Site layout is shown on Figure 2.

1.3 Topography

The topography of the study area is gentle slopes and rocky ridges. The property occurs at elevations between approximately 4200 feet to 4500 feet above sea level. Slope of the landscape drains to the west and north to the seasonal feature, Secret Creek, located north of the current operation. Current site topography is shown on Figure 3.

Precipitation occurs as rain and snow. Annual rainfall is estimated at 15 inches (Susanville Municipal Airport Station ID 048702, years of record 1893-2016).

1.4 Vegetation Communities

The mine site has operated since the early 1980s. Portions of the site are currently being mined and developed for the processing of mined materials.

Areas disturbed by previous mining and processing are considered barren. The remaining areas surrounding the quarry consist mainly of shrub steppe communities with interspersed areas of annual grassland. The dominant habitat type identified through the California Wildlife Habitat Relationships (CWHR) classification is sagebrush (Mayer and Laudenslayer 1988) as shown on Figure 4.

Sagebrush habitat is usually large, open, and often discontinuous, and stands are usually dominated by big sagebrush (*Artemisia tridentata*). This habitat occurs over a range of middle and high elevations. Sagebrush is often mixed with other similar shrub species, such as rabbitbrush (*Chrysothamnus* spp.), horsebrush (*Tetradymia* spp.), and bitterbrush (*Purshia* spp.). In some places

Approximate Project Boundary

Miles
0 2.5 5 10

FIGURE 1
GENERAL SITE LOCATION
WARD LAKE PIT
LASSEN COUNTY, CALIFORNIA

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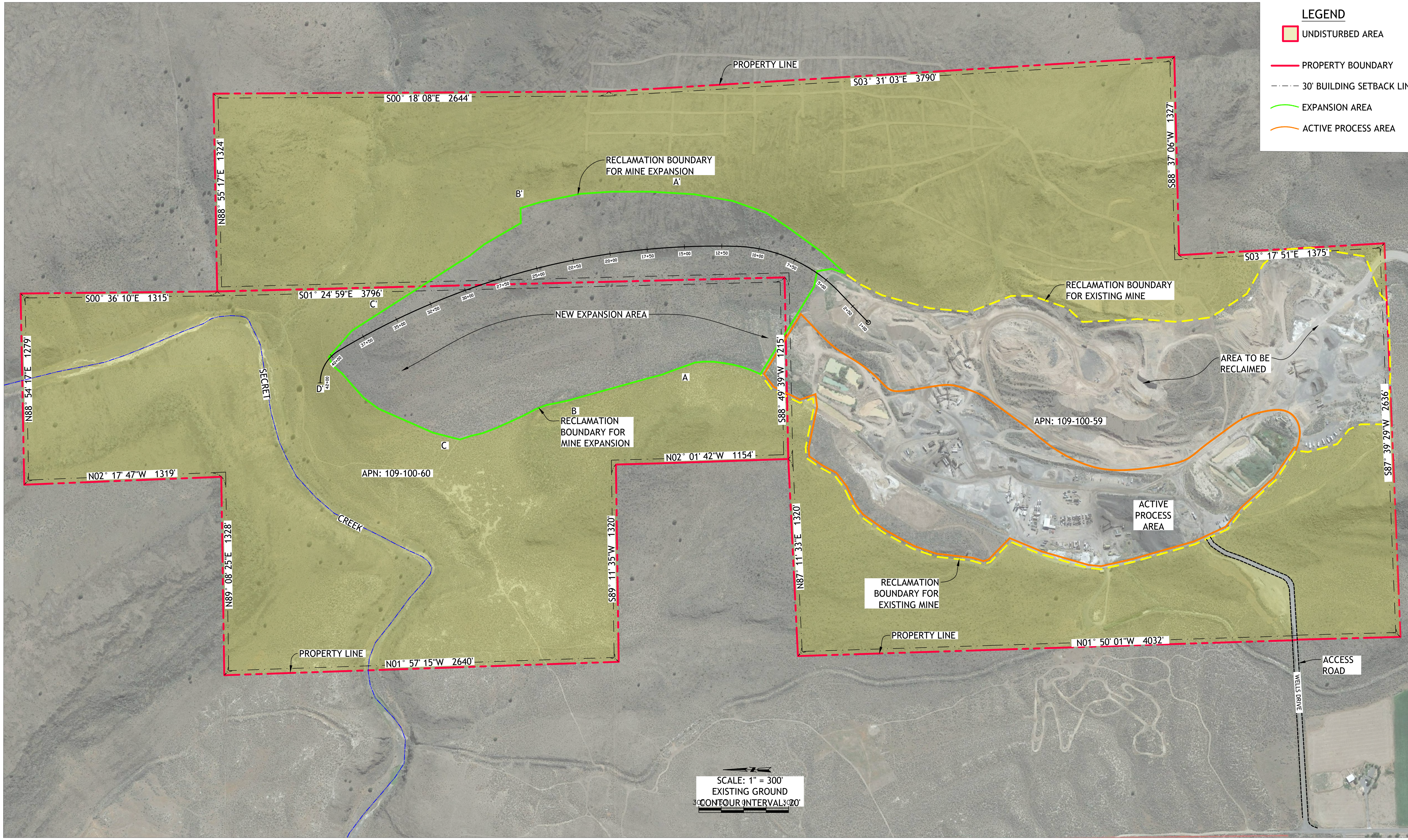

VERIFY SCALES
BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

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FAX (530) 223-1145
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NO.	DATE	REVISION	BY

DSGN: CS
DR: CS
CHK: SG
APVD: SG

FIGURE 2
SITE LAYOUT
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

SHEET OF
DATE 10/05/20
JOB NO. 71305

P:\CAD\71305 HAT CREEK WARD LAKE\DWG\71305 WARD LAKE.DWG

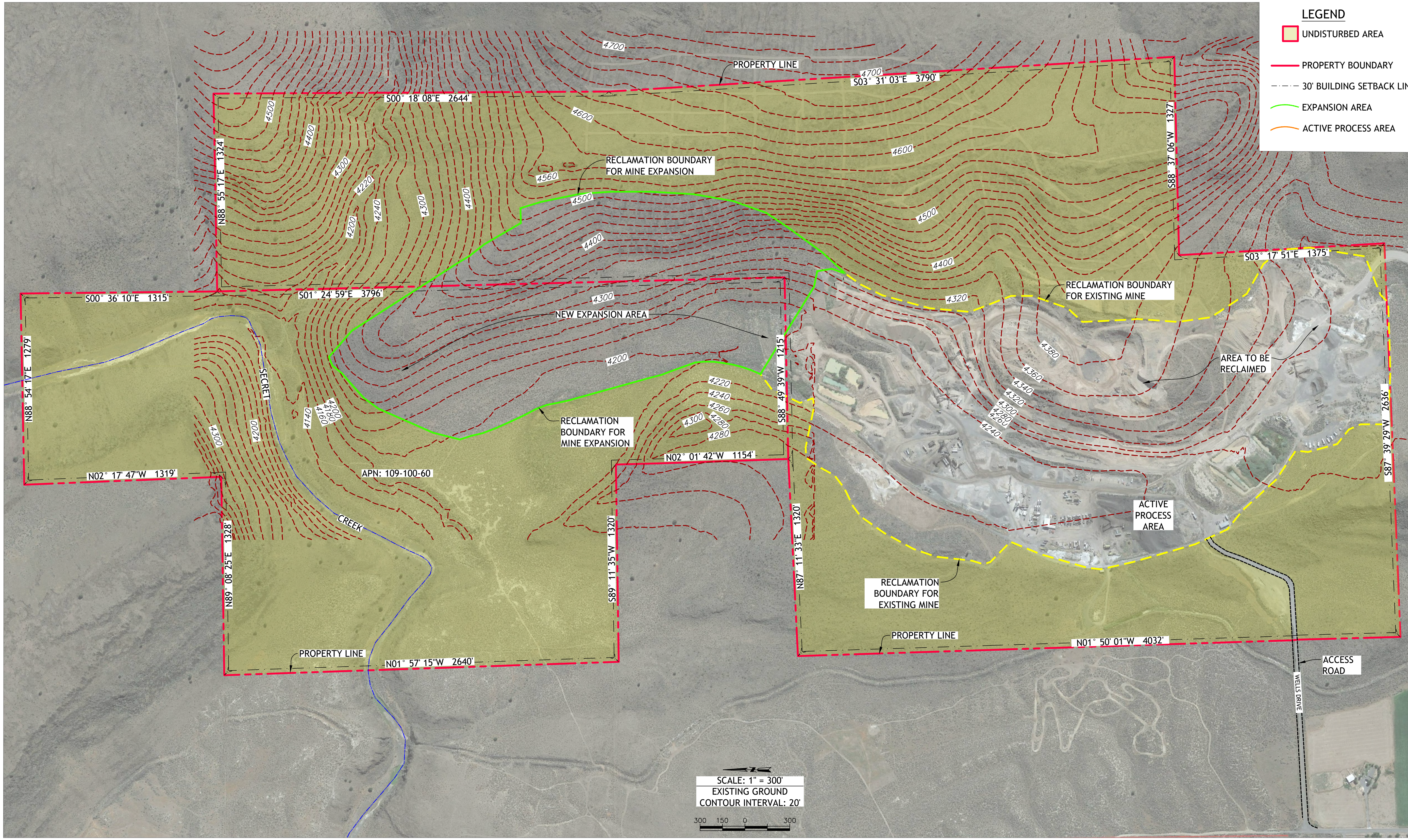

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FIGURE 3
CURRENT TOPOGRAPHY
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

SHEET
OF
DATE 10/05/20
JOB NO. 71305

P:\CAD\71305 HAT CREEK WARD LAKE\DWG\71305 WARD LAKE.DWG

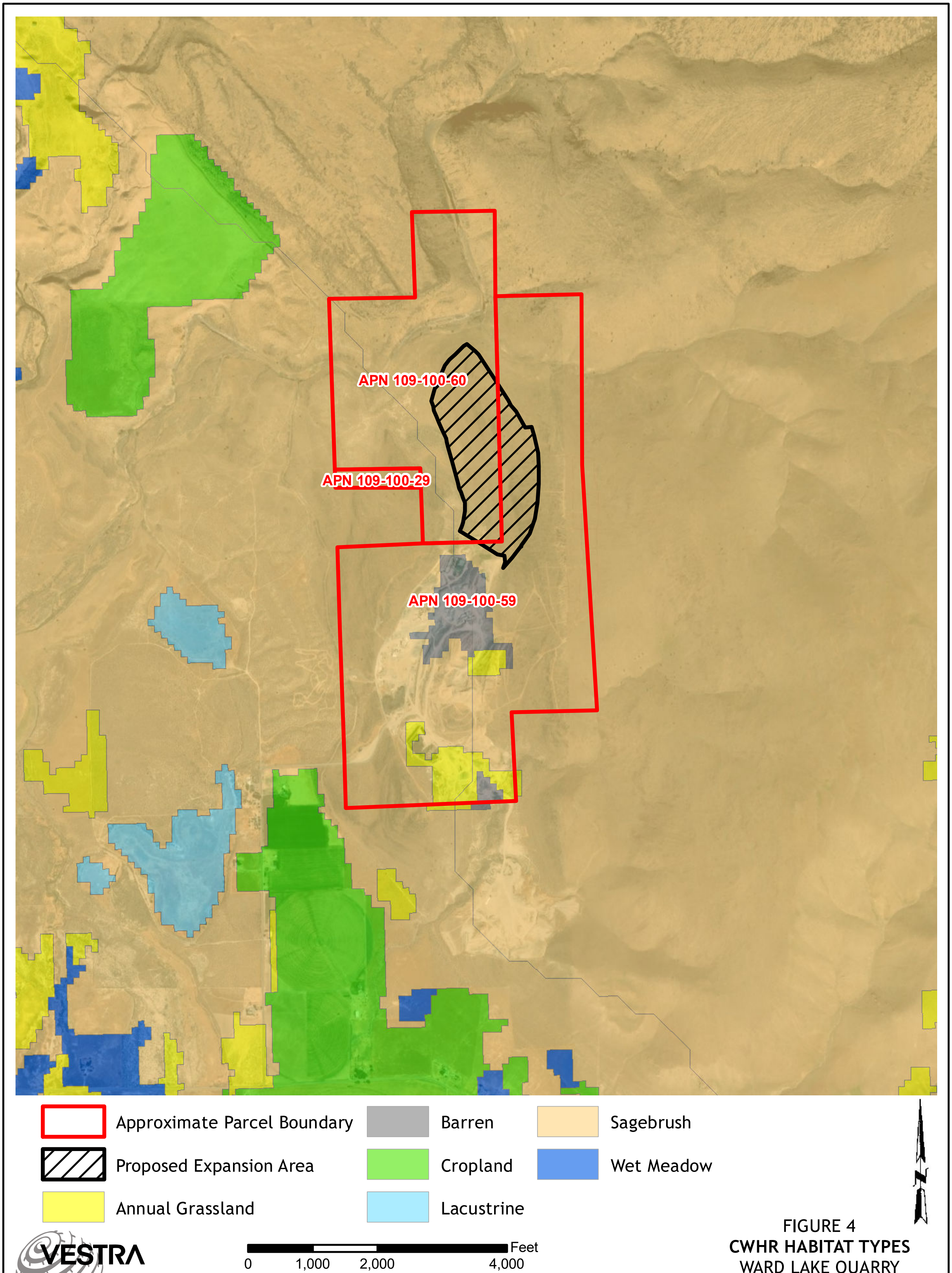

FIGURE 4
CWHR HABITAT TYPES
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

SOURCE: USDA NAIP 2016 AERIAL PHOTOGRAPH; USFS 2009

P:\GIS\71305\WardLakeExpansion2020\Figures\BioReport\71305_HabitatTypes.mxd stands may have an understory of perennial grasses and forbs. Sagebrush habitat borders the quarry operations area along the western and eastern edges.

1.5 Previous Mitigation Considerations

An Environmental Impact Report (EIR) was prepared in 1997 for an expansion of the Ward Lake Quarry (Oberholtzer 1997). The EIR focused on potential effects on deer and antelope herds. The project area falls within Deer Hunt Zone X5a, which is a zone within the greater Deer Assessment Unit (DAU) 2 – northeastern California; and the project is within Pronghorn Hunt Zone 4 – Lassen. The project area is on the edge of California Department of Fish and Wildlife (CDFW)-designated critical winter-range habitat for mule deer and winter-range habitat for pronghorn antelope (see Figures 5 and 6, respectively).

Mule deer numbers have increased since the 1997 EIR. In 1996, the population for DAU 2 was estimated to be 25,000; in 2017, the estimated population was 29,289 (CDFG et al. 1998; CDFW 2017). More specific to the project location, the mule deer population within Hunt Zone X5a has increased, with an estimated 544 animals in 2013 and 942 in 2017.

No blasting, grading, or excavation is allowed from January 1 to March 31. Mule deer population estimates in the region have not shown a significant impact from year-round operations.

The 1997 EIR also addressed effects to Swainson's hawk and golden eagle. Potential effects of the project on these species were discounted because it involved only the removal of 40 acres of foraging habitat, but no nesting habitat removal. These effects to foraging habitat are mitigated through the required reclamation practices. Effects to other wildlife species were not discussed in detail but were deemed to be significant, although mitigatable, through the required reclamation practices.

An additional EIR (VESTRA 2019) was conducted in 2019 to address an increase in operating hours and nighttime operations. Mitigations included in the EIR were limiting nighttime operations from January 1 to March 31, no nighttime blasting, installation of noise barriers, limitation of Jake brake usage, and modification to lighting feature design to minimize the effects of artificial lighting during the nighttime periods. The County also requested limitation of roadway speed, driver education, and signage for possible impacts to wildlife on roadways during nighttime operations.

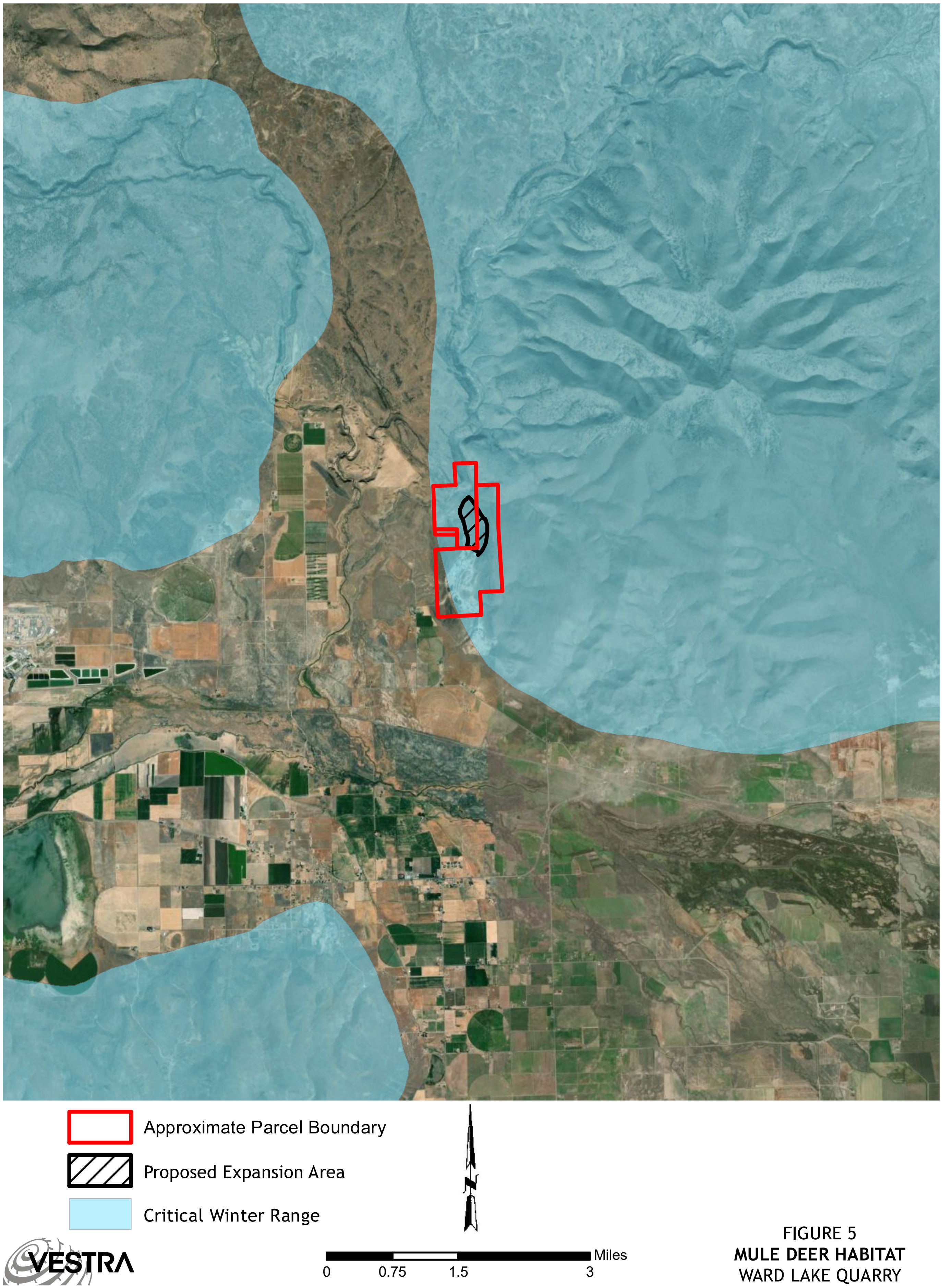

FIGURE 5
MULE DEER HABITAT
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

SOURCE: USDA NAIP 2016 AERIAL PHOTOGRAPH; USFS 2009

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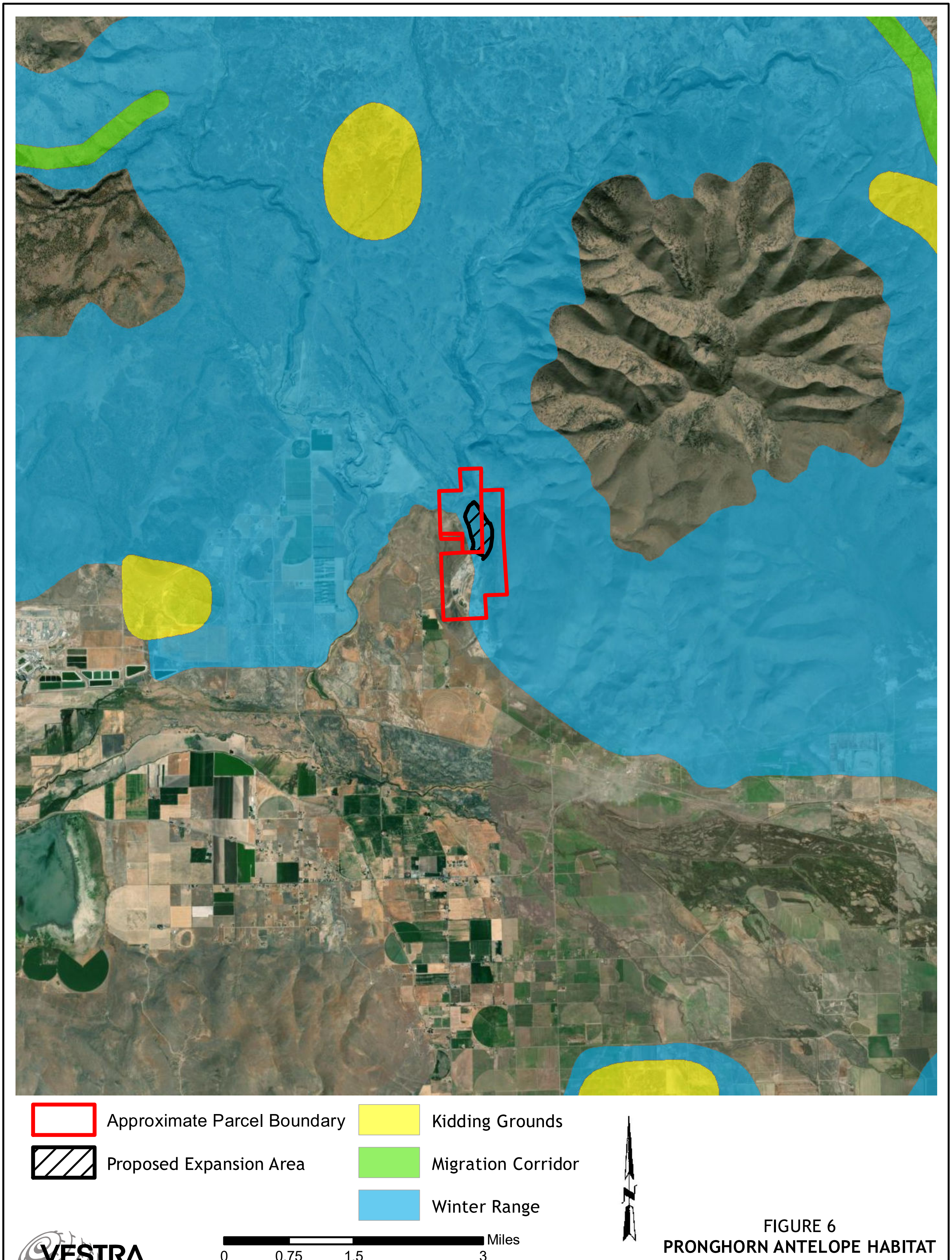

SOURCE: USDA NAIP 2016 AERIAL PHOTOGRAPH; USFS 2009

FIGURE 6
PRONGHORN ANTELOPE HABITAT
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

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2.0 BIOLOGICAL SITE SURVEY

2.1 Pre-Survey Review

Special-status plant and animal species and sensitive habitats that have the potential to occur within the project area were determined, in part, by reviewing agency databases, literature, and other relevant sources. The following information sources were reviewed to aid this determination:

- Litchfield, California, USGS 7.5-minute quadrangle;
- Aerial photography of the project area and vicinity;
- The U.S. Fish and Wildlife Service (USFWS) official list of endangered and threatened species that may occur, or be affected by, projects, as provided by the Klamath, Sacramento, and Yreka Fish and Wildlife Office (Consultation Code 08ESMF00-2020-E-03301), included in Appendix A;
- CDFW California Natural Diversity Database (CNDDB) (Nelson 2020) records for the Litchfield, California, USGS 7.5-minute quadrangle and the eight surrounding quadrangles;
- The California Native Plant Society (CNPS) online Inventory of Rare and Endangered Plants (California Native Plant Society 2015) records for the Litchfield, California, USGS 7.5-minute quadrangle and the eight surrounding quadrangles;
- California Wildlife Habitat Relationships (CWHR) System (California Department of Fish and Game 2020).
- GIS shapefiles of designated critical habitat from the USFWS Critical Habitat Portal website;
- CDFW publications including State and Federally Listed Endangered, Threatened and Rare Plants of California (CDFW 2020a); State and Federally Listed and Threatened Animals of California (CDFW 2020b); and Special Animals List (CDFW 2020c); and
- Pertinent biological literature including Bird Species of Special Concern in California.

2.2 Animal Survey Methods

A pedestrian transect survey was completed onsite in spring 2018 and spring 2020 to determine the habitat types present onsite and to detect any potential habitat for special-status flora or fauna. The survey covered the proposed expansion area and within 50 feet of the proposed boundary.

Additionally, a site-specific burrowing owl survey was completed in April 2020 to determine the presence of burrows onsite. The survey included walking transects within the proposed expansion area and surrounding area to account for the standard burrowing owl buffer zone. The findings are shown in a Burrowing Owl Survey Report, included as Appendix B.

An observation-based pedestrian survey was also conducted on April 24, 2018, and April 25, 2018, in order to assess both potential impacts of daytime and nighttime mining work on wildlife. This survey was conducted under weather conditions satisfactory for nighttime observation (minimal cloud cover, low wind, and 68 percent illumination from moonlight provided clear visibility and audibility) and was conducted for the previous changes to operational hours. During this survey, a game camera was deployed concurrently with transect surveying to obtain additional documentation of wildlife activity within project boundaries. The camera was mounted and programmed to capture photographs based on motion-detection with a thirty-second delay in between captures.

2.2.1 Animal Field Survey

The project area was surveyed through visual and auditory observations following 0.75-mile transects lying generally north-south within the project area. Transects were walked with pauses for visual and auditory observation at points 0.15 to 0.25 miles apart. Observation points along transects were more frequent when a site feature (i.e. berm or stockpile) presented a barrier to the surveyor's perception and when an animal's behavior required further observation.

2.2.2 Animal Survey Results

Mammalian species observed or where sign was observed within or adjacent to the proposed project and expansion areas included:

- Striped skunk (*Mephitis mephitis*)
- Black-tailed jackrabbit (*Lepus californicus*)
- Common raven (*Corvus corax*)
- Black-tailed deer *(Odocoileus hemious)*
- Coyote (*Canis latrans*)
- Western fence lizard (*Sceloporus occidentalis*)
- Cottontail rabbit (*Sylbilagus bachmani*)

Amphibians observed included:

- Sierran treefrog (*Pseudacris sierrae*)
- American bullfrog (*Lithobates catesbeianus*)

Amphibians were observed at dusk and through the night in the northern and southern settling ponds. It was apparent by the number of frog calls that a larger population inhabits the southern settling ponds. Sierran treefrog populations are considered to have a stable conservation status. American bullfrogs are a non-native invasive species in western North America.

Bird species observed within or adjacent to the project area:

- Mourning dove (*Zenaida macroura*)
- Black-billed magpie (*Pica hudsonia*)

- California quail (*Callipepla californica*)
- Canada goose (*Branta candensis*)
- Mallard (*Anas platyrhynchos*)
- Rock wren (*Salpinctes obsoletus*)
- House wren (*Troglodytes aedon*)
- Yellow-rumped warbler (*Setophaga coronata*)
- Red-winged blackbird (*Agelaius phoeniceus*)
- Great horned owl (*Bubo virginianus*)
- Killdeer (*Charadrius vociferus*)
- House sparrow (*Passer domesticus*)
- Turkey vulture (*Cathartes aura*)
- Barn swallow (*Hirundo rustica*)
- Western wood-pewee *(Contopus sordidulus)*

The pair of great horned owls (GHO) observed in 2018 was not observed in 2020. They had been nesting in an abandoned water tower located to the west of the shop and concrete plant. Bird nests were again observed in willow trees next to one of the settling ponds.

2.3 Plant Survey

2.3.1 Plant Survey Methods

The baseline survey was conducted using Division of Mine Reclamation (DMR)-established protocol for measuring vegetation percent cover, density, and species richness of the natural vegetation community (DOC 2003). Data was collected using a $1m^2$ quadrat. The initial plot location was determined by random point projection within an undisturbed reference area using a GPS device and subsequent plots were systematically placed 1m apart. Methods were sufficiently repeated via systematic sampling in order to achieve adequate confidence in results (>80 percent).

2.3.2 Plant Survey Results

Percent cover was quantified for the entire plant community (mean=86.42 percent) and for each growth type (shrub [mean=7.73%], forb [mean=4%], annual grass [mean=24.64%], and perennial grass [mean=6.19%]). The percent cover of the entire vegetative community is greater than the summated percent cover of each growth type due to overlap in canopy layers. Species richness was quantified within each plot (mean=4). For reclamation purposes the percentage of annual grass has been removed from the percent cover assessment as the annual grasses are both considered non-native invading species.

The following plant species were observed:

- Antelope bitterbrush *(Purshia tridentata)*
- Rubber rabbitbrush (*Ericameria nauseosa*)
- Big sage brush *(Artemisia tridentata* spp.*)*

- Western juniper *(Juniperus occidentalis)*
- Mormon tea *(Ephedra viridis)*
- Hooker's balsamroot *(Balsamorhiza hookeri)*
- Bristly fiddleneck *(Amsinckia tesselata)*
- Redstem stork's bill *(Erodium cicutarium)*
- Medusahead (*Elymus caput medausa)*
- Cheatgrass *(Bromus tectorum)*
- Bluebunch wheatgrass *(Pseudoreogneria spicata)*
- Common wooly sunflower (*Eriophyllum lanatum*)

3.0 REGULATORY FRAMEWORK FOR BIOLOGICAL RESOURCES

This section describes the federal and state regulation of special-status species, waters of the United States, and other sensitive biological resources.

3.1 Federal Regulations

3.1.1 Federal Endangered Species Act

Section 9 of the federal Endangered Species Act of 1973 (ESA) prohibits acts that result in the "take" of threatened or endangered species. As defined by the federal ESA, "endangered" refers to any species that is in danger of extinction throughout all or a significant portion of its current range. The term "threatened" is applied to any species likely to become endangered within the foreseeable future throughout all or a significant portion of its current range. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct." Sections 7 and 10 of the federal ESA provide methods for permitting otherwise lawful actions that may result in "incidental take" of a federally listed species. Incidental take refers to take of a listed species that is incidental to, but not the primary purpose of, an otherwise lawful activity. Incidental take is permitted under Section 7 for projects on federal land or involving a federal action; Section 10 provides a process for non-federal actions. The act is administered by the USFWS for terrestrial species.

3.1.2 Clean Water Act

The objective of the Clean Water Act (1977, as amended) is to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Discharge of dredged or fill material into waters of the United States, including jurisdictional wetlands, is regulated by the Corps under Section 404 of the Clean Water Act (33 USC 1251-1376) under a permitting process. Applicants for Section 404 permits are also required to obtain water quality certification or waiver through the local Regional Water Quality Control Board under Section 401 of the Clean Water Act (33 USC 1341).

Corps regulations implementing Section 404 define waters of the United States to include intrastate waters, including lakes, rivers, streams, wetlands, and natural ponds, the use, degradation, or destruction of which could affect interstate or foreign commerce. Wetlands are defined for regulatory purposes as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3; 40 CFR 230.3). To comply with the Corps policy of no net loss of wetlands, discharge into wetlands must be avoided and minimized to the extent practicable. For unavoidable impacts, compensatory mitigation is typically required to replace the loss of wetland functions in the watershed.

Because the project will not result in impacts on waters of the United States, which would require authorization under Section 404, an Army Corps 404 permit and Section 401 water quality certification will not be required.

3.1.3 Migratory Bird Treaty Act

Migratory birds are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703-711). The MBTA makes it unlawful to take, possess, buy, sell, purchase, or barter any migratory bird listed in 50 CFR Part 10, including feathers or other parts, nests, eggs, or products, except as allowed by implementing regulations (50 CFR 21). Mitigation measures can be identified to avoid or minimize adverse effects on migratory birds. Nesting habitat is present throughout the study area in juniper and willow trees, shrubs, ground, and other structures.

3.2 State Regulatory Requirements

3.2.1 California Endangered Species Act

The California Endangered Species Act (CESA) lists species of plants and animals as threatened or endangered. Projects that may have adverse effects on State-listed species require formal consultation with CDFW. "Take" of protected species incidental to otherwise lawful activities may be authorized under Section 2081 of the California Fish and Game Code. Authorization from the CDFW is in the form of an Incidental Take Permit which can identify measures to minimize take. CDFW Species of Special Concern are considered under the CESA. Species of Special Concern have the potential to occur within the project area.

3.2.2 Streambed Alteration Agreement

A Lake or Streambed Alteration Agreement (Sections 1600-1616 of the California Fish and Game Code) requires an entity to notify CDFW prior to commencing any activity that may substantially obstruct the natural flow or use any material from a river, stream, or lake, or deposit or dispose of debris where it may pass into any river, stream, or lake. The notification requirement applies to any ephemeral or perennial river, stream, or lake in California. The project will not occur within any river, stream, or lake and is not subject to a Lake or Streambed Alteration Agreement.

3.2.3 Birds of Prey

Under Section 3503.5 of the California Fish and Game Code, it is unlawful to take, possess, or destroy any birds in the orders of Falconiformes or Strigiformes (birds of prey) or to take, possess, or destroy the nest or eggs of any such bird, except as otherwise provided by this code or any regulation adopted pursuant thereto. Project features will be implemented to protect nesting migratory birds and birds of prey to comply with this code.

3.2.4 Migratory Birds

The California Fish and Game Code Section 3513 states that it is unlawful to take or possess any migratory nongame bird as designated in the MBTA or any part of such migratory nongame bird except as provided by rules and regulations adopted by the Secretary of the Interior under provisions of the MBTA. Project features will be implemented to protect nesting migratory birds and birds of prey to comply with this code.

3.2.5 Fully Protected Species

California statutes also accord "fully protected" status to a number of specifically identified birds, mammals, reptiles, amphibians, and fish. These species cannot be "taken," even with an incidental take permit (California Fish and Game Code, Sections 3505, 3511, 4700, 5050, and 5515). No "fully protected species," are expected to occur in the study area.

3.2.6 Surface Mining and Reclamation Act of 1975

The Surface Mining and Reclamation Act of 1975 (SMARA, Public Resources Code, Sections 2710-2796) provides a comprehensive surface mining and reclamation policy with the regulation of surface mining operations to assure that adverse environmental impacts are minimized and mined lands are reclaimed to a usable condition. SMARA requires that all surface mines in California have an approved Reclamation Plan and ensure financial assurance for the completion of reclamation activities upon closure of a mine site.

4.0 POTENTIAL IMPACTS TO BIOLOGICAL RESOURCES

4.1 Special-Status Species

For each special-status wildlife species, habitat and other ecological requirements were evaluated and compared to the habitats in the study area and immediate vicinity to assess the presence of potential habitat. The habitat assessment is provided in Table 1. The CNDDB query results are included as Figure 7.

4.1.1 Special Status Wildlife Species

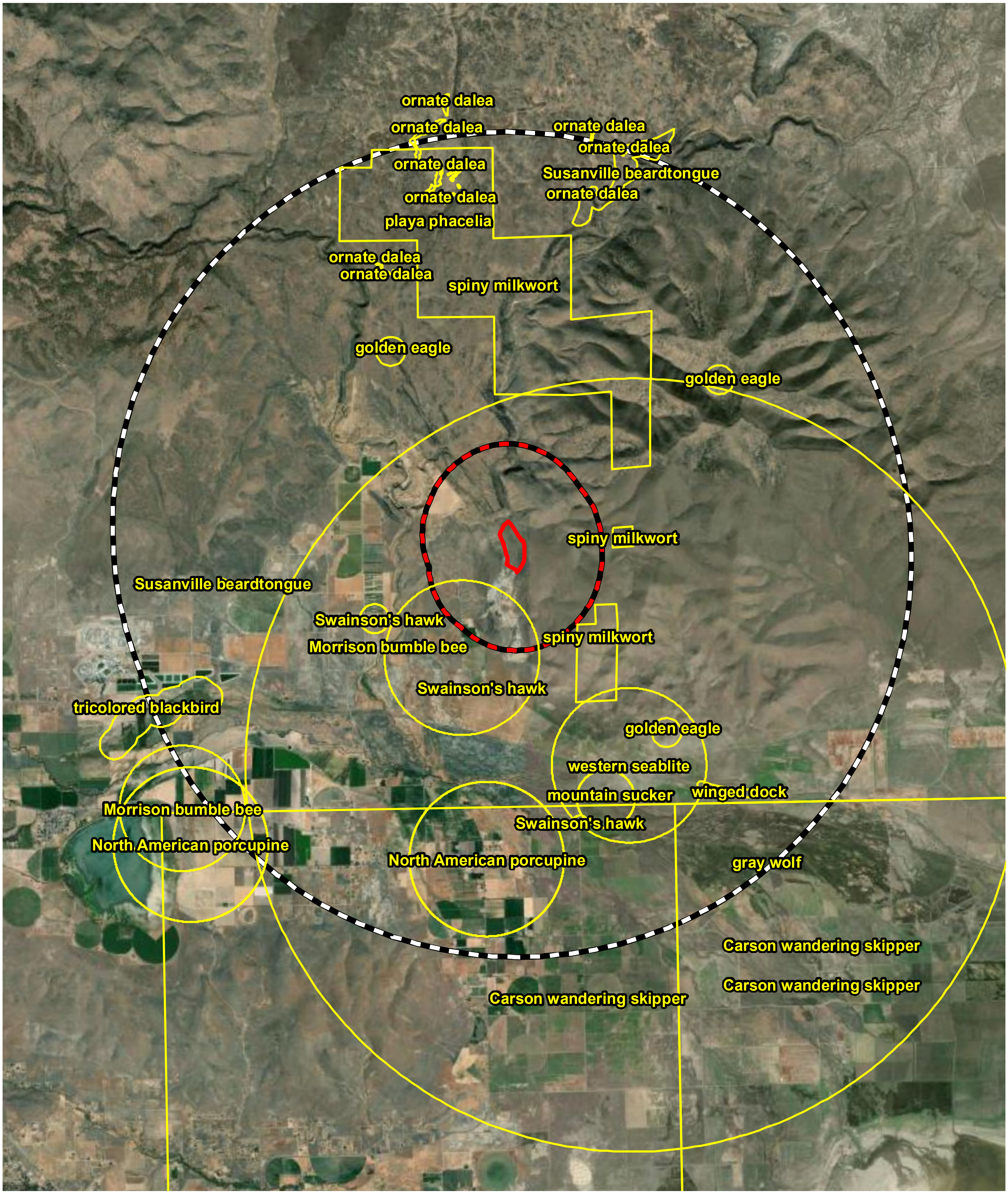
An assessment of special-status species was conducted for the proposed amendment to examine potential effects of expanding the project area. Special-status species considered in this assessment meet one of the following criteria:

- Listed, proposed for listing, or candidates for listing as threatened or endangered under the Federal ESA (50 Code of Federal Regulations [CFR] Part 17.12 [listed plants], 50 CFR Part 17.11 [listed animals], 67 Federal Register [FR] 40657 [candidate species]);
- Listed or proposed for listing by the State of California as threatened or endangered under the CESA (CDFW 2017a);
- Identified by the CDFW as fully protected species, including fish and wildlife that do not have State or Federal threatened or endangered status but may still be threatened with extinction (CDFW 2017b); and
- California Species of Special Concern: vertebrate species that have been designated as "species of special concern" by the CDFW because declining population levels, limited range, and/or continuing threats have made them vulnerable to extinction (CDFW 2017b);

A list and summary of wildlife species identified by a CNDDB search within five miles of the project, CWHR analysis or literature review, and descriptions of their potential to occur within the project area are included in Table 1. Federally listed species which may occur in the project area was obtained from the USFWS.

Table 1
POTENTIALLY OCCURRING SPECIAL-STATUS WILDLIFE SPECIES

Common and Scientific Names	Status Fed/State	Preferred Habitats	Known and Potential Occurrence in Project Area
Invertebrates			
Carson wandering skipper	FT/--	Alkaline desert seeps dominated by saltgrass	No potential for occurrence due to lack of suitable habitat
Amphibians			
Foothill yellow-legged frog *Rana boylii*	--/CSC	Slow-moving, gravelly streams and rivers with sunny banks in forests and chaparral	No potential for occurrence due to lack of gravelly streams or waterbodies



CNDDB Occurrence
Proposed Expansion Area
1-Mile Buffer Around Proposed Expansion Area
5-Mile Buffer Around Proposed Expansion Area

0 0.75 1.5 3 Miles

VESTRA

SOURCE: MAXAR 2019 AERIAL PHOTOGRAPH; CNDDB AUGUST 2020

FIGURE 7
CNDDB OCCURRENCES
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

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Table 1 POTENTIALLY OCCURRING SPECIAL-STATUS WILDLIFE SPECIES			
Common and Scientific Names	**Status Fed/State**	**Preferred Habitats**	**Known and Potential Occurrence in Project Area**
Birds			
Tricolored blackbird *Agelaius tricolor*	--/CE	Nest near fresh water in adjacent vegetation, especially near marshes. Forage in grasslands and croplands	No potential for occurrence due to lack of suitable habitat
Golden eagle *Aquila chrysaetos*	--/CFP	Needs open terrain for hunting – grassland, desert, savannah, shrub. Nests on cliffs and in large trees	Potential for occurrence due to suitable foraging habitat
Northern harrier *Circus cyaneus*	--/CSC	Grasslands, fields, and marshes	Potential for occurrence due to suitable foraging habitat
Swainson's hawk *Buteo swainsoni*	--/CT	Large, open grasslands in riparian systems	Potential for occurrence due to some suitable foraging habitat
Greater sandhill crane *Grus canadensis tabida*	--/CT	Shortgrass plains, grain fields and open wetlands for foraging. Nests in wetlands	No potential for occurrence due to lack of suitable habitat
Greater sage-grouse *Centrocercus urophasianus*	--/CSC	Open, continuous sagebrush communities	Potential for occurrence due to suitable habitat
Burrowing owl *Athene cunicularia*	--/CSC	Open, dry grassland, desert, and shrub	None found during April 2020 survey. Potential for occurrence due to suitable habitat
Long-eared owl *Asio otus*	--/CSC	Roost in dense vegetation and forage in open grasslands or shrublands	Potential for occurrence due to suitable foraging habitat
Short-eared owl *Asio flammeus*	--/CSC	Large, open areas with low vegetation including prairie, grassland, shrubsteppe, agricultural areas	Potential for occurrence due to suitable habitat
Loggerhead shrike *Lanius ludovicianus*	--/CSC	Open areas with short vegetation and well-spaced shrubs or low trees	Potential for occurrence due to suitable habitat
Mammals			
Pallid bat *Antrozous pallidus*	--/CSC	Forages over many habitats; roosts in buildings, trees, rocky outcrops and crevices in mines and caves; also in oak and pine forested areas, usually near a source of water	Potential for occurrence due to suitable habitat
Townsend's big-eared bat *Corynorhinus townsendii*	--/CSC	Found in all but subalpine and alpine habitats. Requires mines, caves, rock piles, and lava tubes for roosting	No potential for occurrence due to lack of suitable habitat
Gray wolf *Canis lupus*	FE/CE	Highly variable	No records in project vicinity in 93 years; has been located recently in other areas of Lassen County
North American wolverine *Gulo gulo luscus*	PFT/CT	Arctic, boreal, and alpine habitats. South of the Canadian border, restricted to high mountain environments near the treeline	No potential for occurrence due to lack of suitable habitat
American badger *Taxidea taxus*	--/CSC	Dry, open stages of shrub and forest with friable soils	Potential for occurrence due to suitable habitat

Table 1 POTENTIALLY OCCURRING SPECIAL-STATUS WILDLIFE SPECIES			
Common and Scientific Names	**Status Fed/State**	**Preferred Habitats**	**Known and Potential Occurrence in Project Area**
Pygmy rabbit *Brachylagus idahoensis*	--/CSC	Sagebrush, bitterbrush, and pinyon-juniper	Potential for occurrence due to suitable habitat
White-tailed jackrabbit *Lepus townsendii townsendii*	--/CSC	Sagebrush, subalpine conifer, juniper, alpine dwarf-shrub, and perennial grassland	Potential for occurrence due to suitable habitat
Key: Federally Endangered (FE), Proposed Federally Endangered (PFE); Federally Threatened (FT); Proposed Federally Threatened (PFT); California Endangered (CE); California Threatened (CT); California Fully Protected (CFP); California Species of Special Concern by DFG (CSC)			

Special-status wildlife species that are known to occur, or have the potential to occur, within the project area include:

- Golden eagle (*Aquila chrysaetos*)
- Northern harrier (*Circus cyaneus*)
- Swainson's hawk (*Buteo swainsoni*)
- Greater sage-grouse (*Centrocercus urophasianus*)
- Burrowing owl (*Athene cunicularia*)
- Long-eared owl (*Asio otus*)
- Short-eared owl (*Asio flammeus*)
- Loggerhead shrike (*Lanius ludovicianus*)
- Gray wolf (*Canis lupus*)
- American badger (*Taxidea taxus*)
- Pallid bat *(Antrozous pallidus)*
- Pygmy rabbit (*Brachylagus idahoensis*)
- White-tailed jackrabbit (*Lepus townsendii townsendii*)

Of the 19 special-status species evaluated, 13 were determined to have a potential to occur, while the rest were determined to have no potential to occur. Species determined to have potential to occur within the project area are discussed below, while species that were determined to be absent are not discussed further.

Birds

Golden Eagle
Aquila chrysaetos
California Fully Protected
The golden eagle is listed by the State of California as Fully Protected, which prohibits take or possession of the species. This species is an uncommon resident throughout California and a migrant in the Central Valley during the winter. These birds typically hunt over the open terrain of grasslands, deserts, savannah, shrub, and early successional forests. They nest on cliffs of variable heights and in large trees in open habitats. There is little data on golden eagle abundance in California and the data that does exist does not show strong trends. Threats to this bird include loss of foraging areas and nesting habitat, and historical pesticide poisoning.

Potential foraging habitat exists in the open sagebrush areas of the project area. Disturbance of an additional 51 acres of land may result in the loss of foraging area for this species. The proposed project area is not a known foraging location for golden eagles; according to CNDDB, there are no known golden eagle occurrences within five miles of the proposed expansion area. No project impacts to golden eagles are anticipated. Mitigation measures to restore habitat described in the Reclamation Plan will be taken to protect eagles if they occur in the proposed project area.

Northern Harrier
Circus cyaneus
State Species of Special Concern
The northern harrier is listed by the State of California as a Species of Special Concern. This species is a common winter resident and occurs in greater numbers in California during migration and winter, as many populations travel farther north to breed. Some populations remain in California and the historic breeding range extended from the Modoc Plateau south to San Diego. Breeding in California has greatly declined due to loss of suitable wetland habitats. Although most suitable habitat has been destroyed or degraded, the Central Valley still supports the majority of nesting in California. Northern harriers inhabit a variety of open habitats that provide vegetative cover including grasslands, coastal ponds/sloughs, coastal marshes, coastal wetlands, salt marshes, and sagebrush areas.

Potential foraging habitat for northern harriers exists in the proposed expansion area. Disturbance of an additional 51 acres of land may result in the loss of foraging area for this species. The proposed project area is not a known foraging or breeding location for northern harriers; according to CNDDB, there are no known occurrences within five miles of the proposed expansion area. No project impacts to northern harriers are anticipated. Mitigation measures to restore habitat described in the Reclamation Plan will be taken to protect northern harriers if they occur in the proposed project area.

Swainson's Hawk
Buteo swainsoni
State Threatened
The Swainson's hawk was listed as a threatened species in 1983. This species breeds in the western United States and Canada and winters in isolated areas in California, Mexico, and Central and South America, though only a small number have been documented to overwinter in California. Historically found throughout California except in the Sierra Nevada, North Coast Ranges and Klamath Mountains, loss of suitable habitat has now restricted breeding areas to the Great Basin and the Central Valley. Nesting Swainson's hawks require large open areas of grassland for foraging adjacent to riparian forests or corridors, juniper-sage flats, or oak savannah for nesting. The main cause of the decline of this species in California is the significant loss and degradation of open areas, such as agricultural lands and grasslands, due to urban development.

There are no records of Swainson's hawks within the project area in the CNDDB, but there are three records of nesting hawks within five miles of the project area. All of these records are located in irrigated farmland; there is no irrigated agricultural habitat suitable for nesting within the project area. Disturbance of an additional 51 acres of land may result in the loss of foraging habitat for this species. Foraging birds likely avoid the area because of ongoing project activities. No Swainson's hawks were observed during site surveys. No project impacts to Swainson's hawks are anticipated.

Greater Sage-Grouse
Centrocercus urophasianus
State Species of Special Concern
The greater sage-grouse is listed by the State of California as a Species of Special Concern. The species was considered for listing under the ESA as Endangered or Threatened in 2015, but the USFWS found that listing was not warranted. This species is a permanent resident in northeastern California and ranges from the Oregon border along the east side of the Cascade Range and Sierra Nevada to northern Inyo County. Lassen and Mono Counties have the most stable populations in California. Greater sage-grouse inhabit open areas with a combination of sagebrush, perennial grassland and wet meadow; large, continuous tracts of sagebrush habitat are required for courtship displays. Declining population numbers are due mostly to habitat loss, impacts of non-native invasive species, and overgrazing.

There are no records of greater sage-grouse within five miles of the project area in the CNDDB; the closest record is 58 miles to the north. Potential breeding and nesting habitat exists in the open sagebrush areas of the project area. Although there are no nearby records, there is suitable habitat within the project area and surrounding areas. Disturbance of an additional 51 acres of land may result in the loss of habitat for this species. No leks or signs of sage grouse activity were located in the proposed project area, and nesting birds will likely avoid the area because of ongoing project activities. No adverse project impacts to greater sage-grouse are anticipated.

Burrowing Owl
Athene cunicularia
State Species of Special Concern
The burrowing owl is listed by the State of California as a Species of Special Concern. This species is a permanent resident in the central valley and southern California. These birds inhabit northeastern California during the summer breeding season. Burrowing owl habitat typically consists of open grasslands and shrublands with perches for hunting and burrows for nesting. Nesting usually occurs in vacant mammal burrows but, where burrows are scarce, these owls may use human structures or dig their own burrows in soft soil. This species exhibits strong site fidelity. These owls forage at all hours of the day and night. Populations are still stable but have been declining, mostly due to habitat loss from agriculture and development and poisoning of ground squirrels.

There are no records of burrowing owls within five miles of the project area in the CNDDB. Although there are no nearby records, this species was considered during site survey because suitable habitat exists within the project area and surrounding areas. There is currently no known nesting sites located in or near the project area, and any potentially nesting birds likely avoid the area because of ongoing project activities. Burrowing owls and burrows were not observed within the proposed project area during site surveys. Mitigation measures described in the reclamation plan will be taken to minimize any disturbance if burrowing owls are observed on-site.

Long-Eared Owl
Asio otus
State Species of Special Concern
The long-eared owl is listed by the State of California as a Species of Special Concern. This species is a permanent resident throughout California, except the central valley and southern California. Long-eared owls roost and nest in dense vegetation, typically live oak thickets and other dense tree stands, especially in riparian areas. These owls hunt in open grasslands and shrublands. This species does not build their own nests; nesting usually occurs in old bird and squirrel nests. These are nocturnal owls that forage during nighttime hours. Resident populations have been slowly declining since the 1940s due mainly to habitat loss and fragmentation.

There are no records of long-eared owls within five miles of the project area in the CNDDB. Although there are no nearby records, there is suitable foraging habitat within the project area and surrounding areas. The addition of 51 acres to the project area will likely disturb foraging habitat for this species. Any birds will likely avoid the area because of ongoing project activities and will forage in adjacent habitat. There are currently no known nesting sites located in or near the project area, and there is no suitable dense nesting vegetation for the long-eared owl in the area. No project impacts to long-eared owls are anticipated.

Short-Eared Owl
Asio flammeus
State Species of Special Concern
The short-eared owl is listed by the State of California as a Species of Special Concern. This species is a permanent resident in northeastern California and a widespread winter migrant in the central valley and western Sierra Nevada. Short-eared owls roost on the ground in dense, low vegetation, typically tall grasses, brush, or wetlands. Nests are made on dry ground concealed in vegetation. These owls hunt in open areas including annual and perennial grasslands, shrublands, marshes, and agricultural fields; grasslands are most preferred. Short-eared owls are active mostly at twilight and nighttime hours, but are often active during the day in the breeding season. There is not a lot of available data on short-eared owl populations, but populations appear to be declining over most of the range because of habitat loss and fragmentation, and overgrazing.

There are no records of short-eared owls within five miles of the project area in the CNDDB. Although there are no nearby records, there is some suitable habitat within the open shrubland of the project area and surrounding areas. There are currently no known nesting sites located in or near the project area, and there is not enough suitable grassland within the area for nesting. Any owls foraging in the area will likely avoid the project area and will forage in adjacent undisturbed habitat. No project impacts to short-eared owls are anticipated.

Loggerhead Shrike
Lanius ludovicianus
State Species of Special Concern
The loggerhead shrike is listed by the State of California as a Species of Special Concern. This species is a permanent resident and winter migrant in lowland and foothill areas throughout California. This species typically inhabits open areas with scattered shrubs, trees and perches, including agricultural fields, pastures, orchards, scrublands, and riparian areas. These birds roost

and nest in shrubs or small trees. Loggerhead shrikes are diurnally active. Populations in the Pacific states have remained fairly stable, but numbers have declined elsewhere in their range. Declines are likely due to increased use of pesticides.

There are no records of loggerhead shrikes within five miles of the project area in the CNDDB. Although there are no nearby records, there is suitable habitat within the open shrubland of the project area and surrounding areas. There are currently no known nest occurrences located in or near the project area, and nesting birds will likely avoid the area to utilize adjacent undisturbed sagebrush habitat. No project impacts to loggerhead shrikes are anticipated.

Mammals

Gray Wolf
Canis lupus
Federally Endangered; California Endangered
The gray wolf was listed as endangered on March 9, 1978 (USDI FWS 1978). Gray wolves are habitat generalists and can potentially occur in a wide range of habitats including temperate forest, mountains, tundra, taiga, and grasslands, so long as there is suitable prey. Prey species primarily include ungulates, such as moose, caribou, deer, and elk, but they will also take smaller prey such as beaver and small mammals, and will readily scavenge.

This species is highly territorial and defends territories in packs. Territory size is a function of prey density and can range from 25 to 1,500 square miles. Both male and female wolves disperse at equal rate and equal distances, sometimes more than 600 miles. Gray wolves once ranged throughout the northern hemisphere, but widespread trapping and extermination efforts severely reduced their distribution and caused dramatic population declines. Current threats to the gray wolf include continued conflict with humans, primarily resulting from livestock depredation, and habitat loss, degradation and fragmentation due to land development.

The last recorded observation of gray wolf in the project vicinity was in 1924 near Litchfield, California. However, it has a large home range and range expansion is documented and could result in wolves reinhabiting the area at some point. CDFW has collected evidence (GPS tracking collar and remote trail camera images in 2016) that suggests that a small number of wolves have traveled into Lassen County (CDFW 2017).

Due to the small project footprint relative to the large home range size of the gray wolf, the proposed project will not alter an amount of habitat significant enough to have any impact on the species. Further, gray wolves are highly mobile and capable of avoiding project-related disturbance. Therefore, the proposed expansion will have no effect on the gray wolf.

American Badger
Taxidea taxus
State Species of Special Concern
The American badger is listed by the State of California as a Species of Special Concern. These animals are permanent residents throughout most of California, except for the far northern North Coast area. Suitable habitat for this species is characterized by herbaceous, shrub, and open stages of most habitats with dry, friable soils. Dry, friable soils, often sandy, are required because badgers eat mostly fossorial (i.e., occurring underground) rodents, and they also take

cover and reproduce in burrows. Badgers are active both day and night, and they may undergo periods of torpor in the winter. Populations are considered to be fairly stable but have declined due to historical trapping, conversion of habitat to intensive agriculture, and rodent poisoning.

There are no records of American badgers within five miles of the project area in the CNDDB; however, there is suitable habitat within the open shrubland of the project area and surrounding areas. No American badgers, signs of badgers, or burrows were observed during the site survey. Any badgers in surrounding areas likely avoid the project area due to a close proximity to ongoing operations in the current mining area. No project impacts to American badgers are anticipated.

Pygmy Rabbit
Brachylagus idahoensis
State Species of Special Concern
The pygmy rabbit is listed by the State of California as a Species of Special Concern. In California, this species is uncommon in the Great Basin areas of Modoc, Lassen, and Mono Counties. These rabbits can be found in sagebrush, bitterbrush, and pinyon-juniper habitats, and they prefer big sagebrush because it makes up the majority of their winter diet. Pygmy rabbits dig burrow for food storage and reproduction. This species is crepuscular and sometimes active during the day. Populations exhibit patchy distributions and are extremely varied across the species range. Because the species is dependent on big sagebrush it is vulnerable to habitat loss and fragmentation from habitat conversion and fire.

There are no CNDDB records of these rabbits within five miles of the project area; however, there is suitable sagebrush habitat for this species, so they could potentially occur. No pygmy rabbits were observed during site surveys. Pygmy rabbits in surrounding areas likely avoid the project area due to the close proximity to ongoing operations. No project impacts to pygmy rabbits are anticipated.

White-Tailed Jackrabbit
Lepus townsendii townsendii
State Species of Special Concern
The white-tailed jackrabbit is listed by the State of California as a Species of Special Concern. This species is an uncommon, permanent resident of northeastern California and the upper eastern slopes of the Sierra Nevada. These rabbits prefer open areas with scattered shrubs, including sagebrush, subalpine conifer, juniper, alpine dwarf-shrub, and perennial grassland, but are also found in wet meadow habitat and early successional stages of conifer forests. These animals move seasonally from higher to lower elevations in winter. Sagebrush is an important part of the winter diet. This species is primarily nocturnal and sometimes crepuscular. There is little available data on the status of populations in California, but evidence indicates sharp declines. It is thought that white-tailed jackrabbits may now be absent from large tracts of its previous range. Overgrazing is thought to be the main cause of habitat fragmentation.

There are no CNDDB records of these rabbits within five miles of the project area; however, there is suitable sagebrush habitat for this species, so they could potentially occur. The disturbance of an additional 51 acres could result in the loss of habitat for this species. No white-tailed jackrabbits were observed during site surveys. White-tailed jackrabbits in surrounding areas likely avoid the project area due to the close proximity to ongoing operations. No project impacts to white-tailed jackrabbits are anticipated.

Pallid Bat
Antrozous pallidus
State Species of Special Concern
The pallid bat is listed by the State of California as a Species of Special Concern. These are crevice-roosting bats of arid and semi-arid regions across much of the American west. They are a locally common species of low elevations. This species is not known to migrate long distances and they likely hibernate close to summer roosts. They are found in a variety of habitats such as grasslands, shrublands, and woodlands, but are most common in open, dry regions with rocky outcroppings or sparsely vegetated grasslands. Water must be available close by to all sites. They typically will use three different types of roosts: a day roost which can be a warm, horizontal opening such as in attics, shutters or crevices; the night roost is in the open, but with foliage nearby; and the hibernation roost mentioned above, which is often in buildings, caves, or cracks in rocks (Brylski et al. 1998). These bats are very sensitive to roosting site disturbance.

There are no records of pallid bats within five miles of the project area in the CNDDB; however, there is suitable foraging habitat within the open shrubland of the project area and surrounding areas and rock outcroppings in the proposed project area could provide roosting habitat. No bats or sign of bats were observed in rock outcroppings during the site survey. No other potential habitat was identified onsite. No project impacts to pallid bats are anticipated.

Potential Effects to Deer and Pronghorn
The sagebrush habitat surrounding the project area provides habitat for mule deer (*Odocoileus hemionus*) and American pronghorn (*Antilocapra americana)*. The project area falls within Deer Hunt Zone X5a, which is a zone within the greater DAU 2 – encompassing northeastern California; and the project is within Pronghorn Hunt Zone 4 – Lassen. The project area is on the edge of CDFW-designated critical winter-range habitat for mule deer (Figure 5) and winter-range habitat for pronghorn antelope (Figure 6). The mule deer population within Hunt Zone X5a has increased, with an estimated 544 animals in 2013 and 942 in 2017. Previous mitigation measures were discussed in Section 1.5.

Site visit found potential noise impacts due to proximity to a canyon which leads to kidding grounds. The project boundary was designed to keep a natural berm at that end of the quarry in order to minimize noise impacts to the kidding grounds. Noise should be contained within Ball's Canyon, approximately 4 miles south of the kidding grounds (see Figure 6).

4.1.2 Special-Status Plants

Special-status plant species include plants that are (1) designated as rare by CDFW or USFWS or are listed as threatened or endangered under the CESA or ESA; (2) proposed for designation as rare or listing as threatened or endangered; (3) designated as state or federal candidate species for listing as threatened or endangered; and/or (4) ranked as California Rare Plant Rank (RPR) 1A, 1B, 2A, 2B, or 3. A list of regionally occurring special-status plant species was compiled based on a review of pertinent literature, the results of the field surveys, and a review of the USFWS species list and CNDDB and a nine-quad search (Tunnison Mountain, Petes Valley, Karlo, Johnstonville, Litchfield, Shaffer Mountain, Janesville, Standish, and Wendel Hot Springs) of CNPS database records.

For each special-status plant species, habitat and other ecological requirements were evaluated and compared to the habitats in the study area and immediate vicinity to assess the presence of potential habitat. The habitat assessment is provided in Table 2.

Six plants ranked 1B or 2B by the CNPS California Rare Plant Ranking (CRPR) are recorded in the CNDDB within five miles of the proposed expansion area. Plant species listed on the CNPS CRPR are considered during this assessment as they meet the definition of Threatened or Endangered under sections 2062 and 2067 of the California Fish and Game code. (CRPR listed as 1, 2, or 3 meet definition of Threatened/Endangered under CESA). The six CRPR plants species and a summary of their potential to occur within the proposed project area are included in Table 2. Consultations found no records of Federally or State-listed threatened or endangered plant species within five miles of the project area.

Table 2
POTENTIALLY OCCURRING SPECIAL-STATUS PLANT SPECIES

Species	CRPR Status	Flowering Period	Habitat	Potentially Occurring	Identified Onsite
Winged dock (*Rumex venosus*)	2B.3	May-June	Great Basin scrub (sandy); 1200-1800 m	No	NA
Western seablite (*Suaeda occidentalis)*	2B.3	July-September	Great Basin scrub (alkaline, mesic); usually in wetlands; 1200-1500 m	No	NA
Playa phacelia (*Phacelia inundata*)	1B.3	May-August	Usually in wetlands; sagebrush scrub, lower montane coniferous forest; 1350-2000 m	No	NA
Ornate dalea (*Dalea ornata*)	2B.1	June	Pinion-Juniper woodland; 1365-1700 m	Yes	No
Spiny milkwort (*Polygala subspinosa*)	2B.2	May-August	Sagebrush scrub, Pinion-Juniper woodland, gravelly, rocky; 1330-1705 m	Yes	Yes
Susanville beardtongue (*Penstemon sudans*)	4.3	June-July	Great Basin scrub, lower montane coniferous forest (openings), Pinyon-Juniper woodland; volcanic, rocky, sometimes roadsides; 1200-2425 m	Yes	No

Key: 1B.2: "moderately" rare, threatened, or endangered in California and elsewhere; **1B.3**: "not very" rare, threatened, or endangered in California and elsewhere; **2B.1**: "seriously" rare, threatened, or endangered in California but more common elsewhere; **2B.2**: "moderately" rare, threatened, or endangered in California but more common elsewhere; **2B.3**: "not very" rare, threatened, or endangered in California but more common elsewhere.

Susanville Beardtongue
Penstemon sudans
CRPR 4.3
Susanville beardtongue is a perennial herb/subshrub that is native to California and is also found in Nevada. It is adapted to open rocky, igneous soils in sagebrush scrub and montane forest

habitats between 1200 and 2200 meters. The species is ranked by the CNPS as 4.3, plants of limited distribution in California. The nearest documented observation of Susanville beardtongue was approximately seven miles from the Ward Lake Quarry, on the northeast side of Shaffer Mountain. This species has the potential to occur within the proposed additional project area due to the rocky slopes within the appropriate elevation range.

During a 2019 site survey, Susanville beardtongue was observed outside of the proposed expansion area. None was observed in the proposed expansion area during the spring 2020 survey. No impact will occur.

Spiny Milkwort
Polygala subspinosa
CRPR 2B.2
Spiny milkwort is a perennial herb native to California, though original observations were in the Southwestern United States. It grows in gravelly or rocky soils found in desert scrub and volcanic mesas from 1350 to 2285 meters in elevation. This species is ranked by the CNPS as 2B.2, classified as moderately rare, threatened or endangered in California but more common elsewhere. The nearest documented observation of this plant was in a gravelly wash located six miles east of the Ward Lake Quarry. Spiny milkwort has the potential to occur within the project area due to the gravelly and rocky soils that exist in the proposed expansion area.

The 2018 site survey determined the presence of spiny milkwort due east of the current operations. The plant was observed growing on a southwest-facing slope along the southern border of the site near BLM. The observed habitat was on steep, rocky slopes growing among other vegetation including perennial grasses and annual forbs. The proposed work may impact spiny milkwort within the proposed additional mining area. Mitigation measures should be considered to reduce adverse impacts to this species.

Ornate Dalea
Dalea ornata
CRPR 2B.1
Ornate dalea is a perennial forb that is native to California that commonly grows on open, rocky hillsides at elevations between 1365 and 1700 meters. This species is known to occur on the Modoc Plateau. The 2018 survey conducted for ornate dalea found no observations of the species. The nearest sighting was approximately two miles from the proposed expansion area. Previous observations of ornate dalea have occurred within one mile of hydrological drainages. Ornate dalea was not observed within the proposed project area or surrounding areas during the site survey. No project impacts to this species are anticipated.

4.1.3 Raptors and Migratory Birds

Raptor species (birds of prey) and migratory birds may nest in trees and other vegetation located within or in the immediate vicinity of the study area. All raptors and migratory birds, including common species and their nests, are protected from "take" under the California Fish and Game Code, Section 3503 and 3503.5, and the Federal Migratory Bird Treaty Act. Large trees onsite and in the surrounding forest provide potential nesting habitat for raptors and migratory birds.

Implementation of the conservation measures described in Section 1.5 would reduce potential impacts on nesting migratory birds and raptors. Mining activities during the nesting season (February 1 through August 31), such as tree removal and blasting activities that disturb a nesting bird or destroy active nests, could result in impacts to nesting birds. Should a site survey detect nesting raptors in close proximity to the project area, appropriate spatial and temporal buffers will be implemented. The project is not anticipated to have a direct effect on raptors or migratory birds or their habitat.

5.0 POTENTIAL EFFECTS

The proposed Reclamation Plan Amendment would expand the project area to include an additional 51 acres of land to be used as a rock quarry. Potential effects to biological resources will be addressed through avoidance and mitigation measures such that the project is not likely to adversely impact special-status species or their habitat.

5.1 Direct Effects

Direct effects of the proposed project are those immediate impacts resulting from the proposed expansion. Potential direct effects of the proposed project to special-status wildlife species are the loss of habitat due to ground disturbance, materials handling, and associated noises.

The proposed quarry will involve disturbance of native vegetation and reconfiguration of slopes within the proposed project area. Such a change in topography will cause a loss of habitat in the area for the 30-year duration of the project. A portion of the proposed expansion area has historically been disturbed; the grading from an old access road, possibly from public land use, is observable through aerial imagery and onsite.

5.1.1 Direct Effects to Birds

The proposed expansion will result in the loss of 51 acres of available sagebrush habitat during the course of the project. Bird species which utilize sagebrush shrub habitat for foraging or nesting will likely avoid the site and seek adjacent areas with undisturbed land. Noise and vibrations generated by heavy equipment operation may cause a disturbance to nesting and foraging birds. However, noise and vibrations associated with mining work already occur in the active project area and any birds in the area are likely acclimated to these noise levels. Foraging birds will avoid the site by changing flight patterns while project work occurs. Areas of the current quarry will be reclaimed, which will restore habitats. No significant effects to birds are expected as a result of the proposed project site expansion. Vegetation removal should occur outside of the nesting season.

5.1.2 Direct Effects to Mammals

The proposed expansion will result in the loss of 51 acres of available sagebrush habitat during the course of the project. This could mean a loss of foraging and breeding habitats. Mammalian species which utilize sagebrush shrub habitat will likely avoid the site and seek adjacent undisturbed open space which consists of large expanses of sage brush habitat. Noise and vibrations generated by heavy equipment operation may cause a disturbance to mammals. However, noise and vibrations associated with mining work already occur in the active project area and any mammals in the area are likely acclimated to these noise levels. Noise impacts to pronghorn habitat will be reduced through design features. Areas of the current quarry will be reclaimed, which will restore habitats. In addition, habitat enhancement and non-native annual control will be undertaken in non-disturbed areas. No significant effects to mammals are expected as a result of the project site expansion.

5.1.3 Direct Effects to Plants

A loss of vegetation within the proposed expansion area will occur during the course of the project. A site survey for special-status plants that were determined to have the potential to occur found that two special-status plants occur within the proposed expansion area. It is possible that these plants may be adversely impacted by the proposed work. Site surveys will be completed prior to vegetation removal. Mitigation measures may be implemented to avoid or reduce such impacts.

5.2 Indirect Effects

Indirect effects are those that are caused by or will result from the proposed action and are expected to occur later in time. Effects could be both short- and/or long-term in nature. The project will result in an increase in human presence within the proposed expansion area for the duration of project activities, which could potentially result in increased disturbance or stress to special-status wildlife. A loss of vegetation may reduce the abundance of species in the project area. After the completion of the project, reclamation activities will restore the site to its previous setting, which will provide valuable habitat to wildlife.

5.3 Cumulative Effects

Cumulative effects include the total impact on a resource due to past, present, and future activities. The Ward Lake Quarry has been in operation since 1980 for rock, sand, and gravel removal and processing operations. The project area is zoned as an upland conservation/resource management district by Lassen County, so this consistent disturbance is anticipated. These previous uses have changed the topography and vegetation of the site, thus changing available habitat within the project area on an annual basis. The proposed expansion would cause additional ground disturbance, but would enhance the brush communities, including sagebrush, bitterbrush, and rabbitbrush, on the site following conclusion of the project and site reclamation. Many of the surrounding parcels are zoned as open space or upland conservation district, so reclamation of the site will create contiguous open space and wildlife habitat.

5.4 Potential Mitigation Measures

The proposed expansion of the project area will not have significant adverse effects on special-status wildlife or their habitat. In the case of present special-status species onsite, and in the spirit of responsible stewardship, the applicant may choose to employ the following as additional mitigation:

1. **Preservation of remaining habitat onsite.** This option would preserve the remaining habitat onsite and involve no additional mining beyond the additional planned 51 acres. Applicant would consent to setting land aside from future development. Most of the surrounding parcels are zoned for development for agricultural or natural resource extraction purposes, so setting undeveloped land aside would ensure undisturbed wildlife habitat.

2. **Partial avoidance.** This option would involve locating the proposed project work in the least environmentally sensitive area in order to avoid disturbance of the rare plant community. Protocol-level surveys will be completed during an appropriate time of year, when the plant is in flowering stage. The area identified as environmentally sensitive would be protected by a buffer zone.
3. **Offsite acquisition of sensitive plant communities.** This option would involve compensating for any loss of sensitive/rare plant communities. This can be achieved through the permanent protection of an offsite native population, permanent protection of an offsite introduced population, or creation and protection of an onsite population. The former is preferred as the success rate of onsite introduction of rare plants is low due to the little knowledge about their specific habitat requirements.
4. **Habitat enhancement.** This option would involve enhancing habitat on the project parcel or nearby parcels to provide additional cover and foraging opportunities for wildlife species.
5. **Bird nest avoidance.** Vegetation will be removed outside of bird nesting season (February through August), to the extent possible, to avoid impacts to shrub-nesting birds.

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Appendix A

USFWS Correspondence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Reno Fish And Wildlife Office
1340 Financial Boulevard, Suite 234
Reno, NV 89502-7147
Phone: (775) 861-6300 Fax: (775) 861-6301
http://www.fws.gov/nevada/

In Reply Refer To:
Consultation Code: 08ENVD00-2018-SLI-0675
Event Code: 08ENVD00-2018-E-01540
Project Name: Ward Lake Expansion

June 29, 2018

Subject: List of threatened and endangered species that may occur in your proposed project location, and/or may be affected by your proposed project

To Whom It May Concern:

The attached species list indicates threatened, endangered, proposed, and candidate species and designated or proposed critical habitat that may occur within the boundary of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act of 1973, as amended (ESA, 16 U.S.C. 1531 *et seq.*), for projects that are authorized, funded, or carried out by a Federal agency. Candidate species have no protection under the ESA but are included for consideration because they could be listed prior to the completion of your project. Consideration of these species during project planning may assist species conservation efforts and may prevent the need for future listing actions. For additional information regarding species that may be found in the proposed project area, visit http://www.fws.gov/nevada/es/ipac.html.

The purpose of the ESA is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the ESA and its implementing regulations (50 CFR 402 *et seq.*), Federal agencies are required to utilize their authorities to carry out programs for the conservation of threatened and endangered species and to determine whether projects may affect threatened and endangered species and/or designated critical habitat.

A Biological Assessment is required for construction projects that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2) (c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Guidelines for preparing a Biological Assessment can be found at: http://www.fws.gov/midwest/endangered/section7/ba_guide.html.

If a Federal action agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by the proposed project, the agency is required to consult with the Service pursuant to 50 CFR 402. In addition, the Service recommends that candidate species, proposed species, and proposed critical habitat be addressed within the consultation. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered Species Consultation Handbook" at:
http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF.

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this species list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally listed, proposed, and candidate species and federally designated and proposed critical habitat. Please note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the ESA, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally, as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation, for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the attached list.

The Nevada Fish and Wildlife Office (NFWO) no longer provides species of concern lists. Most of these species for which we have concern are also on the Animal and Plant At-Risk Tracking List for Nevada (At-Risk list) maintained by the State of Nevada's Natural Heritage Program (Heritage). Instead of maintaining our own list, we adopted Heritage's At-Risk list and are partnering with them to provide distribution data and information on the conservation needs for at-risk species to agencies or project proponents. The mission of Heritage is to continually evaluate the conservation priorities of native plants, animals, and their habitats, particularly those most vulnerable to extinction or in serious decline. In addition, in order to avoid future conflicts, we ask that you consider these at-risk species early in your project planning and explore management alternatives that provide for their long-term conservation.

For a list of at-risk species by county, visit Heritage's website (http://heritage.nv.gov). For a specific list of at-risk species that may occur in the project area, you can obtain a data request form from the website (http://heritage.nv.gov/get_data) or by contacting the Administrator of Heritage at 901 South Stewart Street, Suite 5002, Carson City, Nevada 89701-5245, (775) 684-2900. Please indicate on the form that your request is being obtained as part of your coordination with the Service under the ESA. During your project analysis, if you obtain new information or data for any Nevada sensitive species, we request that you provide the information to Heritage at the above address.

Furthermore, certain species of fish and wildlife are classified as protected by the State of Nevada (http://www.leg.state.nv.us/NAC/NAC-503.html). You must first obtain the appropriate license, permit, or written authorization from the Nevada Department of Wildlife (NDOW) to take, or possess any parts of protected fish and wildlife species. Please visit http://www.ndow.org or contact NDOW in northern Nevada (775) 688-1500, in southern Nevada (702) 486-5127, or in eastern Nevada (775) 777-2300.

Please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 *et seq.*), and projects affecting these species may require development of an eagle conservation plan (http://www.fws.gov/windenergy/eagle_guidance.html). Additionally, wind energy projects should follow the Service's wind energy guidelines (http://www.fws.gov/windenergy/) for minimizing impacts to migratory birds and bats.

The Service's Pacific Southwest Region developed the *Interim Guidelines for the Development of a Project Specific Avian and Bat Protection Plan for Wind Energy Facilities* (Interim Guidelines). This document provides energy facility developers with a tool for assessing the risk of potential impacts to wildlife resources and delineates how best to design and operate a bird- and bat-friendly wind facility. These Interim Guidelines are available upon request from the NFWO. The intent of a Bird and Bat Conservation Strategy is to conserve wildlife resources while supporting project developers through: (1) establishing project development in an adaptive management framework; (2) identifying proper siting and project design strategies; (3) designing and implementing pre-construction surveys; (4) implementing appropriate conservation measures for each development phase; (5) designing and implementing appropriate post-construction monitoring strategies; (6) using post-construction studies to better understand the dynamics of mortality reduction (*e.g.*, changes in blade cut-in speed, assessments of blade "feathering" success, and studies on the effects of visual and acoustic deterrents) including efforts tied into Before-After/Control-Impact analysis; and (7) conducting a thorough risk assessment and validation leading to adjustments in management and mitigation actions.

The template and recommendations set forth in the Interim Guidelines were based upon the Avian Powerline Interaction Committee's Avian Protection Plan template (http://www.aplic.org/) developed for electric utilities and modified accordingly to address the unique concerns of wind energy facilities. These recommendations are also consistent with the Service's wind energy guidelines. We recommend contacting us as early as possible in the planning process to discuss the need and process for developing a site-specific Bird and Bat Conservation Strategy.

The Service has also developed guidance regarding wind power development in relation to prairie grouse leks (sage-grouse are included in this). This document can be found at: http://www.fws.gov/southwest/es/Oklahoma/documents/te_species/wind%20power/prairie%20grouse%20lek%205%20mile%20public.pdf.

Migratory Birds are a Service Trust Resource. Based on the Service's conservation responsibilities and management authority for migratory birds under the Migratory Bird Treaty Act of 1918, as amended (MBTA; 16 U.S.C. 703 *et seq.*), we recommend that any land clearing or other surface disturbance associated with proposed actions within the project area be timed to avoid potential destruction of bird nests or young, or birds that breed in the area. Such destruction may be in violation of the MBTA. Under the MBTA, nests with eggs or young of migratory birds may not be harmed, nor may migratory birds be killed. Therefore, we recommend land clearing be conducted outside the avian breeding season. If this is not feasible, we recommend a qualified biologist survey the area prior to land clearing. If nests are located, or if other evidence of nesting (*i.e.*, mated pairs, territorial defense, carrying nesting material, transporting food) is observed, a protective buffer (the size depending on the habitat requirements of the species) should be delineated and the entire area avoided to prevent destruction or disturbance to nests until they are no longer active.

Guidance for minimizing impacts to migratory birds for projects involving communications towers (*e.g.*, cellular, digital television, radio, and emergency broadcast) can be found at: http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/towers.htm; http://www.towerkill.com; and http://www.fws.gov/migratorybirds/CurrentBirdIssues/Hazards/towers/comtow.html.

If wetlands, springs, or streams are are known to occur in the project area or are present in the vicinity of the project area, we ask that you be aware of potential impacts project activities may have on these habitats. Discharge of fill material into wetlands or waters of the United States is regulated by the U.S. Army Corps of Engineers (ACOE) pursuant to section 404 of the Clean Water Act of 1972, as amended. We recommend you contact the ACOE's Regulatory Section regarding the possible need for a permit. For projects located in northern Nevada (Carson City, Churchill, Douglas, Elko, Esmeralda, Eureka, Humboldt, Lander, Lyon, Mineral, Pershing, Storey, and Washoe Counties) contact the Reno Regulatory Office at 300 Booth Street, Room 3060, Reno, Nevada 89509, (775) 784-5304; in southern Nevada (Clark, Lincoln, Nye, and White Pine Counties) contact the St. George Regulatory Office at 321 North Mall Drive, Suite L-101, St. George, Utah 84790-7314, (435) 986-3979; or in California along the eastern Sierra contact the Sacramento Regulatory Office at 650 Capitol Mall, Suite 5-200, Sacramento, California 95814, (916) 557-5250.

We appreciate your concern for threatened and endangered species. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

The table below outlines lead FWS field offices by county and land ownership/project type. Please refer to this table when you are ready to coordinate (including requests for section 7 consultation) with the field office corresponding to your project, and send any documentation regarding your project to that corresponding office. Therefore, the lead FWS field office may not be the office listed above in the letterhead.

Lead FWS offices by County and Ownership/Program

County	Ownership/Program	Species	Office Lead*

Alameda	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Alameda	All ownerships but tidal/estuarine	All	SFWO
Alpine	Humboldt Toiyabe National Forest	All	RFWO
Alpine	Lake Tahoe Basin Management Unit	All	RFWO
Alpine	Stanislaus National Forest	All	SFWO
Alpine	El Dorado National Forest	All	SFWO
Colusa	Mendocino National Forest	All	AFWO
Colusa	Other	All	By jurisdiction (see map)
Contra Costa	Legal Delta (Excluding ECCHCP)	All	BDFWO
Contra Costa	Antioch Dunes NWR	All	BDFWO
Contra Costa	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Contra Costa	All ownerships but tidal/estuarine	All	SFWO
Del Norte	All	All	AFWO
El Dorado	El Dorado National Forest	All	SFWO
El Dorado	LakeTahoe Basin Management Unit		RFWO
Glenn	Mendocino National Forest	All	AFWO
Glenn	Other	All	By jurisdiction (see map)
Humboldt	All except Shasta Trinity National Forest	All	AFWO

Humboldt	Shasta Trinity National Forest	All	YFWO
Lake	Mendocino National Forest	All	AFWO
Lake	Other	All	By jurisdiction (see map)
Lassen	Modoc National Forest	All	KFWO
Lassen	Lassen National Forest	All	SFWO
Lassen	Toiyabe National Forest	All	RFWO
Lassen	BLM Surprise and Eagle Lake Resource Areas	All	RFWO
Lassen	BLM Alturas Resource Area	All	KFWO
Lassen	Lassen Volcanic National Park	All (includes Eagle Lake trout on all ownerships)	SFWO
Lassen	All other ownerships	All	By jurisdiction (see map)
Marin	Tidal wetlands/marsh adjacent to Bays	Salt marsh species, delta smelt	BDFWO
Marin	All ownerships but tidal/estuarine	All	SFWO
Mendocino	Russian River watershed	All	SFWO
Mendocino	All except Russian River watershed	All	AFWO
Modoc	Modoc National Forest	All	KFWO
Modoc	BLM Alturas Resource Area	All	KFWO
Modoc	Klamath Basin National Wildlife Refuge Complex	All	KFWO
Modoc	BLM Surprise and Eagle Lake Resource Areas	All	RFWO

Modoc	All other ownerships	All	By jurisdiction (See map)
Mono	Inyo National Forest	All	RFWO
Mono	Humboldt Toiyabe National Forest	All	RFWO
Napa	All ownerships but tidal/estuarine	All	SFWO
Napa	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Nevada	Humboldt Toiyabe National Forest	All	RFWO
Nevada	All other ownerships	All	By jurisdiction (See map)
Placer	Lake Tahoe Basin Management Unit	All	RFWO
Placer	All other ownerships	All	SFWO
Sacramento	Legal Delta	Delta Smelt	BDFWO
Sacramento	Other	All	By jurisdiction (see map)
San Francisco	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO
San Francisco	All ownerships but tidal/estuarine	All	SFWO
San Mateo	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO
San Mateo	All ownerships but tidal/estuarine	All	SFWO
San Joaquin	Legal Delta excluding San Joaquin HCP	All	BDFWO

San Joaquin	Other	All	SFWO
Santa Clara	Tidal wetlands/marsh adjacent to San Francisco Bay	Salt marsh species, delta smelt	BDFWO
Santa Clara	All ownerships but tidal/estuarine	All	SFWO
Shasta	Shasta Trinity National Forest except Hat Creek Ranger District (administered by Lassen National Forest)	All	YFWO
Shasta	Hat Creek Ranger District	All	SFWO
Shasta	Bureau of Reclamation (Central Valley Project)	All	BDFWO
Shasta	Whiskeytown National Recreation Area	All	YFWO
Shasta	BLM Alturas Resource Area	All	KFWO
Shasta	Caltrans	By jurisdiction	SFWO/AFWO
Shasta	Ahjumawi Lava Springs State Park	Shasta crayfish	SFWO
Shasta	All other ownerships	All	By jurisdiction (see map)
Shasta	Natural Resource Damage Assessment, all lands	All	SFWO/BDFWO
Sierra	Humboldt Toiyabe National Forest	All	RFWO
Sierra	All other ownerships	All	SFWO
Siskiyou	Klamath National Forest (except Ukonom District)	All	YFWO
Siskiyou	Six Rivers National Forest and Ukonom District	All	AFWO
Siskiyou	Shasta Trinity National Forest	All	YFWO

Siskiyou	Lassen National Forest	All	SFWO
Siskiyou	Modoc National Forest	All	KFWO
Siskiyou	Lava Beds National Volcanic Monument	All	KFWO
Siskiyou	BLM Alturas Resource Area	All	KFWO
Siskiyou	Klamath Basin National Wildlife Refuge Complex	All	KFWO
Siskiyou	All other ownerships	All	By jurisdiction (see map)
Solano	Suisun Marsh	All	BDFWO
Solano	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Solano	All ownerships but tidal/estuarine	All	SFWO
Solano	Other	All	By jurisdiction (see map)
Sonoma	Tidal wetlands/marsh adjacent to San Pablo Bay	Salt marsh species, delta smelt	BDFWO
Sonoma	All ownerships but tidal/estuarine	All	SFWO
Tehama	Mendocino National Forest	All	AFWO
Tehama	Shasta Trinity National Forest except Hat Creek Ranger District (administered by Lassen National Forest)	All	YFWO
Tehama	All other ownerships	All	By jurisdiction (see map)
Trinity	BLM	All	AFWO
Trinity	Six Rivers National Forest	All	AFWO
Trinity	Shasta Trinity National Forest	All	YFWO

Trinity	Mendocino National Forest	All	AFWO
Trinity	BIA (Tribal Trust Lands)	All	AFWO
Trinity	County Government	All	AFWO
Trinity	All other ownerships	All	By jurisdiction (See map)
Yolo	Yolo Bypass	All	BDFWO
Yolo	Other	All	By jurisdiction (see map)
All	FERC-ESA	All	By jurisdiction (see map)
All	FERC-ESA	Shasta crayfish	SFWO
All	FERC-Relicensing (non-ESA)	All	BDFWO

***Office Leads:**

AFWO=Arcata Fish and Wildlife Office

BDFWO=Bay Delta Fish and Wildlife Office

KFWO=Klamath Falls Fish and Wildlife Office

RFWO=Reno Fish and Wildlife Office

YFWO=Yreka Fish and Wildlife Office

Attachment(s):

- Official Species List
- USFWS National Wildlife Refuges and Fish Hatcheries
- Migratory Birds
- Wetlands

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

This species list is provided by:

Reno Fish And Wildlife Office
1340 Financial Boulevard, Suite 234
Reno, NV 89502-7147
(775) 861-6300

Project Summary

Consultation Code: 08ENVD00-2018-SLI-0675

Event Code: 08ENVD00-2018-E-01540

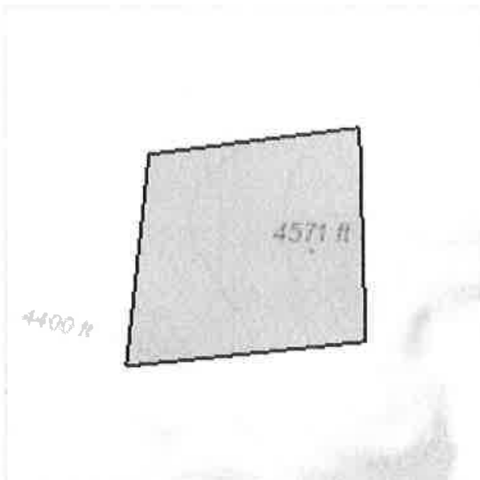
Project Name: Ward Lake Expansion

Project Type: MINING

Project Description: Proposed addition of thirty acres to Ward Lake Mine operations.

Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/place/40.41384728734229N120.41205623177353W



Counties: Lassen, CA

Endangered Species Act Species

There is a total of 1 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Mammals

NAME	STATUS
North American Wolverine *Gulo gulo luscus* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

USFWS National Wildlife Refuge Lands And Fish Hatcheries

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS OR FISH HATCHERIES WITHIN YOUR PROJECT AREA.

Migratory Birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Dec 1 to Aug 31
Clark's Grebe *Aechmophorus clarkii* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Jan 1 to Dec 31

NAME	BREEDING SEASON
Golden Eagle *Aquila chrysaetos* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/1680	Breeds Dec 1 to Aug 31
Lesser Yellowlegs *Tringa flavipes* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-billed Curlew *Numenius americanus* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/5511	Breeds Apr 1 to Jul 31
Marbled Godwit *Limosa fedoa* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9481	Breeds elsewhere
Sage Thrasher *Oreoscoptes montanus* This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA https://ecos.fws.gov/ecp/species/9433	Breeds Apr 15 to Aug 10
Tricolored Blackbird *Agelaius tricolor* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/3910	Breeds Mar 15 to Aug 10
Willet *Tringa semipalmata* This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Apr 20 to Aug 5

Probability Of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence ( )

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ( )
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

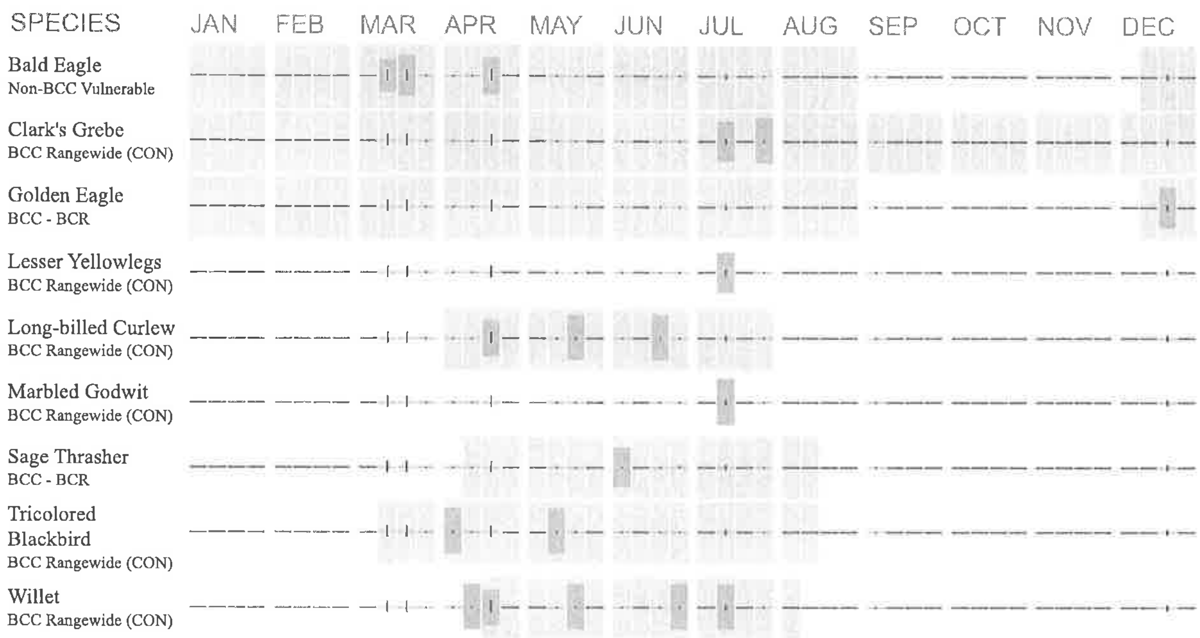
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

---

probability of presence   breeding season | survey effort   – no data



Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

Migratory Birds FAQ

Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?
The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?
To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?
Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and

3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Wetlands

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Please note that the NWI data being shown may be out of date. We are currently working to update our NWI data set. We recommend you verify these results with a site visit to determine the actual extent of wetlands on site.

THERE ARE NO WETLANDS WITHIN YOUR PROJECT AREA.

Appendix B

Burrowing Owl Survey Report

BURROWING OWL SURVEY

WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

Prepared for

Hat Creek Construction & Materials, Inc.

Prepared by

VESTRA Resources, Inc.
5300 Aviation Drive
Redding, California 96002
(530) 223-2585

APRIL 2020

INTRODUCTION

The Ward Lake Quarry is located approximately three miles east of Ward Lake off of Ward Lake Road in Lassen County. The site is located in Section 32, Township 30 North, Range 14 East, MDBM. The coordinates at the center of the project are 40.414478, -120.417222.

The current Ward Lake mine area is approximately 160 acres, 100 acres of which are used for quarry operations. The facility includes the mining of rock, crushing, scales, office, truck shop, cement plant, asphalt plant, settling ponds, fuel storage, and material stockpiles. The project also includes various sediment control structures. The area surrounding the site is used for agriculture, mineral extraction, and open space.

The proposed expansion of Ward Lake Quarry includes the addition of approximately 51 acres to the mine boundary, a portion of which would be used for quarry operations. Access roads currently exist within the remaining area. The proposed expansion area is shown in Figure 1.

BURROWING OWL LIFE HISTORY

Burrowing owls (*Athene cunicularia*) inhabit areas of short grasses or other sparse vegetation, but their most basic habitat requirement is a burrow. Burrows provide protection from many predators, a relatively constant microclimate for nesting and thermoregulation, protection from hazardous or inclement weather, and an area in which to cache prey items. Burrowing owls hunt in both day and night. They perch on prairie dog mounds or other high spots on the ground. Prey is either run down on foot or caught by hovering and swooping. Burrowing owls prey on insects, small mammals, lizards, and birds.

Although its status in northeastern California is poorly known, the species appears to be scarce and may have been so historically. Burrowing owls may currently nest in small numbers in the Honey Lake Basin of Lassen County and in the Plumas County portion of Sierra Valley, and they have been reported from most other large valleys in the region, including Big Valley, Lassen and Modoc counties, and at Modoc National Wildlife Refuge and Surprise Valley in Modoc County (Shuford et al. 2008). Nesting generally occurs between March and September.

Intensive agriculture or development results in loss of burrows which leads to reduced prey availability and creation of suboptimal nesting habitat. Decreased density of adequate burrows may lead to reduced chances for unpaired owls to find mates. Loss of habitat has been cited as factor of decline in California. Due to the declining number of burrowing owls, CDFW has listed the species as a Bird Species of Special Concern.

BURROWING OWL SURVEY

The burrowing owl survey was completed according to the *Burrowing Owl Survey Protocol and Mitigation Guidelines* published by the California Burrowing Owl Consortium. This four-phase survey protocol is intended to help evaluate potential utilization of the Action Area by the species. For purposes of this report, the Action Area is defined as the area within which Project operations could impact an owl. At Ward Lake Quarry, the Action Area includes the proposed

SOURCE: MAXAR 2019 AERIAL PHOTOGRAPH

FIGURE 1
ACTION AREA
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

P:\GIS\71305\WardLakeExpansion2020\Figures\BioReport\71305_OwlActionArea.mxd expansion area and within 500 feet of the proposed boundary, to account for the standard species buffer for burrowing owls (Figure 1).

Phase I: Habitat Assessment

A desktop pre-survey review of the California Natural Diversity Database (CNDDB) was conducted to determine the potential for burrowing owls to occur within the Action Area. There are two documented occurrences of the burrowing owl in Lassen County; the nearest was approximately ten miles east of the Action Area. There are no previous records of the species within 5 miles of the Action Area.

The Action Area is comprised of grazing land identified through the California Wildlife Habitat Relationships (CWHR) classification as Sagebrush (SGB) habitat type. Sagebrush habitat is typically large, open, and often discontinuous, and stands are dominated by big sagebrush (*Artemisia tridentata*). This habitat occurs over a range of middle and high elevations. Sagebrush is mixed with other similar shrub species, such as rabbitbrush (*Chrysothamnus* spp.), horsebrush (*Tetradymia* spp.), and bitterbrush (*Purshia* spp.). The understory onsite consists of perennial grasses, annual grasses, and forbs. Vegetation observed at Ward Lake Quarry includes the following:

- Rubber rabbitbrush (*Ericameria nauseosa*)
- Sagebrush (*Artemisia tridentata* ssp.)
- Mormon tea (*Ephedra viridis*)
- Hooker's balsamroot (*Balsamorhiza hookeri*)
- Bristly fiddleneck (*Amsinckia tesselata*)
- Redstem stork's bill (*Erodium cicutarium*)
- Cheatgrass (*Bromus tectorum*)
- Bluebunch wheatgrass (*Pseudoreogneria spicata*)
- Common wooly sunflower (*Eriophyllum lanatum*)

Common wildlife generally associated with the sagebrush habitat type include mule deer (*Odocoileus hemionus californicus*), black-tailed deer (*Odocoileus hemionus columbianus*), pronghorn (A*ntilocapra Americana*), coyote (*Canis latrans*), jackrabbit *(Lepus californicus*), and Pacific gopher snake *(Pituophis catenifer)*. The following wildlife species, or signs of the species, were observed during the survey:

- Cottontail rabbit (*Sylbilagus bachmani*)
- Chipmunk (*Tamias* sp.)
- Sierran treefrog (*Pseudacris sierrae*)
- Mourning dove (*Zenaida macroura*)
- Black-billed magpie (*Pica hudsonia*)
- California quail (*Callipepla californica*)
- Great horned owl (*Bubo virginianus*)
- Western meadowlark (*Sturnella neglecta*)
- Turkey vulture (*Cathartes aura*)

The habitat assessment found that the Action Area is located within the burrowing owl species range and sagebrush habitat in the area may have the potential to support burrowing owl nesting and foraging. A survey was conducted to assess burrowing owl habitat onsite.

Phase II: Burrow Pedestrian Survey

A pedestrian transect survey was completed throughout the Action Area on March 31, 2020, to determine the presence of burrows onsite. The survey began at 1330 and concluded at 1630. Weather was sunny with approximately 50 percent cloud cover and moderate wind speeds. Ambient temperatures were between 45 and 55 degrees Fahrenheit during the survey period.

Transects were walked within the Action Area in an east-west orientation. Transect spacing was selected to achieve full visual coverage of the ground within any potential burrowing habitat onsite. Habitat quality factors that were considered included topography and soil depth that could potentially support burrows. Transect spacing depended on vegetation density, slope, and the occurrence of large rock outcroppings. Tracks, feathers, pellets, and other sign items that may indicators of a burrow were considered during the survey.

Within the Action Area, soil in areas with slopes between 0 percent and ten percent showed little development with soil depth typically less than three inches and non-friable soils. Slopes greater than ten percent exhibit deep, friable soil with sparse sagebrush shrubs.

Photo: Proposed expansion area (facing east from western boundary)

Photo: Topography of the site (facing NE)

Photo: Shallow soils area

Photo: Deep friable soils area

Results

No burrows were observed that appeared to be able to accommodate an animal the size of a burrowing owl. Several small holes were observed in the ground within the friable soils onsite, though none exceeded 2.5 inches in diameter. The size of the entrance suggests that the burrows were likely created by a snake or chipmunk.

Burrow selection by burrowing owls has been studied by examining global burrowing owl burrow characteristics. The study found that burrowing owls select burrows with an entrance size of 15 centimeters (5.9 inches) or larger in diameter (Johnson et al. 2010). This suggests that the holes observed onsite do not provide habitat for burrowing owls. Additionally, burrowing owls have been observed inhabiting areas with a high density of burrows; this is not the case at the Ward Lake Quarry. Therefore, this assessment finds that no burrowing owl habitat occurs within the Action Area at Ward Lake Quarry.

Photo: Ground hole observed onsite

Phase III: Burrowing Owl Survey, Census, and Mapping

Due to the negative results found in the Phase II of the Burrowing Owl survey, there was no need to implement Phase III of the Burrowing Owl Survey Protocol and Mitigation Guidelines.

REFERENCES

Johnson, David. Gillis, Donald. Gregg, Michael. Rebholz, James. Lincer, James. Belthoff, James. 2010. Users Guide to Installation of Burrows for Burrowing Owls. Tree Top Inc. PP 6.

Shuford, W. D., and Gardali, T., editors. 2008. California Bird Species of Special Concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. Studies of Western Birds 1. Western Field Ornithologists, Camarillo, California, and California Department of Fish and Game, Sacramento.

VESTRA. 2018. "Wildlife Survey Report: Ward Lake Mine."

VESTRA. 2019. "Administrative Draft Subsequent Environmental Impact Report: Modifications to Ward Lake Quarry Operations."

VIEWSHED TECHNICAL SUMMARY

WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

Prepared for

Hat Creek Construction

Prepared by

VESTRA Resources Inc.
5300 Aviation Drive
Redding, California 96002

NOVEMBER 2020

VIEWSHED TECHNICAL SUMMARY

WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

Prepared for

Hat Creek Construction

Prepared by

VESTRA Resources Inc.
5300 Aviation Drive
Redding, California 96002

71305

NOVEMBER 2020

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FIGURES

1.0 INTRODUCTION

1.1 Background

The project site is located approximately 11.5 miles east of the city of Susanville and is situated approximately 3 miles north of Highway 395. The general site location is shown on Figure 1. The existing visual character of the site vicinity is that of high desert shrubland. Topography in project area is sloped toward the Susan River to the south.

This visual analysis is provided for CEQA review of the proposed mining operations and was conducted to present the change in visual quality associated with the project.

1.2 Project Area

The current Ward Lake mine area is approximately 160 acres, 100 acres of which are used for quarry operations. The facility includes the mining of rock, crushing, scales, office, truck shop, cement plant, asphalt plant, settling ponds, fuel storage, and material stockpiles. The project also includes various sediment control structures. The area surrounding the site is used for agriculture, mineral extraction, and open space.

The proposed expansion of Ward Lake Quarry includes the addition of approximately 51 acres to the mine boundary, a portion of which would be used for quarry operations. Access roads currently exist within the remaining area. The proposed expansion area is shown on Figure 2.

1.3 Current Condition

The current visual condition of the site is undeveloped open space. Vegetation is sparse due to the nature of the geology and soils in the area as well as agricultural practices including grazing. This lack of vegetation is part of the current view.

FIGURE 1
GENERAL SITE LOCATION
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

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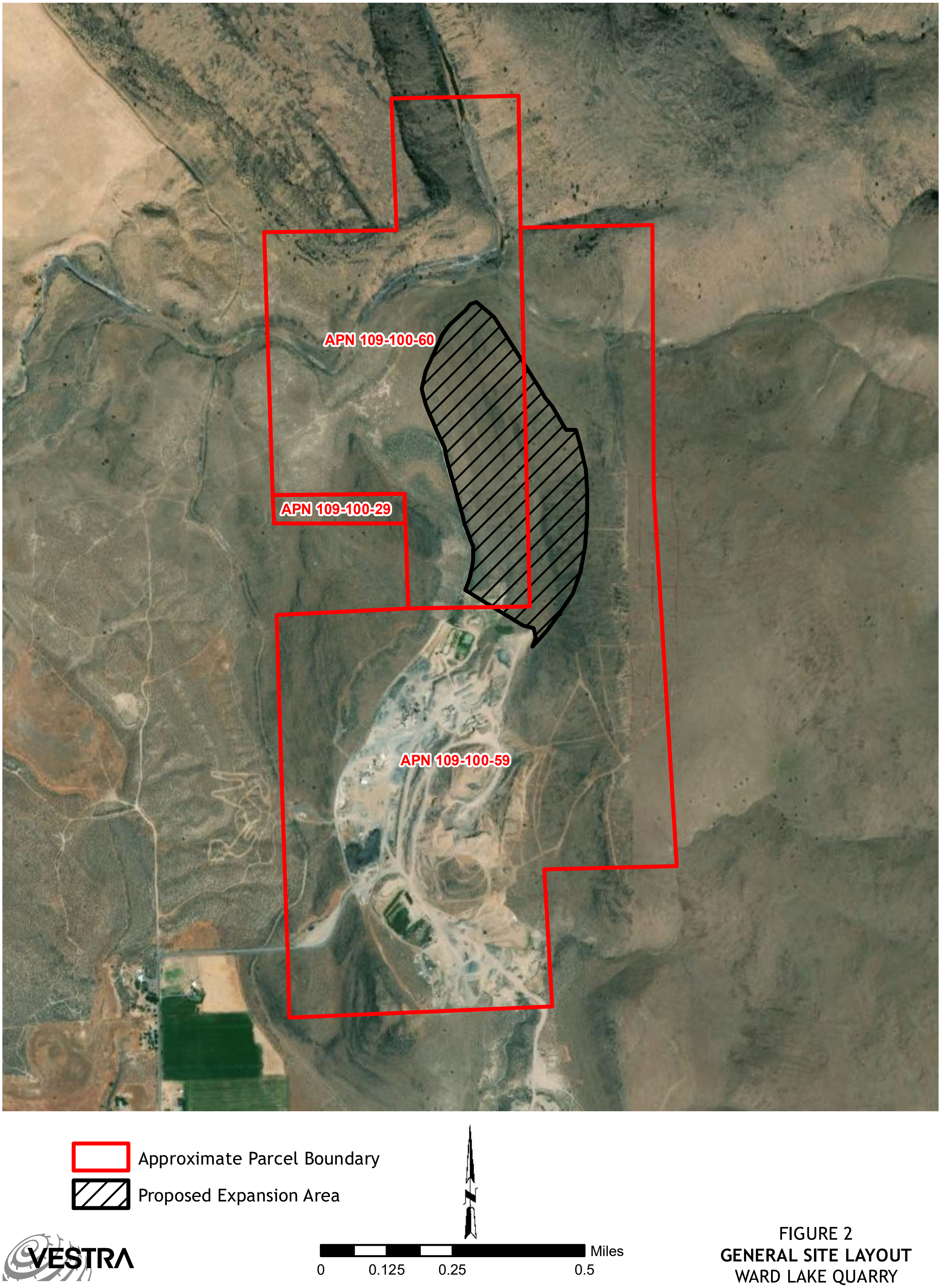

SOURCE: MAXAR 2019 AERIAL PHOTOGRAPH

FIGURE 2
GENERAL SITE LAYOUT
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

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2.0 VISUAL SIMULATION ANALYSIS

2.1 Process

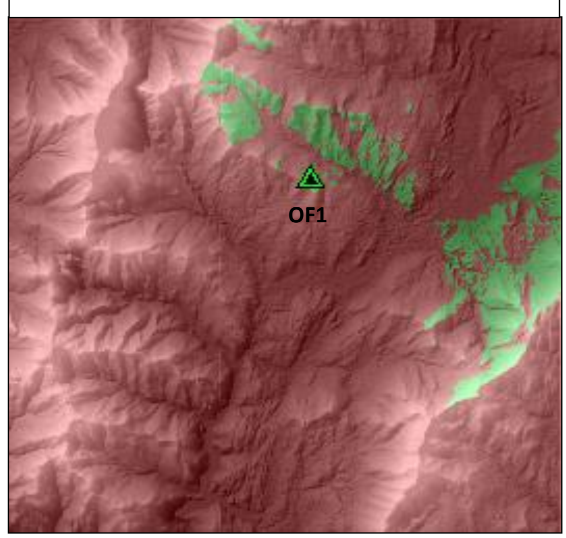
The shape of a terrain surface affects which portions of the surface area can be seen from any given point. To assess the visual components of this project, Geographic Information Systems (GIS) was used to evaluate visibility across the project area from various locations. GIS is a collection of computer hardware, software, and geographic data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. ArcGIS is a Geographic Information System package developed by Environmental Systems Research Institute (ESRI).

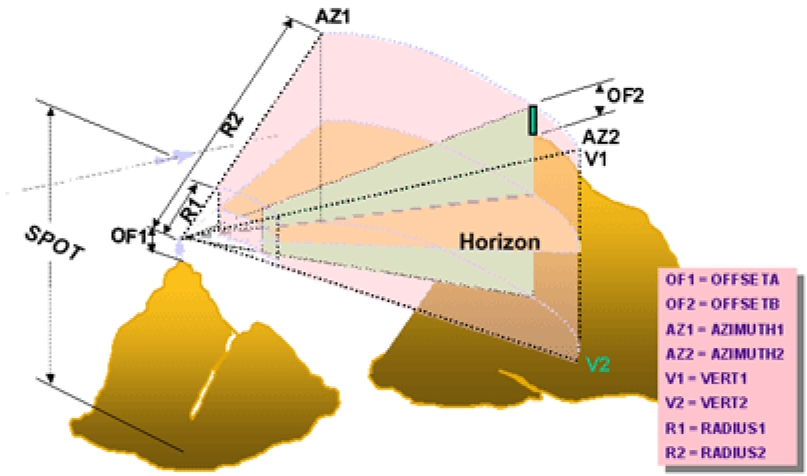
A viewshed identifies the locations in a given area that can be seen from one or more observation points. The elevation data used to perform viewshed analyses are raster-based data. Raster data is data in which a surface is divided into a grid and each cell in the grid contains an elevation value. The resolution of raster data is the distance, in surface units, of the sides of each cell in the grid. An example of this is the elevation data provided by the U.S. Geological Survey (USGS) for use in GIS. These data sets are commonly provided at either a 10-meter or 30-meter resolution. Viewshed analysis provides a value that indicates how many observer points can be seen from each location. If you have only one observer point, each cell from which the observer point can be seen is given a value of one. All cells from which the observer point cannot be seen are given a value of zero. Observer points can be points or linear features.

A viewshed is useful when you want to know how visible objects might be. Not only can you determine which cells can be seen from the observation point, if you have several observation points, you can also determine which observers can see each observed location. Knowing which observer can see which locations can affect decision making.

The image below graphically depicts how a viewshed analysis is performed. The observation point is on the mountaintop to the left (at OF1 in the image). The direction of the viewshed is within the cone looking to the right. You can control how much to offset the observation point from the surface (for example, the height of the tower), and the direction(s) to look in both the horizontal and vertical dimensions.

Displaying a hillshade underneath the elevation and the output from a Viewshed Analysis is a useful technique for visualizing the relationship between visibility and terrain.

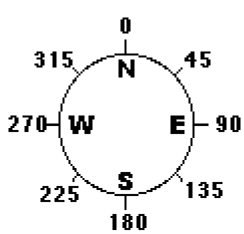




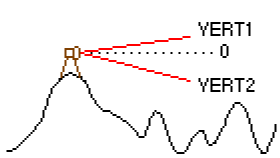
Nine characteristics of the viewshed are controlled as follow:

1. The surface elevations for the observation points (Spot)
2. The vertical distance in surface units to be added to the z-value of the observation points (OffsetA)
3. The vertical distance in surface units to add to the z-value of each cell as it is considered for visibility (OffsetB)

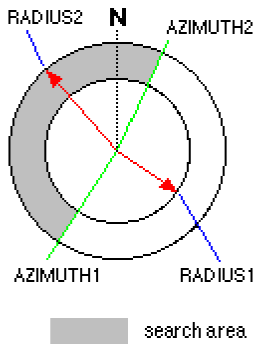
4. The start of the horizontal angle to limit the scan (Azimuth1)
5. The end of the horizontal angle to limit the scan (Azimuth2)



6. The top of the vertical angle to limit the scan (Vert1)
7. The bottom of the vertical angle to limit the scan (Vert2)



8. The inner radius that limits the search distance when identifying areas visible from each observation point (Radius1)
9. The outer radius that limits the search distance when identifying areas visible from each observation point (Radius2)



In order to perform a viewshed analysis, the elevation data should be as detailed as possible. For the Skyline project, the elevation data was derived from the USGS 10-meter digital elevation model (DEM) that is interpolated into a grid format.

Interpolation is a method of creating raster data specifically designed for the creation of hydrologically correct DEMs. It is based on the ANUDEM program developed by Michael Hutchinson (1988, 1989). See Hutchinson and Dowling (1991) for an example of a substantial application of ANUDEM and for additional associated references. A brief summary of ANUDEM and some applications are given in Hutchinson (1993). The version of ANUDEM used is 4.6.3.

The interpolation procedure has been designed to take advantage of the types of input data commonly available and the known characteristics of elevation surfaces. This method uses an iterative finite difference interpolation technique. It is optimized to have the computational efficiency of local interpolation methods, such as inverse distance weighted (IDW) interpolation, without losing the surface continuity of global interpolation methods, such as Kriging and Spline. It is essentially a discretized thin plate spline technique (Wahba, 1990), for which the roughness penalty has been modified to allow the fitted DEM to follow abrupt changes in terrain, such as streams and ridges. It is also the only ArcGIS interpolator specifically designed to work intelligently with contour inputs.

Contours are the most common method for storage and presentation of elevation information. Unfortunately, this method is also the most difficult to properly utilize with general interpolation techniques. The disadvantage lies in the undersampling of information between contours, especially in areas of low relief.

At the beginning of the interpolation process, ArcGIS uses information inherent to the contours to build a generalized drainage model. By identifying areas of local maximum curvature in each contour, the areas of steepest slope are identified and a network of streams and ridges is created (Hutchinson, 1988). This information is used to ensure proper hydrogeomorphic properties of the output DEM and can also be used to verify accuracy of the output DEM.

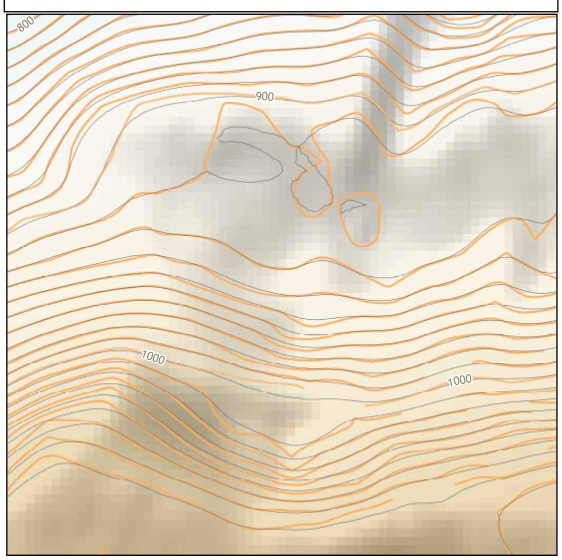
After the general morphology of the surface has been determined, contour data is also used in the interpolation of elevation values at each cell. When the contour data is used to interpolate elevation information, all contour data is read and generalized. A maximum of 50 data points are read from these contours within each cell. At the final resolution, only one critical point is used for each cell. For this reason, having a contour density with several contours crossing output cells is redundant.

Before using in a viewshed analysis, created surfaces should be evaluated to ensure that the data and parameters supplied to the program result in a realistic representation of the surface. There are many ways to evaluate the quality of an output surface, depending on the type of input available to create the surface.

The most common evaluation is to create contours from the new surface and compare them to the input contour data. It is best to create these new contours at one-half the original contour interval to examine the results between contours. Drawing the original contours and the newly created contours on top of one another can help identify interpolation errors.

In the example shown below, the contours created from the new surface are shown with the original 10-foot interval contour data for comparison (1:1,000 scale).

Original 10-foot interval contours compared to contours created from the new surface.



The comparison shows that the contours do differ in some areas, but the difference in this case is acceptable as the distance between the two sets of contour lines rarely exceeds 5 feet in length.

The product of the interpolation of the field survey contour data was the creation of 10-foot-resolution, hydrologically correct digital elevation model (DEM). It has been shown that there is a minor bias in the interpolation algorithm that causes the raster dataset to have slight variations from the input contours. This variation can result in a slight variation in the results when calculating the profile curvature of the output surface but is otherwise not noticeable, and does not affect the overall intended use in a viewshed analysis.

2.2 Observer Locations

The observer location points used in the viewshed analysis were determined using two observer points located at high and low site elevations. Using the viewshed analysis, the proposed mining operation was determined to be intermittently visible from areas along Highway 395. These segment locations and proposed mining area are shown on Figure 3.

2.3 General Map Reference Data

A number of GIS data layers were obtained as reference data for the maps and figures created as a result of the viewshed analysis. Most of vector (linear) data layers are existing data sets from VESTRA's in-house GIS data catalog, which is a compilation of data from various federal, state, county, and municipal sources.

The primary display data layer of aerial imagery utilizes National Agriculture Imagery Program (NAIP) data. The NAIP acquires imagery during the agricultural growing seasons in the continental U.S. The 2018 NAIP imagery for Lassen County has a 50-centimeter ground sample distance (GSD) with a horizontal accuracy that matches within five meters of a reference ortho image.

Highway Segment Potentially Visible from Ward Lake Quarry

Highway

Project Area

Miles
0 0.75 1.5 3

VESTRA

FIGURE 3
HIGHWAY SEGMENTS AND PROPOSED PROJECT AREA
WARD LAKE QUARRY
LASSEN COUNTY, CALIFORNIA

SOURCE: DIGITALGLOBE 2018 AERIAL PHOTOGRAPH

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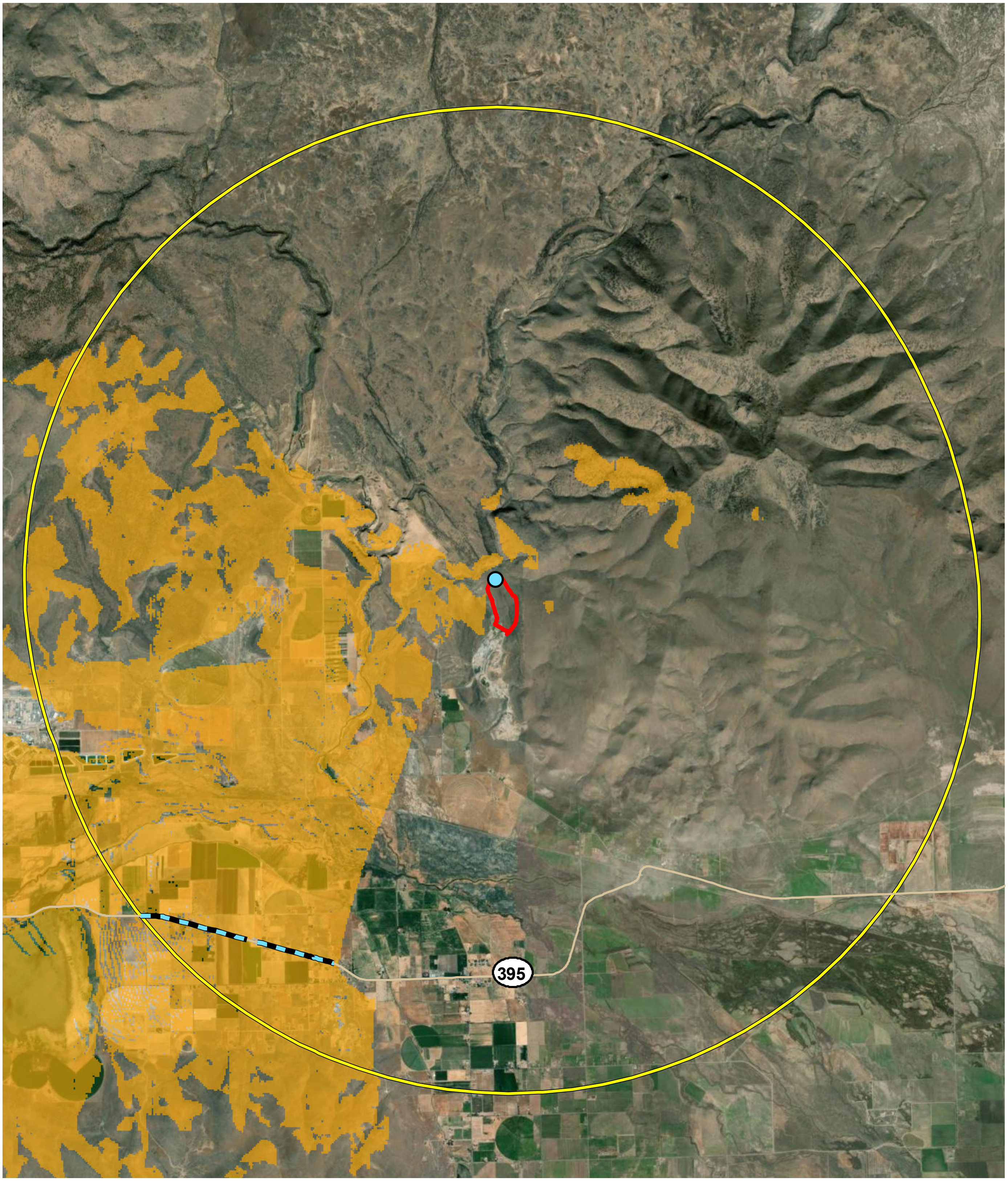
3.0 VIEWSHED ANALYSIS RESULTS

The product of the viewshed analyses of was the creation of 10-meter-resolution raster data layers showing visibility from two locations in the proposed mining area. This is from the proposed mining area outward (rather than from the outside looking inward toward the proposed mining area). The resulting projected data is shown on Figures 4 and 5. Table 1 shows the total linear feet from the viewshed analysis where the proposed mining area is visible from Highway 395 within five miles of the proposed project area.

Table 1
VIEWSHED STATISTICS

Observation Location	Linear Feet of Highway 395 within Five Miles of Project Area
North Observation Point	10,702
South Observation Point	5,974

In summary, the proposed mining area will be visible from portions of Highway 395. This area is not subject to changes in vegetation as the vegetation at the proposed mining area is sparse. No scenic highways or rivers are located in the project vicinity.



North Observation Location
Highway
Segment of Highway Visible from North Observation Location
Viewshed Area Visible from North Observation Location
5-Mile Buffer Around Project Area
Project Area

0 0.75 1.5 3 Miles

VESTRA

FIGURE 4
VIEWSHED ANALYSIS WITHIN FIVE MILES OF NORTH OBSERVATION LOCATION
WARD LAKE QUARRY
SUSANVILLE, CALIFORNIA

SOURCE: DIGITALGLOBE 2018 AERIAL PHOTOGRAPH

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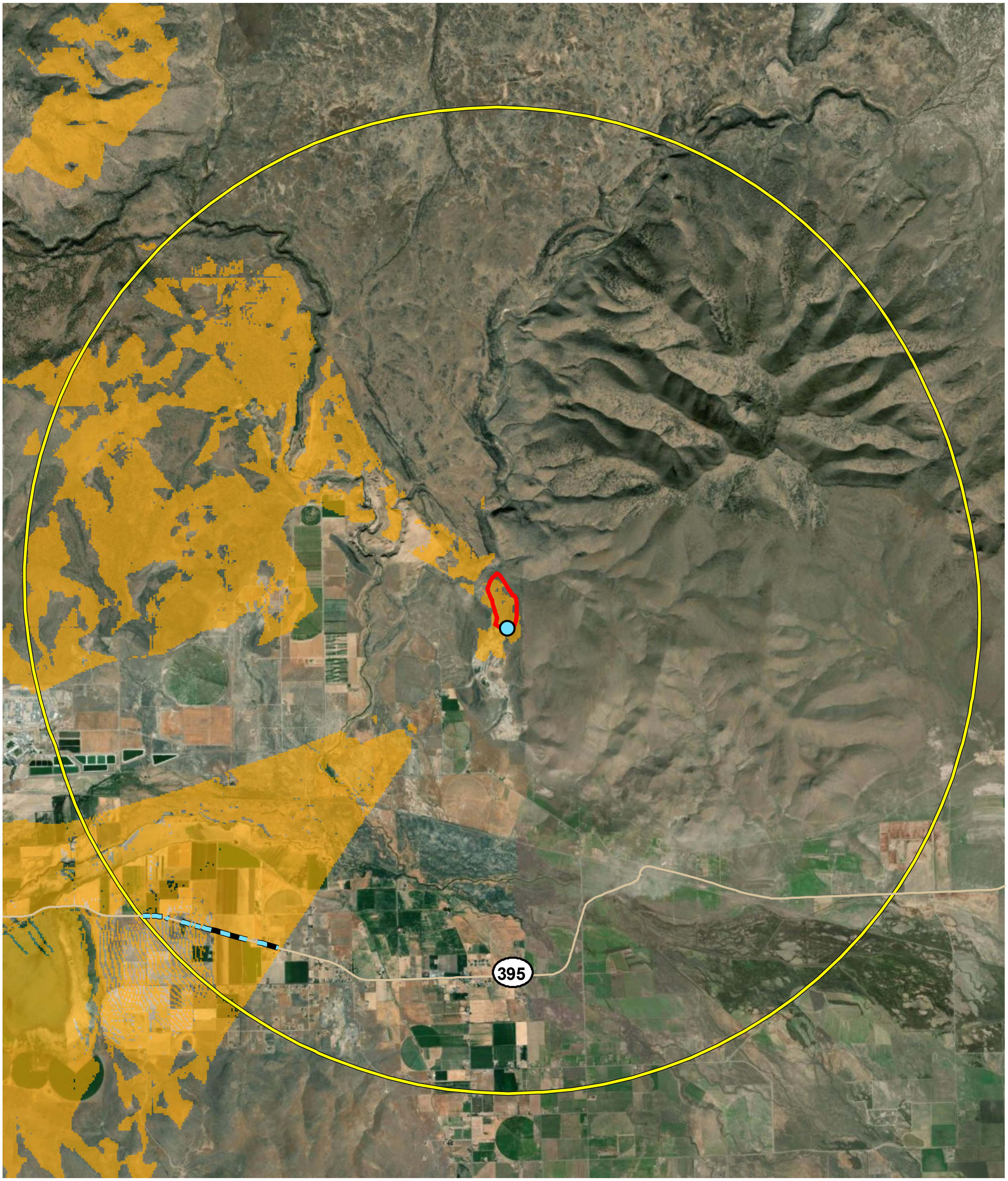

South Observation Location
Highway
Segment of Highway Visible from South Observation Location
Viewshed Area Visible from South Observation Location
5-Mile Buffer Around Project Area
Project Area

VESTRA

0 0.75 1.5 3 Miles

N

FIGURE 5
VIEWSHED ANALYSIS WITHIN FIVE MILES OF SOUTH OBSERVATION LOCATION
WARD LAKE QUARRY
SUSANVILLE, CALIFORNIA

SOURCE: DIGITALGLOBE 2018 AERIAL PHOTOGRAPH

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Ward Lake Pit Expansion
Air Quality and Health Risk Assessment Technical Report

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January 27, 2021

1.0 INTRODUCTION

This document presents results of an air quality analysis and health risk assessment (HRA) associated with the proposed Ward Lake Pit Expansion near Susanville, California in Lassen County. This document provides an overview of the existing air quality conditions at the project site, an analysis of potential air quality impacts that would result from implementation of the proposed project, and identification of applicable mitigation measures. Issues related to climate change and greenhouse gas (GHG) emissions are also addressed.

The HRA focuses on health impacts on existing residences and schools from diesel generators and offroad equipment associated with the aggregate extraction and resultant diesel particulate matter (DPM) emissions from the proposed project. The HRA was prepared based on the California Office of Environmental Health Hazard Assessment (OEHHA)'s *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*.[1] The HRA was conducted to determine the health impacts, in terms of excess cancer risk and non-cancer hazards, using the significance levels identified within the State CEQA Guidelines, Appendix G.

The supporting information, methodology, assumptions, and results used in the air quality analysis are provided in **Attachment A: Air Quality Calculations**. The supporting methodology, assumptions, and results used in the HRA are provided in **Attachment B: Health Risk Assessment Methodology, Assumptions, and Results**. For existing residents, the HRA indicates less-than-significant health impacts from proposed project activities associated with diesel generators and offroad equipment.

The air quality analysis includes a review of criteria pollutant[2] emissions such as carbon monoxide (CO)[3], nitrogen oxides (NO_x)[4], sulfur dioxide (SO_2)[5], volatile organic compounds

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[1] Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, February 2015, Accessed January 26, 2021, http://oehha.ca.gov/air/hot_spots/hotspots2015.html

[2] Criteria air pollutants refer to those air pollutants for which the USEPA and CARB has established National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) under the Federal Clean Air Act (CAA).

[3] CO is a non–reactive pollutant that is a product of incomplete combustion of organic material, and is mostly associated with motor vehicle traffic, and in wintertime, with wood–burning stoves and fireplaces.

[4] When combustion temperatures are extremely high, as in aircraft, truck and automobile engines, atmospheric nitrogen combines with oxygen to form various oxides of nitrogen (NO_x). Nitric oxide (NO) and NO_2 are the most significant air pollutants generally referred to as NO_x. Nitric oxide is a colorless and odorless gas that is relatively harmless to humans, quickly converts to NO_2 and can be measured. Nitrogen dioxide has been found to be a lung irritant capable of producing pulmonary edema.

[5] SO_2 is a combustion product of sulfur or sulfur–containing fuels such as coal and diesel. SO_2 is also a precursor to the formation of atmospheric sulfate and particulate matter, and contributes to potential atmospheric sulfuric acid formation that could precipitate downwind as acid rain.

(VOC) as reactive organic gases (ROG)[6], particulate matter less than 10 micrometers (coarse or PM_{10}), particulate matter less than 2.5 micrometers (fine or $PM_{2.5}$).[7]

2.0 PROJECT OVERVIEW

The existing surface mining operation (100,000 tons per year annual limit) is presently permitted for the mining of rock, crushing, screening, washing, material stockpiling, fuel storage; operation of a cement plant (12,000 cubic-yard annual limit) and asphalt plant (400,000 tons per year); and the use of settling ponds, scales, an office and a truck shop. Grading, excavating, and blasting are prohibited onsite between January 1 and March 31 annually, except in a state of emergency. Currently permitted operations at the project site allow the applicant to provide materials for emergency projects and construction projects that require continuous 24-hour operations. In order to respond to emergency projects, the annual removal volume of the mine presently could exceed 100,000 tons. Operations generally occur from April through October. In addition, the current operation includes mining from 2020 through 2030 to allow increased extraction of materials from the site.

The Lassen County Air Pollution Control District (APCD) is the local air district governing Lassen County which is part of the Northeast Plateau Air Basin. The Lassen County APCD requires permits for proposed construction, alteration or replacement of equipment or facilities which may cause the issuance of air contaminants. The Ward Lake Pit maintains a permit to operate (PTO-19-140: expiration date March 31, 2024) for onsite equipment such as a hot mix asphalt plant, a lime slurry mix plant, a concrete plant, a crushing plant, a wash plant, a sand plant, and several diesel generators (one 750 horsepower [hp] generator associated with the crushing plant[8], one 475 hp generator associated with the portable plant[9], and one 469 hp generator associated with the wash plant[10]. The facility also has a daily and annual limit on the number of haul truck trips.

The proposed project includes increasing the crushing operations (from 100,000 to 200,000 tons per year) and expansion of the mine to include an additional 51 acres of mining area. The

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[6] VOC means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions and thus, a precursor of ozone formation. ROG are any reactive compounds of carbon, excluding methane, CO, CO_2 carbonic acid, metallic carbides or carbonates, ammonium carbonate, and other exempt compounds. The terms VOC and ROG are often used interchangeably.

[7] PM_{10} and $PM_{2.5}$ consists of airborne particles that measure 10 microns or less in diameter and 2.5 microns or less in diameter, respectively. PM_{10} and $PM_{2.5}$ represent fractions of particulate matter that can be inhaled into the air passages and the lungs, causing adverse health effects.

[8] To be removed or replaced by January 2023 with Air District approved engine.

[9] To be removed or replaced by January 2024 with Air District approved engine.

[10] To be removed or replaced by January 2025 with Air District approved engine.

typical and maximum daily operations are not expected to change as a result of the proposed project. The end date of mining would be extended to 2050; an additional 20 years. The equipment supporting for material processing (i.e., loaders, excavators) would also increase in annual operations to match the increase in crushing operations. The proposed project would not change the hot mix asphalt plant, the lime slurry mix plant, the concrete plant, portable plant, and diesel generator operations associated with hot mix asphalt plant and portable plant nor would the proposed project change the daily or annual haul truck trip limit.[11] Therefore, the air quality analysis and HRA focuses on pollutant emissions associated with the aggregate processing operations and supporting activities (i.e., blasting operations and diesel generators associated with crushing and wash plant and offroad equipment such as loaders, excavators, and dozers).

Equipment onsite includes loaders, generators, a concrete batch plant, concrete trucks, service truck, man lift, belly dump, articulated dump truck, crusher and asphalt batch plant. Wet suppression is used when necessary to control dust caused by excavation, processing activities, and materials transport.

3.0 EXISTING CONDITIONS

The project site is located in the Northeast Plateau Air Basin (Air Basin), which comprises Siskiyou, Modoc and Lassen counties. The Air Basin has a climate regime that is distinct from the rest of California. The Air Basin has sharply defined seasons that follow a continental, rather than marine, pattern. Winters are cold and snowy; summers are warm and dry. The Air Basin includes part of the Klamath Mountains to the west and the Cascade Range and Modoc Plateau, plus a slice of the Great Basin along its eastern edge. Mount Shasta rises 14,162 feet, dominating the view from much of the basin. Another volcanic peak, Mount Lassen, stands 10,457 feet high. Extensive forestland runs across saddles between the region's peaks. The volcanic Modoc Plateau extends across the northeastern expanse, with an elevation mostly above 4,500 feet.

The region receives little to no transported air pollution from major urban areas. As in many rural areas in California, particulates from dust and wood smoke are sometimes a problem. Only the city of Yreka experiences occasional ozone concentrations that approach "near exceedances".

[11] Haul truck volumes would not change as a result of the proposed project and is currently limited by the following condition of approval: haul trucks (loaded or empty) associated with the mining operation shall not exceed a daily average of 26 round trips (26 arriving and 26 departing) throughout the calendar year and shall not exceed a daily maximum of 275 round trips (275 arriving and 275 departing), with a maximum of 173 total trips occurring between the hours of 10:00 p.m. and 7:00 a.m., excluding personal employee vehicles and light-duty trucks assigned to employees. The maximum number of annual truck trips would continue to be 8,112.

Land uses such as residences, schools, children's daycare centers, hospitals, and convalescent homes are considered to be more sensitive than the general public to poor air quality because the population groups associated with these uses have increased susceptibility to respiratory distress. Persons engaged in strenuous work or exercise also have increased sensitivity to poor air quality. California Air Resources Board (CARB) has identified the following people as most likely to be affected by air pollution: children less than 14 years of age, the elderly over 65 years of age, athletes, and those with cardiovascular and chronic respiratory diseases. These groups are classified as sensitive population groups.

Residential areas are considered more sensitive to air quality conditions than commercial and industrial areas, because people generally spend longer periods of time at their residences, resulting in greater exposure to ambient air quality conditions. Recreational uses are also considered sensitive, due to the greater exposure to ambient air quality conditions and because the presence of pollution detracts from the recreational experience.

The project site is surrounded by open grazing lands. Immediately adjacent to and south of the site, a smaller aggregate mine is located on Bureau of Land Management (BLM)-administered land. Other BLM land is located to the east and south and the Wells Ranch is located directly to the north. Six homes are located on parcels from 10 to 80 acres in size to the west and south along Ward Lake Road. The nearest residence is approximately 875 feet from the western property line of the project site. Shaffer Elementary School is located 2.4 miles to the southeast of the project site.

Federal Clean Air Act

The federal Clean Air Act (CAA) was first signed into law in 1970. In 1977, and again in 1990, the law was substantially amended. The federal CAA is the foundation for a national air pollution control effort, and it is composed of the following basic elements: National Ambient Air Quality Standards (NAAQS) for criteria air pollutants, hazardous air pollutant standards, state attainment plans, motor control measures, stratospheric ozone protection, and enforcement provisions. The USEPA is responsible for administering the federal CAA. The federal CAA requires the USEPA to set NAAQS for several problem air pollutants based on human health and welfare criteria. Two types of NAAQS were established: primary standards, which protect public health, and secondary standards, which protect the public welfare from non-health-related adverse effects such as visibility reduction.

California Clean Air Act

The California CAA was first signed into law in 1988. The California CAA provides a comprehensive framework for air quality planning and regulation, and spells out, in statute, the state's air quality goals, planning and regulatory strategies, and performance. CARB is the agency responsible for administering the California CAA. CARB established California

Ambient Air Quality Standards (CAAQS) pursuant to the California Health and Safety Code (CH&SC) [§39606(b)], which are similar to the federal standards.

Ambient Air Quality Standards

Regulation of air pollutants is achieved through both NAAQS and CAAQS and emissions limits for individual sources. Regulations implementing the federal CAA and its subsequent amendments established NAAQS (national standards) for the six criteria pollutants. California has adopted more stringent CAAQS (state standards) for most of the criteria air pollutants. In addition, California has established CAAQS for sulfates, hydrogen sulfide, vinyl chloride, and visibility-reducing particles. Because of the meteorological conditions in the state, there is considerable difference between state and federal standards in California.

The ambient air quality standards are intended to protect the public health and welfare, and they incorporate an adequate margin of safety. They are designed to protect those segments of the public most susceptible to respiratory distress, known as sensitive receptors, including asthmatics, the very young, elderly, people weak from other illness or disease, or persons engaged in strenuous work or exercise. Healthy adults can tolerate occasional exposure to air pollution levels somewhat above the ambient air quality standards before adverse health effects are observed.

Under amendments to the federal CAA, USEPA has classified air basins or portions thereof, as either "attainment" or "non-attainment" for each criteria air pollutant, based on whether or not the national standards have been achieved. The California CAA, which is patterned after the federal CAA, also requires areas to be designated as "attainment" or "non-attainment" for the state standards. Thus, areas in California have two sets of attainment/nonattainment designations: one set with respect to the federal standards and one set with respect to the state standards.

Table 1 shows the federal and state ambient air quality standards for different criteria pollutants and also summarizes the related health effects and principal sources for each pollutant.

Table 1: Ambient Air Quality Standards and Major Pollutant Sources

Pollutant	Averaging Time	State Standard	Federal Standard	Major Pollutant Sources
Ozone	8 hour	0.070 ppm	0.070 ppm	Formed when ROG and NOx react in the presence of sunlight. Major sources include on-road motor vehicles, solvent evaporation, and commercial/ industrial mobile equipment.
	1 hour	0.09 ppm	---	
Carbon Monoxide	8 hour	9.0 ppm	9 ppm	Internal combustion engines, primarily gasoline-powered motor vehicles
	1 Hour	20 ppm	35 ppm	
Nitrogen Dioxide	Annual Average	0.030 ppm	0.053 ppm	Motor vehicles, petroleum refining operations, industrial sources, aircraft, ships, and railroads
	1 Hour	0.18 ppm	0.100 ppm	
Sulfur Dioxide	Annual Average	---	0.030 ppm	Fuel combustion, chemical plants, sulfur recovery plants and metal processing
	24 Hour	0.04 ppm	0.14 ppm	
	1 Hour	0.25 ppm	0.075 ppm	
Particulate Matter (PM10)	Annual Arithmetic Mean	20 µg/m³	---	Dust- and fume-producing industrial and agricultural operations, combustion, atmospheric photochemical reactions, and natural activities (e.g., wind-raised dust and ocean sprays)
	24 hour	50 µg/m³	150 µg/m³	
Particulate Matter (PM2.5)	Annual Arithmetic Mean	12 µg/m³	12 µg/m³	Fuel combustion in motor vehicles, equipment, and industrial sources; residential and agricultural burning; also, formed from photochemical reactions of other pollutants, including NOx, sulfur oxides, and organics.
	24 hour	---	35 µg/m³	
Lead	Calendar Quarter	---	1.5 µg/m³	Present source: lead smelters, battery manufacturing & recycling facilities. Past source: combustion of leaded gasoline.
	30 Day Average	1.5 µg/m³	---	

NOTE: ppm = parts per million; and µg/m³ = micrograms per cubic meter

SOURCE: California Air Resources Board, *Air Quality Standards*, Accessed January 26, 2021, https://ww2.arb.ca.gov/resources/california-ambient-air-quality-standards.

Local Air Quality

There are no ambient air quality monitoring stations or other facilities conducting ambient air quality monitoring of toxic contaminants in Lassen County; therefore, local ambient concentrations are not available. The only ambient air quality monitoring station located in the Northeast Plateau Air Basin is the Yreka-Foothill Drive Monitoring Station, located approximately 170 miles northwest in Yreka within Siskiyou County. Consideration of data from "regional sites" impacted by similar natural and man-made sources is an accepted practice by the USEPA; therefore, a summary of ambient air quality monitoring data collected by the Yreka-Foothill Drive Monitoring Station for ozone and $PM_{2.5}$ (PM_{10} monitoring was discontinued in 2016) is provided in **Table 2**. Although the region experiences elevated concentrations, Lassen County is in attainment/unclassified for federal and state PM_{10} and $PM_{2.5}$ standards as well as ozone.[12]

Table 2: Air Quality Data Summary (2017 - 2019)

	Standard[a]	2017	2018	2019
Ozone				
Highest 1 Hour Average (ppm)[b]	0.090	0.053	0.089	0.069
Days over State Standard		0	0	0
Highest 8 Hour Average (ppm)[b]	0.070	0.049	**0.075**	0.059
Days over National Standard		0	**4**	0
Highest 8 Hour Average (ppm)[b]	0.070	0.049	0.075	0.059
Days over State Standard		0	4	0
Particulate Matter ($PM_{2.5}$)				
Highest 24 Hour Average (µg/m³)[b]	35	**79**	**143**	**74**
Days over National Standard		**26**	**57**	**4**
State Annual Average (µg/m³)[b]	12	11.1	**14.4**	5.9

NOTES: Values in **bold** are in excess of at least one applicable standard.

a. Generally, state standards and national standards are not to be exceeded more than once per year.
b. ppm = parts per million; µg/m³ = micrograms per cubic meter.
c. PM_{10} is not measured every day of the year. Number of estimated days over the standard is based on 365 days per year.

Source: California Air Resources Board, *Air Quality Trend Summaries*, *https://www.arb.ca.gov/adam/trends/trends1.php*

According to the Lassen County APCD, the Air Quality Index in Lassen County is classified as "GOOD" for the majority of the year, although events such as wildfires and inversion layers in winter months can periodically degrade air quality

According to the Lassen County 2012 Regional Transportation Plan, elevated PM_{10} concentrations can be caused by sources including fugitive dust, combustion from automobiles and heating, road salt, and conifers, among others. Constituents that comprise suspended particulates include organic, sulfate, and nitrate aerosols that are formed in the air from emitted hydrocarbons, chloride, sulfur oxides, and oxides of nitrogen. Particulates reduce visibility and pose a health hazard by causing respiratory and related problems CARB further identifies motor vehicles, wood-burning stoves and fireplaces, dust from construction, landfills, and agriculture, wildfires and brush/waste burning, industrial sources, and windblown dust from open lands as major sources of PM_{10}.

[12] Maps of State and Federal Area Designations, https://ww2.arb.ca.gov/resources/documents/maps-state-and-federal-area-designations

Toxic Air Contaminants

Toxic Air Contaminants (TAC) are pollutants that may be expected to result in an increase in mortality or serious illness or that may pose a present or potential hazard to human health. Health effects include cancer, birth defects, neurological damage, damage to the body's natural defense system, and diseases that lead to death. Although ambient air quality standards exist for criteria pollutants, no such standards exist for TAC. Many pollutants are identified as TAC because of their potential to increase the risk of developing cancer or because of their acute or chronic health risks. For TAC that are known or suspected carcinogens, the CARB has consistently found that there are no levels or thresholds below which exposure is free of risk. Individual TAC vary greatly in the risk they present. At a given level of exposure, one TAC may pose a hazard that is many times greater than another. For certain TAC, a unit risk factor can be developed to evaluate cancer risk. For acute and chronic health risks, a similar factor called a Hazard Index is used to evaluate risk. In the early 1980s, CARB established a statewide comprehensive air toxics program to reduce exposure to air toxics. The Toxic Air Contaminant Identification and Control Act (Assembly Bill [AB] 1807) created California's program to reduce exposure to air toxics. The Air Toxics "Hot Spots" Information and Assessment Act (AB 2588) supplements the AB 1807 program by requiring a statewide air toxics inventory and notification of people exposed to a significant health risk and sensitive receptors.

Lassen County General Plan

The Natural Resources Element of the Lassen County General Plan includes the following applicable goal, policies, and implementation measures related to air quality:[13]

Goal N-22: Air quality of high standards to safeguard public health, visual quality, and the reputation of Lassen County as an area of exceptional air quality.

Policy NR-74: The Board of Supervisors will continue to consider, adopt and enforce feasible air quality standards which protect the quality of the County's air resources.

NR-Q: The County will continue to regulate the emission of pollutants within its jurisdiction through the regulations and procedures adopted for the Lassen County APCD.

NR-R: In review of proposed projects pursuant to the CEQA, the County shall consider potential air quality impacts and shall, through the APCD, support appropriate measures for mitigation of significant environmental impacts upon air quality.

[13] Lassen County General Plan, *Natural Resources Element*, September 1999, Accessed January 26, 2021, http://www.lassencounty.org/resources/general/lassen-county-general-plan-elements-and-area-plan-updates

Policy NR-75: The County shall consider the appropriateness and feasibility of air pollution control requirements for individual projects and may grant variances to specific requirements pursuant to established procedural guidelines.

4.0 IMPACT ANALYSIS AND MITIGATION

Long-term air quality impacts related to the operation of the proposed project were evaluated. The analysis focuses on daily and annual emissions from operational (mobile, area, stationary, and fugitive sources) activities. The proposed project could affect air quality during proposed project operations. Mitigation measures are presented to reduce impacts to less than significant.

Regulatory models used to estimate air quality impacts include:

- CARB EMFAC[14] emissions inventory model. EMFAC is the latest emission inventory model that calculates emission inventories and emission rates for motor vehicles operating on roads in California. This model reflects CARB's current understanding of how vehicles travel and how much they emit. EMFAC can be used to show how California motor vehicle emissions have changed over time and are projected to change in the future.

- CARB OFFROAD[15] emissions inventory model. OFFROAD is the latest emission inventory model that calculates emission inventories and emission rates for off-road equipment such as loaders, excavators, and off-road haul trucks operating in California. This model reflects CARB's current understanding of how equipment operates and how much they emit. OFFROAD can be used to show how California off-road equipment emissions have changed over time and are projected to change in the future.

- USEPA AP-42, Compilation of Air Pollutant Emission Factors, has been published since 1972 as the primary compilation of USEPA's emission factor information. It contains emission factors and process information for more than 200 air pollution source categories. A source category is a specific industry sector or group of similar emitting sources. The emission factors have been developed and compiled from source test data, material balance studies, and engineering estimates.[16]

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[14] California Air Resources Board, *EMFAC2017 User's Guide*, March 1, 2018, Accessed January 15, 2021, https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-i-users-guide.pdf and https://www.arb.ca.gov/emfac/2017/

[15] California Air Resources Board, *Mobile Source Emissions Inventory Documentation – Off Road Diesel Equipment*, Accessed January 15, 2021, https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road and https://ww3.arb.ca.gov/msei/ordiesel/ordas_ef_fcf_2017.pdf

[16] US Environmental Protection Agency, AP 42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, Accessed January 26, 2021, https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

- AERMOD (American Meteorological Society/USEPA Regulatory Model, Version 19191) is an atmospheric dispersion model which can simulate point, area, volume, and line emissions sources and has the capability to include simple, intermediate, and complex terrain along with meteorological conditions and multiple receptor locations.[17,18] AERMOD is commonly executed to yield 1-hour maximum and annual average concentrations (in $\mu g/m^3$) at each receptor.

Threshold of Significance

The significance of potential impacts was determined based on State CEQA Guidelines, Appendix G. Using Appendix G evaluation thresholds, the proposed project would be considered to have significant air quality impacts if it were to:

A. Conflict with or obstruct implementation of the applicable air quality plan;

B. Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard;

C. Expose sensitive receptors to substantial pollutant concentrations; or

D. Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people.

The thresholds of significance applied to assess project-level health impacts are: exposure of persons by siting a new source or a new sensitive receptor to substantial levels of TAC resulting in (a) a cancer risk level greater than 10 in one million, and (b) a noncancerous risk (chronic or acute) hazard index greater than 1.0. For this threshold, sensitive receptors include residential uses, schools, parks, daycare centers, nursing homes, and medical centers.

Lassen County Rules and Regulations include general provisions and rules for APCD-issued permits, fees, prohibitions (including but not limited to nuisance, particulate matter, specific air contaminants, open burning, gasoline storage, reduction of odorous matter, fugitive dust emissions, and equipment breakdown), procedures, new source siting, and Title V permits. Operation of the project would be implemented in compliance with the Lassen County APCD Air Quality Rules and Regulations.

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[17] US Environmental Protection Agency, Preferred/Recommended Models, *AERMOD Modeling System*, Accessed January 26, 2021, https://www3.epa.gov/ttn/scram/dispersion_prefrec.htm#aermod

[18] Title 40 CFR Part 51, *Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions; Final Rule,* Accessed January 26, 2021, http://www.epa.gov/ttn/scram/guidance/guide/appw_05.pdf

Lassen County APCD has a nuisance rule which implicitly regulates pollutants other than those for which criteria standards have been adopted. Rule 4:2 states that a person shall not discharge from any source whatsoever such quantities of air contaminants or other materials which cause injury, detriment, nuisance or annoyance to any considerable number of persons or to the public or which endanger the comfort, repose, health or safety of any such persons or the public or which cause or have a natural tendency to cause injury or damage to business and property. Rule 4:2 may be interpreted to restrict ambient concentrations of pollutants, such as toxic and hazardous pollutants, until other standards are in place.

Lassen County APCD Rule 4:18 states that reasonable precautions shall be taken to prevent particulate matter from becoming airborne and allows for the application of asphalt, oil, water, or suitable chemicals to dirt roads, material stockpiles, land clearing, excavation, grading or other surfaces which can give rise to airborne dusts.

Additionally, the Lassen County APCD Rule 6:4 includes the following Best Available Control Technology (BACT) Emission thresholds: An applicant shall apply BACT to a new source or modification of an existing source, except cargo carriers, for each affected pollutant emitted, including halogenated hydrocarbons, under the following conditions:

1). A new stationary source emits more than 150 pound per day of ROG, NO_x, PM_{10}, or $PM_{2.5}$; or 550 pounds per day of CO.[19]

2). A modification of an existing stationary source will result in a net emission increase of an affected pollutant by an amount more than any of the limits above.

3). A new source or modification subject to BACT for any pollutant subject to this section shall apply BACT for any other affected pollutant emitted from the new source or modification, if the Air Pollution Control Officer should so require.

Air Emission Estimates

The air quality analysis focuses on pollutant (combustion and fugitive dust) emissions associated with the aggregate processing operations, blasting operations, and supporting equipment (i.e., diesel generators associated with crushing and wash plant and offroad equipment such as loaders, excavators, and dozers).

Table 1 displays the daily emissions for the existing conditions. **Table 2** displays the daily emissions for the proposed project. **Table 3** displays the daily incremental (proposed project minus existing condition) emissions for the proposed project.

[19] Equivalent to 27 tons per year and 100 tons per year, respectively.

Table 4 displays the annual emissions for the existing conditions. **Table 5** displays the annual emissions for the proposed project. **Table 6** displays the annual incremental (proposed project minus existing condition) emissions for the proposed project.

The daily emissions of ROG, CO, NOx, PM_{10}, and $PM_{2.5}$ are less than the significance thresholds. The annual emissions of ROG, CO, NOx, PM_{10}, and $PM_{2.5}$ are less than the significance thresholds. The supporting information, methodology, assumptions, and results used in the air quality analysis are provided in **Attachment A: Air Quality Calculations**.

TABLE 1
Existing Conditions Daily Emissions (pounds)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Onsite Equipment	0.94	9.23	6.13	0.03	0.22	0.21
Generator - Crushing Plant	1.34	14.8	200	123	1.75	1.75
Generator - Portable Plant	0.71	13.0	87.5	13.2	1.50	1.50
Generator - Wash Plant	0.70	12.9	86.4	13.0	1.48	1.48
Aggregate Plant	-	-	-	-	16.5	2.48
Wash Plant	-	-	-	-	4.12	0.62
Sand Plant	-	-	-	-	9.38	1.41
Unpaved Travel	-	-	-	-	22.2	3.33
Material Handling	-	-	-	-	2.33	0.35
Blasting	-	-	-	-	4.04	0.61
Haul Trucks	0.73	7.61	91.6	0.39	0.43	0.41
Total	**4.43**	**57.6**	**471**	**150**	**64.0**	**14.1**

Source: RCH Group, 2021.

TABLE 2
Proposed Project Daily Emissions (pounds)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Onsite Equipment	0.94	9.23	6.13	0.03	0.22	0.21
Generator - Crushing Plant	1.34	14.8	200	123	1.75	1.75
Generator - Portable Plant	0.71	13.0	87.5	13.2	1.50	1.50
Generator - Wash Plant	0.70	12.9	86.4	13.0	1.48	1.48
Aggregate Plant	-	-	-	-	16.5	2.48
Wash Plant	-	-	-	-	4.12	0.62
Sand Plant	-	-	-	-	9.38	1.41
Unpaved Travel	-	-	-	-	22.2	3.33
Material Handling	-	-	-	-	2.33	0.35
Blasting	-	-	-	-	7.42	1.11
Haul Trucks	0.73	7.61	91.6	0.39	0.43	0.41

Total	**4.43**	**57.6**	**471**	**150**	**67.3**	**14.6**

Source: RCH Group, 2021.

TABLE 3
Daily Increment Emissions (pounds)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Existing Condition	4.43	57.6	471	150	64.0	14.1
Proposed Project	4.43	57.6	471	150	67.3	14.6
Project Increment	**0**	**0**	**0**	**0**	**3.38**	**0.51**
Significance Threshold	150	550	150	-	150	150
Significant (Yes/No)	No	No	No	-	No	No

Source: RCH Group, 2021.

TABLE 4
Existing Conditions Annual Emissions (tons)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Onsite Equipment	0.03	0.34	0.23	0.00	0.01	0.01
Generator - Crushing Plant	0.18	2.01	27.2	16.8	0.24	0.24
Generator - Portable Plant	0.10	1.78	11.9	1.80	0.20	0.20
Generator - Wash Plant	0.10	1.76	11.8	1.78	0.20	0.20
Aggregate Plant	-	-	-	-	0.23	0.03
Wash Plant	-	-	-	-	0.07	0.01
Sand Plant	-	-	-	-	0.07	0.01
Unpaved Travel	-	-	-	-	1.33	0.20
Material Handling	-	-	-	-	0.14	0.02
Blasting	-	-	-	-	0.01	0.00
Haul Trucks	0.01	0.11	1.35	0.01	0.01	0.01
Total	**0.42**	**6.00**	**52.5**	**20.4**	**2.51**	**0.94**

Source: RCH Group, 2021.

TABLE 5
Proposed Project Annual Emissions (tons)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Onsite Equipment	0.06	0.61	0.39	0.00	0.01	0.01
Generator - Crushing Plant	0.18	2.01	27.2	16.8	0.24	0.24
Generator - Portable Plant	0.10	1.78	11.9	1.80	0.20	0.20
Generator - Wash Plant	0.10	1.76	11.8	1.78	0.20	0.20
Aggregate Plant					0.47	0.07
Wash Plant					0.13	0.02
Sand Plant					0.13	0.02
Unpaved Travel					2.00	0.30
Material Handling					0.21	0.03
Blasting					0.03	0.00
Haul Trucks	0.01	0.11	1.35	0.01	0.01	0.01
Total	**0.44**	**6.27**	**52.7**	**20.4**	**3.63**	**1.11**

Source: RCH Group, 2021.

TABLE 6
Annual Increment Emissions (pounds)

Emission Source	ROG	CO	NO_x	SO_2	PM_{10}	$PM_{2.5}$
Existing Condition	0.42	6.00	52.5	20.4	2.51	0.94
Proposed Project	0.44	6.27	52.7	20.4	3.63	1.11
Project Increment	**0.02**	**0.27**	**0.17**	**0.00**	**1.12**	**0.17**
Significance Threshold	27	100	27	-	27	27
Significant (Yes/No)	No	No	No	-	No	No

Source: RCH Group, 2021.

Based on Lassen County APCD Rule 4:18 (Fugitive Dust Emissions), reasonable precautions shall be taken to prevent particulate matter from becoming airborne, including, but not limited to, the following provisions:

a. Covering open bodied trucks when used for transportation materials likely to give rise to airborne dust.

b. Installation and use of hoods, fans, and other fabric filters to enclose and vent the handling of dusty materials. Containment methods may be employed during sandblasting and other similar operations.

c. The application of asphalt, oil, water or suitable chemicals to dirt roads, material stockpiles, land clearing, excavation, grading or other surfaces which can give rise to airborne dusts.

d. The prompt removal of earth or other material from paved streets onto which earth or other material for earth moving equipment, erosion by water, or other means has been deposited.

Health Impacts

The proposed project would constitute an emission source of DPM due to operations associated with generators, offroad equipment, and haul trucks. Studies have demonstrated that DPM from diesel-fueled engines is a human carcinogen and that chronic (long-term) inhalation exposure to DPM poses a chronic health risk.

Health effects from carcinogenic air toxics are usually described in terms of individual cancer risk. Individual cancer risk is the likelihood that a person exposed to air toxic concentrations over a 70-year lifetime will contract cancer, based on the use of standard risk-assessment methodology. The maximally exposed individual represents the worst–case risk estimate, based on a theoretical person continuously exposed for a lifetime at the point of highest compound concentration in the air. This is a highly conservative assumption, since most people do not remain at home all day and on average residents change residences every 11 to 12 years. In addition, this assumption assumes that residents are experiencing outdoor concentrations for the entire exposure period.

This HRA analyzes the incremental cancer risks to sensitive receptors in the vicinity of the proposed project, using emission rates (in pounds per hour) from USEPA AP-42, *Compilation of Air Pollutant Emission Factors*, and vender specifications. DPM emission rates were input into the USEPA's AERMOD atmospheric dispersion model to calculate ambient air concentrations at receptors in the proposed project vicinity. This HRA is intended to provide a worst–case estimate of the increased exposure by employing a standard emission estimation program, an accepted pollutant dispersion model, approved toxicity factors, and conservative exposure parameters.

In accordance with OEHHA *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments,* this HRA was accomplished by applying the highest estimated concentrations of TAC at the receptors analyzed to the established cancer potency factors and acceptable reference concentrations for non-cancer health effects. Increased cancer risks were calculated using the modeled DPM concentrations and OEHHA-recommended methodologies for both a child exposure (3rd trimester through 2 years of age) and adult exposure. The cancer risk calculations were based on applying the OEHHA-recommended age sensitivity factors and breathing rates, as well as fraction of time at home and an exposure duration of 30 years, to the DPM concentration exposures. Age-sensitivity factors reflect the greater sensitivity of infants and small children to cancer causing air pollutants. The supporting methodology and assumptions used in this HRA are provided in **Attachment B: Health Risk Assessment Methodology, Assumptions, and Results**.

These conservative methodologies overestimate both non-carcinogenic and carcinogenic health risk, possibly by an order of magnitude or more. Therefore, for carcinogenic risks, the actual probabilities of cancer formation in the populations of concern due to exposure to carcinogenic pollutants are likely to be lower than the risks derived using the HRA methodology. The extrapolation of toxicity data in animals to humans, the estimation of concentration prediction methods within dispersion models; and the variability in lifestyles, fitness and other confounding factors of the human population also contribute to the overestimation of health impacts. Therefore, the results of this HRA are highly overstated.

The following describes the HRA results associated with existing receptors due to existing condition and proposed project activities. The maximum cancer risk from existing condition emissions for a residential-adult receptor would be 0.17 per million and for a residential-child receptor would be 1.35 per million. The maximum cancer risk from proposed project emissions for a residential-adult receptor would be 0.49 per million and for a residential-child receptor would be 1.79 per million.

Therefore, the incremental cancer risk for a residential-adult receptor would be 0.32 per million and for a residential-child receptor would be 0.41 per million. Thus, the cancer risk due to project operations would be below the significance threshold of 10 per million and would be a less-than-significant health impact. The HRA results reflect the increased DPM emissions as a result of the proposed project (greater annual usage of offroad equipment to extract additional aggregate materials (i.e., 200,000 vs 100,000 tons) but also the location in which that materials would be extracted (i.e., within the 51 acres which are located further from nearby sensitive receptors) and the additional 20 years of activities.

Non-Cancer Health Hazard

Both acute (short-term) and chronic (long-term) adverse health impacts unrelated to cancer are measured against a hazard index (HI), which is defined as the ratio of the predicted incremental DPM exposure concentration from the proposed project to a reference exposure level (REL) that could cause adverse health effects. The REL are published by OEHHA based on epidemiological research. The ratio (referred to as the Hazard Quotient [HQ]) of each non-carcinogenic substance that affects a certain organ system is added to produce an overall HI for that organ system. The overall HI is calculated for each organ system. The impact is considered to be significant if the overall HI for the highest-impacted organ system is greater than 1.0.

The chronic reference exposure level for DPM was established by the California OEHHA[20] as 5 μg/m³. Thus, the proposed project-related annual concentration of DPM cannot exceed 5.0 μg/m³; resulting in a chronic acute HI of greater than 1.0 (i.e., DPM annual concentration/5.0 μg/m³). The chronic HI would be less than 0.01. The chronic HI would be below the significance threshold of 1 and the impact of the proposed project would therefore be less than significant.

Odor Impacts

Though offensive odors from stationary and mobile sources rarely cause any physical harm, they still remain unpleasant and can lead to public distress, generating citizen complaints to local governments. The occurrence and severity of odor impacts depend on the nature, frequency, and intensity of the source; wind speed and direction; and the sensitivity of receptors.

Land uses and industrial operations that typically are associated with odor complaints include agricultural uses, wastewater treatment plants, food processing plants, chemical plants, composting, refineries, landfills, solid waste transfer stations, rendering plants, dairies, and fiberglass molding.

The proposed project would not fall into any of these categories. Operation of the proposed project would result in fugitive dust and combustion emissions, which would not include odorous compounds at the low concentrations expected. The odor emissions, if any, would be unlikely to cause a nuisance to the nearby residential areas. With respect to the proposed project, diesel-fueled equipment exhaust would generate some odors. However, odor emissions are highly dispersive, especially in areas with higher average wind speeds. However, odors disperse less quickly during inversions or during calm conditions, which hamper vertical mixing and dispersion. Given the previous information, odor impacts associated with the location of the proposed project would be less than significant.

6.0 GREENHOUSE GAS ANALYSIS

"Global warming" and "global climate change" are the terms used to describe the increase in the average temperature of the earth's near-surface air and oceans since the mid-20th century and its projected continuation. Warming of the climate system is now considered to be unequivocal, with global surface temperature increasing approximately 1.33 degrees Fahrenheit (°F) over the last 100 years. Continued warming is projected to increase global average temperature between 2 and 11°F over the next 100 years.

[20] California Office of Environmental Health Hazards Assessment - Acute, 8-hour, and Chronic Reference Exposure Levels, June 2014, Accessed January 26, 2021, http://www.oehha.ca.gov/air/allrels.html

Natural processes and human actions have been identified as the causes of this warming. The International Panel on Climate Change (IPCC) concludes that variations in natural phenomena such as solar radiation and volcanoes produced most of the warming from pre-industrial times to 1950 and had a small cooling effect afterward.[21] After 1950, however, increasing GHG concentrations resulting from human activity such as fossil fuel burning and deforestation have been responsible for most of the observed temperature increase. These basic conclusions have been endorsed by more than 45 scientific societies and academies of science, including all of the national academies of science of the major industrialized countries. Since 2007, no scientific body of national or international standing has maintained a dissenting opinion.

Increases in GHG concentrations in the earth's atmosphere are thought to be the main cause of human-induced climate change. The IPCC is now 95 percent certain that humans are the main cause of current global warming.[22] GHG naturally trap heat by impeding the exit of solar radiation that has hit the earth and is reflected back into space. Some GHG occur naturally and are necessary for keeping the earth's surface inhabitable. However, increases in the concentrations of these gases in the atmosphere during the last 100 years have decreased the amount of solar radiation that is reflected back into space, intensifying the natural greenhouse effect and resulting in the increase of global average temperature.

Gases that trap heat in the atmosphere are referred to as GHG because they capture heat radiated from the sun as it is reflected back into the atmosphere, much like a greenhouse does. The accumulation of GHG has been implicated as the driving force for global climate change. The primary GHG are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), ozone, and water vapor.

While the presence of the primary GHG in the atmosphere are naturally occurring, CO_2, CH_4, and N_2O are also emitted from human activities, accelerating the rate at which these compounds occur within earth's atmosphere. Emissions of CO_2 are largely by-products of fossil fuel combustion, whereas methane results from off-gassing associated with agricultural practices, coal mines, and landfills. Other GHG include hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride, and are generated in certain industrial processes.

CO_2 is the reference gas for climate change because it is the predominant GHG emitted. The effect that each of the aforementioned gases can have on global warming is a combination of the

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[21] IPCC, *2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Accessed January 26, 2021, https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

[22] IPCC, *2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Accessed January 26, 2021, https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

mass of their emissions and their global warming potential (GWP). GWP indicates, on a pound-for-pound basis, how much a gas is predicted to contribute to global warming relative to how much warming would be predicted to be caused by the same mass of CO_2. CH_4 and N_2O are substantially more potent GHG than CO_2, with GWP of 28 and 265 times that of CO_2, respectively.[23]

In emissions inventories, GHG emissions are typically reported in terms of pounds or metric tons (MT) of CO_2 equivalents (CO_2e). CO_2e are calculated as the product of the mass emitted of a given GHG and its specific GWP. While CH_4 and N_2O have much higher GWP than CO_2, CO_2 is emitted in such vastly higher quantities that it accounts for the majority of GHG emissions in CO_2e.

Fossil fuel combustion, especially for the generation of electricity and powering of motor vehicles, has led to substantial increases in CO_2 emissions (and thus substantial increases in atmospheric concentrations of CO_2). In pre-industrial times (c. 1860), concentrations of atmospheric CO_2 were approximately 280 parts per million (ppm). By November 2020, atmospheric CO_2 concentrations had increased to 413 ppm, 48 percent above pre-industrial concentrations.[24]

There is international scientific consensus that human-caused increases in GHGs have and will continue to contribute to global warming. Potential global warming impacts in California may include, but are not limited to, loss in snow pack, sea level rise, more extreme heat days per year, more high ozone days, more large forest fires, and more drought years. Secondary effects are likely to include a global rise in sea level, impacts to agriculture, changes in disease vectors, and changes in habitat and biodiversity.[25]

Regulatory Setting

California Assembly Bill (AB) 32 establishes regulatory, reporting, and market mechanisms to achieve quantifiable reductions in GHG emissions and establishes a cap on statewide GHG emissions. AB 32 requires that statewide GHG emissions be reduced to 1990 levels by 2020. This reduction is in the process of being accomplished by enforcing a statewide cap on GHG

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[23] IPCC, *2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Accessed January 26, 2021, https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

[24] National Oceanographic and Atmospheric Administration - Earth System Research Laboratory, *Recent Monthly Mean CO2 at Mauna Loa*, Accessed January 26, 2021, www.esrl.noaa.gov/gmd/ccgg/trends/

[25] California Environmental Protection Agency, *Final Climate Action Team Report to the Governor and Legislature, March 2006*, Accessed January 26, 2021, http://documents.cityofdavis.org/Media/CityCouncil/Documents/PDF/CDD/Planning/Subdivisions/West-Davis-Active-Adult-Community/Reference-Documents/CalEPA_2006_Climate_Action_Team_Report_to_Gov-and_Leg.PDF

emissions that was phased in starting in 2012. Towards this progress, in 2018, California emitted approximately 425 million metric tons of CO_2e, six million metric tons of CO_2e below the 2020 GHG limit of 431 million metric tons of CO_2e and two million metric tons of CO2e below the 1990 GHG limit of 427 million metric tons of CO_2e. To effectively implement the cap, CARB develops and implements regulations to reduce statewide GHG emissions from stationary sources. California has taken these measures, because no project individually could have a major impact (either positively or negatively) on the global concentration of GHG.

AB 32 required CARB to adopt a quantified cap on GHG emissions representing 1990 emissions levels and disclosed how it arrived at the cap; instituted a schedule to meet the emissions cap; and developed tracking, reporting, and enforcement mechanisms to ensure that the state reduced GHG emissions enough to meet the cap. AB 32 also included guidance on instituting emissions reductions in an economically efficient manner, along with conditions to ensure that businesses and consumers were not unfairly affected by the reductions. Using these criteria to reduce statewide GHG emissions to 1990 levels by 2020 represented an approximate 25 to 30 percent reduction in emissions levels. However, CARB had discretionary authority to seek greater reductions in more significant and growing GHG sectors, such as transportation, as compared to other sectors that were not anticipated to significantly increase emissions.

AB 32 required CARB to develop a Scoping Plan that describes the approach California will take to reduce GHGs to achieve the goal of reducing emissions to 1990 levels by 2020. The Scoping Plan was first approved by CARB in 2008 and must be updated every five years. The initial AB 32 Scoping Plan contained the main strategies for California to reduce the GHG. The initial Scoping Plan had a range of GHG reduction actions which included direct regulations, alternative compliance mechanisms, monetary and non-monetary incentives, voluntary actions, market-based mechanisms such as a cap-and-trade system, and an AB 32 program implementation fee regulation to fund the program. In August 2011, the initial Scoping Plan was approved by CARB.

The 2013 Scoping Plan Update built upon the initial Scoping Plan with new strategies and recommendations. The 2013 Update identified opportunities to leverage existing and new funds to further drive GHG emission reductions through strategic planning and targeted low carbon investments. The 2013 Update defined climate change priorities for the subsequent five years and set the groundwork to reach California's long-term climate goals set forth in Executive Order S-3-05.[26] The 2013 Scoping Plan Update highlighted California progress toward meeting

[26] In 2005, in recognition of California's vulnerability to the effects of climate change, then-Governor Arnold Schwarzenegger established Executive Order S-3-05, which sets forth the following target dates by which statewide GHG emissions would be progressively reduced: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; and by 2050, reduce GHG emissions to 80 percent below 1990 levels.

the near-term 2020 GHG emission reduction goals defined in the initial Scoping Plan. In the 2013 Update, nine key focus areas were identified (energy, transportation, agriculture, water, waste management, and natural/working lands, along with short-lived climate pollutants, green buildings, and the cap-and-trade program). On May 22, 2014, the First Update to the Climate Change Scoping Plan was approved by CARB.

On April 29, 2015, Executive Order No. B-30-15 was issued to establish a California GHG reduction target of 40 percent below 1990 levels by 2030. The new plan, outlined in SB 32, involves increasing renewable energy use, putting more electric cars on the road, improving energy efficiency, and curbing emissions from key industries. It is designed so State agencies do not fall behind the pace of reductions necessary to reach the existing 2050 reduction goal. Executive Order No. B-30-15 orders "All State agencies with jurisdiction over sources of GHG emissions shall implement measures, pursuant to statutory authority, to achieve reductions of GHG emissions to meet the 2030 and 2050 targets." The Executive Order also states that "CARB shall update the Climate Change Scoping Plan to express the 2030 target in terms of million metric tons of carbon dioxide equivalent." On November 30, 2017, the Second Update to the Climate Change Scoping Plan was approved by the CARB.

Greenhouse Gas Regional Emission Estimates

Worldwide emissions of GHG in 2017 were estimated at 48.4 billion metric tons of CO_2e.[27] This value includes ongoing emissions from industrial and agricultural sources, but excludes emissions from land use changes.

In 2018, the United States emitted about 6,677 million metric tons of CO_2. Emissions increased from 2017 to 2018 by 3.1 percent. The increase in 2018 was largely driven by an increase in emissions from fossil fuel combustion, which was a result of multiple factors, including more electricity use greater due to greater heating and cooling needs due to a colder winter and hotter summer in 2018 in comparison to 2017.[28] GHG emissions in 2018 (after accounting for sequestration from the land sector) were 10.2 percent below 2005 levels.

In 2018, California emitted approximately 425 million metric tons of CO_2e, 0.8 million metric tons of CO_2e higher than 2017 levels and six million metric tons of CO_2e below the 2020 GHG limit of 431 million metric tons of CO_2e).[29] Consistent with recent years, these reductions have occurred while California's economy has continued to grow and generate jobs. The

[27] World Resources Institute, *Climate Analysis Indicator Tool – Global Historical GHG Emissions*, Accessed January 26, 2021, https://www.climatewatchdata.org/ghg-emissions?end_year=2017&start_year=1990

[28] United States Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks*, April 13, 2020, Accessed January 26, 2021, https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

[29] California Air Resources Board, *Emissions Trends Report 2000-2018 (2020 Edition)*, Accessed January 26, 2021, https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2018/ghg_inventory_trends_00-18.pdf

transportation sector remains the largest source of GHG emissions in the state with 40 percent of the emissions in 2018, but saw a decrease in emissions compared to 2017.[30]

Emissions from the electricity sector account for 15 percent of the inventory and showed a slight increase in 2018 due to less hydropower. California in 2018 used more electricity from zero-GHG sources (for the purpose of the GHG inventory, these include hydro, solar, wind, and nuclear energy) than from GHG-emitting sources for both in-state generation and total (in-state plus imports) generation. The industrial sector has seen steady emissions in the past few years, and remains at 21 percent of the inventory.[31]

Thresholds of Significance

At this time, neither the Lassen County APCD nor the County itself has adopted numerical thresholds of significance for GHG emissions that would apply to the proposed project. Lassen County recommends that all projects subject to CEQA review be considered in the context of GHG emissions and climate change impacts, and that CEQA documents include a quantification of GHG emissions from all project sources, as well as minimize and mitigate GHG emissions as feasible. The proposed project would generate GHG emissions through long-term operational activities.

In light of the lack of established GHG emissions thresholds that would apply to the proposed project, CEQA allows lead agencies to identify thresholds of significance applicable to a project that are supported by substantial evidence. Substantial evidence is defined in the CEQA statute to mean "facts, reasonable assumptions predicated on facts, and expert opinion supported by facts" (14 CCR 15384(b)).[32] Substantial evidence can be in the form of technical studies, agency staff reports or opinions, expert opinions supported by facts, and prior CEQA assessments and planning documents. Therefore, to establish additional context in which to consider the order of magnitude of the proposed project's GHG emissions, this analysis accounts for the following considerations by other government agencies and associations about what levels of GHG emissions constitute a cumulatively considerable incremental contribution to climate change:

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[30] California Air Resources Board, *Emissions Trends Report 2000-2018 (2020 Edition)*, Accessed January 26, 2021, https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2018/ghg_inventory_trends_00-18.pdf

[31] California Air Resources Board, *Emissions Trends Report 2000-2018 (2020 Edition)*, Accessed January 26, 2021, https://ww3.arb.ca.gov/cc/inventory/pubs/reports/2000_2018/ghg_inventory_trends_00-18.pdf

[32] 14 CCR 15384 provides the following discussion: "Substantial evidence" as used in the Guidelines is the same as the standard of review used by courts in reviewing agency decisions. Some cases suggest that a higher standard, the so called "fair argument standard" applies when a court is reviewing an agency's decision whether or not to prepare an EIR. Public Resources Code section 21082.2 was amended in 1993 (Chapter 1131) to provide that substantial evidence shall include "facts, reasonable assumptions predicated upon facts, and expert opinion supported by facts." The statute further provides that "argument, speculation, unsubstantiated opinion or narrative, evidence which is clearly inaccurate or erroneous, or evidence of social or economic impacts which do not contribute to, or are not caused by, physical impacts on the environment, is not substantial evidence."

- Sacramento Metropolitan Air Quality Management District (SMAQMD) established thresholds, including 1,100 metric tons of CO_2e per year for the construction or operational phase of land use development projects, or 10,000 direct metric tons of CO_2e per year from stationary source projects.[33]
- Placer County Air Pollution Control District (PCAPCD) recommends a tiered approach to determine if a project's GHG emissions would result in a significant impact. First, project GHG emissions are compared to the de minimis level of 1,100 metric tons of CO_2e per year. If a project does not exceed this threshold, it does not have significant GHG emissions. If the project exceeds the de minimis level and does not exceed the 10,000 metric tons of CO_2e per year bright line threshold, then the project's GHG emissions can be compared to the efficiency thresholds. These thresholds are 4.5 metric tons of CO_2e per-capita for residential projects in an urban area, and 5.5 metric tons of CO_2e per-capita for residential projects in a rural area. For nonresidential development, the thresholds are 26.5 metric tons of CO_2e per 1,000 square feet for projects in urban areas, and 27.3 metric tons of CO_2e per 1,000 square feet for projects in rural areas. The PCAPCD bright-line GHG threshold of 10,000 metric tons of CO_2e per year is also applied to land use projects' construction phase and stationary source projects' construction and operational phases. Generally, GHG emissions from a project that exceed 10,000 metric tons of CO_2e per year would be deemed to have a cumulatively considerable contribution to global climate change.[34]
- Bay Area Air Quality Management District (BAAQMD) has adopted 1,100 metric tons of CO_2e per year as a project-level bright-line GHG significance threshold that would apply to operational emissions from mixed land-use development projects, a threshold of 10,000 metric tons of CO_2e per year as the significance threshold for operational GHG emissions from stationary-source projects, and an efficiency threshold of 4.6 metric tons of CO_2e per service population per year.[35]
- South Coast Air Quality Management District (SCAQMD) formed a GHG CEQA Significance Threshold Working Group to work with SCAQMD staff on developing GHG CEQA significance thresholds until statewide significance thresholds or guidelines

[33] Sacramento Metropolitan Air Quality Management District, Guide to Air Quality Assessment in Sacramento County, May 2018, Accessed January 26, 2021, http://www.airquality.org/Residents/CEQA-Land-Use-Planning/CEQA-Guidance-Tools

[34] Placer County Air Pollution Control District, 2017 CEQA Handbook – Chapter 2, Thresholds of Significance, Accessed January 26, 2021, https://placerair.org/DocumentCenter/View/2047/Chapter-2-Thresholds-of-Significance-PDf

[35] Bay Area Air Quality Management District, CEQA Air Quality Guidelines, May 2017, Accessed January 26, 2021, http://www.baaqmd.gov/~/media/files/planning-and-research/ceqa/ceqa_guidelines_may2017-pdf.pdf?la=en

are established. The SCAQMD adopted an interim 10,000 metric tons of CO_2e per-year screening level threshold for stationary source/industrial projects for which the SCAQMD is the lead agency (SCAQMD Resolution No. 08-35, December 5, 2008).

As described, the 10,000 metric tons of CO_2e per year threshold is used by SMAQMD, PCAPCD, BAAQMD, and SCAQMD for industrial and/or stationary source GHG emissions. Since the proposed project is an industrial project that includes stationary sources (i.e., diesel generators), the proposed project's GHG emissions were compared to the 10,000 metric tons of CO_2e per year quantitative threshold. The substantial evidence for this GHG emissions threshold is based on the expert opinion of various California air districts, which have applied the 10,000 metric tons of CO_2e per year threshold in numerous CEQA documents where those air districts were the lead agency.

GHG Emission Estimates

The existing condition and proposed project's estimated operational GHG emissions are presented in **Table 7**. The estimated incremental GHG emissions would be approximately 61 metric tons of CO_2e, which is well below the significance threshold of 10,000 metric tons of CO_2e. Therefore, the proposed project would have a less-than-significant impact on GHG emissions. Based on the GHG emission calculations and using standard fuel consumption estimates, existing conditions operational activities would require 385,520 gallons of diesel fuel and the proposed project operational activities would require 391,555 gallons of diesel fuel. The incremental increase in fuel usage would be 6,035 gallons of diesel fuel.[36]

TABLE 7
Annual Greenhouse Gas Emissions (metric tons)

Emission Source	Existing Condition	Proposed Project	Project Increment
Onsite Equipment	94	155	61
Generator - Crushing Plant	1,456	1,456	-
Generator - Portable Plant	914	914	-
Generator - Wash Plant	903	903	-
Haul Trucks	546	546	-
Total	**3,913**	**3,974**	**61**
Significance Threshold			10,000
Exceeds Threshold?			No

Source: RCH Group, 2021.

[36] Fuel usage is estimated using the CalEEMod output for CO2, and a 10.15 kg-CO2/gallon conversion factor, as cited in the *U.S. Energy Information Administration Voluntary Reporting of Greenhouse Gases Program*, https://www.eia.gov/environment/pdfpages/0608s(2009)index.php

Attachment A

Air Quality Calculations

The air quality analysis includes a review of criteria pollutant[1] emissions such as carbon monoxide (CO)[2], nitrogen oxides (NO_x)[3], sulfur dioxide (SO_2)[4], volatile organic compounds (VOC) as reactive organic gases (ROG)[5], particulate matter less than 10 micrometers (coarse or PM_{10}), particulate matter less than 2.5 micrometers (fine or $PM_{2.5}$).[6] Regulatory models used to estimate air quality impacts include:

- CARB EMFAC[7] emissions inventory model. EMFAC is the latest emission inventory model that calculates emission inventories and emission rates for motor vehicles operating on roads in California. This model reflects CARB's current understanding of how vehicles travel and how much they emit. EMFAC can be used to show how California motor vehicle emissions have changed over time and are projected to change in the future.

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1 Criteria air pollutants refer to those air pollutants for which the USEPA and CARB has established National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS) under the Federal Clean Air Act (CAA).

2 CO is a non–reactive pollutant that is a product of incomplete combustion of organic material, and is mostly associated with motor vehicle traffic, and in wintertime, with wood–burning stoves and fireplaces.

3 When combustion temperatures are extremely high, as in aircraft, truck and automobile engines, atmospheric nitrogen combines with oxygen to form various oxides of nitrogen (NO_x). Nitric oxide (NO) and NO_2 are the most significant air pollutants generally referred to as NO_x. Nitric oxide is a colorless and odorless gas that is relatively harmless to humans, quickly converts to NO_2 and can be measured. Nitrogen dioxide has been found to be a lung irritant capable of producing pulmonary edema.

4 SO_2 is a combustion product of sulfur or sulfur–containing fuels such as coal and diesel. SO_2 is also a precursor to the formation of atmospheric sulfate and particulate matter, and contributes to potential atmospheric sulfuric acid formation that could precipitate downwind as acid rain.

5 VOC means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions and thus, a precursor of ozone formation. ROG are any reactive compounds of carbon, excluding methane, CO, CO_2 carbonic acid, metallic carbides or carbonates, ammonium carbonate, and other exempt compounds. The terms VOC and ROG are often used interchangeably.

6 PM_{10} and $PM_{2.5}$ consists of airborne particles that measure 10 microns or less in diameter and 2.5 microns or less in diameter, respectively. PM_{10} and $PM_{2.5}$ represent fractions of particulate matter that can be inhaled into the air passages and the lungs, causing adverse health effects.

7 California Air Resources Board, *EMFAC2017 User's Guide*, March 1, 2018, https://ww3.arb.ca.gov/msei/downloads/emfac2017-volume-i-users-guide.pdf and https://www.arb.ca.gov/emfac/2017/

- CARB OFFROAD[8] emissions inventory model. OFFROAD is the latest emission inventory model that calculates emission inventories and emission rates for off-road equipment such as loaders, excavators, and off-road haul trucks operating in California. This model reflects CARB's current understanding of how equipment operates and how much they emit. OFFROAD can be used to show how California off-road equipment emissions have changed over time and are projected to change in the future.
- USEPA Compilation of Air Pollutant Emission Factors (AP-42), has been published since 1972 as the primary compilation of USEPA's emission factor information. It contains emission factors and process information for more than 200 air pollution source categories. A source category is a specific industry sector or group of similar emitting sources. The emission factors have been developed and compiled from source test data, material balance studies, and engineering estimates.[9]

Air Emission Calculation Methodology

The proposed project could affect air quality during project operations (including aggregate processing plant and other processing equipment such as loaders, excavators, diesel generators, vehicular traffic on unpaved roads, basting operations, soil disturbance, and haul trucks).

On-Road Vehicles

Vehicular emissions were computed using the CARB's emission factor model, EMFAC, to estimate on-road emissions. Foreman pickup trucks used on-site were modeled as gasoline and diesel light heavy-duty trucks. Haul trucks were modeled using the diesel T7 single construction haul truck classification, which is a heavy-heavy duty truck emission factor for public vehicles. Criteria pollutant emissions associated with on-road vehicles were calculated by combining the activity information with emissions factors, in grams per mile, derived using the EMFAC emissions model. Emissions calculations were based on **Equation 1**. The EMFAC emissions factors were developed for employee vehicles and haul trucks. **Table A-1** displays the emission factors for haul trucks.

Haul truck volumes would not change as a result of the proposed project and is currently limited by the following condition of approval: haul trucks (loaded or empty) associated with the mining operation shall not exceed a daily average of 26 round trips (26 arriving and 26 departing) throughout the calendar year and shall not exceed a daily maximum of 275 round

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[8] California Air Resources Board, *Mobile Source Emissions Inventory Documentation – Off Road Diesel Equipment*, https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road and https://ww3.arb.ca.gov/msei/ordiesel/ordas_ef_fcf_2017.pdf

[9] US Environmental Protection Agency, AP 42, Compilation of Air Pollutant Emission Factors, Fifth Edition, Volume I, https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

trips (275 arriving and 275 departing), with a maximum of 173 total trips occurring between the hours of 10:00 p.m. and 7:00 a.m., excluding personal employee vehicles and light-duty trucks assigned to employees. The maximum number of annual truck trips would continue to be 8,112. The number of employees would remain at 14.

Equation 1

*Emission Rate (tons/year) = Emission Factor (gram/mile) * trips per day * miles per trip * days/year * (453.59/2000 tons/gram)*

*Emission Rate (pounds/day) = Emission Factor (gram/mile) * trips per day * miles per trip * (1/453.59 pounds/gram)*

TABLE A-1
EMISSIONS FACTORS (g/mile) FOR ON-ROAD VEHICLES

Vehicle Type	Year	VOC	CO	NO_x	CO_2	SO_2	PM_{10}	$PM_{2.5}$
Haul Truck	2021	0.09	0.30	3.15	1,218	0.01	0.02	0.02
Haul Truck	2025	0.05	0.25	2.84	1,204	0.01	0.01	0.01
Haul Truck	2030	0.02	0.21	2.52	1,121	0.01	0.01	0.01
Haul Truck	2035	0.02	0.21	2.57	1,086	0.01	0.01	0.01
Haul Truck	2040	0.02	0.21	2.53	1,038	0.01	0.01	0.01
Haul Truck	2045	0.02	0.21	2.51	996	0.01	0.01	0.01
Haul Truck	2050	0.02	0.21	2.50	968	0.01	0.01	0.01

Source: CARB EMFAC Emissions Model.

Off-Road Equipment

Operation of the proposed project would require the use of heavy-duty equipment, such as loaders and excavators. This equipment would be used to load and unload material. Emission factors from the OFFROAD emissions model were used. Emissions from offroad equipment activities were estimated based on the projected activity schedule, the number of vehicles/pieces of equipment, the types of equipment/type of fuel used, vehicle/equipment utilization rates, equipment horsepower, and the calendar year.

This information was applied to criteria pollutant emissions factors, in grams per horsepower-hour, derived using the OFFROAD emissions model. **Equation 2** outlines how off-road construction equipment emissions were computed, and the emissions factors used in this assessment are summarized, by equipment type within **Table A-2.**

Onsite offroad equipment include four off-highway truck (376 horsepower), two excavator (337 horsepower), five front-end loaders (84 horsepower), and one dozer (365 horsepower) operating onsite to move materials. On average, for the existing condition, the loaders would operate 480 hours per year, the excavators would operate 450 hours per year, the onsite haul trucks would operate 350 hours per year, and the dozer would operate 500 hours per year. On average, for the proposed project, the loaders would operate 1,200 hours per year, the excavators would operate 675 hours per year, the onsite haul trucks would operate 525 hours per year, and the dozer would operate 750 hours per year.

Equation 2

*Emission Rate (tons/year) = Emission Factor (gram/hp-hour) * size (hp) * hours of operation per year * Load Factor * (453.59/2000 tons/gram)*

*Emission Rate (pounds/day) = Emission Factor (gram/hp-hour) * size (hp) * hours of operation per day * Load Factor * (1/453.59 pounds/gram)*

TABLE A-2
EMISSIONS FACTORS (g/hp-hour) FOR OFFROAD EQUIPMENT

Vehicle Type	VOC	CO	NO_x	CO_2	SO_2	PM_{10}	$PM_{2.5}$	CH_4
Diesel Excavator	0.04	0.40	0.20	201	<0.01	0.01	0.01	<0.01
Diesel Off-Highway Trucks	0.06	0.44	0.30	202	<0.01	0.01	0.01	<0.01
Diesel Dozer	0.13	1.06	1.10	210	<0.01	0.05	0.05	<0.01
Diesel Loaders	0.06	1.29	0.62	195	<0.01	0.01	0.01	<0.01

Source: CARB OFFROAD Emissions Model.

Handling and Storage

Fugitive particulate matter emissions are expected from the handling and storage of raw materials from aggregate processing. The methodology for the calculation of particulate emissions from the handling and storage of raw materials is described in Section 13.2.4 of USEPA's AP-42 for aggregate handling and storage piles. The quantity of dust emissions from aggregate handling and storage operations varies with the volume of aggregate passing through the storage cycle. The emission factor for the quantity of emissions per quantity of material was estimated using the following equation:

E = [0.00112*({[G/5]^1.3}/{[H/2]^1.4})]*[I/J]

where:

G = Mean wind speed in miles per hour, 13 mph

H = Moisture Content of soil, 2.0 (dry)

I = pounds of material handled

J = 2,000 (conversion factor, pounds to tons)

The emission factor used in the analysis for handling and storage activities was 0.00388 pounds of PM_{10} per ton of material processed (uncontrolled) and 0.00116 pounds of PM_{10} per ton of material processed (controlled). The $PM_{2.5}$ emissions were assumed to be 15 percent of the PM_{10} emissions (based on AP-42). To account for emission controls, a control efficiency of 80 percent (based on AP-42) from watering was also applied.

Unpaved Vehicle Movement

When a vehicle travels over an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. Additionally, the turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The following is the equation used to develop the emission factor is:

$$EF = k\,(S/30)^{a}\,(W/3)^{b}\,[(365-p)/365]\,(1-CE)$$

where:

k (PM_{10}) = 2.1 (empirical constant)

s = Silt content of 8.3 percent (use whole number value)

W = Mean vehicle weight, 33 tons unloaded and 69 tons loaded

p = Number of days with measurable precipitation (59 days)

a = 0.7 (empirical constant)

b = 0.45 (empirical constant)

CE = Control efficiency rate of 80 percent

The uncontrolled emission factor for unpaved roads was 5.6 and 4.0 pounds per vehicle mile for loaded and unloaded trucks, respectively. The controlled emission factor for unpaved roads was 1.0 and 0.8 pounds per vehicle mile for loaded and unloaded trucks, respectively. The $PM_{2.5}$ emissions were assumed to be 15 percent of the PM_{10} emissions (based on AP-42). To account for emission controls, a control efficiency of 80 percent (based on AP-42 Section 13.2.2) from watering was also applied. Finally, each vehicle was assumed to travel a distance of ¼ of a mile on unpaved area prior to the haul truck access road.

Aggregate Processing

In the general aggregate processing, rock and crushed stone are loosened by drilling and blasting, loaded by front-end loader into large haul trucks that transport the material to the processing operations. Processing operations include crushing, screening, size classification, conveyance, material handling and storage operations. Air emissions include PM_{10} and $PM_{2.5}$.

Fugitive dust sources include the transfer of aggregate, truck loading and unloading, and wind erosion from aggregate storage piles. The amount of fugitive emissions generated during the transfer of the aggregate depends primarily on the surface moisture content of these materials.

The air emission calculations accounted for the production level, the number, types, and size of equipment, the type of material processed, and emission controls. The emission factors were determined using the methodology found in Section 11.19 of USEPA's AP-42. **Table A-3** presents the emission factors for the aggregate processing operations. A ratio of 0.15 is applied to determine the amount of $PM_{2.5}$ per mass of PM_{10} based on AP-42. Emissions control is based on periodic watering.

The aggregate processing plant is rated at 250 tons per hour. The average daily production is 3,000 tons and the annual production is 100,000 tons for the existing condition. The aggregate processing plant has one jaw crusher, two cone crushers, two deck conveyors, and seven secondary conveyers. For the proposed project, the annual production would be 200,000 tons.

TABLE A-3
EMISSIONS FACTORS (pounds/tons or material) FOR AGGREGATE PROCESSING

Emission Point	Uncontrolled PM_{10}	Controlled PM_{10}
Jaw Crusher	0.0024	0.00054
Cone Crusher	0.0024	0.00054
Primary Screening	0.0087	0.00074
Deck Conveyor	0.0011	0.000046
Secondary Crusher	0.0024	0.00054
Secondary Conveyor	0.0011	0.000046
Secondary Screen	0.072	0.0022

Source: Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: *Stationary Point and Area Sources*, Section 11.19.2 Crushed Stone Processing, November 2006.

The sand washing plant processes sand from its raw state into products that meet various specifications. The process requirements vary depending on the input and desired output, but the plant typically scrub, liberate, deslime, wash, classify, decontaminate and dewater the sand, as well as process the effluent stream that results. The wash plant has one feeder, one screen, and two conveyors. The sand plant has one feeder, three screens, and eight conveyors. The emission factors were determined using the methodology found in Section 11.19 of USEPA's AP-42. **Table A-4** presents the emission factors for the sand and wash plant operations. A ratio of 0.15 is applied to determine the amount of $PM_{2.5}$ per mass of PM_{10} based on AP-42.

TABLE A-4
EMISSIONS FACTORS (pounds/tons of material) FOR SAND AND WASH PLANT

	Uncontrolled	Controlled
Emission Point	**PM_{10}**	**PM_{10}**
Feeder	0.0024	0.00054
Primary Screening	0.0087	0.00074
Conveyor	0.0011	0.000046

Source: Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: *Stationary Point and Area Sources*, Section 11.19.2 Crushed Stone Processing, November 2006.

Blasting Operations

Air emissions from blasting include PM_{10} and $PM_{2.5}$. The emission factor for the quantity of emissions (in pounds) per blast event was estimated using the following equation from Section 11.9 of USEPA's AP-42:

$$EF = 0.000014 * (A)^{1.5}$$

where:

EF = PM_{30} emission factor (pounds/blast)

A = blast area (6,750 or 10,125 square feet)

A ratio of 0.52 was applied to determine the amount of PM_{10} per PM_{30} based on AP-42. A ratio of 0.15 was applied to determine the amount of $PM_{2.5}$ per mass PM_{10} based on AP-42. The PM_{10} emission factor used in the analysis was 4.0 pounds per blast event. Currently, the project site conducts blasting operations about three to seven times per year. The proposed project would conduct the same number of blasting operations but the basting operations would be larger. Blasting operations only during daylight hours, normally middle of the day. During the existing conditions, approximately ½ acre is blasted annually (approximately 6,750 square feet per blasting event). Under the proposed project, approximately one acre would be blasted annually (approximately 10,125 square feet per blasting event).

Diesel Generators

The Lassen County APCD requires permits for proposed construction, alteration or replacement of equipment or facilities which may cause the issuance of air contaminants. The Ward Lake Pit maintains a permit to operate (PTO-19-140: expiration date March 31, 2024) for onsite equipment such as a hot mix asphalt plant, a lime slurry mix plant, a concrete plant, a crushing plant, a wash plant, a sand plant, and several diesel generators (one 750 horsepower [hp] generator associated with the crushing plant[10], one 475 hp generator associated with the portable plant[11], and one 469 hp generator associated with the wash plant[12].

All reciprocating internal combustion engines operate by the same basic process. A combustible mixture is first compressed in a small volume between the head of a piston and its surrounding cylinder. The mixture is then ignited, and the resulting high-pressure products of combustion push the piston through the cylinder. This movement is converted from linear to rotary motion by a crankshaft. The piston returns, pushing out exhaust gases, and the cycle is repeated. The emission factors were based on information contained within the manufacturer's specification sheet and USEPA's AP-42 Section 3.4 and Ward Lake Facility Permit to Operate from Lassen County APCD (PTO-19-140). **Table A-5** presents the emission factors for the diesel generators.

TABLE A-5
EMISSIONS FACTORS (pounds/hp-hour) FOR DIESEL GENERATORS

Pollutant	469&475 hp	750 hp
NOx	0.01	0.02
CO	2.03E-03	1.46E-03
SOx	2.05E-03	0.01
PM10/PM2.5	2.34E-04	1.72E-04
CO_2	1.15	1.16
TOC (ROG)	1.10E-04	1.32E-04

Source: Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: *Stationary Point and Area Sources*, Section 3.4, Large Stationary Diesel And All Stationary Dual-fuel Engines, October 1996 and Ward Lake Facility Permit to Operate from Lassen County APCD (PTO-19-140.

10 To be removed or replaced by January 2023 with Air District approved engine.

11 To be removed or replaced by January 2024 with Air District approved engine.

12 To be removed or replaced by January 2025 with Air District approved engine.

Attachment A

Emission Calculations

- Diesel Generators – Existing Condition
- Diesel Generators – Proposed Project
- Onsite Offroad Equipment – Existing Condition
- Onsite Offroad Equipment – Proposed Project
- Aggregate Processing Plant - Existing Condition
- Aggregate Processing Plant - Proposed Project
- Wash Plant - Existing Condition
- Wash Plant - Proposed Project
- Sand Plant - Existing Condition
- Sand Plant - Proposed Project
- Fugitive Dust Emissions - Existing Condition
- Fugitive Dust Emissions - Proposed Project

District-Approved Emissions for Diesel Generators - Existing Condition

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.02	750	27.2	200
CO	1.46E-03	750	2.01	14.8
SOx	0.01	750	16.8	123
PM10/PM2.5	1.72E-04	750	0.24	1.75
CO2	1.16	750	1,605	11,778
TOC (ROG)	1.32E-04	750	0.18	1.34

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.01	475	11.9	87.5
CO	2.03E-03	475	1.78	13.0
SOx	2.05E-03	475	1.80	13.2
PM10/PM2.5	2.34E-04	475	0.20	1.50
CO2	1.15	475	1,008	7,395
TOC (ROG)	1.10E-04	475	0.10	0.71

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.01	469	11.8	86.4
CO	2.03E-03	469	1.76	12.9
SOx	2.05E-03	469	1.78	13.0
PM10/PM2.5	2.34E-04	469	0.20	1.48
CO2	1.15	469	996	7,308
TOC (ROG)	1.10E-04	469	0.10	0.70

Pollutants	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	50.9	374
CO	5.55	40.7
SOx	20.4	149
PM10/PM2.5	0.65	4.73
CO2	3,609	26,481
TOC (ROG)	0.38	2.75

District-Approved Emissions for Diesel Generators - Proposed Project

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.02	750	27.2	200
CO	1.46E-03	750	2.01	14.8
SOx	0.01	750	16.8	123
PM10/PM2.5	1.72E-04	750	0.24	1.75
CO2	1.16	750	1,605	11,778
TOC (ROG)	1.32E-04	750	0.18	1.34

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.01	475	11.9	87.5
CO	2.03E-03	475	1.78	13.0
SOx	2.05E-03	475	1.80	13.2
PM10/PM2.5	2.34E-04	475	0.20	1.50
CO2	1.15	475	1,008	7,395
TOC (ROG)	1.10E-04	475	0.10	0.71

Pollutants	EF (lb/hp-hr)	HP	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	0.01	469	11.8	86.4
CO	2.03E-03	469	1.76	12.9
SOx	2.05E-03	469	1.78	13.0
PM10/PM2.5	2.34E-04	469	0.20	1.48
CO2	1.15	469	996	7,308
TOC (ROG)	1.10E-04	469	0.10	0.70

Pollutants	Annual Emissions (tons)	Daily Emissions (lbs)
NOx	50.9	374
CO	5.55	40.7
SOx	20.4	149
PM10/PM2.5	0.65	4.73
CO2	3,609	26,481
TOC (ROG)	0.38	2.75

Onsite Offroad Equipment - Existing Conditions

	Emission Factor (g/hp-hr)									Number of	Load	Daily	Annual	Daily Emissions (lbs/day)						Annual Emissions (tons/year)							
Source Type	ROG	CO	NOx	CO2	SOx	PM10	PM2.5	CH4	HP	Equipment	Factor	Hours	Hours	ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	CO2	SOx	PM10	PM2.5	CH4
Diesel Excavator	0.04	0.40	0.20	201	0.00	0.01	0.01	0.00	**337**	**2**	0.38	**6**	**450**	**0.14**	**1.35**	**0.67**	**0.01**	**0.02**	**0.02**	**0.01**	**0.05**	**0.03**	**25.6**	**0.00**	**0.00**	**0.00**	**0.00**
Diesel Off-Highway Trucks	0.06	0.44	0.30	202	0.00	0.01	0.01	0.00	**376**	**4**	0.38	**5**	**350**	**0.41**	**2.77**	**1.87**	**0.01**	**0.07**	**0.06**	**0.01**	**0.10**	**0.07**	**44.6**	**0.00**	**0.00**	**0.00**	**0.00**
Diesel Dozer	0.13	1.06	1.10	210	0.00	0.05	0.05	0.00	**365**	**1**	0.40	**6**	**500**	**0.25**	**2.04**	**2.12**	**0.00**	**0.10**	**0.09**	**0.01**	**0.09**	**0.09**	**17.0**	**0.00**	**0.00**	**0.00**	**0.00**
Diesel Loaders	0.06	1.29	0.62	195	0.00	0.01	0.01	0.00	**84**	**5**	0.37	**7**	**480**	**0.15**	**3.08**	**1.47**	**0.00**	**0.04**	**0.03**	**0.01**	**0.11**	**0.05**	**16.0**	**0.00**	**0.00**	**0.00**	**0.00**
												24	450	0.94	9.23	6.13	0.03	0.22	0.21	0.03	0.34	0.23	103	0.00	0.01	0.01	0.00

Onsite Offroad Equipment - Proposed Project

Source Type	ROG	CO	NOx	CO2	SOx	PM10	PM2.5	CH4	HP	Number of Equipment	Load Factor	Daily Hours	Annual Hours
	Emission Factor (g/hp-hr)												
Diesel Excavator	0.04	0.40	0.20	201	0.00	0.01	0.01	0.00	**337**	**2**	0.38	**6**	**675**
Diesel Off-Highway Trucks	0.06	0.44	0.30	202	0.00	0.01	0.01	0.00	**376**	**4**	0.38	**5**	**525**
Diesel Dozer	0.13	1.06	1.10	210	0.00	0.05	0.05	0.00	**365**	**1**	0.40	**6**	**750**
Diesel Loaders	0.06	1.29	0.62	195	0.00	0.01	0.01	0.00	**84**	**5**	0.37	**7**	**1,200**
												24	816

Source Type	ROG	CO	NOx	SOx	PM10	PM2.5	ROG	CO	NOx	CO2	SOx	PM10	PM2.5	CH4
	Daily Emissions (lbs/day)						Annual Emissions (tons/year)							
Diesel Excavator	**0.14**	**1.35**	**0.67**	**0.01**	**0.02**	**0.02**	**0.01**	**0.08**	**0.04**	**38.4**	**0.00**	**0.00**	**0.00**	**0.00**
Diesel Off-Highway Trucks	**0.41**	**2.77**	**1.87**	**0.01**	**0.07**	**0.06**	**0.02**	**0.15**	**0.10**	**66.9**	**0.00**	**0.00**	**0.00**	**0.00**
Diesel Dozer	**0.25**	**2.04**	**2.12**	**0.00**	**0.10**	**0.09**	**0.02**	**0.13**	**0.13**	**25.4**	**0.00**	**0.01**	**0.01**	**0.00**
Diesel Loaders	**0.15**	**3.08**	**1.47**	**0.00**	**0.04**	**0.03**	**0.01**	**0.26**	**0.13**	**39.9**	**0.00**	**0.00**	**0.00**	**0.00**
	0.94	9.23	6.13	0.03	0.22	0.21	0.06	0.61	0.39	171	0.00	0.01	0.01	0.00

Aggregate Procesing Plant - Existing Conditions

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	100,000	1,440	hours/year

						Controlled				Uncontrolled			
Equipment	**Process Rate (ton/hr)**	**Number of Transfers**	**Daily Operation (hours)**	**Uncontrolled Emission Factor (lb/ton)**	**Controlled Emission Factor (lb/ton)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**
Jaw Crusher	250	1	12	0.0024	0.00054	1.62	0.03	0.24	0.00	7.20	0.12	1.08	0.02
Cone Crusher	250	2	12	0.0024	0.00054	3.24	0.03	0.49	0.00	14.4	0.12	2.16	0.02
Primary Screening	250	1	12	0.0087	0.00074	2.22	0.04	0.33	0.01	26.1	0.44	3.92	0.07
Deck Conveyor	250	2	12	0.0011	0.000046	0.28	0.00	0.04	0.00	6.60	0.06	0.99	0.01
Secondary Crusher	250	1	12	0.0024	0.00054	1.62	0.03	0.24	0.00	7.20	0.12	1.08	0.02
Secondary Conveyor	250	7	12	0.0011	0.000046	0.97	0.00	0.14	0.00	23.1	0.06	3.47	0.01
Secondary Screen	250	1	12	0.072	0.0022	6.60	0.11	0.99	0.02	216	3.60	32.4	0.54
Total Aggregate Processing Plant Emissions						***16.5***	***0.23***	***2.48***	***0.03***	***301***	***4.51***	***45.1***	***0.68***

Wash Plant - Existing Conditions

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	100,000	1,440	hours/year

						Controlled				Uncontrolled			
Equipment	**Process Rate (ton/hr)**	**Number of Transfers**	**Daily Operation (hours)**	**Uncontrolled Emission Factor (lb/ton)**	**Controlled Emission Factor (lb/ton)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**
Feeder	250	1	12	0.0024	0.00054	1.62	0.03	0.24	0.00	7.2	0.12	1.08	0.02
Primary Screening	250	1	12	0.0087	0.00074	2.22	0.04	0.33	0.01	26.1	0.44	3.92	0.07
Conveyor	250	2	12	0.0011	0.000046	0.28	0.00	0.04	0.00	6.60	0.06	0.99	0.01
Total Wash Plant Emissions						***4.12***	***0.07***	***0.62***	***0.01***	***39.9***	***0.61***	***5.99***	***0.09***

Sand Plant - Existing Conditions

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	100,000	1,440	hours/year

						Controlled				Uncontrolled			
Equipment	**Process Rate (ton/hr)**	**Number of Transfers**	**Daily Operation (hours)**	**Uncontrolled Emission Factor (lb/ton)**	**Controlled Emission Factor (lb/ton)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**
Feeder	250	1	12	0.0024	0.00054	1.62	0.03	0.24	0.00	7.2	0.12	1.08	0.02
Primary Screening	250	3	12	0.0087	0.00074	6.66	0.04	1.00	0.01	78.3	0.44	11.75	0.07
Conveyor	250	8	12	0.0011	0.000046	1.10	0.00	0.17	0.00	26.40	0.06	3.96	0.01
Total Wash Plant Emissions						***9.38***	***0.07***	***1.41***	***0.01***	***111.9***	***0.61***	***16.79***	***0.09***

Aggregate Procesing Plant - Proposed Project

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	200,000	2,160	hours/year

						Controlled				Uncontrolled			
Equipment	Process Rate (ton/hr)	Number of Transfers	Daily Operation (hours)	Uncontrolled Emission Factor (lb/ton)	Controlled Emission Factor (lb/ton)	PM10 Daily (lb/day)	PM10 Annual (ton/yr)	PM2.5 Daily (lb/day)	PM2.5 Annual (ton/yr)	PM10 Daily (lb/day)	PM10 Annual (ton/yr)	PM2.5 Daily (lb/day)	PM2.5 Annual (ton/yr)
Jaw Crusher	250	1	12	0.0024	0.00054	1.62	0.05	0.24	0.01	7.20	0.24	1.08	0.04
Cone Crusher	250	2	12	0.0024	0.00054	3.24	0.05	0.49	0.01	14.4	0.24	2.16	0.04
Primary Screening	250	1	12	0.0087	0.00074	2.22	0.07	0.33	0.01	26.1	0.87	3.92	0.13
Deck Conveyor	250	2	12	0.0011	0.000046	0.28	0.00	0.04	0.00	6.60	0.11	0.99	0.02
Secondary Crusher	250	1	12	0.0024	0.00054	1.62	0.05	0.24	0.01	7.20	0.24	1.08	0.04
Secondary Conveyor	250	7	12	0.0011	0.000046	0.97	0.00	0.14	0.00	23.1	0.11	3.47	0.02
Secondary Screen	250	1	12	0.072	0.0022	6.60	0.22	0.99	0.03	216	7.20	32.4	1.08
Total Aggregate Processing Plant Emissions						***16.5***	***0.47***	***2.48***	***0.07***	***301***	***9.01***	***45.1***	***1.35***

Wash Plant - Proposed Project

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	200,000	2,160	hours/year

						Controlled				Uncontrolled			
Equipment	**Process Rate (ton/hr)**	**Number of Transfers**	**Daily Operation (hours)**	**Uncontrolled Emission Factor (lb/ton)**	**Controlled Emission Factor (lb/ton)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**	**PM10 Daily (lb/day)**	**PM10 Annual (ton/yr)**	**PM2.5 Daily (lb/day)**	**PM2.5 Annual (ton/yr)**
Feeder	250	1	12	0.0024	0.00054	1.62	0.05	0.24	0.01	7.2	0.24	1.08	0.04
Primary Screening	250	1	12	0.0087	0.00074	2.22	0.07	0.33	0.01	26.1	0.87	3.92	0.13
Conveyor	250	2	12	0.0011	0.000046	0.28	0.00	0.04	0.00	6.60	0.11	0.99	0.02
Total Wash Plant Emissions						***4.12***	***0.13***	***0.62***	***0.02***	***39.9***	***1.22***	***5.99***	***0.18***

Sand Plant - Proposed Project

Operating Assumptions

Hourly Process Rate (ton)	250		
Daily Process Rate (ton)	3,000		
Annual Process Rate (ton)	200,000	2,160	hours/year

						Controlled				Uncontrolled			
	Process		Daily	Uncontrolled Emission	Controlled Emission	PM10	PM10	PM2.5	PM2.5	PM10	PM10	PM2.5	PM2.5
Equipment	**Rate (ton/hr)**	**Number of Transfers**	**Operation (hours)**	**Factor (lb/ton)**	**Factor (lb/ton)**	**Daily (lb/day)**	**Annual (ton/yr)**	**Daily (lb/day)**	**Annual (ton/yr)**	**Daily (lb/day)**	**Annual (ton/yr)**	**Daily (lb/day)**	**Annual (ton/yr)**
Feeder	250	1	12	0.0024	0.00054	1.62	0.05	0.24	0.01	7.2	0.24	1.08	0.04
Primary Screening	250	3	12	0.0087	0.00074	6.66	0.07	1.00	0.01	78.3	0.87	11.75	0.13
Conveyor	250	8	12	0.0011	0.000046	1.10	0.00	0.17	0.00	26.40	0.11	3.96	0.02
Total Wash Plant Emissions						***9.38***	***0.13***	***1.41***	***0.02***	***111.9***	***1.22***	***16.79***	***0.18***

Fugitive PM Emissions - Existing Conditions

Fugitive PM from Trucks on Unpaved Surfaces

Operating Assumptions

Haul road length =	0.25	mile	3,000	tons/day		
Trucks/day =	23		2,000	cy/day		
VMT =	12	miles/day	100,000	tons/year		
Days/year	120	days	66,667	cy/year	1,440	hours/year

Calculated Emission Factor for travel on unpaved roads
PM10 EF = 2.1*(S/12)^0.7*(W/3)^0.45*[(365-K)/365]
S = Silt content, 8.3%
W = Mean vehicle weight, 33 tons unloaded, 69 tons loaded
K = Mean # of days with rain above 0.01 inches, 59

Loaded Emission Factor = 5.58 pounds pm10/vmt
Unloaded Emission Factor = 4.00 pounds pm10/vmt

	PM10 Uncontrolled	PM10 Controlled	PM2.5 Uncontrolled	PM2.5 Controlled
Unpaved Fugitive Emissions (pounds/day)	111	22.2	16.6	3.33
Unpaved Fugitive Emissions (tons/year)	6.65	1.33	1.00	0.20

Fugitive PM Eissions from Material Handling

E = [0.00112*({[G/5]^1.3}/{[H/2]^1.4})]*[I/J]

G = Mean wind speed in miles per hour, 13 mph
H = Moisture Content of soil, 2.0 (dry)
I = lbs of material handled
J = 2,000 (conversion factor, lbs to tons)

	PM10 Uncontrolled	PM10 Controlled	PM2.5 Uncontrolled	PM2.5 Controlled
Material Handling Fugitive Emissions (pounds/day)	11.6	2.33	1.75	0.35
Material Handling Fugitive Emissions (tons/year)	0.70	0.14	0.10	0.02

Blasting

E = 0.000014 (A)^1.5 from AP-42 11.9

E= PM30 emissions
A = horizontal area

PM -10 emissions = 0.52 x E

Two areas of adjacent benches with shots 15' apart
Approx area = 6,750 sf

E= 7.76 pounds of TSP/blast
PM10 = 4.04 pounds/blast
28.3 pounds/year 7 blasts/year
PM2.5 = 0.61 pounds/blast
4.24 pounds/year

Fugitive PM Emissions - Proposed Project

Fugitive PM from Trucks on Unpaved Surfaces

Operating Assumptions

Haul road length =	0.25	mile	3,000	tons/day		
Trucks/day =	23		2,000	cy/day		
VMT =	12	miles/day	200,000	tons/year		
Days/year	180	days	133,333	cy/year	2,160	hours/year

Calculated Emission Factor for travel on unpaved roads
PM10 EF = 2.1*(S/12)^0.7*(W/3)^0.45*[(365-K)/365]
S = Silt content, 8.3%
W = Mean vehicle weight, 33 tons unloaded, 69 tons loaded
K = Mean # of days with rain above 0.01 inches, 59

Loaded Emission Factor = 5.58 pounds pm10/vmt
Unloaded Emission Factor = 4.00 pounds pm10/vmt

	PM10 Uncontrolled	PM10 Controlled	PM2.5 Uncontrolled	PM2.5 Controlled
Unpaved Fugitive Emissions (pounds/day)	111	22.2	16.6	3.33
Unpaved Fugitive Emissions (tons/year)	9.98	2.00	1.50	0.30

Fugitive PM Eissions from Material Handling

E = [0.00112*({[G/5]^1.3}/{[H/2]^1.4})]*[I/J]

G = Mean wind speed in miles per hour, 13 mph
H = Moisture Content of soil, 2.0 (dry)
I = lbs of material handled
J = 2,000 (conversion factor, lbs to tons)

	PM10 Uncontrolled	PM10 Controlled	PM2.5 Uncontrolled	PM2.5 Controlled
Material Handling Fugitive Emissions (pounds/day)	11.6	2.33	1.75	0.35
Material Handling Fugitive Emissions (tons/year)	1.05	0.21	0.16	0.03

Blasting

E = 0.000014 (A)^1.5 from AP-42 11.9

E= PM30 emissions
A = horizontal area

PM -10 emissions = 0.52 x E

Two areas of adjacent benches with shots 15' apart
Approx area = 10,125 sf

E=	14.3	pounds of TSP/blast		
PM10 =	**7.42**	**pounds/blast**		
	51.9	pounds/year	7	blasts/year
PM2.5 =	**1.11**	**pounds/blast**		
	7.79	pounds/year		

Attachment B

Health Risk Assessment Methodology, Assumptions, and Results

A health risk assessment (HRA) is accomplished in four steps: 1) hazards identification, 2) exposure assessment, 3) toxicity assessment, and 4) risk characterization. These steps cover the estimation of air emissions, the estimation of the air concentrations resulting from a dispersion analysis, the incorporation of the toxicity of the pollutants emitted, and the characterization of the risk based on exposure parameters such as breathing rate, age adjustment factors, and exposure duration; each depending on receptor type (i.e., residence, school, daycare centers, hospitals, senior care facilities, recreational areas, adult, infant, child).

This HRA was conducted in accordance with technical guidelines developed by federal, state, and regional agencies, including U.S. Environmental Protection Agency (USEPA), California Environmental Protection Agency (CalEPA), and California Office of Environmental Health Hazard Assessment (OEHHA) *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*.[1] This HRA addresses the diesel particulate matter (DPM) emissions from generators and haul trucks.

According to CalEPA, a HRA should not be interpreted as the expected rates of cancer or other potential human health effects, but rather as estimates of potential risk or likelihood of adverse effects based on current knowledge, under a number of highly conservative assumptions and the best assessment tools currently available.

TERMS AND DEFINITIONS

As the practice of conducting a HRA is particularly complex and involves concepts that are not altogether familiar to most people, several terms and definitions are provided that are considered essential to the understanding of the approach, methodology and results:

Acute effect – a health effect (non-cancer) produced within a short period of time (few minutes to several days) following an exposure to toxic air contaminants (TAC).

Cancer risk – the probability of an individual contracting cancer from a lifetime (i.e., 70 year) exposure to TAC such as DPM in the ambient air.

Chronic effect – a health effect (non-cancer) produced from a continuous exposure occurring over an extended period of time (weeks, months, years).

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[1] Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, March 6, 2015, http://oehha.ca.gov/air/hot_spots/hotspots2015.html.

Hazard Index (HI) – the unitless ratio of an exposure level over the acceptable reference dose. The HI can be applied to multiple compounds in an additive manner.

Hazard Quotient (HQ) – the unitless ratio of an exposure level over the acceptable reference dose. The HQ is applied to individual compounds.

Toxic Air Contaminants – any air pollutant that is capable of causing short-term (acute) and/or long-term (chronic or carcinogenic, i.e., cancer causing) adverse human health effects (i.e., injury or illness). The current California list of TAC lists approximately 200 compounds, including particulate emissions from diesel-fueled engines.

Human Health Effects - comprise disorders such as eye watering, respiratory or heart ailments, and other (i.e., non-cancer) related diseases.

Health Risk Assessment – an analysis designed to predict the generation and dispersion of TAC in the outdoor environment, evaluate the potential for exposure of human populations, and to assess and quantify both the individual and population-wide health risks associated with those levels of exposure.

Incremental – under CEQA, the net difference (or change) in conditions or impacts when comparing the baseline to future year project conditions.

Maximum exposed individual (MEI) – an individual assumed to be located at the point where the highest concentrations of TAC, and therefore, health risks are predicted to occur.

Non-cancer risks – health risks such as eye watering, respiratory or heart ailments, and other non-cancer related diseases.

Receptors – the locations where potential health impacts or risks are predicted (i.e., schools, residences, and recreational sites).

LIMITATIONS AND UNCERTAINTIES

There are a number of important limitations and uncertainties commonly associated with a HRA due to the wide variability of human exposures to TAC, the extended timeframes over which the exposures are evaluated, and the inability to verify the results. Limitations and uncertainties associated with the HRA and identified by the CalEPA include: (a.) lack of reliable monitoring data; (b.) extrapolation of toxicity data in animals to humans; (c.) estimation errors in calculating TAC emissions; (d.) concentration prediction errors with dispersion models; and (e.) the variability in lifestyles, fitness and other confounding factors of the human population. This HRA was performed using the best available data and methodologies, notwithstanding the following uncertainties:

- There are uncertainties associated with the estimation of emissions from project activities. Where project-specific data, such as emission factors, are not available, default assumptions in emission models were used.
- The limitations of the air dispersion model provide a source of uncertainty in the estimation of exposure concentrations. According to USEPA, errors due to the limitation of the algorithms implemented in the air dispersion model in the highest estimated concentrations of +/- 10 percent to 40 percent are typical.[2]
- The source parameters used to model emission sources add uncertainty. For all emission sources, the source parameters used source-specific, recommended as defaults, or expected to produce more conservative results. Discrepancies might exist in actual emissions characteristics of an emission source and its representation in the dispersion model.
- The exposure duration estimates do not take into account that people do not usually reside at the same location for 30 years and that other exposures (i.e., school children) are also of much shorter durations than was assumed in this HRA. This exposure duration is a highly conservative assumption, since most people do not remain at home all day and on average residents change residences every 11 to 12 years. In addition, this assumption adopts that residents are experiencing outdoor concentrations for the entire exposure period.
- For the risk and hazards calculations as well as the cumulative health impact, numerous assumptions must be made in order to estimate human exposure to pollutants. These assumptions include parameters such as breathing rates, exposure time and frequency, exposure duration, and human activity patterns. While a mean value derived from scientifically defensible studies is the best estimate of central tendency, most of the exposure variables used in this HRA are high-end estimates. The combination of several high-end estimates used as exposure parameters may substantially overestimate pollutant intake. The excess lifetime cancer risks calculated in this HRA are therefore likely to be higher than may be required to be protective of public health.
- The Cal/EPA cancer potency factor for DPM was used to estimate cancer risks associated with exposure to DPM emissions from construction activities. However, the cancer potency factor derived by Cal/EPA for DPM is highly uncertain in both the estimation of response and dose. In the past, due to inadequate animal test data and epidemiology data on diesel exhaust, the International Agency for Research on Cancer (IARC), a branch of the World Health Organization, had classified DPM as Probably Carcinogenic

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[2] United States Environmental Protection Agency, *Guideline on Air Quality Models (Revised), 40 Code of Federal Regulations, Part 51, Appendix W*, November 2005, https://www3.epa.gov/scram001/guidance/guide/appw_05.pdf

to Humans (Group 2); the USEPA had also concluded that the existing data did not provide an adequate basis for quantitative risk assessment.[3] However, based on two recent scientific studies,[4] IARC recently re-classified DPM as Carcinogenic to Humans to Group 1,[5] which means that the agency has determined that there is "sufficient evidence of carcinogenicity" of a substance in humans and represents the strongest weight-of-evidence rating in IARC's carcinogen classification scheme. This determination by the IARC may provide additional impetus for the USEPA to identify a quantitative dose-response relationship between exposure to DPM and cancer.

In summary, the estimated health impacts are based primarily on a series of conservative assumptions related to predicted environmental concentrations, exposure, and chemical toxicity. The use of conservative assumptions tends to produce upper-bound estimates of risk. USEPA acknowledges this uncertainty by stating: "the methods used [to estimate risk] are conservative, meaning that the real risks from the source may be lower than the calculations, but it is unlikely that they will be higher." The USEPA notes that the conservative assumptions used in a HRA are intended to assure that the estimated risks do not underestimate the actual risks posed by a site and that the estimated risks do not necessarily represent actual risks experienced by populations at or near a site.[6]

HAZARDS IDENTIFICATION

California Air Resources Board (CARB) has developed a list of TAC, where a TAC is "an air pollutant which may cause or contribute to an increase in mortality or in serious illness, or which may pose a present or potential hazard to human health (California Health and Safety Code Section 39655). All USEPA hazardous air pollutants are TAC. CARB administers the Air Toxics "Hot Spots" program under Assembly Bill 2588 "Hot Spots" Information and Assessment Act, which requires periodic local review of facilities which emit TAC. Local air agencies periodically must prioritize stationary sources of TAC and prepare health risk assessments for high-priority sources.

Diesel exhaust is a complex mixture of numerous individual gaseous and particulate compounds emitted from diesel-fueled combustion engines. Diesel particulate matter is formed

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[3] United States Environmental Protection Agency, *Health Assessment Document for Diesel Engine Exhaust*, May 2002, https://cfpub.epa.gov/si/si_public_record_report.cfm?dirEntryId=29060

[4] Attfield MD, Schleiff PL, Lubin JH, Blair A, Stewart PA, Vermeulen R, Coble JB, Silverman DT, *The Diesel Exhaust in Miners Study: A Nested Case-Control Study of Lung Cancer and Diesel Exhaust*, June 2012, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3369553/

[5] International Agency for Research on Cancer, *Diesel Engine Exhaust Carcinogenic*, June 2012, https://www.iarc.fr/en/media-centre/pr/2012/pdfs/pr213_E.pdf

[6] United States Environmental Protection Agency, *Risk Assessment Guidance for Superfund Human Health Risk Assessment*, December 1989, https://www.epa.gov/sites/production/files/2015-09/documents/rags_a.pdf

primarily through the incomplete combustion of diesel fuel. DPM is removed from the atmosphere through physical processes including atmospheric fall-out and washout by rain. Humans can be exposed to airborne DPM by deposition on water, soil, and vegetation; although the main pathway of exposure is inhalation. Cal/EPA has concluded that potential cancer risk from inhalation exposure to whole diesel exhaust outweigh the multi-pathway cancer risk from the speciated components.

In August 1998, the CARB identified DPM as an air toxic. CARB developed the *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel- Fueled Engines and Vehicles* and *Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines* and approved these documents on September 28, 2000.[7,8] The documents represent proposals to reduce DPM emissions, with the goal of reducing emissions and the associated health risk by 75 percent in 2010 and by 85 percent in 2020. The program aimed to require the use of state-of-the-art catalyzed DPM filters and ultra-low-sulfur diesel fuel.

In 2001, CARB assessed the state-wide health risks from exposure to diesel exhaust and to other toxic air contaminants. It is difficult to distinguish the health risks of diesel emissions from those of other air toxics, since diesel exhaust contains approximately 40 different TAC. The CARB study detected diesel exhaust by using ambient air carbon soot measurements as a surrogate for diesel emissions. The study reported that the state-wide cancer risk from exposure to diesel exhaust was about 540 per million population as compared to a total risk for exposure to all ambient air toxics of 760 per million. This estimate, which accounts for about 70 percent of the total risk from TAC, included both urban and rural areas in the state. The estimate can also be considered an average worst-case for the state, since it assumes constant exposure to outdoor concentrations of diesel exhaust and does not account for expected lower concentrations indoors, where most of time is spent. Based on 2012 estimates of California statewide exposure, DPM is estimated to increase statewide cancer risk by 520 cancers per million residents exposed over a lifetime.[9]

Exposure to DPM results in a greater incidence of chronic non-cancer health effects, such as cough, labored breathing, chest tightness, wheezing, and bronchitis. Individuals particularly vulnerable to DPM are children, whose lung tissue is still developing, the elderly and people with illnesses who may have other serious health problems that can be aggravated by exposure to DPM. In general, children are more vulnerable than adults to air pollutants because they

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[7] California Air Resources Board, *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles*, October 2000, http://www.arb.ca.gov/diesel/documents/rrpfinal.pdf

[8] California Air Resources Board, *Risk Management Guidance for the Permitting of New Stationary Diesel-Fueled Engines*, October 2000, https://www.arb.ca.gov/diesel/documents/rmgFinal.pdf

[9] California Air Resources Board, *Summary: Diesel Particulate Matter Health Impacts*, April 12, 2016, https://www.arb.ca.gov/research/diesel/diesel-health_summ.htm

have higher inhalation rates, narrower airways, and less mature immune systems. In addition, children with allergies may have an enhanced allergic response when exposed to diesel exhaust).

EXPOSURE ASSESSMENT

Dispersion is the process by which atmospheric pollutants disseminate due to wind and vertical stability. The results of a dispersion analysis are used to assess pollutant concentrations at or near an emission source. The results of an analysis allow predicted concentrations of pollutants to be compared directly to air quality standards and other criteria such as health risks based on modeled concentrations.

A rising pollutant plume reacts with the environment in several ways before it levels off. First, the plume's own turbulence interacts with atmospheric turbulence to entrain ambient air. This mixing process reduces and eventually eliminates the density and momentum differences that cause the plume to rise. Second, the wind transports the plume during its rise and entrainment process. Higher winds mix the plume more rapidly, resulting in a lower final rise. Third, the plume interacts with the vertical temperature stratification of the atmosphere, rising as a result of buoyancy in the unstable-to-neutrally stratified mixed layer. However, after the plume encounters the mixing lid and the stably stratified air above, its vertical motion is dampened.

Molecules of gas or small particles injected into the atmosphere will separate from each other as they are acted on by turbulent eddies. The Gaussian mathematical model such as AERMOD simulates the dispersion of the gas or particles within the atmosphere. The formulation of the Gaussian model is based on the following assumptions:

- The predictions are not time-dependent (all conditions remain unchanged with time)
- The wind speed and direction are uniform, both horizontally and vertically, throughout the region of concern
- The rate of diffusion is not a function of position
- Diffusion in the direction of the transporting wind is negligible when compared to the transport flow

Dispersion Modeling Approach

Air dispersion modeling was performed to estimate the downwind dispersion of DPM exhaust emissions resulting from construction activities. The following sections present the fundamental components of an air dispersion modeling analysis including air dispersion model selection and options, receptor locations, meteorological data, and source exhaust parameters.

Model Selection and Options

AERMOD (Version 19191)[10] was used for the dispersion analysis. AERMOD is the USEPA preferred atmospheric dispersion modeling system for general industrial sources. The model can simulate point, area, volume, and line sources. AERMOD is the appropriate model for this analysis based on the coverage of simple, intermediate, and complex terrain. It also predicts both short-term and long-term (annual) average concentrations. The model was executed using the regulatory default options (stack-tip downwash, buoyancy-induced dispersion, and final plume rise), default wind speed profile categories, default potential temperature gradients, and assuming no pollutant decay.

The selection of the appropriate dispersion coefficients depends on the land use within three kilometers (km) of the project site. The types of land use were based on the classification method defined by Auer (1978); using pertinent United States Geological Survey (USGS) 1:24,000 scale (7.5 minute) topographic maps of the area. If the Auer land use types of heavy industrial, light-to-moderate industrial, commercial, and compact residential account for 50 percent or more of the total area, the USEPA *Guideline on Air Quality Models* recommends using urban dispersion coefficients; otherwise, the appropriate rural coefficients can be used. Based on observation of the area surrounding the project site, rural (urban is only designated within dense city centers such as downtown San Francisco) dispersion coefficients were applied within AERMOD.

Receptor Locations

Some receptors are considered more sensitive to air pollutants than others, because of preexisting health problems, proximity to the emissions source, or duration of exposure to air pollutants. Land uses such as primary and secondary schools, hospitals, and convalescent homes are considered to be relatively sensitive to poor air quality because the very young, the old, and the infirm are more susceptible to respiratory infections and other air quality-related health problems than the general public. Residential areas are also considered sensitive to poor air quality because people in residential areas are often at home for extended periods. Recreational land uses are moderately sensitive to air pollution because vigorous exercise associated with recreation places having a high demand on respiratory system function.

Sensitive receptors were placed at existing residences to estimate health impacts due to proposed project construction on existing receptors. The Project Site is surrounded by open grazing lands. Immediate adjacent to and south of the site, a smaller aggregate mine is located on Bureau of Land management (BLM)-administered land. Other BLM land is located to the east and south and the Wells Ranch is located directly to the north. The character of the area surrounding

[10] United States Environmental Protection Agency, AERMOD Modeling System, https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

the Project site is rural residential with homes on large, agricultural-sized parcels. Eight homes are located on parcels from 10 to 80 acres in size to the west and south along Ward Lake Road. The nearest residence is approximately 875 feet from the western property line of the Project Site. Shaffer Elementary School is located 2.4 miles to the southeast of the Project Site. There are approximately 24 residences abutting Highway 395 and Center Road. Traveling farther west along Center Road, toward the California State Correctional Center, there are approximately six additional residences. **Figure 1** displays the location of the sensitive receptors used in this HRA. Receptors were placed at a height of 1.8 meters (typical breathing height). Terrain elevations for receptor locations were used based on available USGS information for the area.

Meteorological Data

Hourly meteorological data from Alturas Municipal Airport, located approximately 100 miles to the north the proposed project, were used in the dispersion modeling analysis.[11] Meteorological data from 2009 through 2013 were used.[12] **Figure 2** displays the annual wind rose. Wind directions are predominately from the west or south with a high frequency of calm wind speed conditions (over 40 percent), as shown in **Figure 3**. The average annual wind speed is 5.44 miles per hour.

Source Release Characteristics

Offroad equipment was treated as area sources located within the boundary of the mining operations. These sources were assigned a release height of 3.05 meters and an initial vertical dimension of 4.15 meters, which reflects the height of the equipment plus an additional height of the exhaust plume above the exhaust point to account for plume rise due to buoyancy and momentum. Haul trucks were treated as a line source (i.e., volume sources placed at regular intervals) located along an access road. The haul trucks were assigned a release height of 3.05 meters and an initial vertical dimension of 4.15 meters, which accounts for dispersion from the movement of vehicles.[13]

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[11] Redding is located approximately 110 miles to the west of the Project Site. However, the meteorological conditions at Redding would not be representative of the Project Site given the elevation and proximity to mountainous terrain. The Project Site is at 4,365 feet in elevation, Alturas is at 4,375 feet, while Redding is at 500 feet. Redding's wind rose exhibit a south-north wind direction familiar to wide valley flow. Therefore, the Alturas is the most representative meteorological data readily available.

[12] California Air Resources Board, Air Quality Planning and Science Division, Meteorological Files, October 5, 2015, https://www.arb.ca.gov/toxics/harp/metfiles2.htm

[13] While haul truck emissions contribute substantially to overall project emissions, they are spread over many miles. Hence, the portion of trucking emissions that would impact one receptor is much smaller than the emissions that the generator activity at the project site would impact a receptor near the site.

FIGURE 1
HEALTH RISK ASSESSMENT RECEPTORS

FIGURE 2
ANNUAL WINDROSE

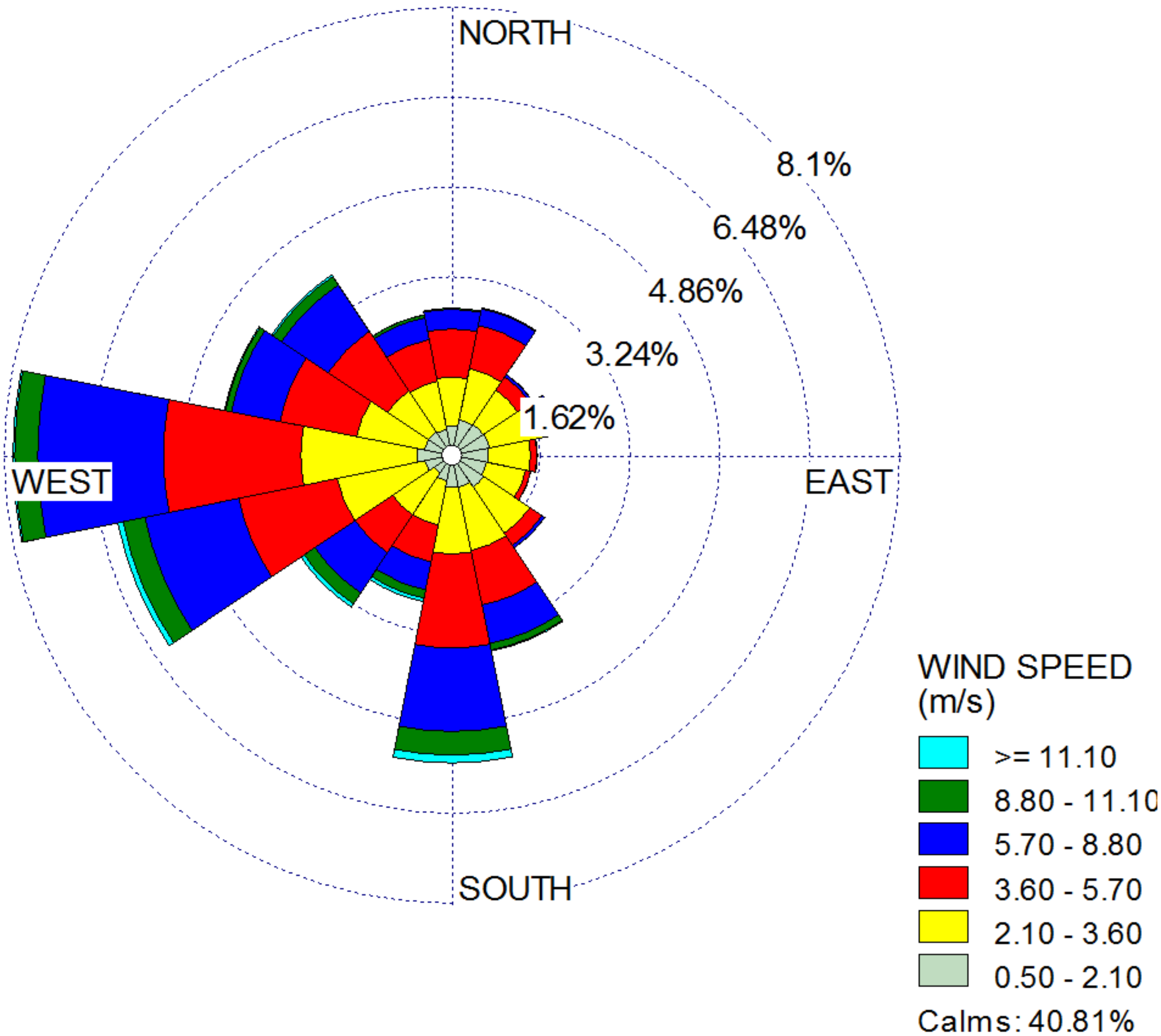
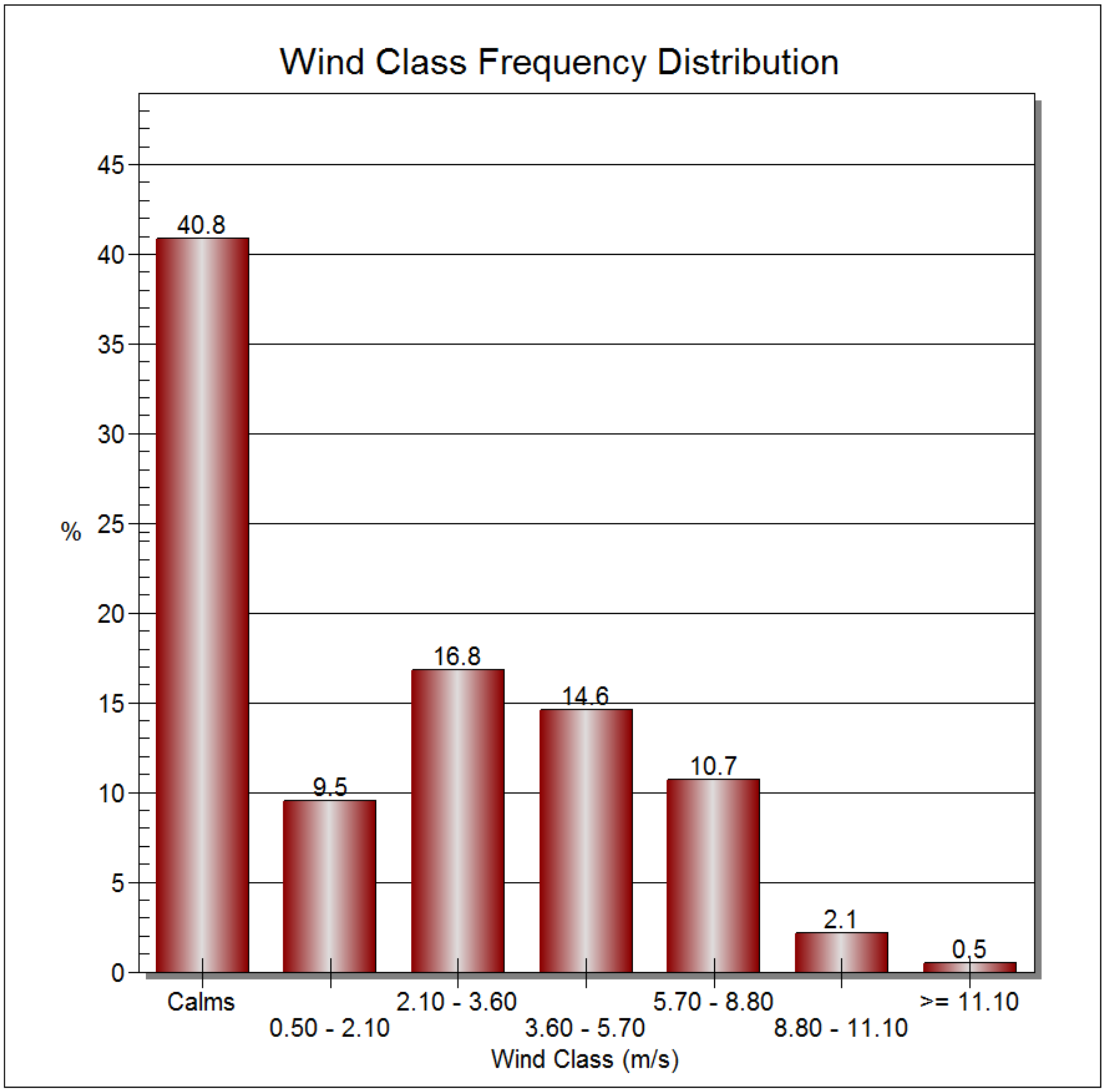


FIGURE 3
ANNUAL WIND SPEED DISTRIBUTION



The Ward Lake Pit maintains a permit to operate (PTO-19-140: expiration date March 31, 2024) for onsite equipment such as a hot mix asphalt plant, a lime slurry mix plant, a concrete plant, a crushing plant, a wash plant, a sand plant, and several diesel generators (one 750 horsepower [hp] generator associated with the crushing plant[14], one 475 hp generator associated with the portable plant[15], and one 469 hp generator associated with the wash plant.[16]. The release height of the generators was assumed to be 3.05 meters (10 feet), while the exhaust temperature, exit diameter, exhaust flow rate were based on manufacturer specifications.[17]

Terrain elevations for emission source locations were used based on available USGS information for the area. AERMAP (Version 18081)[18] was used to develop the terrain elevations.

EXPOSURE PARAMETERS

This HRA was conducted following methodologies in OEHHA's *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*.[19] This was accomplished by applying the estimated concentrations at the receptors analyzed to the established cancer risk estimates and acceptable reference concentrations for non-cancer health effects.

OEHHA's revisions to its *Guidance Manual* were primarily designed to ensure that the greater sensitivity of children to cancer and other health risks is reflected in HRAs. For example, OEHHA now recommends that risks be analyzed separately for multiple age groups, focusing especially on young children and teenagers, rather than the past practice of analyzing risks to the general population, without distinction by age. OEHHA also now recommends that statistical "age sensitivity factors" be incorporated into a HRA, and that children's relatively high breathing rates be accounted for. On the other hand, the *Guidance Manual* revisions also include some changes that would reduce calculated health risks. For example, under the former guidance, OEHHA recommended that residential cancer risks be assessed by assuming 70 years of exposure at a residential receptor; under the *Guidance Manual*, this assumption is lessened to 30 years.

OEHHA has developed exposure factors (e.g., daily breathing rates) for six age groups including the last trimester to birth, birth to 2 years, 2 to 9 years, 2 to 16 years, 16 to 30 years,

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[14] To be removed or replaced by January 2023 with Air District approved engine.

[15] To be removed or replaced by January 2024 with Air District approved engine.

[16] To be removed or replaced by January 2025 with Air District approved engine.

[17] Caterpillar 3412 Generator Specification Sheets, https://www.cat.com/en_US/articles/configurations/ep-genset-ratings/3516b1.html and Caterpillar 3406 Generator Specification Sheets, https://www.cat.com/en_IN/articles/configurations/ep-genset-ratings/3406c.html

[18] US Environmental Protection Agency, AERMAP, https://www.epa.gov/scram/air-quality-dispersion-modeling-preferred-and-recommended-models

[19] Office of Environmental Health Hazard Assessment, *Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments*, March 6, 2015, http://oehha.ca.gov/air/hot_spots/hotspots2015.html

and 16 to 70 years. These age bins allow for more refined exposure information to be used when estimating exposure and the potential for developing cancer over a lifetime. This means that exposure variates are needed for the third trimester, ages zero to less than two, ages two to less than nine, ages two to less than 16, ages 16 to less than 30, and ages 16 to 70. Residential receptors utilize the 95th percentile breathing rate values. The breathing rates are age-specific and are 1,090 liters per kilogram-day for ages less than 2 years, 745 liters per kilogram-day for ages 2 to 16 years, 335 liters per kilogram-day for ages 16 to 30 years, and 290 liters per kilogram-day for ages 30 to 70 years. A school child breathing rate is 520 liters per kilogram-day and an off-site worker breathing rate is 230 liters per kilogram-day.

OEHHA developed age sensitivity factors (ASF) to take into account the increased sensitivity to carcinogens during early-in-life exposures. OEHHA recommends that cancer risks be weighted by a factor of 10 for exposures that occur from the third trimester of pregnancy to 2 years of age, and by a factor of 3 for exposures from 2 years through 15 years of age.

Based on OEHHA recommendations, the cancer risk to residential receptors assumes exposure occurs 24 hours per day for 350 days per year while accounting for a percentage of time at home. OEHHA evaluated information from activity pattern databases to estimate the fraction of time at home (FAH) during the day. This information was used to adjust exposure duration and cancer risk based on the assumption that a person is not present at home continuously for 24 hours and therefore exposure to emissions is not occurring when a person is away from their home. In general, the FAH factors are age-specific and are 0.85 for ages less than 2 years, 0.72 for ages 2 to 16 years, and 0.73 for ages 30 to 70 years.

OEHHA has decreased the exposure duration currently being used for estimating cancer risk at the maximum exposed individual resident from 70 years to 30 years. This is based on studies showing that 30 years is a reasonable estimate of the 90th to 95th percentile of residency duration in the population. Additionally, OEHHA recommends using the 9 and 70-year exposure duration to represent the potential impacts over the range of residency periods.

Given the exposure durations of less than 24 hours, sensitive recreational receptors were evaluated for acute impacts only. Based on OEHHA recommendations, for children at school sites, exposure is assumed to occur 10 hours per day for 180 days (or 36 weeks) per year. Cancer risk estimates for children at school sites are calculated based on 9 year exposure duration. School sites also include teachers and other adult staff which are treated as off-site workers.

RISK CHARACTERIZATION

Cancer risk is defined as the lifetime probability of developing cancer from exposure to carcinogenic substances. Cancer risks are expressed as the chance in one million of getting cancer (i.e., number of cancer cases among one million people exposed). The cancer risks are assumed to occur exclusively through the inhalation pathway. The cancer risk can be estimated by using the cancer potency factor (milligrams per kilogram of body weight per day [mg/kg-day]), the 30-year annual average concentration (microgram per cubic meter [$\mu g/m^3$]), and the lifetime exposure adjustment.

Following guidelines established by OEHHA, the incremental cancer risks attributable to the proposed project were calculated by applying exposure parameters to modeled DPM concentrations in order to determine the inhalation dose (mg/kg-day) or the amount of pollutants inhaled per body weight mass per day. The cancer risks occur exclusively through the inhalation pathway; therefore, the cancer risks can be estimated from the following equation:

$$\text{Dose-inh} = \frac{C_{air} * \{DBR\} * A * ASF * FAH * EF * ED * 10^{-6}}{AT}$$

where:

Dose-inh	= Dose of the toxic substance through inhalation in mg/kg-day
10^{-6}	= Micrograms to milligrams conversion, Liters to cubic meters conversion
C_{air}	= Concentration in air in microgram (μg)/cubic meter (m^3)
{DBR}	= Daily breathing rate in liter (L)/kg body weight – day
A	= Inhalation absorption factor, 1.0
ASF	= Age Sensitivity Factor
EF	= Exposure frequency (days/year)
ED	= Exposure duration (years)
FAH	= Fraction of Time at Home
AT	= Averaging time period over which exposure is averaged in days (25,550 days for a 70 year cancer risk)

To determine incremental cancer risk, the estimated inhalation dose attributed to the proposed project was multiplied by the cancer potency slope factor (cancer risk per mg/kg-day). The cancer potency slope factor is the upper bound on the increased cancer risk from a lifetime exposure to a pollutant. These slope factors are based on epidemiological studies and are different values for different pollutants. This allows the estimated inhalation dose to be equated to a cancer risk.

Non-cancer adverse health impacts, acute (short-term) and chronic (long-term), are measured against a hazard index (HI), which is defined as the ratio of the predicted incremental exposure concentration from the proposed project to a published reference exposure level (REL) that could cause adverse health effects as established by OEHHA. The ratio (referred to as the

Hazard Quotient [HQ]) of each non-carcinogenic substance that affects a certain organ system is added to produce an overall HI for that organ system. The overall HI is calculated for each organ system. If the overall HI for the highest-impacted organ system is greater than one, then the impact is considered to be significant.

The HI is an expression used for the potential for non-cancer health effects. The relationship for the non-cancer health effects is given by the annual concentration (in $\mu g/m^3$) and the REL (in $\mu g/m^3$). The acute hazard index was determined using the "simple" concurrent maximum approach, which tends to be conservative (i.e., overpredicts).

The relationship for the non-cancer health effects is given by the following equation:

$$HI = C/REL$$

Where:

HI = Hazard index; an expression of the potential for non-cancer health effects.

C = Annual average concentration ($\mu g/m^3$) during the 70 year exposure period.

REL = Concentration at which no adverse health effects are anticipated.

The chronic REL for DPM was established by the California OEHHA as 5 $\mu g/m^3$.[20]

[20] Office of Environmental Health Hazards Assessment - Acute, 8-hour, and Chronic Reference Exposure Levels, November 4, 2019, http://www.oehha.ca.gov/air/allrels.html

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM
350	days per year
25,550	days per lifetime
1090	95th Percentile Daily Breathing Rates (0<2 Years
861	95th Percentile Daily Breathing Rates (2<9 Years
745	95th Percentile Daily Breathing Rates (2<16 Years
335	95th Percentile Daily Breathing Rates (16<30 Years
290	95th Percentile Daily Breathing Rates (30<70 Years
0.85	fraction of 0<2 Years
0.72	fraction of 2<16 Years
0.73	fraction of 16<70 Years

Project: Ward Lake Pit Expansion
Date: January 25, 2021
Condition: Proposed Project
Receptor: Existing Residence

Exposure Year	Calender Year	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	2.77E-03	1,090	10.0	0.85	0.39
2	2022	2.77E-03	1,090	10.0	0.85	0.39
3	2023	2.77E-03	745	4.75	0.72	0.11
4	2024	2.77E-03	745	3.00	0.72	0.07
5	2025	2.77E-03	745	3.00	0.72	0.07
6	2026	2.77E-03	745	3.00	0.72	0.07
7	2027	2.77E-03	745	3.00	0.72	0.07
8	2028	2.77E-03	745	3.00	0.72	0.07
9	2029	2.77E-03	745	3.00	0.72	0.07
10	2030	2.77E-03	745	3.00	0.72	0.07

0.00	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
1.35	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.17	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?

Health Risk Assessment Assumptions

5	Chronic Reference Exposure Level (ug/m3) for DPM
1.1	Cancer Potency Slope Factor (cancer risk per mg/kg-day) for DPM
350	days per year
25,550	days per lifetime
1090	95th Percentile Daily Breathing Rates (0<2 Years
861	95th Percentile Daily Breathing Rates (2<9 Years
745	95th Percentile Daily Breathing Rates (2<16 Years
335	95th Percentile Daily Breathing Rates (16<30 Years
290	95th Percentile Daily Breathing Rates (30<70 Years
0.85	fraction of 0<2 Years
0.72	fraction of 2<16 Years
0.73	fraction of 16<70 Years

Project:	Ward Lake Pit Expansion
Date:	January 25, 2021
Condition:	Proposed Project
Receptor:	Existing Residence

Exposure Year	Calender Year	Annual PM2.5 Concentration (ug/m3)	Daily Breathing Rates (L/kg-day)	Exposure Factor	fraction of time at home	Cancer Risk
1	2021	2.61E-03	1,090	10.0	0.85	0.36
2	2022	2.61E-03	1,090	10.0	0.85	0.36
3	2023	2.61E-03	745	4.75	0.72	0.10
4	2024	2.61E-03	745	3.00	0.72	0.06
5	2025	2.61E-03	745	3.00	0.72	0.06
6	2026	2.61E-03	745	3.00	0.72	0.06
7	2027	2.61E-03	745	3.00	0.72	0.06
8	2028	2.61E-03	745	3.00	0.72	0.06
9	2029	2.61E-03	745	3.00	0.72	0.06
10	2030	2.61E-03	745	3.00	0.72	0.06
11	2031	2.61E-03	745	3.00	0.72	0.06
12	2032	2.61E-03	745	3.00	0.72	0.06
13	2033	2.61E-03	745	3.00	0.72	0.06
14	2034	2.61E-03	745	3.00	0.72	0.06
15	2035	2.61E-03	745	3.00	0.72	0.06
16	2036	2.61E-03	745	3.00	0.72	0.06
17	2037	2.61E-03	335	1.70	0.73	0.02
18	2038	2.61E-03	335	1.00	0.73	0.01
19	2039	2.61E-03	335	1.00	0.73	0.01
20	2040	2.61E-03	335	1.00	0.73	0.01
21	2041	2.61E-03	335	1.00	0.73	0.01
22	2042	2.61E-03	335	1.00	0.73	0.01
23	2043	2.61E-03	335	1.00	0.73	0.01
24	2044	2.61E-03	335	1.00	0.73	0.01
25	2045	2.61E-03	335	1.00	0.73	0.01
26	2046	2.61E-03	335	1.00	0.73	0.01
27	2047	2.61E-03	335	1.00	0.73	0.01
28	2048	2.61E-03	335	1.00	0.73	0.01
29	2049	2.61E-03	335	1.00	0.73	0.01
30	2050	2.61E-03	335	1.00	0.73	0.01

0.00	Chronic Hazard Impact
1	Significance Threshold
No	Significant?
1.79	Cancer Risk (Child)
10	Significance Threshold
No	Significant?
0.49	Cancer Risk (Adult)
10	Significance Threshold
No	Significant?