# MINING AND RECLAMATION PLAN AMENDMENT

**For**

**CRYSTAL CREEK AGGREGATES**

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**PROPERTY OWNER:**

TULLIS, INC.
P.O. BOX 493416
REDDING, CA 96049
(530) 241-5105

**OPERATOR:**

TULLIS, INC. DBA CRYSTAL CREEK AGGREGATES
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DATE: March 26, 2007
REVISED: August 27, 2019; December 26, 2022

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**PROJECT SUMMARY**

A. Project Name: Mining and Reclamation Plan Amendment For Crystal Creek Aggregates.

B. California Mine Identification Numbers: 91-45-0021 (Crystal Creek Aggregates)

C. Federal Bureau of Land Management (BLM) and U.S. Forest Service (USFS) Mine Identification Number: N/A

D. Current Use Permit and Reclamation Plan Numbers: UP-07-020 and RP 07-002

E. Mine Operator:
Tullis, Inc. dba Crystal Creek Aggregates
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Phone: (530) 241-5105
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F. Mine Operator's Representative:
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G. Owners of Property:
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H. Owner of Mineral Rights:
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I. Location:
Assessor's Parcel Number (s): 065-250-031 and 065-250-032.
Section, Township, and Range: Sections 29 and 30 of T32N, R5W, M.D.B.M. Latitude 040.682 N. Longitude -122.4644. Note: Latitude and Longitude Location is at the entry gate to the mine.

Directions to site: The mine is located approximately 2 miles west of the City of Redding. The site can be reached via State Route 299 West to Iron Mountain Road, then following Iron Mountain Road approximately 1 mile north to the property entrance on the west side of the road.

J. Total parcel size(s): 189.97 acres.

K. Acreage in current Reclamation Plan: 110.69 acres

L. Acreage being added to Reclamation Plan: 0 acres.

M. Total acreage in amended Reclamation Plan: 110.69 acres. [1]

N. Maximum anticipated depth of mining: The lowest point in the finished quarry will be 640 feet mean sea level (MSL) at the bottom of the proposed pond.

O. Quantity and type of materials mined: Total quantity is 12,680,000 cubic yards. Maximum yearly extraction is expected to be 250,000 cubic yards of Portland Concrete Cement (PCC) grade aggregate.

P. Proposed start-up date and termination date: The existing operation began in 1990. The ending date for this Reclamation Plan Amendment is estimated to be December 31, 2102. Mining activity would deplete the material in the Reclamation Plan Amendment Area by that year if the average yearly extraction were 161,000 cubic yards. The actual termination date of the mining operation is when the 12,680,000 cubic yards of material are extracted from the mine.

Q. The proposed land uses after reclamation will be “Industrial” and “Mineral Resource”.

[1] The Reclamation Plan Amendment addresses two areas within the CCA operation which comprise the Reclamation Plan Amendment or Project Area. One is often referenced as either/or the mine, Mining Area, quarry and quarry area, which is the specific area being, or to be mined. The other area is the Plant Area where the processing and stockpiling of the aggregate materials is located in addition to an office, truck scales, and other ancillary uses as discussed in this Reclamation Plan Amendment. The Reclamation Plan Amendment Area is also referred to as the Project Area or Project Site.

## SUMMARY OF MAJOR CHANGES TO EXISTING APPROVED RECLAMATION PLAN

The following is a list of the major changes to the existing Reclamation Plan.

1. The volume of aggregate to be extracted is increasing from 7,960,000 cubic yards to 12,680,000 cubic yards, an increase of 4,720,000 cubic yards.
2. Pond #6 in the quarry is increasing in surface area from 23.49 surface acres to 32.67 surface acres, an increase of 9.18 acres.
3. The depth of the mine is increased by 60 feet from a bottom elevation of 700 feet to 640 feet in Pond #6.
4. The typical quarry benches are increasing from 24 feet high and 30 feet wide to 40 feet high and 40 feet wide. However, around the pond perimeter, the maximum quarry bench size will be 44 feet high and 60 feet wide. The quarry face between benches goes from a slope of 1-¼:1 to 1:1.
5. The revegetation of the benches is revised to make the mine more resistant to wildland fires. The mine was in one of the main paths of the Carr Fire, which burned 229,651 acres in Shasta and Trinity Counties.
6. Increase in permitted blasting days from 12 to 24 per year.

## INTRODUCTION

The Crystal Creek Aggregates (CCA) mining operation is an existing aggregate quarry in Shasta County, California. In addition to mining, the Project includes a rock crushing/screening plant, and washing operation. This Reclamation Plan Amendment (hereafter referred to as "Plan") addresses the reclamation of the existing and proposed mined lands and processing areas. The Plan addresses the following topics and their sequence:

- Regulatory Framework
- Location and Land Uses
- Environmental Setting
- Project Description
- Mine Reclamation
- Additional Reclamation Policies
- Monitoring
- Miscellaneous Items
- Acceptance of Reclamation

Nine Reclamation Plan Map Sheets[2] are provided in the folder at the end of this report. The Map Sheets are as follows:

- Sheet 1, Existing & Proposed Plan Overview
- Sheet 2, Proposed Mining Plan
- Sheet 3, Existing Quarry Cross Sections
- Sheet 4, Proposed Quarry Cross Sections
- Sheet 5, Proposed Phasing Plan Overview
- Sheet 6, Proposed Phasing Cross Sections
- Sheet 7, Reclamation Plan
- Sheet 8, Reclamation Plan Details
- Sheet 9, Comprehensive Project Plan & Wetland Delineation

Throughout the Plan, the terms "Property" and "Site" refer to the real property within which the "Project" is located. The term "Project" refers to the lands within the Reclamation Plan Boundary. Appendix A – Definitions, contains definitions of terms used in this document. Appendix A also contains definitions of terms from the Surface Mining and Reclamation Act (SMARA).

[2] The word "Sheet" or "Sheets" can be used interchangeably with "Map" or "Maps."

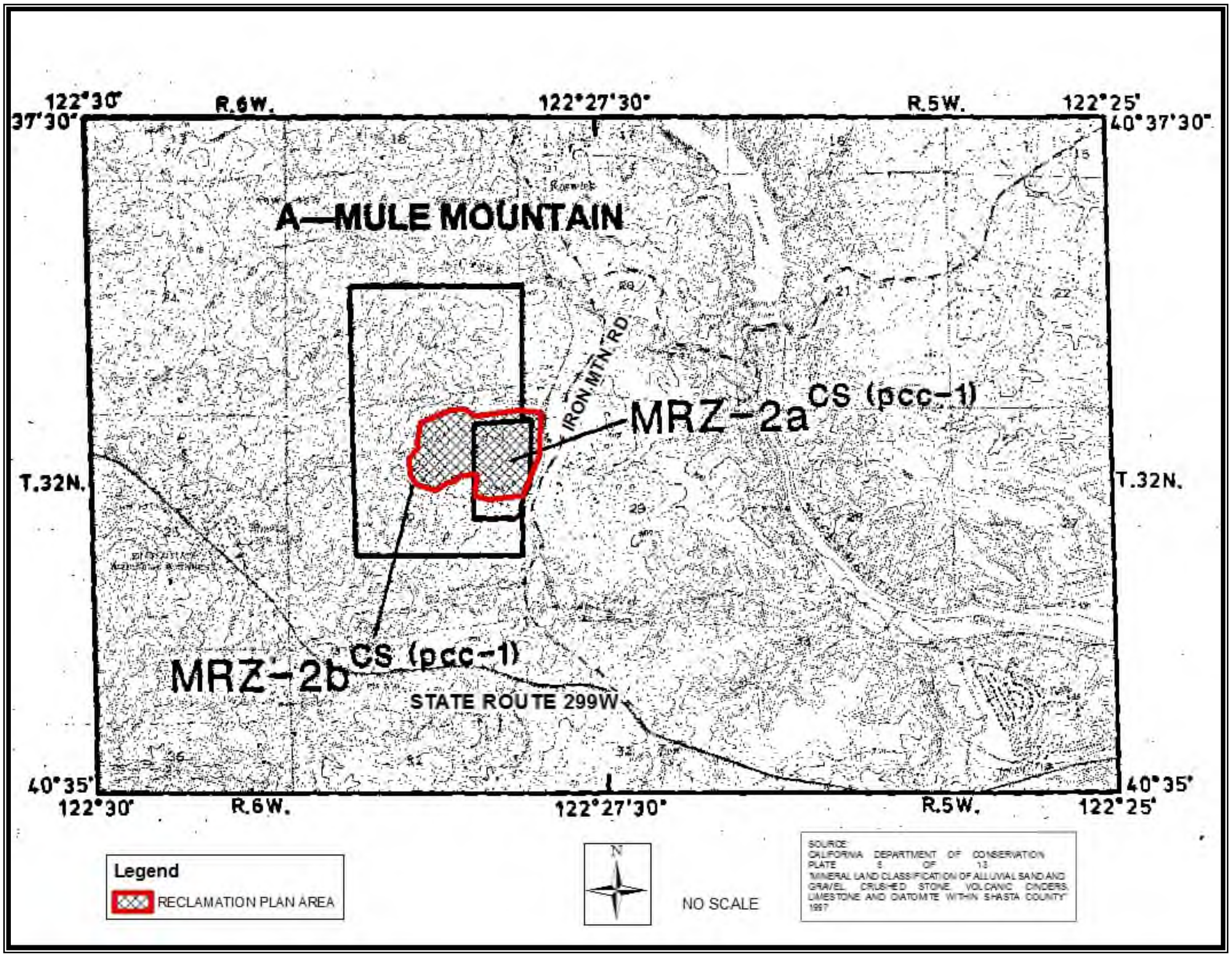
## REGULATORY FRAMEWORK

Shasta County is the “Lead Agency” that has the responsibility of approving the Plan. Shasta County has its own Surface Mining and Reclamation policy (Ordinance No. SCC95-6) in accordance with State Policy (§2772) establishing procedures for the review and approval of reclamation plans.

The Director of the Department of Conservation must have an opportunity to review the submitted Plan (§2774 (b) (2)). The Director has 30 days after finding the submitted Reclamation Plan as complete to prepare written comments if the Director so chooses.

The California Surface Mining and Reclamation Act (SMARA) of 1975 was utilized by the Aggregate Producers Association to have the State Geologist classify land in Shasta County into mineral resource zones (MRZ’s) according to the known or inferred mineral potential of that land. On June 6, 1997, the California Department of Conservation, Division of Mines and Geology released an open file report 97-03: “*Mineral Land Classification of Alluvial Sand and Gravel, Crushed Stone, Volcanic Cinders, Limestone, And Diatomite Within Shasta County, California*,” by Don Dupras, 1997. **Figure 1 – Mineral Resource Zones** is excerpted from the State report, which specifically identifies the CCA property. This report classified the initial CCA mining area as MRZ-2a$^{cs\ (pcc\text{-}1)}$ which indicates that the property has known reserves of Portland Concrete Cement (PCC) grade material. The “PCC” designation is only given to areas with proven reserves of the highest grade of construction aggregates. The 2008 amendment of the CCA mine extended the mine in the area labeled MRZ-2b$^{cs\ (pcc\text{-}1)}$. This designation is for locations where geologic information indicates there are inferred aggregate resources present. In this case, the existing CCA mines prove there is a proven quality of the adjacent material.

**Figure 1 – Mineral Resource Zones**



## LOCATION AND LAND USES

The first part of this section discusses the location of the property in relation to the general area. The second part describes the adjacent land uses and the final part identifies current uses on the site.

The mine is located in Sections 29 and 30, T32N. R.5W. M.D.M. in the unincorporated territory of Shasta County, Assessor Parcel Numbers 065-250-031 and 065-250-032. The quarry is approximately two miles west of Redding, California and south of the small-unincorporated community of Keswick. The property is approximately one mile north of State Route 299 West and approximately 550 feet west of the intersection of Iron Mountain Road and Laurie Anne Lane. Rock Creek is approximately 3,250 feet to the north, and Middle Creek is approximately 3,700 feet south of the property. **Figure 2, Vicinity Map**, shows the site's location in relation to other geographic and man-made features.

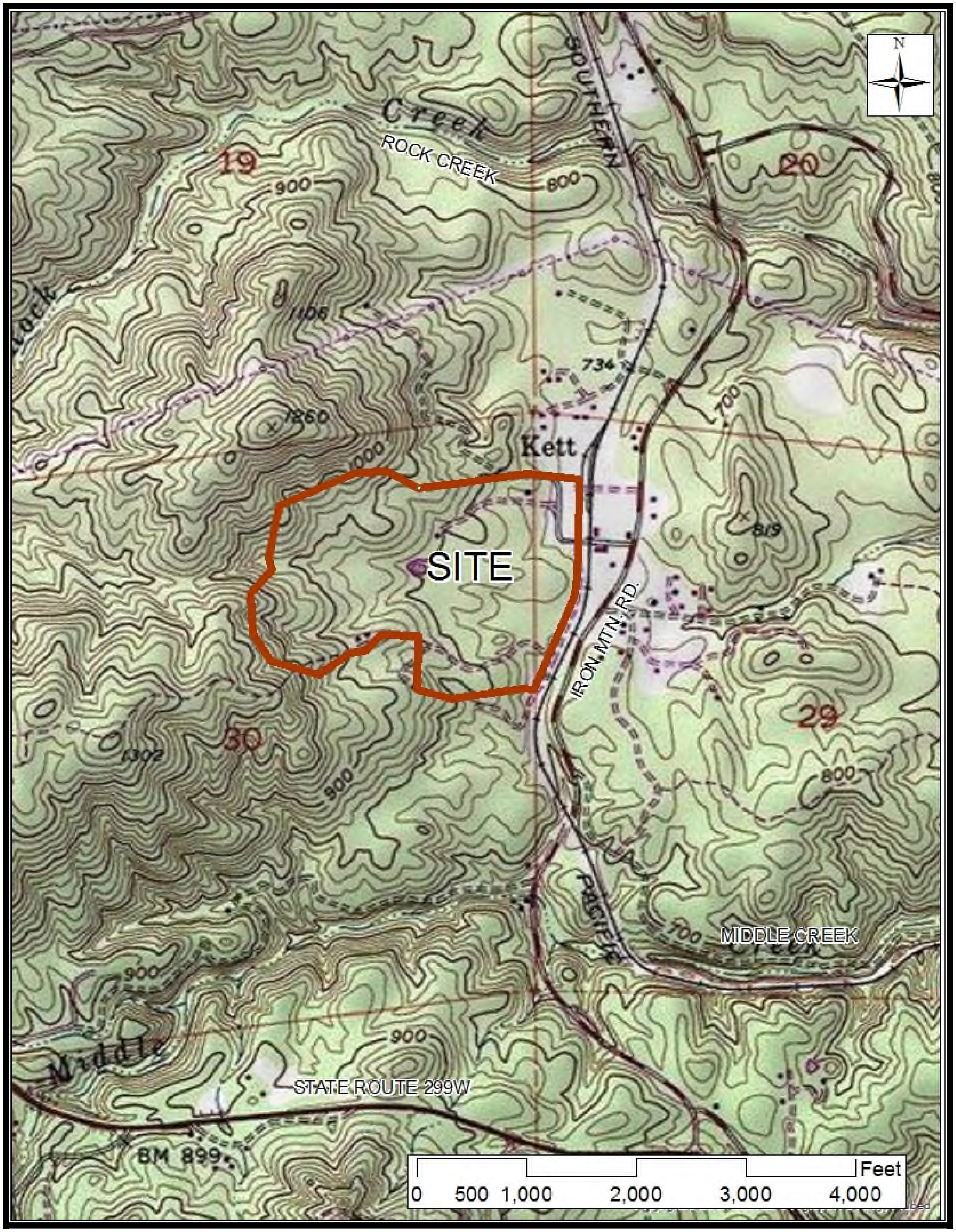
Adjacent land uses within one-half mile of the site include, but are not limited to, the following:

- Vacant BLM Land to the west.
- Vacant BLM Land and four vacant private parcels to the north. The two closest private parcels are zoned Industrial, and the two northern parcels are Rural Residential. The Carr Fire destroyed the residences on these properties.
- Industrial uses (Weyerhaeuser Lumber) to the east.
- Large lot residential parcels (2+ acres) are to the east and southeast of Weyerhaeuser Lumber. The Care Fire destroyed most of these residences.
- Jerry and Kerry Comingdeer own the adjacent land to the south (110.18 acres).

From 1990 until September 2021Crytal Creek Aggregate, Inc. owned and operated Crystal Creek Aggregate. The mining operation was purchased in September 2021 by Tullis, Inc. and is now operating the mine under Tullis, Inc. dba. Crystal Creek Aggregates. Existing land uses of the property include an aggregate processing facility along with numerous material stockpiles located on the eastern side of the mine. Ancillary activities to these uses include, but are not limited to, an office, scales, equipment storage area, recycle ponds, and settling ponds. In the southern portion of this area was an approximate 2.80-acre recycle site for the storing and processing of used concrete and rubble from the Carr Fire. This was a temporary use whereby the concrete and rubble were crushed into a road base product. The recycling activity will cease, and the area will be used for additional aggregate stockpiles. It is estimated that this area could provide for the storage of 50,000 CYs of aggregate material.

The mid-and western portion of the mine is mainly undeveloped except for the existing approximate 4.97-acre quarry being mined located in the mid-and northern portions of this area.

**Figure 2**
**VICINITY MAP**



## ENVIRONMENTAL SETTING

This section describes the topography, geology, earthquakes, soils, hydrology & climate, botany, wetlands, wildlife, and aesthetics.

### Topography

Elevations within the Reclamation Plan Area range from 1,060 feet on the western side of the mine to 715 feet at the stormwater sampling point below Pond #3 in the southeastern portion, an elevation change of 345 feet. The Project is located in the hills west of the Sacramento River between the town of Old Shasta and Iron Mountain Road. The property is comprised of two distinct topographic areas, the relatively level aggregate processing plant and stockpile areas in the eastern portion and hilly to steep slopes in the western area within which the mining area is located.

The Plant Area is located in the eastern area of the property of, approximately 53.38 acres is a relatively level bench created by previous industrial uses and current CCA mining activities. This area slopes generally to the southeast, at about two percent, to where three settling ponds are located. These ponds capture and treat stormwater before flowing into an unnamed intermittent drainage which is tributary to Middle Creek, approximately 3,700 feet to the south.

A portion of the southern drainage flows west to Ponds #4 and #5. Pond #5 does not have an above-ground discharge point. The distance between the ponds is approximately 110 feet. Subsurface water flows between the two ponds through cracked rock. Pond #4 discharges into a 36-inch culvert on the eastern side of the pond. Whereas Pond #5 provides supplemental water to the aggregate processing plant, the pump and pipeline at this pond convey water to the aggregate processing plant's recycle ponds. Water from the recycle ponds is pumped back into the adjacent wash plant to clean the aggregate. The water then flows back to the recycle ponds where the sediment settles, and the process is repeated. Pond #5 also provides makeup water for the water loss during the washing of material at the wash plant.

All structures, including the office, processing equipment, and petroleum storage facilities,s are located in the northern half of the Plant Area. The primary vehicular access road is located at the northeastern corner of the property. This road ranges in width between 22 and 44 feet, which is paved with a lockable gate at the property line. A second access road along the eastern property line is located about 1,400 feet south of the primary entrance. This road is also paved and has a lockable gate. Both roads connect to Iron Mountain Road, a County public road.

The remainder of the Reclamation Plan Amendment Area is the mining area of 57.31 acres, configured as a bowl surrounded by hills and ridges on its western, southern, and northern sides. The bowl has several hillocks and drainages traversing through it. The terrain is moderate to steep, whereas lesser steep areas have eight percent slopes that steepen to hillsides with slopes of up to 50 percent. Drainage flows from the hillsides to the lower central area of the mine site, which then conveys all runoff to Pond #4. Refer to the eight Reclamation Plan Amendment 22-0001 Sheets 1 – 8 and Sheet 9 for an overview and details of existing and proposed property conditions.[3]

[3] Reclamation Plan Amendment 22-0001 Sheets contain eight sheets or maps which are: 1 –Existing & Proposed Plan Overview, 2 – Proposed Mining Plan, 3 – Existing Quarry Cross Sections, 4 – Proposed Quarry Cross Sections, 5 – Proposed Phasing Plan Overview, 6 – Proposed Phasing Cross Sections, 7 – Reclamation Plan, 8 – Reclamation Plan Details, 9 – . Comprehensive Project Plan & Wetland Delineation

## Geology

Bajada Geosciences, Inc. prepared the geology section of this Reclamation Plan Amendment. This section discusses the site's geology from the regional context to a site-specific one. The following text is derived from their report. [4]

### General [5]

The project site is located in the eastern Klamath Mountains within the Klamath Mountains geomorphic Geologic Province of California. The quarry is situated near the northwestern margin of the Sacramento Valley, approximately four miles west of the City of Redding. This area is characterized by moderately to steeply inclined hills with moderately to steeply incised drainages.

### Regional Geology

The CCA Quarry is in the eastern Klamath Mountains in California. The Klamath Mountains form a geologic province that extends from northern California to southern Oregon. In California, the Klamath Mountains province extends from the Pacific Ocean to the Great Valley. The province consists of an arcuate-shaped belt of lithologic belts that are convex to the west (Snoke & Barnes, 2006).

These lithologic belts have been accreted due to tectonic processes between the North American and Pacific tectonic plates. A total of eight accretionary episodes have been identified within the Klamath Mountains (Irwin & Wooden, 1999), as shown in **Figure 3, Klamath Accreted Terrane**.[6] The oldest of these tectonic accretions is located on the east side of the Klamath Mountains and each accretionary terrane becomes more recent in age towards the west. Each of the accretionary episodes is separated by thrust faults, resulting in relatively older rocks resting on relatively more recent rocks. In addition, during accretion of the eight terranes, there has been clockwise rotation of the Klamath Mountains of about 110 degrees (Irwin & Wooden, 1999).

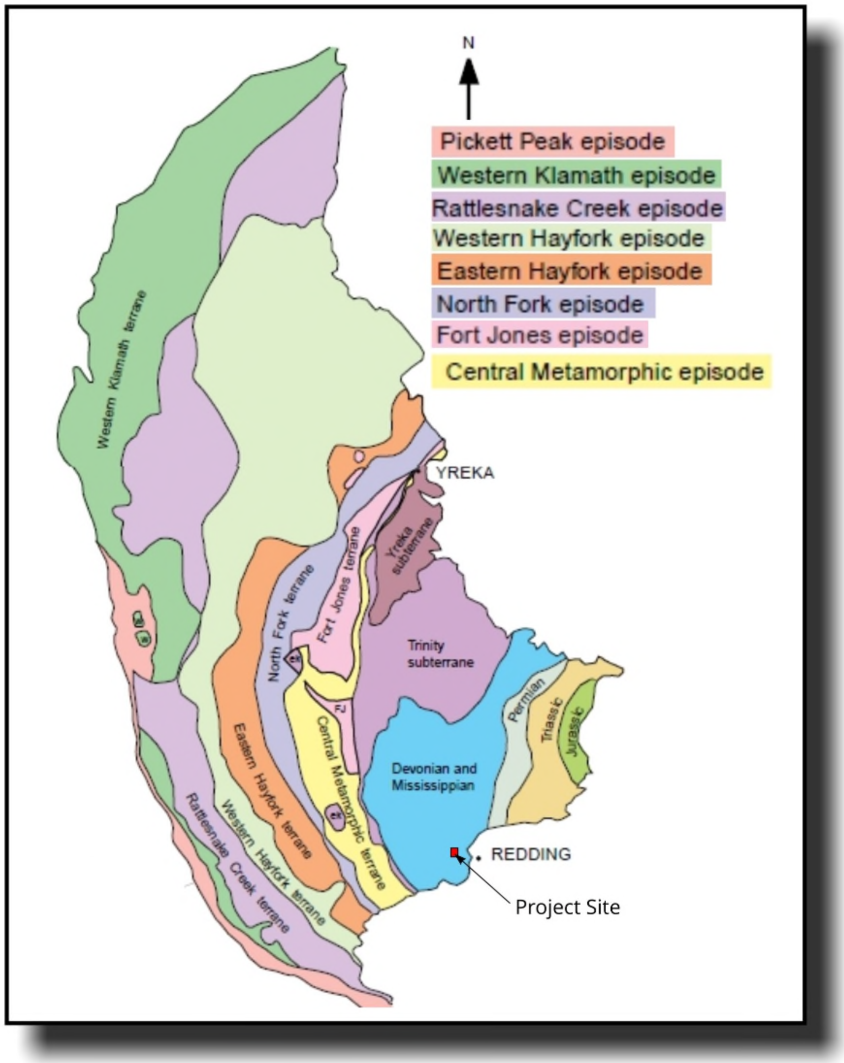
At least 10 plutons have been mapped within the Klamath Mountains. The ages of those plutons have been estimated to range from about 150 to over 400 million years old (Irwin & Wooden, 1999). Most of the plutons intruded the accreted terranes; however, some were emplaced pre-amalgamation (Silberman and Danielson, 1991).

The quarry is located within the Eastern Klamath terrane, which is about 180 to 400 million years old (Silurian-Devonian to Jurassic). The Eastern Klamath terrane is composed of three subterranes: Redding, Trinity, and Yreka subterranes. Mammoth Mine is located within the Redding subterrane. The Redding subterrane consists of Mississippian to Devonian-age metavolcanic and metasedimentary rocks. Formations within the Redding Subterrane consist of the Baird, Bragdon, and Kennett Formations, the Mule Mountain

[4] Bajada Geosciences, Inc. September 2, 2022. *Geotechnical Report Crystal Creek Aggregate Expansion. Shasta County, California,* on file with the Shasta County Planning Division.
[5] The format style in the *Geotechnical Report* is revised in certain instances to complement the Reclamation Plan Amendment text format.
[6] Figure 3, Klamath Accreted Terrane, referenced herein, is actually Figure 1 in the Irwin & Wooden reference.

stock, Balaklala Rhyolite, and Copley Greenstone. Those formations are locally faulted into place. Superjacent rocks consist of alluvium, colluvium, local terrace, and landslide deposits.

**Figure 3**
**KLAMATH ACCRETED TERRANE**
**(Figure 1 from the Irwin & Wooden Reference)**




Quarry Geology

The existing quarry highwalls expose Mule Mountain Stock (Dmm), Copley Greenstone (Dc), and epidote and/or chloritic amphibolite (Da). These materials are unconformably in contact in some locations and have been juxtaposed by faulting in other locations. In areas outside of the active quarry face, Dmm and Dc are visible in outcrop, as float on the ground surface, and exposed within scoured drainages. In addition, Balaklala Rhyolite (Dbc) is locally found, as shown on Plate 3.[7]

[7] Refer to the discussion on *Plates* in the Bajada Geosciences, Inc. September 2, 2022. *Geotechnical Report Crystal Creek Aggregate Expansion. Shasta County, California,* on file with the Shasta County Planning Division.

Granitics of Dmm consist of granodiorite, albite granite, and trondhjemite that increase in hardness and competency and decrease in weathering with depth. Regolithic and saprolitic soils associated with weathering of Dmm for overburden thicknesses ranging from a few feet to over 20 feet. Below the overburden, weathering decreases from highly weathered to fresh (ISRM [1981] Grades IV to I) over thicknesses ranging from about 5 to 20 feet. Weathering is often observed penetrating relatively fresh rocks along discontinuities. Moderately weathered to fresh Dmm ranges from weak rock to strong rock (ISRM [1981] Grades R2 to R4). Some sulfide enrichment was observed locally within Dmm.

The Dc greenstone is generally hard, dense, and locally has been sulfide enriched to exhibit pyrite mineralization. Generally, the greenstone observed within the quarry ranges from medium-strong to very strong (ISRM [1981] Grade R3 to R5), with most of the rock being strong (R4).

The greenstone is generally moderately weathered grading to fresh with depth. The weathering zone is about 15 to 20 feet thick and consists of about 3 to 5 feet of colluvial soils and regolith (ISRM Grades V to VI) overlying highly fractured and weathered greenstone. Colluvial soils are present within fractures in about the upper ten feet of the greenstone profile. The fracturing, weathering, and colluvial infilling diminish with depth. Below the weathering zone, the greenstone is slightly weathered to fresh (Grade I to II). In areas where relatively closely spaced fractures are present, slight to moderate weathering (Grade II to III) can be present at depth.

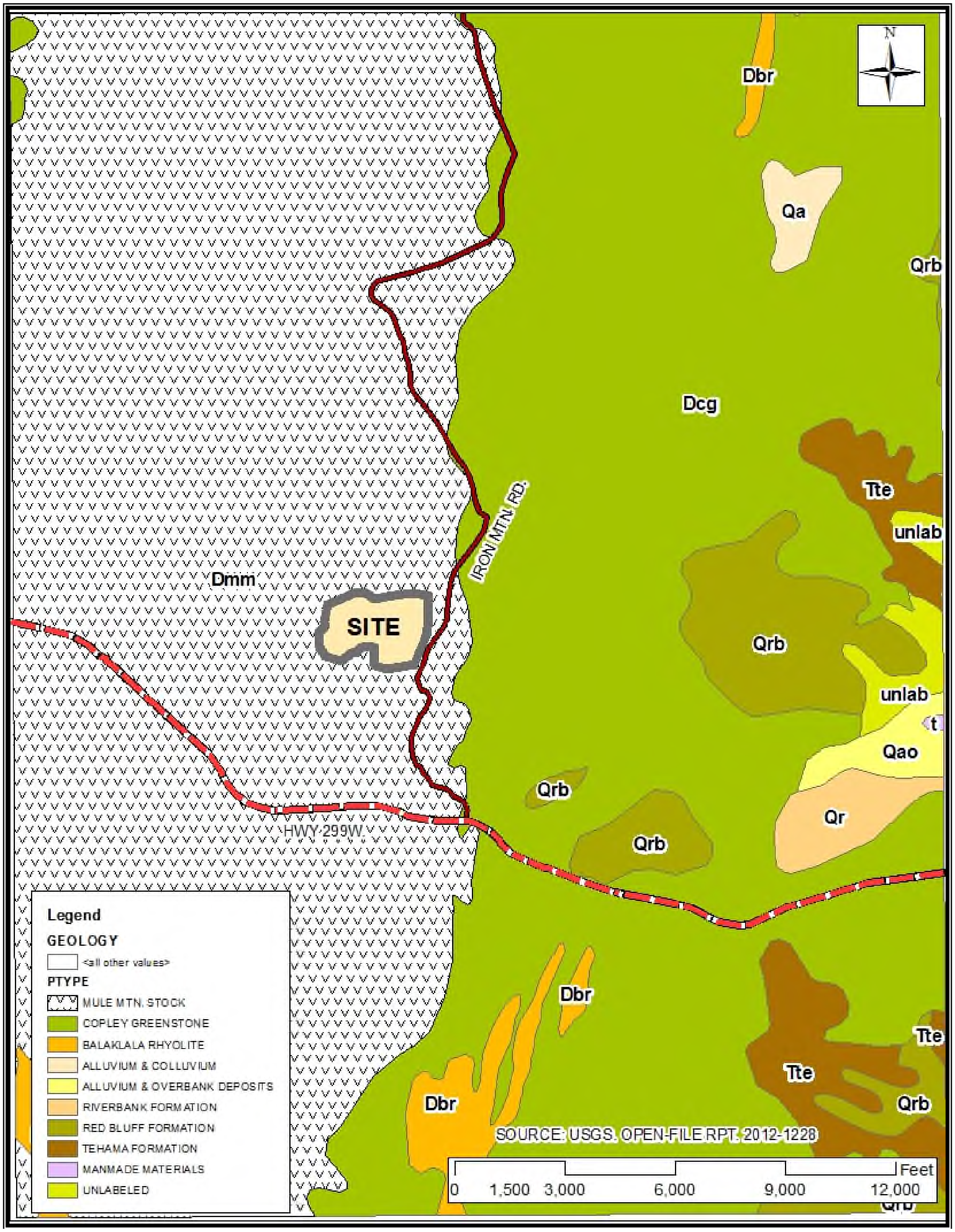
The rock is massive to moderately fractured with persistent discontinuities that are moderately to very widely spaced, partially open to tight, undulating to planar, and generally rough. Open apertures were observed to be filled with calcium carbonate, epidote, and quartz. Some discontinuity planes appeared to have a relatively thin coating of iron oxide, zinc oxide, calcium carbonate or other coatings. Few discontinuities were observed to be open and unfilled except where prior blasting and mining had occurred. Few discontinuities were observed to be seeping water except at Site A, noted on Plate 3, where relatively persistent and moderate water seepage was observed discharging along a fault plane.

Relatively higher-grade metamorphism appears to have altered Dc into epidote and/or chloritic amphibolite. While still within green schist-phase metamorphism, these materials have generally lost the relic texture of basaltic or andesitic rocks from which they were derived. In general, Da materials are found close to the disconformable (not fault-emplaced) contact with Dmm and have an aphanitic, more crystalline texture, as compared to Dc. No exposures of Da were observed near the ground surface and Da exposed at depth was slightly weathered to fresh (ISRM [1981] Grades III to I) and medium strong to strong (ISRM [1981] Grades R3 to R4). Da was observed to be slightly to highly fractured with closed, tight, rough planes having no apparent coatings.

Dbc was not observed in highwall exposures at the site but was observed in outcrop and as surface float in the project expansion area. In the few Dcb outcrops observed, the rock materials were highly weathered (ISRM [1981] Grade IV), very weak (ISRM [1981] Grade R21), and moderately fractured.

**Figure 4, Geology Map**, provides additional information regarding the general geology of the area. [8]

**Figure 4**
**GEOLOGY MAP**




[8] Prepared by The Land Designers, Inc.

## Earthquakes

Bajada Geosciences, Inc. reviewed potential earthquake faults impacting the site.[9] All faults are pre-Holocene and inactive. A field review shows there is no danger of these faults rupturing in the future. In addition to this information, the following is known.

- Central Shasta County is not situated in an area rated with high earthquake activity.
- The property is not in a fault rupture zone as defined by the Alquist-Priolo Earthquake Zoning Act.
- The soils in the area are not prone to liquefaction.

<u>Mine recommendations by Bajada Geosciences, Inc.</u>

The Bajada Geosciences, Inc. report contains several recommendations regarding the mining operation. These proposals are addressed in the "Pit Water Management" and "Pit Slope Design"[10] parts of the report. The recommended mining practices are the following:

*Pit Water Management Procedures*

- As the pit floor is lowered and additional geotechnical conditions are exposed, depressurization may need to be implemented to enhance pit slope stability. When necessary, surface water should be diverted to reduce the amount of water handled by CCA within the pit.
- Depressurization systems could include a combination of techniques, including diversion ditches, vertical pumping wells, and horizontal drains. These measures should be implemented based on regular site reconnaissance, a staged approach during pit development, and could involve the installation of depressurization systems and associated monitoring of groundwater pressures. This will enable an assessment of the pit slope drainage capability and the requirements for additional installations.
- If and when needed, pit dewatering systems should be designed by the project civil engineer.

*Pit Slope Design Operational and Maintenance Methods*

- Presplitting all final rock faces.
- Scaling of blasted rock faces to remove loose rocks.
- Maintenance of a 25-foot wide offset barrier from all inactive rock faces.
- Complete daily inspection of rock faces.
- When bench-level wedge or planar failures occur, remove debris from those failures as routine maintenance.

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[9] Bajada Geosciences, Inc. September 2, 2022. *Geotechnical Report Crystal Creek Aggregate Expansion, Shasta County, California*

[10] Terms used in the Bajada Geosciences, Inc. Report.

It is anticipated that depressurization improvements will not be needed for the quarry site if water within the pit is drawn down at a relatively slow rate allowing piezometric pressures within rock discontinuities to dissipate during the drawdown. If drawdown occurs rapidly, then elevated water pressures within those discontinuities can lead to relatively shallow to some deep-seated rock failures.

For the project site, if water levels are drawn down at a rate of less than 3 feet per day then no depressurization measures will be needed. If dewatering requires a draw-down rate in excess of three feet per day, then depressurization measures should be installed in accordance with recommendations contained within the geotechnical report (Bajada, 2019). Depressurization measures shall be constructed pursuant to California Code of Regulations Section 3713(a) in accordance with the following:

1. Water Code Sections 13700, et seq. and 13800, et seq.
2. Local ordinances set forth within Section 13803;
3. Department of Water Resources report referenced in Section 13800; and
4. Subdivisions (1) and (2) of Section 2511 (g) of Chapter 15 of Title 23.[11]

**Soils**

The *Soil Survey of Shasta County Area, California, August 1974* mapped the soils in the area. There is one soil series within the Reclamation Plan Amendment Area with two sub-series, DgE3 on the west and DfD2 on the east.[12] **Figure 5, Soils Map**, shows the soils in the Reclamation Plan Amendment Area.

The following describes the one soil series and the two subsoil series.[13]

<u>Diamond Springs Series</u>

The Diamond Springs Series consists of well-drained soils underlain by granitic or light-colored meta-volcanic rocks. These soils are on uplands near the communities of Shasta, Keswick, and Ingot. Slopes range from 8 to 50 percent. Elevations range from 1,000 to 2,000 feet. The vegetation is predominantly Manzanita, Toyon, Black Oak, Interior Live Oak, Ponderosa Pine, and Knobcone Pine.

The representative profile of the surface layer is light brownish-gray and pale-brown, strongly acid very stony sandy loam, and sandy loam about 10 inches thick. The upper 5 inches of the subsoil is pink, strongly acid sandy loam, and the lower 24 inches is reddish-yellow and yellowish-red, strongly acid sandy clay loam and sandy loam. The substratum is variably colored strongly acid sandy loam. Strongly weathered metadacite is at a depth of about 54 inches. These soils are used as woodland and wildlife habitat and for watershed.

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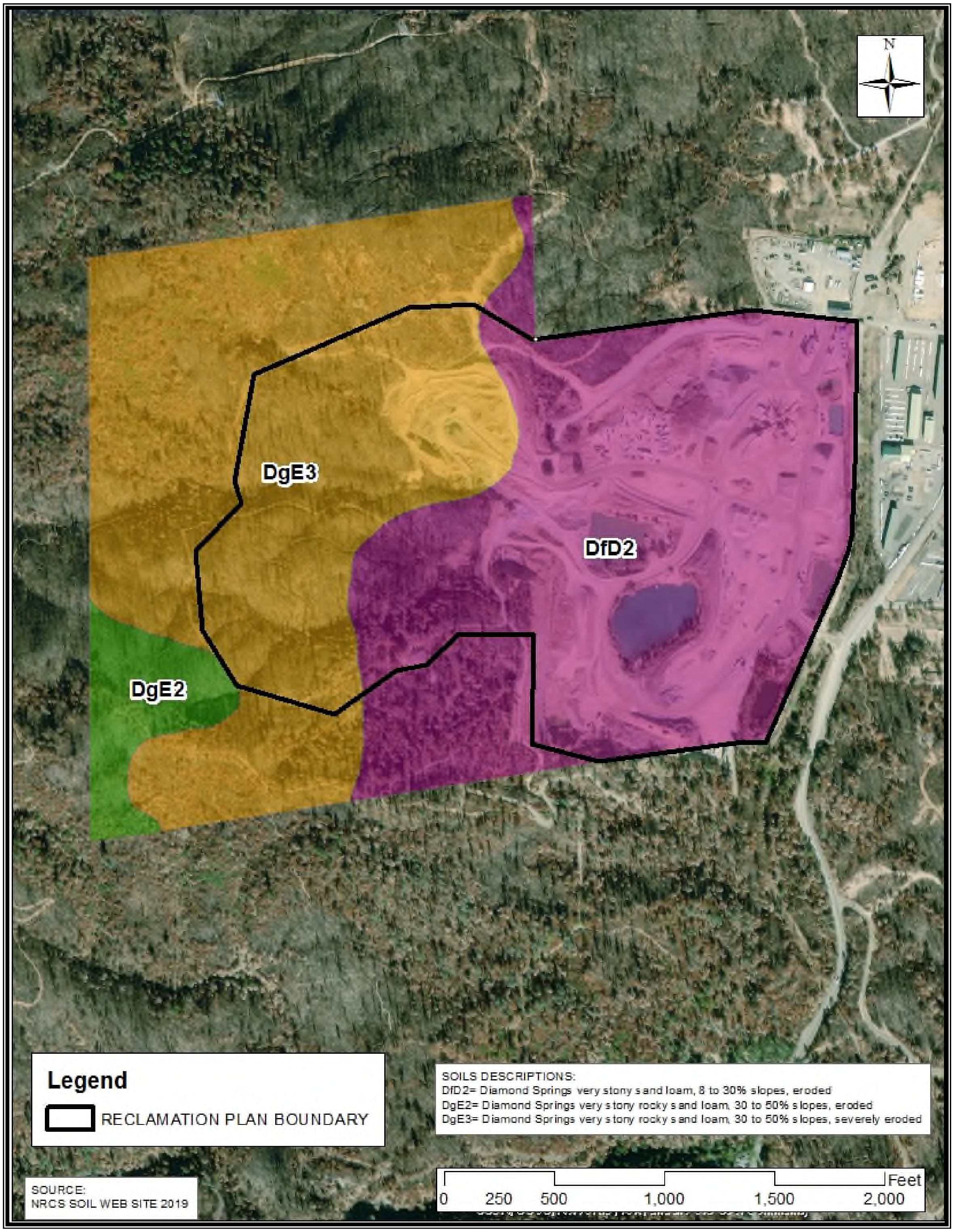
[11] Text section prepared for reclamation plan by Bajada Geosciences, Inc. September 2, 2022. *Geotechnical Report Crystal Creek Aggregate Expansion. Shasta County, California*

[12] A third sub-series DgE2 to the southwest is not within the Reclamation Plan Amendment Boundary and is shown for informational purposes since it is an adjacent soil.

[13] United States Department of Agriculture, Soil Conservation Service and Forest Service, University of California Agricultural Experiment Station, August 1974. *Soil Survey of Shasta County Area, California*

**Figure 5**
**SOILS MAP**




Depth of soil varies with slope and the effects of past disturbances. In general, soils are deepest in the lowest reach of the drainages and shallowest on the upper slopes, where they are most susceptible to erosion.

Soils in the Project area have been heavily disturbed in some areas by mining during the gold rush, especially in the bottom of the central drainage, where many trenches, dikes, collapsed tunnels, and cuts are evident. One small tunnel has been identified within the reclamation plan boundary.[14] The following provides descriptions of the two soil sub-types and a representative profile:

Diamond Springs very stony sandy loam, 8 to 30 percent slopes, eroded (DfD2).

"The soil has the profile described as representative for the series. Permeability is moderate. Runoff is medium to rapid, and the hazard of further erosion is moderate to high. Available water capacity is 3 to 8 inches. Weathered bedrock is at a depth of 24 to 60 inches. Stones and rock outcrops cover 3 to 15 percent of the surface. Included with this soil in mapping were small areas of Kanaka soils. This Diamond Springs soil is used as woodland and wildlife habitat and for watershed. Capability unit VIs- 1(22); range site, not assigned; woodland suitability group 7; wildlife group 8."

Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, severely eroded (DgE3).

"This soil has moderate permeability. Runoff is rapid, and the hazard of further erosion is high. Available water capacity is 2.5 to 4 inches. Weathered bedrock is at a depth of 20 to 30 inches. Exposed bedrock outcrops cover 5 to 20 percent of the surface. Included with this soil in mapping were small areas of Aiken, Goulding, and Kanaka soils. This Diamond Springs soil is used mainly for watershed and as wildlife habitat. It has limited use as woodland. Capability unit VIIs-1 (22); range site, not assigned; woodland suitability group I; wildlife group 8."

Representative profile of Diamond Springs very stony sandy loam, 8 to 30 percent slopes, eroded, about 1.2 miles east of Shasta on State Highway 299.

"AP-0 to 3 inches, light brownish-gray (10YR 6/2) very stony sandy loam, very dark grayish brown (10YR 3/2) moist; moderate, fine, granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine roots; many very fine interstitial pores; strongly acid; abrupt, smooth boundary."

"A3-3 to 10 inches, pale-brown (10YR 6/3) sandy loam, brown (7.5YR 4/2) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and medium roots and few fine roots; common very fine and medium tubular pores and many very fine interstitial pores; strongly acid; clear, smooth boundary."

"B1-10 to 15 inches, pink (7.5YR 6/4) sandy loam, brown (7.5YR 4/4) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine tubular pores and many very fine interstitial and few fine tubular pores; few thin clay bridges; strongly acid; clear, smooth boundary."

"B2t-15 to 29 inches, reddish-yellow (7.5YR 7/6) and yellowish- red (5YR 5/8) sandy clay loam, strong brown (7.5YR 5/6) moist; weak, fine, angular blocky structure; hard, friable, sticky and plastic; few very fine and fine roots and common medium roots; many very fine interstitial and tubular pores and few fine interstitial and tubular pores; common

[14] Gallaway Enterprises. October 2022. *Biological Resource Assessment, Terrestrial and Aquatic Wildlife and Botanical Resources* on file with the Shasta County Department of Resource Management Planning Division.

moderately thick clay bridges and few thin clay films in pores; strongly acid; gradual, wavy boundary."

"B3-29 to 39 inches, yellowish-red (5YR 5/8) and reddish- yellow (7.5YR 7/6) sandy loam, strong brown (7.5YR 5/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine tubular pores and common very fine interstitial pores; common moderately thick clay bridges in pores; strongly acid; gradual, wavy boundary.

01-39 to 54 inches, reddish-yellow, very pale brown, and pale-brown (7.5YR 6/6, 10YR 8/4, 6/3) light sandy loam, yellowish brown (10YR 5/6) moist; massive; slightly hard, very friable, non-sticky and slightly plastic; few very fine and medium roots; many very fine interstitial pores; few moderately thick clay bridges in pores and along fracture planes; strongly acid; gradual, irregular boundary."

"C2-54 inches, weathered metadacite.

The A horizon in these soil series range from 7 to 13 inches in thickness, from light brownish gray or pale brown to yellowish red in color, and from medium acid to very strongly acid in reaction. The B-horizon ranges from 7 to 35 inches in thickness, from pink to light brown or yellowish red to reddish yellow in color, and from medium acid to strongly acid in reaction. The C1 horizon is 6 to 20 inches thick. Well-weathered metadacite rock is at a depth of 20 to 60 inches. Much of this soil is deeper than the Diamond Springs soils recognized elsewhere in California. Diamond Springs soils are generally near areas of Auburn, Chaix, Goulding, and Kanaka soils."

Prior to the Carr Fire, these soils supported a dense vegetative cover and have not been altered except for the loss of vegetative cover and removal of dead trees; therefore testing of soil suitability is not necessary (SMARA §3705 (e)).

**Hydrology & Climate**

This section discusses three subjects: climate, surface flows, and onsite Pond #6.[15]

Climate

The property is located in the foothills of the Klamath Mountains at the northwestern end of the Sacramento Valley. The climate is Mediterranean, characterized by cool, wet winters and hot, dry summers. Rainfall averages 51 inches annually most of which occurs between November 1 and April 30. The yearly average temperature is approximately 70 degrees Fahrenheit (F), with an average low of 44 degrees F in January and a high of 95 degrees F in July. During the summer months, temperatures regularly exceed 100 degrees F. The growing season in the Sacramento Valley can be 250-300 days.

[15] Refer to Lawrence & Associates. August 2022. *Hydrological Evaluation for Proposed Quarry Changes Crystal Creek Aggregates* on file with the Shasta County Planning Division for in-depth information.

Surface Flows

The Project Site has two types of hydrologic regimes: the quarry area to the west and the existing Plant Area to the east. This section describes how each location functions hydrologically.
The Quarry Area is within a single watershed. Runoff from this area is mainly sheet flow from the various hillsides and ridges into small drainages converging from the north and south into a central channel, which flows east into Pond #4.

The Plant Area receives stormwater from off-site uphill areas to the west, as well as on-site runoff from precipitation. Both of these sources discharge into five onsite settling ponds and are subject to treatment before leaving the property. The type of stormwater treatment is passive using Best Management Practices (BMPs) and includes extended detention times for sediment to settle out, interior basin vegetative cover for filtration and cobble/filter fabric outlet structures.

The Project Site operates under a General Industrial Stormwater Permit (Order No. 2014-0057-DWQ) issued by the State Water Resources Control Board. The permit requires the operator to perform stormwater quality monitoring, water testing and reporting certain stormwater discharges from the property. Since permitted, CCA has undertaken required water quality monitoring and testing in compliance with National Pollutant Discharge Elimination System (NPDES) permit conditions. Stormwater flows from the amendment area contain industrial activities, and they are therefore covered under the General Industrial Stormwater Permit.

A Stormwater Pollution Prevention Program (SWPPP) was prepared for the existing operation and will be amended to include the proposed Reclamation Plan Amendment Area. The SWPPP has two objectives:

1. To identify and evaluate sources of pollutants associated with the activity that may affect the quality of the stormwater and authorized non-stormwater discharges from the property.
2. To identify and implement site-specific best management practices (BMPs) to reduce or prevent pollutants associated with the activities in stormwater discharges and authorized non-stormwater discharges.

Onsite Pond #6

At the conclusion of mining activities, a lake or pond with a surface area of 32.67 acres when full with approximately 4,500 linear feet of shoreline will be created. The maximum water depth will be 96 feet between a high water level of 736 feet, with the lake floor at 640 feet MSL.

**Botany, Wildlife, and Wetlands**

Botany and Wildlife

The property is located within an area previously heavily affected by pollution from smelters, which operated to the north during the late 19th and early 20th centuries. Stack emissions from these operations were responsible for denuding most of the original plant life in the area.

In 2018, the area was greatly affected by the Carr Fire, which killed most of the vegetation in the area outside of the plant site. The Plant Area was not significantly affected since it lacks flammable vegetation. The Plant Area and associated structures were saved since water from the ponds was used to combat the fire. However, there was some fire damage to the landscaping on the east side of the property, albeit relatively minor.

Botanical and wetland surveys were conducted by North State Resources (NSR) in May and June 2006 for the previous 2007 Reclamation Plan Amendment. These studies identified vegetation as being in the intermediate stages of succession from scrub/brush to mixed conifer/broadleaf. Identified vegetation habitats at that time were:

- Blue Oak – Gray Pine
- Valley Foothill Riparian
- Mixed Chaparral
- Annual Grassland
- Wet Meadow
- Fresh Emergent Wetland

A review of the California Natural Diversity Database and CNPS Electronic Inventory in 2006 identified eight plant species as having the possibility of occurring in the Project area and proposed expansion area.[16] Onsite field visits performed by NSR found no Species of Special Concern.

NSR also conducted a Special-Status wildlife assessment for the 2007 reclamation amendment area. The study concluded that there were four species with potential to occur; however, there are no known occurrences on-site.[17] A field survey was conducted on January 11, 2007, and no sensitive species were identified.[18]

Subsequently, in May and June of 2020, Gallaway Enterprises conducted biological and botanical habitat assessments in and outside the Reclamation Plan Amendment Area to evaluate site conditions and the potential for biological and botanical species to occur. Other primary references consulted included species lists, and information gathered from the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC), National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB), the California Native Plant Society (CNPS) list of rare and endangered plants, and literature review.

Habitat assessments for botanical and wildlife species were conducted to determine the suitable habitat elements for special-status species within and outside the Reclamation Plan Amendment area. The habitat assessments were conducted by walking the entire Amendment area, where accessible, and recording specific habitat types and elements. If habitat was observed for special-status species, it was then evaluated for quality based on vegetation composition and structure, physical features (e.g., soils, elevation), micro-climate, surrounding area, presence of predatory species, and available resources (e.g., prey items, nesting substrates), and land-use patterns.
A protocol-level rare plant survey and habitat evaluation for rare plants was conducted on May 21 and 27 and June 2 and 4, 2020. The survey and evaluation were conducted by walking transects

[16] Eight possible special concern botanical species per North State Resources: Fox sedge, Silky cryptantha, Four angled spikerush, Red Bluff dwarf rush, Legenere, slender Orcutt grass, Canyon Creek stonecrop, Greene's tuctoria.
[17] Four possible special concern wildlife species per North State Resources: Northwestern pond turtle, Coopers hawk, Pallid bat, Townsend's big-eared bat.
[18] North State Resources. December 3, 2007. *Special-Status Wildlife Assessment for the Crystal Creek Aggregate Inc. Phase II Project on* file with the Shasta County Planning Division.

through the entire Amendment area and taking inventory of observed botanical species. The protocol-level survey was conducted for species with blooming periods that overlapped the survey dates."[19]

Identified vegetation habitats are:

- Montane Hardwood-Conifer Woodland
- Mixed Chaparral
- Annual Grassland
- Riverine
- Lacustrine
- Barren

No endangered, threatened, rare plants or special-status botanical species were found within the Reclamation Plan Amendment Area; therefore, there will be no effects on botanical species or their habitats, and no avoidance and minimization measures are proposed.

Oaks within the Amendment Area were largely devastated by the Carr Fire. The few live black oaks remaining on the site are in various states of health.

One species of special concern (SSC), the western pond turtle, was observed within the Amendment Area. When water is present, all of the historic created ponds provide suitable habitat for western pond turtles. Due to the regular heavy disturbance and steep engineered banks, however, the active mining ponds do not provide quality habitat for western pond turtles.

Potential habitat was identified for several avian species protected under the Migratory Bird Treaty Act (MBTA) and for several CDFW SSC that may occur within or adjacent to the Reclamation Plan Amendment Area.

Mature oak trees within the Reclamation Plan Amendment Area that have suitable habitat elements (e.g., cavities, peeling bark) may provide suitable day roost habitat for pallid bats; however, there are no CNDDB occurrences within 5 miles of the Amendment Area. There are very few existing large oak trees, and the few large oak trees present have largely been impacted by the Carr Fire resulting in poor quality of habitat within the site. There is, therefore, a low potential for pallid bats to occur within the Amendment Area.

Townsend's big-eared bat is designated as a CDFW SSC. In California, most populations of Townsend's big-eared bats occur in montane forest habitats. Roosting sites are typically caves, cliffs, and rock ledges but have included abandoned mines and other man-made structures. Townsend's big-eared bats are extremely sensitive to disturbance at roosting sites, particularly during the reproductive season and during hibernation.

The Reclamation Plan Amendment Area is the site of a historic and active mining operation. The historic mining activities included some tunneling and excavation. One small tunnel was observed within the Amendment Area during the field survey. However, due to the small size of the tunnel

[19] Gallaway Enterprises. October 2022. *Biological Resource Assessment, Terrestrial and Aquatic Wildlife and Botanical Resources* on file with the Shasta County Department of Resource Management Planning Division.

and the noise/disturbance from the adjacent active portion of the mine, there is a low potential for Townsend’s big-eared bats to occur within the tunnel.

The Biological Resource Assessment recommends minimization and mitigation measures to further reduce or eliminate mine expansion-associated impacts on special-status wildlife species. Measures include conducting surveys to determine the presence or absence of western pond turtles, setbacks from turtle eggs if uncovered during excavation activities, and measures preventing turtles from entering open trenches and de-watered areas. Mature trees are to be removed and/or fallen between September 1 and March 15, outside of the Pallid Bats maternity season. Trees should be removed at dusk to minimize impacts to roosting bats.

If mine expansion activities include disturbing or removing any historic tunnels, this work shall be initiated outside of the bat maternity season (March 16 - August 31). Pre-construction surveys within the tunnels, where accessible, will need to occur within the tunnels, where accessible, within seven days prior to the start of mining activities. If Townsend’s big-eared or other bat species are observed utilizing the mine expansion area, CDFW will be consulted before construction activities commence. Bats may need to be humanely evicted if adverse impacts are to occur.

All of the proposed measures may be amended or superseded by the mine expansion-specific permits issued by the regulatory agencies, which include Shasta County and CDFW.

Wetlands

In 2006 NSR biologists systematically delineated ephemeral drainage, intermittent stream, perennial marsh, and seasonal wetlands within an approximately 58-acre portion of the Project site where mining activities were being proposed. These features occupied a total of 0.613 acres. As explained in the 2006 NSR report, “these features do not qualify as waters of the U.S. because, in accordance with the National Pollution Discharge Elimination System (NPDES) permit obtained for mining activities, these waters must receive treatment before entering Middle Creek, a federally-jurisdictional intermittent stream that is tributary to the Sacramento River. All features that drain out of the study area, including all ephemeral drainages and intermittent streams, enter a detention basin to allow the settling out of fine particulates. The federal definition of “waters of the United States” specifically excludes features such as the treatment pond from jurisdiction.”

This 2006 NSR wetland delineation was used to obtain the Shasta County Use Permit Amendment 07-020 and Reclamation Plan Amendment 07-002 that the Mine currently functions under, as well as the Lake and Streambed Alteration Agreement (LSAA) from the California Department of Fish and Wildlife (CDFW) in 2010 (LSAA Number 1600-2010-0018-R1). These permits covered an area totaling 110.69 acres which included the pre-existing mine Plant Area and the area surveyed by NSR where active mining activities were being proposed. This 110.69-acre area is referred to henceforth as the Permitted Area.

In 2020, due to the current proposed Use Permit Amendment that will add the 69.28-acre Mineral Resource Area (MR) to the existing 110.69-acre Permitted Area, Gallaway Enterprises began conducting a delineation of aquatic resources, including waters of the United States (WOTUS) and Waters of the State (WOTS), for the overall 179.97-acre Crystal Creek Aggregates Use Permit Amendment Project Site. However, in 2021 the definition of WOTUS was returned to the pre-2015 definition of waters of the United States, therefore, Gallaway Enterprises revised the draft Delineation of Aquatic Resources to be commensurate with the current definitions. Within the

179.97-acre Project Site, Gallaway Enterprises identified a total of 7.387 acres of actively managed and disturbed mining ponds and ephemeral and intermittent drainages in the active mining and Plant Area portions of the Permitted Area; a total of 0.796 acres of wetlands, ponds, and ephemeral and intermittent drainages within the Permitted Area that are not yet actively being mined; and a total of 1.884 acres of wetlands, ponds and ephemeral and intermittent drainages in the MR area.

**Aesthetics**

The property has three existing visual environments: The Plant Area in the eastern portion of the site, the active Quarry Area in the northern part of the western mid-area; and, the undeveloped lands in the most western and southern areas of the active quarry site. The active quarry lacks vegetation and is essentially an excavation into a hillside. The undeveloped lands in the mine area mainly lack vegetation due to the Carr Fire, and the majority of burned trees have been fallen or removed. The Plant Area contains aggregate material stockpiles, an office, scales, crushing, screening, and washing facilities. The Shasta County General Plan Land Use Classification for the Plant Area is Industrial, and the zoning is also Industrial.

The main visual changes resulting from this Reclamation Plan Amendment as opposed to the currently approved 2008 Reclamation Plan are that the ridge between the Plant Area and quarry is being removed, and the quarry highwalls are increasing in height from 22 feet to 40 feet, except for one highwall rising 46 feet from the bottom of the quarry floor.[20] Benches are also being increased in width from 30 feet to 40 feet except for the bench along the perimeter of Pond #6, which will be increasing to 60 feet in width. The proposed revegetation of the quarry benches also differs from the 2008 Plan in that a more fire-resistant ponderosa pine and grassland environs replaces a tree and shrub vegetation type.

The mine is east of the Old Shasta Community; however, the mine is not visible from this community since a ridge separates the two areas. The upper benches of the quarry are also below this ridge.

The general visual composition of the Project Area is as follows:

- At the eastern portion of the property and along the Iron Mountain Road corridor is the Weyerhaeuser Lumber operation. Both sides of Iron Mountain Road are chain link fenced in front of this business. Behind the fencing is storage for lumber/trusses. Several tall covered sheds, approximately thirty-plus feet in height, and other structures are located on the Weyerhaeuser site.
- Further to the east of the Weyerhaeuser facility are large residential parcels. Many of the homes in this location were lost to the Carr Fire, and some residences are being rebuilt.
- North of the mine is BLM property and four privately owned parcels. These parcels range in size from 1.48 to 4.59-acres. Two homes are in the process of being constructed on two parcels.
- A Western Area Power Administration (WAPA) transmission powerline with towers is about 700 feet north of the quarry.
- The land to the west is vacant BLM property.

[20] Refer to Reclamation Plan Amendment **Sheet 3 – Existing Quarry Cross Sections**.

- The property to the south is vacant and owned by the mine operator (Jerry Dale and Kerry M Comingdeer Trust).
- Almost all the surrounding lands were adversely impacted to some degree by the Carr Fire. The visual impacts from this event have been the significant loss of tree and shrub cover, which has created a more visibly open and barren landscape.

Amending the Reclamation Plan will not have a significant impact on aesthetics for the following reasons:

1. The mine is not expanding outside its currently approved mining limits, and the area of disturbed terrain does not change from that of the currently approved 2008 Reclamation Plan.
2. The mine site was essentially denuded of vegetation by the Carr Fire. What remains is mainly bare ground with dead trees and brush snags.
3. The mine does not contain unique geologic or topographical features that differentiate it from other ridge systems in the area. The mine does not provide scenic views or impede the viewsheds of other areas.
4. The main public viewing area of the mine is from Iron Mountain Road. Existing industrial uses and associated structures largely block these views. In order to observe the mine, the public must look through a lumber storage yard, tall lumber storage sheds, and security fencing.
5. Although there is a residential area east of Iron Mountain Road with views of the mine, these locations are not public viewing areas. These viewpoints are located along Laurie Ann and Sanders Lane, which are private roads and do not provide opportunities for general public access.
6. The aesthetics of the future mining operation have been carefully designed to incorporate existing natural features and vegetation, creating a softer, more balanced appearance. The aesthetic design features are as follows:

    A. <u>Concurrent Reclamation</u> is proposed for the Project. As finished grades are reached in each phase, the quarry benches will be resoiled and revegetated, except in areas that are still needed to access existing and/or future mining areas. The newly established vegetation will grow even as mining continues, minimizing to the maximum extent feasible, visible indications of the mining activities.

    B. <u>Revegetating the Benches</u> with pine trees to create a pine forest. The intent is to create a forest setting that reduces the fire danger in the area as well as creating a treed landscape, which would result in an aesthetically pleasing view.

    C. <u>Creating a Large Pond</u> in the mine. This creates an attractive water feature that would attract wildlife.

    D. <u>Creating a Riparian Zone</u> around future Pond #6. This contributes to the aesthetic enhancement of the area.

    E. <u>Existing Ponds and Landscaping</u> along the eastern side of the Plant Area. These features are a partial visual screen of views into the Plant Area and, to some degree, the Mining Area from drivers along Iron Mountain Road and from certain viewing areas east of Iron Mountain Road.

F. Existing Ponds with Riparian Vegetation within the Plant Area. These features create islands of vegetation within the plant area and break up the visual appearance of the industrial activity.

G. Mining Area is Below the Western Ridgeline. This ensures that Project activities are not visible from locations west of the site, in particular the Community of Old Shasta.

H. Top of the Quarry Area does not create a “straight line” form along the ridgeline. An undulating feature will be created that disrupts and “softens” what could otherwise result in a relatively rigid manmade appearance.

## PROJECT OVERVIEW

This section describes the need for the mining operation and how mining is conducted. Items addressed in the Project Description are:

- Purpose and Goal
- Project Description
- Operating Schedule
- Office and Scale Facilities
- Topsoil and Overburden Storage

### Purpose and Goal

The current mining area is permitted under Shasta County Use Permit Amendment 07-020 and Reclamation Plan Amendment 07-002. The goal of the proposed Reclamation Plan Amendment is to increase the life of the mine and to be an all-around aggregate extraction and materials processing operation. The mine must be diverse enough to meet the needs of most construction projects requiring aggregate material.

The mine operator has found that he cannot provide significant amounts of aggregate for large construction projects since the current use permit limits the annual tonnage of processed aggregate to 250,000 tons (125,000 cubic yards). The operator must have the ability to satisfy both existing clients and also large projects that require tens of thousands of tons of aggregate material, which is not feasible under current permit conditions.

The need for future increased mine production decreases the life of the mine under current permit conditions. The mine owner needs a sufficient quantity of available material to meet demand without having to periodically apply to the County for additional reclamation plan amendments to meet anticipated demand. This location is an identified and proven source of concrete grade aggregate close to main population centers and highways in Shasta County. The mine is a valuable resource to the community at a countywide level. Permitting a longer mining life that increases the volume of material assures that this resource is available to meet future County construction needs.

**Project Description**

All processing of quarried material occurs in the eastern portion of the Project Site on the industrially zoned land. **Sheet 1 – Existing & Proposed Project Overview** and **Sheet Map 2 – Proposed Mining Plan** of the Reclamation Plan Amendment Sheets show the location of the existing aggregate crushing, screening, and wash sites in addition to the recycle wash ponds. The operating method produces finished aggregate involving several steps, which are constantly repeated as mining progresses. These steps are:

- Removal of woody vegetation.
- Salvage and storage of topsoil/overburden.
- Extraction of marketable material from the ground.
- Aggregate transport to the processing area.
- Mechanical processing of rock into finished product and final sale.
- Reclamation of mined areas.

The standard procedure for limiting clearing to existing extraction areas and those slated to be mined in the near future was disrupted by the Carr Fire of July 2018. The existing and future quarry area was severely impacted by the blaze resulting in the destruction of the majority of the vegetation. The intense heat damaged most seed sources that were on the ground. This results in a site composed mainly of bare ground with burned trees and snags. There has been some revegetation in the eleven months since the fire in the form of grasses and forbs at certain locations as well as crown sprouting of specific species of bushes and trees such as Toyon and oaks. Crystal Creek Aggregates is currently removing dead trees since they are a safety hazard to mine workers. The snags are placed in piles and chipped, and then sold to a local cogeneration plant.

Before CCA mines a new location, the topsoil is removed and stored at the plant's stockpile area. Topsoil is stored separately from other materials with clear signage to prevent its loss or disturbance during storage. As mine excavation moves further away to the west and south of the Plant Area, it is anticipated that the storing of topsoil and overburden will occur in the quarry area to reduce travel distance. Stockpiling of topsoil for future reclamation will typically not occur earlier than one year from the date that the site is mined (SMARA §3711 (a)).

The mined aggregate is more heavily weathered closer to the surface and becomes harder and denser with increased depth. A bulldozer with rippers breaks up the softer upper layers of the material. As mining progresses deeper and the rock becomes too hard for ripping, drilling and blasting practices are employed. This mining method involves drilling holes in a particular sequence and depth to access a predetermined volume of rock. The holes are then filled with explosives and stemmed (topped off) with crushed stone, which acts to direct the blast downward into the quarry wall. The use of stemming materials also prevents the blast from discharging into the air, thereby significantly reducing the amount of noise and dust produced. After blasting, the freshly broken rock is available for transport. This mining method results in the creation of numerous benches on the hillsides with a central depression on the quarry floor.

The loosened material is transported from the quarry to the primary plant site in haul trucks. It is then deposited into a vibrating grizzly feeder and jaw crusher unit. Following primary crushing, the material is fed onto a three-deck dry screening unit, which sorts and distributes material via conveyor to either finish stockpiles or a cone crusher for additional crushing and screening.

Depending on the type and size of material being produced, the three screens allow for the production of different material sizes. Water sprays control dust during the crushing operation.

Fifty percent of the material generated by the crushing and screening plant is transported by a loader to the screening and wash plant for further processing. Material is loaded into a hopper that feeds material onto a conveyor then onto a three-deck material screen unit with a water weir to clean the material. This screen unit contains spray bars and screens to separate fine and coarse material. The materials are sorted into finished products ranging from sand to 3/4-inch washed aggregate. Process water is collected and channeled via an underground 8-inch corrugated metal pipe to settling ponds where heavy sediments and flocculent materials are discharged. The heavy sediments essentially fall to the bottom of the pond. The water is continuously recycled back into the system. Makeup water is added as needed to replace water, which remains in the final product, or is lost due to evaporation.

The production rates of both the crushing and screening operation and the wash plant could be up to 150 tons per hour.

The wash ponds are periodically cleaned with sediment removed using an excavator. The sediment is placed in the topsoil stockpile area, where it can be used for final reclamation.

The crushing, screening, and washing processing operations run on shore power supplied by PG&E. A 20,000-gallon diesel tank is used to fuel CCA equipment and vehicles. Another 350-gallon tank is used to store waste oil. The waste oil is transported offsite by a hazardous waste company. All tanks have secondary containment. A Spill Prevention Control and Countermeasure Plan (SPCC) has been prepared in accordance with 49 CFR 112.

**Operating Schedule & Equipment**

Currently, normal mining and processing activities occur up to 6 days per week, Monday through Saturday. Current hours of operation are from 6 a.m. to 5 p.m. during Pacific Standard Time. During Daylight Savings Time, hours are from 6 a.m. to 6 p.m., Monday through Friday and 6 a.m. to 5 p.m. on Saturdays. No change in these hours is proposed.

Permitted hours for blasting are from 9:30 a.m. to 3:30 p.m., Monday through Friday. No change to these hours is proposed. However, blasting is currently limited to 12 times per year. The proposed use permit amendment requests an increase to 24 times per year.

<u>Existing Equipment List</u>

*<u>Mobile Equipment:</u>*
3 Excavators
1 Motor Grader
1 Backhoe
2 Forklifts
2 Haul trucks
3 Water Trucks
1 Dozer
1 Skid Steer
4 Front End Loaders

*Primary Crushing & Dry Screening Plant*
1 Vibrating Grizzly Feeder
1 Jaw Crusher
1 Dozer Trap
1 Cone Crusher
3 Deck Dry Screening Unit
Associated Conveyors
Material Stockpiles

*Wash Plant*
1 Variable Speed Feeder
1 Wet Screening Unit with Three Screening Decks
1 Water Weir with 36” Twin Sand Screws
1 Ionic Flocculant Tank
1 Sand Pump & Hydrocyclone Separator
1 Catch Basin
Associated Conveyors
Material Stockpiles

A control room and a storage facility are also located immediately north of the primary crushing and dry screening plant and west of the wash plant. There is an approximately 30-foot high dual LED light standard between the dozer trap and the 3-deck screening unit and an approximate 40 foot high photoelectric LED light standard providing security lighting.

**Office and Scale Facilities**

Located in the northeast corner of the Project site are the scale office and truck scales. The scales weigh both incoming and outgoing trucks. The office is a mobile office trailer 14 feet by 70 feet that contains a restroom connected to an existing septic tank and leach field. The Shasta Community Services District provides potable water. A fire hydrant is located approximately 20-feet northeast of the office trailer.

**Topsoil and Overburden Storage**

The existing topsoil/overburden storage area is shown on Reclamation Plan Amendment **Sheet 1 – Existing & Proposed Plan Overview** and **Sheet 2 – Proposed Mining Plan**. The storage area is three acres in size. The topsoil storage area is a separate stockpile from the overburden storage at this location. 0.3 acres of land is set aside to store topsoil, and 2.7 acres are devoted to overburden storage. The difference in stockpile sizes is that the volume of overburden used to resoil the benches is much larger than the topsoil layer placed on them. There are 22 inches of overburden being applied instead of 2 inches of topsoil.

A five-foot-high topsoil stockpile on the 0.3 acres is large enough to store the 1,816 cubic yards of topsoil. The 2.7-acre overburden stockpile can store approximately 76,000 cubic yards of overburden at a height of 25 feet. Both stockpile areas will have a maximum of 1.5:1 slope on their banks. Any excess overburden will be stored at the existing aggregate stockpiles locations in the Plant Area.

Soil and overburden stockpile areas will be protected if there is the potential for erosion. If necessary, an erosion control barrier will be placed around the perimeter of the stockpiles. The erosion barrier can be straw bales, silt fence, fiber rolls, gravel berms, or other devices identified in CCA's Industrial Stormwater Pollution Prevention Plan (SWPPP)[21]. Stockpiles are considered to be eroding if they have erosion rills greater than six inches deep and exceed five feet in length. Topsoil stockpiles are segregated from overburden stockpiles. Topsoil stockpile(s) will have a sign designating them as topsoil.

Potential erosion in other areas of the plant site is expected to be minimal due to the relatively flat gravel-surfaced areas. No other areas besides the stockpiles themselves are expected to create potentially significant erosion impacts.

### Aggregate Stockpile Storage

There are 9.5 acres of land devoted to the stockpiling of aggregates. The stockpiles are situated in the Plant Site Area. The stockpiles consist of processed aggregates awaiting transport offsite. In addition, there is usually a stockpile of raw aggregate near the screening and washing plant for processing. The stored aggregates vary in size from sand to riprap boulders. The stockpiles are segregated into areas of similar-sized products. The location and size of the stockpiles vary over the season based on market demand and the resultant type of product created. The largest of the stockpiles could encompass up to an acre of land and can be 30 to 40 feet in height. The 30-40 foot stockpile height is usually the exception since most stockpiles are 20-25 high which is the distance a loader can reach to dump their bucket load.

Potential erosion concerns for most stockpiles are minimal since the particle size of most of the product is large enough that it cannot be transported by wind or stormwater. The exception is sand stockpiles in which wind can move the particles. To counter potential wind erosion, water is applied to the stockpiles by either a water truck or sprinklers along the top of the stockpiles. An existing additional measure to treat stormwater runoff at the Plant Site is the five settling ponds that receive runoff from the stockpile areas.

### Potential Contaminants

Potential contaminants include a 20,000 and 1,000-gallon diesel tank used to refuel equipment, 270-gallons of petroleum lubricants, a 350-gallon waste oil tank, 2,000 pounds of bagged flocculent used at the recycle ponds, domestic garbage, and sewage if the septic system fails.

## MINE RECLAMATION OVERVIEW

The purpose of this section is to describe the final post-reclamation condition of the project site and the procedures employed to achieve this result.

Topics covered in this section are:

- Reclamation Objectives
- Existing Conditions

[21] CCA is covered under the State of California General Industrial Storm Water Permit. Order Number 2014-0057-DWQ and not an individual NPDES permit.

- Establishment of Test Plots
- Phasing
- Reclamation Prescriptions
- Wetland Mitigation
- Post-vegetation Monitoring

**Reclamation Objectives**

There are two types of end uses for the project site resulting in different reclamation prescriptions. The first is the eastern plant site area (53.38-acres), and the second is the middle and western (57.31-acres) portions of the Project Site. These prescriptions are:

1. Eastern Plant Site Area: This eastern area will be reclaimed for industrial uses after the mining extraction and processing terminates. This end-use is consistent with the current Industrial general plan land use classification and zoning district designation.
2. Middle and Western Site Area: This area will be reclaimed as a mineral reserve area. This use is consistent with the California Department of Conservation's designation of the site as a Mineral Resource Zone, as noted on pages 7 and 8 of this Reclamation Plan Amendment.

The primary objectives of the Reclamation Plan Amendment are to:

1. Establish a new vegetative cover that provides future fire protection.
2. Stabilize finished mined surfaces and prevent erosion.
3. Revegetate with plant species adapted to this locale.

**Existing Conditions**

The vegetation regime has drastically changed since the approved 2007 Reclamation Plan due to the Carr Fire, which burned the majority of the vegetation on site. Wildland Resource Managers surveyed the property since the fire in the spring and fall of 2019 and noted that there is crown sprouting of certain plant species and regrowth of grasses in specific areas.[22]

**Establishment of Test Plots**

Bench Area

There are two test plot areas shown on Reclamation Plan Amendment **Sheet 7 – Reclamation Plan**. Test Plot #1 is situated on an existing quarry bench and used to review site revegetation without the addition of soil, overburden, seed, or plants on a bench. Test Plot #2 judges the success of revegetation of the benches based on the reclamation policies in this Reclamation Amendment Plan.

[22] Personal communications (November 15, 2019) Steve Kerns, Principal – Wildland Resource Managers and Keith Hamblin, Planner – The Land Designers.

Each test plot will be at least 900 square feet and fenced to prevent disturbance. Test Plot #2 will be resoiled with 22 inches of overburden materials and 2 inches of salvaged topsoil. The prepared plot will be mulched with straw or wood chips at a rate of 2 tons per acre in order to protect the newly planted plots from erosion. No fertilizer or other amendments are added since the vegetation selected is native to the area. After two years without intervention, if the prescribed trees and grasses have not become established, the operator will propose alternatives to Shasta County for each plant type that is not performing as anticipated. Use of the test plots can be discontinued once the success of the plantings is confirmed by Shasta County. Test Plot #1 will be established when the amended reclamation plan is approved since the plot is on an existing bench. Test Plot #2 will be established when final grade is established on a new quarry bench. This test plot needs to be established on a finished bench since that is the site conditions for revegetation to be successful in the reclamation plan. Test Plot #1 will be removed at a future date since its location is proposed for excavation in Phase 1. The test plot will be reestablished at the same location after a final grade is achieved and will be managed in the same manner as Test Plot #2. If needed, a qualified professional will be consulted should the test plots indicate the proposed revegetation will not be successful on the site.

Pond #6 Bank Area

No test plots are proposed to monitor the success of replanting the banks of the new Pond #6 in the quarry. Existing Ponds #1, #2, #3, #4, and #5 are reference locations that prove the prescribed riparian species will readily grow and thrive in the new Pond #6.

## Phasing

Phasing for this Reclamation Plan Amendment divides the progression of mining into clearly identifiable mining segments and not sequentially over a time period. This allows reclamation to be started as soon as finished mining surfaces are completed and no longer needed by the operation except under some circumstances.[23] Phasing also assists responsible agencies in determining compliance with the Plan since defined areas for reclamation are identified. The actual completion of each phase is not time-dependent since the depletion of permitted reserves is based on market demand, which is difficult to forecast.

Reclamation Plan **Sheet 5 – Proposed Phasing Plan Overview**, shows the three mining phases and how mining progresses over the 79-year life of the quarry. Phase 1 contains land that is presently disturbed and being mined under the current Reclamation Plan. Phase 2 advances mining into the southern portion of the quarry. Phase 3 is the smallest area located in the northwest corner of the quarry. Portions of Pond #6 will be created as each phase is mined.

**Table 1, Mine Phases, Volumes & Years of Each Phase**, identifies the three mining phases for the quarry. The extraction area, volume of material, and cumulative materials extracted in each phase is identified. The quantity of aggregate to be extracted varies from 2.15 to 5.42 million cubic yards per phase. This table also indicates the estimated life of each phase. The life of each phase is based upon the percent of aggregate in each phase to the total amount of aggregate in the mine. Phase 1 contains thirty-nine percent of the available material, so the life of this phase is thirty-nine percent of the 79-year life of the mine, which is thirty years.

[23] An example would be a quarry bench still needed by the mining operation if the location is still to be used by equipment and employees to access a future mining area.

**Table 1**
**MINE PHASES, VOLUMES & YEARS OF EACH PHASE**

| Phase | Area (Acres) | Volume (MCY) | Cumulative (MCY) | Life of Phase (Years) |
|---|---|---|---|---|
| 1 | 22.66 | 4.84 | 4.84 | 30 |
| 2 | 21.26 | 5.42 | 10.26 | 35 |
| 3 | 8.82 | 2.15 | 12.41 | 14 |
| **Totals** | **52.74** | **12.41** | **12.41** | **79** |

All phases encompass quarry benches that are reclaimed by resoiling and revegetation. Within each phase, the operator intends to begin creating the top quarry benches as soon as possible. The top benches are the most visible feature of the quarry to outside observers. The operator wants vegetation growing at these locations to minimize visual impacts.

Most aggregate products sold by CCA require blending sand and other loosely consolidated material with the mine's harder rock. The sand and loosely consolidated aggregate are found near the ground surface whereas the harder material is deeper underground, where it is less subject to weathering. For this reason, it is not feasible to mine solely hard rock or just weathered rock. It must be noted that a particular location in the mine might not provide this variety of material and that a number of sites in the quarry may require some excavation within all phases to provide this blend. For this reason, mining may occur throughout any of the three phases during the Reclamation Plan Amendment period based on the need for a particular type of aggregate sought for construction activities. However, the phases proposed identify those specific areas within which the majority of mining will be undertaken.

Crystal Creek Aggregates sells about twenty aggregate products. These products include base rock, drain rock, decorative stone, riprap, structural backfill, sand, plaster sand, and specialty products. The specialty products are utilized by businesses, public agencies, and organizations for projects such as golf courses, walking paths, and landscaping. The stone products are desired due to their attractive surfaces, and the sand is requested for its appealing golden color. The market area for some of the mine's products ranges from Portland, Oregon, to the San Francisco Bay Area.

**Reclamation Prescriptions**

The following section describes how the Plant Site, Quarry Benches, and Pond #6 Bench Area are to be reclaimed.

Plant Site

Reclamation involves removing those items that are not compatible with the end use of this location identified for industrial land uses. This includes general cleanup activities and removal of residual items, such as tires, used conveyor belts, etc., from the mining area. Another activity involves the stabilization of this location from potential erosion impacts.

The reclamation prescriptions for the Plant Area are as follows:

1. Remove all equipment and other facilities related to the mining operation that is not compatible with the "Industrial" zoning designation. This includes but is not limited to

aggregate processing machinery, vehicles, and equipment used by the mining operation. The scales and scale building can remain since certain industrial uses could use these facilities. Processing equipment and rolling stock can remain if a permitted use, such as a contractor's equipment storage yard, is created at the time of reclamation. A contractor's yard is a permitted use in the Industrial zoning district.

2. Clean up all trash and other debris.
3. All aggregate stockpile materials will be sold, transported off-site, spread onto the ground, or used on-site as erosion control measures (i.e., rock-lined ditches, and energy dissipaters at culverts).
4. Rubble heaps will be graded to blend into the existing ground surface.
5. The final contours of the industrial area will be based on the availability of fill, drainage patterns, and future building locations. However, all finished slopes will have positive drainage towards the settling ponds #1 through #5. See **Sheet 7 – Reclamation Plan**, of the Reclamation Amendment Plan Sheets for drainage details.
6. The two existing recycle ponds will be filled with engineered fill and leveled for eventual industrial use.
7. Currently, there are plantings of redwood trees along portions of Settling Ponds #2 and #3 and cypress trees and oleanders along the eastern property line. These plantings are for erosion control purposes, aesthetics, and as a visual screen from Iron Mountain Road.

   Future revegetation will occur in areas where it will not conflict with plant site activities such as aggregate stockpiling, crushing and screening plant operation, parking, traffic circulation, etc. Gravel armoring is the primary erosion control measure employed in the locations of these active plant activities. In addition, SMARA Section 3705 (g) allows non-native plant species if they meet the end uses specified in the approved reclamation plan if they are not noxious weeds or a species known to displace a native species in the area. As stated in this reclamation plan, this area's end-use is industrial. Therefore, plantings of both native and non-native can occur in the industrial area to achieve the objectives for erosion control, landscaping requirements, aesthetics, visual screens, fire protection, vehicular safety, and dust control.

Quarry Benches

At the conclusion of mining, the quarry area will contain finished benches above the surface of Pond #6, ranging in elevation from 724 to 1,060 feet mean sea level (MSL). The number of benches along the quarry wall will vary from two on the northeastern side to seven in the southwestern quadrant. The benches will be 40 feet wide and 40 feet high except for the bench along Pond #6, which will be 60 feet wide and 44 feet tall. The highwall between benches is proposed to be vertical. During the creation of the benches and highwalls, the wall between the benches will have some slope in most cases due to the walls being created by heavy equipment, variations in rock types, and the blasting/ripping of the rock. These highwalls will take into consideration the critical gradient of the material involved. The highwalls will conform to either the existing topography and/or end-use.

The quarry benches will have a minimum of two feet of soil placed on them, of which twenty-two inches is overburden, and two inches is topsoil. The topsoil and overburden are transported to the bench being reclaimed by haul and/or dump trucks. These vehicles will release the material into either a pile or in a row, depending on the type of vehicle used. A cat will be used to grade and flatten the piles/rows of the deposited material to the finished resoiling depth. If required, a grader may also be used in the finishing grading. No compaction of this soil is required since this would reduce the ability of plant roots to spread within the soil. There would be no buildings or structures constructed on the benches. In locations where the soil has been compacted, a cat with rippers would rip the ground to a depth of eight inches. Approximately 274 cubic yards of topsoil and 2,952 cubic yards of overburden would be used to resoil each acre of a bench. Given a bench width of 40 feet, 1,089 linear feet of bench equals an acre of land within which the above-noted quantities of topsoil and overburden would be applied. A greater than the twenty-two-inch depth of resoiling is permitted and is at the option of the mine operator.

Benches are scheduled to be resoiled when they are excavated to their finished grade, and the bench location is no longer needed to serve future mining activities such as trucks and excavation equipment accessing new extraction areas. This method would support concurrent reclamation since there would be a minimal time lapse between creating the final bench and its resoiling.

**Table 2, Resoiling Quantities for Each Mine Phase**, identifies each phase of the mine and the number of cubic yards of topsoil and overburden needed to resoil them.

**Table 2**
**RESOILING QUANTITIES FOR EACH MINE PHASE**

| Phase # | Linear Feet Bench Resoiled | Topsoil Required Cubic Yards (CY) | Overburden Required (CY) |
|---|---|---|---|
| 1 | 7,006 | 2,015 | 21,688 |
| 2 | 11,012 | 2,993 | 32,222 |
| 3 | 4,609 | 1,245 | 13,408 |
| **Totals** | **22,627** | **6,253** | **67,318** |

The estimated depth of topsoil and overburden to be removed from the quarry would be an average depth of five feet over the entire quarry area. This results in a total quantity of 462,300 cubic yards of material being generated. Per the NRCS soil survey, the A horizon of this soil series is seven to thirteen inches deep. Using seven inches as the average depth of the A horizon, 29,587 cubic yards of this material will be topsoil, and 32,713 cubic yards is overburden. In comparing the required quantities needed to resoil the benches to the amount of topsoil and overburden available, there is more than enough material to meet this requirement. This quantity of topsoil and overburden is generated over the 79-year life of the mine, so the storing and use of this material will take place over a long time span.

*Revegetation*

Revegetation occurs on the post-mining benches. Therefore, the first planting location is designated as the “upper benches” since they are above the wetland/riparian bench around the perimeter of Pond #6. These upper benches are a separate planting area since they are not subject to the moister soil conditions found at the bench around the pond.

*Upper benches*

Wildland Resource Managers (WRM) surveyed the site and consulted with Keith Hamblin of the Land Designers regarding a revegetation plan for the bench areas.[24] One of the Reclamation Plan's objectives is to create a fire-resistant plant community on the quarry benches. As previously noted, the Carr Fire devastated most of the homes and vegetation in the area, and concerted efforts are being undertaken not to repeat this event in the future.

During the fire, Cal FIRE and other firefighting agencies staged over a hundred firefighting vehicles, including three helicopters, at the CCA site since the property had a large area cleared of vegetation. This provided safety for firefighting personnel and their equipment during this catastrophic event. The helicopters used vast amounts of water from the ponds to fight the fire. The main hindrance to firefighters battling the fire at the CCA site was the adjacent dense growth of tree and brush vegetation that fed the firestorm.

This Reclamation Plan Amendment presents an excellent opportunity to lower the fire danger in the area, provide a future safe haven for the staging of firefighting equipment and personnel, and provide protection to the communities of Keswick and Old Shasta. The main methods to achieve these goals are to eliminate fuel ladders where fire proceeds from lower vegetation into the crowns of trees and by reducing the amount of burnable material present (fuel load). To achieve this goal, brush species are eliminated from the revegetation plant pallet. This action reduces both the fuel load and potential future fuel ladders. In its place, the planting of ponderosa pine, grasses, and legumes is proposed. Ponderosa pine is chosen since it is native to the area, grows on the property, and is fast growing. The trees will initially be planted on an 8 foot by 8-foot spacing and then thinned out at a future date. The final spacing will be pines trees spaced 20 to 30 feet apart with grasses and legumes as the understory species. The proposed spacing of the trees reduces the chance of a fire spreading from one tree to the other.

The upper bench planting program establishes a stable, self-renewing community of trees that tolerates the climate without irrigation or fertilization at the cessation of mining at each phase. In addition, the establishment of "volunteer" pines, grasses, and forbs from the surrounding area will count towards determining vegetative success as long as there are no noxious weeds, non-native species, or plants present that increase the fire danger.

Consultations with Wildland Resource Managers establish two interim success criteria for the benches: (1) a 50% pine seedling survival rate after three years of planting, and (2) at year 20, an average tree spacing of 20 feet to 30 feet.[25] 50% survival of seedlings after three years would result in a density of 340 trees per acre. Upper bench reclamation is successful if the cover, richness, and density standards listed in **Table 3, Planting Prescription for Upper Benches**, are achieved at the

[24] Consultations with Steve Kerns, Principal – Wildland Resource Managers (May and June 2019).

[25] The 20 to 30 foot spacing of trees is not required for the last phase of the mine since it would require monitoring for more than two years after the cessation of mining. SMARA 3705 (j). This would affect the timing of the release of the financial assurance mechanism for the mine.

end of two years from the termination of mining activities. The timing of planting is the fall season for the grasses, which should be before October 15. The pines are planted in the spring, with the best planting time of late March into early April.

Grass and legume seeds will be broadcast onto the benches. Broadcasting the seed can be performed by laborers using belly grinder seeders, tractors/quads with seeders, or other currently acceptable methods. The pine trees will be planted as bare root seedlings; however container plantings are another acceptable method. Laborers with planting tools are typically used to plant the seedlings/containerized trees. It should be noted that technology is bound to change in the 79-year life of the mine, and new methods of seed dispersal/trees planting would be acceptable in the future based on new technologies. The specific planting method is not as important as employing a planting technique that ensures the success of the planting. **Table 3, Planting Prescriptions for Upper Benches**, identifies the planting prescription for the upper benches. **Figure 6, Upper Benches Planting Cross- Section**, shows the proposed planting area for all the upper mine benches.

**Table 3**
**PLANTING PRESCRIPTION FOR UPPER BENCHES**

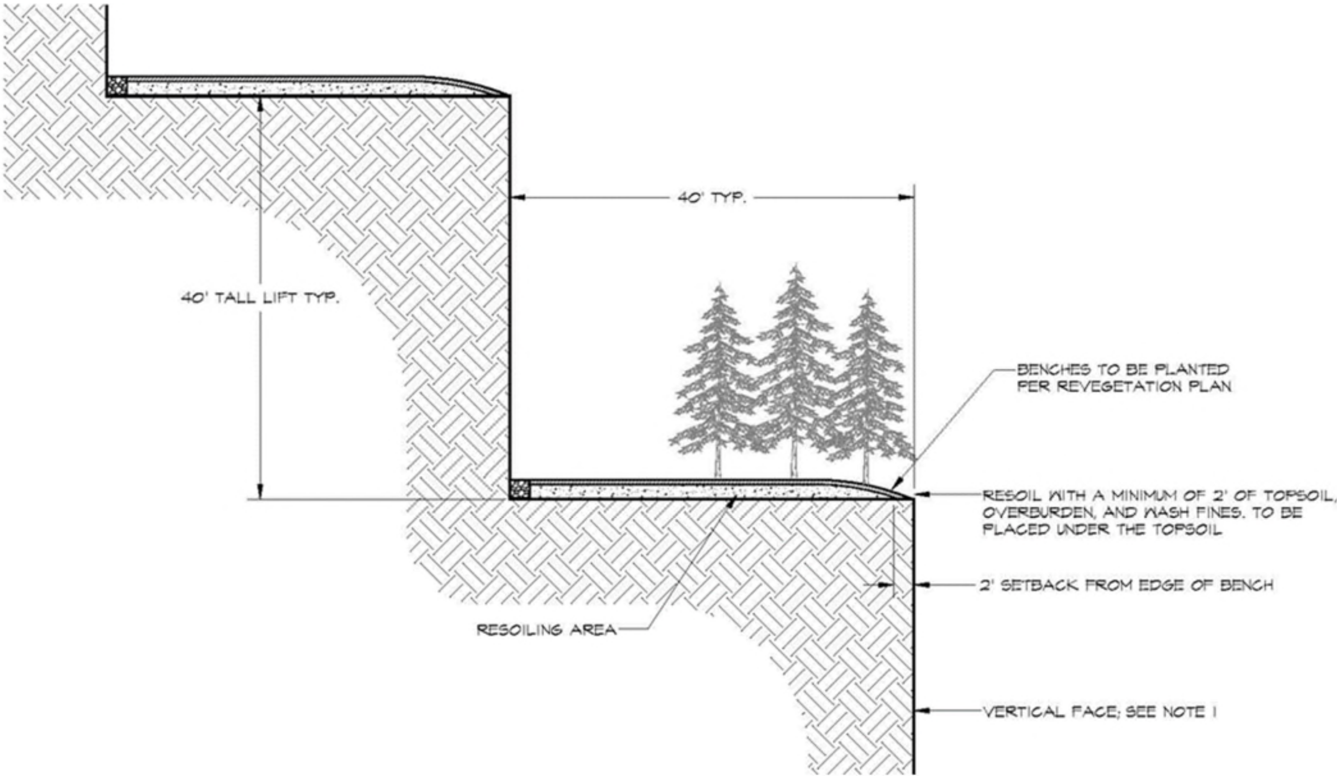
| Common Name | Species | Richness | Density | % Cover |
|---|---|---|---|---|
| **Tree** | | | | |
| ponderosa pine | Pinus Ponderosa | 1 species tree | 20-30 ft. apart | NA |
| **Grasses & legume** | | | | |
| meadow barley | Hordeum brachyantherum | 2 species grass & 1 legume | NA | 60% outside the drip line of the trees |
| slender wheatgrass | Elymus trachycaulus | | | |
| blue wildrye | Elymus glaucus | | | |
| tomcat clover | Trifolium willdenovii | | | |

<u>Ponds</u>

At the conclusion of mining operations, six ponds will remain (see **Sheet 7 – Reclamation Plan** of the Reclamation Plan Amendment Sheets). Five of the ponds currently exist, and the sixth pond, Pond #6, will be created in the quarry area. Existing ponds #1 through #5 are labeled “Settling Pond” on the Reclamation Plan Amendment Map Sheets. Pond #6 has a surface area of approximately 32.67 acres whereas, the existing ponds vary in size from about 0.36 acres to 2.85 acres. The high water level of around 736 feet for Pond #6 will be two feet higher than Pond #4 at an elevation of approximately 734 feet. **Sheet 2 – Proposed Mining Plan** shows the location of the proposed spillway, which will be riprapped.

Ponds #1 through #3 are located in the mid to southeast side of the Plant Area. These ponds are landscaped as part of current reclamation and will not be disturbed except for maintenance purposes. The ponds are used to manage stormwater runoff from the plant and stockpile areas. Therefore, no additional planting is proposed for these ponds.

**Figure 6**
**UPPER BENCHES PLANTING CROSS-SECTION**




Ponds #4 and #5 are located in the mid to southwestern side of the Plant Area. These ponds have riparian vegetation around their perimeters consisting of willows and cottonwood trees. This vegetation is a product of natural reseeding and not planted vegetation. The pond's perimeter consists of quarried ground with no re-soiling. Of the 2,425 linear feet of shoreline around these two ponds, only approximately 827 linear feet do not have tree cover. This results in 65 percent of the shoreline with tree cover and 35 percent lacking such cover. Pond #4 is used as a reference area to forecast the success of revegetation around Pond #6 to be created in the quarry. Based on current results, there should be no problems associated with this new pond having its shoreline revegetated with trees, grasses, and rushes. Ponds #4 and 5 are to remain after reclamation.

There will be approximately 4,406 linear feet of shoreline around Pond #6. Along the perimeter of Pond #6, a wetland/riparian planting area is proposed that is 44 feet in width, which includes a 32-foot wide area above the high water line (HWL) of the pond and a 12-foot wide area below the HWL. The 12-foot wide location was selected since it is in the shallow area of the pond where "water-loving" plants can be found and are dry during certain months of the year, primarily June through September, due to evapotranspiration and the amount of water withdrawn. **Figure 7, Pond #6 Wetland / Riparian Bench Cross-Section**, illustrates features along the pond's lower bench.

Within the Pond #6 bench, there will be a meandering drainage course receiving runoff from the upper quarry benches. A revegetation goal is to establish a self-sustaining population of wetland/ riparian species on the lowest bench around the pond. This is achieved by planting trees, grasses, legumes, cattails, and rushes that grow in riparian/wetland habitats. The cattail and rushes are best suited around the pond and the shallow areas along the pond perimeter, although other saturated locations on the bench can also provide habitat. **Figure 8, Pond #6 Wetland/ Riparian Bench**

**Planting Details**, shows the lower bench area and planting locations. Other habitat improvements are depicted in this figure. These enhancements include placing woody material and rock jetties into the pond area. In addition, when the bench is resoiled, there can be a variation in terrain features such as humps and depressions. These types of landform changes create microclimates that may enhance the variety and success of specific plants at this location.

**Figure 7**
**POND #6 WETLAND / RIPARIAN BENCH CROSS-SECTION**

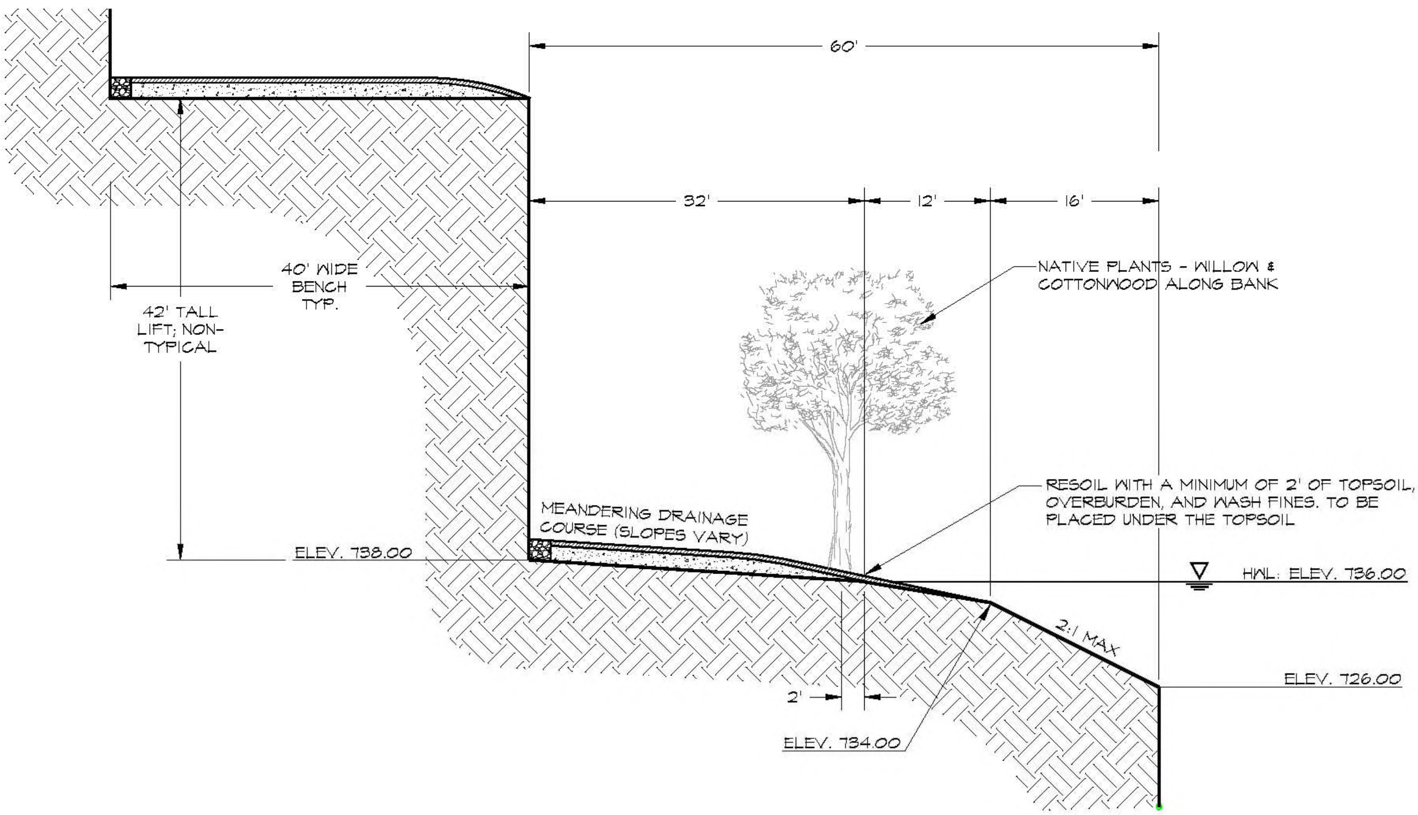
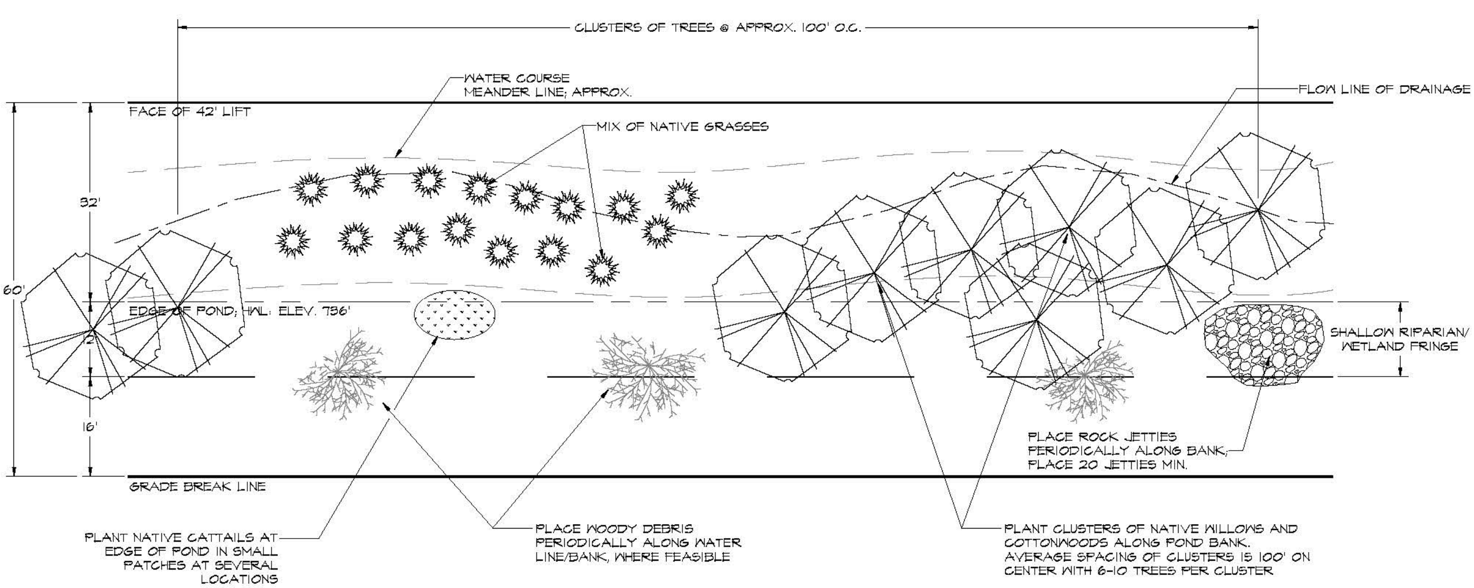



**Figure 8**
**POND #6 WETLAND / RIPARIAN BENCH PLANTING DETAILS**



The wetland/riparian bench reclamation is successful if the cover, richness, and density standards listed in **Table 4, Planting Prescription for Riparian/Wetland Bench**, are achieved at the end of two years from the termination of mining activities.

**Table 4**
**PLANTING PRESCRIPTIONS FOR RIPARIAN/WETLAND BENCH**

| Common Name | Species | Richness | Density | % Cover |
|---|---|---|---|---|
| **Trees** | | | | |
| native willow | Salix spp. | 2 species trees | 6 trees per 100 linear ft. of pond perimeter on average | NA |
| Fremont's cottonwood | Populous fremontii | | | |
| **Cattail Family** | | | | |
| Native cattails | Typhus spp. | 1 species | NA | 1,000 square feet |
| **Grasses, legume & rushes** | | | | |
| meadow barley | Hordeum brachyantherum | 2 species grass, 1 rush & 1 legume | NA | 60% outside the drip line of the trees |
| slender wheatgrass | Elymus trachycaulus | | | |
| native rushes | Juncus spp. | | | |
| tomcat clover | Trifolium willdenovii | | | |

The reclamation of the bench adjacent to Pond #6 will have the following qualities:

1. Compacted soils will be disked or ripped to a depth of eight inches.
2. Resoiling of the bench area above the high water mark to a depth of two feet, minimum. A deeper resoiling depth is permitted. Resoiling along the pond edge will occur during dry weather conditions, whereby the amount of sediment is reduced from entering the pond. Resoiling of the shallow pond perimeter can be less than two feet in depth since this ground is tapering downward to meet the deeper quarried rock in the pond.
3. The terrain of the terrace outside the pond does not need to be flat. Small mounds and indentations are permitted to provide minor microclimates.
4. Planting of trees around the perimeter of the new pond as shown in **Figure 7, Pond #6 Wetland/Riparian Bench Cross-Section** and **Figure 8, Pond #6 Wetland/Riparian Bench Planting Details**.
5. Rubble along the perimeter of the new pond will be graded to match the existing terrain. Rubble is the unused stones left from the mining of the quarry.
6. Rubble heaps in areas subject to pond inundation may remain if they are configured in a way to enhance wildlife habitat and not result in erosion.
7. The maximum slope of the pond bench below the high watermark is to be 2:1.
8. Establishing "volunteer" riparian/wetland vegetation from the surrounding area counts towards determining vegetative success as long as the vegetation is not noxious weeds or non-native species.

During reclamation activities around Pond #6, those soils in the mine that contain riparian/wetland plants will be salvaged where possible and transported to the new pond area. This material will hasten revegetation since the material contains riparian/wetland seeds and plants. In adherence to SMARA section 3703 (c), wetland loss by the mining operation will be replaced at a minimum ratio of one to one. The replacement area includes new wetlands to be located along the perimeter of Pond #6 as well as existing wetlands along the existing Ponds #1 through #5.

The planting locations identified in **Figure 8, Pond #6 Wetland/Riparian Bench Planting Details**, will either be pole cuttings from willow and cottonwood trees growing in the area or transplanted as whole trees from the CCA site and/or container stock. The average spacing of the tree clusters is 100 feet resulting in 61 tree plantings around the perimeter of Pond #6, with each planting location containing a cluster of six to ten trees. This results in a planting of a minimum of 366 trees around the pond. Set planting locations, or spacing of each cluster of trees, cannot be currently provided since the microclimate at the edge of the pond must be analyzed before planting. When a planting location is chosen, a cluster of pole cuttings (six or more stems), or a single whole plant, will be planted. Each planting location must be judged on whether a planting hole can be dug at that location and if there is sufficient moisture during the summer months to sustain the planting. Monitoring identifies which areas have the greatest survival rate.

The following outlines how pole cuttings should be harvested and planted: [26]

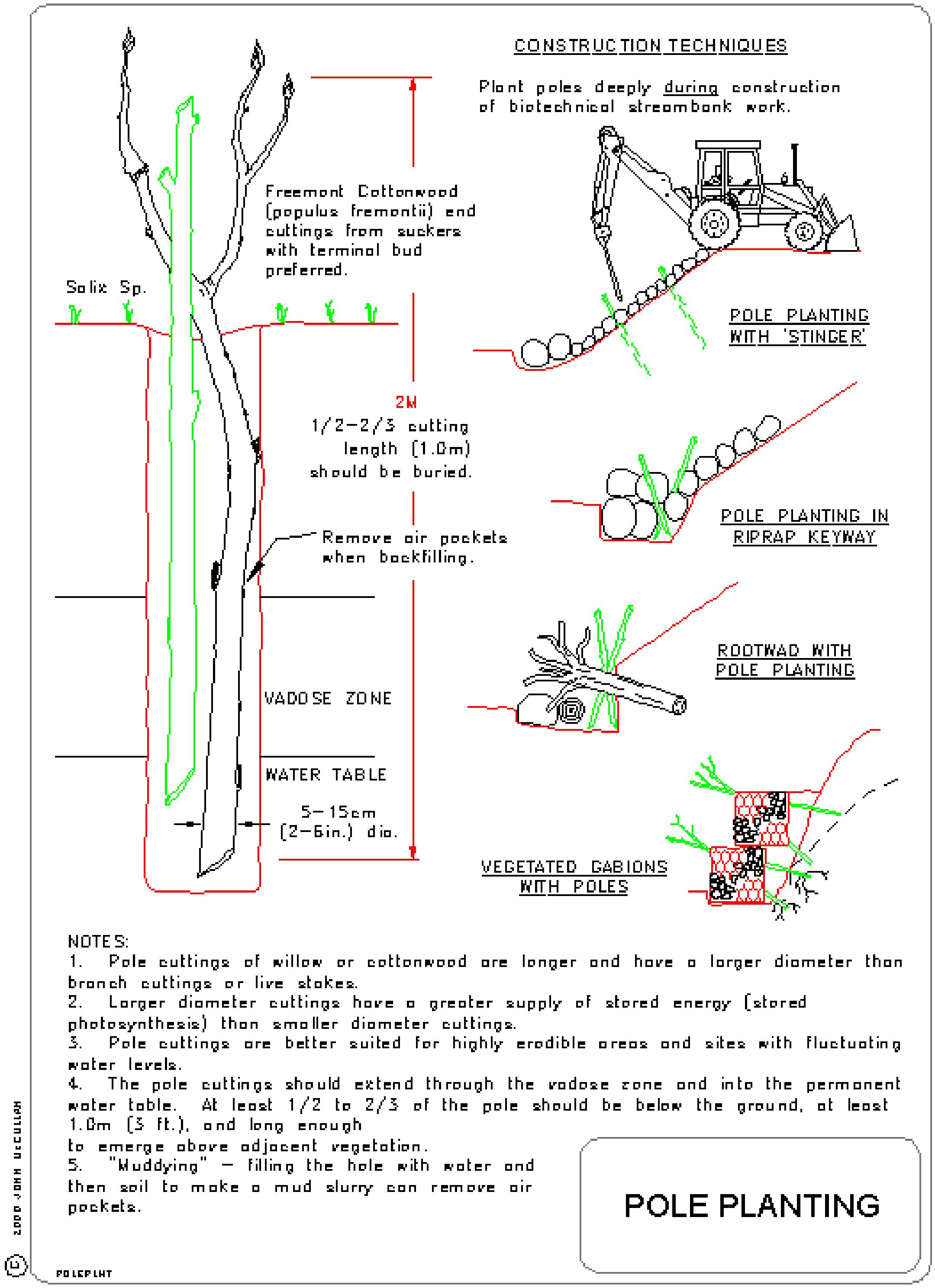
1. Selection.
   a. The cuttings should be a mix of ages, with the majority between two and five years old.
   b. Pole cuttings should average from 0.75 to 3.5 inches in diameter and six to nine feet long.
2. Installation Period.
   a. Cuttings should be planted between the late fall and early spring when the plants are dormant, and there is adequate moisture for the plants to be established.
   b. The best time to install the cuttings is late fall since this gives the plants a greater period to be established.
3. Harvesting.
   a. Choose cuttings that are less than two years old.
   b. Avoid suckers of the current year's growth.
   c. The best cuttings are two to five years old with smooth bark and not deeply furrowed.
   d. Select reasonably straight cuttings.
   e. Soak cuttings a minimum of 24 hours before planting.
   f. Trim all the side branches of the poles.
   g. Trim the terminal bud (bud at the growing tip) from the willows but leave the terminal bud on the cottonwoods.
4. Planting techniques
   a. One-half to two-thirds of the cuttings should be below the ground surface to prevent desiccation.

[26] Source: Bio Draw 2.0. Salix Applied Earthcare. 2002.

b. Cuttings should be long enough to extend into permanent water or capillary fringe six to eight inches.

**Figure 9, Pole Planting Techniques**, illustrates the various pole plants, cuttings, depths, and construction techniques.

**Figure 9**
**POLE PLANTING TECHNIQUES**



**Wetland Mitigation**

The CCA mining operation will directly impact certain wetlands in the Permitted Area. To determine the amount of wetlands impacted, the following discussion addresses SMARA's definition of wetlands used to determine the area of wetland loss and mitigation requirements for the loss of wetlands and Crystal Creek Aggregates proposed mitigation measures to compensate for the loss.

Two sections in SMARA discuss wetlands: section 3701 defines what is a wetland, and section 3703(c) addresses the amount of mitigation required for wetland habitat impacted. These two relevant sections are:

> Section 3701 states: "…the definition of wetlands shall be the same. As defined in the California Fish and Game Code, section 2785, subsection (g*).* which states, *'Wetlands' means land which may be covered periodically or permanently with shallow water and which include saltwater marshes, freshwater marshes, open and closed brackish water marshes, swamps, mudflats, fens, and vernal pools."*
>
> Section 3703(c) states: *"Wetland habitat shall be avoided. Any wetland habitat impacted as a consequence of surface mining operations shall be mitigated at a minimum of one to one ratio for wetland habitat acreage and wetland habitat value.*"

As previously noted, a LSAA was obtained in 2010 that covered the 110.69-acre Permitted Area. Pursuant to this LSAA, the CDFW took jurisdiction over two segments of intermittent stream habitat (totaling 1,439 linear feet) and one seasonal wetland (totaling 0.055 acre) and did not take jurisdiction over the remining aquatic resources that had been delineated by NSR in 2006 within the Permitted Area. Since this LSAA was obtained in 2010, active mining activities have been ongoing within the Permitted Area, however, the entirety of the mining activities covered within the Permitted Area have not been completed. Therefore, in order to identify the quantity of and impacts to aquatic resources within; 1) the Permitted Area that have yet to be impacted; and 2) the MR area, Gallaway Enterprises conducted a delineation of Aquatic Resources for the overall 179.97 acre Crystal Creek Aggregates Use Permit Amendment Project Site that was updated in September 2022. Refer to **Sheet 9, Comprehensive Project Plan & Wetland Delineation,** for an overview of wetlands within the overall 179.67 acre Use Pemit Amendment Project boundary and the Reclamation Plan Amendment area.

No impacts to the 1.884 acres of aquatic resources identified within the MR area are proposed by the Use Permit Amendment.

Within the Permitted Area, a total of 34.80 acres of land remains to be mined under the existing Use Permit and proposed Use Permit Amendment. Based on a comparison between the 2006 NSR delineation and the updated 2022 delineation prepared by Gallaway Enterprises, the two segments of intermittent stream and the one seasonal wetland that CDFW took jurisdiction over and permitted impacts to under the LSAA have already been impacted and fall within the area currently mined. A summary of the impacts that have already occurred within the Permitted Area is provided in **Table 5, Summary of SMARA Mining Area Wetland Impacts & Onsite Wetland Mitigation**. Within the 34.80-acre of land currently unmined within the Permitted Area, Gallaway Enterprises identified a total of 0.796 acres of aquatic resources (see **Table 5** for details). None of these aquatic resources meet the definition of WOTUS since they all drain into one of the active mining ponds within the Project Site which are engineered to be isolated in order to control runoff and function as sediment ponds. Further, none of these aquatic resources had been determined to fall under CDFW jurisdiction pursuant to the 2010 LSAA. It should be noted, however, that features identified as non-jurisdictional WOTUS not only may still fall under State jurisdiction per Section 401 of the Clean Water Act, but will also require a significant nexus determination by the US Army Corps of Engineers to confirm their jurisdictional status.

**Table 5**
**SUMMARY OF SMARA MINING AREA WETLAND IMPACTS & ONSITE WETLAND MITIGATION**

| **Wetland Impacts*** | |
|---|---|
| **CDFW Jurisdictional Feature Impacts Permitted and Completed** | |
| **Type** | **Acres** |
| Intermittent Drainages | 0.079 |
| Seasonal Wetland | 0.055 |
| **Total** | **0.134** |
| **Non-Jurisdictional Feature Impacts Permitted and Completed^** | |
| **Type** | **Acres** |
| Ephemeral Drainages | 0.015 |
| Seasonal Wetland | 0.064 |
| **Total** | **0.079** |
| **Non-Jurisdictional Feature Impacts Permitted and Ongoing^^** | |
| **Type** | **Acres** |
| Ephemeral Drainages | 0.284 |
| Intermittent Drainages | 0.209 |
| Ponds | 0.232 |
| Seasonal wetlands | 0.022 |
| **Total** | **0.747** |
| **Wetland Mitigation** | |
| **Type** | **Acres** |
| Planted Riparian Pond Perimeter with Intermittent Drainage Course | 4.450 |
| Pond #6 | 32.670 |
| **Total** | **37.120** |

*The limits of wetland impacts under the Use Permit
on Gallaway Enterprises' September 2022 *Draft Delineation of Aquatic Resources*. Amendments are identical to the limits permitted under LSAA No. 1600-2010-0018-R1.
^These features were determined to be non-jurisdictional by CDFW and impacts to these features were not required to be covered under the 2010 LSAA. The impact total acreages are estimates based on the NSR 2006 delineation map.
^^These impact totals reflect the remainder of the acreage of impacts still to be completed to features determined to be non-jurisdictional under LSAA No. 1600-2010-0018-R1 based

Crystal Creek Aggregates proposes onsite mitigation to compensate for the wetland impacts within the Permitted Area. The currently approved Reclamation Plan RP 07-002 Condition of Approval Number 17 identified the creation of 1.8 acres of marshes, wetlands, and riparian habitat in a strip surrounding the proposed pond. However, due to a change in the design of the benches in the mining area, the wetland mitigation has increased. Two onsite mitigation measures are proposed. The first is creating a meandering intermittent drainage course within the bench area around the proposed Pond #6, with the planting of riparian vegetation within and along the drainage course1 extending into the edges of Pond #6. **Figure 8, Pond #6 Wetland/ Riparian Bench Planting Details**, provides an illustration. This proposal creates 4.45 acres of riparian habitat. Secondly, Pond #6 will create a 32.67-acre freshwater body, whereas the currently approved Reclamation Pond #4 (now #6) was 23.48 acres. The new pond area is 32.23 acres larger than the existing 0.438

acres of ponds being removed via excavation. Pond #6 will have a shallow edge environment transitioning into the deeper pond water area. Since these two proposed habitats are adjacent to one another, a multi-habitat ecosystem will be created, providing a variety of integrated wetland features.

**Table 5, Summary of SMARA Mining Area Wetland Impacts & Onsite Wetland Mitigation**, compares wetland impacts and onsite mitigation to reduce potential impacts to a less than significant level. **Table 5** illustrates that the wetlands created more than offset the wetland impact.

### Post Vegetation Monitoring

Planted trees may require protection from grazing deer and other animals. Protective screening such as plastic cones or tubes will be provided, as necessary. Fencing the entire Reclamation Plan Amendment Boundary is unnecessary since there are no cattle or other livestock grazing in this area. However, the operator does have the option to fence the boundary.

Following the completion of reclamation, revegetation progress will be monitored until success standards are met without human intervention. During monitoring, both natural regeneration and planted native plants will be counted toward meeting the revegetation standards as long as they are not noxious weeds. Non-native species will not be counted. Should the success of revegetation not seem attainable after two years of monitoring, the operator has the option of consulting a qualified professional and submitting and alternative vegetative planting program to the Shasta County Planning Division. The alternative vegetative planting program will provide vegetation monitoring results to date, identify where the success criteria have and have not been met, and present alternative native vegetation planting prescription and performance standards. The performance standard will address species richness, density, and cover percentage as applicable to each revegetation area. Valid sampling techniques will be used to measure vegetative success, and sample sizes must be sufficient to produce at least an 80 percent confidence level. Standard statistical methods for achieving the 80 percent confidence level can be found in “Measurements of Terrestrial Vegetation” by C.D Bonham, 1988, as well as other publications.

## ADDITIONAL RECLAMATION POLICIES

The previous section described reclamation and revegetation policies for the Reclamation Plan Amendment area. This section lists additional measures that will be implemented as well as certain previously identified measures. Certain measures are very important to reclaim the site and are provided in one location for easy referencing.

### Erosion and Sediment Control Policies

The following reclamation policies are proposed to significantly reduce or eliminate potentially significant erosion impacts significantly.

- In resoiled areas that exhibit an erosion rill with a cross-section greater than five square inches and exceeding five feet in length will be arrested by graded rock interceptors.
- Roads with erosion rills with a cross-section area greater than five square inches and exceeding five feet in length will have the rills filled in with gravel or cobbles.

- Ditches with erosion rills with a cross-section area greater than five square inches and exceeding five feet in length will have riprap placed in them.
- Stockpiles that have erosion rills with a cross-section area greater than five square inches and exceeding five feet in length will have those rills filled in with soil or overburden and covered with straw mulch. An alternative to mulching is installing silt fences around the stockpiles.
- Culverts that have scouring greater than six inches in depth will have riprap placed in the scour area.
- Eroding areas will have mulch applied at a minimum rate of two tons per acre.
- Cut and fill slopes of 2:1 or less with the potential of eroding shall have straw mulch applied to them.
- Fill slopes will be 2:1 or less unless specific geologic and engineering analysis demonstrates that a steeper slope will have a minimum safety factor for the end-use and that the slopes can be revegetated successfully.
- Design erosion control measures to handle runoff from a 20 year, one-hour intensity rain event.
- Temporary mulching of erodible areas will occur before October 15 of each year. This includes topsoil stockpiles that will not be used prior to April 15 of the following year.
- Erosion and sedimentation control structures will be in place by October 15 of each year. Control structures will not be removed before April 15 of the following year and then only when necessary for ongoing operations.
- Newly resoiled benches may need to have straw mulch or wood chips applied to their surface for erosion control until the grass is established. Straw mulch is to be applied at a rate of two tons per acre and the chips at six tons per acre.
- Ditches and other manmade stormwater conveyances will be seeded with grasses where water velocities permit this type of bank and bed protection. In locations where water velocities are too great for grass installation, the conveyances will be rock-lined in areas with erodible soils.
- The spillway from Pond #6 to Settling Pond #4 will have riprap armoring, so there is no degradation of the outlet.

**Topsoil and Overburden Policies**

- Stockpiled topsoil is used for re-soiling. The topsoil will be stored separately from the other salvaged materials. Signs will be placed to differentiate the topsoil stockpiles from the overburden stockpiles. Topsoil will be stored in the area designated on **Sheet 1 – Existing & Proposed Plan Overview**, of the Reclamation Plan Amendment Sheets. As mining proceeds further west from the Plant Area, new topsoil stockpile areas can be created in the quarry area. These new locations will meet the same requirements as the initial topsoil storage area.

- During bench re-soiling, overburden and fines will first be laid down to at least 22 inches. A minimum of two inches of topsoil material will then be installed on top of the overburden.
- Finished grades at the reclaimed sites will vary since there is no maximum depth of soil and overburden that can be placed on them. Greater fill depth is regulated by such factors as employee safety in resoiling a location, the potential of increased erosion, the potential of increasing vegetation success, and the availability of fill material.
- Where topsoil or overburden is used at locations sensitive to settlement, compaction of the material is required based on standard engineering practices. Fill shall be compacted per the Uniform Building Code, local grading ordinances, or other methods approved by the lead agency, which is Shasta County.

**Specific Policies/Reclamation Schedule**

Reclamation shall occur, to the maximum extent feasible, concurrently with mining activity. Overburden and topsoil will be placed on each finished bench, and vegetation planted within two years after reaching final grade, except for those portions that serve as haul routes or other functions necessary for future mining phases of the quarry.

Final reclamation occurs when all the aggregates in each mining phase are exhausted and the finished grades are attained. Interior haul roads, stockpiles, and plant sites will be reclaimed when they are no longer needed. **Table 6, Reclamation Schedule**, sets the timing of specific reclamation activities. The following bullet points address other reclamation activities not listed in **Table 6** or provide additional clarification to the proposed reclamation activities.

- Clean up all trash and other debris.
- All waste will be disposed of in accordance with state and local health and safety regulations and ordinances.
- At closure, fill slopes will conform to surrounding topography and/or end-use.
- Pursuant to CCR Section 3713(b) prior to closure, all portals, shafts, tunnels, or other surface openings to underground workings shall be gated or otherwise protected from public entry to eliminate the threat to public safety or to preserve access for wildlife habitat.
- All pond slopes will be 2:1 or less around the pond perimeter.
- The wash ponds will be filled in.
- Control of noxious weeds will occur when there is a 20% cover of weeds. Plowing, replanting, hoeing, and spraying are techniques used to control weeds.
- Compacted areas proposed for revegetation will be ripped to a depth of eight inches.
- Existing roads in the industrial use area are to remain as well as the road around Pond #6 and those necessary for the user to access areas of the remaining property. All other roads are to be removed and reclaimed per CCR 3705 (d).
- All refuse, such as paper, scrap wood, etc., will be removed.
- Permits for the proposed activities will be obtained, as necessary.

To prevent the leaking and spilling of petroleum products, the following actions will be taken:

1. All petroleum tanks and barrels will have secondary containment.
2. All equipment and machinery will be regularly checked and maintained.
3. Employees shall receive spill prevention training.
4. Adherence to the Spill Prevention Control and Countermeasure Plan (SPCCP) and Business Plan for Emergency Response (HMBP) for the Project will be required.

**Table 6**
**RECLAMATION SCHEDULE**

| Item # | Reclamation Action | Timing |
|---|---|---|
| 1 | Create Pond 6. | Last phase of mining. |
| 2 | Resoiling and planting of benches. | Concurrent reclamation with each phase of mining. Reclamation starts when the finished grade is achieved and a bench is no longer needed for future mining activities. |
| 3 | Permanent road in the quarry on Bench #2. | Concurrent reclamation as the final grade of Bench #2 is achieved, and the location is resoiled. |
| 4 | Safety fence around the quarry perimeter highwall. | Install a fence when each section of the top of the finished highwall is completed. |
| 5 | Finish grading of the plant site. | At the cessation of mining activities and when final reclamation has begun. |
| 6 | Removal of temporary mining roads. | When a road is no longer needed to support mining activities. All temporary roads will be removed before the final reclamation is completed. |
| 7 | Fill in wash ponds. | When ponds are no longer needed to wash aggregate. |
| 8 | Removal of mining equipment, facilities, and machinery inconsistent with the industrial zoning of the property. | At the cessation of mining activities and when final reclamation has begun. |

As previously noted, **Table 6, Reclamation Schedule**, lists the main reclamation activities and their timing. Concurrent reclamation means that reclamation will begin as soon as the mining activity at a location has ended and future mining activities do not impact the location. Examples of when a site is no longer impacted are cited in the previous paragraphs in this section. Concurrent reclamation, to the maximum degree feasible, is desired to occur as soon as possible and not postponed until the end of mining. The exact timing for concurrent reclamation and most other reclamation activities cannot be provided since their initiation is a performance-based standard enacted when a specific type of activity is completed. **Table 6** also provides latitude in initiating certain reclamation activities so the operator can choose when to perform a particular action instead of being held to a specific timeline.

## MONITORING

The responsibility of determining if the property is being reclaimed rests with the lead agency, which is. Shasta County. Section 2774(b) of the *Surface Mining and Reclamation Act* requires the lead agency to inspect the mine operation at least once a year. The yearly inspection will determine if the applicant is complying with the policies listed in the approved Reclamation Plan Amendment in addition to any conditions Shasta County may impose as part of the use permit and any other regulatory permits required. Furthermore, the annual monitoring shall occur approximately the same time each year and the end of the growing season until success standards are met.

Monitoring will be limited to the success of the revegetation and erosion control of the property. Monitoring can be performed during any month from March through June. The monitoring criteria for revegetation success are described on pages 34 through 37. Erosion control success will be determined by visually inspecting for the presence of bare ground areas, gullies, and/or rill erosion. Erosion will be remedied by either vegetative or structural means. These measures include re-grading, constructing check dams, and/or mulching. Different erosion situations require varying means of control and must be decided after examining the erosion source. Monitoring shall identify the revegetation success and if there are any areas with erosion. The monitoring report should also state remedial measures to correct any problems and identify modifications to the monitoring, rehabilitation, and revegetation techniques.

The Shasta County Department of Resource Management Planning Division, or a consultant hired by the operator, can monitor the property with concurrence by the Planning Division. All monitoring reports shall be submitted to the Shasta County Planning Division every year.

## MISCELLANEOUS ITEMS

This section addresses the financial assurance for the mine, public health and safety issues and the future mining of the property.

### Financial Assurance Policies

Financial assurances held for reclamation work will be released when the performance standards (as described within the Reclamation Plan Amendment's aforementioned policies and standards) are satisfied. This includes no human interference where specified (including but not limited to fertilization, irrigation, weeding, etc.) and the removal of all equipment, supplies, etc. The financial assurance will be in the form of a performance bond or other financial mechanism approved by the State Mines and Geology Board.

The operator will submit the yearly updated financial assurance to the Shasta County Department of Resource Management Planning Division.

### Public Health and Safety

This section addresses the measures taken to lessen the exposure of people and animals to site hazards, including vertical slopes and open water. To limit access to the site and minimize potential water hazards, the operator will implement the following actions:

- Cyclone fencing will be installed at all locations where there are finished highwalls, and there is the danger of persons falling from a cliff. The fencing does not need to be immediately adjacent to the cliff's edge but can be set back. Reasons for the setback include factors such as terrain, installing the fence in a straight line, fence visibility, etc. Therefore, a fence may be adjacent to the cliff at one location and 50 feet away at another.
- Highwalls in the process of being created will have a construction road along their top. This road must have a safety berm to keep personnel, vehicles, and equipment from going over the highwall edge.
- Access from Iron Mountain Road onto the Project Site is controlled using cyclone fencing. The owner is in the process of fencing adjoining properties (under the same ownership) to deter trespassing wherever there are features (e.g., existing trails, roads, etc.) which have historically provided access to the Project Site.
- Pond Slopes: The finished slopes around pond edges will not exceed 2:1 between the low and high watermarks. This will help prevent the ponds from becoming a trap for any animals which might access the area after mining has ceased.

### Future Mining of Property

The plant site area will be reclaimed for industrial use. The industrial area will not likely have future mining activity since industrial buildings and associated activities will probably be developed. However, industrial use does not preclude mining on adjacent lands if deemed a compatible land use with mining. In addition, the quarry area and adjoining lands contain aggregate reserves of marketable quality. Potential future operators may seek to utilize this resource after the exhaustion of aggregates in the mining plan area. Therefore, replanting the quarry area with vegetation and its partial use as a lake does not compromise future mining at this location or adjacent lands.

Tullis, Inc. dba Crystal Creek Aggregates is also the only landowner within the Reclamation Plan Amendment Boundaries so they are aware of the proposed uses and potential uses of this amendment to the Reclamation Plan.

**County Ordinances Applicable to the Mining Operation**

The property constituting Crystal Creek Aggregates' Mine operation is zoned Mineral Resources (MR), and Interim Mineral Resources (I-MR). The General Plan Designations are Mineral Resource (MR), and Industrial-Interim Mineral Resource Overlay (I-IMR). The proposed Reclamation Plan Amendment is consistent with the objectives and policies described in sections 6.3.3 and 6.3.4 of the General Plan, and with Shasta County Municipal Zoning Code sections 17.12.030 and 17.88.020 which allow surface mining operations with approval of a use permit.

Pursuant to Shasta County Municipal Code section 18.040.080 (G)(11), prior to approval, the approving body shall make the following findings:

1. The project has been reviewed pursuant to CEQA, and the county's environmental review guidelines, all adverse impacts related to the Reclamation Plan Amendment have been mitigated by the plan and/or the recommended condition of approval, and the appropriate environmental determination has been adopted;
2. The reclamation plan complies with the requirements of the State Surface Mining and Reclamation Act of 1975 (SMARA), specifically PRC Code Sections 2772 and 2773, and the Reclamation Standards specified in California Code of Regulations, Title 14, Division 2, Chapter 8, Subchapter 1, Article 9, Sections 3700 through 3713;
3. That the Reclamation Plan Amendment has been forwarded to the Department of Conservation for review.
4. The Reclamation Plan Amendment complies with the purpose, intent, and requirements of Shasta County Municipal Code Chapter 18;
5. The proposed goal of reclamation is consistent with the general plan policies and the zone district for the area.

## ACCEPTANCE OF RECLAMATION

I, Chris Handley, hereby accept full responsibility by Tullis, Inc. dba Crystal Creek Aggregates for reclaiming all mined lands described and submitted herein, with any modifications required by Shasta County as conditions of approval.

| | |
|---|---|
| ______________________________ | 12/28/22 |
| Chris Handley – Owner of Operation | Date |

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## APPENDIX A – DEFINITIONS

### Reclamation Plan Amendment Definitions

Various terms are used in Crystal Creek Aggregates Reclamation Plan Amendment. These terms have various meanings to different individuals and groups. In order for all parties to use terms in the same manner, the definition of several words used the Reclamation Plan Amendment text are listed.

- **Aggregate**. Any of several hard, inert materials, such as sand, gravel, or crushed stone, mixed with a cement or bituminous material to form concrete, mortar, or plaster, or used alone, as in railroad ballast, graded fill, barriers, or ornamental products.
- **Existing Reclamation Plan**. Land currently within the boundaries of Reclamation Plan 07-002 approved on June 12, 2008, comprises 110.69 acres.
- **Existing Use Permit**. Use Permit 07-020 approved on June 12, 2008.
- **Material**. This word is interchangeable with the term "Aggregate."
- **Mined Lands**.[27] Per SMARA §2729. "Mined lands" includes the surface, subsurface, and groundwater of an area in which surface mining operations will be, are being, or have been conducted, including private ways and roads appurtenant to any such area, land excavations, workings, mining waste, and areas in which structures, facilities, equipment, machines, tools, or other materials or property which result from or are used in, surface mining operations are located.
- **Mining Area (MA)**. The existing and proposed Mining Area (MA) in the Reclamation Plan Amendment west of the Plant Area. This area includes the existing mining and proposed Reclamation Pond #6 area as well as the benches and highwalls shown on the existing and proposed 110-69-acre Reclamation Plan Amendment map. The words are interchangeable with "Quarry Area."
- **Plant Area**. Includes those areas directly outside the existing Mining Area (MA) and Remaining Mineral Resource Area, including, but not limited to, the following:
    - Existing Settling Ponds #1, #2, and #3
    - Existing Ponds #4 and #5
    - Existing Recycle Ponds
    - Existing topsoil and material stockpiles
    - Existing office, scales, equipment storage area, roadways, driveways, parking area, drainage courses, culverts, water lines and fire hydrants, water tender/tank, septic tank and leach fields, electrical lines and utility poles, covered fuel storage, crushing and screening plant, and landscaping; and,
- **Project**. Those lands encompass areas for increased development and operation of CCA being sought by Reclamation Plan Amendment 22-0001.

[27] Surface Mining and Reclamation Act and Associated Laws (SMARA) Public Resources Code, Division 2, Chapter 9, Section 2710 et seq.

- **Project Area**. All land within which the proposed project encompasses approximately 110.69 acres that include the existing Plant Area and Mining Area (MA). This Project Area does not include an additional 69.28 acres that are included in the proposed use permit area of 179.97 acres.

- **Project Site or Site**. The words are interchangeable with "Project Area."

- **Property**. All 17.95 acres owned by Tullis Inc. of APN 065-250-032 and 162.02 acres of the 172.02 acres of APN 065-250-031.) are directly part of the proposed Project.

- **Quarry**. A quarry is a type of open-pit mine in which dimension stone, rock, construction aggregate, riprap, sand, gravel, or slate is obtained by blasting, cutting and excavated from the ground. [28]

- **Reclamation**. [29] Per SMARA §2733. "Reclamation" means the combined process of land treatment that minimizes water degradation, air pollution, damage to aquatic or wildlife habitat, flooding, erosion, and other adverse effects from surface mining operations, including adverse surface effects incidental to underground mines, so that mined lands are reclaimed to a usable condition which is readily adaptable for alternate land uses and create no danger to public health or safety. The process may extend to affected lands surrounding mined lands, and may require backfilling, grading, resoiling, revegetation, soil compaction, stabilization, or other measures.

- **Reclamation Plan Amendment Area**. The Reclamation Plan Amendment area of 110.69 acres includes the existing Plant Area and existing and proposed Mining Area (MA). The boundaries of the existing Reclamation Plan will be retained.

- **Reclamation Plan Amendment**. Land for which Reclamation Plan Amendment 22-0001 is being processed. Whereas the boundaries of the existing Reclamation Plan will not be altered, the design of the Mining Area (MA) will be redesigned, in particular the benches, highwalls, Pond #6 area, and depth.

- **Surface Mining Operations**. [30] Per SMARA §2735. "Surface mining operations" means all, or any part of, the process involved in the mining of minerals on mined lands by removing overburden and mining directly from the mineral deposits, open-pit mining of minerals naturally exposed, mining by the auger method, dredging and quarrying, or surface work incident to an underground mine. Surface mining operations shall include, but are not limited to:

    (a) In place distillation or retorting or leaching.
    (b) The production and disposal of mining waste.
    (c) Prospecting and exploratory activities.

- **Use Permit Amendment**. Land for which Use Permit Amendment 22-0001 is being processed.

[28] Sources: Wikipedia https://en.wikipedia.org/wiki/Quarry and Dictionary.com https://www.dictionary.com/ browse/ quarry
[29] Ibid.
[30] Surface Mining and Reclamation Act and Associated Laws (SMARA) Public Resources Code, Division 2, Chapter 9, Section 2710 et seq.

- **Use Permit Amendment Area**. Approximately 179.97 acres of land which currently includes the boundaries of the existing Use Permit where the Plant Area is located and the existing and proposed Mining Area (MA).

**DEFINITIONS FROM THE SURFACE MINING AND RECLAMATION ACT AND ASSOCIATED LAWS (SMARA) PUBLIC RESOURCES CODE, DIVISION 2, CHAPTER 9, SECTION 2710 ET SEQ.**

§ 2729. "Mined lands" includes the surface, subsurface, and ground water of an area in which surface mining operations will be, are being, or have been conducted, including private ways and roads appurtenant to any such area, land excavations, workings, mining waste, and areas in which structures, facilities, equipment, machines, tools, or other materials or property which result from, or are used in, surface mining operations are located.

§ 2733. "Reclamation" means the combined process of land treatment that minimizes water degradation, air pollution, damage to aquatic or wildlife habitat, flooding, erosion, and other adverse effects from surface mining operations, including adverse surface effects incidental to underground mines, so that mined lands are reclaimed to a usable condition which is readily adaptable for alternate land uses and create no danger to public health or safety. The process may extend to affected lands surrounding mined lands, and may require backfilling, grading, resoiling, revegetation, soil compaction, stabilization, or other measures.

§ 2735. "Surface mining operations" means all, or any part of, the process involved in the mining of minerals on mined lands by removing overburden and mining directly from the mineral deposits, open-pit mining of minerals naturally exposed, mining by the auger method, dredging and quarrying, or surface work incident to an underground mine. Surface mining operations shall include, but are not limited to:

(a) In place distillation or retorting or leaching.
(b) The production and disposal of mining waste.
(c) Prospecting and exploratory activities

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# APPENDIX B – CHART PER PRC 2772(b)

**Location and Page(s) of SMARA section referenced.**

P – Pages containing referenced material.
RPT – Reclamation Plan Text
RPM – Reclamation Plan Map Sheets
BGR – Bajada Geosciences Geotechnical Report
L&A – Lawrence & Associates Hydrological Evaluation
GAL-A – Gallaway Draft Delineation of Aquatic Resources
GAL-B – Gallaway Biological Resource Assessment

Date: February 9, 2020
Updated: December 26, 2022

## GENERAL CONSIDERATIONS

| AUTHORITY | REQUIREMENTS/PRACTICES/STANDARDS | Yes, No or N/A | LOCATION IN DOCUMENT |
|---|---|---|---|
| PRC 2772(c)(1) | Contact information:<br>Name and address of the surface mining operator and any person designated by the operator as an agent for service of process (must reside in CA). | Yes | RPT P. 1 |
| PRC 2772(c)(2) | Material quantity and type:<br>The anticipated total quantity and type of minerals to be mined (see Annual Report Instructions, Exhibit B, for mineral types and units of measure) | Yes | RPT P. 2 |
| PRC 2772(c)(3) | Dates:<br>The initiation and termination dates of mining (be as specific as possible, e.g., December 31, 2030). | Yes | RPT P. 2 |
| PRC 2772(c)(4) | Depth of mining:<br>The maximum anticipated depth of the surface mining operation. | Yes | RPT P. 2, RPM |
| PRC 2772(c)(5) (A-F) | Reclamation plan maps shall include:<br>Size and legal description of lands affected by surface mining operations; | Yes | RPM |
| | Names and addresses of owners of all surface interests and mineral interests; | Yes | RPM |
| | Property lines, setbacks, and the reclamation plan boundary; | Yes | RPM |
| | Existing and final topography with contour lines at appropriate intervals; | Yes | RPM |
| | Detailed geologic description of the area of the surface mining operation; | Yes | BGR |
| | Locations of railroads, utility features, and roads (access roads, temporary roads to be reclaimed, and any roads remaining for the end use). | Yes | RPM |
| | All maps, diagrams, or calculations that are required to be prepared by a California-licensed professional shall include the preparer's name, license number, signature & seal. | Yes | RPM |
| PRC 2772(c)(6) | Mining method and schedule:<br>A description of the mining methods and a time schedule that provides for completion of mining on each segment so that reclamation can be concurrent or phased. | Yes | RPM Sheet 5 of 8<br>RPT P. 24-27, 29-34 & 44-47 |
| PRC 2772(c)(7) | Subsequent use(s):<br>A description of the proposed subsequent use(s) after reclamation | Yes | RPT P.2, 49-50 |
| | Evidence that all landowners have been notified of the proposed use. | Yes | RPT P. 50 |
| PRC 2772(c)(9) | Impact on future mining:<br>A statement regarding the impact of reclamation on future mining on the site. | Yes | RPT P. 49-50 |
| PRC 2772(c)(10) | Statement signed by the operator accepting responsibility for reclamation of the mined lands per the reclamation plan. | Yes | RPT P. 51 |
| PRC 2772 (c)(11) | Any other information the Lead Agency may require by Ordinance. | Yes | RPT P. 48 & 50 |
| PRC 2776(b- c) | Pre-SMARA areas:<br>Reclamation plans shall apply to operations conducted after January 1, 1976 or to be conducted in the future. Mined lands disturbed prior to January 1, 1976 and not disturbed after that date may be excluded from the reclamation plan. | N/A | |

| | | | |
|---|---|---|---|
| CCR 3502(b)(2) | Public health and safety:<br>A description of how any potential public health and safety concerns that may arise due to exposure of the public to the site will be addressed. | Yes | RPT P.49 |
| CCR 3709(a) | Equipment storage and waste disposal:<br>Designate areas for equipment storage and show on maps. | Yes | RPM Sheets 1 & 2 of 8<br>RPT P. 28 |
| | All waste shall be disposed of in accordance with state and local health and safety ordinances. | Yes | RPT P. 46 |
| CCR 3709(b) | Structures and equipment should be dismantled and removed at closure, except as demonstrated to be necessary for the proposed end use. | Yes | RPT P. 32-33 & 47 |
| CCR 3713(a) | Well closures:<br>Drill holes, water wells, monitoring wells will be completed or abandoned in accordance with laws, unless demonstrated necessary for the proposed end use. | Yes | RPT P. 14-15 |
| CCR 3713(b) | Underground openings:<br>Any portals, shafts, tunnels, or openings will be gated or protected from public entry, and to preserve access for wildlife (e.g. bats). | Yes | RPT P.46 |
| **GEOLOGY & GEOTECHNICAL** | | | |
| PRC 2772(c)(5) | A description of the general geology of the area | Yes | RPT P. 10-11 & BGR |
| | A detailed description of the geology of the mine site. | | RPT P. 11-13 & BGR |
| PRC 2773.3 | If a metallic mine is located on, or within one mile of, any “Native American sacred site” and is located in an “area of special concern, ” the reclamation plan shall require that all excavations and/or excess materials be backfilled and graded to achieve the approximate original contours of the mined lands prior to mining. | N/A | |
| CCR 3502(b)(4) | The source and disposition of fill materials used for backfilling or grading shall be considered in the reclamation plan. | Yes | RPT P. 26-29, 32-34, 45-46 |
| CCR 3502(b)(3) | The designed steepness and treatment of final slopes must consider the physical properties of slope materials, maximum water content, and landscaping. | Yes | RPT P. 23-25, 33-37 & BGR |
| | The reclamation plan shall specify slope angles flatter than the critical gradient for the type of slope materials. | Yes | RPT P. 3, 23-24, 33 & BGR |
| | When final slopes approach the critical gradient, a Slope Stability Analysis will be required. | Yes | BGR |
| CCR 3704.1 | Backfilling required for surface mining operations for metallic minerals. | N/A | |
| CCR 3704(a) | For urban use, fill shall be compacted in accordance with Uniform Building Code, local grading ordinance, or other methods approved by the lead agency. | Yes | RPT P. 46 |
| CCR 3704(b) | For resource conservation, compact to the standards required for that end use. | Yes | RPT P. 33-34 & 46 |
| CCR 3704(d) | Final reclamation fill slopes shall not exceed 2:1 (H:V), except when allowed by site-specific engineering analysis, and the proposed final slope can be successfully revegetated. See also Section 3502(b)(3). | Yes | RPT. P. 45, 49 & BGR |
| CCR 3704(e) | At closure, all fill slopes shall conform with the surrounding topography or approved end use. | Yes | RPT P. 33 & 46 |
| CCR 3704(f) | Final cut slopes must have a minimum slope stability factor of safety that is suitable for the end use and conforms with the surrounding topography or end use. | Yes | BGR |
| **HYDROLOGY & WATER QUALITY** | | | |
| PRC 2770.5 | For operations within the 100-year flood plain (defined by FEMA) and within one mile up- or downstream of a state highway bridge, Caltrans must be notified and provided a 45-day review period by the lead agency. | N/A | |
| PRC 2772(c)(8)(A) | Description of the manner in which contaminants will be controlled and mine waste will be disposed. | Yes | Contaminants RPT P. 29. Mine waste is overburden and wash fines. RPT P. 27-29 |
| PRC 2772(c)(8)(B) | The reclamation plan shall include a description of the manner in which stream banks/beds will be rehabilitated to minimize erosion and sedimentation. | N/A | |

| | | | |
|---|---|---|---|
| PRC 2773(a) | The reclamation plan shall establish site-specific sediment and erosion control criteria for monitoring compliance with the reclamation plan. | Yes | RPT P. 28-29, 31, 33, 44-45 & 48 |
| CCR 3502(b)(6) | Temporary stream and watershed diversions shall be detailed in the reclamation plan. | Yes | RPM & L&A |
| CCR 3503(a)(2) | Stockpiles of overburden and minerals shall be managed to minimize water and wind erosion. | Yes | RPT P. 29, 44-45, 48 |
| CCR 3503(b)(2) | Operations shall be conducted to substantially prevent siltation of groundwater recharge areas. | N/A | |
| CCR 3503(a)(3) | Erosion control facilities shall be constructed and maintained where necessary to control erosion. | N/A | |
| CCR 3503(b)(1) | Settling ponds shall be constructed where they will provide a significant benefit to water quality | Yes | RPT P. 9, 19, 23, 29, 33, 36-37, RPM & L&A |
| CCR 3503(d) | Disposal of mine waste and overburden shall be stable and shall not restrict natural drainage without suitable provisions for diversion. | N/A | |
| CCR 3503(e) | Grading and revegetation shall be designed to minimize erosion and convey surface runoff to natural drainage courses or interior basins. | Yes | RPT P. 33-40, 44-45 & RPM |
| | Spillway protection shall be designed to prevent erosion. | Yes | RPT P. 36, 45 & RPM |
| CCR 3706(a) | Surface mining and reclamation activities shall be conducted to protect on-site and downstream beneficial uses of water. | Yes | RPT P. 19 & L&A |
| CCR 3706(b) | Water quality, recharge potential, and groundwater storage that is accessed by others shall not be diminished. | Yes | L&A |
| CCR 3706(c) | Erosion and sedimentation shall be controlled during all phases of construction, operation, reclamation, and closure of surface mining operations to minimize siltation of lakes and water courses as per RWQCB/SWRCB. | Yes | RPT P 9, 19, 28-29, 34-35, 44-45 |
| CCR 3706(d) | Surface runoff and drainage shall be controlled to protect surrounding land and water resources. | Yes | RPT P. 9,19-20, 28-29, 33-34, 35-37, 39-40, 42-45 & L&A |
| | Erosion control methods shall be designed for not less than 20 year/1 hour intensity storm event. | Yes | RPT. 45 |
| CCR 3706(e) | Impacted drainages shall not cause increased erosion or sedimentation. Mitigation alternatives shall be proposed in the reclamation plan. | Yes | RPM<br>RPT P. 36-41, & 44-46 |
| CCR 3706(f)(1) | Stream diversions shall be constructed in accordance with the Lake and Streambed Alteration Agreement (LSAA) between the operator and the Department of Fish and Wildlife. | Yes | RPT P. 22, 42-44 |
| CCR 3706(f)(2) | Stream diversions shall also be constructed in accordance with Federal Clean Water Act and the Rivers and Harbors Act of 1899. | Yes | RPT P. 22, 42-44 |
| CCR 3706(g) | All temporary stream diversions shall eventually be removed and the affected land reclaimed. | Yes | RPM |
| CCR 3710(a) | Surface and groundwater shall be protected from siltation and pollutants in accordance with the Porter-Cologne Act, the Federal Clean Water Act, and RWQCB/SWRCB requirements. | Yes | RPT P. 19 |
| CCR 3710(b) | In-stream mining shall be conducted in accordance with Section 1600 et seq. of the California Fish and Game Code, Section 404 of the Clean Water Act, and Section 10 of the Rivers and Harbors Act of 1899. | Yes | RPT P. 42-44 |
| CCR 3710(c) | In-stream mining shall be regulated to prevent impacts to structures, habitats, riparian vegetation, groundwater levels, and banks. | N/A | |
| | In-stream channel elevations and bank erosion shall be evaluated annually using extraction quantities, cross-sections, and aerial photos. | N/A | |
| CCR 3712 | Mine waste and tailings and mine waste disposal units are governed by SWRCB waste disposal regulations and shall be reclaimed in accordance with this article: CCR Article 1. Surface Mining and Reclamation Practice. Section 3500 et seq. | N/A | |
| **SENSITIVE SPECIES & HABITAT** | | | |
| CCR 3502(b)(1) | A description of the environmental setting (identify sensitive species, wildlife habitat, sensitive natural communities, e.g. wetlands). | Yes | RPT P. 19-23, GAL-A & GAL-B |

| | | | |
|---|---|---|---|
| | Impacts of reclamation on surrounding land uses. | Yes | RPT P. 23-25 |
| CCR 3503(c) | Fish and wildlife habitat shall be protected by all reasonable measures. | Yes | RPT P. 19-23 & GAL-B |
| CCR 3703(a) | Sensitive species shall be conserved or mitigated as prescribed by the federal and California Endangered Species Acts. | Yes | RPT P. 19-23 & GAL-B |
| CCR 3703(b) | Wildlife habitat shall be established on disturbed land at least as good as pre-project, unless end use precludes its use as wildlife habitat. | Yes | RPT P. 33-44 & GAL-B |
| CCR 3703(c) | Wetlands shall be avoided or mitigated at 1:1 minimum for both acreage and habitat value. | Yes | RPT P. 42-44 & GAL-A |
| CCR 3704(g) | Piles or dumps shall not be placed in wetlands without mitigation. | N/A | |
| CCR 3710(d) | In-stream mining shall not cause fish to be trapped in pools or off-channel pits or restrict migratory or spawning activities. | N/A | |
| **TOPSOIL** | | | |
| CCR 3503(a)(1) | Removal of vegetation and overburden preceding mining shall be kept to a minimum. | Yes | RPT P.26 |
| CCR 3503(f) | When the reclamation plan calls for resoiling, mine waste shall be leveled and covered with a layer of finer material. A soil layer shall then be placed on this prepared surface. | Yes | RPT P. 45-46 & RPM |
| | The use of soil conditioners, mulches, or imported topsoil shall be considered where such measures appear necessary. | N/A | |
| CCR 3704(c) | Mine waste shall be stockpiled to facilitate phased reclamation and kept separate from topsoil or other growth media. | Yes | RPT P. 28-29, 45-46 & RPM |
| CCR 3705(e) | If soil is altered or other than native topsoil, soil analysis is required. Add fertilizers or soil amendments if necessary. | N/A | |
| CCR 3711(a) | All salvageable topsoil shall be removed as a separate layer. | Yes | RPT P. 28-29 |
| | Topsoil and vegetation removal should not precede mining by more than one year. | Yes | RPT P. 26 |
| CCR 3711(b) | Topsoil resources shall be mapped prior to stripping and location of topsoil stockpiles shown on map included in the reclamation plan. | Yes | RPT P. 15-18 & RPM |
| | Topsoil and other growth media shall be maintained in separate stockpiles. | Yes | RPT P. 26-29 & 45-46 |
| | Test plots may be required to determine the suitability of growth media for revegetation purposes. | Yes | RPT P. 30-31 |
| CCR 3711(c) | Soil salvage operations and phases of reclamation shall be set forth in the reclamation plan to minimize the area disturbed and to achieve maximum revegetation success. | Yes | RPT P. 31-32 |
| CCR 3711(d) | Topsoil and growth media shall be used to phase reclamation as soon as can be accommodated following the mining of an area. | Yes | RPT. P. 24, 30-31, 33-34, 45-47 |
| | Topsoil stockpiles shall not be disturbed until needed for reclamation. | Yes | RPT. P. 29-30 & 45 |
| | Topsoil stockpiles shall be clearly identified. | Yes | RPT. P. 26, 28-29, 45-46 & RPM |
| | Topsoil shall be planted with vegetation or otherwise protected to prevent erosion and discourage weeds. | Yes | RPT. P. 29 & 44-46 |
| CCR 3711(e) | Topsoil shall be redistributed in a manner resulting in a stable, uniform thickness consistent with the end use. | Yes | RPT P. 30-31, 33-34, 36-37 & 45-48 |
| **REVEGETATION** | | | |
| PRC 2773(a) | The reclamation plan shall be specific to the property and shall establish site-specific criteria for evaluating compliance with the reclamation plan with respect to revegetation. | Yes | RPT P. 34-40 |
| CCR 3503(g) | Available research regarding revegetation methods and selection of species given the topography, resoiling characteristics, and climate of the mined areas shall be used | Yes | RPT P. 34-41 & WRM |
| CCR 3705(a) | Baseline studies shall be conducted prior to mining activities to document vegetative cover, density, and species richness. | Yes | RPT P. 34-39 GAL-B |
| | Vegetative cover shall be similar to surrounding habitats and self-sustaining. | Yes | RPT P. 36-39 GAL-B |

| | | | |
|---|---|---|---|
| CCR 3705(b) | Test plots shall be conducted simultaneously with mining to ensure successful implementation of the proposed revegetation plan. | Yes | RPT P. 30-31, 44 & RPM |
| CCR 3705(c) | Decompaction methods, such as ripping and disking, shall be used in areas to be revegetated to establish a suitable root zone for planting. | Yes | RPT P. 39 & 46 |
| CCR 3705(d) | Roads shall be stripped of road base materials, resoiled, and revegetated, unless exempted. | Yes | RPT P. 46-47 |
| CCR 3705(f) | Temporary access shall not disrupt the soil surface on arid lands except where necessary for safe access. Barriers shall be installed to keep unauthorized vehicles out. | N/A | |
| CCR 3705(g) | Use local native plant species (unless non-native species meet the end use). | Yes | RPT P. 33, 34-40 & 44 |
| | Areas to be developed for industrial, commercial, or residential shall be revegetated for the interim period to control erosion. | Yes | RPT P. 33 |
| CCR 3705(h) | Planting shall be conducted during the most favorable period of the year for plant establishment. | Yes | RPT P. 35-36 & 40 |
| CCR 3705(i) | Use soil stabilizing practices and irrigation when necessary to establish vegetation. | Yes | RPT P. 30-31 & 44-45 |
| CCR 3705(j) | If irrigation is used, demonstrate that revegetation has been self-sustaining without irrigation for two years prior to the release of financial assurance. | N/A | |
| CCR 3705(k) | Noxious weeds shall be monitored and managed. | Yes | RPT P. 46 |
| CCR 3705(l) | Plant protection measures such as fencing and caging shall be used where needed for revegetation success. Protection measures shall be maintained until revegetation efforts are successfully completed and the lead agency authorizes removal. | Yes | RPT P. 44-45 |
| CCR3705(m) | Quantitative success standards for vegetative cover, density, and species richness shall be included in the reclamation plan. | Yes | RPT P. 34-41 |
| | Monitoring to occur until success standards have been achieved. | Yes | RPT P. 35-36, 44-45 & 48 |
| | Sampling techniques for measuring success shall be specified. Sample size must be sufficient to provide at least an 80 percent statistical confidence level. | Yes | RPT P. 44 |
| **AGRICULTURE** | | | |
| CCR 3707(a) | Where the end use will be agriculture, prime agricultural land shall be returned to a fertility level specified in the reclamation plan. | N/A | |
| CCR 3707(b) | Segregate and replace topsoil in proper sequence by horizon in prime agricultural soils. | N/A | |
| CCR 3707(c) | Post reclamation productivity rates for prime agricultural land must be equal to pre-project condition or to a similar site for two consecutive years. | N/A | |
| | Productivity rates shall be specified in the reclamation plan. | N/A | |
| CCR 3707(d) | If fertilizers and amendments are applied, they shall not cause contamination of surface or groundwater. | N/A | |
| CCR 3708 | For sites where the end use is to be agricultural, non-prime agricultural land must be reclaimed to be capable of sustaining economically viable crops common to the area. | N/A | |

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## APPENDIX C – MAP SHEETS

The following Map Sheets referenced in the Reclamation Plan Amendment are provided on the subsequent pages.

- Sheet 1, Existing & Proposed Plan Overview
- Sheet 2, Proposed Mining Plan
- Sheet 3, Existing Quarry Cross Sections
- Sheet 4, Proposed Quarry Cross Sections
- Sheet 5, Proposed Phasing Plan Overview
- Sheet 6, Proposed Phasing Cross Sections
- Sheet 7, Reclamation Plan
- Sheet 8, Reclamation Plan Details
- Sheet 9, Comprehensive Project Plan & Wetland Delineation

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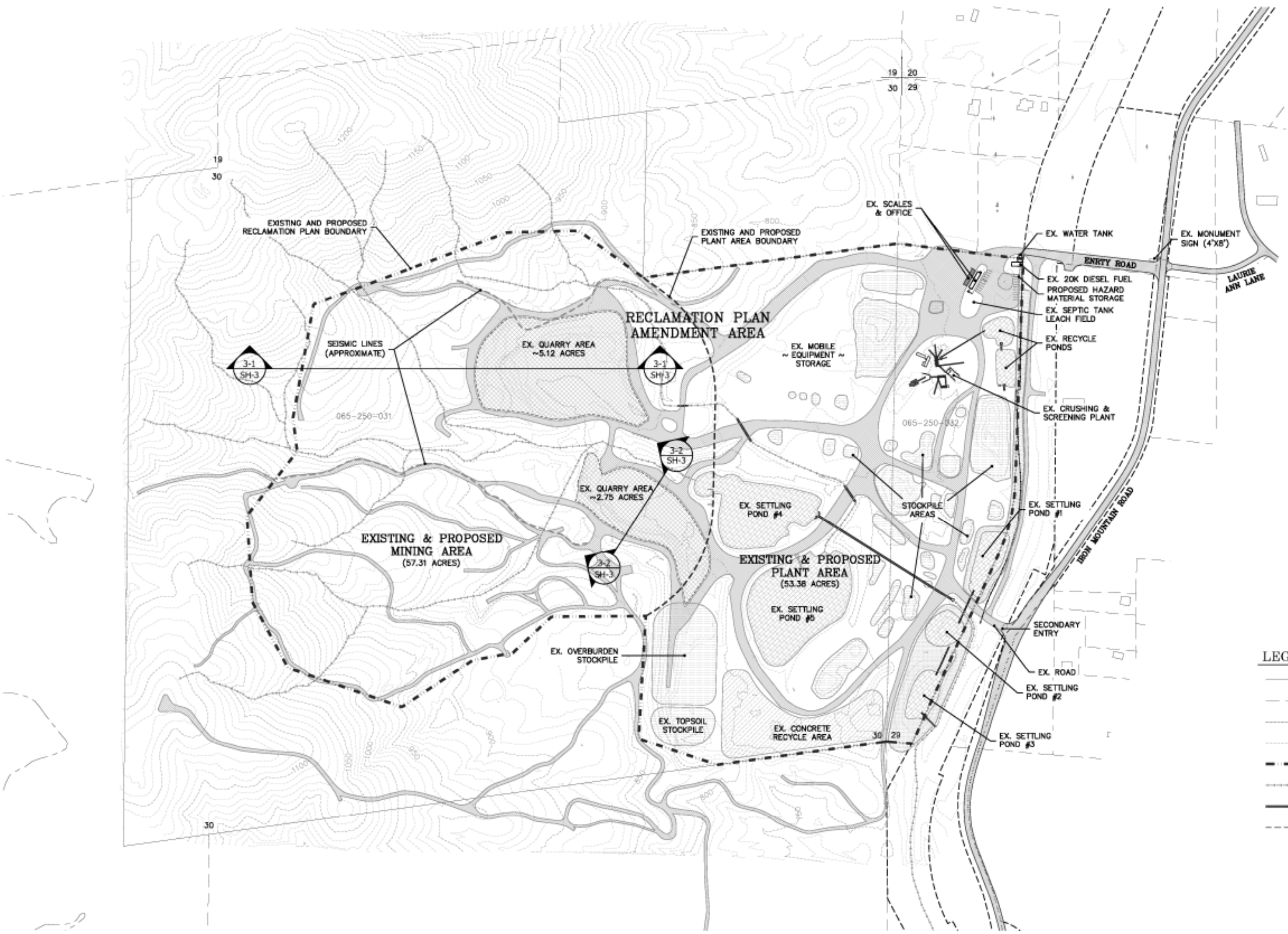
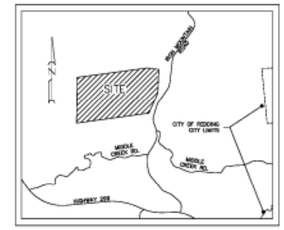



VICINITY MAP
NOT TO SCALE

**OWNER**
TULLIS, INC. DBA
CRYSTAL CREEK AGGREGATES
P.O. BOX 493416
REDDING, CA 96049
(530) 241-5105

**MINE OPERATOR**
TULLIS, INC. DBA
CRYSTAL CREEK AGGREGATES
P.O. BOX 493416
REDDING, CA 96049
(530) 241-5105

**ENGINEER**
DUANE K. MILLER
CIVIL ENGINEER, INC.
PO BOX 1307
ANDERSON, CA 96007
(530) 365-5610

**LAND PLANNER**
KEITH HAMBLIN
LAND DESIGNERS, INC.
1975 PLACER ST, SUITE A
REDDING, CA 96001
530-244-0506

**APN**
065-250-031
065-250-032

**ACREAGE**
RECLAMATION AREA: 110.69 ACRES
MINING AREA: 57.31 ACRES
PLANT AREA: 53.38 ACRES

**PARCEL TABLE**

| APN | AREA (ACRES) | GENERAL PLAN | ZONING |
|---|---|---|---|
| PORTION OF 065-250-031 | 29.19 | I-IMR (Industrial; Interim Minerals) | M-IMR (General Industrial; Interim Mineral Resource) |
| PORTION OF 065-250-031 | 63.55 | MR (Mineral Resource) | MR (Mineral Resource) |
| 065-250-032 | 17.95 | I-IMR (Industrial; Interim Minerals) | M-IMR (General Industrial; Interim Mineral Resource) |
| TOTAL | 110.69 | | |

**LEGEND**

| | |
|---|---|
| PROPERTY LINE | (EX) LANDSCAPING |
| PARCEL BOUNDARIES | (EX) PONDS |
| APN BOUNDARIES | (EX) STOCKPILE AREAS |
| 120 10' OG CONTOURS | (EX) QUARRY AREAS |
| RECLAMATION PLAN BOUNDARY | (EX) ROAD |
| (EX) DRAINAGE COURSES | (EX) TRUCK ROUTE |
| (EX) CULVERTS | |
| (EX) SEISMIC LINES (APPROXIMATE) | |

LOCATED IN SECTION 30 TOWNSHIP 32 NORTH, RANGE 5 WEST, M.D.M. IN THE UNINCORPORATED TERRITORY OF SHASTA COUNTY, CALIFORNIA

RECLAMATION PLAN
AMENDMENT 22-0001

GRAPHIC SCALE
( IN FEET )
1 inch = 200 ft.

**NOTES**

1. DETAILED GEOLOGIC DESCRIPTION IS PROVIDED IN RECLAMATION PLAN TEXT.
2. STOCKPILE AREA LOCATIONS AND SIZES VARY.

**PROPOSED MINING QUANTITIES**

| | |
|---|---|
| RECLAMATION AREA: | 110.69 ACRES |
| MINING AREA: | 57.31 ACRES |
| VOLUME: | 12.41 MILLION C.Y. |

**SHEET INDEX**



PLANS PREPARED UNDER THE SUPERVISION OF:

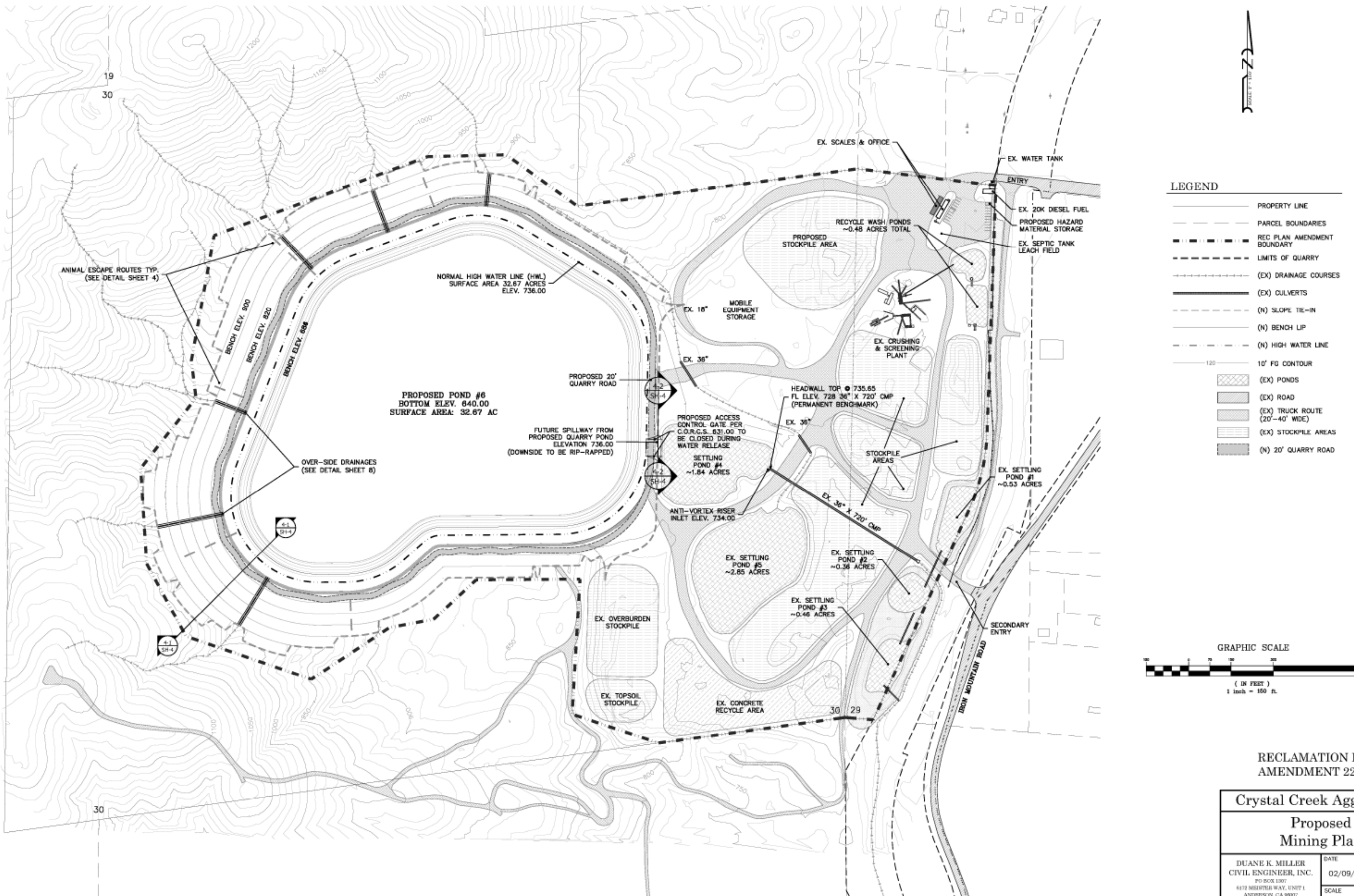
REGISTERED PROFESSIONAL ENGINEER DUANE K. MILLER No. 29490 EXP. 03/31/23 CIVIL STATE OF CALIFORNIA

Crystal Creek Aggregates

Existing & Proposed Plan Overview

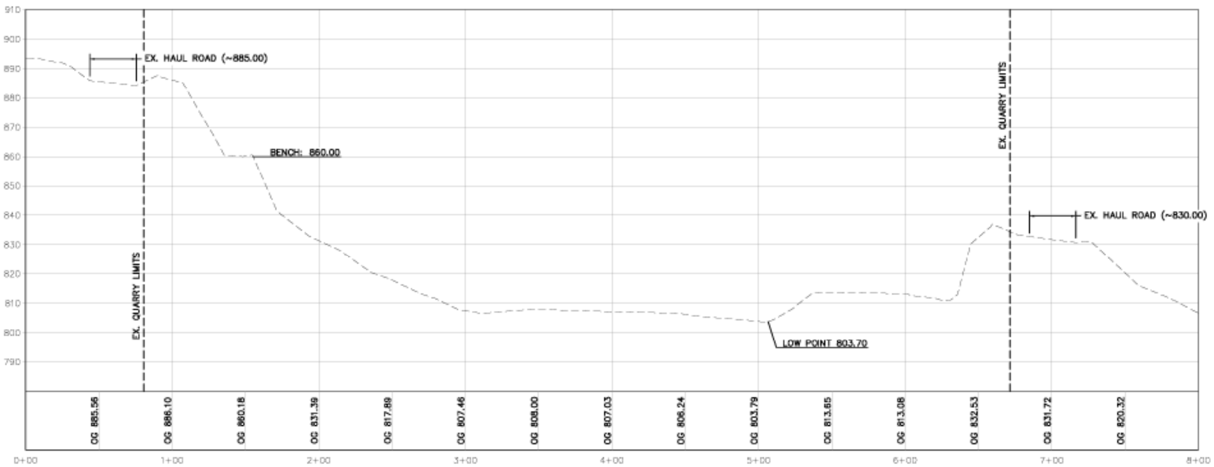

DUANE K. MILLER
CIVIL ENGINEER, INC.
PO BOX 1307
6172 MEISTER WAY, UNIT 1
ANDERSON, CA 96007
530 365-5610
DKMENGR.COM


| DATE | SHEET |
|---|---|
| 02/09/22 | 1 |
| SCALE | OF |
| 1"= 200' | 8 |



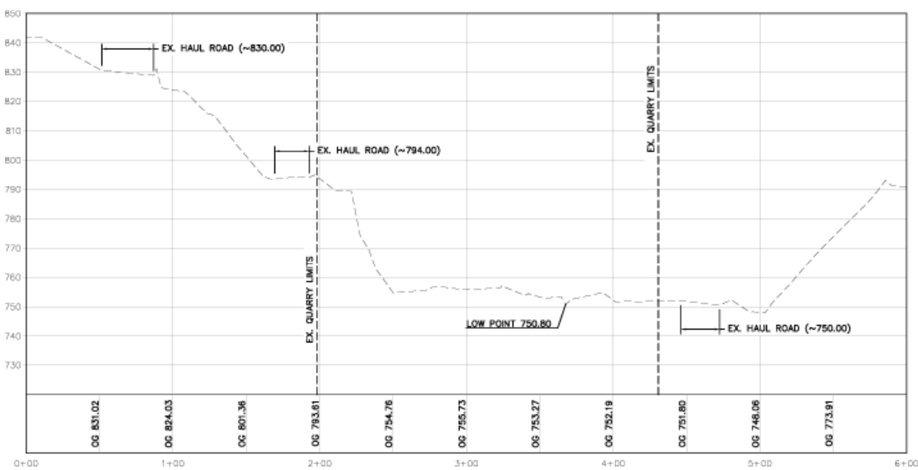

RECLAMATION PLAN
AMENDMENT 22-0001

| | | |
|---|---|---|
| Crystal Creek Aggregates | | |
| Proposed Mining Plan | | |
| DUANE K. MILLER<br>CIVIL ENGINEER, INC.<br>6172 MEISTER WAY, UNIT 1<br>ANDERSON, CA 96007<br>DKMENGR.COM | DATE<br>02/09/22 | SHEET<br>2 |
| | SCALE<br>1"= 150' | OF<br>8 |




3-1: EXISTING QUARRY SECTION

HORZ: 1"=40'; VERT: 1"=20'




3-2: EXISTING QUARRY SECTION

HORZ: 1"=40'; VERT: 1"=20'

GRAPHIC SCALE

( IN FEET )
1 inch = 40 ft.

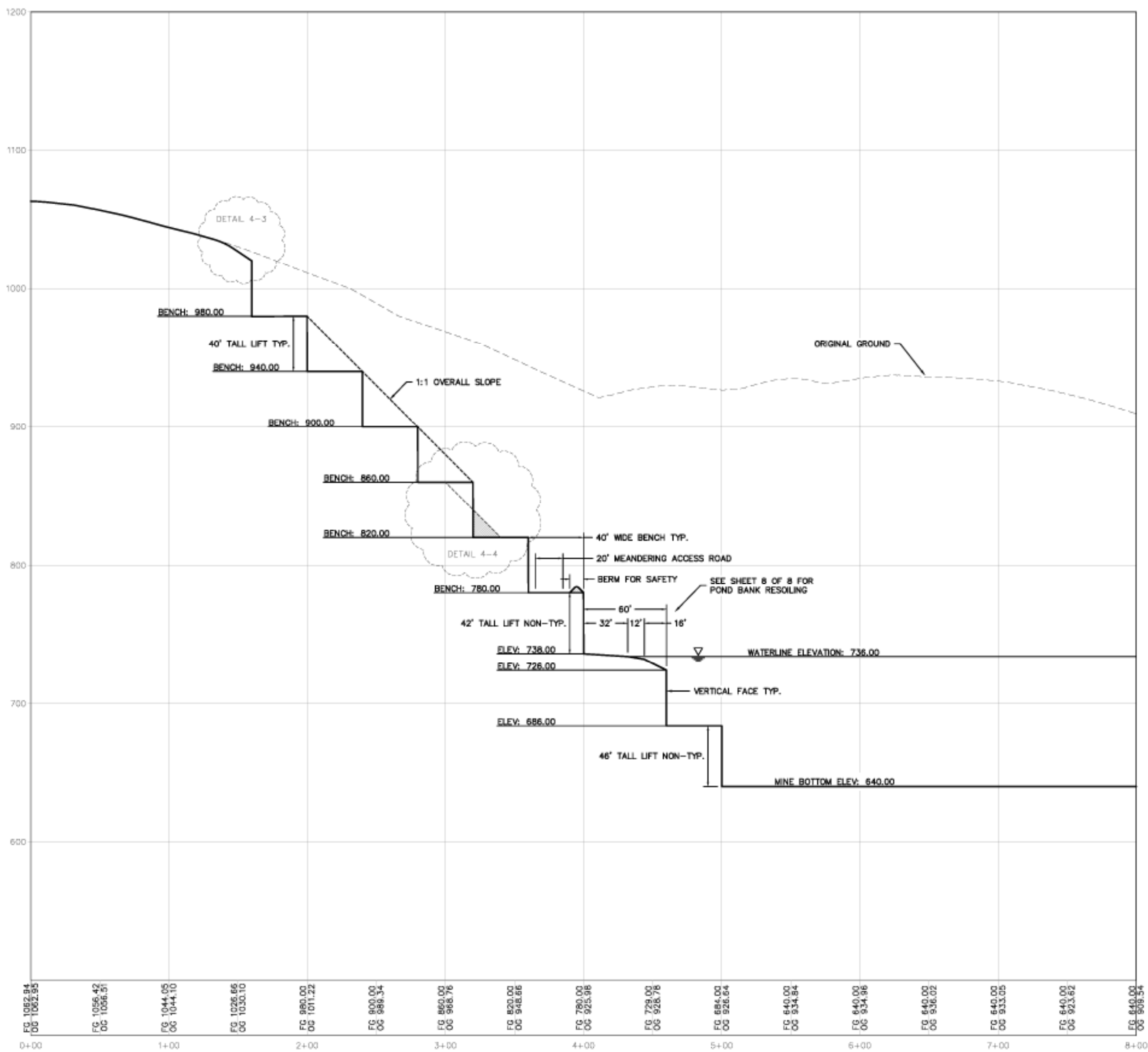
NOTES:

1. CROSS SECTION ELEVATIONS BASED ON JUNE 9, 2020 EXISTING TOPOGRAPHIC DATA.

RECLAMATION PLAN
AMENDMENT 22-0001

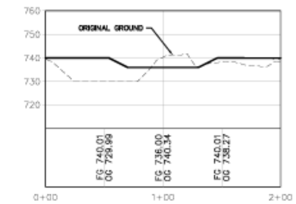
| Crystal Creek Aggregates | | |
|---|---|---|
| Existing Quarry Cross-Sections | | |
| DUANE K. MILLER CIVIL ENGINEER, INC.<br>PO BOX 1307<br>6172 MEISTER WAY, UNIT 1<br>ANDERSON, CA 96007<br>530-365-5610<br>DKMENGR.COM | DATE 02/09/22 | SHEET 3 |
| | SCALE 1"= 40' | OF 8 |

P:\Projects\18.000 Jobs\18.068\DWG\PLANS\REC PLAN\P - MINE RECLAMATION 10/25/2021



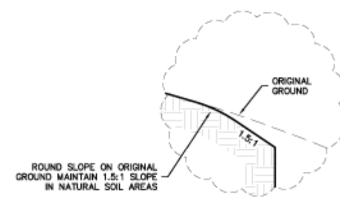

4-1: TYPICAL QUARRY SECTION

SCALE: 1"=40'




4-2: TYPICAL SPILLWAY SECTION

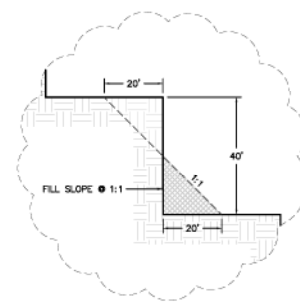
SCALE: 1"=50'




NOTE:
PARENT MATERIAL TO DICTATE FINAL SLOPE.

4-3: SLOPE ROUNDING DETAIL

SCALE: 1"=20'

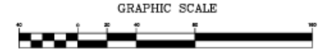



NOTE:
THE LOCATION OF ANIMAL ESCAPE ROUTES DOWN TO AND AWAY FROM THE 780' BENCH MAY VARY TO MAKE ROOM FOR 20' QUARRY ACCESS ROAD.

4-4: ANIMAL ESCAPE ROUTE DETAIL

SCALE: 1"=20'

GRAPHIC SCALE



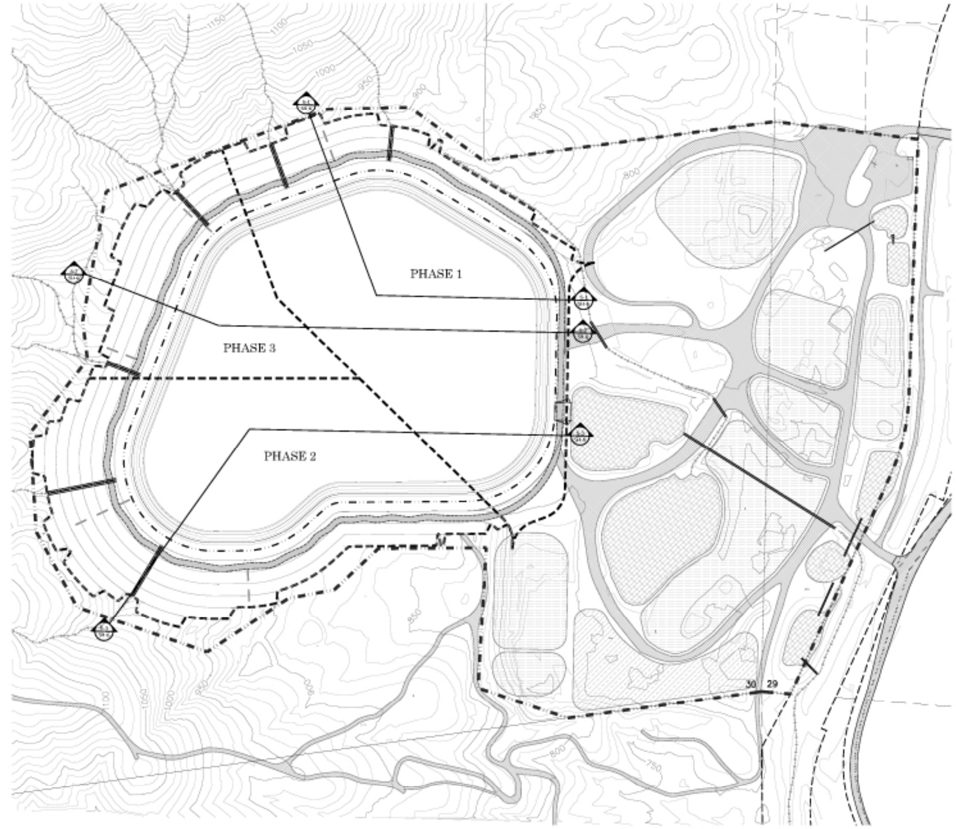
( IN FEET )
1 inch = 40 ft.

RECLAMATION PLAN
AMENDMENT 22-0001

| | | |
|---|---|---|
| Crystal Creek Aggregates | | |
| Proposed Quarry Cross-Sections | | |
| DUANE K. MILLER CIVIL ENGINEER, INC. PO BOX 1307 6172 MEISTER WAY, UNIT 1 ANDERSON, CA 96007 530-365-5610 DKMENGR.COM | DATE 02/09/22 | SHEET 4 |
| | SCALE 1"= 40' | OF 8 |

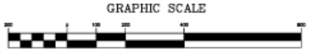
P:\Projects\18.000 Jobs\18.068\DWG\PLANS\REC PLAN\P - MINE RECLAMATION 10/29/2021


UNDERLYING AERIAL PHOTOGRAPH DATE OF JUNE 9, 2020




PHASING PLAN

RECLAMATION PLAN
AMENDMENT 22-0001




| PHASE QUANTITIES | | | |
|---|---|---|---|
| PHASE | AREA (ACRES) | VOLUME (MCY) | CUMULATIVE (MCY) |
| 1 | 22.66 | 4.84 | 4.84 |
| 2 | 21.26 | 5.42 | 10.26 |
| 3 | 8.82 | 2.15 | 12.41 |
| TOTAL | 52.74 | | |

LEGEND

- PHASING BOUNDARY
- REC PLAN BOUNDARY
- ADJACENT PARCEL
- 10' FG CONTOURS
- (N) BENCH LIP

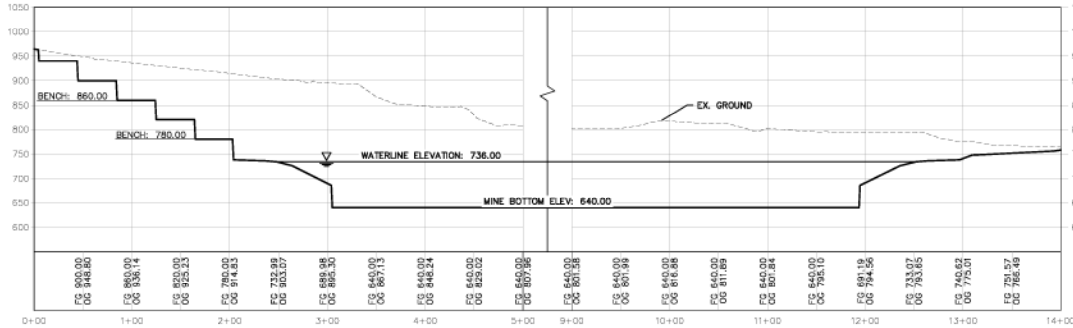
Crystal Creek Aggregates

Proposed Phasing
Plan Overview

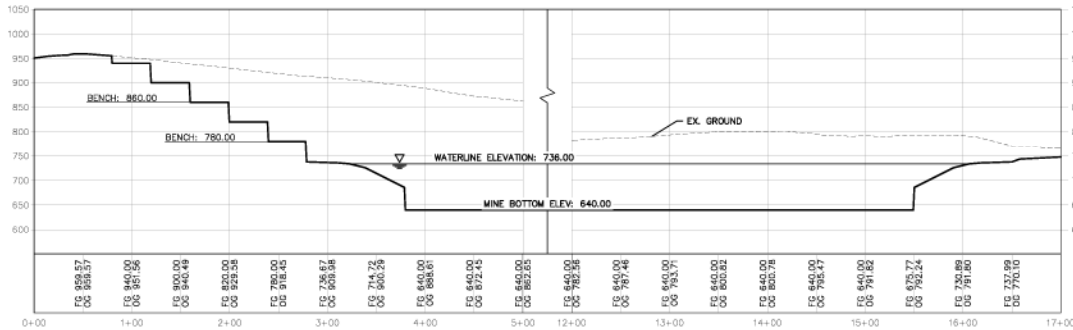
DUANE K. MILLER
CIVIL ENGINEER, INC.
PO BOX 1307
6172 MEISTER WAY, UNIT 1
ANDERSON, CA 96007
530-365-5610
DKMENGR.COM

| DATE | SHEET |
|---|---|
| 02/09/22 | 5 |
| SCALE | OF |
| 1"= 200' | 8 |

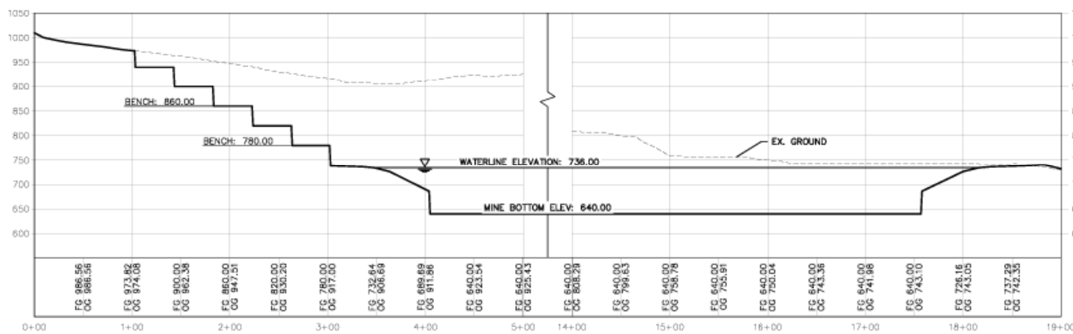
P:\Projects\18.000 Jobs\18.068\DWG\PLANS\REC PLAN\P - MINE RECLAMATION 10/29/2021




6-1: PHASE 1 CROSS SECTION
HORZ: 1"=60'; VERT: 1"=120'




6-2: PHASE 2 CROSS SECTION
HORZ: 1"=60'; VERT: 1"=120'




6-3: PHASE 3 CROSS SECTION
HORZ: 1"=60'; VERT: 1"=120'

GRAPHIC SCALE
( IN FEET )
1 inch = 60 ft.

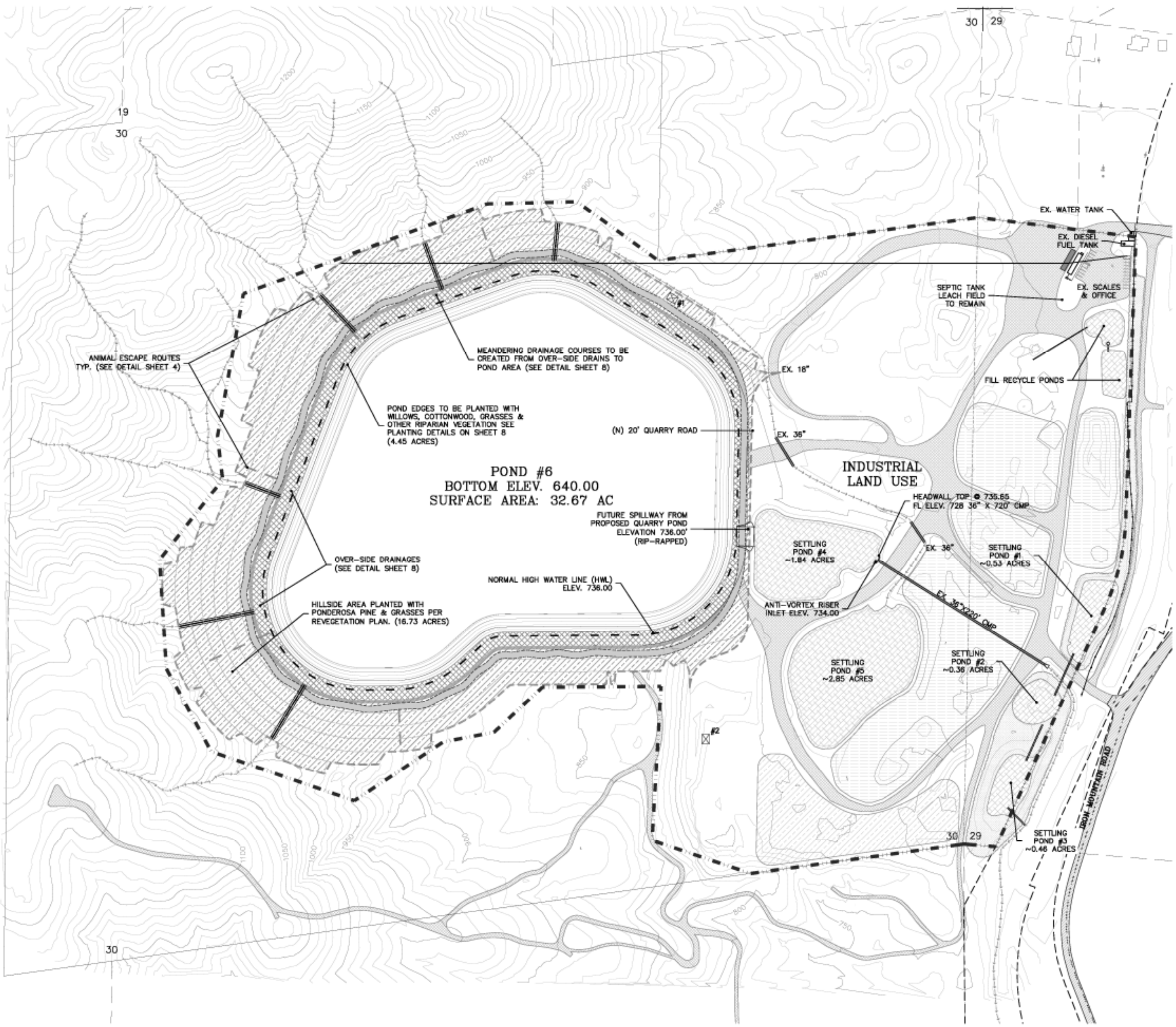
RECLAMATION PLAN
AMENDMENT 22-0001

Crystal Creek Aggregates

Proposed Phasing
Cross Sections

DUANE K. MILLER
CIVIL ENGINEER, INC.

| DATE | SHEET |
| --- | --- |
| 02/09/22 | 6 |
| SCALE | OF |
| 1"= 60' | 8 |




NOTES

1. ROAD CONFIGURATION COULD CHANGE AT TIME OF RECLAMATION.
2. ALL PONDS SHOWN ARE TO REMAIN AT TIME OF RECLAMATION, EXCEPT FOR RECYCLE PONDS.
3. OFFICE & SCALES CAN REMAIN AT TIME OF RECLAMATION.
4. PROPOSED POND SPILLWAY AT 736.00'. DOWNSIDE TO BE RIP-RAPPED.
5. FINISHED GROUND CONTOURING IN INDUSTRIAL ZONED AREA TO BE BASED ON AMOUNT OF SOIL AND OVERBURDENED PRESENT TO RESOIL AT TERMINATION OF MINING OPERATIONS.

LEGEND

- PROPERTY LINE
- PARCEL BOUNDARIES
- REC PLAN AMENDED BOUNDARY
- LIMITS OF QUARRY
- RIPARIAN PLANTING BOUNDARY
- HIGH WATER LINE
- 10' FG CONTOUR
- (EX) LANDSCAPING
- POND EDGE PLANTING (4.59 ACRES)
- BENCH REVEGETATION (16.71 ACRES)
- REVEGETATION TEST PLOT

GRAPHIC SCALE

( IN FEET )
1 inch = 150 ft.

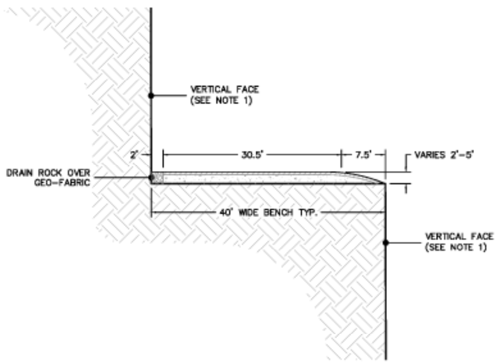
RECLAMATION PLAN
AMENDMENT 22-0001

| Crystal Creek Aggregates | | |
|---|---|---|
| Reclamation Plan | | |
| DUANE K. MILLER<br>CIVIL ENGINEER, INC.<br>PO BOX 1307<br>6172 MEISTER WAY, UNIT 1<br>ANDERSON, CA 96007<br>530-365-5610<br>DKMENGR.COM | DATE<br>02/09/22 | SHEET<br>7 |
| | SCALE<br>1"= 150' | OF<br>8 |

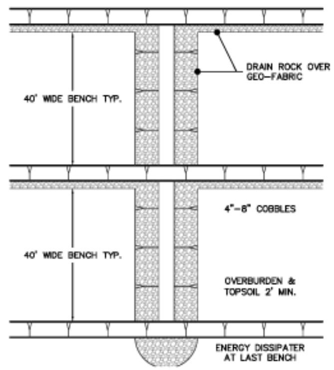
P:\Projects\18.000 Jobs\18.068\DWG\PLANS\REC PLAN\P - MINE RECLAMATION 10/29/2021

NOTES

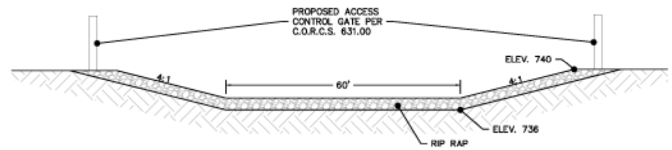
1. SLOPES AND BENCHES WILL VARY BASED ON GEOLOGY AND FIELD CONDITIONS. REFER TO GEOTECHNICAL REPORT.
2. VERTICAL FACES SHALL BE SCALED PRIOR TO RECLAMATION.



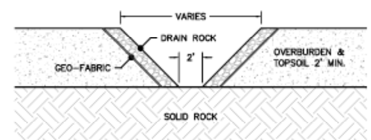

8-2: TYPICAL BENCH SECTION
SCALE: 1"=10'



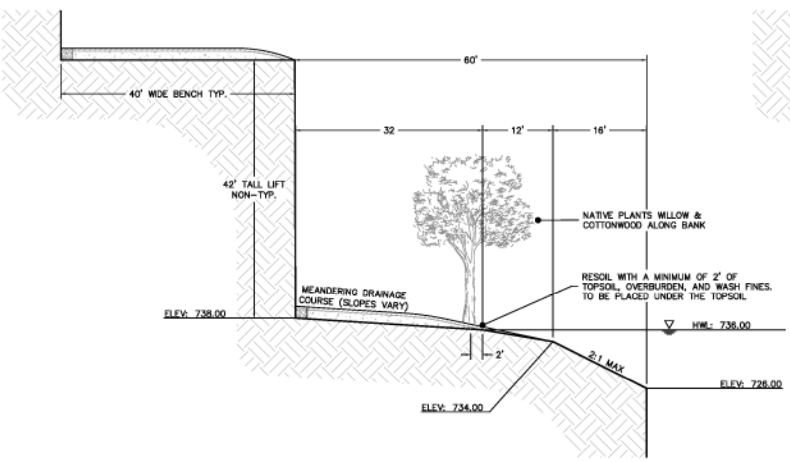

8-4: TYPICAL OVER-SIDE DRAINAGES
SCALE: N.T.S.



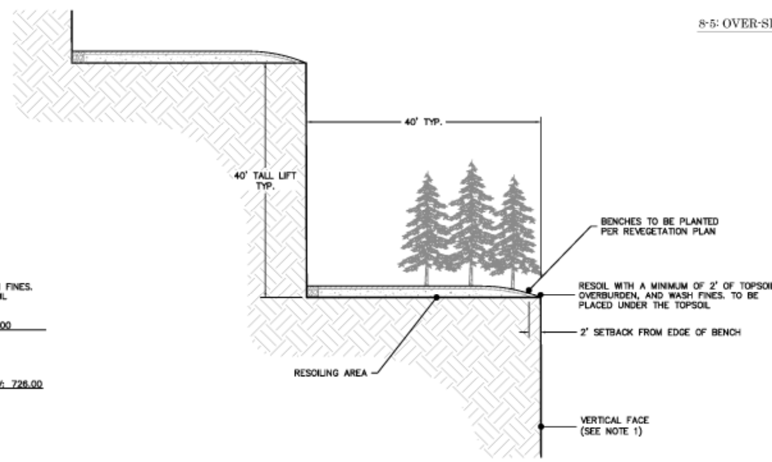

8-6: PROPOSED SPILLWAY DETAIL
SCALE: N.T.S.




8-5: OVER-SIDE DRAINAGES SECTION
SCALE: N.T.S.



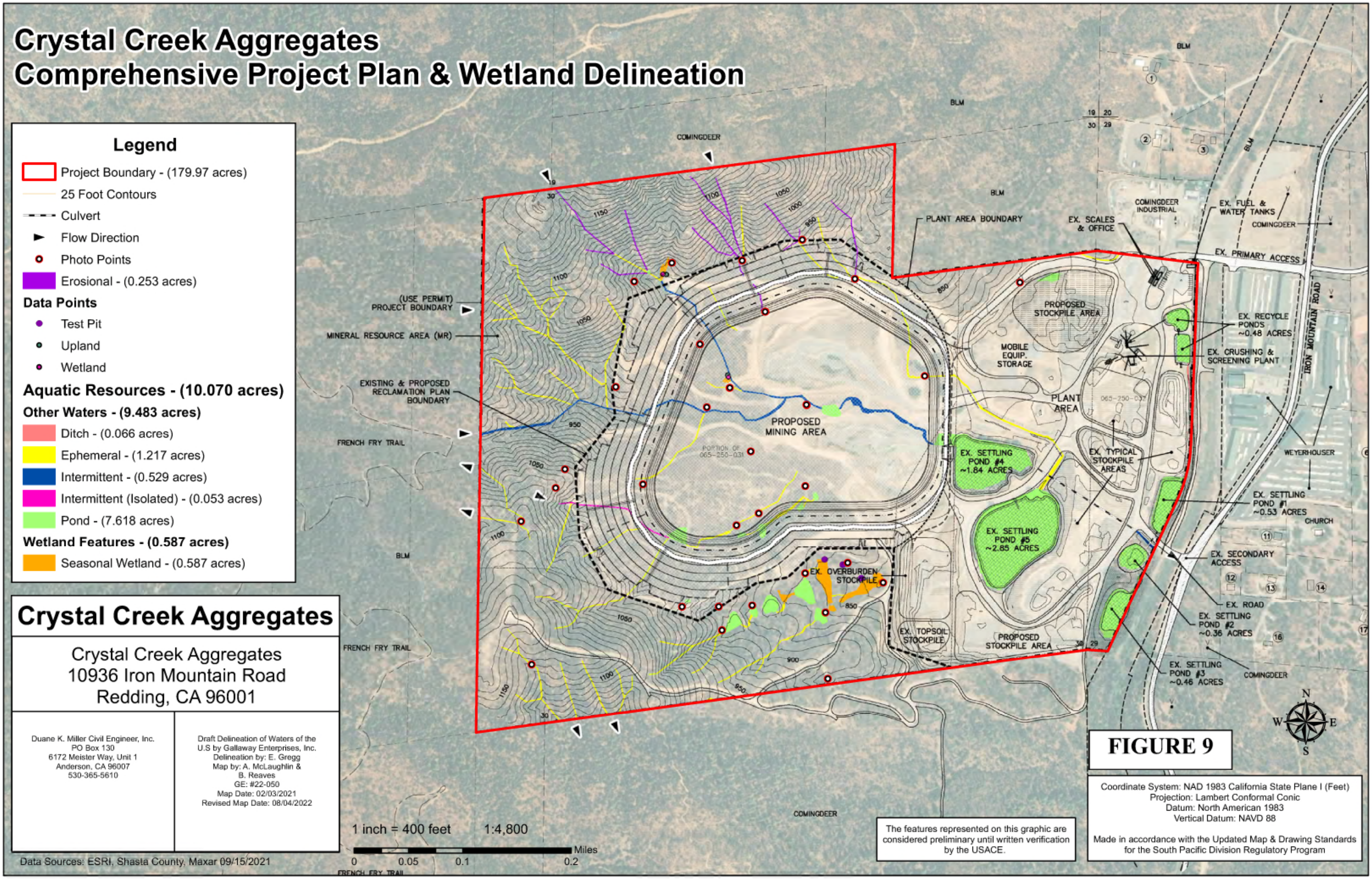

8-1: POND BANK RESOILING & TREE PLANTING
SCALE: 1"=10'




8-3: TYPICAL RESOILING & TREE PLANTING
SCALE: 1"=10'

RECLAMATION PLAN
AMENDMENT 22-0001

| | | |
|---|---|---|
| Crystal Creek Aggregate | | |
| Reclamation Plan Details | | |
| DUANE K. MILLER<br>CIVIL ENGINEER, INC.<br>PO BOX 1307<br>6172 MEISTER WAY, UNIT 1<br>ANDERSON, CA 96007<br>530-365-5410<br>DKMENGR.COM | DATE<br>02/09/22 | SHEET<br>8 |
| | SCALE<br>VARIES | OF<br>8 |


Crystal Creek Aggregates
Comprehensive Project Plan & Wetland Delineation
Legend
Project Boundary - (179.97 acres)
25 Foot Contours
Culvert
Flow Direction
Photo Points
Erosional - (0.253 acres)
Data Points
Test Pit
Upland
Wetland
Aquatic Resources - (10.070 acres)
Other Waters - (9.483 acres)
Ditch - (0.066 acres)
Ephemeral - (1.217 acres)
Intermittent - (0.529 acres)
Intermittent (Isolated) - (0.053 acres)
Pond - (7.618 acres)
Wetland Features - (0.587 acres)
Seasonal Wetland - (0.587 acres)
Crystal Creek Aggregates
Crystal Creek Aggregates
10936 Iron Mountain Road
Redding, CA 96001
Duane K. Miller Civil Engineer, Inc.
PO Box 130
6172 Meister Way, Unit 1
Anderson, CA 96007
530-365-5610
Draft Delineation of Waters of the
U.S by Gallaway Enterprises, Inc.
Delineation by: E. Gregg
Map by: A. McLaughlin &
B. Reaves
GE: #22-050
Map Date: 02/03/2021
Revised Map Date: 08/04/2022
Data Sources: ESRI, Shasta County, Maxar 09/15/2021
1 inch = 400 feet
1:4,800
0
0.05
0.1
0.2
Miles
The features represented on this graphic are considered preliminary until written verification by the USACE.
FIGURE 9
Coordinate System: NAD 1983 California State Plane I (Feet)
Projection: Lambert Conformal Conic
Datum: North American 1983
Vertical Datum: NAVD 88
Made in accordance with the Updated Map & Drawing Standards for the South Pacific Division Regulatory Program
N
S
E
W
PROPOSED MINING AREA
PLANT AREA BOUNDARY
PLANT AREA
PROPOSED STOCKPILE AREA
MOBILE EQUIP. STORAGE
EX. SCALES & OFFICE
EX. PRIMARY ACCESS
EX. FUEL & WATER TANKS
EX. RECYCLE PONDS ~0.48 ACRES
EX. CRUSHING & SCREENING PLANT
EX. SETTLING POND #4 ~1.84 ACRES
EX. SETTLING POND #5 ~2.85 ACRES
EX. SETTLING POND #1 ~0.53 ACRES
EX. SETTLING POND #2 ~0.36 ACRES
EX. SETTLING POND #3 ~0.46 ACRES
EX. TYPICAL STOCKPILE AREAS
EX. SECONDARY ACCESS
EX. ROAD
EX. OVERBURDEN STOCKPILE
EX. TOPSOIL STOCKPILE
PROPOSED STOCKPILE AREA
(USE PERMIT) PROJECT BOUNDARY
MINERAL RESOURCE AREA (MR)
EXISTING & PROPOSED RECLAMATION PLAN BOUNDARY
FRENCH FRY TRAIL
IRON MOUNTAIN ROAD
COMINGDEER
COMINGDEER INDUSTRIAL
WEYERHOUSER
CHURCH
BLM

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## APPENDIX D – TECHNICAL REPORTS

The following Technical Reports referenced in the Reclamation Plan Amendment are provided on the subsequent pages.

- Bajada Geosciences, Inc. September 2, 2022. *Geotechnical Report Crystal Creek Aggregate Expansion. Shasta County, California*
- Lawrence & Associates. August 2022. *Hydrological Evaluation for Proposed Quarry Changes Crystal Creek Aggregates*
- Gallaway Enterprises. October 2022. *Biological Resource Assessment, Terrestrial and Aquatic Wildlife and Botanical Resources*
- Gallaway Enterprises. September 2022. *Draft Delineation of Aquatic Resources*

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# GEOTECHNICAL REPORT

Crystal Creek Aggregates Quarry Expansion
Shasta County, California

Submitted To:

Mr. Chris Handley
**CRYSTAL CREEK AGGREGATES**
10936 Iron Moutain Road
Redding, CA 96001

Prepared by:
Bajada Geosciences, Inc.

September 2, 2022
Project No. 1901.0114

September 2, 2022
1901.0114

Mr. Chris Handley
**CRYSTAL CREEK AGGREGATES**
10936 Iron Mountain Road,
Redding, CA 96001

**Subject:** **Crystal Creek Aggregates Quarry Expansion Project**
**10936 Iron Mountain Road**
**Shasta County, California**

Dear Mr. Handley:

Bajada Geosciences, Inc., is pleased to submit this geotechnical report for the Crystal Creek Aggregates Quarry Expansion Project, located at 10936 Iron Mountain Road, in unincorporated Shasta County, California. This report is being submitted in accordance with our proposal dated March 22, 2019.

This geotechnical report discusses field mapping, laboratory testing results, conditions encountered, and geotechnical analyses associated with the study. Recommendations are provided for design and construction of the proposed quarry, where necessary.

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.**

REGISTERED GEOLOGIST
JAMES A. BIANCHIN
EG NO. 1644
CERTIFIED
ENGINEERING
GEOLOGIST
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
JON M. EVERETT
No. 2531
Exp. 6-30-23
GEOTECHNICAL
STATE OF CALIFORNIA

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

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

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# CRYSTAL CREEK AGGREGATES QUARRY EXPANSION PROJECT
# SHASTA COUNTY, CALIFORNIA

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**CRYSTAL CREEK AGGREGATES QUARRY EXPANSION PROJECT**
**SHASTA COUNTY, CALIFORNIA**



**PLATES**

**TABLE OF CONTENTS (continued)**
**GEOTECHNICAL REPORT**
**CRYSTAL CREEK AGGREGATES QUARRY EXPANSION PROJECT**
**SHASTA COUNTY, CALIFORNIA**

## APPENDICES

# EXECUTIVE SUMMARY

A proposed expansion of the Crystal Creek Quarry will result in highwalls up to 420 feet tall, with an overall slope inclination of 45 degrees. Maximum bench widths of 40 feet are proposed except for one bench that will be 60 feet wide. Bench heights of 40 are proposed for most bench faces; however, two bench faces are proposed at heights of 42 feet and one bench face at a height of 46 feet.

Geologic mapping of the proposed expansion area observed rock materials of the Copley Greenstone, Mule Mountain Stock, rhyolite, and colluvial and alluvial soils. The Copley Greenstone consists of greenstone and chloritic/epidote amphibolite. The Mule Mountain Stock consists of granodiorite and trondhjemite. Gabbro is present within the quarry and rhyolite is exposed within the expansion area. Colluvial soils, including saprolitic soils, mantle rock materials and range in thickness up to about 15 feet. A number of pre-Holocene faults were observed projecting across the quarry. Structural domains were numerous and relatively chaotic due to that faulting.

Laboratory testing of cored rock materials found the slightly weathered to fresh rock ranged from medium strong to very strong (ISRM [1981] Grade R3 to R5), with most of the rock being strong (R4). Discontinuities were moderately to very widely spaced, partially open to tight, undulating to planar, and generally rough. Few open apertures were observed but those present were filled with calcium carbonate, epidote, and quartz. Some discontinuity planes appeared to have a relatively thin coating of iron oxide, zinc oxide, calcium carbonate or other coatings. Few discontinuities were observed to be open and unfilled except where prior blasting and mining had occurred.

Kinematic evaluations of slope stability found no planar or wedge failures on an overall slope scale. On a bench scale, some failures of steeply inclined planes and wedges could occur (backbreak), which might result in periodic maintenance needs. Limit-equilibrium evaluations of slope stability found that factors of safety from those evaluations met or exceeded appropriate thresholds for static and pseudostatic conditions for the proposed quarry configuration. Limit-equilibrium evaluations of stability for colluvial and saprolitic soils found that those materials should be laid back at an inclination of 1.5:1 or flatter.

# 1 INTRODUCTION

BAJADA Geosciences, Inc. (BAJADA), is pleased to submit this preliminary pit slope stability study to Crystal Creek Aggregates (CCA), for the expansion of the existing quarry located in Shasta County, California. The project address is at 10936 Iron Mountain Road and includes the following parcels: APN 065-250-002, -24, -25, -026 (portion), and 065-260-010. The location is shown on Plate 1 – Site Location Map. The following report discusses our understanding of the project, observations and measurements made within the mine area, our analyses, and presents our opinion regarding slope stability at the proposed pit expansion.

## 1.1 PROJECT DESCRIPTION

We understand that that CCA is proposing an expansion to its reclamation plan for the existing quarry site. We understand that the existing Reclamation Plan Area covers about 110 acres. The proposed Project Reclamation Plan Area will remain the same and will have a total mining area of about 57 acres (Duane K, Miller Civil Engineer, Inc. [DKM], 2020). Total mined-out volume will exceed 12-million cubic yards of rock and overburden materials according to the proposed reclamation plan (DKM, 2020).

The materials quarried from the pit are used as aggregate for construction, decorative stone, and sand materials for various applications. The project, as we understand it, consists of the vertical and horizontal expansion of the existing quarry, as shown on Plate 2 – Proposed Mine Configuration (DKM, 2020).

The proposed Reclamation Plan, as shown on Plate 2, will create highwalls extending from elevation 1,060 down to elevation 640 feet. In general, highwall benches are proposed to be up to 40 feet tall and 40 feet wide with vertical slope faces. Interbench ramps are not proposed for the project; however, at elevation 738, just above where pit groundwater elevation is projected (post reclamation), a 60-foot-wide bench is proposed with the pit-side 16 feet of that bench inclined towards the pit at a 2:1 (horizontal:vertical) inclination. In addition, bench faces at elevations 640, 686, and 738 will be 46, 42, and 42 feet tall, respectively (DKM, 2020).

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 to moderately 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. According to Cooksley Geophysical (1998), seismic velocities along two refraction surveys indicate that ripping depths might vary up to 30 feet deep or more prior to blasting being necessary. 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 will be placed on excavated benches to help facilitate revegetation.

The approximate center of the quarry has the following latitude and longitude:

- Latitude: 40° 36' 15.6" (40.604343°)
- Longitude: -122° 28' 6.9" (-122.468602°)

## 1.2 PREVIOUS WORK PERFORMED

Geophysical refraction surveys were performed at the site by Cooksley (1998). That study consisted of two seismic refraction surveys performed at locations shown on Plate 2 (DKM, 2020). For that study, 1,000- and 2,211-foot-long refraction surveys were performed. Results of that study are presented in Appendix A – Previous Geoscience Studies.

In addition, a preliminary geologic report was prepared for the site by Cooksley Geophysical (2008). That report describes the estimated geological conditions at the site based upon surficial observations. It was used as a supplement to a global stability evaluation performed by Materials Testing, Inc. (2007). That report evaluated gross stability of proposed quarry slopes using limit-equilibrium methods based upon rock strengths estimated from three unconfined compression tests.

We know of no previous geotechnical or rock slope stability evaluations that have been performed at the existing pit. 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 12.0) of this report.

## 1.3 SCOPE OF SERVICES

Services performed for this study included:

- Reconnaissance of the site surface conditions;
- Acquisition of selected, existing, available geological data relevant to the subject site conditions;
- Review of pertinent, selected regional geological data;
- Observation of exposed geological conditions at the project site. Plate 3 – Geologic Map, presents the geological conditions mapped at the site;
- Collection of eight samples of surficially available on-site rock materials 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 B – Laboratory Testing.
- Performance of kinematic rock slope stability evaluations for the proposed pit slope

configurations.

- Performance of limit-equilibrium evaluations of potential planar, wedge, and toppling failures identified within the kinematic analyses. Results of the limit-equilibrium analyses are presented in Appendix C – Slope Stability Analyses;
- Performance of limit-equilibrium evaluations of the gross stability for the proposed highwall;
- 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 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 pit. In addition, acquisition of high-resolution overlapping (stereo) photographs of selected existing highwalls for use with software to evaluate discontinuity orientations and populations of those highwalls was performed. Field exploration occurred over the course of three working days.

Subsurface exploration was not performed as part of our services.

## 1.5 HISTORY OF PREVIOUS SLOPE INSTABILITIES

We understand that significant rock planar, wedge, or toppling failures have not occurred at the mine during its history. Minor sloughing, raveling, and local wedge failures are visible in existing highwalls; however, these are localized failures that appear to have occurred in areas where aggressive blasting practices have occurred. In addition, some slope failures of oversteepened colluvial and regolithic soils (overburden) have occurred and one was observed on the southern margin of the existing quarry, as shown on Plate 3.

# 2 PIT SLOPE DESIGN CONCEPTS

## 2.1 GENERAL

The design of quarry highwalls and pit slopes is the balance of economic factors with safety/social factors (Read & Stacey, 2009). Mine operators want to maximize the resource extracted from the mine and, hence, would prefer steep overall slope angles within a pit. Balanced against this is the increased likelihood that steep slopes will lead to the development of slope stability issues that could ultimately impact worker safety, productivity, and, therefore, mine profitability. The approach is to base the pit design on achieving an acceptable level of risk and incorporating this into the stability analyses as a factor of safety (FOS). Pit slopes are considered constructed overly conservative if no instability occurs during operations. Hence, some instability should be anticipated, accommodated for, and monitored during pit development.

Imprinted on pit slope design due to economic-safety/social factors are environmental and/or regulatory factors. While technical evaluations may indicate that a slope is acceptable due to the aforementioned factors, it is not unusual for regulatory and permitting processes to dictate that flatter slopes be utilized in design. Those factors are often out of the control of the geotechnical consultant and mine operator.

This section briefly introduces pit slope terminology that is used throughout this report and some of the key geotechnical and mining factors that can impact slope design. In addition, a summary of the analysis techniques utilized in this study and the adopted risk management approach are discussed.

## 2.2 PIT SLOPE GEOMETRIES

There are three predominant pit slope geometries that need to be recognized and addressed for any pit slope stability evaluation (Read & Stacey, 2009; Wyllie & Mah, 2010):

- Bench Geometry;
- Inter-ramp Slope; and
- Overall Slope.

Those geometries are illustrated on Plate 4 – Common Quarry Geometries and discussed below.

### 2.2.1 **Bench Geometry**

The height of benches is typically determined by the size of the shovel chosen for the mining operation or the preferred blasting and extraction methodologies of the mine operator. The bench face angle is usually selected in such a way as to reduce, to an acceptable level, the amount of material that will likely fall from the face or crest. The bench width is sized to prevent small wedges and blocks from the bench faces falling down the slope and potentially impacting men and equipment. The bench geometry that results from the bench face angle and bench width will ultimately dictate the inter-ramp slope angle. Stacked benches can be used in certain circumstances to steepen inter-ramp slopes.

#### 2.2.2 Inter-Ramp Slope

We understand that inter-bench ramps are not proposed for the quarry. Therefore, this slope definition does not apply to the CCA quarry expansion.

#### 2.2.3 Overall Slope

Overall slope inclination for the proposed quarry expansion is governed by bench geometry since inter-bench ramps are not proposed.

### 2.3 KEY FACTORS FOR PIT SLOPE DESIGN

As noted by Wyllie & Mah (2010), stability of pit slopes in rock is typically controlled by the following key geotechnical and mining factors:

- **Lithology and Alteration** – The rock types intersected by the final pit walls and level of alteration are key factors that impact eventual stability of the pit. Geological domains are created by grouping rock masses with similar geomechanical characteristics.
- **Large-Scale Structural Features –** The orientation and strength of major, continuous geological features such as faults, shear planes, weak bedding planes, structural fabric, and/or persistent planar joints will strongly influence the overall stability of the pit walls.
- **Small-Scale Structural Features –** The orientation, strength, and persistence of smaller scale structural features such as joints will control the stability of individual benches and may ultimately restrict the inter-ramp slope angles.
- **Rock Mass Quality –** Rock mass strengths are typically estimated via intact rock strength and rock mass classification schemes such as the rock mass rating (RMR) system (Hoek, 1995). Lower rock mass quality typically results in flatter overall slope angles.
- **Blasting Practice** – Production blasting can cause considerable damage to interim and final pit walls. This increased disturbance is typically accounted for with a reduction in the effective strength of the rock mass. Controlled blasting programs near the final wall can be implemented to reduce blasting induced disturbances and allow steeper slopes. Scaling of blast induced fracturing is essential.
- **Groundwater Conditions –** High groundwater pressures and water pressure in tension cracks will reduce rock mass shear strength and may adversely impact slope stability. If needed, depressurization programs can reduce water pressure behind the pit walls and allow steeper pit slopes to be developed.
- **Stress Conditions –** Mining induces stress changes due to lateral unloading within the vicinity of the pit. Stress release can lead to effective reductions in the quality of the rock mass and increases in slope displacements. Localized stress decrease can reduce confinement and result in an increased incidence of raveling type failures in the walls.

Modifying the mining arrangement and sequence can sometimes manage these stress changes to enhance the integrity of the final pit walls.

## 2.4 METHODOLOGY FOR PIT SLOPE STABILITY ASSESSMENT

Assessment of pit slope stability is based on the development of a geotechnical model for varying domains encountered within the projected mine area. Those domains are based upon geological, structural (geomechanical), rock mass, and hydrogeological models (Read & Stacey, 2009). Each domain has independent characteristics that affect slope stability. Once the domains have been delineated, a number of different types of stability analyses can be undertaken to estimate appropriate slope angles for a given open pit slope. Slope stability analyses undertaken for this study included the following types:

- **Kinematic Stability Analyses** – Stereographic analyses were conducted on the discontinuity orientation data and the DIPS program (Rocscience, 2019) was utilized to identify the kinematically possible failure modes. Appropriate bench face angles and/or inter-ramp slope angles are assigned in such a way as to reduce the potential for discontinuities to form unstable wedges or planes. Typically, it is not cost effective to eliminate all potentially unstable blocks and a certain percentage of bench face failures and/or multiple bench instabilities are acceptable. Most of the smaller unstable features will be removed during mining by scaling the bench faces and during periodic maintenance activities.

- **Planar and Wedge Stability Analyses** – Limit-equilibrium analyses of potential rock planar and wedge failures were performed with SLIDE 2018 program (Rocscience, 2019) and GEO5 (Fine Civil Engineering Software, 2019), respectively. These programs provide an estimate for the factor of safety against large-scale, multiple-bench failures through the rock mass. In these particular analyses, as with many pit designs, minimum static and pseudostatic (pseudo-earthquake forces) factors of safety of at least 1.3 and 1.1, respectively, were specified for these types of failure (Wyllie and Mah, 2004). Lower static factors of safety (e.g. 1.2) may sometimes be utilized for shorter periods of time, such as near the end of mine life, and where good monitoring is implemented.

- **Rock Mass Stability Analyses** – Limit-equilibrium analyses of the rock slopes were performed with SLIDE 2018 program (Rocscience, 2019). This program provides an estimate for the factor of safety against large-scale, multiple-bench failures through the rock mass. In this particular analysis, as with many pit designs, minimum static and pseudostatic factors of safety of at least 1.3 and 1.1, respectively, were specified for this type of failure (Wyllie and Mah, 2004). Lower static factors of safety (e.g. 1.2) may sometimes be utilized for shorter periods of time, such as near the end of mine life, and where good monitoring is implemented.

# 3 GEOLOGICAL CONDITIONS

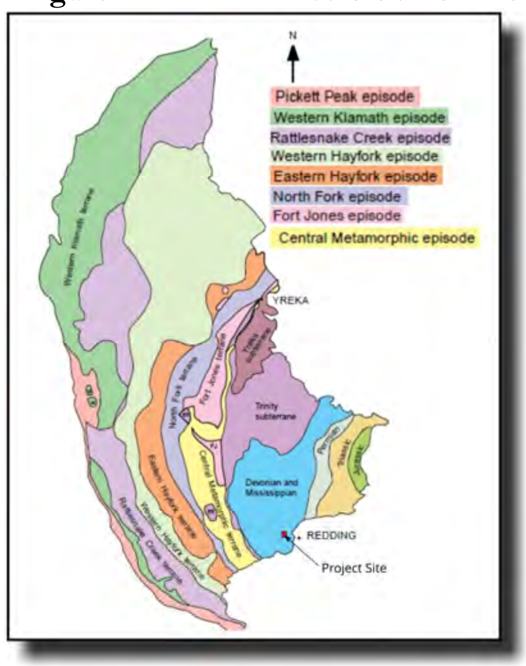
## 3.1 GENERAL

The project site is located in the eastern Klamath Mountains within the Klamath Mountains geomorphic Geologic Province of California. The quarry is situated near the northwestern margin of the Sacramento Valley, approximately 4 miles west of the City of Redding. This area is characterized by moderately to steeply inclined hills with moderately to steeply incised drainages.

## 3.2 REGIONAL GEOLOGY

The CCA quarry is in the eastern Klamath Mountains in California. The Klamath Mountains form a geologic province that extends from northern California to Southern Oregon. In California, the Klamath Mountains province extends from the Pacific Ocean to the Great Valley. The province consists of an arcuate-shaped belt of lithologic belts that are convex to the west (Snoke & Barnes, 2006).

**Figure 1 – Klamath Accreted Terrane**




These lithologic belts have been accreted due to tectonic processes between the North American and Pacific tectonic plates. A total of eight accretionary episodes have been identified within the Klamath Mountains (Irwin & Wooden, 1999), as shown on Figure 1. The oldest of these tectonic accretions is located on the east side of the Klamath Mountains and each accretionary terrane becomes more recent in age towards the west. Each of the accretionary episodes is separated by thrust faults, resulting in relatively older rocks resting on relatively more recent rocks. In addition, during accretion of the eight terranes, there has been clockwise rotation of the Klamath Mountains of about 110 degrees (Irwin & Wooden, 1999).

At least 10 plutons have been mapped within the Klamath Mountains. Ages of those plutons have been estimated to range from about 150- to over 400-million years old (Irwin & Wooden, 1999). Most of the plutons intruded the accreted terranes; however, some were emplaced pre-amalgamation (Silberman and Danielson, 1991).

The quarry is located within the Eastern Klamath terrane, which is about 180- to 400-million years old (Silurian-Devonian to Jurassic). The Eastern Klamath terrane is composed of three subterranes: Redding, Trinity, and Yreka subterranes. The Redding subterrane consists of Mississippian to

Devonian-age metavolcanic and metasedimentary rocks. Formations within the Redding subterrane consist of the Baird, Bragdon, and Kennett Formations, the Mule Mountain stock, Balaklala Rhyolite, and Copley Greenstone. Those formations are locally faulted into place. Superjacent rocks consist of alluvium, colluvium, local terrace, and landslide deposits.

## 3.3 QUARRY GEOLOGY

The existing quarry highwalls expose Mule Mountain Stock (Dmm), Copley Greenstone (Dc), and epidote and/or chloritic amphibolite, and gabbro (Da). These materials are unconformably in contact in some locations and have been juxtaposed by faulting in other locations. In areas outside of the active quarry face, Dmm and Dc are visible in outcrop, as float on the ground surface, and exposed within scoured drainages. In addition, Balaklala Ryholite (Dbc) is locally found, as shown on Plate 3.

Granitics of Dmm consist of granodiorite, albite granite, and trondhjemite that increase in hardness and competency and decrease in weathering with depth. Regolithic and saprolitic soils associated with weathering of Dmm produce overburden thicknesses ranging from a few feet to over 20 feet. Below the overburden, weathering decreases from highly weathered to fresh (International Society of Rock Mechanics [ISRM,1981] Grades IV to I) over thicknesses ranging from about 5 to 20 feet. These zones of weathering are often observed penetrating relatively fresh rocks along discontinuities. Moderately weathered to fresh Dmm ranges from weak rock to strong rock (ISRM [1981] Grades R2 to R4). Some sulfide enrichment was observed locally within Dmm.

The Dc greenstone is generally hard, dense, and locally has been sulfide enriched to exhibit pyrite mineralization. Generally, the greenstone observed within the quarry ranges from medium strong to very strong (ISRM [1981] Grade R3 to R5), with most of the rock being strong (R4).

The greenstone is generally moderately weathered grading to fresh with depth. The weathering zone is about 5 to 10 feet thick and consists of about 3 to 5 feet of colluvial soils and regolith (ISRM Grades V to VI) overlying highly fractured and weathered greenstone. Colluvial soils are present within fractures in about the upper ten feet of the greenstone profile. The fracturing, weathering, and colluvial infilling diminish with depth. Below the weathering zone, the greenstone is slightly weathered to fresh (Grade I to II). In areas where relatively closely spaced fractures are present, slight to moderate weathering (Grade II to III) can be present at depth.

Dc is massive to moderately fractured with persistent discontinuities that are moderately to very widely spaced, partially open to tight, undulating to planar, and generally rough. Few open apertures were observed but those present were filled with calcium carbonate, epidote, and quartz. Some discontinuity planes appeared to have a relatively thin coating of iron oxide, zinc oxide, calcium carbonate or other coatings. Few discontinuities were observed to be open and unfilled except where prior blasting and mining had occurred. Few discontinuities were observed to be seeping water except at Location A noted on Plate 3, where relatively persistent and moderate water seepage was observed discharging along a fault plane.

Relatively higher-grade metamorphism appears to have altered Dc into epidote and/or chloritic amphibolite. While still within green schist-phase metamorphism, these materials have generally lost the relic texture of basaltic or andesitic rocks from which they were derived. In general, Da materials are found close to the disconformable (not fault-emplaced) contact with Dmm and have an aphanitic, more crystalline texture, as compared to Dc. No exposures of Da were observed near the ground surface and Da exposed at depth was slightly weathered to fresh (ISRM [1981] Grades III to I) and medium strong to strong (ISRM [1981] Grades R3 to R4). Da was observed to be slightly to highly fractured with closed, tight, rough planes having no apparent coatings.

Dbc was not observed in highwall exposures at the site but was observed in outcrop and as surface float in the project expansion area. In the few Dbc outcrops observed, the rock materials were highly weathered (ISRM [1981] Grade IV), very weak (ISRM [1981] Grade R21), and moderately fractured.

Two cross sections through the quarry showing the final proposed quarry geometry were constructed and presented as Plates 5.1 and 5.2 – Geotechnical Sections A-A' and B-B', respectively. Locations of those cross sections are shown on Plate 2. Due to the lack of subsurface drill hole and core hole information, the projection of geologic conditions along these sections should be considered illustrative and subject to change as quarry development occurs.

## 3.4 FAULT CONSIDERATIONS

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 quarry is not located within an Alquist-Priolo Earthquake Fault Zone established by the State. Because of this, the likelihood of faulting occurring across the quarry site is low.

A number of regional faults are present in the project area, as shown on Plate 6 – Fault Location Map. The closest mapped faults to the site are the pre-Holocene Hoadley and Spring Creek faults, both located within a few miles of the site. The closest mapped Holocene-active fault is the Hat Creek-McArthur fault zone, located about 39 miles east of the site.

A number of previously undocumented faults were observed within quarry highwall and excavation exposures. Those faults are shown on Plate 3 – Geologic Map and Plate 7 – Lineation Map. The faults observed at the project site juxtapose Devonian-age rock materials categorizing the faults as pre-Holocene in age. Those faults and lineations have a general east-west trend ranging from about 70 degrees east of north to 70 degrees west of north, following a similar general trend for pre-Holocene faults on the region. Mullions and slickensides along exposed fault surfaces indicate a strike-slip movement with near horizontal displacement.

### 3.5 PROBABILISTIC ESTIMATES OF STRING 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, 2019). The evaluations were performed using an estimated shear wave velocity in the upper 100 feet of the profile of 400 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 | 0.20 |
| Design-Basis Ground-Motion | 50 | 10 | 475 | 0.14 |

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.

### 3.6 GROUNDWATER CONDITIONS

Groundwater conditions at the quarry are unknown. During our site observations and mapping in April and May 2019, groundwater was observed discharging from local discontinuities and water was observed stored in local retention ponds. Based on review of historical aerial photographs, water appears to be present year-round in those retention ponds.

# 4 STRUCTURAL GEOLOGY & GEOTECHNICAL CONDITIONS

## 4.1 GENERAL

The following section discusses large- and small-scale structural geological features at the site and characterizes rock mass properties and strength used during analyses.

## 4.2 LARGE-SCALE STRUCTURAL FEATURES

A number of fault zones are exposed in the existing quarry and a number of lineations are visible on historical aerial photographs of the region, as discussed in Section 3.4 and shown on Plate 7. The faults and lineations are generally high angle and have general trends, as follows:

| FAULT SET ORIENTATIONS | | |
|---|---|---|
| **Fault Set No.** | **Strike** | **Dip** |
| 1 | N75 to 85W | 80°N to Vertical |
| 2 | N60 to 70E | 70 to 85°N |
| 3 | N60W | 50°N |

Offset magnitudes along the faults are generally indiscernible. Slickensides and mullions imply near horizontal to slightly inclined lateral movement along the fault planes. Gouge thicknesses were observed to range from about 12 inches to up to 15 feet wide. The gouge generally consisted of clay carbonate, clay, and fissile, highly sheared rock derived from the foot and/or hanging wall.

In addition to faulting, a bedding or flow band within the Copley Greenstone was observed at two locations within the quarry (Sites 1 and 3). That bedding or flow band is a dark colored unit within the lighter-colored greenstone with and orientation measured to strike about east-west and dip at about 20 degrees to the north.

## 4.3 SMALL-SCALE STRUCTURAL FEATURES

Measurements of discontinuity orientations were performed using two methods:

1. Manual measurement of planes at selected locations across the site; and
2. Use of software to estimate discontinuity orientations from photogrammetry (hand-held camera and photogrammetrically acquired data).

Manual measurements were taken with a Brunton compass and the orientations measured during this study are presented in Appendix A. Along with the discontinuity measurements, additional information was collected on selected discontinuity planes that would be applied to rating the overall quality of the rock mass exposed within the highwalls.

Discontinuity data estimates using software were performed by first obtaining overlapping, stereo-imagery of highwalls using a GPS-enabled camera (hand-held and via unmanned aerial systems). Those imagery were processed using photogrammetric software to develop a dense point cloud of the highwalls. The point cloud was then imported into software that computes planar features from the data based on user-defined input criteria.

The software evaluation produced millions of estimated discontinuity plane orientations. Discontinuity orientations were then plotted on an equal angle stereonet and populations were contoured to identify predominant discontinuity planes exposed within the highwall slope. Those projections are presented as Plate 8.1 through 8.5 – Site 1 through Site 5 Discontinuities, respectively. Locations of Sites 1 through 5 are shown on Plate 9 – Structural Domain Map. The primary discontinuity planes identified from this analysis have the following orientations:

| PRIMARY DISCONTINUITY PLANES | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Site 1 | | Site 2 | | Site 3 | | Site 4 | | Site 5 | |
| Dip Direction | Dip | Dip Direction | Dip | Dip Direction | Dip | Dip Direction | Dip | Dip Direction | Dip |
| 57 | 66 | 25 | 53 | 159 | 73 | 23 | 77 | 53 | 48 |
| 93 | 57 | 59 | 70 | 170 | 78 | 238 | 45 | 87 | 44 |
| 135 | 54 | 79 | 83 | 200 | 76 | 355 | 29 | 88 | 83 |
| 212 | 61 | 191 | 83 | 223 | 82 | | | 98 | 83 |
| 271 | 86 | 207 | 68 | 254 | 63 | | | 231 | 87 |
| 298 | 59 | | | | | | | 254 | 88 |

The principal discontinuity sets are shown in a stereographic plot on Plate 10 – Stereonet Evaluations.

Data were collected on the roughness, aperture and infilling of discontinuities during surface mapping with the quarry. These data indicated that most discontinuity surfaces did not have significant infill and were of moderate roughness. Persistence was assumed to be relatively short to moderately long (up to about ten feet). The characteristics of the encountered discontinuities are utilized in combination with the intact properties of the rock to classify the rock mass as presented in Section 4.5.

Shear strength of the discontinuities was estimated from laboratory unconfined compression tests obtained through this study and reported by MTI (2007), and by backcalculating strengths along intact and existing failed wedges observed in the field. Results of the tests and evaluations are presented in Appendices B and C.

## 4.4 GEOTECHNICAL DOMAINS

Based on the information presented in Section 4.3, the structural geologies appear to be grossly dissimilar across the site. The orientations of predominant discontinuities measured at each site noted on Plate 9 varied significantly from one site to the next creating numerous geotechnical structural domains across the site. This is likely due to the faulting creating a relatively chaotic structural regime.

### 4.5 ROCK MASS QUALITY

The Rock Mass Rating (RMR) classification system (Bieniawski, 1989) was used to summarize the geomechanical characteristics of the rock masses encountered at the CCA site. It is based on five parameters describing the key rock mass characteristics, including: Unconfined Compressive Strength (UCS), Rock Quality Designation (RQD), joint spacing, joint conditions, and groundwater conditions. Ratings are assigned to each of the five parameters and the sum of these ratings defines the rock mass quality as an RMR value. RMR values range from near zero, equating to very poor rock, to 100, equating to very good rock.

RMR is used widely on geomechanical projects as is the Geological Strength Index (GSI; Marinos et al., 2005; Marinos et al., 2000). The GSI was developed as a tool for relating failure criteria to geological observations in the field (Wyllie & Mah, 2010). It provides a method for estimating the reduction in rock mass strength for different geological conditions. For this project, we set the GSI at 60 to be conservative.

The intact rock strengths were obtained from field estimates and laboratory UCS tests. The estimated UCS and deformability parameters for the site greenstone and Mule Mountain Stock are summarized in the following table:

**GEOTECHNICAL ROCK MASS DESIGN PARAMETERS**

| Sample | Rock Type | Unconfined Compressive Strength (psi) | Rock Mass Rating (RMR) | Geologic Strength Index (GSI) |
|---|---|---|---|---|
| MTI 1-A | Unknown | 12,380 | Unknown | Unknown |
| MTI 1-B | Unknown | 22,430 | Unknown | Unknown |
| MTI 1-C | Unknown | 12,110 | Unknown | Unknown |
| Site 1-1 | Greenstone | 19,810 | 75 | 60 |
| Site 1-2 | Trondhjemite | NT[1] | 71 | 60 |
| Site 2-1 | Greenstone | 20,120 | 74 | 60 |
| Site 2-2 | Greenstone | 18,550 | 72 | 60 |
| Site 4-1 | Greenstone | 1,380[2] | 69 | 60 |
| Site 4-2 | Amphibolite | 15,300 | 71 | 60 |
| Site 4-3 | Trondhjemite | 390[2] | 65 | 60 |
| Site 4-4 | Trondhjemite | 890[2] | 66 | 60 |

[1] – Not Tested. Sufficient sample height to diameter ratio could not be obtained due to existing rock discontinuities.

[2] – Failure occurred along existing discontinuity plane and does not represent intact rock strength

As noted above, the average UCS values for the rock tested from the quarry is 19,350 pounds per square inch (psi), excluding those samples that failed along existing discontinuities. If all UCS results are utilized, than the average rock strength is 12,336 psi. Those intact rock strengths for the CCA quarry greenstone, amphibolite, and unweathered granitics are strong to very strong with an average strength of very strong (Grade R5), with typical UCS values ranging between about 12,000 and 22,000 pounds per square inch (psi). It indicates that the rock mass qualities in the CCA pit area are generally GOOD to VERY GOOD.

# 5 KINEMATIC STABILITY ANALYSES

## 5.1 GENERAL

Kinematic analyses were undertaken on the discontinuity orientation data within the geotechnical database. The purpose of this analysis was to identify the kinematically possible failure modes within each design sector using the stereographic technique. This section introduces the pit design sectors utilized throughout the stability analyses, the kinematically possible failure modes, and the results of the stereographic analyses.

## 5.2 PROPOSED PIT DESIGN

The proposed pit, as shown on Plate 2, has bench face orientations in all compass directions with the tallest of the proposed high walls having a dip direction ranging from 25 to 85 degrees. The overall pit slope inclination is 45 degrees. On a bench-scale, there are proposed vertical slopes up to 46 feet tall.

## 5.3 MODES OF FAILURE

Kinematically possible failure modes in rock slopes typically include planar, wedge, and toppling failures. These failure modes can be identified by using stereographic analysis of peak pole concentrations of the discontinuity data. These failure modes will occur if the discontinuities are continuous over the bench scale or more, if weak infilling is present along the measured discontinuities, or the geometry of the discontinuities is conducive to failure. A brief introduction on each mode of failure is provided below:

### 5.3.1 Planar Failure

This failure mode is kinematically possible when a discontinuity plane is inclined flatter than the slope face (it daylights) and at an angle steeper than the friction angle.

### 5.3.2 Wedge Failure

Wedge failures are kinematically possible when the plunge of the intersection of two planes (sliding vector) is inclined flatter than the slope face (it daylights) and at an angle greater than the combined friction angle, which is estimated from the characteristics of each plane that forms the wedge. Where kinematics are the controlling factor, the recommended pit slope angles have been adjusted to reduce the potential for large-scale, multiple bench wedge failures.

### 5.3.3 Toppling Failure

This failure mode is kinematically possible due to interlayer slip along discontinuity surfaces where sub-vertical jointing dips into the slope at a steep angle β. The condition for toppling to occur is when $\beta > (\varphi_j + (90-\Psi))$, where $\Psi$ is the slope face angle and $\varphi_j$ is the friction angle of the joint (Goodman, 1989).

### 5.4 STEREOGRAPHIC ANALYSES

Stereographic analyses have been carried out for each failure mode using the DIPS program (Rocscience, 2019). Because of the multitude of proposed pit angles noted in Section 4.2, we evaluated all slope angles to estimate the possibility of planar and wedge failures occurring.

#### Overall Slope Scale

Stereographic analyses of the pit wall for the proposed quarry expansion indicate that potential toppling, planar, and wedge failures should not impact the gross stability of the overall highwall. This is due to the quarry highwall having an overall inclination of 45 degrees, which is the same angle as the discontinuity angle of internal friction used in our analyses, making such failures kinematically not possible. Thus, from a gross stability due to rock-slope failures, the proposed overall slope inclination of 45 degrees for the quarry should be kinematically stable.

#### Bench-Level Scale

We understand that CCA is proposing vertical bench faces up to 46 feet tall as part of pit construction. Vertical bench faces can increase potential toppling, planar, and wedge failure exposure, resulting in backbreak of slopes and narrowing of benches. Backbreak is the loss of bench face due to localized bench failures, as shown on Plate 4. It is good mining practice to reduce the amount of backbreak so that a reduction in the potential amount of rock on catchment benches is minimized and to lower the potential that rock mobilized by a backbreak might mobilize downslope to the pit floor.

For vertical bench faces, stereographic analyses indicate that potential wedge and planar failures are present throughout the proposed highwall areas, as shown on Plate 10.

# 6 ROCK MASS STABILITY ANALYSES

## 6.1 GENERAL

Conventional limit-equilibrium analyses were conducted to backcalculate rock strengths along discontinuity surfaces, and to evaluate the stability of planar and wedge failures and the gross stability of the proposed highwalls. This section provides a detailed discussion of overall slope stability for the project.

## 6.2 ESTIMATE OF ROCK MASS STRENGTH

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 pit walls.

Following Hoek, et. al. (1995), the petrographic constant for intact rock ($m_i$) has been set for greenstone (basalt) encountered within the pit using a value of 25. Intact rock strength and rock mass quality at the site have been discussed in Section 4.5.

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 was conservatively established to be 60, which is more conservative than the typical estimation using RMR values.

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 rock encountered within the pit walls.

| SUMMARY OF ROCK MASS STRENGTH PARAMETERS | | | |
|---|---|---|---|
| **Basic Parameter** | **Symbol** | **Unit** | **Values** |
| Unit Weight | Γ | pcf | 150 |
| Intact Unconfined Compressive Strength (UCS) | $\sigma_{ci}$ | psi | 12,110 |
| Basic Rock Mass Rating (1989) | RMR | - | 65 |
| Geologic Strength Index | GSI | - | 60 |
| Petrographic Constant for Intact Rock | $m_i$ | - | 25 |
| **Disturbed Rock Mass (Disturbance Factor D=1.0)** | | | |
| Hoek-Brown Constant for Rock Mass | $m_b$ | - | 1.436 |
| Hoek-Brown Constant | S | - | 0.0013 |
| Friction angle of Rock Mass | Ø' | degrees | 43 |
| Cohesion of Rock Mass | C' | psf | 28,061 |
| Compressive Strength of Rock Mass | $S_{cm}$ | ksf | 61.013 |
| Deformation Modulus | $E_m$ | ksf | 169,644 |

## 6.3 LIMIT-EQUILIBRIUM ANALYSES

Limit-equilibrium stability analyses were performed using GEO5 – Rock Stability (Fine Civil Engineering Software, 2019) and SLIDE 2018 (Rocscience, 2019) computer programs for the pit design. GEO5 was used to evaluate limit-equilibrium conditions for potential wedge failures identified during kinematic evaluations and to backcalculate rock strengths along discontinuities for wedges observed in the field. SLIDE 2018 was used to estimate the gross stability of the overall pit slope and to perform limit-equilibrium evaluations of potential planar rock failures. Results of the limit-equilibrium analyses are presented in Appendix C. The limit-equilibrium analyses were completed to evaluate the overall stability of the jointed rock mass and to demonstrate the sensitivity of the calculated Factors of Safety (FOS) to different overall slope angles, blasting disturbance, and groundwater levels.

The evaluation of stability of rock slopes generally takes into consideration a number of rock strength parameters, geologic conditions within the slope, orientations of discontinuities (fractures, joints, flow bands, faults, etc.), 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 if the modeled scenario meets or exceeds a target minimum 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 on the verge of failure.

Slopes having a minimum FOS of 1.5 for static evaluations are typically considered stable for permanent engineered conditions. For open pit slopes, the FOS for static conditions is often reduced to 1.3 because the risk to structures, people, and improvements is relatively low. Pseudostatic (pseudo-earthquake forces) FOS values above 1.1 are considered stable for most engineered projects. In the case of mines, the pseudostatic stability values can be reduced and are considered acceptable provided they remain above 1.01.

#### 6.3.1 **Evaluation of Potential Wedge Failures**

As noted in Section 5.4 and shown on Plate 10, it is kinematically infeasible for rock wedges to occur on an overall slope scale but possible for wedges to occur on a bench-scale. Thus, instead of posing a gross stability problem for the proposed quarry, wedges pose a potential localized maintenance and possible safety issue along benches constructed during mining. Because of the numerous and chaotic structural domains on site, it is unreasonable to perform limit-equilibrium calculations for potential wedges formed by all predominant discontinuity planes for all slope face orientations of the proposed quarry. Therefore, to evaluate the likelihood of wedge failures occurring at the site, we modeled various wedge trends and plunges. Limit-equilibrium analyses were performed using rock mass strength criterion described in Section 6.2. That criterion estimated a minimum angle of internal friction (Ø) of 51 degrees but we reduced that value to 45 degrees for discontinuity surfaces. Because cohesion along discontinuity plane sets is difficult to estimate, we backcalculated that value for wedges observed in the field and used a cohesion intercept with a marginal value of 500 psf.

In addition, the majority of discontinuities observed at the site were closed or healed. These conditions imply a low transmissive environment for groundwater and a low likelihood of high water pressures within fractures unless poor blasting practices are performed. Thus, our analyses were initially performed under dry conditions and then for critical wedge orientations, the stability was modeled where 25-, 50-, 75-, and 100-percent of the discontinuities were filled with water. Results of those analyses are presented on Plate 11 – Rock Wedge Stability Results.

As noted on Plate 11, under dry conditions, wedges should generally be stable, provided appropriate blasting methods have been utilized. Under wet conditions, the FOS for wedges decreases proportional to the amount of water filling the discontinuities forming the wedge. Thus, if good drainage control can be maintained, fewer wedge failures should occur. Regardless, wedge failures should be expected on a bench-scale during construction of the quarry, but those failures should only impact maintenance within the quarry provided good safety practices are utilized.

#### 6.3.2 **Evaluation of Planar Failures**

Using the strength criterion discussed in Section 6.2, we performed limit-equilibrium evaluations for potential planar failures that were identified in the kinematic evaluations performed for this site. Results of those analyses are presented in Appendix C. Using those strength values, it was estimated that planar failures exposed within the proposed pit should have static and pseudostatic FOS values exceeding 1.3 for those planes inclined at 55 degrees or flatter. Thus, some planar failures are anticipated on a bench-scale, that will lead to annual maintenance requirements. It should be noted that few very persistent planes were observed in the areas mapped indicating that planar failures will likely be local and not extensive.

#### 6.3.3 **Evaluation of Toppling**

There were no predominant discontinuity planes identified during this study that have the potential for block or flexural toppling failures. One predominant discontinuity plane was inclined at 45 degrees, which is marginal for direct toppling, but it did not meet the kinematic test for potential failure, as described in Section 5.3.3 of this report.

#### 6.3.4 **Evaluation of Gross Pit Slope Stability**

Slope stability evaluations to estimate the gross stability of the overall pit slope were performed using the rock strength criteria noted above in Section 5.3. Analyses were performed on the proposed pit slope configuration shown on Plate 2. Results of those analyses are presented in Appendix C.

Stability analyses were performed using Spencer's methods for both entirely dry slopes and for a piezometric surface located at reasonable estimated depth along with a worst-case scenario with water at the ground surface. In all cases, the static and pseudostatic FOS against slope failure was greater than 1.3 and 1.01, respectively. Thus, the proposed pit configuration with an overall slope of 45 degrees should be grossly stable under the conditions evaluated.

# 7 OVERBURDEN STABILITY ANALYSES & EROSION

## 7.1 GENERAL

Colluvial soils, regolithic and saprolitic rock materials, and highly to intensely weathered rock mantle more competent rock materials across the site. These soils are typically referred to as overburden and will not remain stable if excavated at inclinations similar to the underlying competent rock materials. An illustration of this is located at the southern part of the existing quarry where a small landslide has occurred within overburden on an oversteepened slope (see Plate 3). This section evaluates the stability of overburden and recommends maximum inclinations for cut slope faces of those materials.

## 7.2 STRENGTH VALUES

Evaluations of overburden strengths were performed and presented in MTI (2007). Those strengths are as follows:

| OVERBURDEN STRENGTH VALUES | | | |
|---|---|---|---|
| Soil Layer | Shear Wave Velocity (feet/second)[1] | Cohesion (psf)[2] | Angle of Internal Friction (degrees)[2] |
| 1 | 1,000 | 100 | 20 |
| 2 | 2,000 | 100 | 24 |
| 3 | 3,000 | 250 | 28 |
| [1] – per Cooksley (1998); [2] – per MTI (2007) | | | |

Those strength values appeared relatively conservative and were utilized in limit-equilibrium stability analyses performed during this study.

## 7.3 LIMIT-EQUILIRIUM EVALUATIONS

Slope stability evaluations for overburden soils were performed using SLIDE 2018 (Rocscience, 2019). For overburden soils, a FOS for static conditions of 1.3 was used because the risk to structures, people, and improvements is relatively low. A pseudostatic FOS value of above 1.0 was used as a threshold for these soils.

Based on our evaluations, we recommend that permanent cut slopes exposing overburden soils be excavated no steeper than 1.5:1 (horizontal to vertical). That inclination provides a static FOS of greater than 1.3 and should be grossly stable. Localized slumps and failures can be expected; however, the bench immediately below the cut slope should have adequate area as catchment for those localized instabilities.

# 8 PIT WATER MANAGEMENT

Limited groundwater data is available for the site. Existing ponds are maintained at about elevation 734 feet, which is about 134 feet above the planned pit bottom, but this is largely controlled by the outlet elevation of the ponds. It is anticipated that progressive development of the pit will result in lowering the pond elevations, which could result in a lowering of the groundwater table in the vicinity of the excavation.

The groundwater table with respect to the pit floor influences the mine development in that groundwater inflows need to be pumped out of the pit. Groundwater depressurization measures are not likely to be needed; however, as the pit floor is lowered and additional geotechnical conditions exposed, depressurization may need to be implemented to enhance pit slope stability. When necessary, surface water should be diverted to reduce the amount of water handled by CCA within the pit.

As discussed earlier, slope depressurization systems are likely not to be needed. If they are, then depressurization systems could include a combination of techniques including diversion ditches, vertical pumping wells, and horizontal drains. These measures should be implemented based on regular site reconnaissance, a staged approach during pit development, and could involve the installation of depressurization systems and associated monitoring of groundwater pressures. This will enable an assessment of the pit slope drainage capability and the requirements for additional installations.

Pit inflows will occur along discontinuities extending through the granitics and greenstone. It is anticipated that most of the discontinuities are closed or open and filled/healed. Thus, inflows from good quality, low permeability rock are expected to be low. If and when needed, pit dewatering systems should be design by the project civil engineer.

# 9 PIT SLOPE DESIGN

## 9.1 GENERAL

This feasibility pit slope design has considered relevant site-specific geotechnical data, limited hydrogeological information, and the results of various stability analyses. Recommended pit slope geometries are summarized in this section, and some operational considerations related to the recommended slopes are considered.

## 9.2 RECOMMENDED PIT SLOPE DESIGN

### 9.2.1 Bench Geometries

Benches are proposed to up to be 40 feet wide and up to 40 to 46 feet tall, with vertical faces. This geometry is stable for the overall slope angle of the quarry but could expose the potential for bench-level wedge and planar failures leading to potential backbreak of the bench face, which is not unusual for this type of quarry construction. CCA can implement a number of operational and maintenance procedures that can reduce the potential of backbreak and safety issues associated with local bench-level slope failures. Those procedures include:

- Presplitting all final rock faces;
- Scaling of blasted rock faces to remove loose rocks;
- Maintenance of a 25-foot wide offset barrier from all inactive rock faces; and
- Complete daily inspection of rock faces.

We recommend that if the proposed bench faces are constructed at vertical angles, the procedures noted above be implemented and maintained by CCA and future mine owners should the mine change ownership. Furthermore, when bench-level wedge or planar failures occur, we recommend that debris from those failures be removed from the bench as routine maintenance. By implementing those procedures, impacts from backbreak should be reduced to an acceptable level.

### 9.2.2 Mining Buffer Area

To reduce the potential of highwall migration into adjacent parcels, we recommend that the top of the proposed highwalls be situated no closer than 40 horizontal feet from non-project related parcel boundaries.

### 9.2.3 Erosion Considerations

Erosion is unlikely within portions of the quarry that expose moderately weathered to fresh rock materials. Erosion could occur within overburden soils and cause some rilling of slopes exposing overburden soils near the top of highwall. The amount of erosion should be relatively limited and should be contained on benches below those slopes and within existing and proposed ponds.

To limit erosion, control of waters entering the quarry should be maintained so that they are either diverted away from quarried areas or are channeled into ponds located on site. Some erosion might occur where flow concentrations are present within overburden soils but that erosion should be contained on benches located below those soils.

If significant erosion is observed within the quarry that could extend off property, then erosion control measures should be implemented using best management practices to reduce the erosion.

## 9.3 OPERATIONAL CONSIDERATIONS

### 9.3.1 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 pit slopes by reducing face damage from blasting. Typical controlled blasting strategies utilize small diameter blast hole 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 blasthole 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 pit 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 pit can be developed with variable slopes and blast patterns to develop optimal blasting design for final pit walls. Trial blasts are also recommended wherever there is a substantial change in rock mass characteristics, in order to evaluate and optimize blast performance.

### 9.3.2 Bench Scaling

It is important that benches be kept clear and that the bench faces be maintained regularly so that they remain functional during mining operations. Scaling is an important part of the bench maintenance program and should be conducted after blasting in areas where access is still available. Routine scaling may allow the bench widths to be minimized, due to a reduction in the volume of material to be controlled.

# 10 NATURALLY OCCURRING ASBESTOS (NOA)

## 10.1 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 3.0, the highwall exposes amphibolite, which is a metamorphosed volcanic rock containing chlorite, amphibole, and other minerals of concern. These are considered ultramafic rock materials and, thus, may pose a risk associated with NOA.

In California, NOA is considered a concern if it exceeds a concentration of more than 0.25-percent (CGS, 2002). If NOA concentrations exceed that threshold, then mitigation measures are typically required to reduce the potential of inducing NOA to become aerosol.

## 10.2 SAMPLING AND TESTING

Soil and rock materials within specific areas were sampled using random multi-increment sampling. The two sample locations are shown on Plate 3. Sample materials were collected in 6-inch long and 4-inch diameter plastic sample containers, labeled appropriately, then sealed to prevent loss or introduction of contaminates. All samples were transported by BAJADA personnel to our Redding facility.

Two samples were transmitted from our Redding office to Asbestos TEM Laboratories, Inc., to perform testing for the potential presence of NOA. The Chain of Custody form used to transmit samples is included in Appendix B – Laboratory Testing. Testing was performed on each sample using a polarized light microscope with a point count of 400 in conformance with standard test method CARB 435. Results of the laboratory testing found that NOA was not present in the samples that were analyzed. Results of the testing are included in Appendix B.

# 11 CLOSURE

This 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.

Conclusions contained in this report were 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 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 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 Crystal Creek Aggregates with this project. If you have any questions, please do not hesitate to contact our office.

# 12 REFERENCES

Bateman, P.C., and Wahrhaftig, C., (1966), Geology of the Sierra Nevada, in Bailey, E.H., Editor, Geology of Northern California, California Division of Mines and Geology Bulletin 190, p. 107-183.

Bieniawski, Z.T. (1989), Engineering Rock Mass Classifications, Wiley, New York.

Blake, T.F., Hollingsworth, R.A., Stewart, J.P., D'Antonio, R., Earnst, J., Gharib, F., Horsman, L., Hsu, D., Kuperferman, S., Masuda, R., Pradel, D., Real, C., Redder, W., and Sathialingam, N (2002), Recommended Procedures for Implementation of DMG Special Publication 117 Guidelines for Analyzing and Mitigating Landslide Hazards in California, ASCE Los Angeles Section Geotechnical Group, June, 132 p.

California Geological Survey (2002), Guidelines for Geologic Investigations of Naturally Occurring Asbestos in California, Special Publication 124, 70 p.

Cooksley Geophysics, Inc. (1998), Refraction Seismic Investigation, Rock Classification at the Proposed Expansion of the Crystal Creek Rock Quarry, Redding, California, dated June, 3 p. with attachments.

_____ (2008), Geologic Report to Accompany Global Slope Stability Analyses for the Crystal Creek Aggregate Expansion, dated August 19, 7 p. with attachments.

Duane K. Miller Civil Engineer, Inc. (2020), Reclamation Plan Amendment 19-0001, Plan Sheets 1 of 6 through 6 of 6, dated April 6.

Fine Civil Engineering Software (2019), GEO5 – Rock Stability, version 2019.54.

Goodman, R.E., 1989, Introduction to Rock Mechanics, 2nd Edition, John Wiley.

Hart, E.W. and Bryant, W.A. (1997), Fault-Rupture Zones in California, Alquist-Priolo Earthquake Fault Zoning Act with Index to earthquake Fault Zone Maps, California Division of Mines and Geology Special Publication 42, with supplements 1 and 2 added in 1999, 38 p.

Hinds, N.E. (1952), Evolution of the California Landscape, California Division of Mines and Geology Bulletin 158, pp 145-152.

Hoek, E. (1995), Rock Engineering, Course Notes, Rotterdam, The Netherlands, 313 p.

Hoek, E., Carranza-Torres, C., and Corkum, B. (2002), Hoek-Brown Failure Criterion – 2—2 Edition, *Proc. NARMS-TAC Conference*, Toronto, 2002, 1, 267-273.

International Society of Rock Mechanics (1981), Rock Characterization, Testing, and Monitoring; ISRM Suggested Method, Pergamon Press, Oxford, UK.

Irwin, W.P., and Mankinen, E.A. (1998), Rotation and Accretionary Evolution of the Klamath Mountains, California and Oregon, From Devonian to Present Time, U.S. Geological Survey Open-File Report 98-114.

Irwin, W.P., and Wooden, J.P. (1999), Plutons and Accretionary Episodes of the Klamath Mountains, California and Oregon, U.S. Geological Survey Open-File Report 99-374.

Jennings, C.W. (1994), Fault Activity Map of California and Adjacent Area, with Locations and Ages of Recent Volcanic Eruptions, California Division of Mines and Geology, Geologic Data Map No. 6, Scale 1:750,000.

Marinos, P and Hoek, E. (2000) GSI – A Geologically Friendly Tool for Rock Mass Strength Estimation. *Proc. GeoEng2000 Conference*, Melbourne. 1422-1442.

Marinos, V., Marinos, P., and Hoek, E. (2005), The Geological Strength Index: Applications and Limitations, Bulletin of Engineering Geology and Environment, vol. 64, p. 55-65.

Materials Testing, Inc. (2007), CCA Quarry Expansion, Shasta County, California, Global Slope Stability Analysis, dated October 22, 2 p. with attachments.

New Hampshire Department of Environmental Services (2010), Frequently Asked Questions webpage accessed at http://des.nh.gov/organization/divisions/waste/orcb/prs/adsp/categories/faq.htm on October 7, 2010.

Read, J., and Stacey, P. (2009), Guidelines for Open Pit Slope Design, CRC Press, Taylor & Francis Group, Leiden, The Netherlands, 496 p.

Rocscience (2007), ROCKLAB! 1.031**,** Rock Strength Analysis Using Generalized Hoek-Brown Failure Criterion, User's Guide, 24 p.

Rocscience (2019), DIPS, Version 7.015, Plotting, Analysis, and Presentation of Structural Data using Spherical Projection Techniques, March 19.

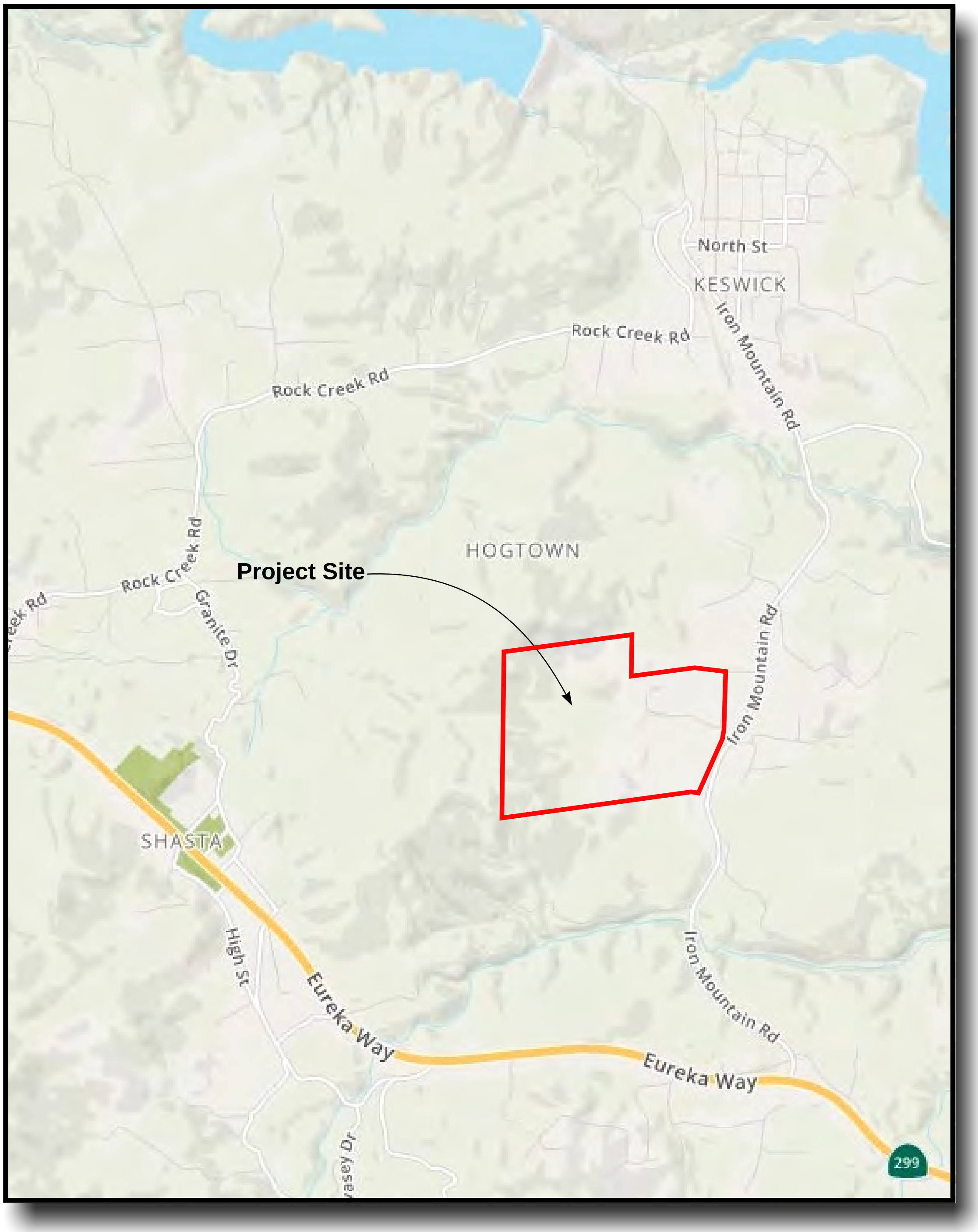
Rocscience (2019), SLIDE 2019, 2D Limit Equilibrium Slope Stability Analysis, Build 8.024, April 17.

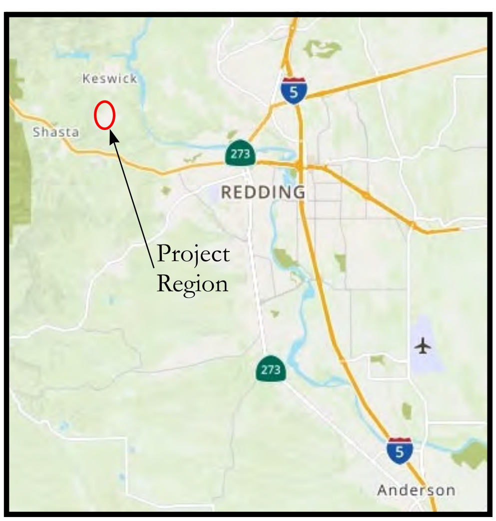
Silberman, M.L., and Danielson, J. (1991), Geologic Setting, Characteristics, and Geochemistry of Gold-Bearing Quartz Veins in the Klamath Mountains in the Redding 1x2 Degree Quadrangle, Northern California, U.S. Geological Survey Open-File Report 91-595, 29 p.

Snokes, A.W., and Barnes, C.G. (2006), The Development of Tectonic Concepts for the Klamath Mountains Province, California and Oregon, Geologic Society of America Special Paper 410, 29 p.

United States Geological Survey (2019), Unified Hazard Tool, accessed on line at: https://earthquake.usgs.gov/hazards/interactive/ .

Wyllie, D.C., and Mah, C.W. (2010), Rock Slope Engineering, Civil and Mining, 4th Edition, Taylor & Francis, New York, 431 p.




Base maps from Mapquest. Scale undetermined.

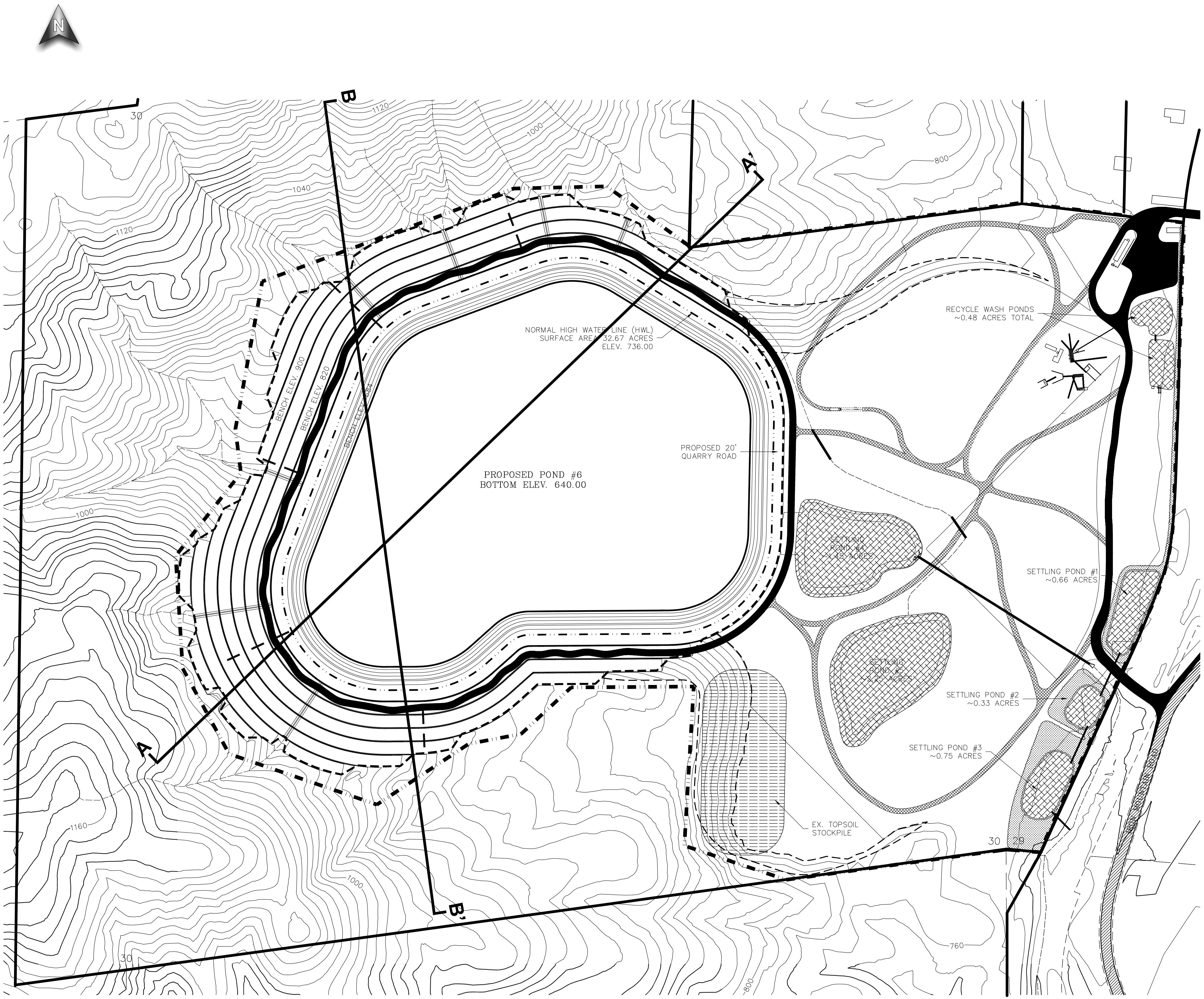
## SITE LOCATION MAP

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 1

BAJADA Geosciences, Inc.

Project no. 1901.0114



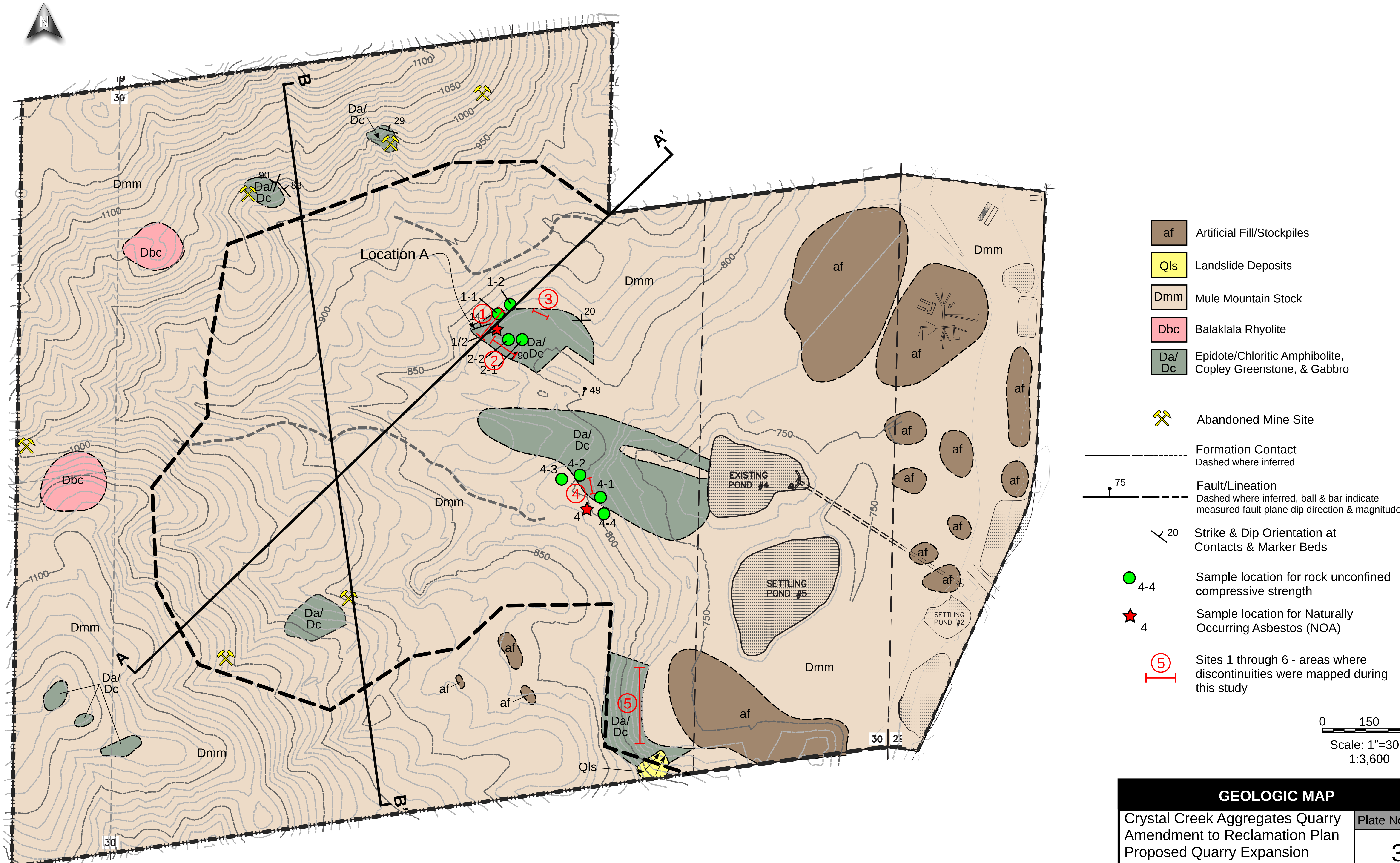

B B' Cross Sections
see Plates 5.1 & 5.2

0 150 300

Scale: 1"=300'
1:3,600

Map from Duane Miller Engineering (2020)

| **PROPOSED MINE CONFIGURATION** | |
|---|---|
| Crystal Creek Aggregates Quarry<br>Amendment to Reclamation Plan<br>Proposed Quarry Expansion<br>Shasta County, California | Plate No.<br>2 |
| BAJADA Geosciences, Inc. | Project no.<br>1901.0114 |




**GEOLOGIC MAP**

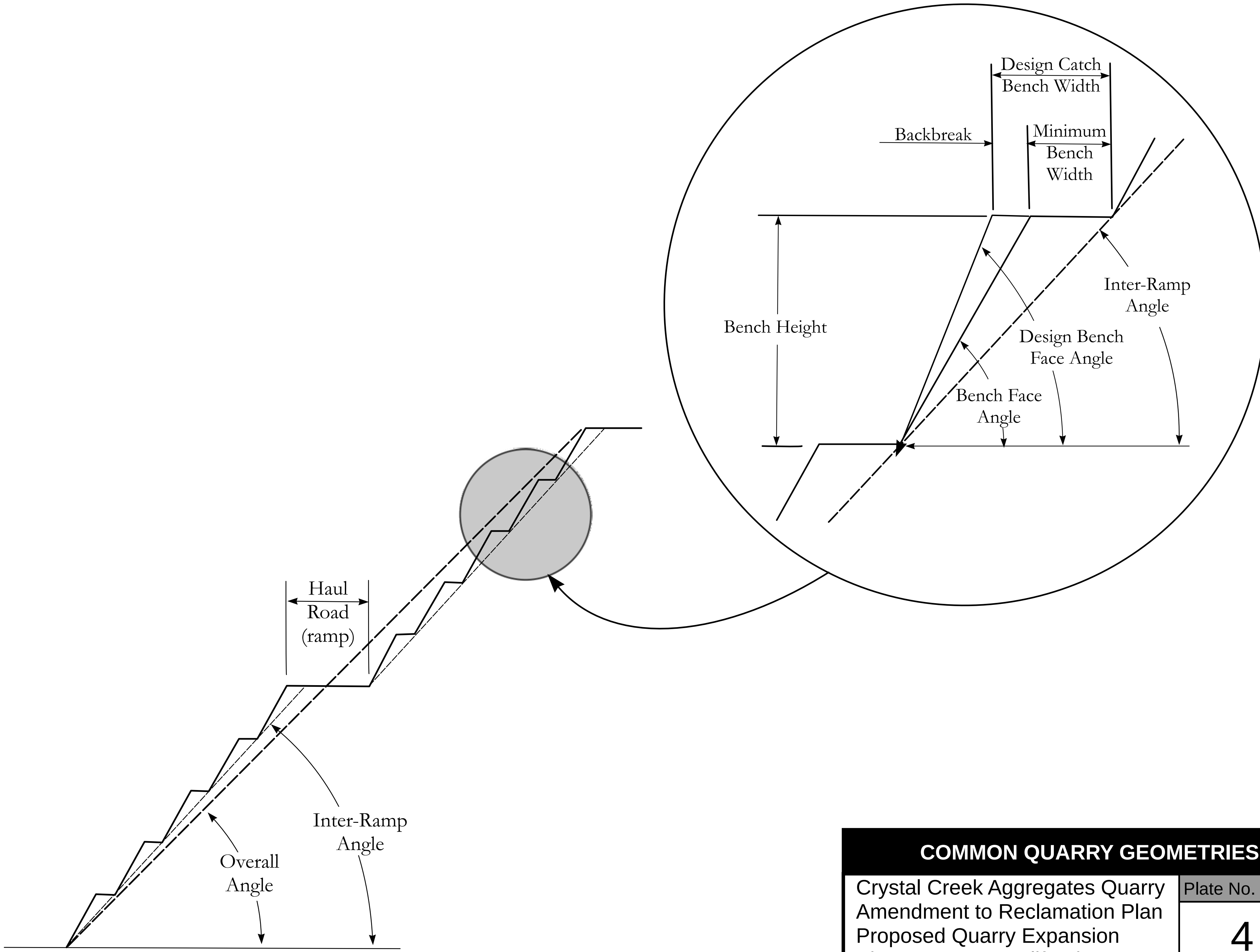
Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 3

BAJADA Geosciences, Inc.

Project no. 1901.0114

Base map from Duane K. Miller Civil Engineer (2020)



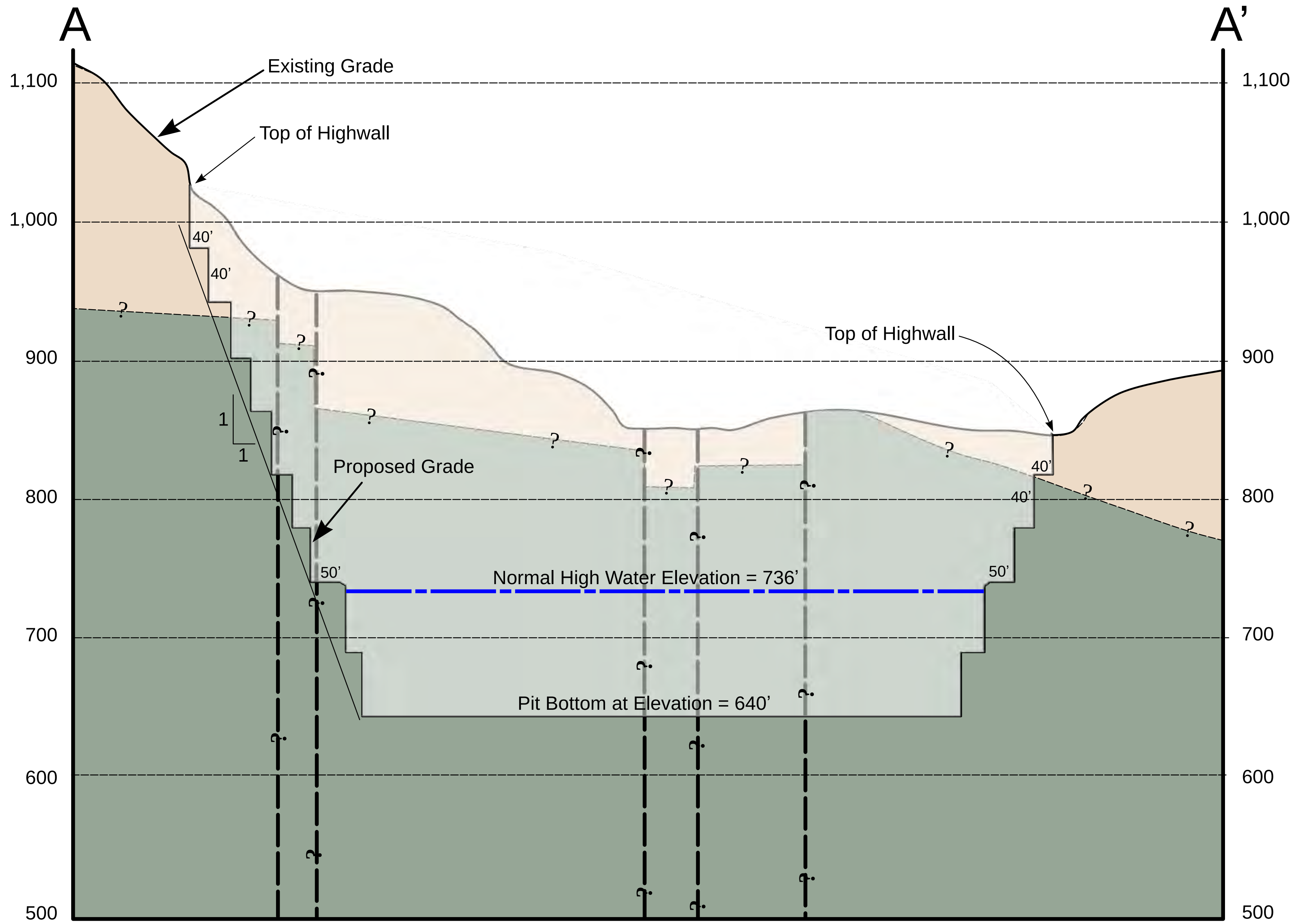

**COMMON QUARRY GEOMETRIES**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

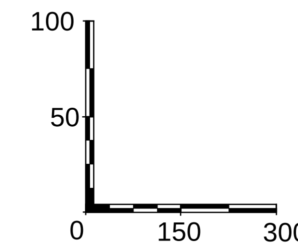
Plate No. 4

BAJADA Geosciences, Inc.

Project no. 1901.0114

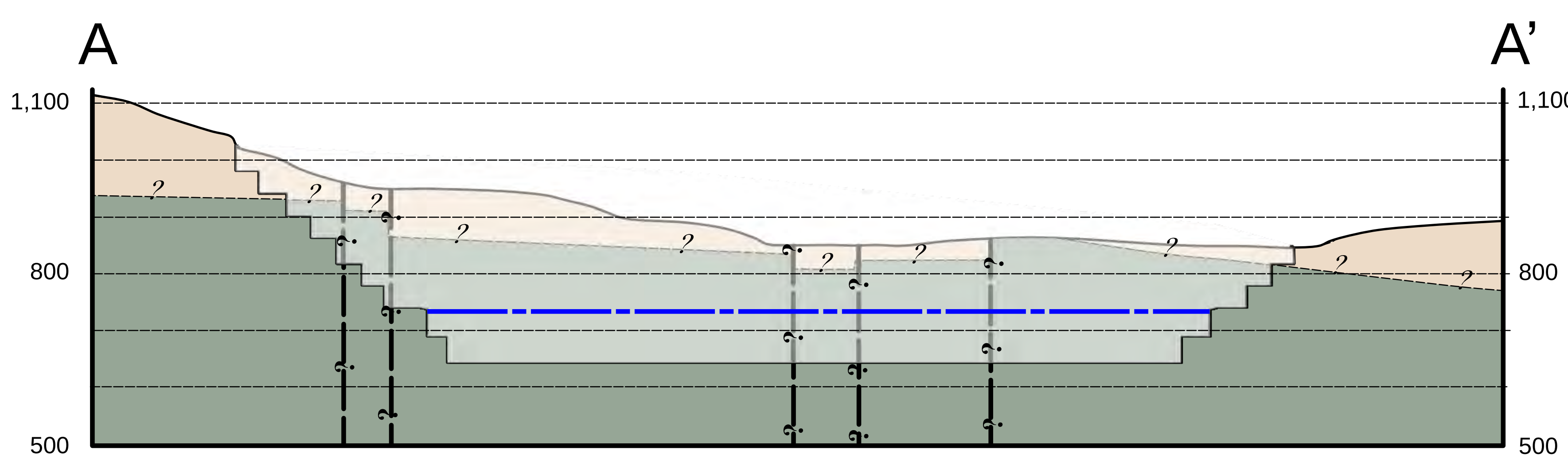


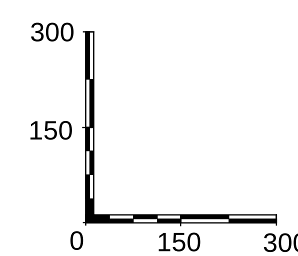

| | |
|---|---|
| af | Artificial Fill/Stockpiles |
| Qls | Landslide Deposits |
| Dmm | Mule Mountain Stock |
| Dbc | Balaklala Rhyolite |
| Da/ Dc | Epidote/Chloritic Amphibolite<br>Copley Greenstone & Gabbro |




Scale:
Horizontal:1"=300'
Vertical: 1"=100'
Vertical Exaggeration 3x

No subsurface information was available for this quarry. Projections of subsurface geological conditions are conjecture and subject to change as the quarry is mined and further mapping performed.

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Vertical: 1"=300'
No Vertical Exaggeration

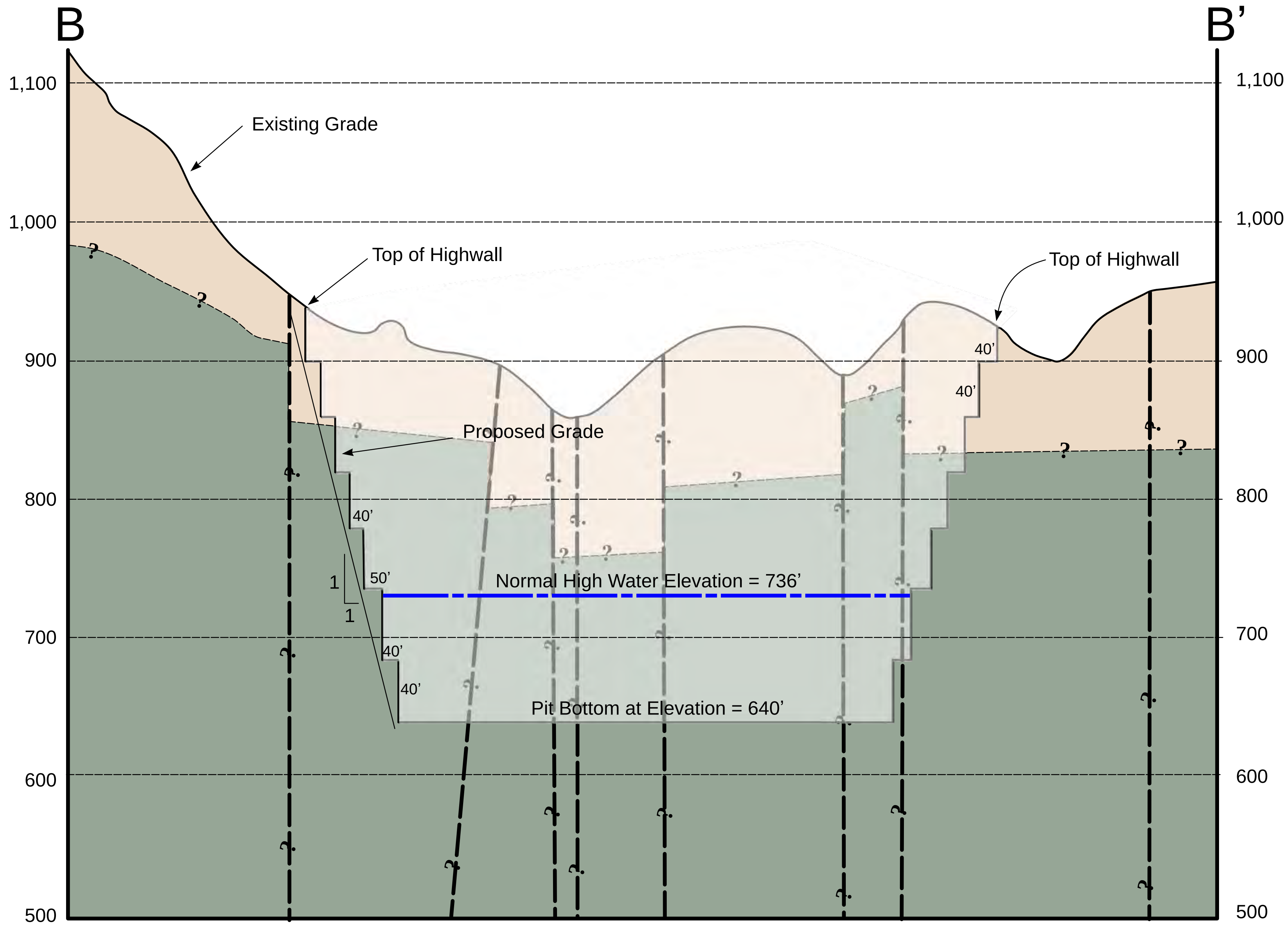
**GEOTECHNICAL SECTION A-A'**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No.
5.1

BAJADA Geosciences, Inc.

Project no.
1901.0114



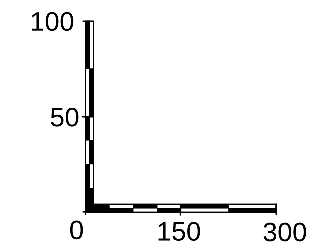

af Artificial Fill/Stockpiles

Qls Landslide Deposits

Dmm Mule Mountain Stock

Dbc Balaklala Rhyolite

Da/Dc Epidote/Chloritic Amphibolite, Copley Greenstone & Gabbro

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Vertical Exaggeration 3x

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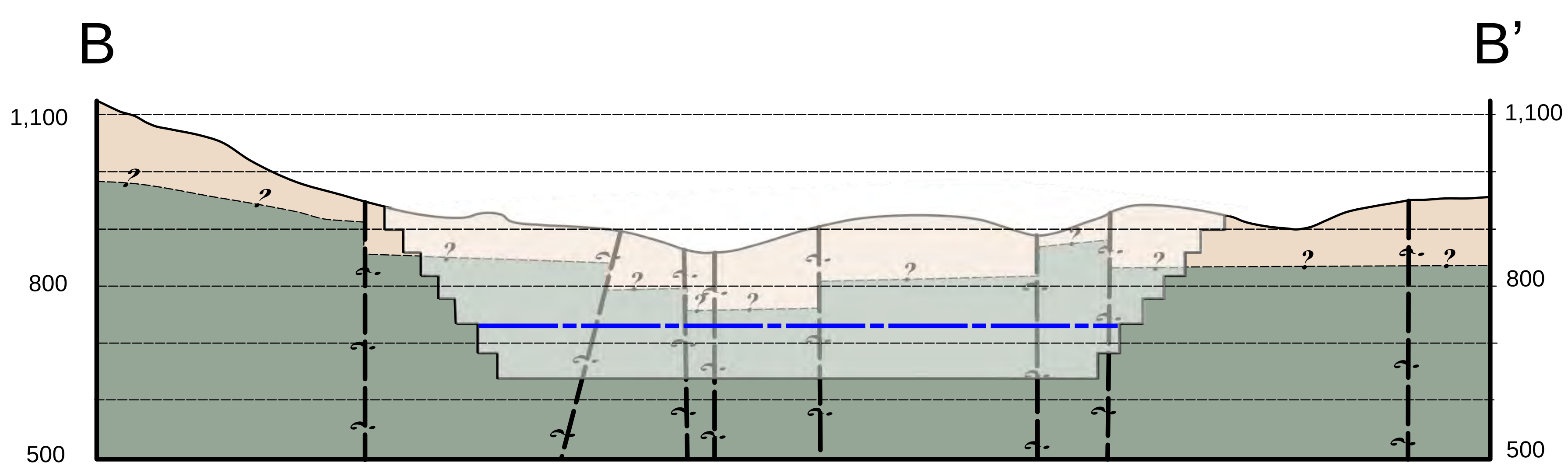


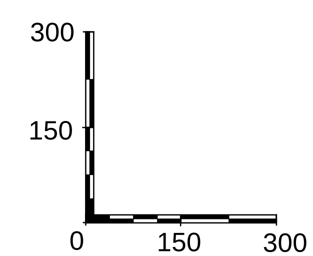


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No Vertical Exaggeration

**GEOTECHNICAL SECTION B-B'**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 5.2

BAJADA Geosciences, Inc.

Project no. 1901.0114


| 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) |

Base map from USGS Interactive Fault Map (2019)

Scale undetermined

# FAULT LOCATION MAP

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 6

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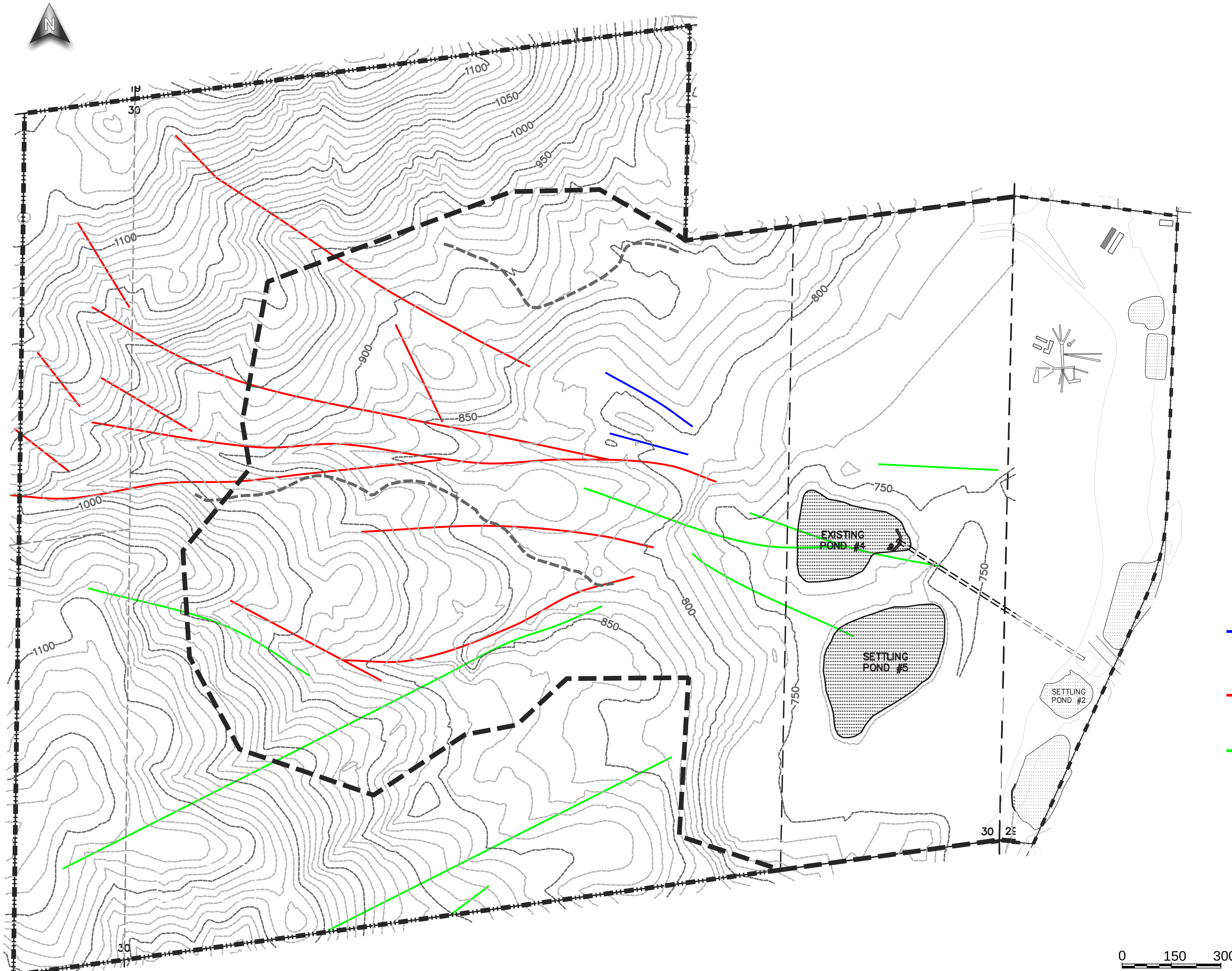



Mapped in the field

From recent aerial photographs

From pre-development 1952 aerial photographs

**LINEATION MAP**

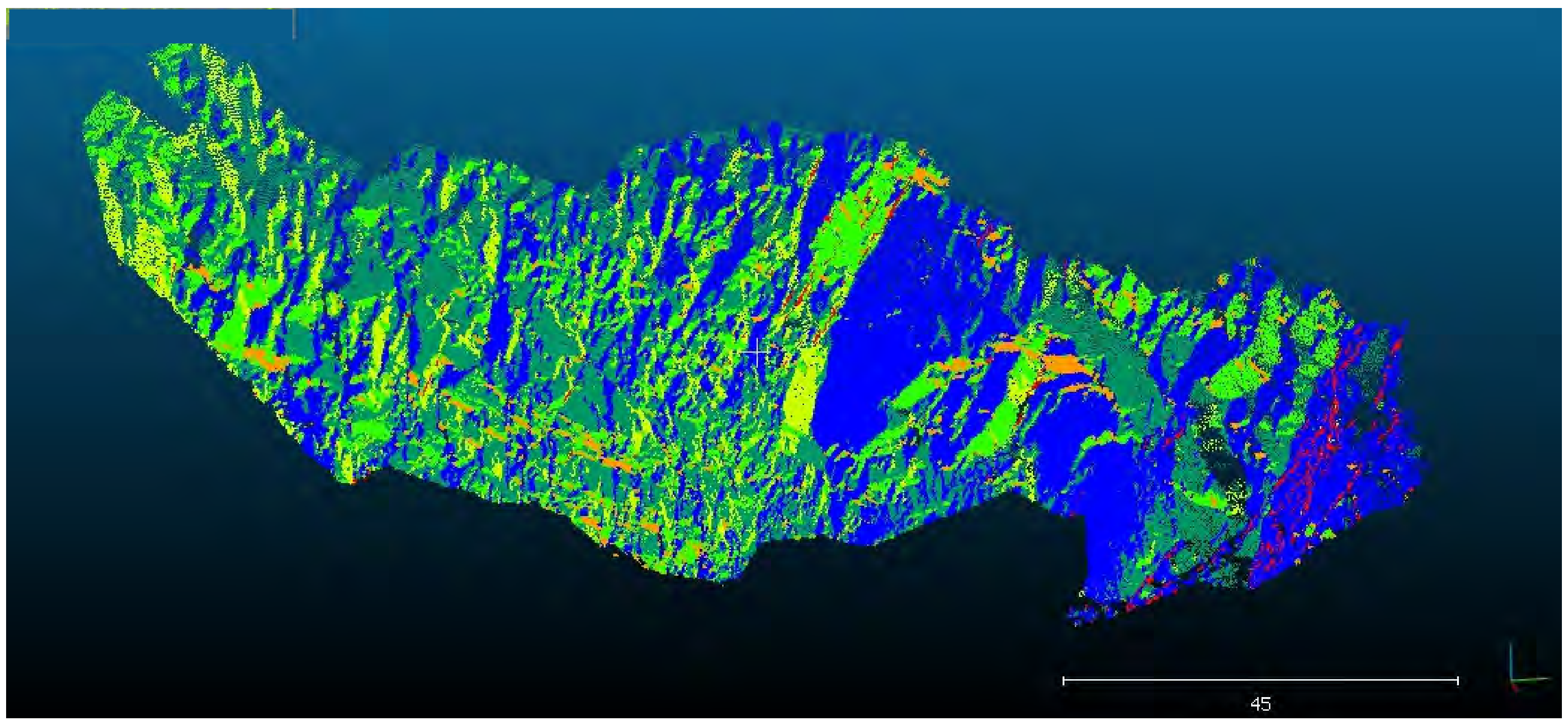
Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

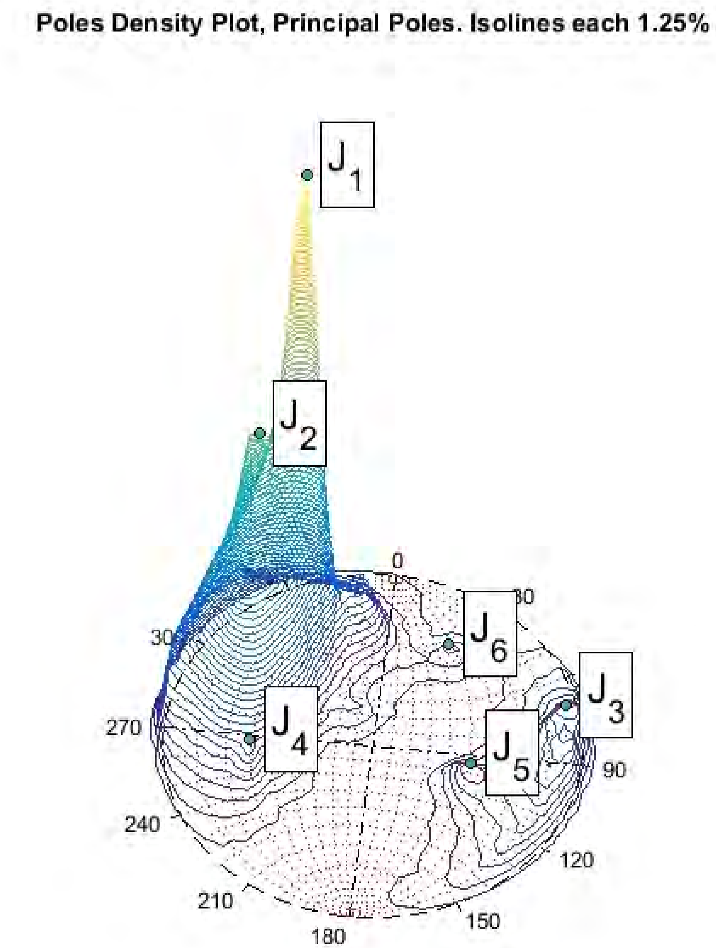
Plate No. 7

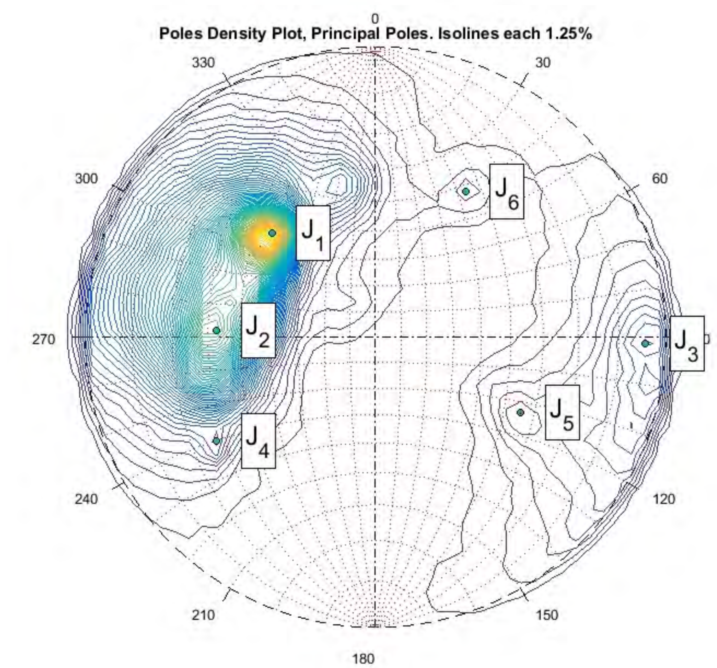
BAJADA Geosciences, Inc.

Project no. 1901.0114

Base map from Duane K. Miller Civil Engineer (2020)




| PRIMARY DISCONTINUITIES | | | | |
|---|---|---|---|---|
| Discontinuity | Color | Dip Direction | Dip | % |
| J1 | (blue) | 135 | 54 | 33 |
| J2 | (dark green) | 93 | 57 | 28 |
| J3 | (bright green) | 271 | 86 | 16 |
| J4 | (yellow-green) | 57 | 66 | 7 |
| J5 | (orange) | 298 | 59 | 5 |
| J6 | (magenta) | 212 | 61 | 2 |

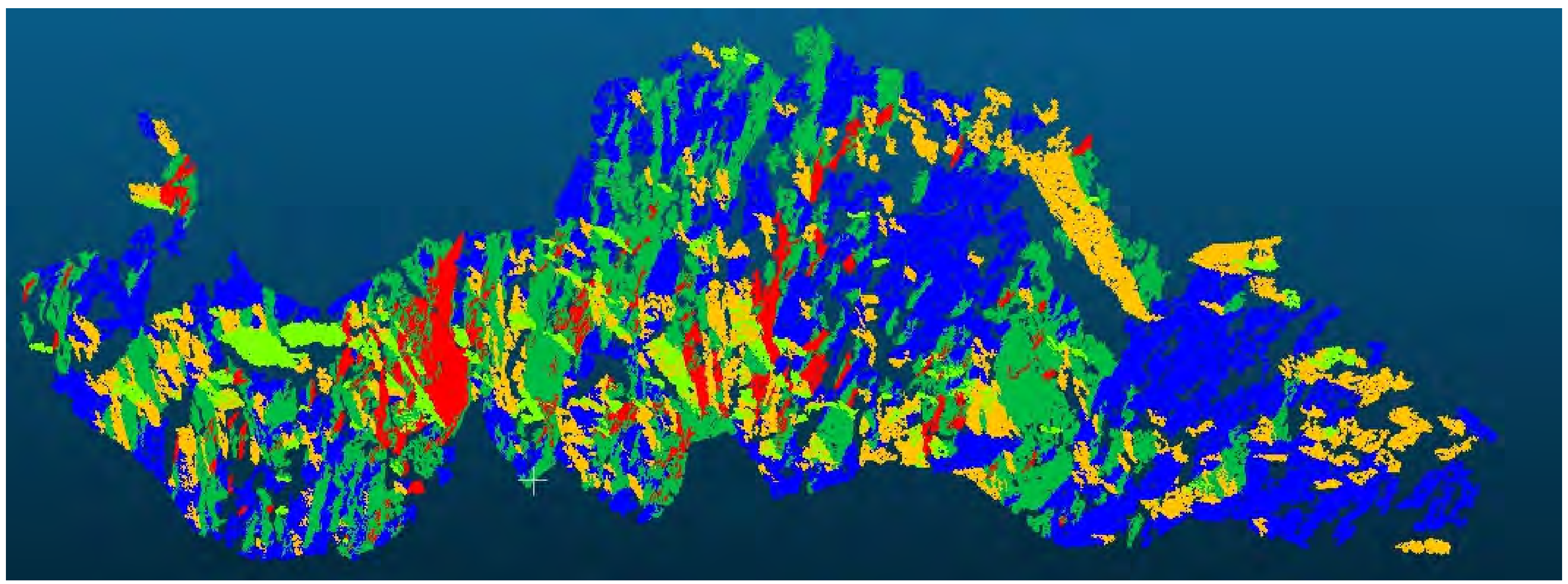
**SITE 1 DISCONTINUITIES**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

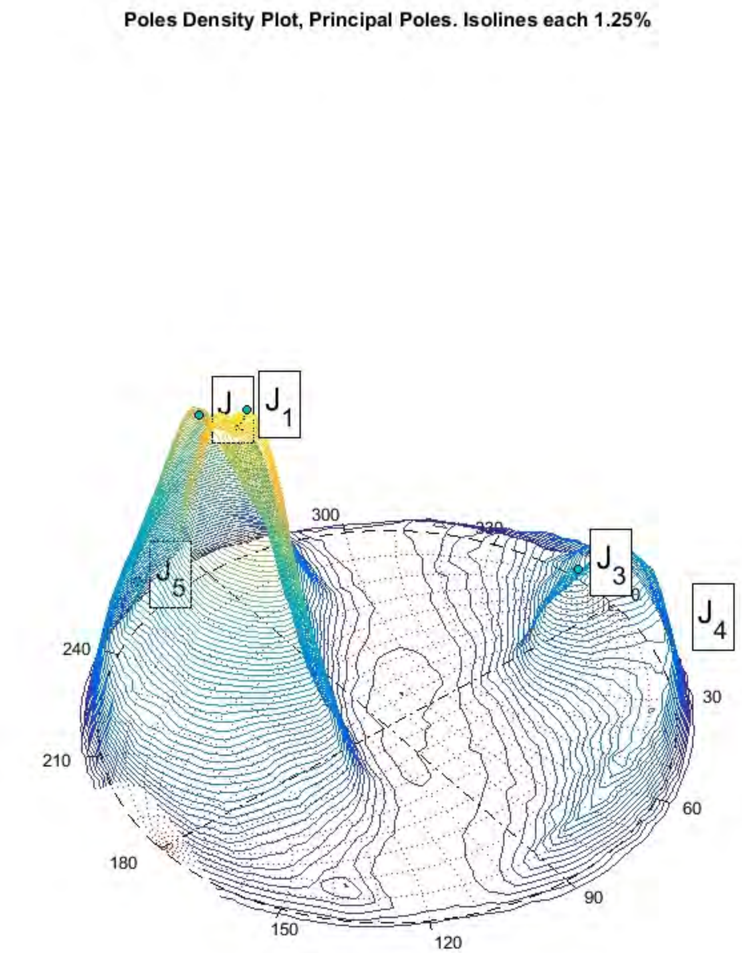
Plate No. **8.1**

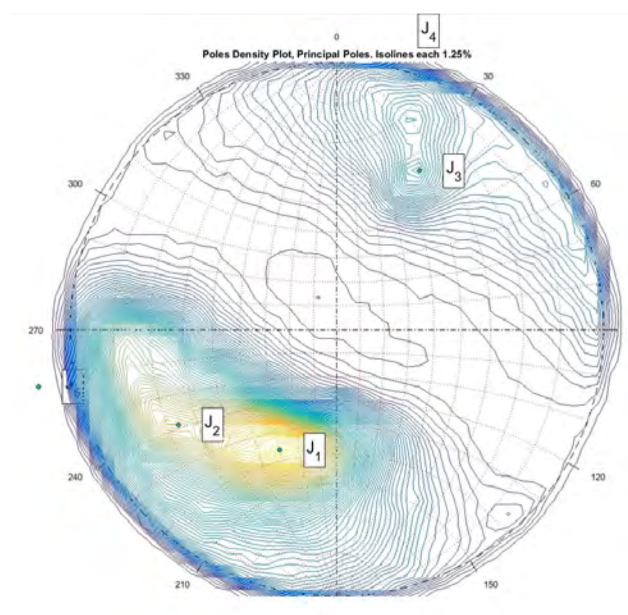
BAJADA Geosciences, Inc.

Project no. 1901.0114



| PRIMARY DISCONTINUITIES | | | | |
|---|---|---|---|---|
| Discontinuity | Color | Dip Direction | Dip | % |
| J1 | | 25 | 53 | 21 |
| J2 | | 59 | 70 | 25 |
| J3 | | 207 | 68 | 11 |
| J4 | | 191 | 83 | 17 |
| J5 | | 79 | 83 | 12 |



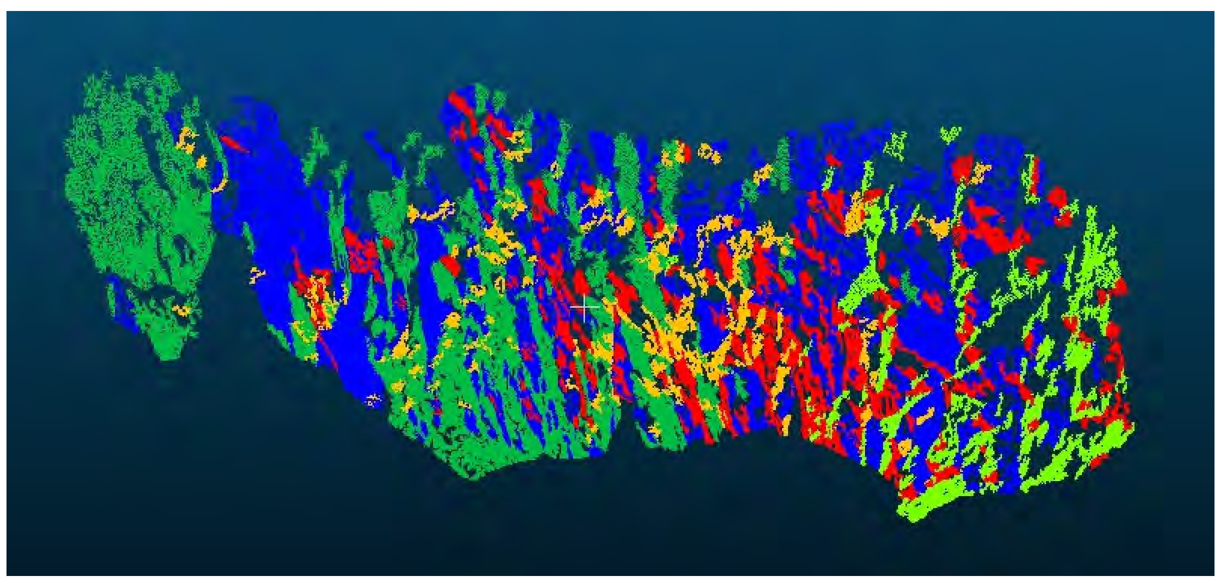

**SITE 2 DISCONTINUITIES**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

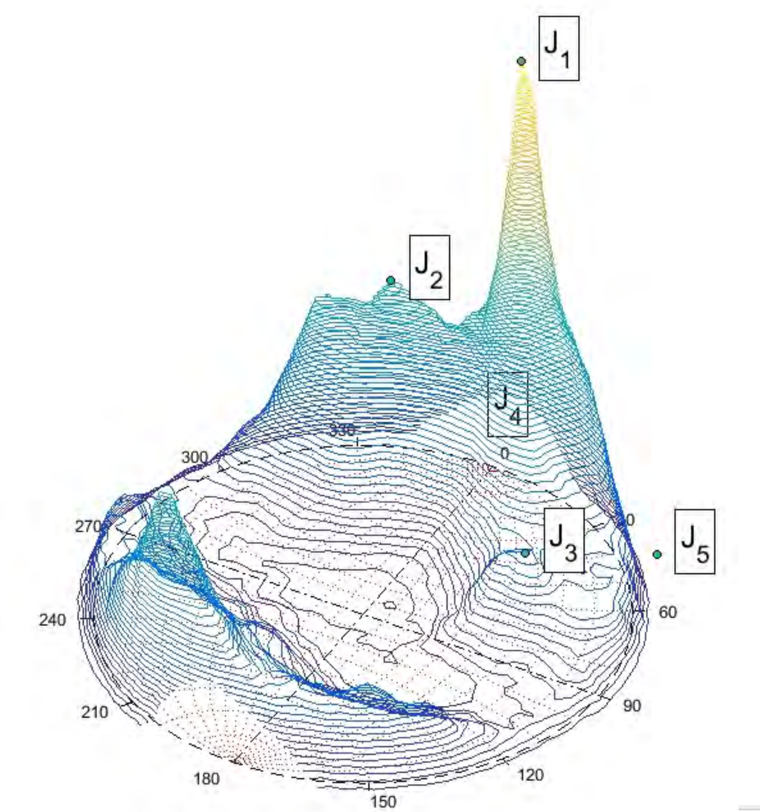
Plate No. **8.2**

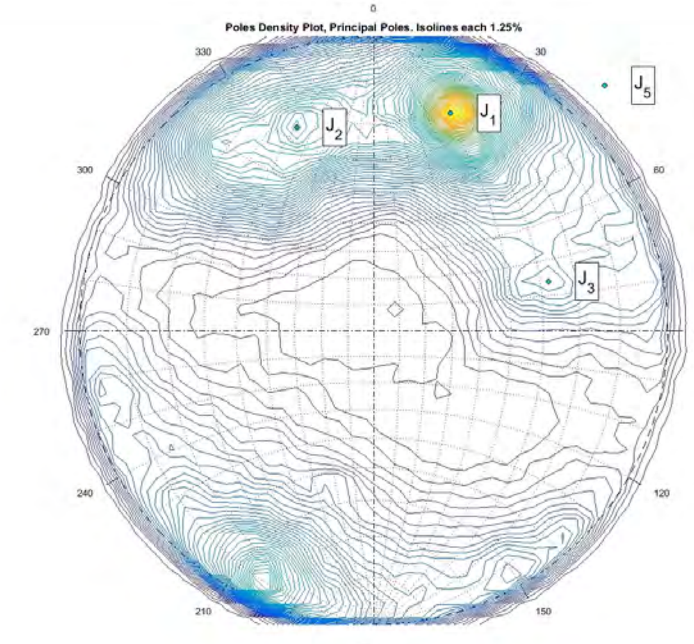
BAJADA Geosciences, Inc.

Project no. 1901.0114



Poles Density Plot, Principal Poles. Isolines each 1.25%




| PRIMARY DISCONTINUITIES | | | | |
|---|---|---|---|---|
| Discontinuity | Color | Dip Direction | Dip | % |
| J1 | Blue | 200 | 76 | 27 |
| J2 | Green | 159 | 73 | 23 |
| J3 | Light green | 254 | 63 | 10 |
| J4 | Orange | 170 | 78 | 11 |
| J5 | Red | 223 | 82 | 17 |

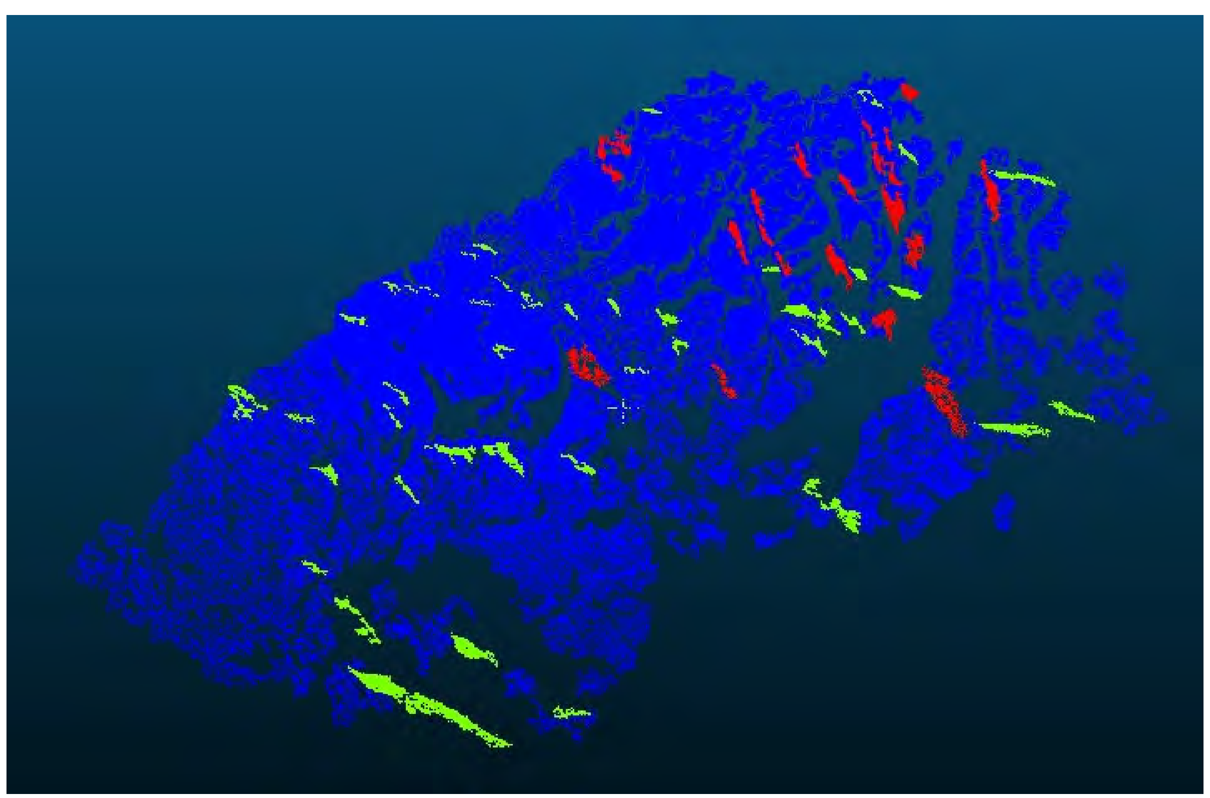
## SITE 3 DISCONTINUITIES

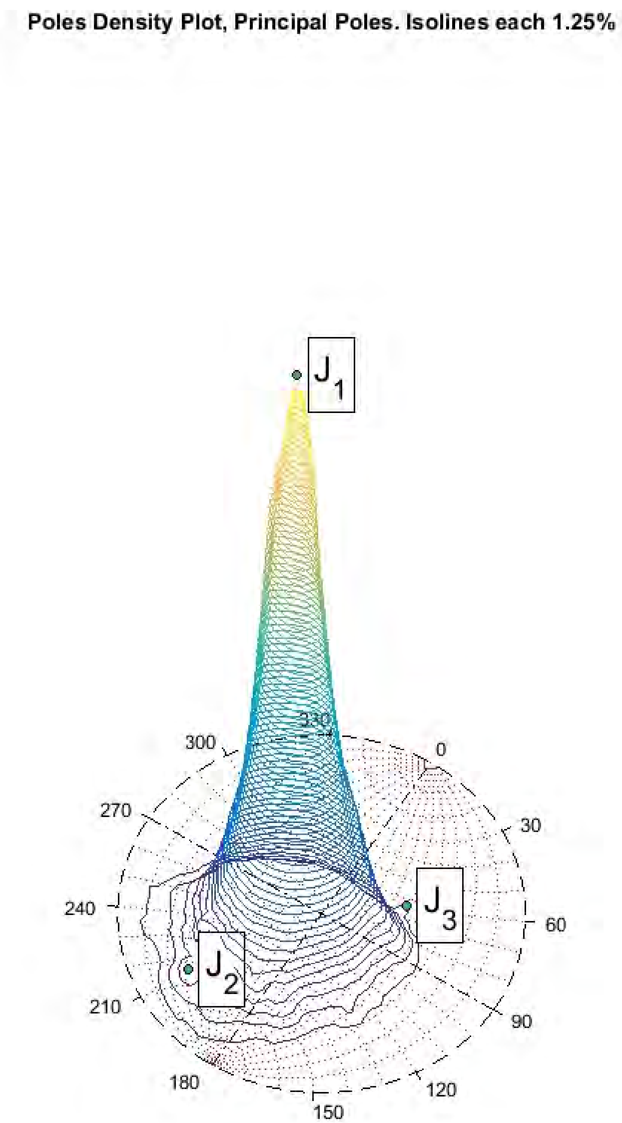
Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

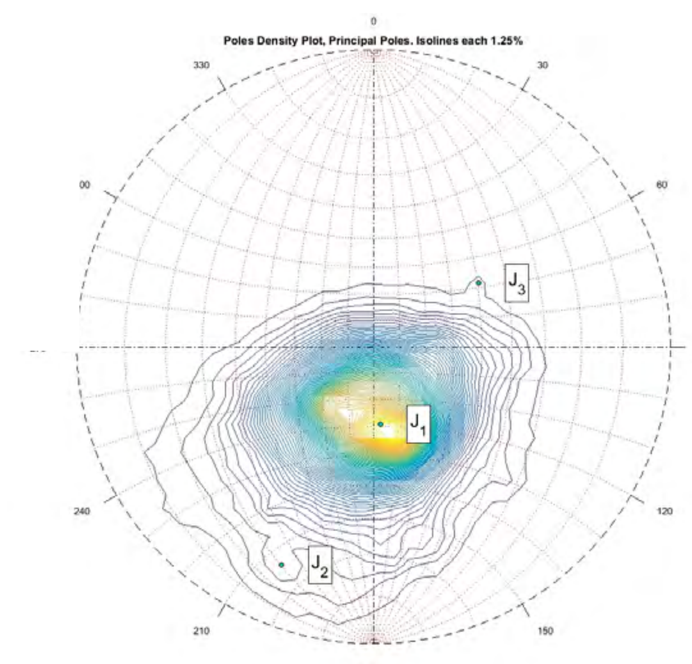
Plate No. 8.3

BAJADA Geosciences, Inc.

Project no. 1901.0114






| PRIMARY DISCONTINUITIES | | | | |
|---|---|---|---|---|
| Discontinuity | Color | Dip Direction | Dip | % |
| J1 | Blue | 355 | 29 | 68 |
| J2 | Green | 23 | 77 | 9 |
| J3 | Red | 239 | 45 | 4 |

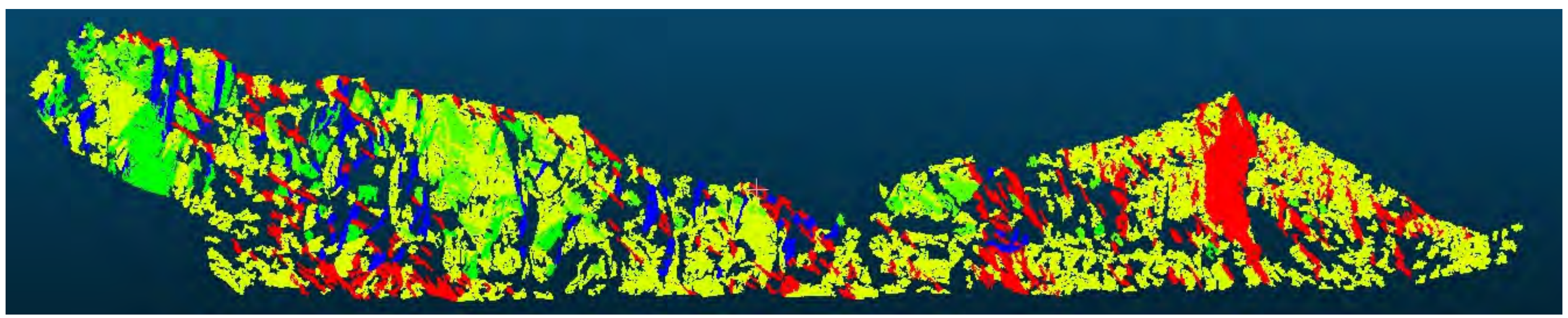
## SITE 4 DISCONTINUITIES

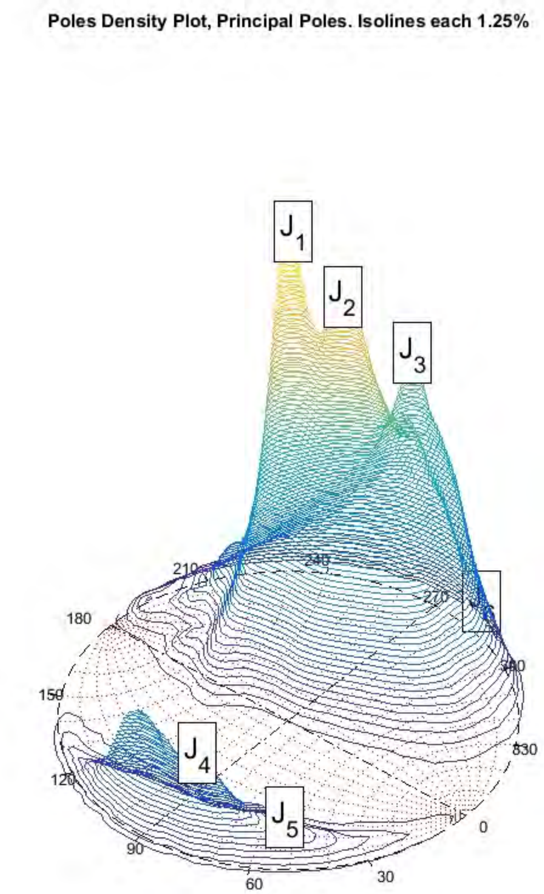
Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

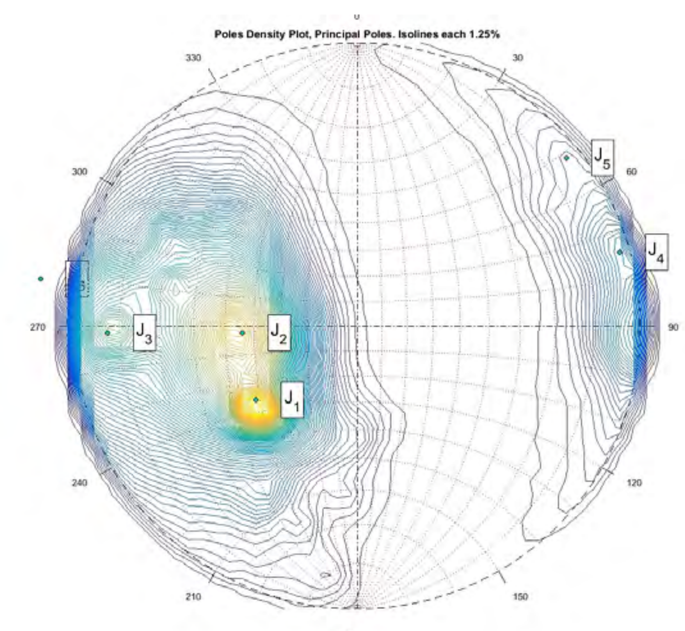
Plate No. **8.4**

BAJADA Geosciences, Inc.

Project no. 1901.0114






| PRIMARY DISCONTINUITIES | | | | |
|---|---|---|---|---|
| **Discontinuity** | **Color** | **Dip Direction** | **Dip** | **%** |
| J1 | Red | 54 | 48 | 21 |
| J2 | Yellow | 87 | 44 | 25 |
| J3 | Yellow | 88 | 83 | 19 |
| J4 | Green | 254 | 88 | 8 |
| J5 | Blue | 231 | 83 | 7 |
| J6 | Green | 98 | 83 | 7 |

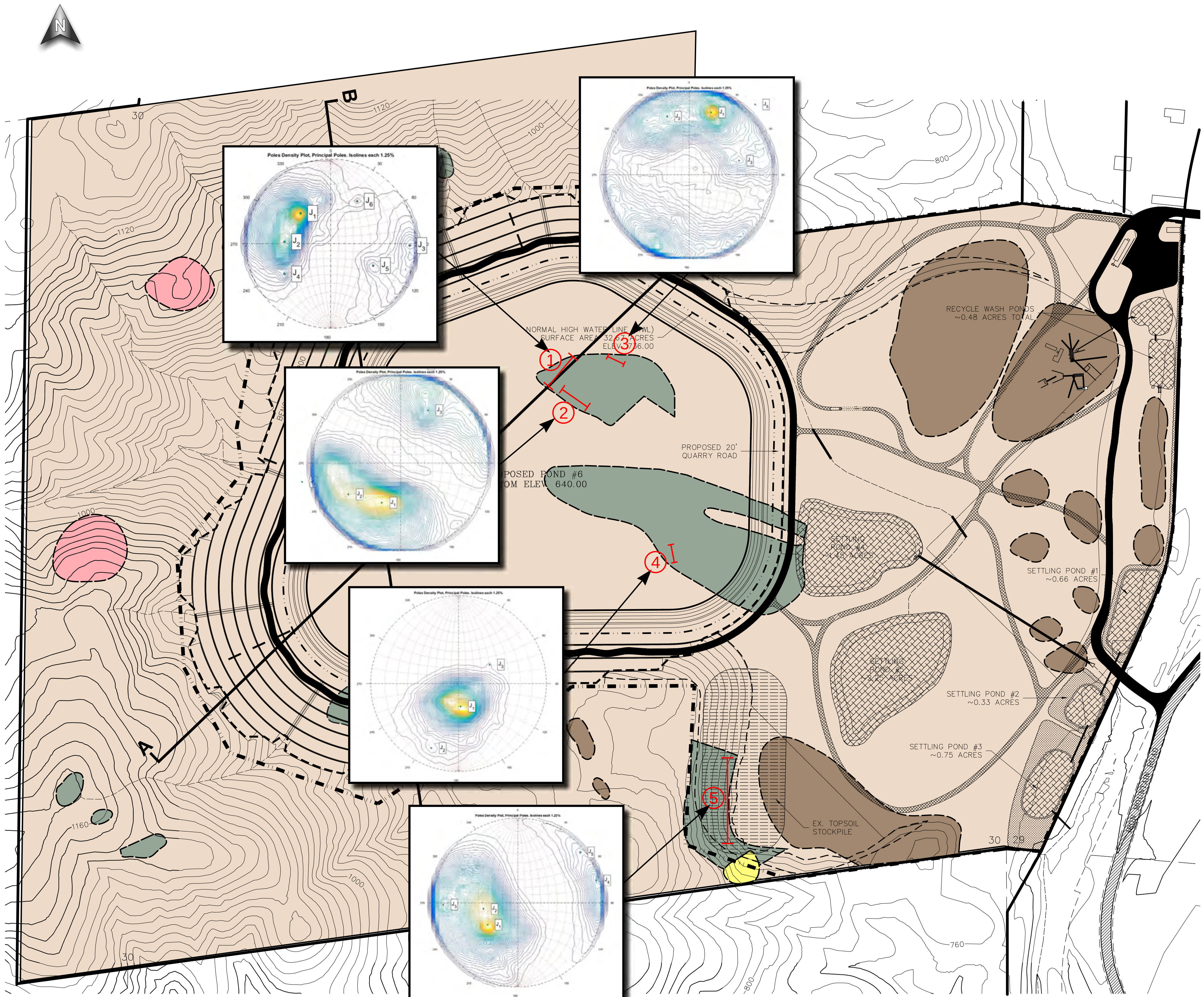
## SITE 5 DISCONTINUITIES

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. **8.5**

BAJADA Geosciences, Inc.

Project no. 1901.0114




Map from Duane Miller Engineering (2020)

6 Sites 1 through 6 - areas where discontinuities were mapped during this study

B B' Cross Sections see Plates 5.1 & 5.2

0 150 300
Scale: 1"=300'
1:3,600

**STRUCTURAL DOMAIN MAP**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

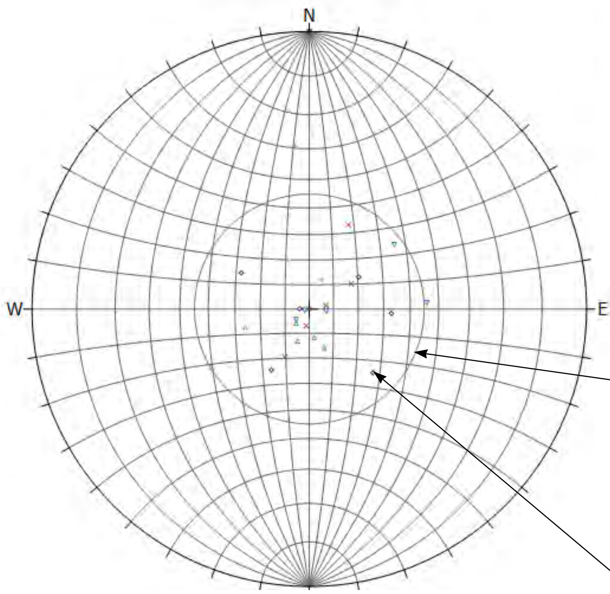
Plate No.
9

Project no.
1901.0114

BAJADA Geosciences, Inc.

# KINEMATIC TEST OF POTENTIAL FAILURES AT OVERALL SLOPE-SCALE

## POTENTIAL PLANAR FAILURES



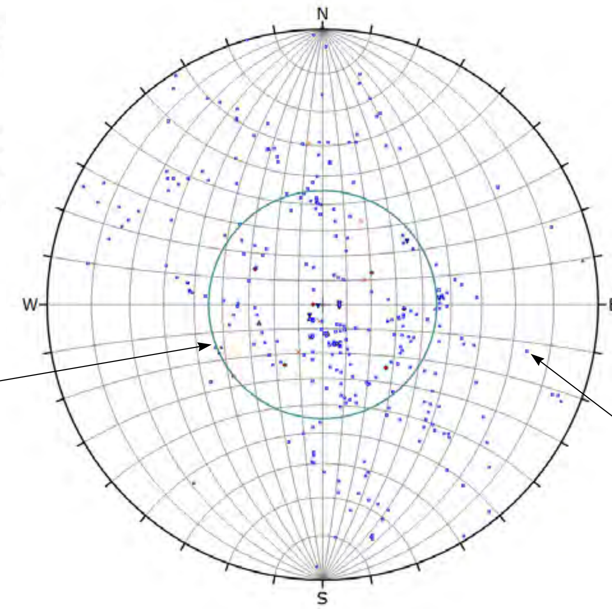

| Symbol | SITE | Quantity |
|---|---|---|
| ◇ | 1 | 6 |
| × | 2 | 5 |
| △ | 3 | 5 |
| · | 4 | 3 |
| ▽ | 5 | 6 |

| | |
|---|---|
| Plot Mode | Dip Vectors |
| Vector Count | 25 (25 Entries) |
| Hemisphere | Lower |
| Projection | Equal Angle |

Angle of Internal Friction (45 degrees)

Dip Vector of Potential Planar Failure

## POTENTIAL WEDGE FAILURES




| Symbol | SITE | Quantity |
|---|---|---|
| ◆ | 1 | 6 |
| × | 2 | 5 |
| ▲ | 3 | 5 |
| · | 4 | 3 |
| ▼ | 5 | 6 |
| **Symbol** | **Feature** | |
| ▪ | Intersection | |

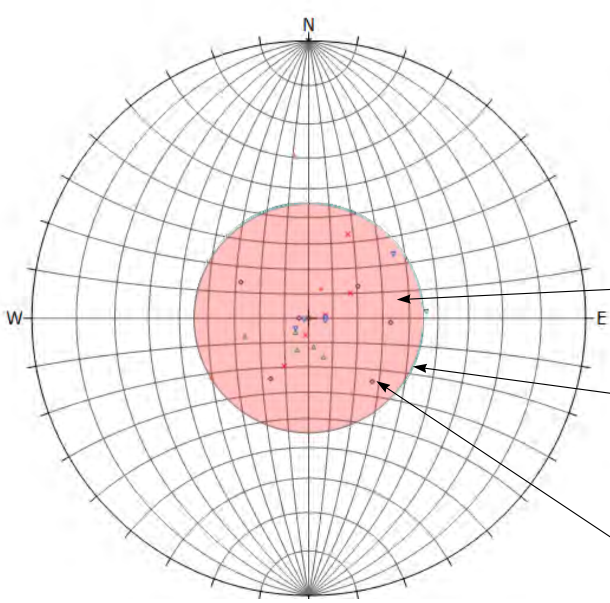
| | |
|---|---|
| Plot Mode | Dip Vectors |
| Vector Count | 25 (25 Entries) |
| Intersection Mode | Grid Data Planes |
| Intersections Count | 300 |
| Hemisphere | Lower |
| Projection | Equal Angle |

Trend & Plunge of Potential Wedge Failure

Overall slope angle at 45 degrees

# KINEMATIC TEST OF POTENTIAL FAILURES AT BENCH-SCALE

## POTENTIAL PLANAR FAILURES




| Symbol | SITE | Quantity |
|---|---|---|
| ◇ | 1 | 6 |
| × | 2 | 5 |
| △ | 3 | 5 |
| · | 4 | 3 |
| ▽ | 5 | 6 |

| | |
|---|---|
| Plot Mode | Dip Vectors |
| Vector Count | 25 (25 Entries) |
| Hemisphere | Lower |
| Projection | Equal Angle |

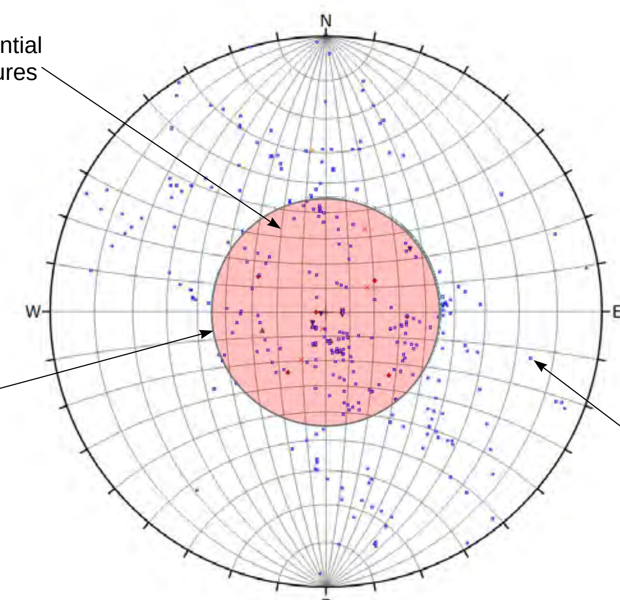
Area of Potential Planar Failures

Angle of Internal Friction (45 degrees)

Dip Vector of Potential Planar Failure

## POTENTIAL WEDGE FAILURES

Area of Potential Wedge Failures



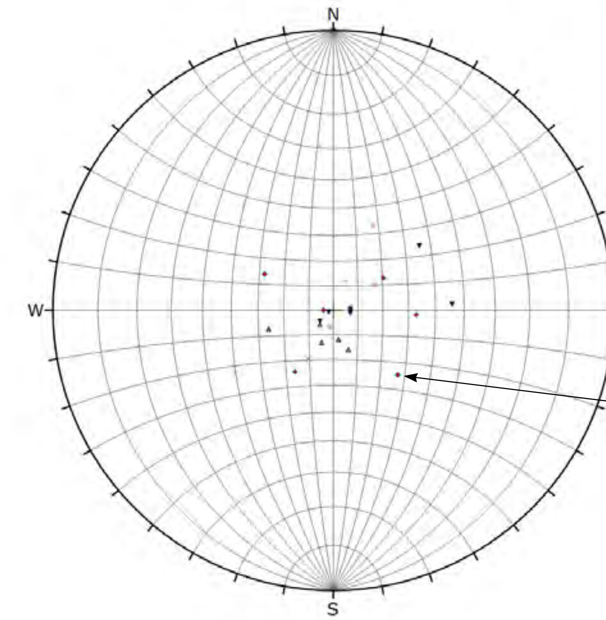

| Symbol | SITE | Quantity |
|---|---|---|
| ◆ | 1 | 6 |
| × | 2 | 5 |
| ▲ | 3 | 5 |
| · | 4 | 3 |
| ▼ | 5 | 6 |
| **Symbol** | **Feature** | |
| ▪ | Intersection | |

| | |
|---|---|
| Plot Mode | Dip Vectors |
| Vector Count | 25 (25 Entries) |
| Intersection Mode | Grid Data Planes |
| Intersections Count | 300 |
| Hemisphere | Lower |
| Projection | Equal Angle |

Trend & Plunge of Potential Wedge Failure

Bench face angle at 90 degrees

## PREDOMINANT DISCONTINUITY PLANES

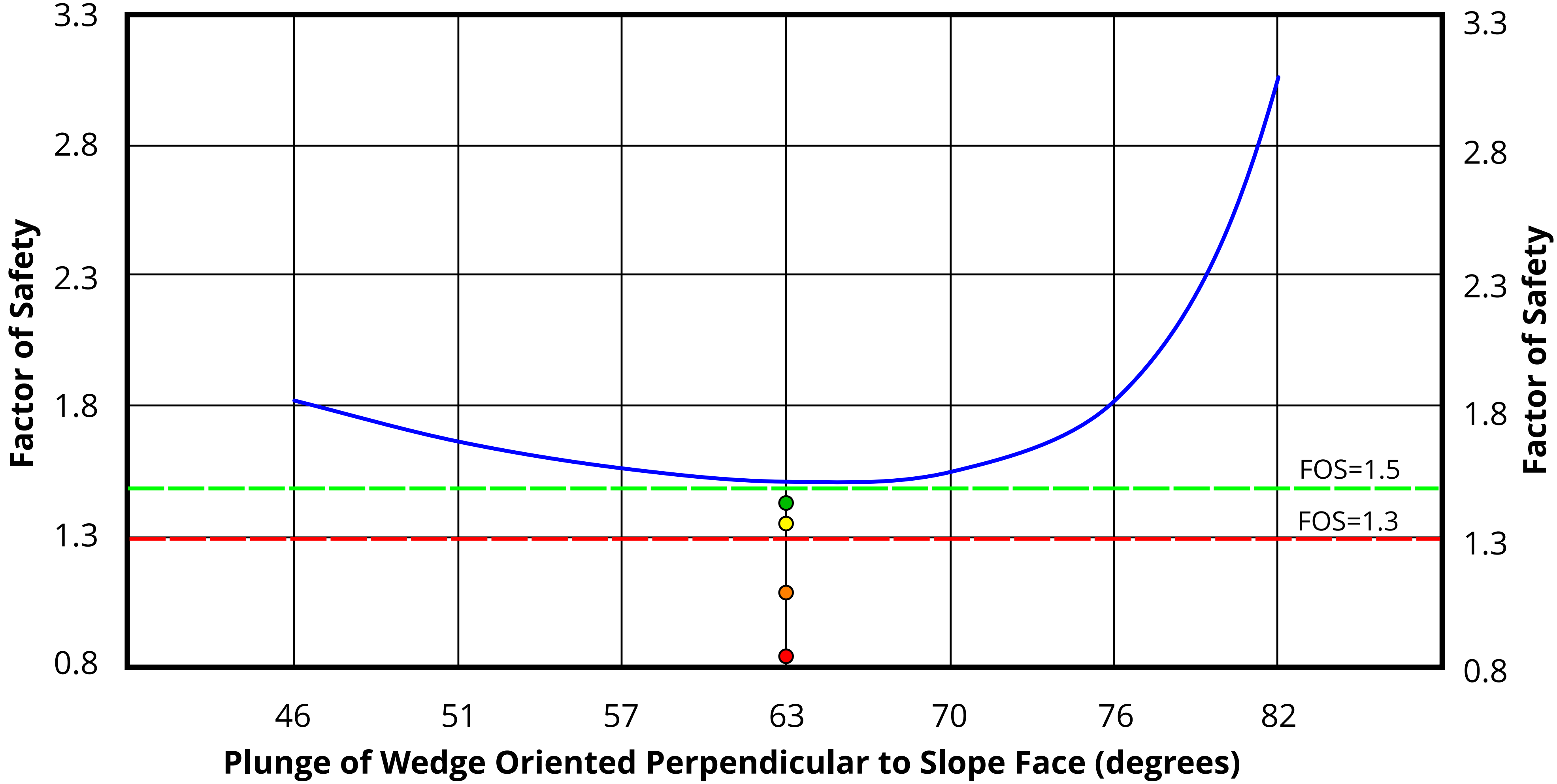



Dip Vector of Predominant Discontinuity Set

| Symbol | SITE | Quantity |
|---|---|---|
| ◆ | 1 | 6 |
| × | 2 | 5 |
| ▲ | 3 | 5 |
| · | 4 | 3 |
| ▼ | 5 | 6 |

| | |
|---|---|
| Plot Mode | Dip Vectors |
| Vector Count | 25 (25 Entries) |
| Hemisphere | Lower |
| Projection | Equal Angle |

| STEREONET EVALUATIONS | |
|---|---|
| Crystal Creek Aggregates Quarry<br>Amendment to Reclamation Plan<br>Proposed Quarry Expansion<br>Shasta County, California | Plate No.<br>10 |
| BAJADA Geosciences, Inc. | Project no.<br>1901.0114 |




| Percent water within discontinuities | |
|---|---|
| 25% | 75% |
| 50% | 100% |

Discontinuities modeled dry

**ROCK WEDGE STABILITY RESULTS**

| | |
|---|---|
| Crystal Creek Aggregates Quarry<br>Amendment to Reclamation Plan<br>Proposed Quarry Expansion<br>Shasta County, California | Plate No.<br>11 |
| BAJADA Geosciences, Inc. | Project no.<br>1901.0114 |

# APPENDIX A

## Previous Geoscience Studies

# APPENDIX A
# PREVIOUS GEOSCIENCE STUDIES

Site specific geologic and geotechnical studies have previously been performed at the Crystal Creek Aggregate Quarry site by Cooksley Geophysics, Inc. (1998 & 2008) and Materials Testing, Inc. (2007). Those studies are included within this appendix.

# GEOLOGIC REPORT TO ACCOMPANY THE GLOBAL SLOPE STABILITY ANALYSES FOR THE CRYSTAL CREEK AGGREGATE EXPANSION

**OIGINALLY SUBMITTED MAY 12, 2008**
**REVISED AUGUST 19, 2008**

CERTIFIED PROFESSIONAL IN EROSION AND SEDIMENT CONTROL
CPESC
Travis Morgan Deem
No. 3948

REGISTERED GEOLOGIST
J. W.
COOKSLEY, JR.
No. EG 285
Certified
Engineering
Geologist
STATE OF CALIFORNIA

# PURPOSE AND SCOPE OF INVESTIGATION

The Crystal Creek Aggregate (CCA) site is an existing quarry operation in Shasta County, CA. Mining for construction aggregate has been ongoing since 1990 under the same ownership. CCA has obtained approval for a 55.3 acre expansion of the quarry area with an estimated life of 65 years.

In October 2007, CCA employed Materials Testing, Inc. (MTI) to produce a slope stability analyses in response to informal technical comments from the Office of Mine Reclamation (OMR). The goal of the study was to determine the Factor of Safety of the proposed quarry benches. OMR offered further comment in their reclamation plan review letter dated April 10, 2008 which requested that additional geologic review be conducted to fully address the issue. Subsequent to initial review of this document, OMR requested clarification of certain items previously noted by their staff but not fully explained in the original report. This updated document seeks to satisfy OMR's concerns given available surface and, where available, subsurface data.

This engineering geological report assesses the potential for geologic hazards at CCA's proposed expansion site. The main objective of this investigation is to assess the strength and the resistance to slope failure of the rock units at the mine. The scope of investigation includes a refraction seismic survey directed at classifying and measuring thickness of the various soil units, weathered layers and the underlying rock units. This phase was conducted in 1998. Additional aerial photography and field reconnaissance was conducted during October 2007, spring 2008 and summer 2008 to identify rock outcrops and major geologic features.

# REGIONAL GEOLOGIC SETTING

The CCA site is located in the extreme southwest corner of the Klamath Mountains. This area is underlain by metasedimentary units of Paleozoic age that have been locally intruded by trondhejemite and related intrusives of Late Jurassic age and by quartz diorite (related to the Shasta Bally batholith, also Late Jurassic in age). Alluvial cover is thin at the subject site, seldom exceeding five feet.

No active faults have been mapped in the area investigated. The lone seismic event of significant magnitude in the past fifty years was an earthquake of magnitude 5.2 (Richter scale) that occurred on Thanksgiving Day, November 26, 1998. The epicenter was reported under Keswick Reservoir, about 4 miles north of the subject site at a depth of 25.96 km. The Crystal Creek quarry area was not damaged. No secondary effects were observed.

# SITE DESCRIPTION AND CONDITIONS

The site is located in Sections 19, 29 and 30, of T32N., R.5W. M.D.B.M., assessor parcel numbers 065-250-002, 065-250-023 (portion), 065-250-024, and 065-260-010. The property is 2 miles directly west of Redding, California and south of the small unincorporated community of Keswick and1 mile north of State Route 299 West. The site is approximately 550 feet west of the intersection of Iron Mountain Road and Laurie Anne Lane. The eastern portion of the property is relatively level land, while the western half contains rolling to hilly terrain. Rock Creek is 3,256 feet to the north of the property and Middle Creek is 3,700 feet south of the property.

The following rock units are present at the site:

**Copley Greenstone**

The oldest rock formation on this project is the Copley Greenstone. Kinkle, A.R., et al, (1956, p.10) estimate the thickness of this formation to be at least 3,700 feet in Modesty Gulch in the Whiskey Town Quadrangle. A Devonian age is assigned to this unit. The Copley is generally massive and competent in an engineering sense. It is normally jointed, the joints commonly being near vertical and of random strike. Where bedding was observed, it appeared to be of variable attitude with the dip being within 30 degrees of horizontal. In general, the lithologic and structural features within the Copley favor stability.

**Intrusive Rocks**

Several types of intrusives pierce the Copley Greenstone. These intrusives are mainly dikes of Late Jurassic age and range in texture from medium grained to very coarse grained, some being porphyritic. Their composition ranges from silicic to intermediate. This category includes the trondhjemite of the Mule Mountain Stock, medium grained intrusives of granitic to dioritic composition, and may include the quartz diorite of the Shasta Bally Batholith. The coarser grained intrusive (trondhjemite) tends to be less competent, deeply weathered, and more easily eroded. These dikes are known to occur in the vicinity of the quarry but within the mining boundaries there are no in situ occurrences of this material. The only surface expression of this rock within the project boundary is as isolated float which may actually have been imported for incorporation into building foundations during the gold rush.

**Surficial Deposits**

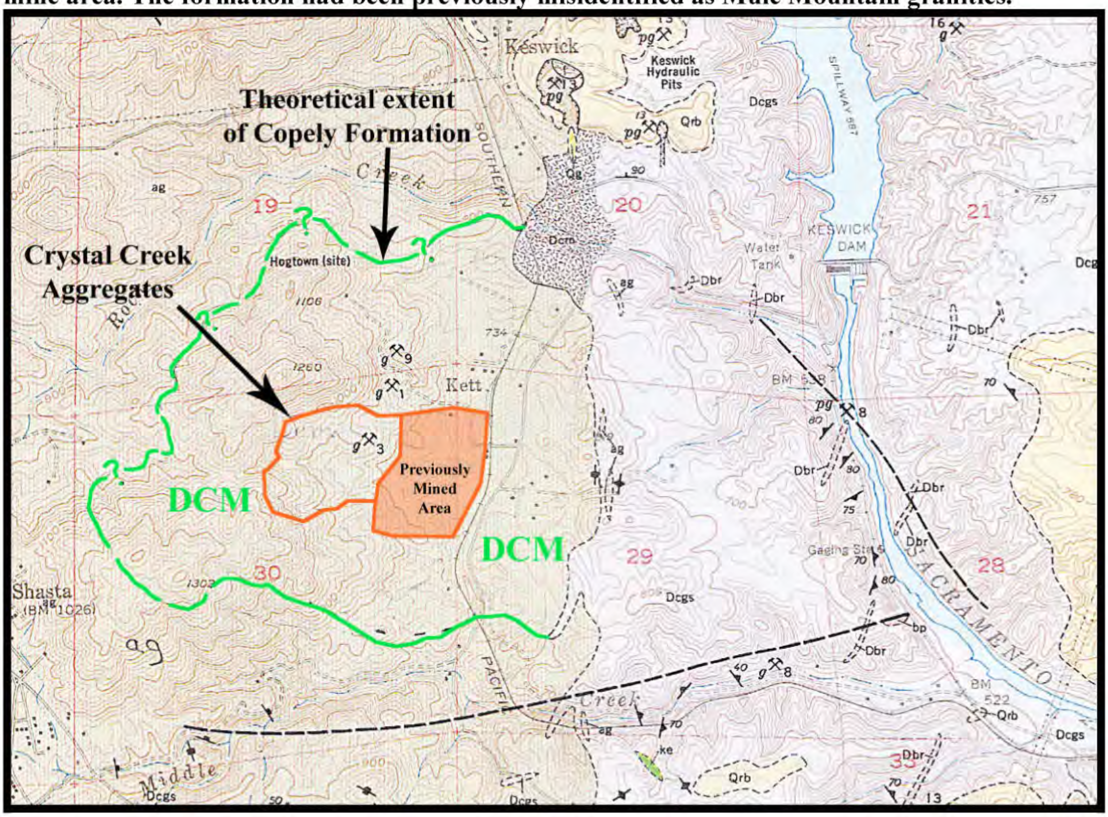
These deposits include the unconsolidated deposits at the surface and the zones of intense to intermediate weathering of the bedrock. The average thickness of the unconsolidated layer is probably less than 5 feet. The weathered layers extend another 0 to 60 feet below the unconsolidated soil, as evidenced in the refraction seismic survey performed by Cooksley Geophysics in 1998.

## DESCRIPTION OF THE INVESTIGATION

Cumulative evidence derived from both the seismic and field surveys indicates that the main rock unit being quarried at the site is the Copley Greenstone. The Copley constitutes approximately 75% of the identifiable outcrops within the study area. In the sections derived from the 1998 seismic investigations, Copley Greenstone is correlative with velocities in excess of 10.0 feet per millisecond and altered intrusives, including the Mule Mountain Stock, correlates with the 5.7 – 10.0 feet per millisecond range. Velocities in the 1.0 – 4.0 feet per millisecond represent soil and weathered rock.

Investigations conducted since the beginning of 2008 consist of inspecting the majority of known outcrops, looking for indications of bedding planes or discontinuities, and photographing the few exposures of in situ rock where they occur at the surface. This procedure led to recognition of Copley Greenstone in an area previously mapped as Mule Mountain Stock (V.F. Hollister and J.R. Evans, 1965). One important observation is that small, localized areas of intrusive Mule Mountain Stock are exposed throughout the Copley. The competence of these exposures range from soft, porphyritic, trondhejemite, to hard, medium-grained intrusive to very hard migmatite. Figure 1 shows the probable extent of the Copley  based on surface observations and areas of known gold mining activity which are locally associated with the Devonian volcanics.

**Figure 1: Geologic map of the mine area showing theoretical boundaries of the Devonian Volcanics in the mine area. The formation had been previously misidentified as Mule Mountain granitics.**



Surface observations of outcrops and float were made throughout the project area. The main objectives in this phase of the program were to map the extent of Copley Greenstone and the various intrusive rocks and to observe structural features, e.g., faults, joints and folding (tilting). Due to the amount of vegetative cover and deep weathering no signs of these underlying geologic structures were observed in the unmined areas. Within the previously mined zone the Copely manifests as a massive, largely homogenous body of rock with no adverse structural deformities or zones of weakness. Visible banding in exposed quarry faces are the result of ancient bedding / discontinuities which were later fused during metamorphic alteration.

Attention was also directed to observation of slope failure, extreme erosion, and slumps in the cut slopes of roads. Particular attention was directed to identifying any signs of slope failure in the finished benches of the existing quarry area.

During the initial stages of preparing this update it was intended that geologic cross sections would be produced in order to better characterize the rock mass. Subsequent to the completion of field work it was determined that there was not adequate information available to produce meaningful cross sections. The density of vegetation and depth of weathered material prevented observation beyond that necessary to define the general boundaries of the rock mass shown in figure 1. Where there is a good surface expression of the rock mass it generally presents itself in the same manner throughout the site but these instances are localized and of limited area. The comments from OMR explicitly requested that geologic cross sections be provided and every reasonable attempt was made to satisfy that expectation. The cross sections which accompany this report are accurate; having been derived from flown contours but are purely for the purpose of showing the general nature of the existing landforms in both the previously mined and unmined areas. The reader is also referred to the seismic sections which depict the various units in detail.

# LIKELY MODES OF FAILURE

This section addresses specific modes of slope failure and the potential for occuring at the site. Particular attention was directed to finding recent scarps, failed banks along roads, arcuate scarps and arcuate shapes of vegetative cover. No evidence of these features appears on the air photos and no indicators of failure were found during field surveys.

**Competence of natural outcrops of Copley**

In at least one location (Photo 2 on accompanying map) the Copley can be seen to naturally exhibit stability in vertical exposures. Where the local rock is exposed in the finished quarry walls, (Photos 9, 10, 11) stability has been proven at slopes as steep as 1:1. Further evidence of the stability and resistance to erosion can be seen in Photo 9. At this location, stormwater runoff from the proposed expansion area flows over the highwall and into an existing pond. Despite the concentration of flow and velocity of water down the 52 foot slope, there is no indication of erosion or instability.

**Rotational shear failures in over-steepened slopes are not present.**
The competent nature of the Copley Greenstone is not compatible with the development of shear failures in the moderate terrain conditions at the quarry. Along seismic traverse "A", up to 50 feet of weathered rock with a seismic velocity of 2.0 feet per millisecond (fpms) covers fairly competent rock possessing seismic velocities generally in excess of 8.5 fpms. The shallow slope at which this unit rests precludes the formation of rotational shears. No evidence of rotational slope failure was noted in the inspection of the area.

**Translational slope failures are absent in the quarry area.**
Because of its competence and massive structure, the Copley Greenstone seems devoid of translational shear failures. No evidence of bedding plane or wedge failures were seen in the course of the geological recon or the seismic field work. No evidence of past slope failure is confirmable on the aerial photo and existing highwalls are stable.

**There is no evidence of toppling failures.**
In the course of operations of the Crystal Creek Quarry, no instances of rock toppling has been noted. The formation lacks the type of structure (e.g. vertical bedding tipping at high angle into the quarry) which would facilitate this type of failure.

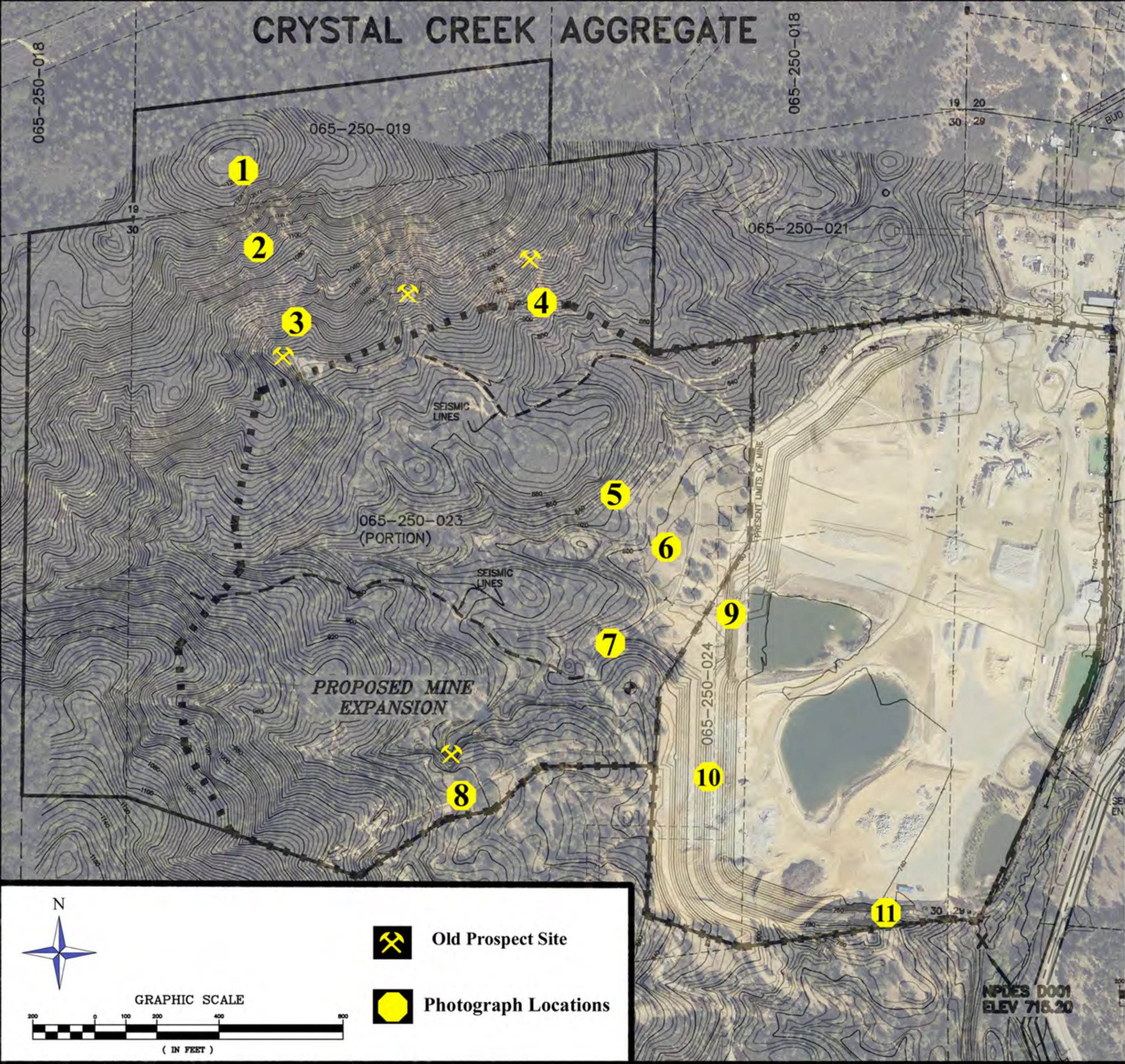
**The MTI study adequately analyzed the level of safety based on likely failure modes.**
Although MTI had not conducted a detailed site examination prior to producing their study, the findings of this investigation confirm that their conclusions were reasonable given site conditions. As noted above, the formation is not prone to rotational sheer failures. Indications of other failure modes being present are absent. This model serves to demonstrate the basic integrity of the material and stability of final slopes.

## CONCLUSION

As a result of the surface phase of the investigation, no past, imminent or probable failures were recorded in either the Copley Greenstone or the intrusive rocks. The MTI study was adequate given the known qualities of the rock mass being mined and the final design of the cutslopes. The natural tendency of the rock mass to resist failure, combined with the proven stability of the existing highwall substantiates the findings of the MTI study; that the finished benches will be stable. In addition, provided that the operator engages in safe mining practices and avoids over-steepening or undercutting of active faces, the working face of the quarry should also remain stable. Geologic structures can be complex and can change at depth. It is recommended that the operator conduct regular inspection of all slopes for early detection of potential hazards and / or emerging failures.

## ATTACHMENTS

1. Map showing site contours, aerial features, photo locations and old mine adits.
2. Site cross sections.
3. 1998 Cooksley Geophysical - Seismic Study.
4. October 2007 MTI - Global Slope Stability Analyses.




1. Steeply dipping joints in Copley Greenstone

2. Near vertical joints in massive Copley.

3. Near vertical joints of Copley surrounded by weathered migmatite.

4. Large boulders of Copely above collapsed adit entrance.

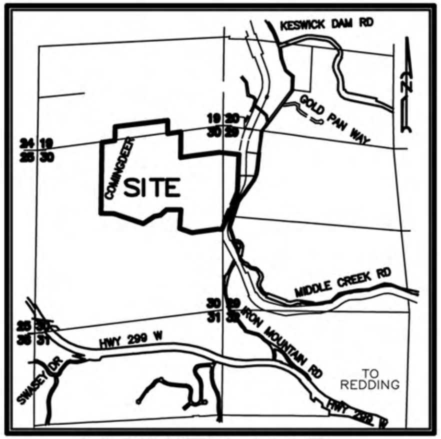
5. Massive Copley. Note joint crossing top half of photo through hat.

6. Surface expression of Copley formation.

7. Copley exposed in road cut showing beds dipping into hill at low angle.

8. Medium grained intrusive exposed near old mine workings.

9. Quarry wall in excess of 45 degrees above pond. Note rock cleaned by winter stormwater emerging from left.



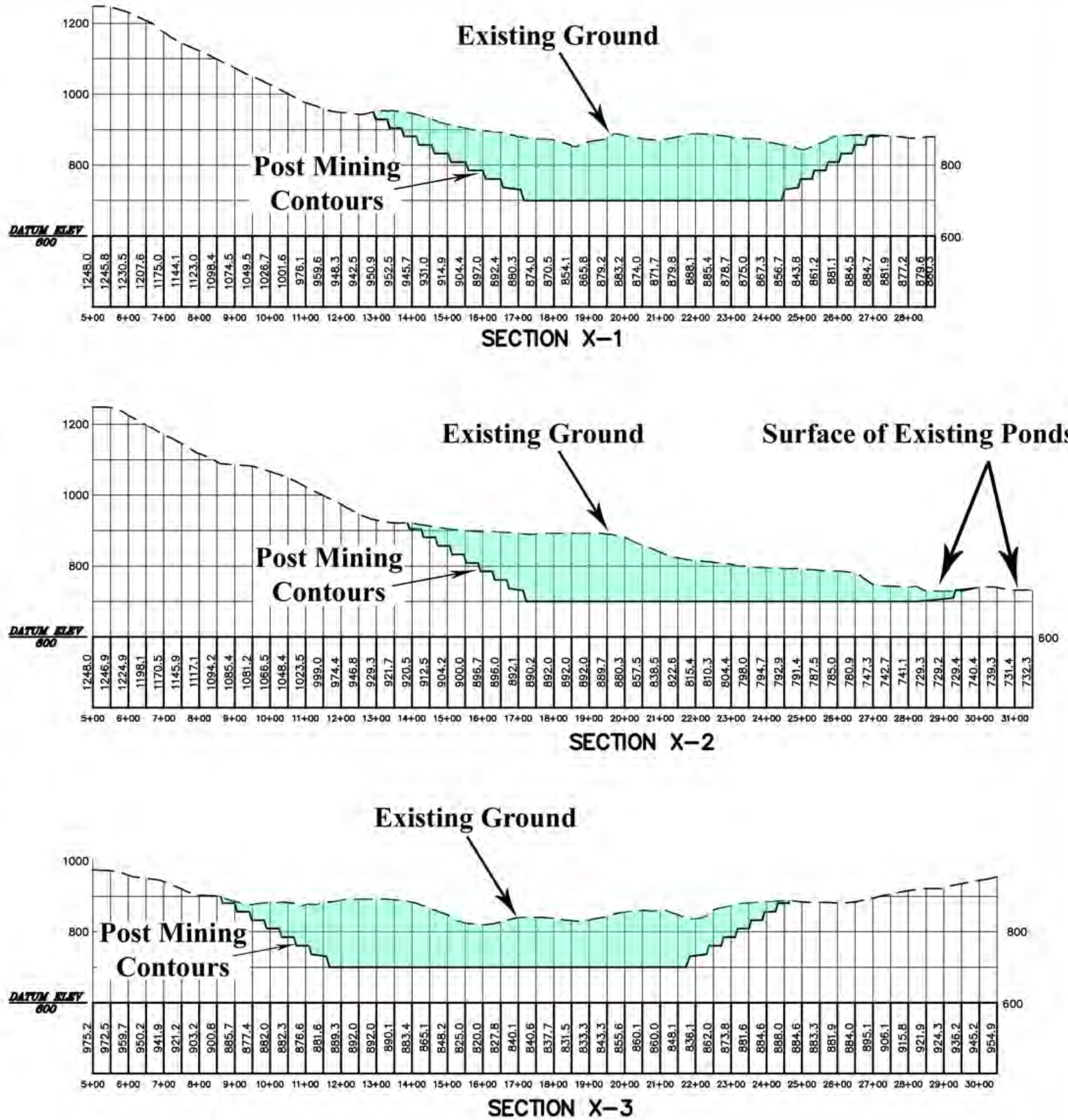

VICINITY MAP
n.t.s.

10. Southwest corner of quarry with Copley exposed in wall.

11. South quarry wall showing Copley resting on 45 degree slope.


THE LAND DESIGNERS
1975 PLACER STREET, SUITE A
REDDING, CA 96001
(530) 244-0506
LAND USE PLANNERS


ATTACHMENT 1


# CRYSTAL CREEK AGGREGATES
# CURRENT LANDFORMS AND POST-MINING X-SECTIONS

ATTACHMENT 2

98-010

# REFRACTION SEISMIC INVESTIGATION ROCK CLASSIFICATION AT THE PROPOSED EXPANSION OF THE CRYSTAL CREEK ROCK QUARRY, REDDING, CALIFORNIA


Prepared by:

*COOKSLEY GEOPHYSICS, INC.*

James W. Cooksley


June 1998

## TABLE OF CONTENTS

# REFRACTION SEISMIC INVESTIGATION ROCK CLASSIFICATION AT THE PROPOSED EXPANSION OF THE CRYSTAL CREEK ROCK QUARRY, REDDING, CALIFORNIA

## EXECUTIVE SUMMARY

This investigation is directed to defining the depth of hard bedrock and defining areas of rock alteration and structural deformation. The study was conducted in the area west of the existing Crystal Creek Aggregates quarry, Redding, California.

Two seismic refraction lines, one thousand (1,000) feet and the other two thousand, two hundred eleven (2,211) feet in length, were executed over brushy, mildly hilly terrain. The data indicates that the depth to unweathered, non-rippable rock ranges from about ten (10) to in excess of one hundred (100) feet.

## INTRODUCTION

A refraction seismic investigation program was conducted along two (2) roughly parallel, east-trending traverse lines located (see map in APPENDIX) across the proposed quarry expansion area west of the existing quarry area of Crystal Creek Aggregat, of Redding, California. The seismic program was directed toward determining the top of bedrock and assessing the excavation characteristics of the rock units underlying the site. Data were taken along the seismic lines using twenty-to thirty-three foot sensor spacings as shown on the enclosed air photo map of the site. A twenty-four channel seismic recording system was used to acquire the data.

## DATA ACQUISITION

Data acquisition and recording was carried out using a Bison Series 9000, Model 9024 twenty-four channel seismograph. This unit records data on paper and in computer memory. Timing for the Bison 9024 is electronically controlled within the instrument.

Seismic vibrations were produced by striking a 20-pound hammer to a metal plate or by striking the ground with an accelerating eighty-pound mass.. The hammer blows were stacked and enhanced at each shot point. The number of blows varied according to the subsurface's capacity to propagate seismic energy. Time of shot (hammer blow) was provided by a trigger circuit attached to the hammer.

## INTERPRETATIONS

In this refraction seismic investigation, the subsurface is mapped in terms of velocity units. A velocity unit is a three-dimensional unit which, due to its elastic properties and density, propagates seismic waves at a characteristic velocity or within a characteristic velocity range. Velocities denoted in this report and in the seismic refraction sections are expressed in feet per millisecond (fpms). At least one velocity is present within a geological rock unit. Each zone of weathering or zone of fracturing within a given rock unit could constitute an additional velocity unit. Conversely, when two rock units such as water saturated gravel and moderately weathered rock propagate seismic waves at the same velocity and are adjacent to each other, both units would be part of the same velocity unit.

In the interpretation of seismic data, the geologic setting is of major importance. The contact between soil and rock strata is ideally defined on a seismic profile as an abrupt change in velocities. Actually a geologic contact is often a gradational change in physical properties. Discontinuous velocities might result from variation in the degree of alteration in the form of physical and chemical weathering and should be considered in the interpretation of the data.

The seismic/geologic correlation chart below has been derived from the seismic refraction sections accompanying this report. The scope of this study did not include any reconnaissance or detailed geologic mapping, air photo interpretations or an in-depth field study of petrology and stratigraphy of the site. However, the bedrock units are discussed at some length by Kinkel, A.R., Jr., Hall, W.E., and Albers, J.P., in the Geological Survey Professional Paper 285 entitled Geology and Base-Metal Deposits of West Shasta Copper-Zinc District Shasta County, California. This information was used in interpreting the seismic sections and compiling the correlation table.

### CORRELATION TABLE

| Seismic Velocity in fpms | Inferred Geologic Unit | Rippability[1] |
|---|---|---|
| 1.0 to 1.4 | Unconsolidated surficial deposit. | Easily excavated |
| 1.7 to 3.0 | Intensely weathered rock. | Easily excavated or light ripping |
| 4.0 | Moderately weathered rock. | Medium ripping |
| 5.7 to 10.0 | Weaker or moderately sheared bedrock unit. | Very heavy ripping to not rippable |
| 10.0 to 17.8 + | Masive bedrock. | Not rippable |

Note [1]: Rippability based on performance of a Caterpillar D-8 tractor using a single shank ripper.

## BIBLIOGRAPHY


Dobrin, M.B., 1960, Introduction to geophysical prospecting: McGraw-Hill, New York

Ewing, Maurice W., Jardetzky, Wenceslas S., and Press, Frank, 1957, Elastic waves in layered medias: McGraw-Hill, New York

Green, R., 1962, The hidden layer problem: Geoph. Prosp., 10, p. 166-177

Hagedoorn, J.G., 1959, The plus-minus method of interpreting seismic refraction section: Geoph. Prosp. 7, p. 158-182

Hawkins, L.V., 1961, The reciprocal method of routine shallow seismic refraction investigations: Geophysics 26, p. 806-819

Heiland, C.A., 1940, Geophysical exploration: Prentice Hall, New York, reprinted by Hafner Publication Co.

Jakosky, J.J., 1957, Exploration geophysics: Trija Publ. Co., Newport, CA

Kinkel, A.R., Jr., Hall, W.E., and Albers, J.P., Geological Survey Professional Paper 285, Geology and Base-Metal Deposits of West Shasta Copper-Zinc District, Shasta Co., CA

Leet, D.L., 1938, Practical seismology and seismic prospecting: D. Appleton-Century Co., New York

Levin, Franklyn K., and Ingram, John D., 1962, Headwaves from a bed of finite thickness: Geophysics 27, p. 753-765

Musgrave, albert W., editor, 1967, seismic refraction prospecting: Society of Exploration Geophysicists, Tulsa, OK

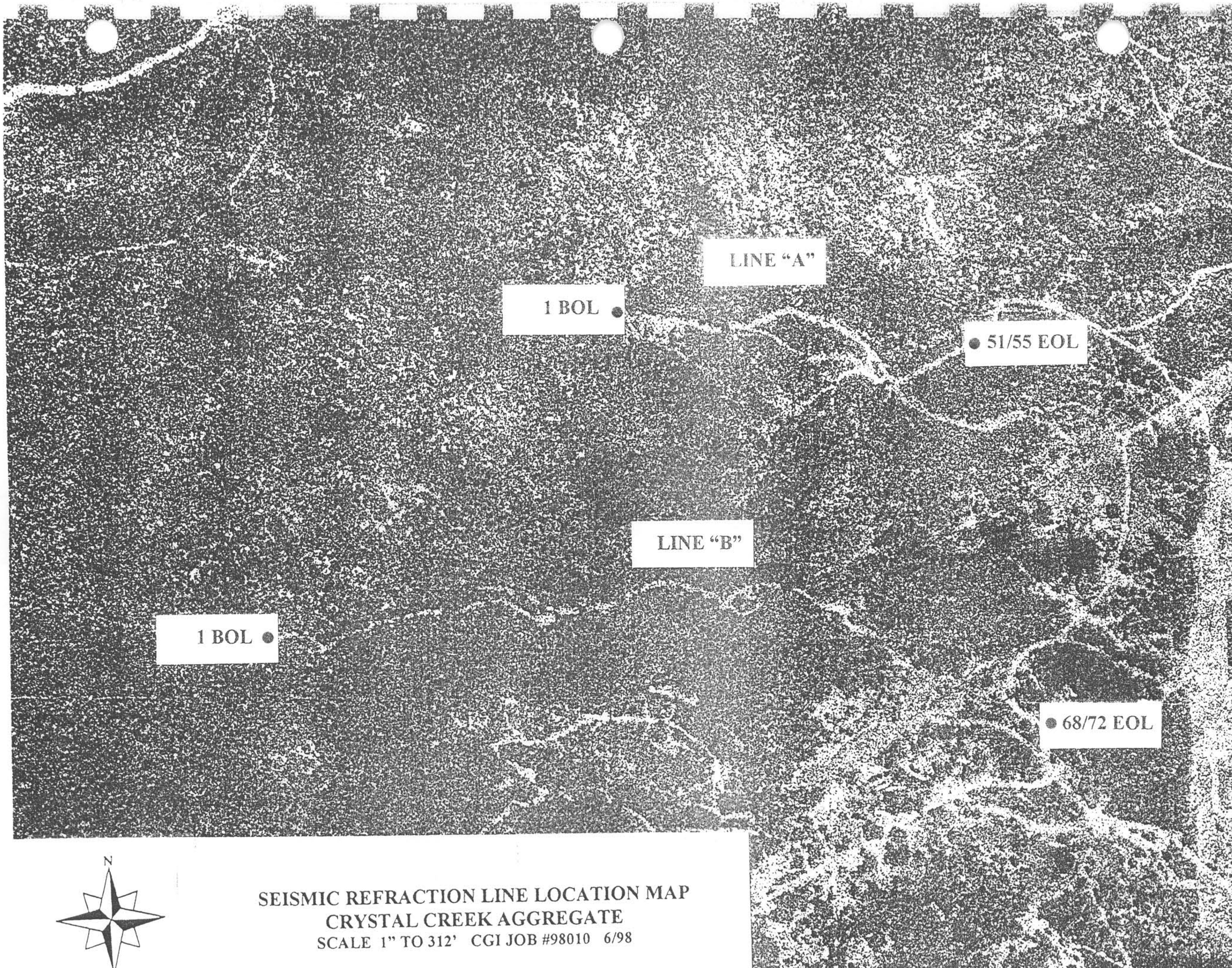
Nettleton, L.L., 1940, Geophysical exploration for oil: McGraw-Hill, New York

Redpath, B.B., 1973, Seismic refraction exploration for engineering site investigations: U.S. Army Engineer Waterways Experiment Station, Technical Report E-73-4

Soske, J.L., 1959, The blind zone problem in engineering geophysics: Geophysics 24, p. 359-365

# APPENDIX

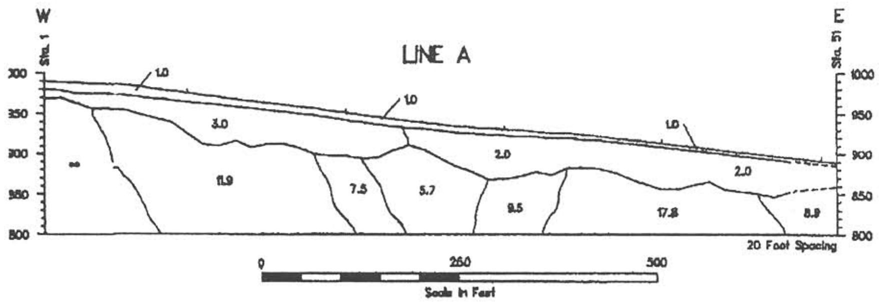
Rough Location Map (air photo)
Seismic Section A
Seismic Section B
Reproduced pages from Caterpillar Performance Handbook




SEISMIC REFRACTION LINE LOCATION MAP
CRYSTAL CREEK AGGREGATE
SCALE 1" TO 312' CGI JOB #98010 6/98

Seismic Sections

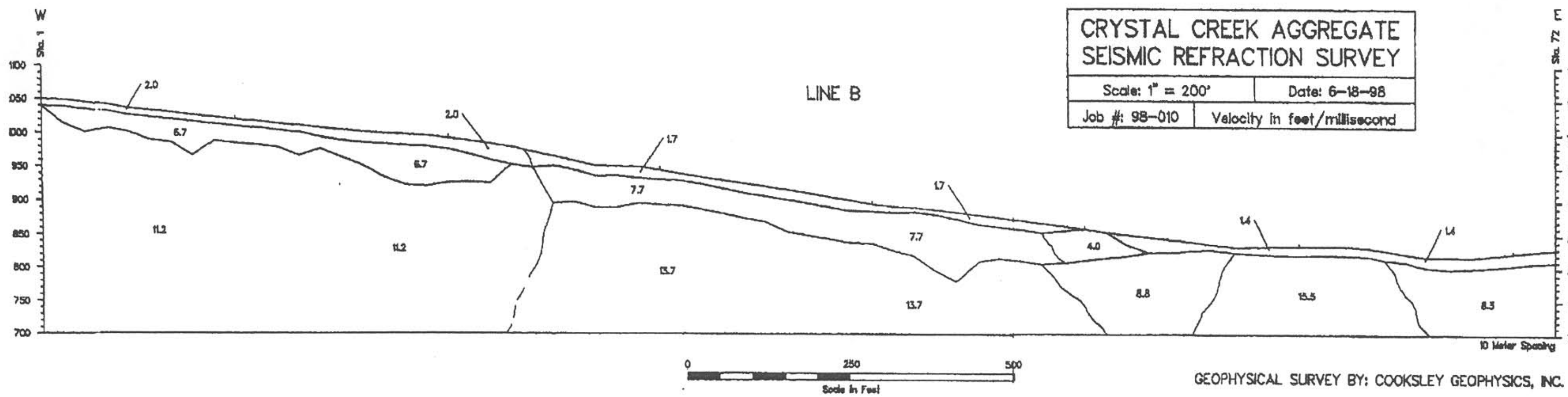
Line A and B




CORRELATION TABLE

| Seismic Velocity in fpms | Inferred Geologic Unit | Rippability[1] |
|---|---|---|
| 1.0 to 1.4 | Unconsolidated surfucial deposit | Easily excavated |
| 1.7 to 3.0 | Intensely weathered rock | Easily excavated or light ripping |
| 4.0 | Moderately weathered rock | Medium ripping |
| 5.7 to 10.0 | Weaker or moderately sheared bedrock unit | Very heavy ripping to not rippable |
| 10.0 to 17.8+ | Massive bedrock | Not rippable |

Note[1]: Rippability based on performance of a Caterpillar D-8 tractor using a single shank ripper




CRYSTAL CREEK AGGREGATE
SEISMIC REFRACTION SURVEY

| | |
|---|---|
| Scale: 1" = 200' | Date: 6-18-98 |
| Job #: 98-010 | Velocity in feet/millisecond |

GEOPHYSICAL SURVEY BY: COOKSLEY GEOPHYSICS, INC.

# CATERPILLAR PERFORMANCE HANDBOOK

a CAT publication

by Caterpillar Tractor Co., Peoria, Illinois, U.S.A.

OCTOBER 1982



CATERPILLAR



Form AEKO8585

Printed in U.S.A.

## USE OF SEISMIC VELOCITY CHARTS

The charts of ripper performance estimated by seismic wave velocities have been developed from field tests conducted in a variety of materials. Considering the extreme variations among materials and even among rocks of a specific classification, the charts must be recognized as being at best only one indicator of rippability.

Accordingly, consider the following precautions when evaluating the feasibility of ripping a given formation:

— Tooth penetration is often the key to ripping success, regardless of seismic velocity. This is particularly true in homogeneous materials such as mudstones and claystones and the fine-grained caliches. It is also true in tightly cemented formations such as conglomerates, some glacial tills and caliches containing rock fragments.

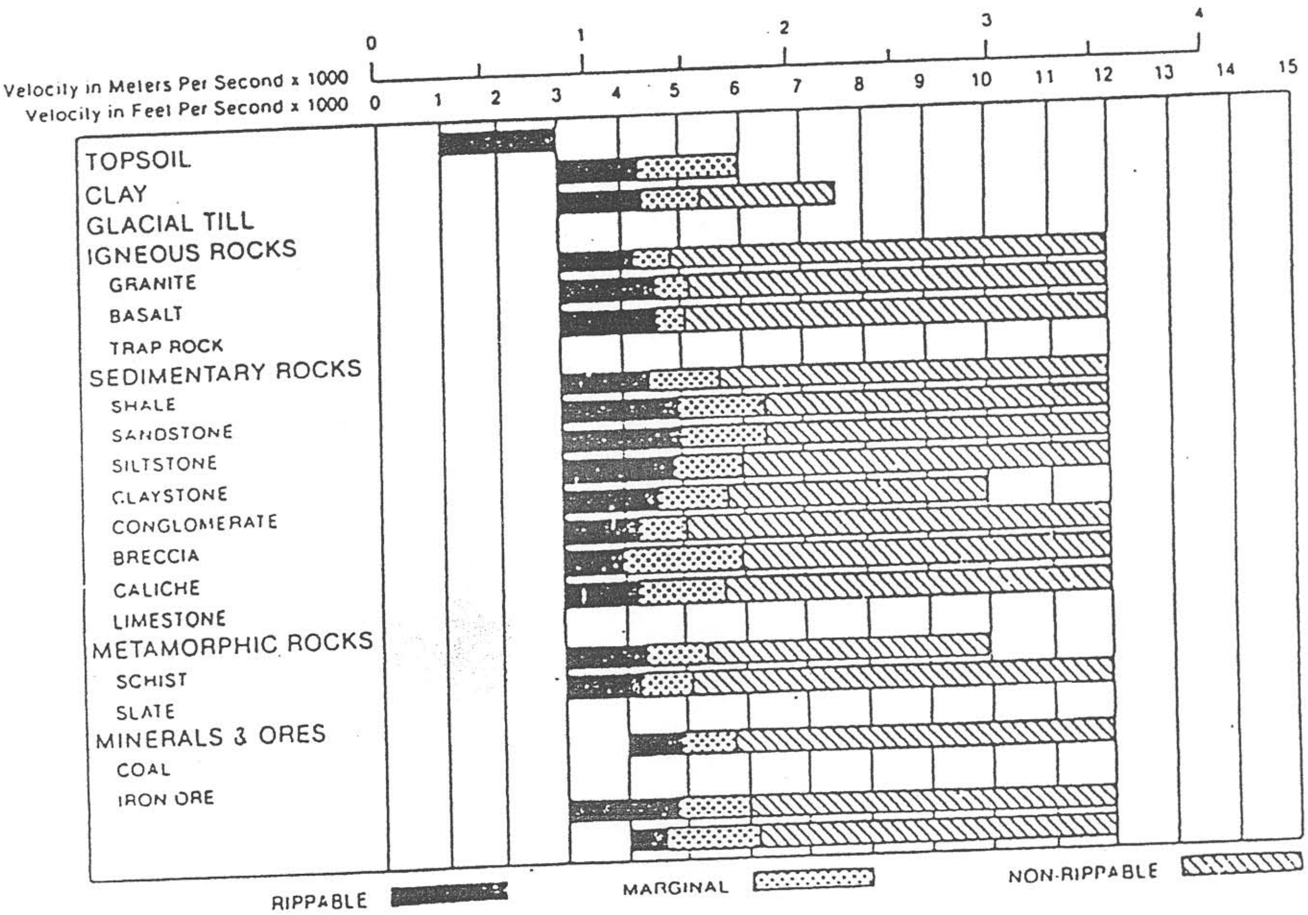
— Low seismic velocities of sedimentaries can indicate probable rippability. However, if the fractures and bedding joints do not allow tooth penetration, the material may not be ripped effectively.

— Pre-blasting or "popping" may induce sufficient fracturing to permit tooth entry, particularly in the caliches, conglomerates and some other rocks; but the economics should be checked carefully when considering popping in the higher grades of sandstones, limestones and granites.

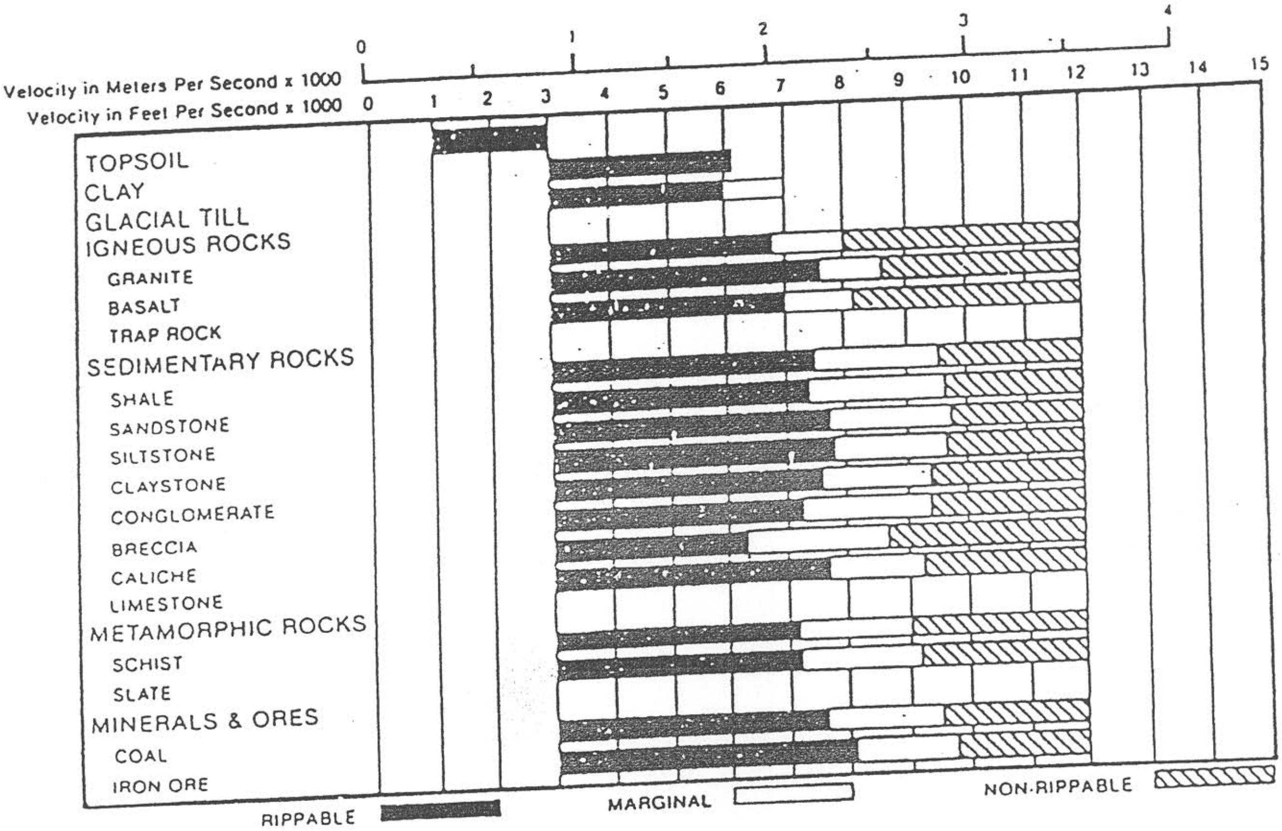
Ripping is still more art than science, and much will depend on the skill and experience of the tractor operator. Ripping for scraper loading may call for different techniques than if the same material is to be dozed away. If cross-ripping is called for, it, too, requires a change in approach. The number of shanks used, length and depth of shank and tooth angle, direction, throttle position — all must be adjusted according to field conditions encountered. Ripping success may well depend on the operator finding the proper combination for those conditions.

## D7G Ripper Performance

- Estimated by Seismic Wave Velocities



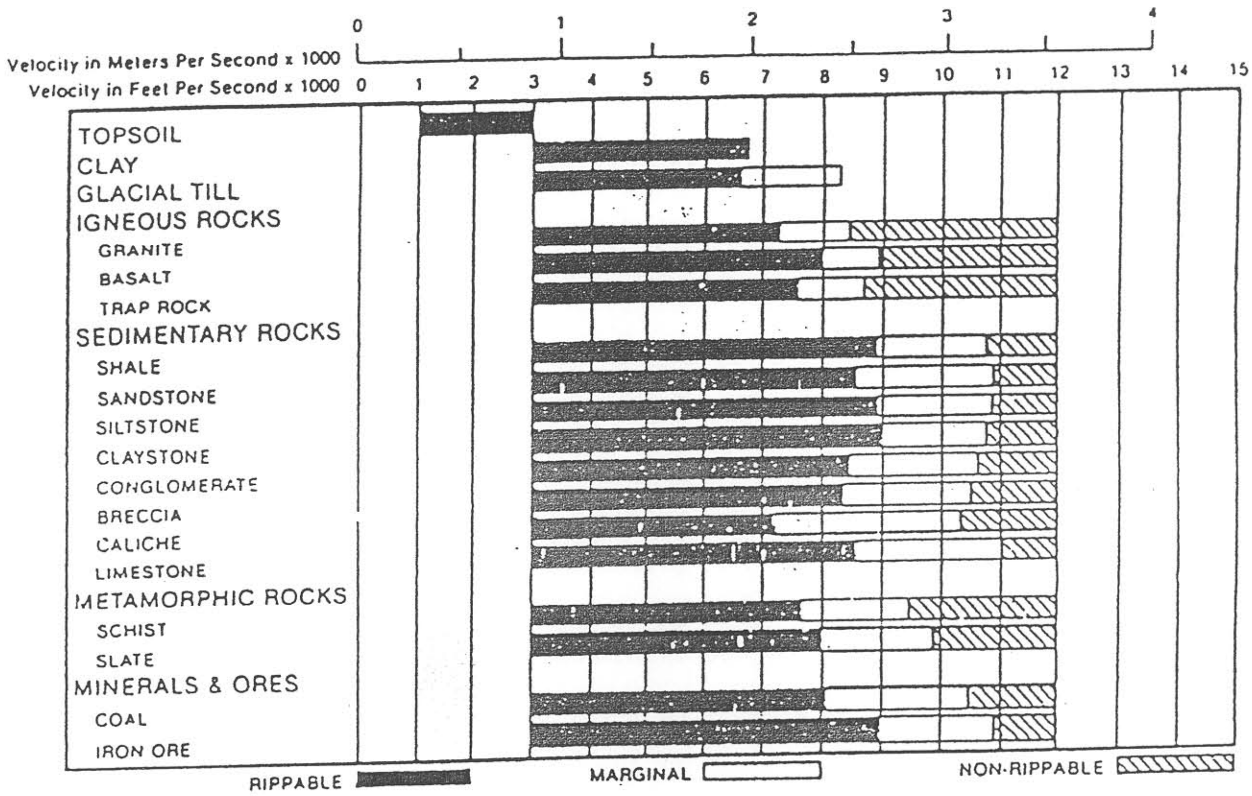
D8L Ripper Performance
- Multi or Single Shank No. 8 Ripper
- Estimated by Seismic Wave Velocities



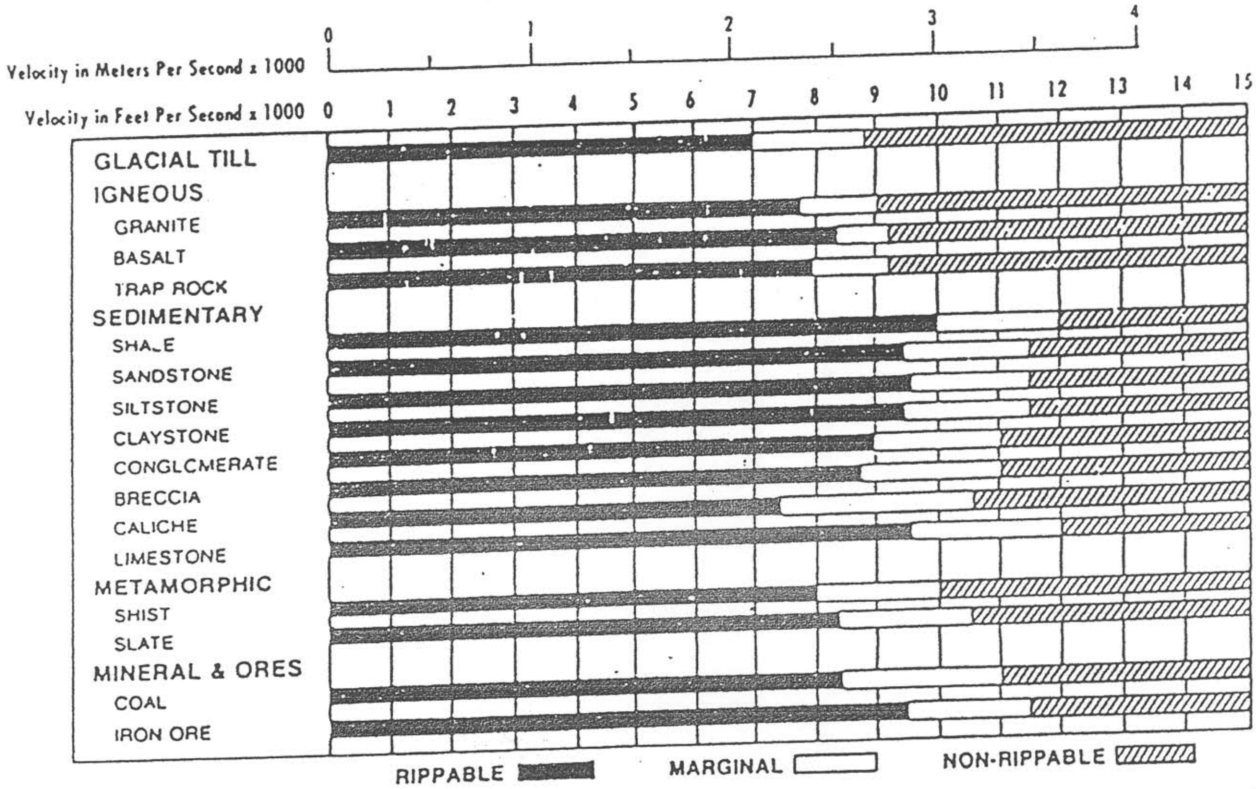
Rippers

## D9L Ripper Performance

- Multi or Single Shank No. 9 Ripper
- Estimated by Seismic Wave Velocities



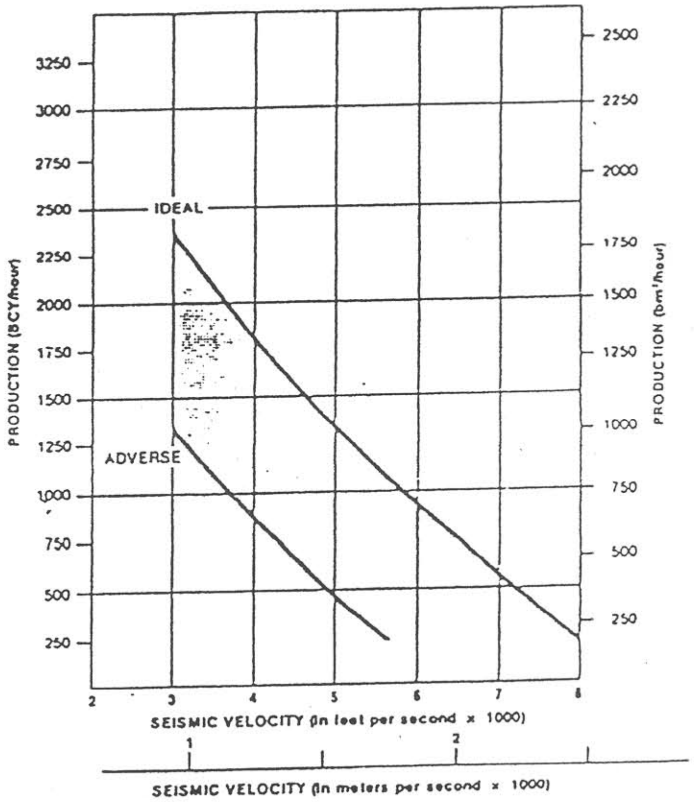
D10 Ripper Performance
- Multi or Single Shank No. 10 Ripper
- Estimated by Seismic Wave Velocities



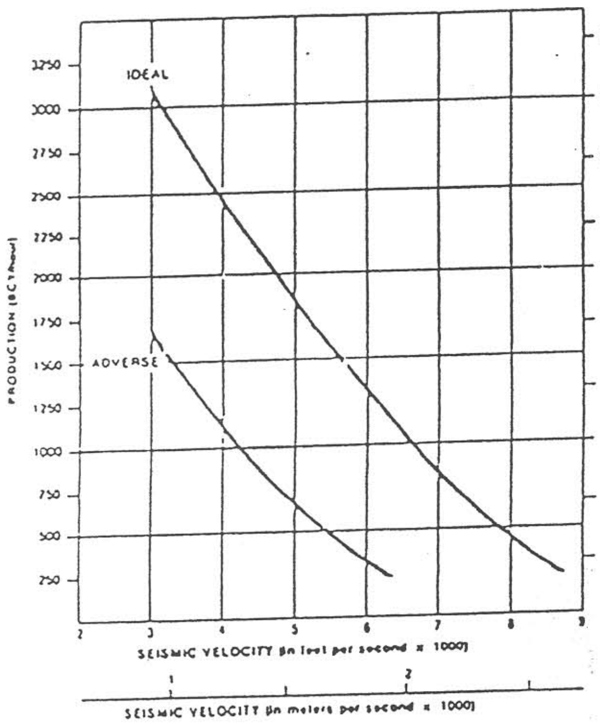
**Considerations for using production estimating graphs:**

- Machine rips full-time.— no dozing.
- Power shift tractors with single shank rippers.
- 100% efficiency (60 min. hour).
- Charts are for all classes of material.
- In igneous rock with seismic velocity of 8000 fps or higher for the D10, and 6000 fps or higher for the D9 and D8, the production figures shown should be reduced by 25%.
- Upper limit of charts reflect ripping under ideal conditions only. If conditions such as thick lamination, vertical lamination or any factor which would adversely affect production are present, the lower limit should be used.

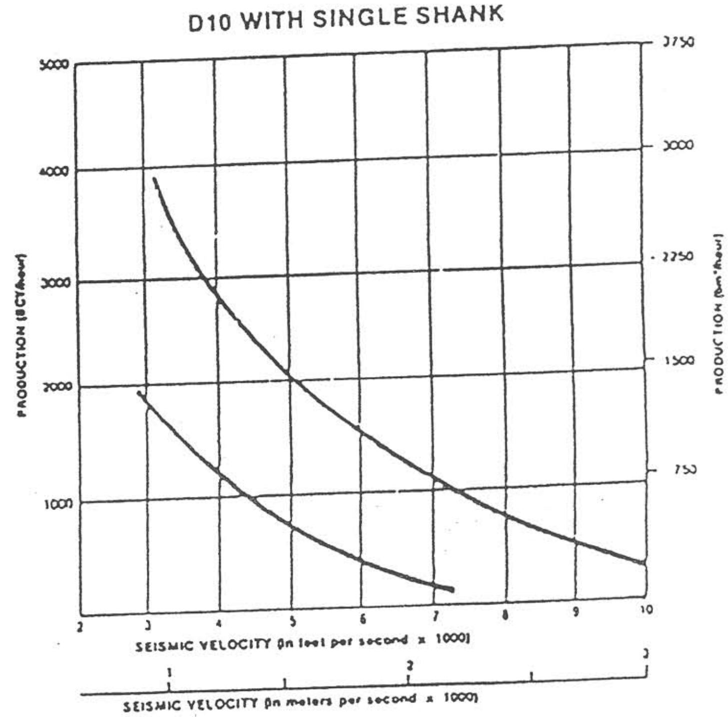
D8L WITH SINGLE SHANK



## D9L WITH SINGLE SHANK




## D10 WITH SINGLE SHANK



MTI

## Materials Testing, Inc.

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(707) 447-4025, fax 447-4143

Client No. 380
22 October 2007

Crystal Creek Aggregate, Inc.
Mr. Jerry Comingdeer
10936 Iron Mountain Road
Redding, CA 96001

Subject: CCA Quarry Expansion
Shasta County, California
**GLOBAL SLOPE STABILITY ANALYSIS**

References:

1. Amendment to Reclamation Plan No. 1-90
By: Duane K. Miller Civil Engineer, Inc.
Dated: July 10, 2007 Sheets 1-6

2. Geological Engineering Investigation
By: Cooksley Geoscience, LLC
Dated: January 2007

Dear Mr. Comingdeer:

At your request, **MATERIALS TESTING, INC.** reviewed the referenced plans and performed a global slope stability analysis on the proposed cut slopes west of the existing Crystal Creek Aggregate quarry in Shasta County, California.

The expansion pit is proposed to be a maximum of three hundred and forty (340) feet in vertical height. Individual benches are proposed to have a width of thirty (30) feet with a height of twenty four (24) feet laid back at an inclination of ¼ to 1 (horizontal to vertical). This configuration of benching yields an overall cut slope of 1.5 to 1. The grade appears to drain surface water to the west away from the slope.

Our field investigation consisted of visual observations of the native topography along with obtaining representative samples of the rock and slope soil. A disturbed bulk soil sample was obtained for material classification. A relatively undisturbed rock sample was cored for compressive strength and bulk specific gravity performed in accordance with ASTM D2938 and ASTM C127, respectively. Sieve analysis testing ASTM C136 (particle size distribution) was performed on the bulk soil sample as well as Atterberg Limits Testing (ASTM D4318). The surface soils consist of moist light brown silty clayey sand with gravel. A summary of all laboratory test results is presented on the attached data sheets.

Cross sections were developed from the referenced plans and the subsurface stratigraphy was plotted by extrapolation of the seismic lines shown in Reference #2. Three slope stability analyses were performed utilizing data from the referenced reclamation plan and laboratory testing on samples taken during our field investigation. Information gathered from the field investigation coupled with the plans indicates that the rock and soils vary along the proposed cut slopes. An analysis of the slopes was performed at the tallest point of the quarry expansion and along the referenced seismic lines A and B. It was assumed that water would infiltrate the soil from the surface for a more conservative analysis.

The analysis was performed with the aid of an integrated slope stability analysis program known as XSTABL version 5 utilizing the Janbu method of slices. The attached sheets contain all the laboratory data and location of the cross sections analyzed. Based on our field and laboratory test results, the following conservative strength parameters were utilized in the analysis:

| Soil Layer | Velocity (f.p.m.s.) | Unit Weight (p.c.f.) | Friction Angle (deg) | Cohesion (p.s.f.) |
|---|---|---|---|---|
| 1 | 1.0 | 111.3 | 20 | 100 |
| 2 | 2.0 | 111.3 | 24 | 100 |
| 3 | 3.0 | 140.0 | 28 | 250 |
| 4 | 6.7 | 140.0 | 30 | 400 |
| 5 | 11.2 | 169.0 | 40 | 200 |
| 6 | 11.9 | 169.0 | 40 | 200 |
| 7 | $\infty$ | 169.0 | 40 | 200 |

Based on the conditions analyzed, the proposed cut slopes were calculated to have a factor of safety greater than 1.50. A seismic coefficient of 0.15 was then added to the analysis and a factor of safety greater than 1.15 was obtained. An acceptable factor of safety for a static condition is 1.50 and 1.15 for a dynamic condition.

Based on our analysis with the information presented above, it is the opinion of **MATERIALS TESTING, INC.**, that the cut slopes will perform adequately. However, proper positive surface drainage and erosion control measures must be maintained by the property owners at all times. Irrigation and rainfall water must be collected and directed to a suitable drainage facility and water must not be allowed to flow over the top of the slope. It is probable that surface and near surface incremental movement will occur, especially in exposed weathered bedrock. It is recommended that observation of the slopes be performed during and after construction for suitable recommendations.

Should you have any questions relating to the contents of this letter or should you require additional information, please contact our office at your convenience.

Reviewed By:

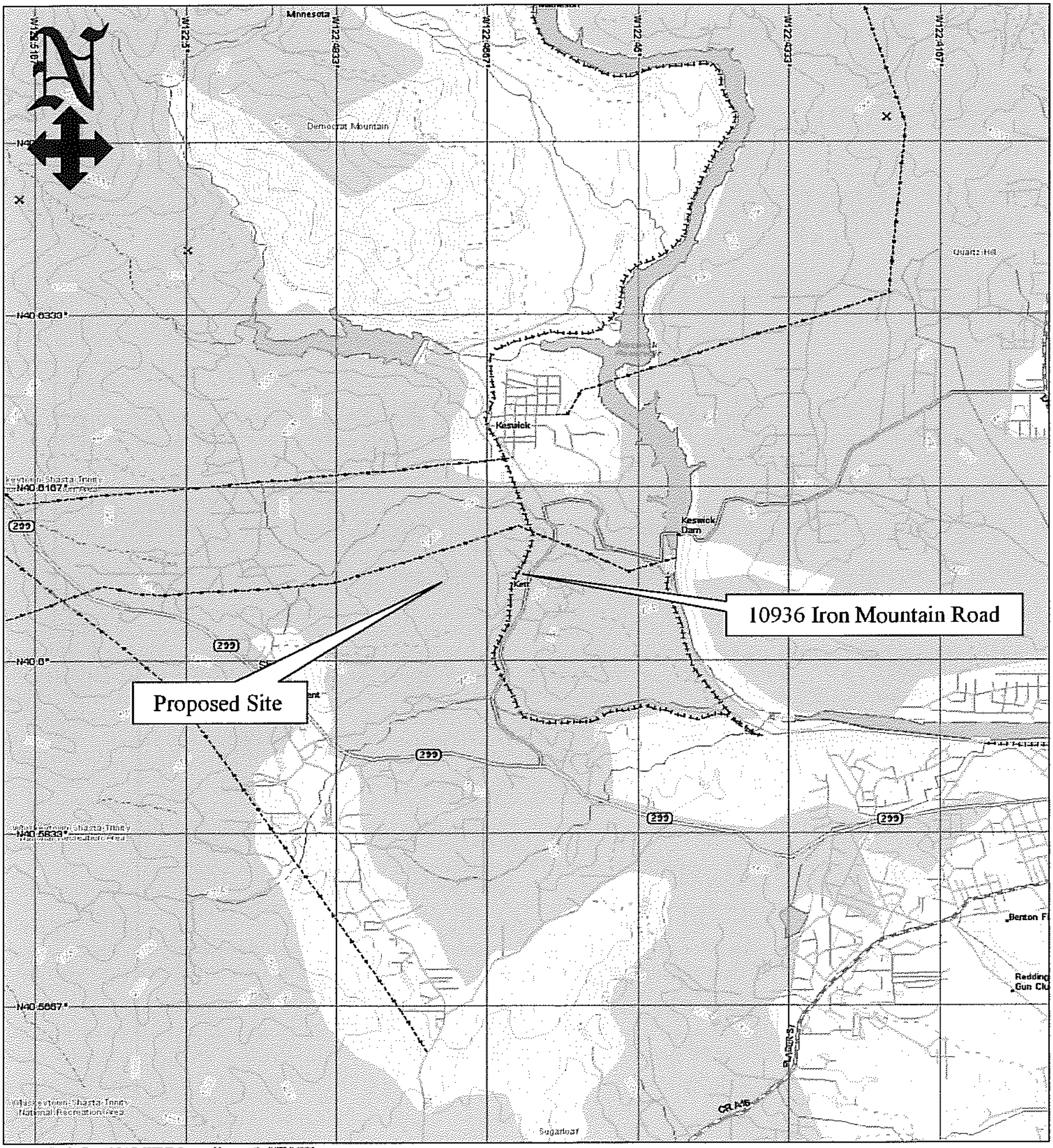
REGISTERED PROFESSIONAL ENGINEER
DOUGLAS G. KING
No. 33981
Exp. 12/31/08
CIVIL
STATE OF CALIFORNIA

Douglas G. King, P.E.
Principal Engineer

Respectfully Submitted,
**KC ENGINEERING COMPANY**

Andrew L. King
Staff Engineer

Copies: 2 to Client
1 to Cooksley Geoscience, LLC
1 e-copy to Duane K. Miller Civil Engineer, Inc.
1 e-copy to Bill Walker, Shasta County
1 e-copy to Keith Hamblin, Travis Deem







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Project No. 380
Proposed CCA Quarry Expansion
Shasta County, California
**Figure No. 1 - "Vicinity Map"**

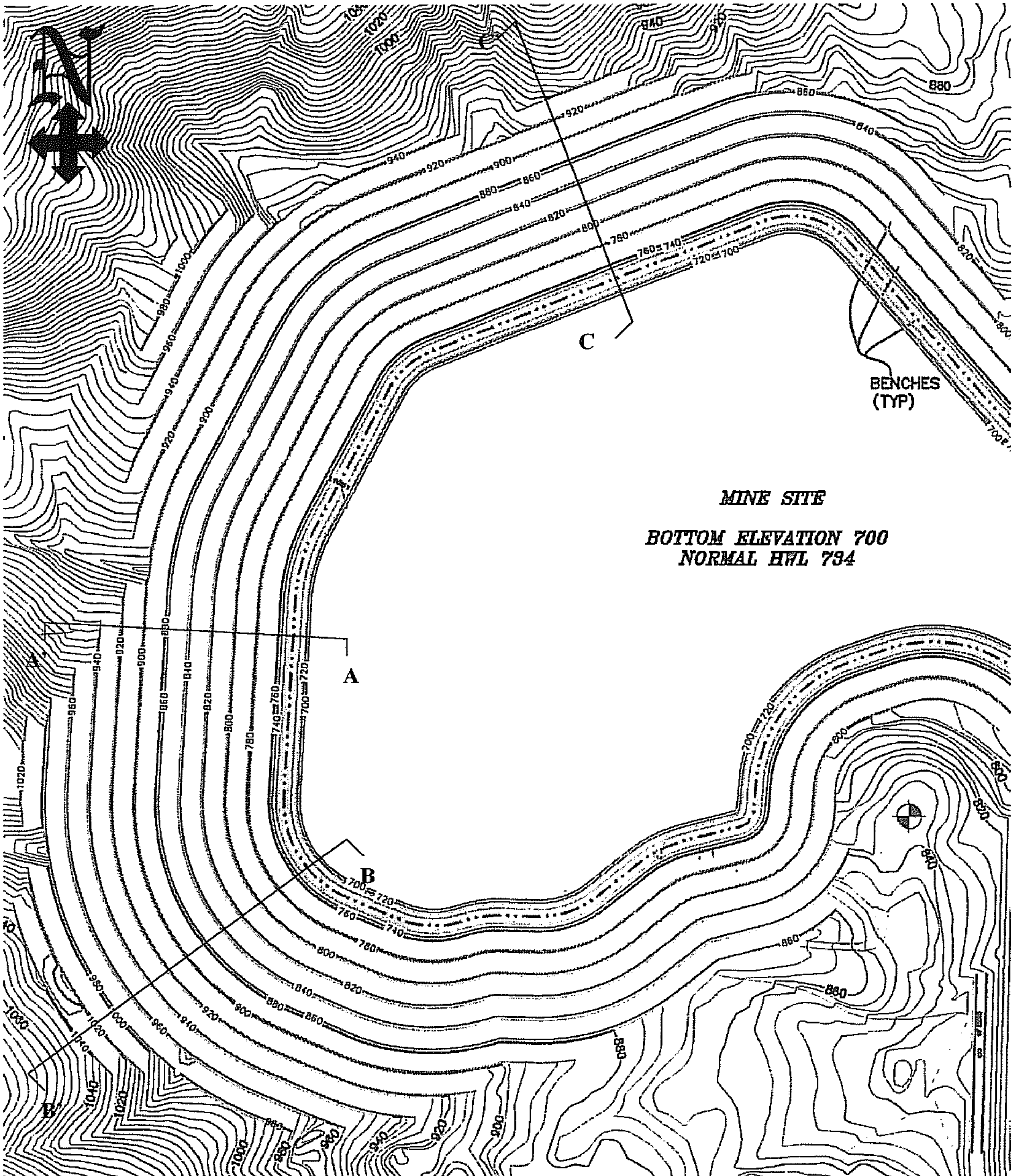


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**Figure No. 2 - "Site Map"**

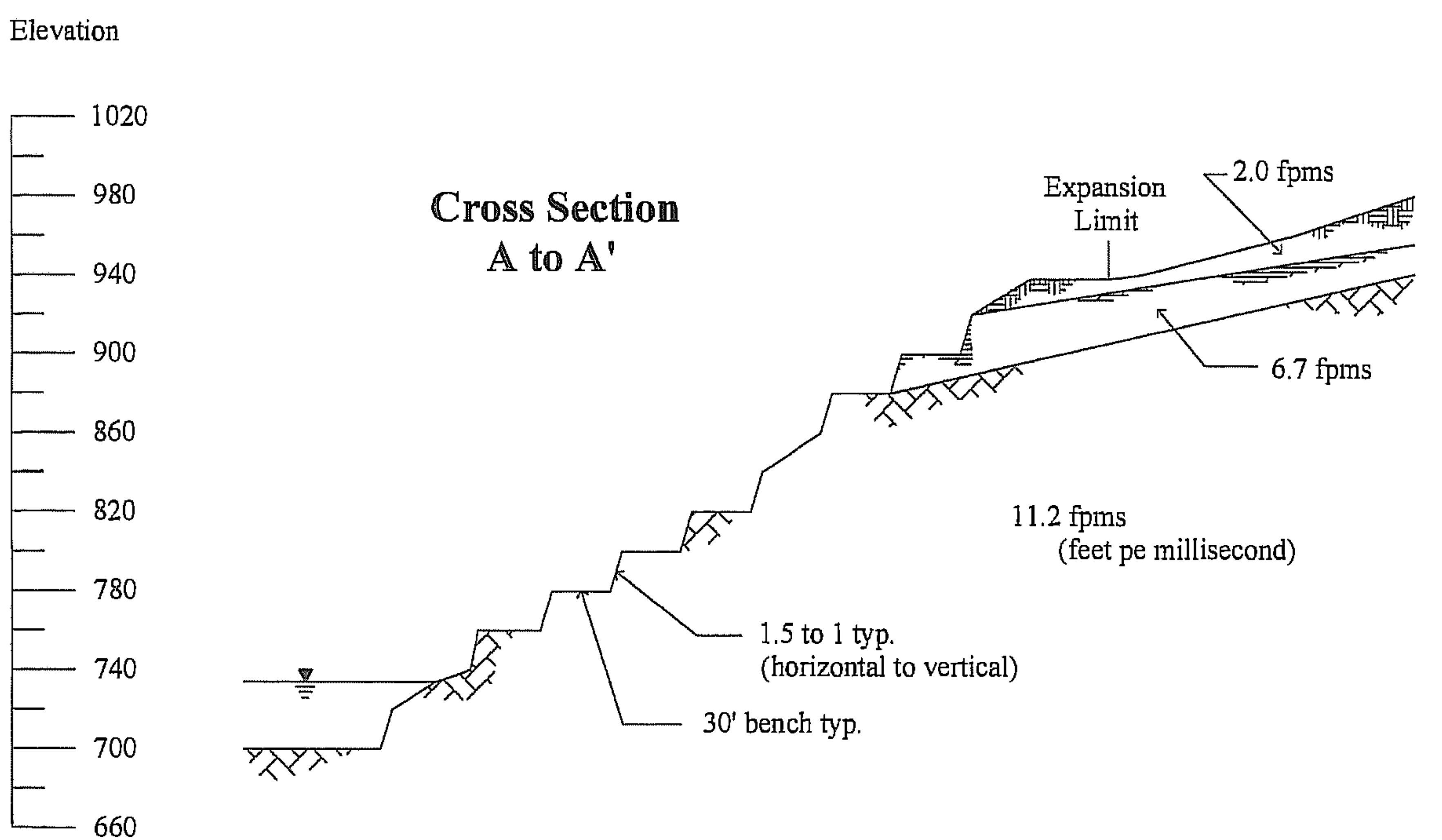


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**Figure No. 3 - "Cross Section- A to A' "**

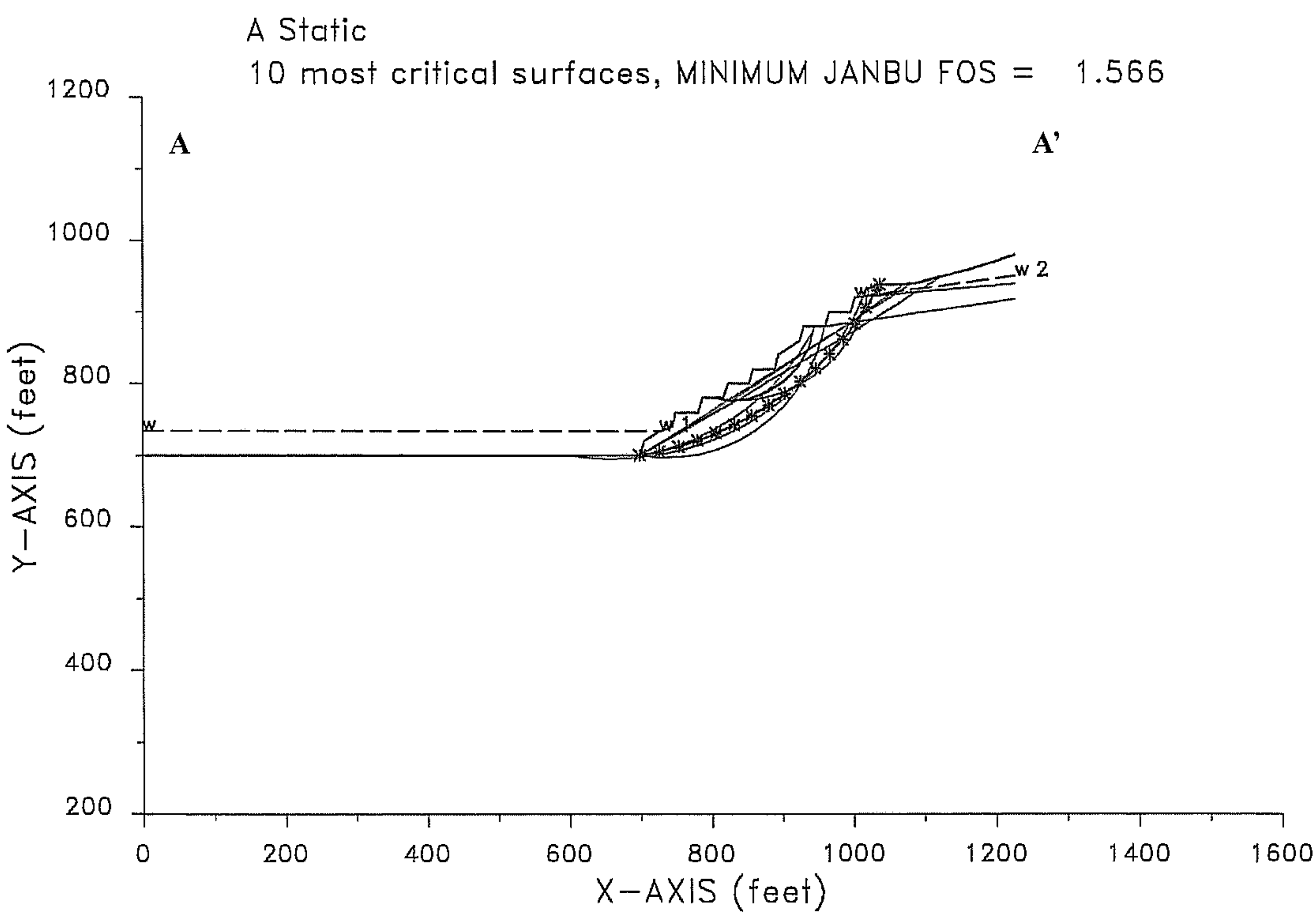


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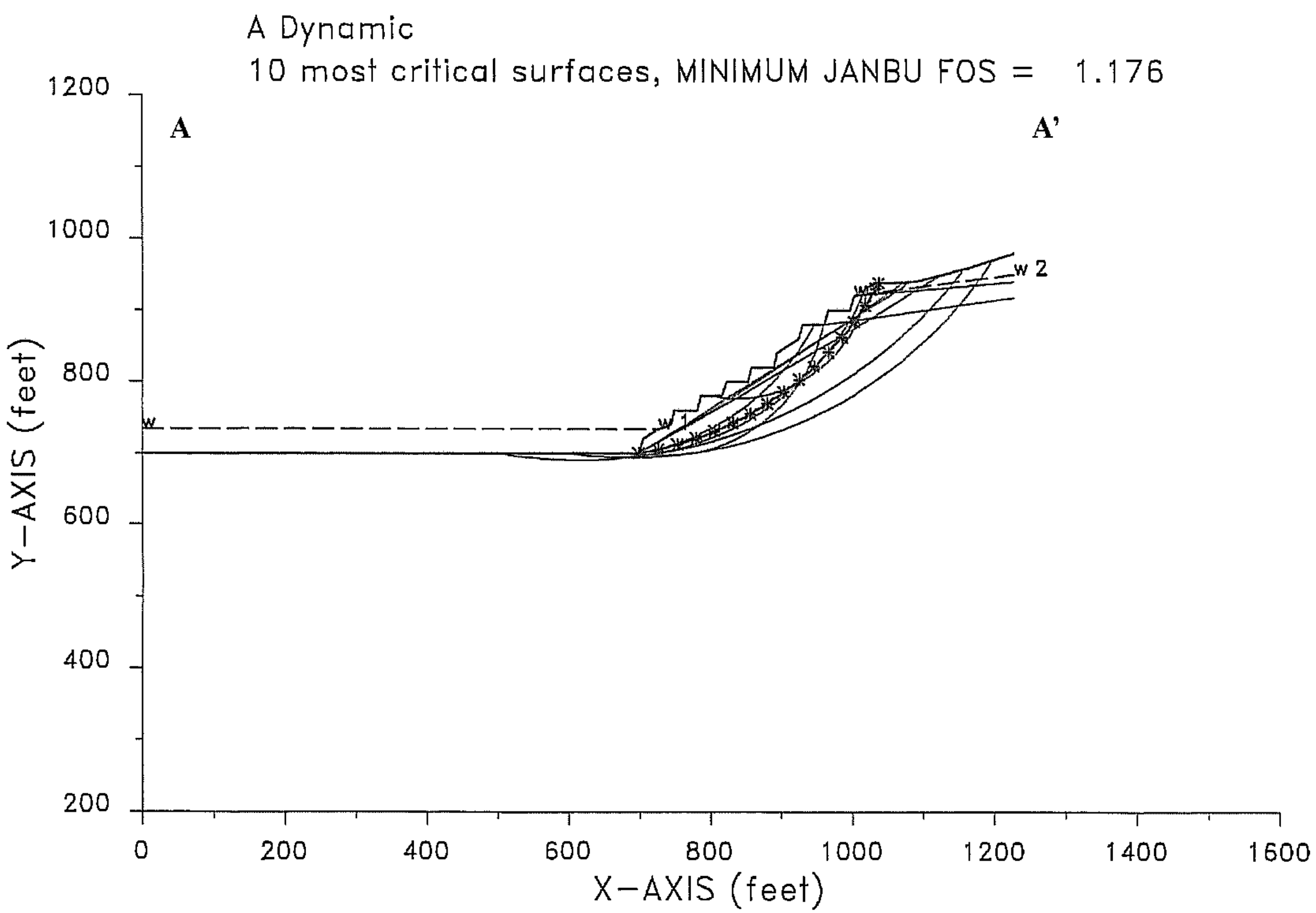
**Figure No. 4 - "Critical Surface- A to A' Static"**

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Shasta County, California
**Figure No. 5 - "Critical Surface- A to A' Dynamic"**

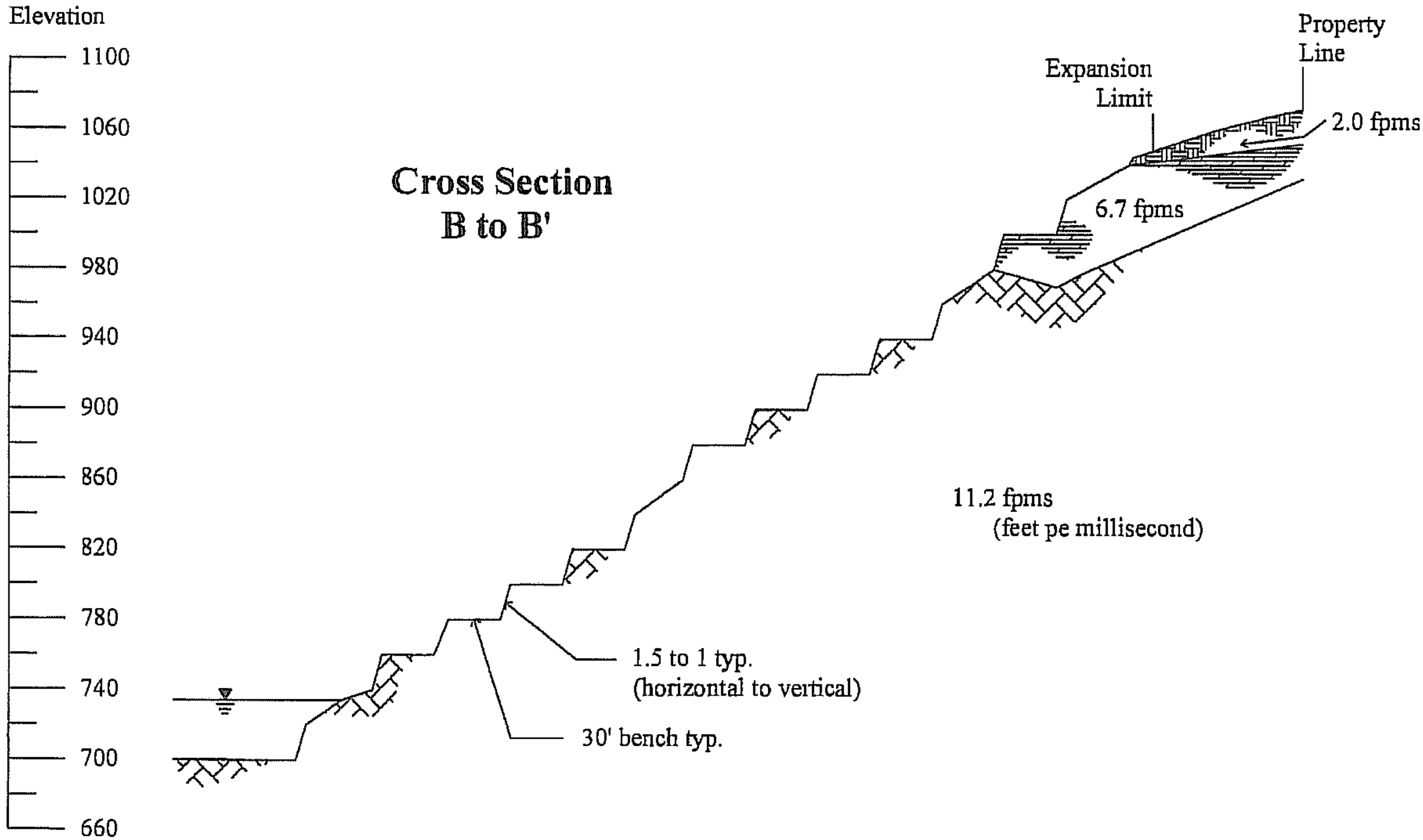


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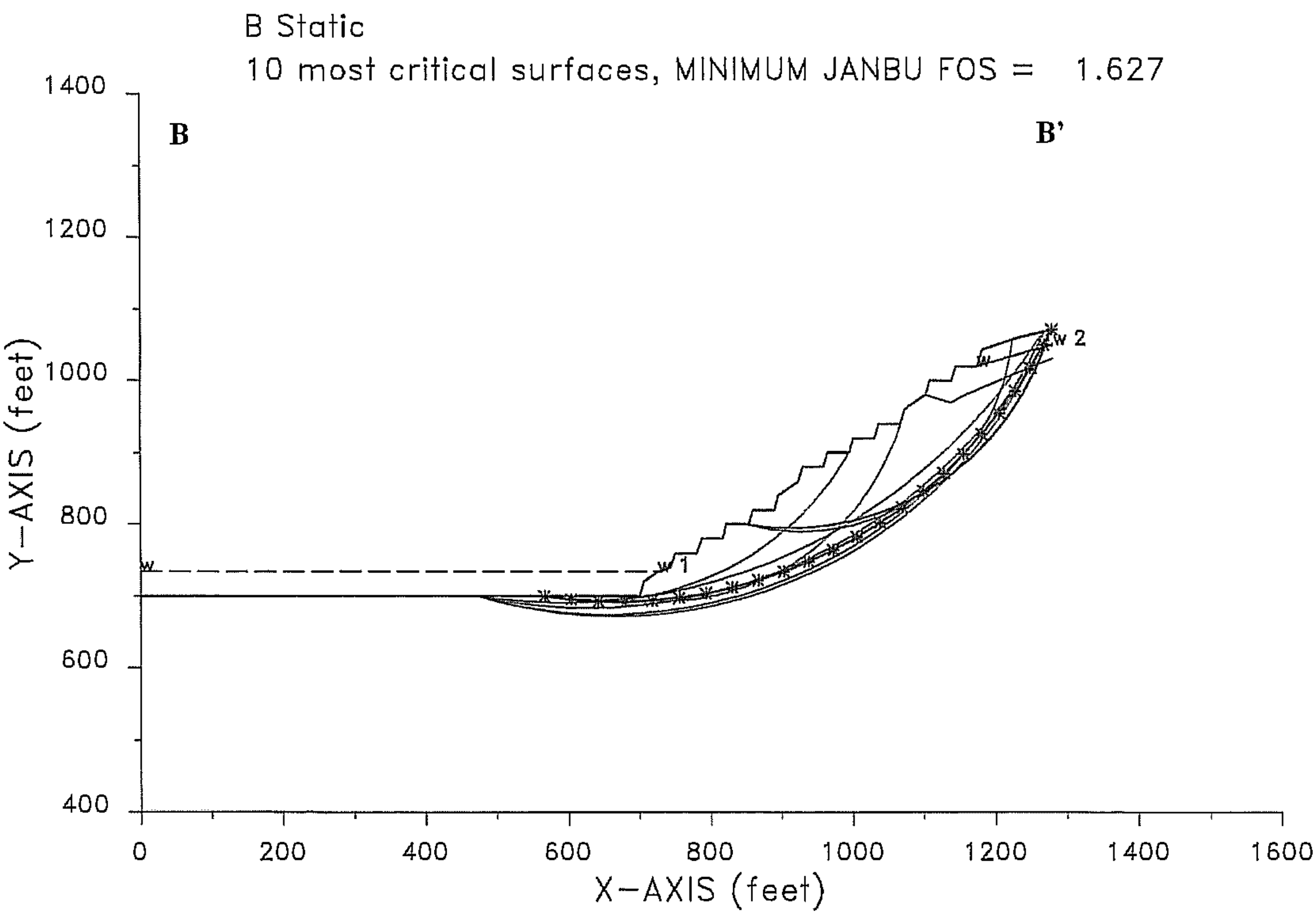
**Figure No. 6 - "Cross Section- B to B' "**

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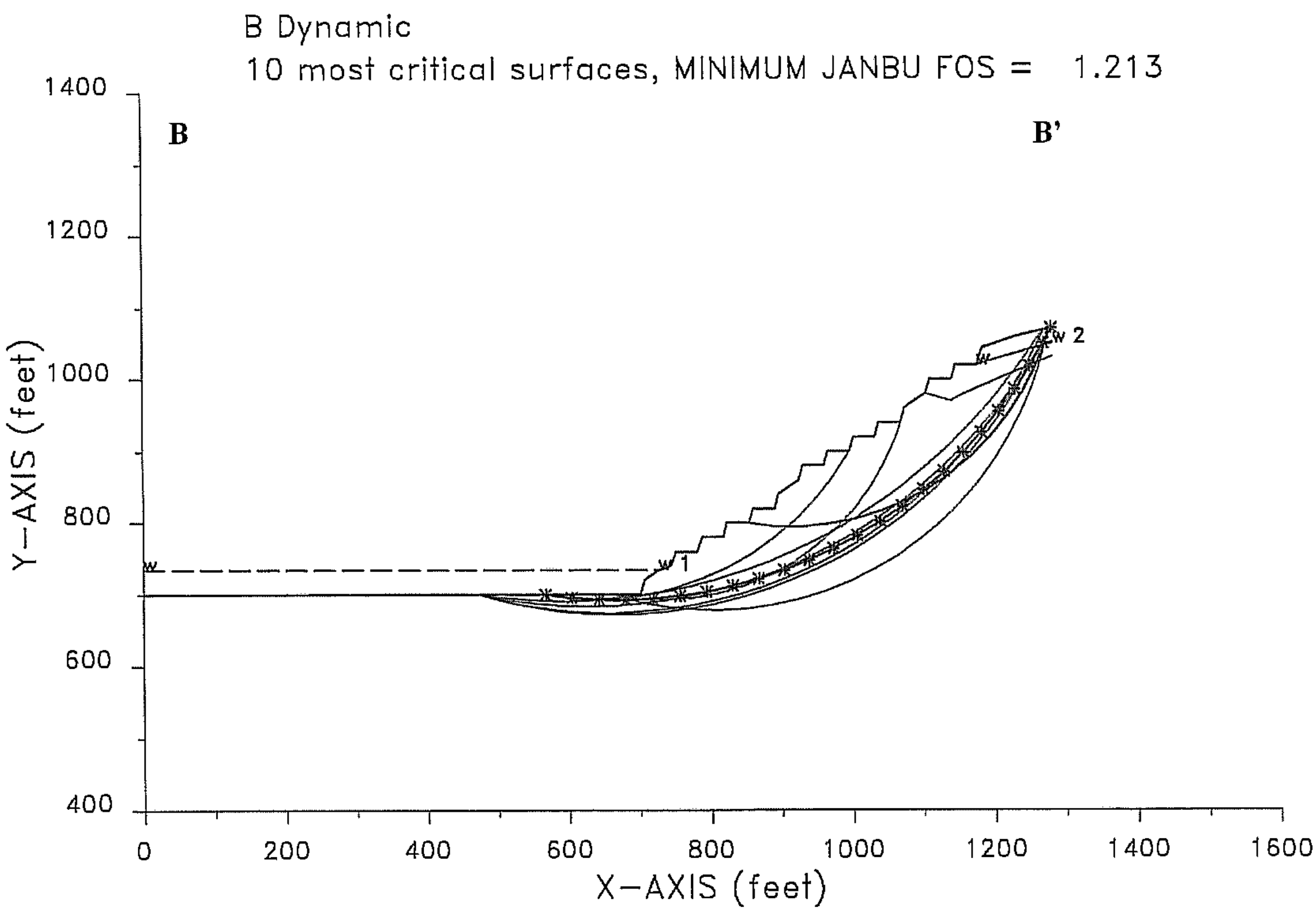
Shasta County, California
**Figure No. 7 - "Critical Surface- B to B' Static"**

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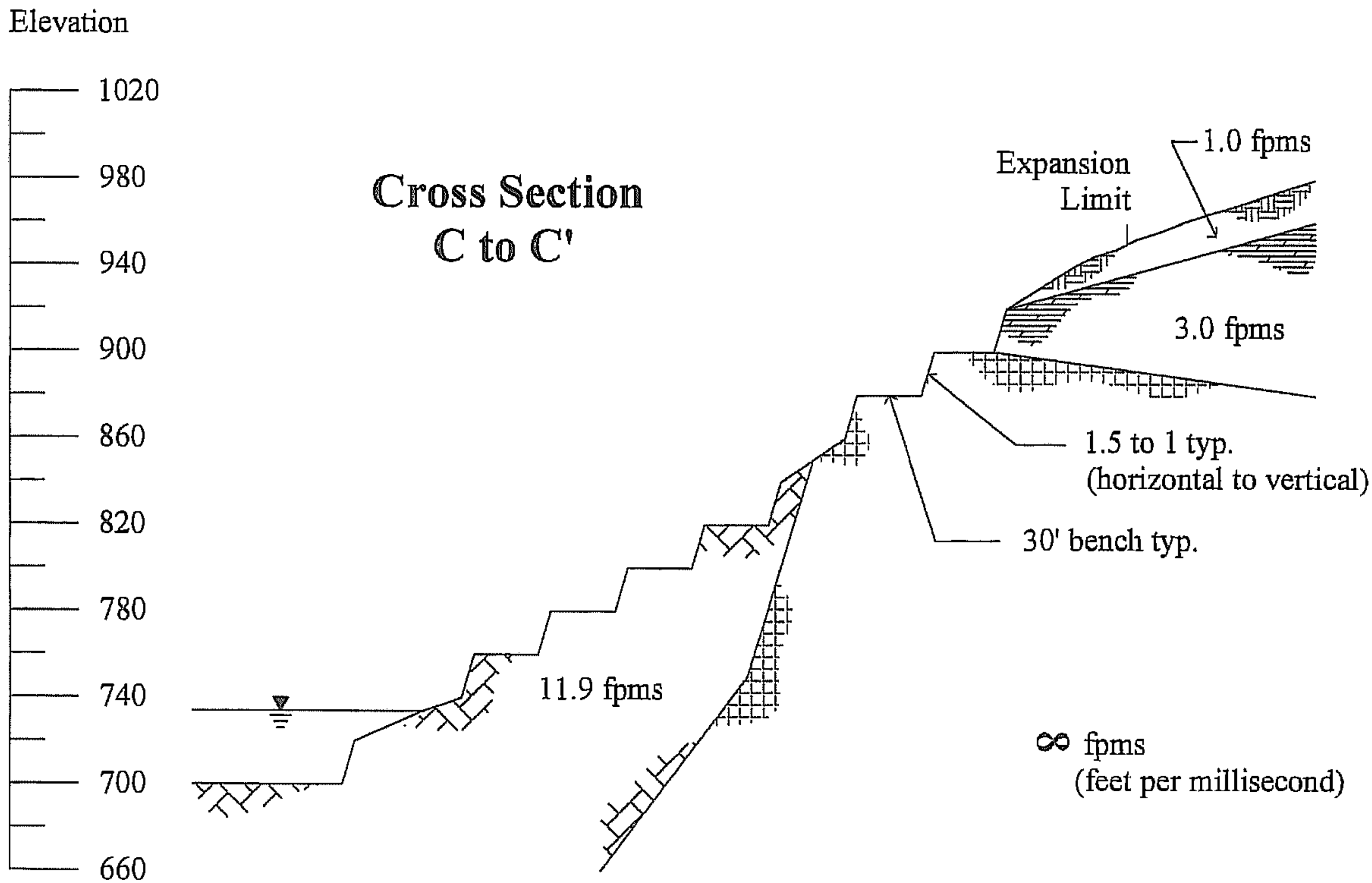
Proposed CCA Quarry Expansion
Shasta County, California
**Figure No. 8 - "Critical Surface- B to B' Dynamic"**





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Project No. 380
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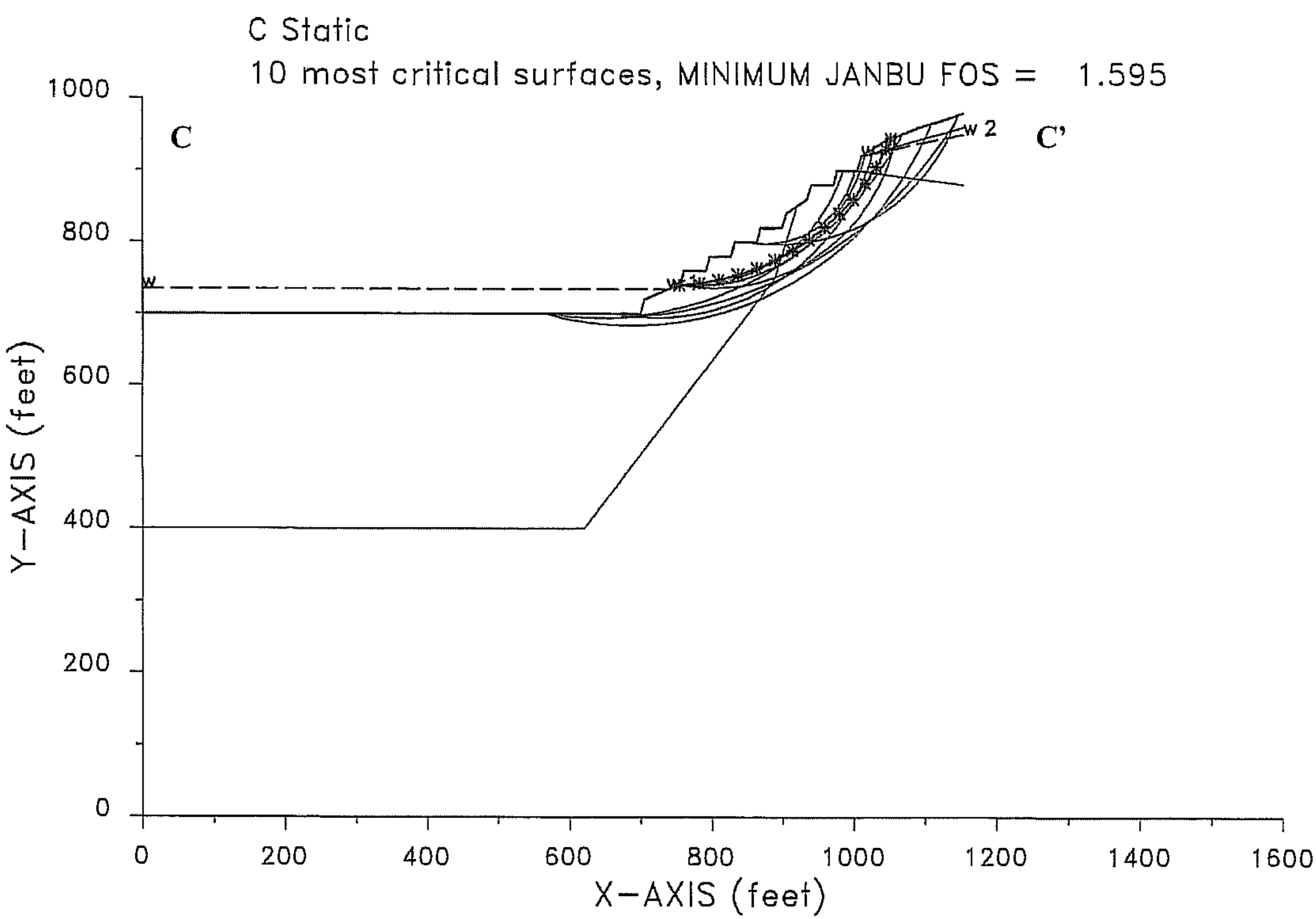
**Figure No. 9 - "Cross Section- C to C' "**

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Project No. 380
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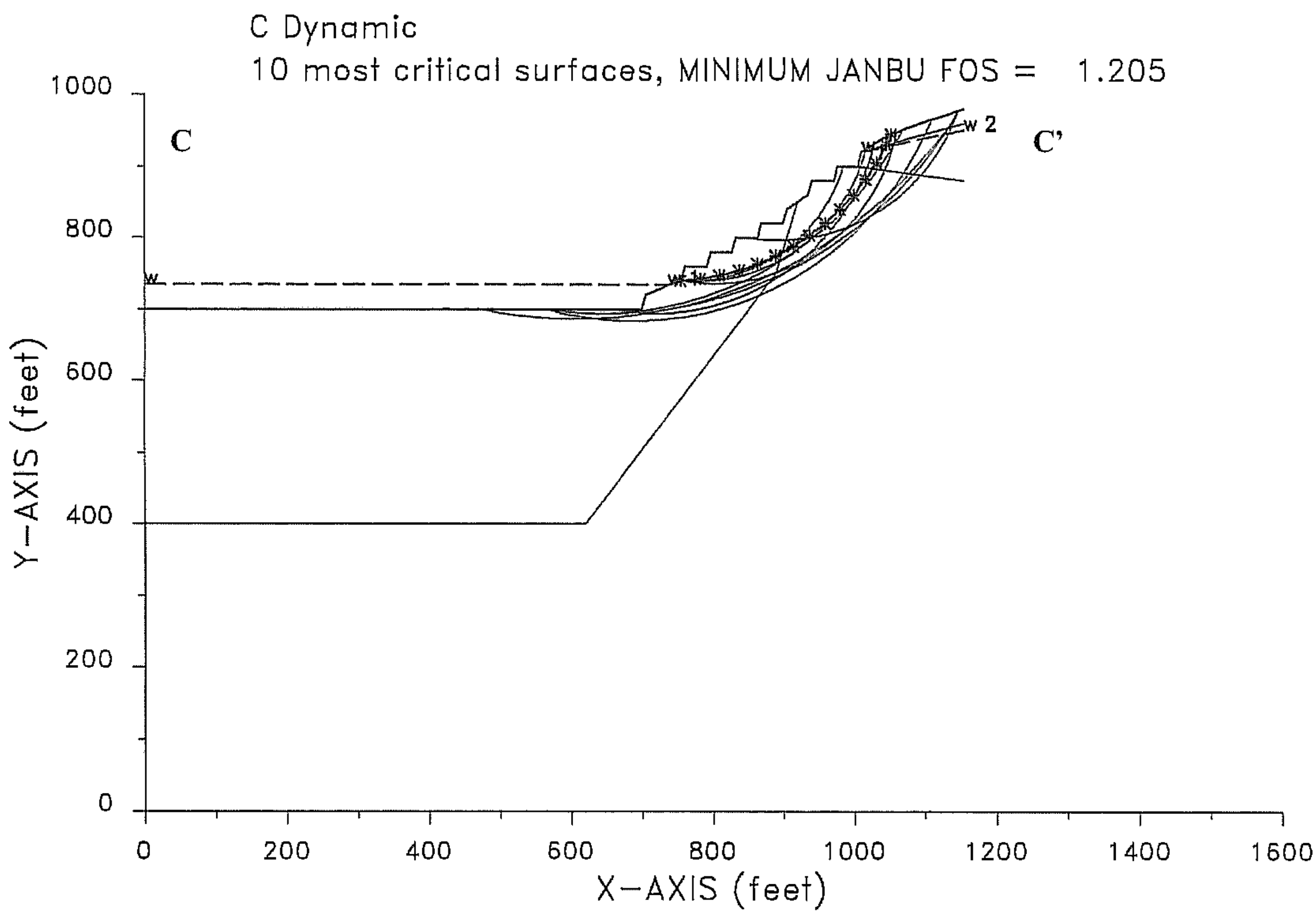
**Figure No. 10 - "Critical Surface- C to C' Static"**

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Project No. 380
Proposed CCA Quarry Expansion
Shasta County, California
**Figure No. 11 - "Critical Surface- C to C' Dynamic"**

M T I

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**(707) 447-4025, fax 447-4143**


| | | | |
|---|---|---|---|
| Client: | Crystal Creek Aggregate, Inc.<br>10936 Iron Mountain Road<br>Redding, CA 96001 | Date:<br>Client No:<br>Report No: | 10/09/07<br>0380-002<br>0104-010 |

Project: Quarry Expansion
Description: Quality Testing

---

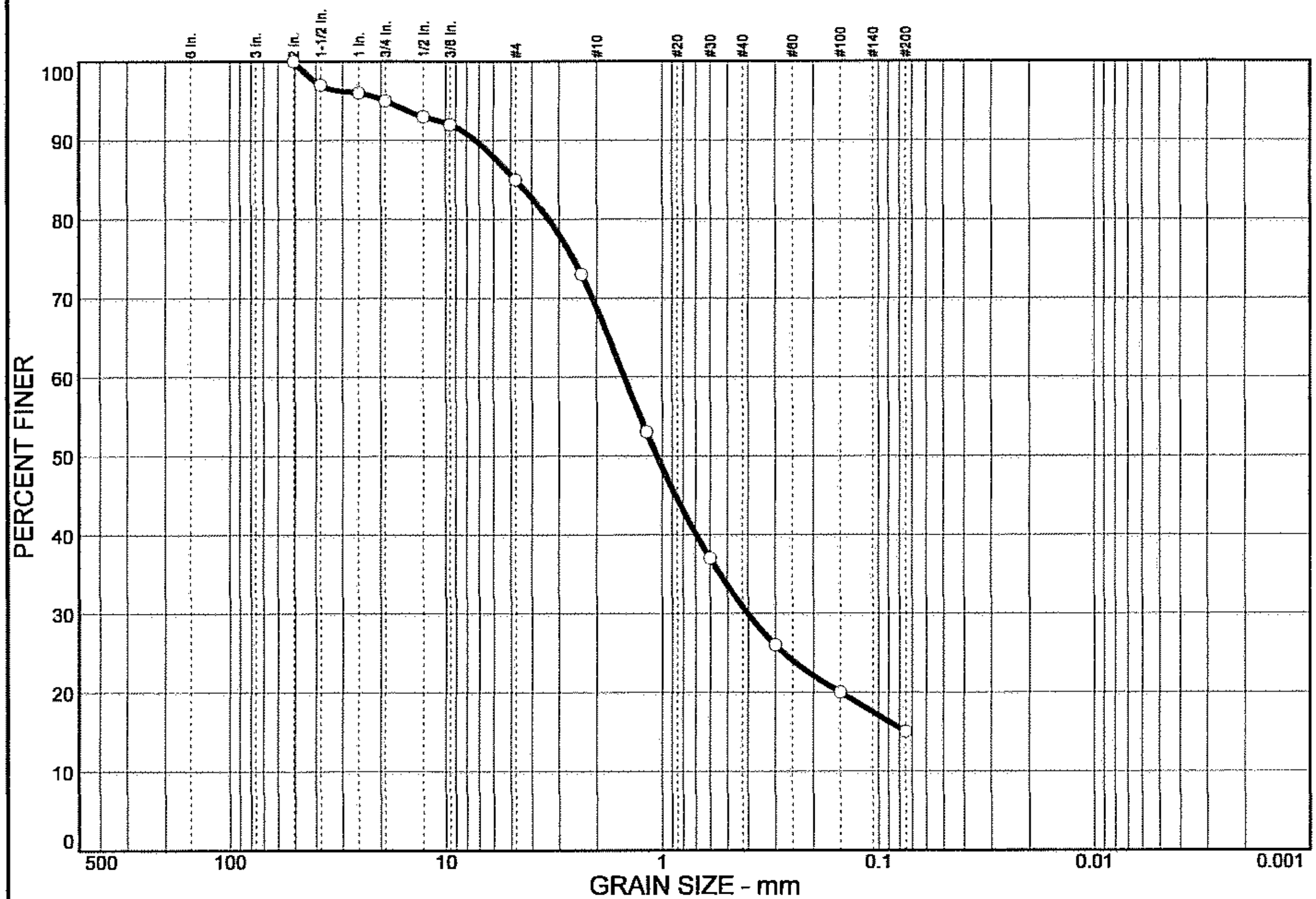
## UNCONFINED COMPRESSIVE STRENGTH DATA OF ROCK CORE SPECIMENS (ASTM D-2938)

| **Identification** | 1-A | 1-B | 1-C | |
|---|---|---|---|---|
| **Date Received** | 10/02/07 | 10/02/07 | 10/02/07 | |
| **Date Tested** | 10/03/07 | 10/03/07 | 10/03/07 | |
| **Diameter** | 2.00 | 2.00 | 2.00 | |
| **X-Sect. Area, $in^2$** | 3.14 | 3.14 | 3.14 | |
| **Trimmed Length, in.** | 4.00 | 4.00 | 4.00 | |
| **L/D** | 2.00 | 2.00 | 2.00 | |
| **Max. Load, lbs.** | 38,852 | 70,420 | 38,011 | |
| **Compr. Strength, psi** | 12,380 | 22,430 | 12,110 | |
| **Fracture Type** | | | | |

**Remarks:**

Cored Specimens obtained and tested in accordance with ASTM D4543.
SSD Bulk Specific Gravity (ASTM C127) = 2.711

# PARTICLE SIZE DISTRIBUTION TEST REPORT




| % + 3" | % GRAVEL | % SAND | % SILT | % CLAY |
|---|---|---|---|---|
| 0.0 | 15.0 | 70.0 | 15.0 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2 in. | 100.0 | | |
| 1-1/2 in. | 97.0 | | |
| 1 in. | 96.0 | | |
| 3/4 in. | 95.0 | | |
| 1/2 in. | 93.0 | | |
| 3/8 in. | 92.0 | | |
| #4 | 85.0 | | |
| #8 | 73.0 | | |
| #16 | 53.0 | | |
| #30 | 37.0 | | |
| #50 | 26.0 | | |
| #100 | 20.0 | | |
| #200 | 15.0 | | |

* (no specification provided)

**Soil Description**

Light Brown Silty Clayey Sand with Gravel

**Atterberg Limits**

PL= 23 LL= 29 PI= 6

**Coefficients**

$D_{85}$= 4.75 $D_{60}$= 1.49 $D_{50}$= 1.06
$D_{30}$= 0.403 $D_{15}$= 0.0750 $D_{10}$=
$C_u$= $C_c$=

**Classification**

USCS= SC/SM AASHTO= —

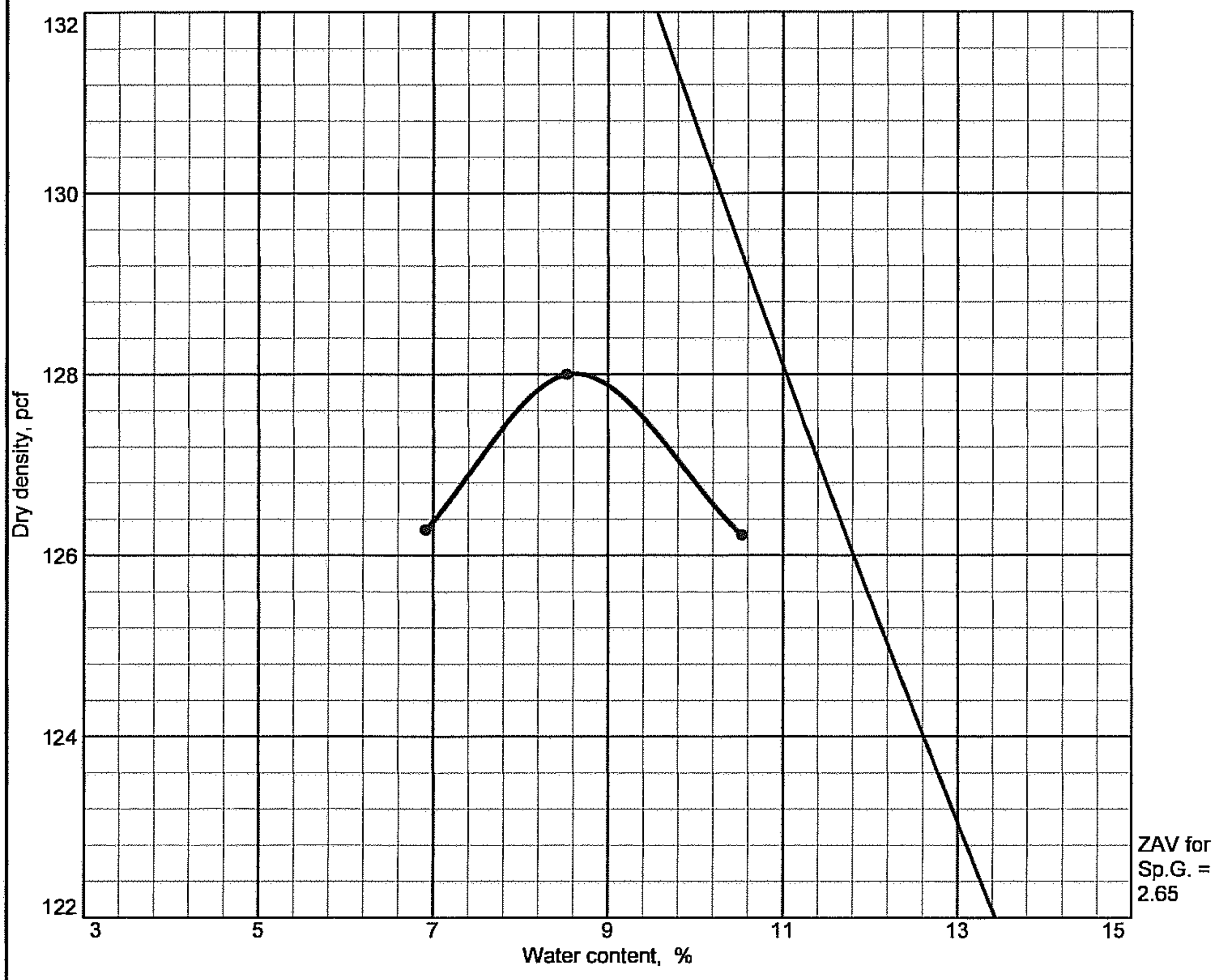
**Remarks**

**Sample No.:** 2 **Source of Sample:** Quarry Expansion (10/03/07) **Date:** 10/03/07
**Location:** **Elev./Depth:** —

Materials Testing, Inc.

**Client:** Crystal Creek Aggregate
**Project:** Quarry Expansion
**Project No:** 0380-004 **Report Number:** 0400-009

# COMPACTION TEST REPORT




Test specification: ASTM D 1557-02 Procedure A Modified

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > No.4 | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| | SC/SM | | | | | | 15.0 | 15 |

**TEST RESULTS**

Maximum dry density = 128.0 pcf

Optimum moisture = 8.6 %

**MATERIAL DESCRIPTION**

Light Brown Silty Clayey Sand with Gravel

**Project No.** 0380-004 **Client:** Crystal Creek Aggregate

**Project:** Quarry Expansion

● **Source:** Quarry Expansion **Sample No.:** 2

MTI Materials Testing, Inc.

**Remarks:**

Curve #1 (10-03-07)

**Report Number:** 0400-011

# APPENDIX B

## Laboratory Testing

# APPENDIX B
# 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 seven rock samples obtained during field evaluations in accordance with standard test method 7012. The results of the tests are attached as the plate labeled Rock Core Compressive Strength Data.

## Naturally Occurring Asbestos Tests

Naturally occurring asbestos tests were performed on two composite samples in accordance with standard test method CARB 435. Results of the tests are attached to this appendix.

M T I

**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.<br>28301 Inwood Road<br>Shingletown, CA 96088 | Date: | 06/07/19 |
| | | Client No: | 3237-026 |
| | | Report No: | 0100-001 |
| Project: | CCA Expansion Shasta County, California | Page: | 1 of 2 |
| Location: | Job # 1901.0114 | | |

## ROCK CORE COMPRESSIVE STRENGTH DATA
### (ASTM D7012 Method C)

| **Hole #** | Site 1-1 | Site 1-2 | Site 2-1 | Site 2-2 |
|---|---|---|---|---|
| **Material** | Greenstone | Trondhjemite | Greenstone | Greenstone |
| **Date Cored** | 06/04/19 | 06/03/19 | 06/04/19 | 06/04/19 |
| **End Preparation Date:** | 06/04/19 | --- | 06/04/19 | 06/04/19 |
| **Date Tested** | 06/07/19 | --- | 06/07/19 | 06/07/19 |
| **Bagged Age in Days** | 3 | --- | 3 | 3 |
| **Average Diameter, in** | 1.99 | --- | 2.00 | 2.00 |
| **Cross Sect. Area, $in^2$** | 3.11 | --- | 3.14 | 3.14 |
| **Trimmed Length, in** | 2.2 | --- | 2.3 | 2.4 |
| **L/D Factor** | 1.11 | --- | 1.15 | 1.20 |
| **Maximum Load, lbs.** | 61,610 | --- | 63,180 | 58,240 |
| **Time to Failure, min.** | 7:36 | --- | 7:30 | 5:00 |
| **Compr. Strength, psi** | 19,810 | --- | 20,120 | 18,550 |
| **Fracture Pattern, Type** | 2 | --- | 2 | 1 |

**Notes:** Specimens prepared in accordance with ASTM D4543.

Tested by Ricky Mathews.

M T I
# 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.<br>28301 Inwood Road<br>Shingletown, CA 96088 | Date: | 06/07/19 |
| | | Client No: | 3237-026 |
| | | Report No: | 0100-001 |
| Project: | CCA Expansion Shasta County, California | Page: | 2 of 2 |
| Location: | Job# 1901.0114 | | |

## ROCK CORE COMPRESSIVE STRENGTH DATA
### (ASTM D7012 Method C)

| **Hole #** | Site 4-1 | Site 4-2 | Site 4-3 | Site 4-4 |
|---|---|---|---|---|
| **Material** | Greenstone | Amphibolite | Trondhjemite | Trondhjemite |
| **Date Cored** | 06/03/19 | 06/0319 | 06/03/19 | 06/03/19 |
| **End Preparation Date:** | 06/04/19 | 06/04/19 | 06/04/19 | 06/04/19 |
| **Date Tested** | 06/07/19 | 06/07/19 | 06/07/19 | 06/07/19 |
| **Bagged Age in Days** | 3 | 3 | 3 | 3 |
| **Average Diameter, in** | 1.99 | 1.99 | 1.99 | 2.00 |
| **Cross Sect. Area, in$^2$** | 3.11 | 3.11 | 3.11 | 3.14 |
| **Trimmed Length, in** | 2.2 | 2.2 | 2.2 | 2.3 |
| **L/D Factor** | 1.11 | 1.11 | 1.11 | 1.15 |
| **Maximum Load, lbs.** | 4,300 | 47,590 | 1,220 | 2,790 |
| **Time to Failure, min.** | 0:05 | 4:27 | 0:40 | 0:50 |
| **Compr. Strength, psi** | 1,380 | 15,300 | 390 | 890 |
| **Fracture Pattern, Type** | 2 | 3 | 3 | 4 |

**Notes:** Specimens prepared in accordance with ASTM D4543.

Respectfully Submitted,
**MATERIALS TESTING, INC.**

Andrew L. King
Project Engineer

Tested by Ricky Mathews.

# ASBESTOS TEM LABORATORIES, INC.

## CARB Method 435
## Polarized Light Microscopy
## Analytical Report

**Laboratory Job # 96-02884**

630 Bancroft Way
Berkeley, CA 94710
(510) 704-8930
FAX (510) 704-8429

ASBESTOS TEM LABORATORIES, INC

CA DPH ELAP
Lab No. 1866

NVLAP Lab Code: 101891-0
Berkeley, CA

Jun/07/2019

Jim Bianchin
Bajada Geosciences, Inc.
28301 Inwood Road
Shingletown, CA 96088

RE: LABORATORY JOB # 96-02884
Polarized light microscopy analytical results for 2 bulk sample(s).
Job Site: 1901.0114
Job No.: Crystal Creek Aggregate

Enclosed please find the bulk material analytical results for one or more samples submitted for asbestos analysis. The analyses were performed in accordance with the California Air Resources Board (ARB) Method 435 for the determination of asbestos in serpentine aggregate samples.

Prior to analysis, samples are logged-in and all data pertinent to the sample recorded. The samples are checked for damage or disruption of any chain-of-custody seals. A unique laboratory ID number is assigned to each sample. A hard copy log-in sheet containing all pertinent information concerning the sample is generated. This and all other relevant paper work are kept with the sample throughout the analytical procedures to assure proper analysis.

Sample preparation follows a standard CARB 435 prep method. The entire sample is dried at 135-150 C and then crushed to ~3/8" gravel size using a Bico Chipmunk crusher. If the submitted sample is >1 pint, the sample was split using a 1/2" riffle splitter following ASTM Method C-702-98 to obtain a 1 pint aliquot. The entire 1 pint aliquot, or entire original sample, is then pulverized in a Bico Braun disc pulverizer calibrated to produce a nominal 200 mesh final product. If necessary, additional homogenization steps are undertaken using a 3/8" riffle splitter. Small aliquots are collected from throughout the pulverized material to create three separate microsope slide mounts containing the appropriate refractive index oil. The prepared slides are placed under a polarizing light microscope where standard mineralogical techniques are used to analyze the various materials present, including asbestos. If asbestos is identified and of less than 10% concentration by visual area estimate then an additional five sample mounts are prepared. Quantification of asbestos concentration is obtained using the standard CAL ARB Method 435 point count protocol. For samples observed to contain visible asbestos of less than 10% concentration, a point counting techinique is used with 50 points counted on each of eight sample mounts for a total of 400 points. The data is then compiled into standard report format and subjected to a thorough quality assurance check before the information is released to the client.

While the CARB 435 method has much to commend it, there are a number of situations where it fails to provide sufficient accuracy to make a definitive determination of the presence/absence of asbestos and/or an accurate count of the asbestos concentration present in a given sample. These problems include, but are not limited to, 1) statistical uncertainty with samples containing <1% asbestos when too few particles are counted, 2) definitive identification and discrimination between various fibrous amphibole minerals such as tremolite/actinolite/hornblende and the "Libby amphiboles" such as tremolite/winchite/richterite/arfvedsonite, and C) small asbestiform fibers which are near or below the resolution limit of the PLM microscope such as those found in various California coast range serpentine bodies. In these cases, further analysis by transmission electron microscopy is recommended to obtain a more accurate result.

Sincerely Yours,

Lab Manager
ASBESTOS TEM LABORATORIES, INC.

--- These results relate only to the samples tested and must not be reproduced, except in full, without the approval of the laboratory. ---

# POLARIZED LIGHT MICROSCOPY
# CARB 435 ANALYTICAL REPORT



Contact: Jim Bianchin

Address: Bajada Geosciences, Inc.
28301 Inwood Road
Shingletown, CA 96088

Samples Submitted: 2
Samples Analyzed: 2
Job Site / No. Crystal Creek Aggregate
1901.0114

Report No. **364128**
Date Submitted: May-24-19
Date Reported: Jun-07-19

| SAMPLE ID | POINTS COUNTED | ASBESTOS % | ASBESTOS TYPE | LOCATION / DESCRIPTION |
|---|---|---|---|---|
| **Site 1/2**<br>Lab ID # 96-02884-001 | **400** - Total Points | **<0.25%** | **None Detected** | Trondhjemite<br>No Asbestos Detected |
| **Site 4**<br>Lab ID # 96-02884-002 | **400** - Total Points | **<0.25%** | **None Detected** | Amphibolite/Greenstone<br>No Asbestos Detected |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |
| Lab ID # | - Total Points | | | |

**QC Reviewer** R. Mc Ba[illegible]

**Analys** Jo Ann Hrentro

# ASBESTOS TEM LABORATORIES CHAIN OF CUSTODY

CALIFORNIA: 600 Bancroft Way, Suite A, Berkeley, CA 94710 Phone (510) 704-8930 Fax (510) 704-8429
NEVADA: 1350 Freeport Blvd. #104, Sparks, NV 89431 Phone (775) 359-3377 Fax (775) 359-2798
You may also email this chain of custody to coc@asbestostemlabs.com
* denotes required field

| | | | |
|---|---|---|---|
| Company: Bajada Geosciences, Inc. | Contact:* Jim Bianchin | Phone:* (530) 638-5263 | Email:* jim.bianchin@bajadageo.com |
| Address:* 28301 Inwood Road | City:* Shingletown | State:* CA Zip: 96088 | Email: |
| Job Site:* Crystal Creek Aggregate | Job #: 1901.0114 | PO #: | Email: |

| | |
|---|---|
| Reporting* | ■ Email ☐ Phone ☐ Fax ■ Mail ☐ FTP ☐ Pickup — Billing ☐ Fax ☐ Email ☐ Mail ☐ Pre-Paid ■ On Receipt: via CC ☐ 3rd Party |
| Results Due:* | ☐ 2 HR ☐ 4 HR ☐ 6 HR ☐ 8 HR ☐ 24 HR ☐ 48 HR ☐ 3 DAY ☐ 4 DAY ■ 5 DAY X 10 DAY ☐ Hold Samples ☐ After Hours: ** ______ see below |
| Asbestos Air | ☐ PCM (NIOSH 7400A ☐ TEM AHERA ☐ TEM CARB Mod. AHERA ☐ TEM EPA Yamate Level II ☐ TEM NIOSH 7402 ☐ ISO 10312 ☐ ISO 13794 |
| Asbestos Bulk | ☐ PLM Standard (EPA 600/R-93-1) ☐ PLM 400 PC ☐ PLM 1000 PC ☐ PLM 400 PC Grav. Red. ☐ PLM 1000 PC Grav. Red. ☐ TEM EPA Qualitative ☐ TEM EPA Quantitatve |
| | ☐ TEM Chatfield (Semi-Quant) ☐ PREP ONLY ☐ Custom Analysis: ** |
| Asbestos Soils | ☐ CARB 435 Prep Only ■ CARB 435 PLM 400 PC ☐ CARB 435 PLM 1000 PC ☐ EPA Soil Screening Qualitative ☐ TEM EPA/CARB Quantitative |
| Asbestos Dust | ☐ ASTM D-5755 Fiber Count ☐ ASTM D-5756 Wt. % ☐ ASTM D-5756 Mass ☐ ASTM D-6480-99 Dust Wipe ☐ Total Particulates (Grav.) |
| Asbestos Water | ☐ 100.2 Potable Drinking Water ☐ 100.1 Non Potable Water ☐ REPORT TO STATE: EDT # ______ |
| Lead/Silica | ☐ Lead Paint Chips ☐ Lead Dust Wipe ☐ Lead Air Cassette ☐ Lead Soil ☐ Silica Dust Airborne by NIOSH 7500 ☐ Crystalline Silica (Single Species) ☐ Silica Dust Bulk by NIOSH 7500 ☐ Crystalline Silica in Bulk (Single Species) |
| Sample Storage | ☐ No Test, Hold Until: ______ ☐ Test AND Hold Until: ______ All samples will be held for 3 months from the date of receipt at ATEM. Additional sample storage time may be obtained through ATEM Customer Service. |
| Custom Order | ☐ Sensitivity: ______ ☐ Composite 8 Hour TWA ☐ **Special Instructions:** |
| REANALYSIS | Original Login/Lot # ______ / ______ New Analysis Type: ______ TAT: ______ Special Instructions: ______ |

| Sample #* | Sample Type | Date Collected | Time On | Time Off | Total Time (min) | Flow Rate (lpm) On | Flow Rate (lpm) Off | Flow Rate (lpm) Average | Volume or Area Sampled | Hold Sample | Description* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Site 1/2 GB | Composite bulk | 5/20/19 | | | | | | | | ☐ | Trondhjemite |
| Site4 GB | Composite bulk | 5/20/19 | | | | | | | | ☐ | Amphibolite/Greenstone |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |
| | | | | | | | | | | ☐ | |

| | |
|---|---|
| Submitted By*: JB | Received By: MD |
| Date/Time Submitted*: 5/23/19 / 1354 | Date/Time Received |
| Submitted By | Received By |
| Date/Time Submitted | Date/Time Received |

** Any special instructions, RUSH results or Custom Analysis, you must clarify these specifications AND, of more importance, contact us here at ATEM ahead of time to manage scheduling to meet your requests. Drop off and processing of samples after hours cannot be accommodated without proper notification from you, and confirmation by ATEM staff.

# APPENDIX C

## Slope Stability Analyses

# APPENDIX C
# 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. (2019) 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 obtained using topographic data from DKM (2019).

**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** |
| Overall slope, static conditions, reasonable water table, backcalculated strength. | 1.36 | A-A'BCStatic.slim |
| Overall Slope, pseudostatic conditions, reasonable water table, backcalculated strength. | 1.06 | A-A'BCPS.slim |
| Overall slope, static, reasonable water table, strength from Hoek & Brown criterion. | 2.39 | A-A'StaticLowH2O.slim |
| Overall slope, pseudostatic, reasonable water table, strength from Hoek & Brown criterion. | 1.92 | A-A'LowH2OPS.slim |
| Overall slope, static, worst case water table, strength from Hoek & Brown criterion. | 1.65 | A-A'StaticHighH2O.slim |
| Overall slope, pseudostatic, worst case water table, strength from Hoek & Brown criterion. | 1.30 | A-A'StaticHighH2OPS.slim |
| Maximum overburden inclination, static, dry. | 1.30 | OverburdenStatic.slim |
| Planar failure, discontinuity dipping at 55 degrees, static, strength from Hoek & Brown criterion. | 2.15 | 55deg.slmd |
| Planar failure, discontinuity dipping at 65 degrees, static, strength from Hoek & Brown criterion. | 2.05 | 65deg.slmd |
| Planar failure, discontinuity dipping at 75 degrees, static, strength from Hoek & Brown criterion. | 2.26 | 75deg.slmd |
| Planar failure, discontinuity dipping at 75 degrees, static, backcalculation of discontinuity strength | 1.52 | 75PlanarBackCalculate.slmd |

**REFERENCES**

Fellenius, W. (1936), Calculation of the Stability of Earth Dams, Transactions of the Second Congress on Large Dams, vol. 4, pp. 445-463.

Frelund, D.G., and Krahn, J. (1977), Comparison of Slope Stability Methods of Analysis, Canadian Geotechnical Journal, vol. 14, pp. 429-439.

Janbu, N., Bjerrum, L., and Kjaernsli, B. (1956), Veiledning ved losning av fundamenterings-oppgaver-2. Stabilitetsberegning for fyllinger, skjaeringer og naturlige skraninger. (Soil Mechanics Applies to Some Engineering Problems – Chapter 2. Stability Calculations for Embankments, Cuts, and Natural Slopes), Publication 16, Norwegian Geotechnical Institute, Oslo, pp. 17-26.

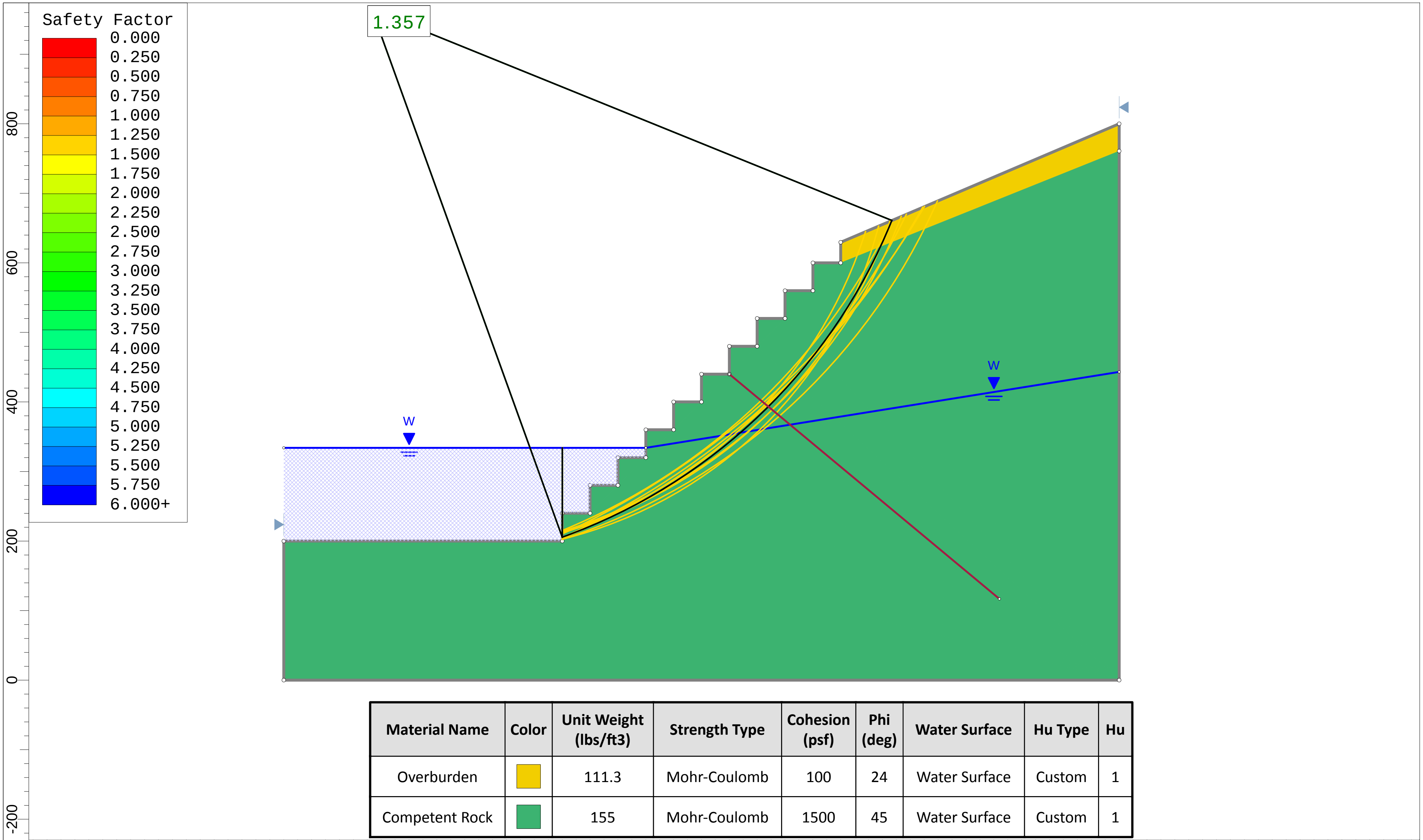
Lambe, T.W., and Whitman, R.V., (1969), Soil Mechanics, John Wiley & Sons, New York, 553 pp.

Rocscience (2019), SLIDE 2019, 2D Limit Equilibrium Slope Stability Analysis, Build 8.024, April 17.

Sherard, J.L., Woodward, R.J., Gizienski, S.F., and Clevenger, W.A. (1963), Stability Analyses, Earth and Earth-Rock Dams, 1st Edition, John Wiley & Sons, New York, 345 pp.

Spencer, E. (1967), A Method of Analyses of the Stability of Embankments Assuming Parallel Inter-Slice Forces, Geotechnique, vol. 17, no. 1, pp. 11-26.

Wright, S. (1969), A Study of Slope Stability and the Undrained Shear Strength of Clay Shales, Ph.D. Thesis, University of California, Berkley.




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 1500 | 45 | Water Surface | Custom | 1 |

**Bajada Geosciences, Inc.**

SLIDEINTERPRET 8.023

| | | | |
|---|---|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion | | |
| *Analysis Description* | Gross Stability, Static, Backcalculate Minimum Shar Strength | | |
| *Drawn By* J.Bianchin | *Scale* 1:2326 | *Company* | Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 9:14:14 AM | *File Name* | A-A'BCStatic.slim |

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:00.674s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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 | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 1500 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## *Global Minimums*

### Method: spencer

| FS | 1.357450 |
|---|---|
| Center: | 126.532, 963.759 |
| Radius: | 806.056 |
| Left Slip Surface Endpoint: | 400.000, 205.510 |
| Right Slip Surface Endpoint: | 873.534, 660.916 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 873.534 660.916 |
| Resisting Moment: | 4.1603e+09 lb-ft |
| Driving Moment: | 3.06478e+09 lb-ft |
| Resisting Horizontal Force: | 3.79917e+06 lb |
| Driving Horizontal Force: | 2.79874e+06 lb |
| Total Slice Area: | 47695.2 ft2 |
| Surface Horizontal Width: | 473.534 ft |
| Surface Average Height: | 100.722 ft |

## *Valid/Invalid Surfaces*

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 886 |
| Number of Invalid Surfaces: | 4114 |

#### Error Codes:

Error Code -103 reported for 1118 surfaces

Error Code -108 reported for 3 surfaces
Error Code -111 reported for 331 surfaces
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

### Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.35745

| 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 | 9.47412 | 103662 | 20.191 | Competent Rock | 1500 | 45 | 13465.2 | 18278.4 | 24687.4 | 7909.08 | 16778.3 | 29639.3 | 21730.2 |
| 2 | 9.47412 | 98445.9 | 20.9102 | Competent Rock | 1500 | 45 | 1895.32 | 2572.8 | 8760.23 | 7687.44 | 1072.79 | 9484.37 | 1796.93 |
| 3 | 9.47412 | 93029.3 | 21.6329 | Competent Rock | 1500 | 45 | 1624.9 | 2205.71 | 8162.99 | 7457.27 | 705.715 | 8807.41 | 1350.14 |
| 4 | 9.47412 | 87409 | 22.3592 | Competent Rock | 1500 | 45 | 1358.9 | 1844.64 | 7563.1 | 7218.46 | 344.639 | 8122.07 | 903.607 |
| 5 | 9.47412 | 108883 | 23.0894 | Competent Rock | 1500 | 45 | 11181.3 | 15178 | 20648.8 | 6970.85 | 13678 | 25415.6 | 18444.7 |
| 6 | 9.47412 | 110637 | 23.8235 | Competent Rock | 1500 | 45 | 3244.93 | 4404.83 | 9619.15 | 6714.32 | 2904.83 | 11051.9 | 4337.6 |
| 7 | 9.47412 | 104386 | 24.5618 | Competent Rock | 1500 | 45 | 2949.29 | 4003.52 | 8952.23 | 6448.71 | 2503.52 | 10300.1 | 3851.43 |
| 8 | 9.47412 | 97918.2 | 25.3045 | Competent Rock | 1500 | 45 | 2659.31 | 3609.88 | 8283.74 | 6173.86 | 2109.88 | 9541.04 | 3367.18 |
| 9 | 9.47412 | 110738 | 26.0517 | Competent Rock | 1500 | 45 | 7160.27 | 9719.71 | 14109.3 | 5889.6 | 8219.73 | 17609.6 | 11720 |
| 10 | 9.47412 | 119406 | 26.8038 | Competent Rock | 1500 | 45 | 4330.15 | 5877.96 | 9973.72 | 5595.76 | 4377.96 | 12161.4 | 6565.64 |
| 11 | 9.47412 | 112261 | 27.5609 | Competent Rock | 1500 | 45 | 4016.66 | 5452.41 | 9244.56 | 5292.15 | 3952.41 | 11340.9 | 6048.78 |
| 12 | 9.47412 | 104881 | 28.3232 | Competent Rock | 1500 | 45 | 3709.85 | 5035.94 | 8514.5 | 4978.56 | 3535.94 | 10514 | 5535.43 |
| 13 | 9.47412 | 114111 | 29.0911 | Competent Rock | 1500 | 45 | 4660.88 | 6326.91 | 9481.7 | 4654.78 | 4826.92 | 12075 | 7420.17 |
| 14 | 9.47412 | 139859 | 29.8647 | Competent Rock | 1500 | 45 | 6036.05 | 8193.64 | 11093.4 | 4399.76 | 6693.61 | 14559.3 | 10159.5 |
| 15 | 9.47412 | 131744 | 30.6443 | Competent Rock | 1500 | 45 | 5622.46 | 7632.21 | 10282.1 | 4149.86 | 6132.23 | 13613.1 | 9463.22 |
| 16 | 9.47412 | 123371 | 31.4303 | Competent Rock | 1500 | 45 | 5218.14 | 7083.37 | 9472.46 | 3889.05 | 5583.41 | 12661.4 | 8772.37 |
| 17 | 9.47412 | 121308 | 32.223 | Competent Rock | 1500 | 45 | 5189.66 | 7044.71 | 9161.71 | 3617.04 | 5544.67 | 12432.7 | 8815.69 |
| 18 | 9.47412 | 164569 | 33.0226 | Competent Rock | 1500 | 45 | 7650.03 | 10384.5 | 12218.1 | 3333.56 | 8884.52 | 17190.4 | 13856.8 |
| 19 | 9.47412 | 155386 | 33.8295 | Competent Rock | 1500 | 45 | 7211.74 | 9789.58 | 11327.8 | 3038.28 | 8289.54 | 16161 | 13122.8 |
| 20 | 9.47412 | 145917 | 34.6442 | Competent Rock | 1500 | 45 | 6783.78 | 9208.64 | 10439.5 | 2730.87 | 7708.6 | 15127 | 12396.1 |
| 21 | 9.47412 | 136154 | 35.4669 | Competent | 1500 | 45 | 6366.22 | 8641.83 | 9552.79 | 2410.99 | 7141.8 | 14088.2 | 11677.2 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rock | | | | | | | | |
| 22 | 9.47412 | 178359 | 36.2981 | Competent Rock | 1500 | 45 | 8598.92 | 11672.6 | 12250.9 | 2078.23 | 10172.6 | 18567 | 16488.7 |
| 23 | 9.47412 | 174451 | 37.1383 | Competent Rock | 1500 | 45 | 8469.19 | 11496.5 | 11728.7 | 1732.2 | 9996.49 | 18142.8 | 16410.6 |
| 24 | 9.47412 | 163750 | 37.9879 | Competent Rock | 1500 | 45 | 8023.99 | 10892.2 | 10764.6 | 1372.44 | 9392.19 | 17030.9 | 15658.5 |
| 25 | 9.47412 | 152715 | 38.8475 | Competent Rock | 1500 | 45 | 7590.19 | 10303.3 | 9801.77 | 998.483 | 8803.29 | 15914.8 | 14916.3 |
| 26 | 9.47412 | 180561 | 39.7176 | Competent Rock | 1500 | 45 | 8990.17 | 12203.7 | 11313.5 | 609.808 | 10703.7 | 18781.9 | 18172.1 |
| 27 | 9.47412 | 188332 | 40.5988 | Competent Rock | 1500 | 45 | 9427.46 | 12797.3 | 11503.2 | 205.856 | 11297.3 | 19583.1 | 19377.3 |
| 28 | 9.57935 | 178104 | 41.4969 | Competent Rock | 1500 | 45 | 8824.71 | 11979.1 | 10479.2 | 0 | 10479.2 | 18285.8 | 18285.8 |
| 29 | 9.57935 | 165316 | 42.4126 | Competent Rock | 1500 | 45 | 8088 | 10979.1 | 9479.03 | 0 | 9479.03 | 16867.6 | 16867.6 |
| 30 | 9.57935 | 180251 | 43.3418 | Competent Rock | 1500 | 45 | 8541.31 | 11594.4 | 10094.4 | 0 | 10094.4 | 18155.1 | 18155.1 |
| 31 | 9.57935 | 197852 | 44.2856 | Competent Rock | 1500 | 45 | 9074.96 | 12318.8 | 10818.9 | 0 | 10818.9 | 19670.3 | 19670.3 |
| 32 | 9.57935 | 183743 | 45.2447 | Competent Rock | 1500 | 45 | 8304.81 | 11273.4 | 9773.34 | 0 | 9773.34 | 18149.4 | 18149.4 |
| 33 | 9.57935 | 169149 | 46.2204 | Competent Rock | 1500 | 45 | 7543.36 | 10239.7 | 8739.75 | 0 | 8739.75 | 16611.5 | 16611.5 |
| 34 | 9.57935 | 171755 | 47.2136 | Competent Rock | 1500 | 45 | 7465.28 | 10133.7 | 8633.73 | 0 | 8633.73 | 16699.3 | 16699.3 |
| 35 | 9.57935 | 197791 | 48.2259 | Competent Rock | 1500 | 45 | 8250.9 | 11200.2 | 9700.2 | 0 | 9700.2 | 18936.7 | 18936.7 |
| 36 | 9.57935 | 181574 | 49.2586 | Competent Rock | 1500 | 45 | 7458.73 | 10124.9 | 8624.84 | 0 | 8624.84 | 17283.8 | 17283.8 |
| 37 | 9.57935 | 164747 | 50.3135 | Competent Rock | 1500 | 45 | 6676.19 | 9062.59 | 7562.57 | 0 | 7562.57 | 15607.9 | 15607.9 |
| 38 | 9.57935 | 154550 | 51.3922 | Competent Rock | 1500 | 45 | 6152.12 | 8351.2 | 6851.22 | 0 | 6851.22 | 14555.7 | 14555.7 |
| 39 | 9.57935 | 188490 | 52.4971 | Competent Rock | 1500 | 45 | 7109.61 | 9650.94 | 8150.94 | 0 | 8150.94 | 17415.4 | 17415.4 |
| 40 | 9.57935 | 169566 | 53.6305 | Competent Rock | 1500 | 45 | 6298.5 | 8549.9 | 7049.89 | 0 | 7049.89 | 15602.5 | 15602.5 |
| 41 | 9.57935 | 149829 | 54.7952 | Competent Rock | 1500 | 45 | 5498.24 | 7463.59 | 5963.59 | 0 | 5963.59 | 13756.5 | 13756.5 |
| 42 | 9.57935 | 129208 | 55.9945 | Competent Rock | 1500 | 45 | 4709.4 | 6392.77 | 4892.77 | 0 | 4892.77 | 11873.3 | 11873.3 |
| 43 | 9.57935 | 140162 | 57.2323 | Competent Rock | 1500 | 45 | 4877.54 | 6621.01 | 5121.01 | 0 | 5121.01 | 12698.8 | 12698.8 |
| 44 | 9.57935 | 125131 | 58.5132 | Competent Rock | 1500 | 45 | 4292.45 | 5826.78 | 4326.78 | 0 | 4326.78 | 11335.1 | 11335.1 |
| 45 | 9.57935 | 107242 | 59.8428 | Competent Rock | 1500 | 45 | 3659.28 | 4967.29 | 3467.29 | 0 | 3467.29 | 9765.38 | 9765.38 |
| 46 | 9.57935 | 88013.7 | 61.2279 | Competent Rock | 1500 | 45 | 3027.13 | 4109.18 | 2609.18 | 0 | 2609.18 | 8121.87 | 8121.87 |
| 47 | 9.57935 | 67260.1 | 62.677 | Competent Rock | 1500 | 45 | 2396.96 | 3253.75 | 1753.75 | 0 | 1753.75 | 6393.19 | 6393.19 |
| 48 | 9.57935 | 44745.7 | 64.201 | Competent Rock | 1500 | 45 | 1770.05 | 2402.75 | 902.751 | 0 | 902.751 | 4564.44 | 4564.44 |
| 49 | 8.28332 | 21718.9 | 65.6987 | Overburden | 100 | 24 | 439.05 | 595.989 | 1114.01 | 0 | 1114.01 | 2086.34 | 2086.34 |
| 50 | 8.28332 | 7444.75 | 67.1729 | Overburden | 100 | 24 | 146.241 | 198.515 | 221.269 | 0 | 221.269 | 568.703 | 568.703 |

**Query 1 (spencer) - Safety Factor**: 1.35745

| 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 | 9.47412 | 103662 | 20.191 | Competent Rock | 1500 | 45 | 13465.2 | 18278.4 | 24687.4 | 7909.08 | 16778.3 | 29639.3 | 21730.2 |
| 2 | 9.47412 | 98445.9 | 20.9102 | Competent | 1500 | 45 | 1895.32 | 2572.8 | 8760.23 | 7687.44 | 1072.79 | 9484.37 | 1796.93 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rock | | | | | | | | |
| 3 | 9.47412 | 93029.3 | 21.6329 | Competent Rock | 1500 | 45 | 1624.9 | 2205.71 | 8162.99 | 7457.27 | 705.715 | 8807.41 | 1350.14 |
| 4 | 9.47412 | 87409 | 22.3592 | Competent Rock | 1500 | 45 | 1358.9 | 1844.64 | 7563.1 | 7218.46 | 344.639 | 8122.07 | 903.607 |
| 5 | 9.47412 | 108883 | 23.0894 | Competent Rock | 1500 | 45 | 11181.3 | 15178 | 20648.8 | 6970.85 | 13678 | 25415.6 | 18444.7 |
| 6 | 9.47412 | 110637 | 23.8235 | Competent Rock | 1500 | 45 | 3244.93 | 4404.83 | 9619.15 | 6714.32 | 2904.83 | 11051.9 | 4337.6 |
| 7 | 9.47412 | 104386 | 24.5618 | Competent Rock | 1500 | 45 | 2949.29 | 4003.52 | 8952.23 | 6448.71 | 2503.52 | 10300.1 | 3851.43 |
| 8 | 9.47412 | 97918.2 | 25.3045 | Competent Rock | 1500 | 45 | 2659.31 | 3609.88 | 8283.74 | 6173.86 | 2109.88 | 9541.04 | 3367.18 |
| 9 | 9.47412 | 110738 | 26.0517 | Competent Rock | 1500 | 45 | 7160.27 | 9719.71 | 14109.3 | 5889.6 | 8219.73 | 17609.6 | 11720 |
| 10 | 9.47412 | 119406 | 26.8038 | Competent Rock | 1500 | 45 | 4330.15 | 5877.96 | 9973.72 | 5595.76 | 4377.96 | 12161.4 | 6565.64 |
| 11 | 9.47412 | 112261 | 27.5609 | Competent Rock | 1500 | 45 | 4016.66 | 5452.41 | 9244.56 | 5292.15 | 3952.41 | 11340.9 | 6048.78 |
| 12 | 9.47412 | 104881 | 28.3232 | Competent Rock | 1500 | 45 | 3709.85 | 5035.94 | 8514.5 | 4978.56 | 3535.94 | 10514 | 5535.43 |
| 13 | 9.47412 | 114111 | 29.0911 | Competent Rock | 1500 | 45 | 4660.88 | 6326.91 | 9481.7 | 4654.78 | 4826.92 | 12075 | 7420.17 |
| 14 | 9.47412 | 139859 | 29.8647 | Competent Rock | 1500 | 45 | 6036.05 | 8193.64 | 11093.4 | 4399.76 | 6693.61 | 14559.3 | 10159.5 |
| 15 | 9.47412 | 131744 | 30.6443 | Competent Rock | 1500 | 45 | 5622.46 | 7632.21 | 10282.1 | 4149.86 | 6132.23 | 13613.1 | 9463.22 |
| 16 | 9.47412 | 123371 | 31.4303 | Competent Rock | 1500 | 45 | 5218.14 | 7083.37 | 9472.46 | 3889.05 | 5583.41 | 12661.4 | 8772.37 |
| 17 | 9.47412 | 121308 | 32.223 | Competent Rock | 1500 | 45 | 5189.66 | 7044.71 | 9161.71 | 3617.04 | 5544.67 | 12432.7 | 8815.69 |
| 18 | 9.47412 | 164569 | 33.0226 | Competent Rock | 1500 | 45 | 7650.03 | 10384.5 | 12218.1 | 3333.56 | 8884.52 | 17190.4 | 13856.8 |
| 19 | 9.47412 | 155386 | 33.8295 | Competent Rock | 1500 | 45 | 7211.74 | 9789.58 | 11327.8 | 3038.28 | 8289.54 | 16161 | 13122.8 |
| 20 | 9.47412 | 145917 | 34.6442 | Competent Rock | 1500 | 45 | 6783.78 | 9208.64 | 10439.5 | 2730.87 | 7708.6 | 15127 | 12396.1 |
| 21 | 9.47412 | 136154 | 35.4669 | Competent Rock | 1500 | 45 | 6366.22 | 8641.83 | 9552.79 | 2410.99 | 7141.8 | 14088.2 | 11677.2 |
| 22 | 9.47412 | 178359 | 36.2981 | Competent Rock | 1500 | 45 | 8598.92 | 11672.6 | 12250.9 | 2078.23 | 10172.6 | 18567 | 16488.7 |
| 23 | 9.47412 | 174451 | 37.1383 | Competent Rock | 1500 | 45 | 8469.19 | 11496.5 | 11728.7 | 1732.2 | 9996.49 | 18142.8 | 16410.6 |
| 24 | 9.47412 | 163750 | 37.9879 | Competent Rock | 1500 | 45 | 8023.99 | 10892.2 | 10764.6 | 1372.44 | 9392.19 | 17030.9 | 15658.5 |
| 25 | 9.47412 | 152715 | 38.8475 | Competent Rock | 1500 | 45 | 7590.19 | 10303.3 | 9801.77 | 998.483 | 8803.29 | 15914.8 | 14916.3 |
| 26 | 9.47412 | 180561 | 39.7176 | Competent Rock | 1500 | 45 | 8990.17 | 12203.7 | 11313.5 | 609.808 | 10703.7 | 18781.9 | 18172.1 |
| 27 | 9.47412 | 188332 | 40.5988 | Competent Rock | 1500 | 45 | 9427.46 | 12797.3 | 11503.2 | 205.856 | 11297.3 | 19583.1 | 19377.3 |
| 28 | 9.57935 | 178104 | 41.4969 | Competent Rock | 1500 | 45 | 8824.71 | 11979.1 | 10479.2 | 0 | 10479.2 | 18285.8 | 18285.8 |
| 29 | 9.57935 | 165316 | 42.4126 | Competent Rock | 1500 | 45 | 8088 | 10979.1 | 9479.03 | 0 | 9479.03 | 16867.6 | 16867.6 |
| 30 | 9.57935 | 180251 | 43.3418 | Competent Rock | 1500 | 45 | 8541.31 | 11594.4 | 10094.4 | 0 | 10094.4 | 18155.1 | 18155.1 |
| 31 | 9.57935 | 197852 | 44.2856 | Competent Rock | 1500 | 45 | 9074.96 | 12318.8 | 10818.9 | 0 | 10818.9 | 19670.3 | 19670.3 |
| 32 | 9.57935 | 183743 | 45.2447 | Competent Rock | 1500 | 45 | 8304.81 | 11273.4 | 9773.34 | 0 | 9773.34 | 18149.4 | 18149.4 |
| 33 | 9.57935 | 169149 | 46.2204 | Competent Rock | 1500 | 45 | 7543.36 | 10239.7 | 8739.75 | 0 | 8739.75 | 16611.5 | 16611.5 |
| 34 | 9.57935 | 171755 | 47.2136 | Competent Rock | 1500 | 45 | 7465.28 | 10133.7 | 8633.73 | 0 | 8633.73 | 16699.3 | 16699.3 |
| 35 | 9.57935 | 197791 | 48.2259 | Competent Rock | 1500 | 45 | 8250.9 | 11200.2 | 9700.2 | 0 | 9700.2 | 18936.7 | 18936.7 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 9.57935 | 181574 | 49.2586 | Competent Rock | 1500 | 45 | 7458.73 | 10124.9 | 8624.84 | 0 | 8624.84 | 17283.8 | 17283.8 |
| 37 | 9.57935 | 164747 | 50.3135 | Competent Rock | 1500 | 45 | 6676.19 | 9062.59 | 7562.57 | 0 | 7562.57 | 15607.9 | 15607.9 |
| 38 | 9.57935 | 154550 | 51.3922 | Competent Rock | 1500 | 45 | 6152.12 | 8351.2 | 6851.22 | 0 | 6851.22 | 14555.7 | 14555.7 |
| 39 | 9.57935 | 188490 | 52.4971 | Competent Rock | 1500 | 45 | 7109.61 | 9650.94 | 8150.94 | 0 | 8150.94 | 17415.4 | 17415.4 |
| 40 | 9.57935 | 169566 | 53.6305 | Competent Rock | 1500 | 45 | 6298.5 | 8549.9 | 7049.89 | 0 | 7049.89 | 15602.5 | 15602.5 |
| 41 | 9.57935 | 149829 | 54.7952 | Competent Rock | 1500 | 45 | 5498.24 | 7463.59 | 5963.59 | 0 | 5963.59 | 13756.5 | 13756.5 |
| 42 | 9.57935 | 129208 | 55.9945 | Competent Rock | 1500 | 45 | 4709.4 | 6392.77 | 4892.77 | 0 | 4892.77 | 11873.3 | 11873.3 |
| 43 | 9.57935 | 140162 | 57.2323 | Competent Rock | 1500 | 45 | 4877.54 | 6621.01 | 5121.01 | 0 | 5121.01 | 12698.8 | 12698.8 |
| 44 | 9.57935 | 125131 | 58.5132 | Competent Rock | 1500 | 45 | 4292.45 | 5826.78 | 4326.78 | 0 | 4326.78 | 11335.1 | 11335.1 |
| 45 | 9.57935 | 107242 | 59.8428 | Competent Rock | 1500 | 45 | 3659.28 | 4967.29 | 3467.29 | 0 | 3467.29 | 9765.38 | 9765.38 |
| 46 | 9.57935 | 88013.7 | 61.2279 | Competent Rock | 1500 | 45 | 3027.13 | 4109.18 | 2609.18 | 0 | 2609.18 | 8121.87 | 8121.87 |
| 47 | 9.57935 | 67260.1 | 62.677 | Competent Rock | 1500 | 45 | 2396.96 | 3253.75 | 1753.75 | 0 | 1753.75 | 6393.19 | 6393.19 |
| 48 | 9.57935 | 44745.7 | 64.201 | Competent Rock | 1500 | 45 | 1770.05 | 2402.75 | 902.751 | 0 | 902.751 | 4564.44 | 4564.44 |
| 49 | 8.28332 | 21718.9 | 65.6987 | Overburden | 100 | 24 | 439.05 | 595.989 | 1114.01 | 0 | 1114.01 | 2086.34 | 2086.34 |
| 50 | 8.28332 | 7444.75 | 67.1729 | Overburden | 100 | 24 | 146.241 | 198.515 | 221.269 | 0 | 221.269 | 568.703 | 568.703 |

## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.35745

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 205.51 | 515105 | 0 | 0 |
| 2 | 409.474 | 208.994 | 280913 | 182285 | 32.9796 |
| 3 | 418.948 | 212.614 | 267150 | 173354 | 32.9796 |
| 4 | 428.422 | 216.371 | 251865 | 163436 | 32.9797 |
| 5 | 437.896 | 220.268 | 235259 | 152660 | 32.9796 |
| 6 | 447.371 | 224.307 | 442441 | 287101 | 32.9796 |
| 7 | 456.845 | 228.49 | 432929 | 280928 | 32.9796 |
| 8 | 466.319 | 232.82 | 422094 | 273897 | 32.9796 |
| 9 | 475.793 | 237.299 | 410170 | 266160 | 32.9796 |
| 10 | 485.267 | 241.931 | 497490 | 322822 | 32.9796 |
| 11 | 494.741 | 246.717 | 490753 | 318451 | 32.9797 |
| 12 | 504.215 | 251.662 | 483076 | 313469 | 32.9796 |
| 13 | 513.689 | 256.768 | 474729 | 308052 | 32.9796 |
| 14 | 523.164 | 262.04 | 474998 | 308227 | 32.9796 |
| 15 | 532.638 | 267.48 | 471806 | 306156 | 32.9796 |
| 16 | 542.112 | 273.093 | 467334 | 303254 | 32.9796 |
| 17 | 551.586 | 278.883 | 461901 | 299729 | 32.9797 |
| 18 | 561.06 | 284.854 | 456334 | 296116 | 32.9796 |
| 19 | 570.534 | 291.012 | 453537 | 294301 | 32.9796 |
| 20 | 580.008 | 297.361 | 449901 | 291941 | 32.9796 |
| 21 | 589.482 | 303.908 | 445795 | 289277 | 32.9796 |
| 22 | 598.957 | 310.657 | 441601 | 286556 | 32.9796 |
| 23 | 608.431 | 317.616 | 437773 | 284072 | 32.9796 |
| 24 | 617.905 | 324.792 | 433814 | 281503 | 32.9796 |
| 25 | 627.379 | 332.19 | 430150 | 279125 | 32.9796 |
| 26 | 636.853 | 339.821 | 427233 | 277232 | 32.9796 |
| 27 | 646.327 | 347.691 | 423320 | 274693 | 32.9796 |
| 28 | 655.801 | 355.811 | 419185 | 272010 | 32.9796 |
| 29 | 665.381 | 364.285 | 414875 | 269213 | 32.9796 |
| 30 | 674.96 | 373.036 | 409361 | 265635 | 32.9796 |
| 31 | 684.539 | 382.077 | 399883 | 259485 | 32.9796 |
| 32 | 694.119 | 391.42 | 385686 | 250272 | 32.9796 |
| 33 | 703.698 | 401.082 | 370774 | 240596 | 32.9796 |
| 34 | 713.277 | 411.078 | 355631 | 230770 | 32.9797 |
| 35 | 722.857 | 421.428 | 337750 | 219167 | 32.9797 |
| 36 | 732.436 | 432.151 | 312726 | 202928 | 32.9796 |
| 37 | 742.015 | 443.272 | 288224 | 187029 | 32.9796 |
| 38 | 751.595 | 454.816 | 264843 | 171857 | 32.9796 |
| 39 | 761.174 | 466.812 | 241555 | 156745 | 32.9795 |
| 40 | 770.753 | 479.295 | 207879 | 134893 | 32.9796 |
| 41 | 780.333 | 492.303 | 176481 | 114519 | 32.9796 |
| 42 | 789.912 | 505.88 | 148155 | 96138.2 | 32.9797 |
| 43 | 799.491 | 520.079 | 123772 | 80316 | 32.9797 |
| 44 | 809.071 | 534.962 | 94257.3 | 61163.7 | 32.9796 |
| 45 | 818.65 | 550.602 | 67683.2 | 43919.8 | 32.9796 |
| 46 | 828.229 | 567.089 | 45552.5 | 29559.1 | 32.9796 |
| 47 | 837.809 | 584.534 | 29018.6 | 18830.2 | 32.9796 |
| 48 | 847.388 | 603.075 | 19451.2 | 12621.9 | 32.9796 |
| 49 | 856.968 | 622.892 | 18508.7 | 12010.3 | 32.9795 |
| 50 | 865.251 | 641.237 | 1707.76 | 1108.17 | 32.9796 |
| 51 | 873.534 | 660.916 | 0 | 0 | 0 |

**Query 1 (spencer) - Safety Factor**: 1.35745

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 205.51 | 515105 | 0 | 0 |
| 2 | 409.474 | 208.994 | 280913 | 182285 | 32.9796 |
| 3 | 418.948 | 212.614 | 267150 | 173354 | 32.9796 |
| 4 | 428.422 | 216.371 | 251865 | 163436 | 32.9797 |
| 5 | 437.896 | 220.268 | 235259 | 152660 | 32.9796 |
| 6 | 447.371 | 224.307 | 442441 | 287101 | 32.9796 |
| 7 | 456.845 | 228.49 | 432929 | 280928 | 32.9796 |
| 8 | 466.319 | 232.82 | 422094 | 273897 | 32.9796 |
| 9 | 475.793 | 237.299 | 410170 | 266160 | 32.9796 |
| 10 | 485.267 | 241.931 | 497490 | 322822 | 32.9796 |
| 11 | 494.741 | 246.717 | 490753 | 318451 | 32.9797 |
| 12 | 504.215 | 251.662 | 483076 | 313469 | 32.9796 |
| 13 | 513.689 | 256.768 | 474729 | 308052 | 32.9796 |
| 14 | 523.164 | 262.04 | 474998 | 308227 | 32.9796 |
| 15 | 532.638 | 267.48 | 471806 | 306156 | 32.9796 |
| 16 | 542.112 | 273.093 | 467334 | 303254 | 32.9796 |
| 17 | 551.586 | 278.883 | 461901 | 299729 | 32.9797 |
| 18 | 561.06 | 284.854 | 456334 | 296116 | 32.9796 |
| 19 | 570.534 | 291.012 | 453537 | 294301 | 32.9796 |
| 20 | 580.008 | 297.361 | 449901 | 291941 | 32.9796 |
| 21 | 589.482 | 303.908 | 445795 | 289277 | 32.9796 |
| 22 | 598.957 | 310.657 | 441601 | 286556 | 32.9796 |
| 23 | 608.431 | 317.616 | 437773 | 284072 | 32.9796 |
| 24 | 617.905 | 324.792 | 433814 | 281503 | 32.9796 |
| 25 | 627.379 | 332.19 | 430150 | 279125 | 32.9796 |
| 26 | 636.853 | 339.821 | 427233 | 277232 | 32.9796 |
| 27 | 646.327 | 347.691 | 423320 | 274693 | 32.9796 |
| 28 | 655.801 | 355.811 | 419185 | 272010 | 32.9796 |
| 29 | 665.381 | 364.285 | 414875 | 269213 | 32.9796 |
| 30 | 674.96 | 373.036 | 409361 | 265635 | 32.9796 |
| 31 | 684.539 | 382.077 | 399883 | 259485 | 32.9796 |
| 32 | 694.119 | 391.42 | 385686 | 250272 | 32.9796 |
| 33 | 703.698 | 401.082 | 370774 | 240596 | 32.9796 |
| 34 | 713.277 | 411.078 | 355631 | 230770 | 32.9797 |
| 35 | 722.857 | 421.428 | 337750 | 219167 | 32.9797 |
| 36 | 732.436 | 432.151 | 312726 | 202928 | 32.9796 |
| 37 | 742.015 | 443.272 | 288224 | 187029 | 32.9796 |
| 38 | 751.595 | 454.816 | 264843 | 171857 | 32.9796 |
| 39 | 761.174 | 466.812 | 241555 | 156745 | 32.9795 |
| 40 | 770.753 | 479.295 | 207879 | 134893 | 32.9796 |
| 41 | 780.333 | 492.303 | 176481 | 114519 | 32.9796 |
| 42 | 789.912 | 505.88 | 148155 | 96138.2 | 32.9797 |
| 43 | 799.491 | 520.079 | 123772 | 80316 | 32.9797 |
| 44 | 809.071 | 534.962 | 94257.3 | 61163.7 | 32.9796 |
| 45 | 818.65 | 550.602 | 67683.2 | 43919.8 | 32.9796 |
| 46 | 828.229 | 567.089 | 45552.5 | 29559.1 | 32.9796 |
| 47 | 837.809 | 584.534 | 29018.6 | 18830.2 | 32.9796 |
| 48 | 847.388 | 603.075 | 19451.2 | 12621.9 | 32.9796 |
| 49 | 856.968 | 622.892 | 18508.7 | 12010.3 | 32.9795 |
| 50 | 865.251 | 641.237 | 1707.76 | 1108.17 | 32.9796 |
| 51 | 873.534 | 660.916 | 0 | 0 | 0 |

## *Entity Information*

### Water Table

| X | Y |
|---|---|
| 0 | 334 |
| 520 | 334 |
| 1200 | 443.215 |

### Focus Search Line

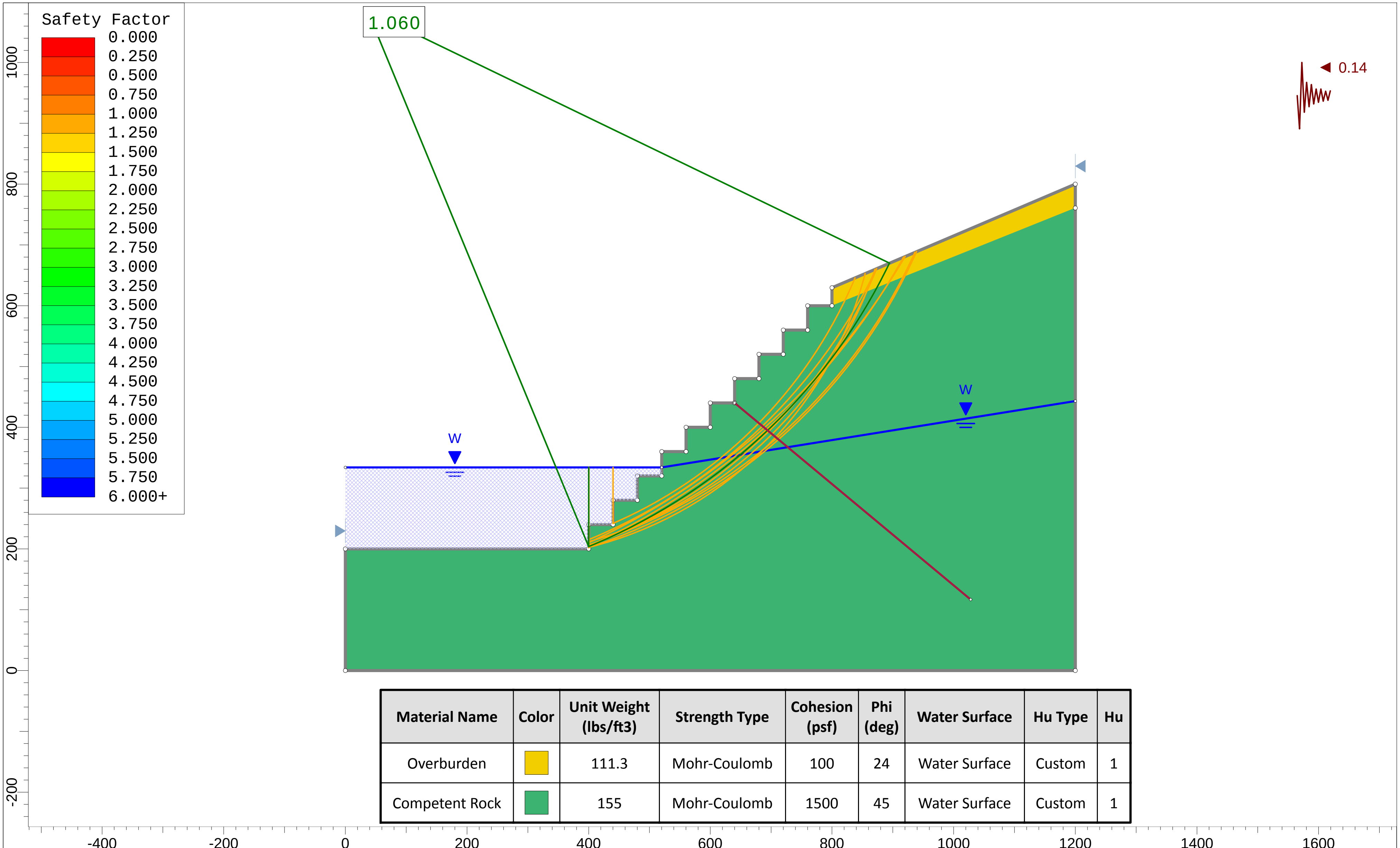
| X | Y |
|---|---|
| 640 | 440 |
| 1028.05 | 116.815 |

### External Boundary

| X | Y |
|---|---|
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

### Material Boundary

| X | Y |
|---|---|
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 1500 | 45 | Water Surface | Custom | 1 |

**BAJADA Geosciences, Inc.**

SLIDEINTERPRET 8.023

*Project* Crystal Creek Aggregate Quarry Expansion

*Analysis Description* Gross Stability, Pseudostatic, Backcalculate Minimum Shar Strength

*Drawn By* J.Bianchin | *Scale* 1:2619 | *Company* Bajada Geosciences, Inc.

*Date* 5/17/2019, 9:14:14 AM | *File Name* A-A'BCPS.slim

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:00.765s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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): 0.14

## Materials

| Property | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 1500 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## Global Minimums

### Method: spencer

| FS | 1.059520 |
|---|---|
| Center: | 36.341, 1085.181 |
| Radius: | 953.585 |
| Left Slip Surface Endpoint: | 400.000, 203.662 |
| Right Slip Surface Endpoint: | 894.783, 669.968 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 894.783 669.968 |
| Resisting Moment: | 4.55263e+09 lb-ft |
| Driving Moment: | 4.29688e+09 lb-ft |
| Resisting Horizontal Force: | 3.56619e+06 lb |
| Driving Horizontal Force: | 3.36585e+06 lb |
| Total Slice Area: | 48515.4 ft2 |
| Surface Horizontal Width: | 494.783 ft |
| Surface Average Height: | 98.054 ft |

## Valid/Invalid Surfaces

### Method: spencer

Number of Valid Surfaces: 679
Number of Invalid Surfaces: 4321

**Error Codes:**

Error Code -103 reported for 1118 surfaces
Error Code -108 reported for 7 surfaces
Error Code -111 reported for 534 surfaces
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

**Error Codes**

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.05952

| 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 | 9.97605 | 111472 | 22.7429 | Competent Rock | 1500 | 45 | 28323.5 | 30009.3 | 36511.9 | 8002.62 | 28509.3 | 48384.8 | 40382.2 |
| 2 | 9.97605 | 104902 | 23.3945 | Competent Rock | 1500 | 45 | 1026.56 | 1087.66 | 7325.15 | 7737.49 | -412.342 | 7769.26 | 31.7707 |
| 3 | 9.97605 | 98122.9 | 24.0492 | Competent Rock | 1500 | 45 | 712.82 | 755.247 | 6719.18 | 7463.93 | -744.753 | 7037.28 | -426.652 |
| 4 | 9.97605 | 91132.2 | 24.7073 | Competent Rock | 1500 | 45 | 416.84 | 441.65 | 6123.48 | 7181.83 | -1058.35 | 6315.27 | -866.562 |
| 5 | 9.97605 | 120523 | 25.3689 | Competent Rock | 1500 | 45 | 20451.5 | 21668.8 | 27059.9 | 6891.03 | 20168.9 | 36757.4 | 29866.4 |
| 6 | 9.97605 | 113453 | 26.0341 | Competent Rock | 1500 | 45 | 2539.07 | 2690.2 | 7781.61 | 6591.41 | 1190.2 | 9021.87 | 2430.46 |
| 7 | 9.97605 | 105806 | 26.7032 | Competent Rock | 1500 | 45 | 2220.45 | 2352.61 | 7135.42 | 6282.8 | 852.615 | 8252.34 | 1969.54 |
| 8 | 9.97605 | 97931.9 | 27.3762 | Competent Rock | 1500 | 45 | 1919.88 | 2034.16 | 6499.22 | 5965.06 | 534.161 | 7493.38 | 1528.32 |
| 9 | 9.97605 | 126069 | 28.0533 | Competent Rock | 1500 | 45 | 11326 | 12000.1 | 16138.1 | 5638.02 | 10500.1 | 22173.8 | 16535.7 |
| 10 | 9.97605 | 118440 | 28.7347 | Competent Rock | 1500 | 45 | 3759.19 | 3982.94 | 7784.44 | 5301.5 | 2482.94 | 9845.5 | 4544 |
| 11 | 9.97605 | 109862 | 29.4205 | Competent Rock | 1500 | 45 | 3446.46 | 3651.59 | 7106.92 | 4955.32 | 2151.6 | 9050.52 | 4095.2 |
| 12 | 9.97605 | 101039 | 30.1111 | Competent Rock | 1500 | 45 | 3151.77 | 3339.36 | 6438.65 | 4599.29 | 1839.36 | 8266.48 | 3667.19 |
| 13 | 9.97605 | 143573 | 30.8065 | Competent Rock | 1500 | 45 | 6654.2 | 7050.26 | 9830.57 | 4280.3 | 5550.27 | 13798.3 | 9517.99 |
| 14 | 9.97605 | 135777 | 31.5069 | Competent Rock | 1500 | 45 | 5810.06 | 6155.87 | 8659.73 | 4003.9 | 4655.83 | 12221.1 | 8217.2 |
| 15 | 9.97605 | 126189 | 32.2127 | Competent Rock | 1500 | 45 | 5362.28 | 5681.44 | 7898.43 | 3716.99 | 4181.44 | 11276.9 | 7559.9 |
| 16 | 9.97605 | 116335 | 32.924 | Competent Rock | 1500 | 45 | 4936.91 | 5230.76 | 7150.09 | 3419.33 | 3730.76 | 10346.9 | 6927.53 |
| 17 | 9.97605 | 165685 | 33.641 | Competent Rock | 1500 | 45 | 8120.43 | 8603.76 | 10214.4 | 3110.65 | 7103.75 | 15618 | 12507.3 |
| 18 | 9.97605 | 157654 | 34.3641 | Competent Rock | 1500 | 45 | 7785.41 | 8248.8 | 9539.49 | 2790.68 | 6748.81 | 14863.1 | 12072.4 |
| 19 | 9.97605 | 146960 | 35.0935 | Competent Rock | 1500 | 45 | 7330.47 | 7766.78 | 8725.89 | 2459.13 | 6266.76 | 13876.6 | 11417.5 |
| 20 | 9.97605 | 135972 | 35.8294 | Competent | 1500 | 45 | 6898.37 | 7308.96 | 7924.64 | 2115.68 | 5808.96 | 12905.3 | 10789.6 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rock | | | | | | | | | |
| 21 | 9.97605 | 183563 | 36.5723 | Competent Rock | 1500 | 45 | 9687.45 | 10264 | 10524 | 1760.02 | 8764.03 | 17711.3 | 15951.3 |
| 22 | 9.97605 | 174930 | 37.3223 | Competent Rock | 1500 | 45 | 9373.94 | 9931.88 | 9823.63 | 1391.77 | 8431.86 | 16970.4 | 15578.7 |
| 23 | 9.97605 | 163006 | 38.0799 | Competent Rock | 1500 | 45 | 8922.67 | 9453.75 | 8964.29 | 1010.57 | 7953.72 | 15955.5 | 14944.9 |
| 24 | 9.97605 | 150751 | 38.8455 | Competent Rock | 1500 | 45 | 8494.57 | 9000.17 | 8116.18 | 616.015 | 7500.16 | 14957.1 | 14341.1 |
| 25 | 9.97605 | 196443 | 39.6194 | Competent Rock | 1500 | 45 | 10938.3 | 11589.4 | 10297 | 207.666 | 10089.4 | 19352.3 | 19144.6 |
| 26 | 9.77251 | 183373 | 40.394 | Competent Rock | 1500 | 45 | 10439.9 | 11061.2 | 9561.2 | 0 | 9561.2 | 18444.3 | 18444.3 |
| 27 | 9.77251 | 170603 | 41.1695 | Competent Rock | 1500 | 45 | 9581.88 | 10152.2 | 8652.19 | 0 | 8652.19 | 17031.5 | 17031.5 |
| 28 | 9.77251 | 157477 | 41.9543 | Competent Rock | 1500 | 45 | 8743.76 | 9264.19 | 7764.16 | 0 | 7764.16 | 15624.4 | 15624.4 |
| 29 | 9.77251 | 196628 | 42.7489 | Competent Rock | 1500 | 45 | 10286.2 | 10898.5 | 9398.44 | 0 | 9398.44 | 18906.6 | 18906.6 |
| 30 | 9.77251 | 190693 | 43.5538 | Competent Rock | 1500 | 45 | 9769.84 | 10351.3 | 8851.35 | 0 | 8851.35 | 18140 | 18140 |
| 31 | 9.77251 | 176416 | 44.3696 | Competent Rock | 1500 | 45 | 8917.19 | 9447.94 | 7947.94 | 0 | 7947.94 | 16671 | 16671 |
| 32 | 9.77251 | 161723 | 45.1969 | Competent Rock | 1500 | 45 | 8084.24 | 8565.41 | 7065.41 | 0 | 7065.41 | 15205.4 | 15205.4 |
| 33 | 9.77251 | 193601 | 46.0365 | Competent Rock | 1500 | 45 | 9156.51 | 9701.51 | 8201.53 | 0 | 8201.53 | 17695.5 | 17695.5 |
| 34 | 9.77251 | 191605 | 46.889 | Competent Rock | 1500 | 45 | 8837.95 | 9363.99 | 7863.95 | 0 | 7863.95 | 17304.8 | 17304.8 |
| 35 | 9.77251 | 175549 | 47.7553 | Competent Rock | 1500 | 45 | 7994.39 | 8470.22 | 6970.23 | 0 | 6970.23 | 15773 | 15773 |
| 36 | 9.77251 | 158994 | 48.6363 | Competent Rock | 1500 | 45 | 7170.75 | 7597.55 | 6097.55 | 0 | 6097.55 | 14241.5 | 14241.5 |
| 37 | 9.77251 | 183275 | 49.5329 | Competent Rock | 1500 | 45 | 7839.55 | 8306.16 | 6806.16 | 0 | 6806.16 | 15995.8 | 15995.8 |
| 38 | 9.77251 | 184864 | 50.4463 | Competent Rock | 1500 | 45 | 7673.22 | 8129.93 | 6629.96 | 0 | 6629.96 | 15920.6 | 15920.6 |
| 39 | 9.77251 | 166638 | 51.3777 | Competent Rock | 1500 | 45 | 6842.95 | 7250.24 | 5750.24 | 0 | 5750.24 | 14315.4 | 14315.4 |
| 40 | 9.77251 | 147788 | 52.3285 | Competent Rock | 1500 | 45 | 6033.38 | 6392.49 | 4892.48 | 0 | 4892.48 | 12706.8 | 12706.8 |
| 41 | 9.77251 | 148324 | 53.3001 | Competent Rock | 1500 | 45 | 5870.55 | 6219.97 | 4719.97 | 0 | 4719.97 | 12596 | 12596 |
| 42 | 9.77251 | 146987 | 54.2945 | Competent Rock | 1500 | 45 | 5650.44 | 5986.75 | 4486.76 | 0 | 4486.76 | 12348.6 | 12348.6 |
| 43 | 9.77251 | 132201 | 55.3134 | Competent Rock | 1500 | 45 | 5042.75 | 5342.89 | 3842.89 | 0 | 3842.89 | 11129.2 | 11129.2 |
| 44 | 9.77251 | 116589 | 56.3593 | Competent Rock | 1500 | 45 | 4443.92 | 4708.42 | 3208.42 | 0 | 3208.42 | 9886.76 | 9886.76 |
| 45 | 9.77251 | 100083 | 57.4347 | Competent Rock | 1500 | 45 | 3854.59 | 4084.01 | 2584.02 | 0 | 2584.02 | 8619.31 | 8619.31 |
| 46 | 9.77251 | 82601.4 | 58.5427 | Competent Rock | 1500 | 45 | 3275.48 | 3470.44 | 1970.44 | 0 | 1970.44 | 7324.5 | 7324.5 |
| 47 | 9.77251 | 64049.2 | 59.687 | Competent Rock | 1500 | 45 | 2707.45 | 2868.6 | 1368.6 | 0 | 1368.6 | 5999.45 | 5999.45 |
| 48 | 9.77251 | 44313 | 60.8719 | Competent Rock | 1500 | 45 | 2151.49 | 2279.54 | 779.544 | 0 | 779.544 | 4640.54 | 4640.54 |
| 49 | 10.3068 | 27335 | 62.1376 | Overburden | 100 | 24 | 494.253 | 523.671 | 951.579 | 0 | 951.579 | 1886.54 | 1886.54 |
| 50 | 10.3068 | 9335.31 | 63.494 | Overburden | 100 | 24 | 171.14 | 181.326 | 182.661 | 0 | 182.661 | 525.824 | 525.824 |

## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.05952

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 203.662 | 530027 | 0 | 0 |
| 2 | 409.976 | 207.844 | 376330 | 375041 | 44.9017 |
| 3 | 419.952 | 212.16 | 348445 | 347252 | 44.9017 |
| 4 | 429.928 | 216.611 | 320087 | 318990 | 44.9016 |
| 5 | 439.904 | 221.201 | 291565 | 290566 | 44.9017 |
| 6 | 449.88 | 225.932 | 539820 | 537971 | 44.9017 |
| 7 | 459.856 | 230.805 | 516011 | 514243 | 44.9017 |
| 8 | 469.832 | 235.823 | 492213 | 490526 | 44.9016 |
| 9 | 479.808 | 240.989 | 468756 | 467150 | 44.9017 |
| 10 | 489.784 | 246.305 | 564264 | 562330 | 44.9016 |
| 11 | 499.761 | 251.775 | 543764 | 541901 | 44.9017 |
| 12 | 509.737 | 257.401 | 523946 | 522151 | 44.9017 |
| 13 | 519.713 | 263.186 | 505160 | 503429 | 44.9017 |
| 14 | 529.689 | 269.134 | 499006 | 497296 | 44.9017 |
| 15 | 539.665 | 275.249 | 484908 | 483247 | 44.9017 |
| 16 | 549.641 | 281.535 | 471003 | 469389 | 44.9017 |
| 17 | 559.617 | 287.995 | 457697 | 456129 | 44.9017 |
| 18 | 569.593 | 294.633 | 447570 | 446036 | 44.9016 |
| 19 | 579.569 | 301.454 | 437963 | 436462 | 44.9016 |
| 20 | 589.545 | 308.464 | 429231 | 427761 | 44.9017 |
| 21 | 599.521 | 315.667 | 421820 | 420375 | 44.9017 |
| 22 | 609.497 | 323.068 | 414711 | 413290 | 44.9017 |
| 23 | 619.473 | 330.674 | 408863 | 407463 | 44.9017 |
| 24 | 629.449 | 338.491 | 404838 | 403451 | 44.9017 |
| 25 | 639.425 | 346.525 | 403129 | 401747 | 44.9016 |
| 26 | 649.401 | 354.783 | 399528 | 398159 | 44.9017 |
| 27 | 659.174 | 363.099 | 396206 | 394848 | 44.9016 |
| 28 | 668.946 | 371.645 | 391863 | 390521 | 44.9017 |
| 29 | 678.719 | 380.43 | 386914 | 385589 | 44.9017 |
| 30 | 688.491 | 389.463 | 374843 | 373559 | 44.9017 |
| 31 | 698.264 | 398.754 | 361224 | 359986 | 44.9016 |
| 32 | 708.036 | 408.314 | 347544 | 346353 | 44.9017 |
| 33 | 717.809 | 418.154 | 334252 | 333107 | 44.9017 |
| 34 | 727.581 | 428.286 | 313379 | 312305 | 44.9017 |
| 35 | 737.354 | 438.726 | 290686 | 289690 | 44.9017 |
| 36 | 747.126 | 449.486 | 269101 | 268179 | 44.9017 |
| 37 | 756.899 | 460.585 | 249126 | 248272 | 44.9016 |
| 38 | 766.671 | 472.041 | 221985 | 221224 | 44.9016 |
| 39 | 776.444 | 483.873 | 192518 | 191858 | 44.9016 |
| 40 | 786.217 | 496.105 | 165613 | 165046 | 44.9018 |
| 41 | 795.989 | 508.762 | 141862 | 141376 | 44.9017 |
| 42 | 805.762 | 521.873 | 116488 | 116089 | 44.9017 |
| 43 | 815.534 | 535.47 | 90030.3 | 89721.8 | 44.9017 |
| 44 | 825.307 | 549.591 | 66457.7 | 66230 | 44.9017 |
| 45 | 835.079 | 564.277 | 46372.1 | 46213.2 | 44.9017 |
| 46 | 844.852 | 579.578 | 30428.3 | 30324.1 | 44.9017 |
| 47 | 854.624 | 595.552 | 19344.9 | 19278.6 | 44.9016 |
| 48 | 864.397 | 612.267 | 13916.6 | 13868.9 | 44.9016 |
| 49 | 874.169 | 629.804 | 15032.1 | 14980.6 | 44.9017 |
| 50 | 884.476 | 649.302 | -2262.09 | -2254.34 | 44.9017 |
| 51 | 894.783 | 669.968 | 0 | 0 | 0 |

## *Entity Information*

### Water Table

| X | Y |
|---|---|
| 0 | 334 |
| 520 | 334 |
| 1200 | 443.215 |

## Focus Search Line

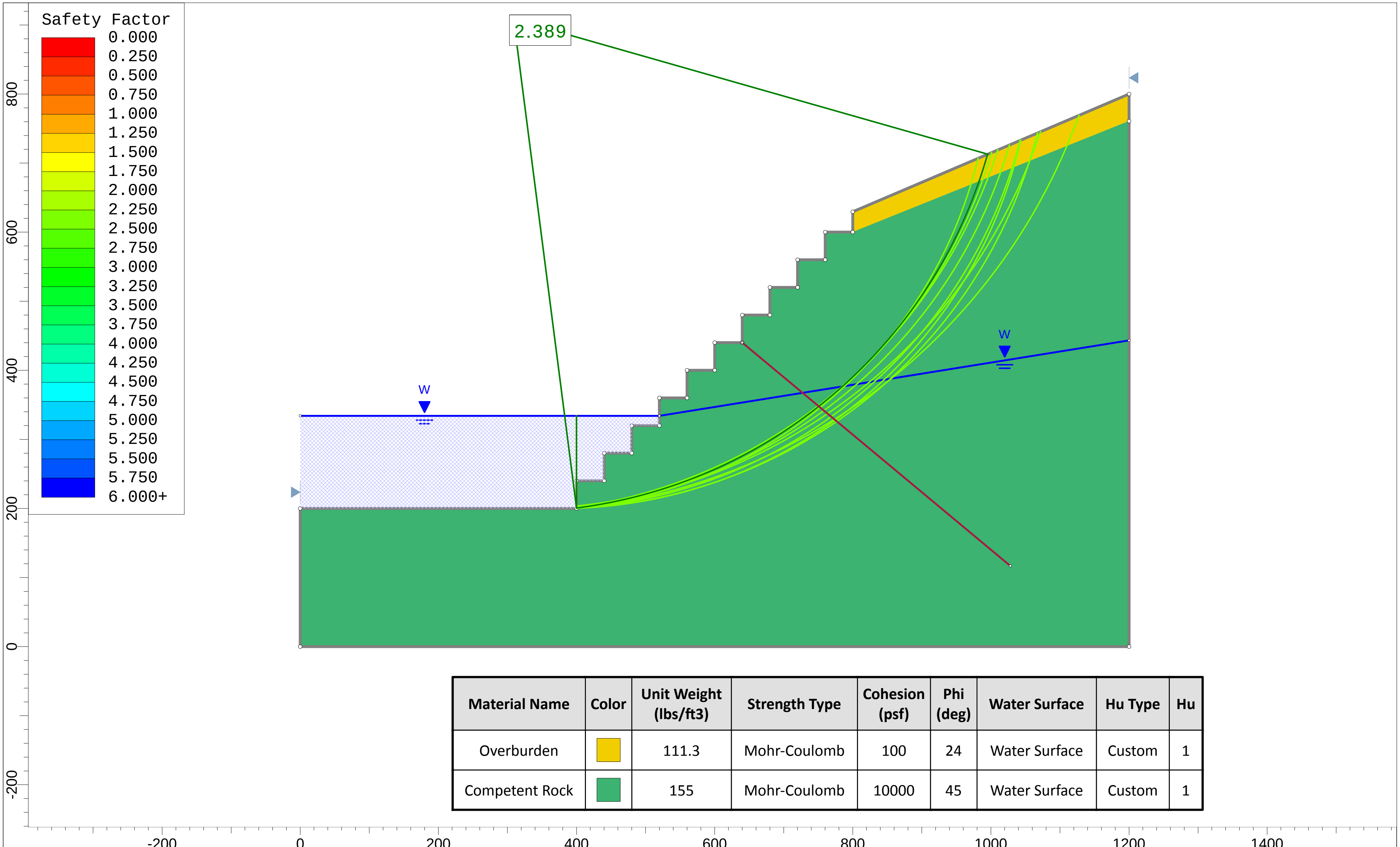
| X | Y |
|---|---|
| 640 | 440 |
| 1028.05 | 116.815 |

## External Boundary

| X | Y |
|---|---|
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

## Material Boundary

| X | Y |
|---|---|
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 10000 | 45 | Water Surface | Custom | 1 |

**BAJADA Geosciences, Inc.**

SLIDEINTERPRET 8.023

| | |
|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion |
| *Analysis Description* | Gross Stability, Static, Low Piezometric Surface |
| *Drawn By* | J.Bianchin |
| *Scale* | 1:2306 |
| *Company* | Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 9:14:14 AM |
| *File Name* | A-A'StaticLowH20.slim |

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:01.64s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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 | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 10000 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## *Global Minimums*

### Method: spencer

| FS | 2.389330 |
|---|---|
| Center: | 308.862, 908.387 |
| Radius: | 713.929 |
| Left Slip Surface Endpoint: | 400.000, 200.298 |
| Right Slip Surface Endpoint: | 995.499, 712.877 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 995.499 712.877 |
| Resisting Moment: | 1.26482e+10 lb-ft |
| Driving Moment: | 5.29361e+09 lb-ft |
| Resisting Horizontal Force: | 1.36306e+07 lb |
| Driving Horizontal Force: | 5.70478e+06 lb |
| Total Slice Area: | 96575.8 ft2 |
| Surface Horizontal Width: | 595.499 ft |
| Surface Average Height: | 162.176 ft |

## *Valid/Invalid Surfaces*

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 734 |
| Number of Invalid Surfaces: | 4266 |

#### Error Codes:

Error Code -103 reported for 1118 surfaces

Error Code -108 reported for 6 surfaces
Error Code -111 reported for 450 surfaces
Error Code -112 reported for 30 surfaces
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

### Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 2.38933

| 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 | 12.0373 | 143138 | 7.82178 | Competent Rock | 10000 | 45 | 11341.4 | 27098.4 | 25389.8 | 8291.39 | 17098.4 | 26947.8 | 18656.4 |
| 2 | 12.0373 | 139857 | 8.79812 | Competent Rock | 10000 | 45 | 6065.02 | 14491.3 | 12673 | 8181.67 | 4491.37 | 13611.8 | 5430.08 |
| 3 | 12.0373 | 136184 | 9.77704 | Competent Rock | 10000 | 45 | 5896.7 | 14089.2 | 12148 | 8058.83 | 4089.19 | 13164.1 | 5105.3 |
| 4 | 12.0373 | 162299 | 10.7589 | Competent Rock | 10000 | 45 | 10011.8 | 23921.6 | 21844.4 | 7922.75 | 13921.6 | 23746.8 | 15824 |
| 5 | 12.0373 | 172233 | 11.7439 | Competent Rock | 10000 | 45 | 7127.81 | 17030.7 | 14804 | 7773.31 | 7030.73 | 16285.8 | 8512.52 |
| 6 | 12.0373 | 167361 | 12.7324 | Competent Rock | 10000 | 45 | 6926.79 | 16550.4 | 14160.8 | 7610.38 | 6550.38 | 15725.9 | 8115.53 |
| 7 | 12.0373 | 177863 | 13.7249 | Competent Rock | 10000 | 45 | 8670.84 | 20717.5 | 18151.2 | 7433.79 | 10717.4 | 20268.9 | 12835.1 |
| 8 | 12.0373 | 200974 | 14.7215 | Competent Rock | 10000 | 45 | 8020.7 | 19164.1 | 16407.5 | 7243.39 | 9164.12 | 18514.9 | 11271.5 |
| 9 | 12.0373 | 194863 | 15.7227 | Competent Rock | 10000 | 45 | 7791.66 | 18616.8 | 15655.8 | 7038.98 | 8616.81 | 17849.3 | 10810.3 |
| 10 | 12.0373 | 190311 | 16.7289 | Competent Rock | 10000 | 45 | 7723.6 | 18454.2 | 15274.6 | 6820.38 | 8454.23 | 17596.1 | 10775.7 |
| 11 | 12.0373 | 245474 | 17.7404 | Competent Rock | 10000 | 45 | 9358.02 | 22359.4 | 19010.8 | 6651.4 | 12359.4 | 22004.6 | 15353.2 |
| 12 | 12.0373 | 238068 | 18.7577 | Competent Rock | 10000 | 45 | 9041.53 | 21603.2 | 18127.5 | 6524.35 | 11603.1 | 21198 | 14673.7 |
| 13 | 12.0373 | 230216 | 19.7811 | Competent Rock | 10000 | 45 | 8726.3 | 20850 | 17232.4 | 6382.37 | 10850 | 20370.8 | 13988.4 |
| 14 | 12.0373 | 274743 | 20.8112 | Competent Rock | 10000 | 45 | 10024.1 | 23950.9 | 20176.2 | 6225.19 | 13951 | 23986.2 | 17761 |
| 15 | 12.0373 | 287769 | 21.8483 | Competent Rock | 10000 | 45 | 10339.3 | 24704.1 | 20756.6 | 6052.51 | 14704.1 | 24902.2 | 18849.7 |
| 16 | 12.0373 | 278525 | 22.893 | Competent Rock | 10000 | 45 | 9991.67 | 23873.4 | 19737.4 | 5863.97 | 13873.4 | 23956.6 | 18092.6 |
| 17 | 12.0373 | 297523 | 23.9459 | Competent Rock | 10000 | 45 | 10479.8 | 25039.8 | 20699 | 5659.23 | 15039.8 | 25353.1 | 19693.8 |
| 18 | 12.0373 | 333202 | 25.0074 | Competent Rock | 10000 | 45 | 11432.5 | 27316 | 22753.9 | 5437.9 | 17316 | 28086.8 | 22648.9 |
| 19 | 12.0373 | 322468 | 26.0782 | Competent Rock | 10000 | 45 | 11055.6 | 26415.4 | 21614.9 | 5199.54 | 16415.4 | 27025.8 | 21826.2 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 12.0373 | 315831 | 27.1588 | Competent Rock | 10000 | 45 | 10808.7 | 25825.6 | 20769.3 | 4943.7 | 15825.6 | 26314.4 | 21370.7 |
| 21 | 12.0373 | 374047 | 28.25 | Competent Rock | 10000 | 45 | 12332.7 | 29466.9 | 24136.8 | 4669.87 | 19467 | 30763.5 | 26093.6 |
| 22 | 12.0373 | 361698 | 29.3526 | Competent Rock | 10000 | 45 | 11928.9 | 28502.1 | 22879.7 | 4377.5 | 18502.2 | 29588.2 | 25210.7 |
| 23 | 12.0373 | 348777 | 30.4671 | Competent Rock | 10000 | 45 | 11528.3 | 27544.9 | 21610.9 | 4066 | 17544.9 | 28392.7 | 24326.7 |
| 24 | 12.0373 | 390408 | 31.5946 | Competent Rock | 10000 | 45 | 12547.9 | 29981 | 23715.7 | 3734.71 | 19981 | 31433.6 | 27698.9 |
| 25 | 12.0373 | 395769 | 32.7359 | Competent Rock | 10000 | 45 | 12619.7 | 30152.7 | 23535.5 | 3382.91 | 20152.6 | 31648.4 | 28265.5 |
| 26 | 12.0373 | 381007 | 33.8921 | Competent Rock | 10000 | 45 | 12194.3 | 29136.3 | 22146.1 | 3009.81 | 19136.3 | 30337.9 | 27328.1 |
| 27 | 12.0373 | 396618 | 35.0641 | Competent Rock | 10000 | 45 | 12526.6 | 29930.2 | 22544.8 | 2614.56 | 19930.3 | 31336.9 | 28722.4 |
| 28 | 12.0373 | 424096 | 36.2532 | Competent Rock | 10000 | 45 | 13132.8 | 31378.6 | 23574.8 | 2196.2 | 21378.6 | 33205.3 | 31009.1 |
| 29 | 12.0373 | 407257 | 37.4607 | Competent Rock | 10000 | 45 | 12683.6 | 30305.4 | 22059 | 1753.66 | 20305.4 | 31777.7 | 30024.1 |
| 30 | 12.0373 | 396590 | 38.6881 | Competent Rock | 10000 | 45 | 12396.9 | 29620.4 | 20906.1 | 1285.77 | 19620.4 | 30833.7 | 29548 |
| 31 | 12.0373 | 445897 | 39.9369 | Competent Rock | 10000 | 45 | 13469.8 | 32183.9 | 22975.2 | 791.227 | 22184 | 34252.5 | 33461.2 |
| 32 | 12.0373 | 426661 | 41.2089 | Competent Rock | 10000 | 45 | 12997 | 31054.1 | 21322.7 | 268.553 | 21054.1 | 32704.2 | 32435.7 |
| 33 | 11.6398 | 393447 | 42.4843 | Competent Rock | 10000 | 45 | 12434.4 | 29709.8 | 19709.8 | 0 | 19709.8 | 31097.5 | 31097.5 |
| 34 | 11.6398 | 404005 | 43.7644 | Competent Rock | 10000 | 45 | 12435.6 | 29712.8 | 19712.8 | 0 | 19712.8 | 31623.3 | 31623.3 |
| 35 | 11.6398 | 402331 | 45.0726 | Competent Rock | 10000 | 45 | 12163.6 | 29062.9 | 19062.9 | 0 | 19062.9 | 31257.4 | 31257.4 |
| 36 | 11.6398 | 389578 | 46.4114 | Competent Rock | 10000 | 45 | 11659.7 | 27858.9 | 17858.8 | 0 | 17858.8 | 30107.6 | 30107.6 |
| 37 | 11.6398 | 375777 | 47.784 | Competent Rock | 10000 | 45 | 11142.9 | 26624.1 | 16624.1 | 0 | 16624.1 | 28906.1 | 28906.1 |
| 38 | 11.6398 | 360845 | 49.1939 | Competent Rock | 10000 | 45 | 10612.8 | 25357.4 | 15357.4 | 0 | 15357.4 | 27649.7 | 27649.7 |
| 39 | 11.6398 | 344684 | 50.6452 | Competent Rock | 10000 | 45 | 10068.7 | 24057.5 | 14057.5 | 0 | 14057.5 | 26335 | 26335 |
| 40 | 11.6398 | 327175 | 52.1429 | Competent Rock | 10000 | 45 | 9510.03 | 22722.6 | 12722.6 | 0 | 12722.6 | 24957.7 | 24957.7 |
| 41 | 11.6398 | 308179 | 53.6928 | Competent Rock | 10000 | 45 | 8935.94 | 21350.9 | 11350.9 | 0 | 11350.9 | 23512.5 | 23512.5 |
| 42 | 11.6398 | 287527 | 55.3022 | Competent Rock | 10000 | 45 | 8345.4 | 19939.9 | 9939.9 | 0 | 9939.9 | 21993.2 | 21993.2 |
| 43 | 11.6398 | 265009 | 56.9799 | Competent Rock | 10000 | 45 | 7737.09 | 18486.5 | 8486.44 | 0 | 8486.44 | 20391.4 | 20391.4 |
| 44 | 11.6398 | 240362 | 58.737 | Competent Rock | 10000 | 45 | 7109.35 | 16986.6 | 6986.58 | 0 | 6986.58 | 18696.4 | 18696.4 |
| 45 | 11.6398 | 213245 | 60.5882 | Competent Rock | 10000 | 45 | 6459.97 | 15435 | 5434.98 | 0 | 5434.98 | 16894.1 | 16894.1 |
| 46 | 11.6398 | 183208 | 62.5527 | Competent Rock | 10000 | 45 | 5785.91 | 13824.5 | 3824.45 | 0 | 3824.45 | 14964.1 | 14964.1 |
| 47 | 11.6398 | 149625 | 64.6574 | Competent Rock | 10000 | 45 | 5082.84 | 12144.6 | 2144.59 | 0 | 2144.59 | 12876.8 | 12876.8 |
| 48 | 11.6398 | 111592 | 66.9412 | Competent Rock | 10000 | 45 | 4344.2 | 10379.7 | 379.721 | 0 | 379.721 | 10584.9 | 10584.9 |
| 49 | 11.6398 | 67697.5 | 69.4655 | Competent Rock | 10000 | 45 | 3559.27 | 8504.28 | -1495.72 | 0 | -1495.72 | 8006.52 | 8006.52 |
| 50 | 12.4313 | 23531.9 | 72.4518 | Overburden | 100 | 24 | 206.518 | 493.44 | 883.683 | 0 | 883.683 | 1536.76 | 1536.76 |

## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 2.38933

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 200.298 | 557737 | 0 | 0 |
| 2 | 412.037 | 201.952 | 376491 | 183626 | 25.9999 |
| 3 | 424.075 | 203.815 | 425833 | 207691 | 25.9998 |
| 4 | 436.112 | 205.889 | 471564 | 229996 | 25.9999 |
| 5 | 448.149 | 208.176 | 726732 | 354449 | 25.9999 |
| 6 | 460.186 | 210.679 | 775424 | 378197 | 25.9998 |
| 7 | 472.224 | 213.399 | 820227 | 400049 | 25.9999 |
| 8 | 484.261 | 216.338 | 956026 | 466282 | 25.9999 |
| 9 | 496.298 | 219.501 | 1.00061e+06 | 488027 | 25.9999 |
| 10 | 508.335 | 222.89 | 1.04128e+06 | 507863 | 25.9999 |
| 11 | 520.373 | 226.508 | 1.08504e+06 | 529204 | 25.9998 |
| 12 | 532.41 | 230.359 | 1.12439e+06 | 548398 | 25.9998 |
| 13 | 544.447 | 234.447 | 1.15904e+06 | 565299 | 25.9999 |
| 14 | 556.484 | 238.776 | 1.1894e+06 | 580107 | 25.9999 |
| 15 | 568.522 | 243.351 | 1.21767e+06 | 593893 | 25.9998 |
| 16 | 580.559 | 248.177 | 1.24186e+06 | 605691 | 25.9998 |
| 17 | 592.596 | 253.26 | 1.26172e+06 | 615377 | 25.9998 |
| 18 | 604.633 | 258.606 | 1.27712e+06 | 622891 | 25.9999 |
| 19 | 616.671 | 264.221 | 1.28688e+06 | 627648 | 25.9998 |
| 20 | 628.708 | 270.112 | 1.29252e+06 | 630400 | 25.9999 |
| 21 | 640.745 | 276.288 | 1.29427e+06 | 631256 | 25.9999 |
| 22 | 652.782 | 282.756 | 1.28651e+06 | 627467 | 25.9998 |
| 23 | 664.82 | 289.525 | 1.27511e+06 | 621908 | 25.9998 |
| 24 | 676.857 | 296.606 | 1.26075e+06 | 614903 | 25.9998 |
| 25 | 688.894 | 304.01 | 1.23609e+06 | 602878 | 25.9999 |
| 26 | 700.931 | 311.749 | 1.20576e+06 | 588085 | 25.9999 |
| 27 | 712.969 | 319.835 | 1.17336e+06 | 572282 | 25.9998 |
| 28 | 725.006 | 328.284 | 1.13356e+06 | 552872 | 25.9999 |
| 29 | 737.043 | 337.111 | 1.08343e+06 | 528423 | 26 |
| 30 | 749.081 | 346.334 | 1.03254e+06 | 503600 | 25.9998 |
| 31 | 761.118 | 355.974 | 980131 | 478039 | 25.9999 |
| 32 | 773.155 | 366.052 | 910612 | 444132 | 25.9998 |
| 33 | 785.192 | 376.593 | 842182 | 410757 | 25.9999 |
| 34 | 796.832 | 387.253 | 776703 | 378821 | 25.9999 |
| 35 | 808.472 | 398.401 | 701583 | 342182 | 25.9998 |
| 36 | 820.112 | 410.07 | 620611 | 302690 | 25.9998 |
| 37 | 831.751 | 422.298 | 537853 | 262327 | 25.9999 |
| 38 | 843.391 | 435.128 | 454179 | 221516 | 25.9998 |
| 39 | 855.031 | 448.61 | 370573 | 180739 | 25.9998 |
| 40 | 866.671 | 462.803 | 288164 | 140546 | 25.9998 |
| 41 | 878.31 | 477.778 | 208256 | 101573 | 25.9999 |
| 42 | 889.95 | 493.619 | 132378 | 64564.7 | 25.9999 |
| 43 | 901.59 | 510.431 | 62343.1 | 30406.6 | 25.9999 |
| 44 | 913.23 | 528.341 | 344.296 | 167.923 | 25.9998 |
| 45 | 924.869 | 547.513 | -50910.9 | -24830.8 | 25.9999 |
| 46 | 936.509 | 568.16 | -87991 | -42915.8 | 25.9999 |
| 47 | 948.149 | 590.57 | -106400 | -51894.2 | 25.9998 |
| 48 | 959.789 | 615.147 | -99986.6 | -48766.4 | 25.9999 |
| 49 | 971.428 | 642.49 | -59840.7 | -29186.1 | 25.9999 |
| 50 | 983.068 | 673.565 | 28037.7 | 13674.8 | 25.9998 |
| 51 | 995.499 | 712.877 | 0 | 0 | 0 |

## *Entity Information*

### Water Table

| X | Y |
|---|---|
| 0 | 334 |
| 520 | 334 |
| 1200 | 443.215 |

## Focus Search Line

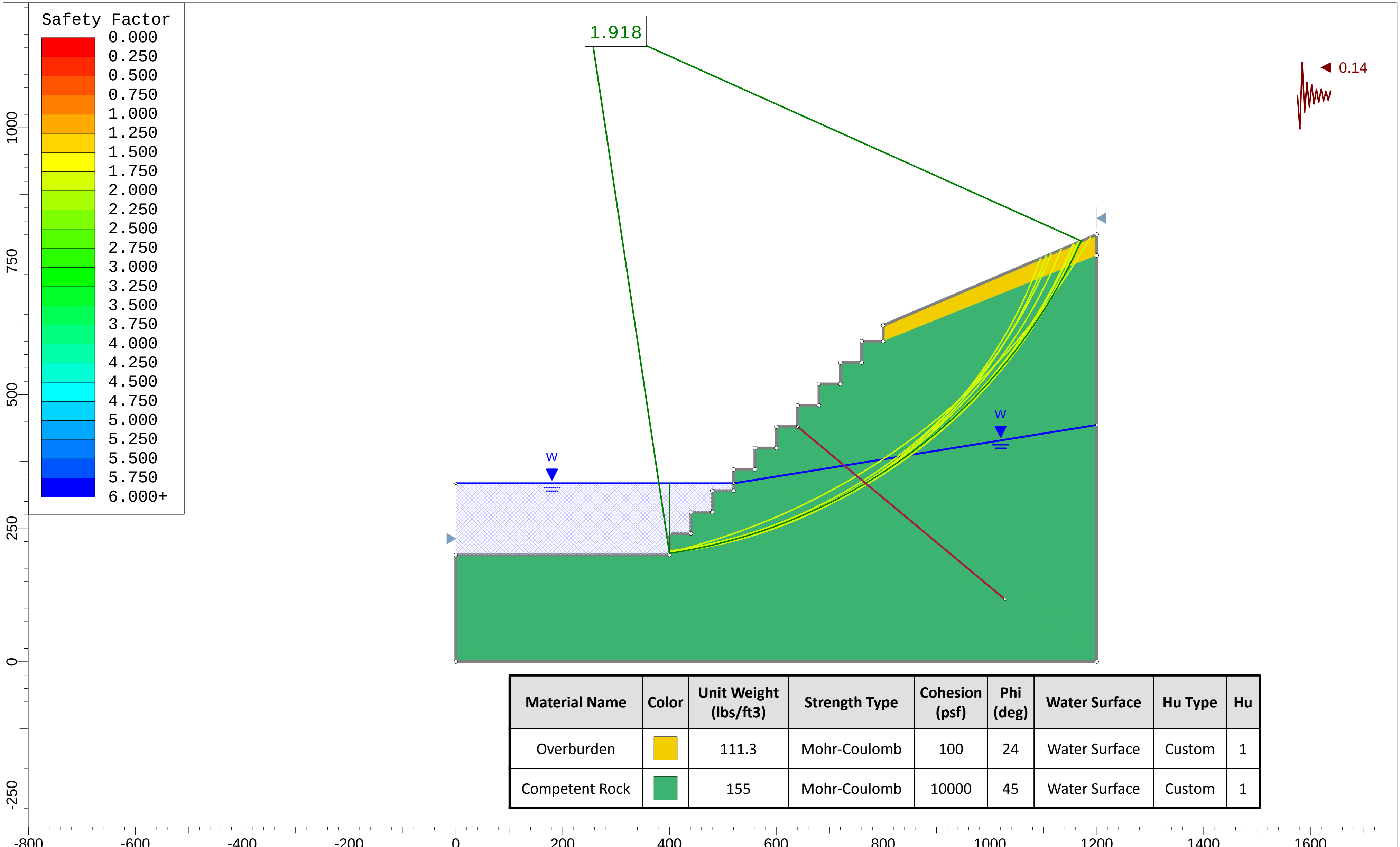
| X | Y |
|---|---|
| 640 | 440 |
| 1028.05 | 116.815 |

## External Boundary

| X | Y |
|---|---|
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

## Material Boundary

| X | Y |
|---|---|
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 10000 | 45 | Water Surface | Custom | 1 |

**BAJADA Geosciences, Inc.**

| | | | |
|---|---|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion | | |
| *Analysis Description* | Gross Stability, Pseudostatic, Low Piezometric Surface | | |
| *Drawn By* | J.Bianchin | *Scale* 1:2983 | *Company* Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 9:14:14 AM | | *File Name* A-A'LowH20PS.slim |

SLIDEINTERPRET 8.023

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:02.252s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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): 0.14

## Materials

| Property | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 10000 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## Global Minimums

### Method: spencer

| FS | 1.918000 |
|---|---|
| Center: | 249.636, 1201.423 |
| Radius: | 1010.057 |
| Left Slip Surface Endpoint: | 400.000, 202.621 |
| Right Slip Surface Endpoint: | 1171.062, 787.671 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 1171.062 787.671 |
| Resisting Moment: | 2.3476e+10 lb-ft |
| Driving Moment: | 1.22398e+10 lb-ft |
| Resisting Horizontal Force: | 1.88607e+07 lb |
| Driving Horizontal Force: | 9.83349e+06 lb |
| Total Slice Area: | 136299 ft2 |
| Surface Horizontal Width: | 771.062 ft |
| Surface Average Height: | 176.768 ft |

## Valid/Invalid Surfaces

### Method: spencer

Number of Valid Surfaces: 211
Number of Invalid Surfaces: 4789

**Error Codes:**

Error Code -103 reported for 1118 surfaces
Error Code -108 reported for 7 surfaces
Error Code -111 reported for 1001 surfaces
Error Code -112 reported for 1 surface
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

**Error Codes**

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.918

| 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 | 15.3881 | 176507 | 9.00314 | Competent Rock | 10000 | 45 | 20189.4 | 38723.2 | 36845.2 | 8121.98 | 28723.2 | 40044 | 31922 |
| 2 | 15.3881 | 170401 | 9.88806 | Competent Rock | 10000 | 45 | 8748.87 | 16780.3 | 14742.5 | 7962.22 | 6780.33 | 16267.6 | 8305.37 |
| 3 | 15.3881 | 186542 | 10.7754 | Competent Rock | 10000 | 45 | 16670.9 | 31974.7 | 29761.9 | 7787.16 | 21974.7 | 32934.6 | 25147.4 |
| 4 | 15.3881 | 213425 | 11.6653 | Competent Rock | 10000 | 45 | 9960.6 | 19104.4 | 16701.1 | 7596.66 | 9104.46 | 18757.6 | 11160.9 |
| 5 | 15.3881 | 205549 | 12.5581 | Competent Rock | 10000 | 45 | 9588.61 | 18391 | 15781.6 | 7390.59 | 8390.98 | 17917.5 | 10526.9 |
| 6 | 15.3881 | 242735 | 13.454 | Competent Rock | 10000 | 45 | 13872.1 | 26606.7 | 23775.5 | 7168.79 | 16606.7 | 27094.1 | 19925.3 |
| 7 | 15.3881 | 244982 | 14.3533 | Competent Rock | 10000 | 45 | 10592.4 | 20316.3 | 17247.4 | 6931.08 | 10316.4 | 19957.9 | 13026.8 |
| 8 | 15.3881 | 251816 | 15.2562 | Competent Rock | 10000 | 45 | 10953.8 | 21009.3 | 17686.6 | 6677.28 | 11009.3 | 20674.2 | 13996.9 |
| 9 | 15.3881 | 306919 | 16.163 | Competent Rock | 10000 | 45 | 12288.7 | 23569.7 | 20085.2 | 6515.4 | 13569.8 | 23646.8 | 17131.4 |
| 10 | 15.3881 | 295964 | 17.074 | Competent Rock | 10000 | 45 | 11746 | 22528.9 | 18912 | 6383.02 | 12528.9 | 22519.7 | 16136.7 |
| 11 | 15.3881 | 341834 | 17.9895 | Competent Rock | 10000 | 45 | 12950.2 | 24838.5 | 21072.3 | 6233.88 | 14838.4 | 25277.5 | 19043.6 |
| 12 | 15.3881 | 367529 | 18.9097 | Competent Rock | 10000 | 45 | 13506.4 | 25905.2 | 21972.9 | 6067.73 | 15905.2 | 26599.7 | 20532 |
| 13 | 15.3881 | 354901 | 19.835 | Competent Rock | 10000 | 45 | 12948.4 | 24835.1 | 20719.4 | 5884.3 | 14835.1 | 25390.1 | 19505.8 |
| 14 | 15.3881 | 436451 | 20.7658 | Competent Rock | 10000 | 45 | 15038.3 | 28843.4 | 24526.7 | 5683.29 | 18843.4 | 30228.9 | 24545.6 |
| 15 | 15.3881 | 422189 | 21.7023 | Competent Rock | 10000 | 45 | 14439.9 | 27695.8 | 23160.2 | 5464.39 | 17695.8 | 28907.2 | 23442.9 |
| 16 | 15.3881 | 445725 | 22.645 | Competent Rock | 10000 | 45 | 14873 | 28526.4 | 23753.7 | 5227.23 | 18526.5 | 29958.4 | 24731.2 |
| 17 | 15.3881 | 486964 | 23.5941 | Competent Rock | 10000 | 45 | 15743.1 | 30195.3 | 25166.8 | 4971.47 | 20195.3 | 32042.8 | 27071.4 |
| 18 | 15.3881 | 470566 | 24.5502 | Competent | 10000 | 45 | 15142 | 29042.3 | 23738.9 | 4696.69 | 19042.2 | 30655.6 | 25958.9 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rock | | | | | | | | | |
| 19 | 15.3881 | 530138 | 25.5137 | Competent Rock | 10000 | 45 | 16419.1 | 31491.9 | 25894.4 | 4402.46 | 21491.9 | 33730.7 | 29328.2 |
| 20 | 15.3881 | 530928 | 26.4849 | Competent Rock | 10000 | 45 | 16252.5 | 31172.3 | 25260.7 | 4088.33 | 21172.4 | 33358.5 | 29270.2 |
| 21 | 15.3881 | 531772 | 27.4644 | Competent Rock | 10000 | 45 | 16104.3 | 30888.1 | 24641.9 | 3753.79 | 20888.1 | 33012.6 | 29258.8 |
| 22 | 15.3881 | 588169 | 28.4527 | Competent Rock | 10000 | 45 | 17213 | 33014.5 | 26412.8 | 3398.29 | 23014.5 | 35740.3 | 32342 |
| 23 | 15.3881 | 567863 | 29.4504 | Competent Rock | 10000 | 45 | 16605.5 | 31849.3 | 24870.6 | 3021.27 | 21849.3 | 34246.5 | 31225.2 |
| 24 | 15.3881 | 604453 | 30.4579 | Competent Rock | 10000 | 45 | 17243.1 | 33072.3 | 25694.4 | 2622.08 | 23072.3 | 35834.3 | 33212.2 |
| 25 | 15.3881 | 620089 | 31.476 | Competent Rock | 10000 | 45 | 17425.5 | 33422.2 | 25622.2 | 2200.03 | 23422.2 | 36290.5 | 34090.5 |
| 26 | 15.3881 | 597455 | 32.5052 | Competent Rock | 10000 | 45 | 16840.7 | 32300.4 | 24054.8 | 1754.4 | 22300.4 | 34785.7 | 33031.3 |
| 27 | 15.3881 | 631756 | 33.5465 | Competent Rock | 10000 | 45 | 17409.4 | 33391.3 | 24675.6 | 1284.36 | 23391.3 | 36219 | 34934.6 |
| 28 | 15.3881 | 622315 | 34.6004 | Competent Rock | 10000 | 45 | 17127.4 | 32850.4 | 23639.4 | 789.033 | 22850.4 | 35455 | 34665.9 |
| 29 | 15.3881 | 611870 | 35.6678 | Competent Rock | 10000 | 45 | 16853 | 32324 | 22591.5 | 267.462 | 22324 | 34687.2 | 34419.7 |
| 30 | 15.0909 | 588904 | 36.7392 | Competent Rock | 10000 | 45 | 16434.5 | 31521.3 | 21521.4 | 0 | 21521.4 | 33788.7 | 33788.7 |
| 31 | 15.0909 | 576830 | 37.8151 | Competent Rock | 10000 | 45 | 15870.1 | 30438.8 | 20438.7 | 0 | 20438.7 | 32755.5 | 32755.5 |
| 32 | 15.0909 | 563685 | 38.9069 | Competent Rock | 10000 | 45 | 15305.5 | 29355.9 | 19355.9 | 0 | 19355.9 | 31709 | 31709 |
| 33 | 15.0909 | 549420 | 40.0159 | Competent Rock | 10000 | 45 | 14740.6 | 28272.5 | 18272.5 | 0 | 18272.5 | 30648.3 | 30648.3 |
| 34 | 15.0909 | 533980 | 41.1431 | Competent Rock | 10000 | 45 | 14175.1 | 27187.9 | 17187.9 | 0 | 17187.9 | 29572.4 | 29572.4 |
| 35 | 15.0909 | 517303 | 42.2901 | Competent Rock | 10000 | 45 | 13608.6 | 26101.2 | 16101.2 | 0 | 16101.2 | 28479.7 | 28479.7 |
| 36 | 15.0909 | 499323 | 43.4584 | Competent Rock | 10000 | 45 | 13040.4 | 25011.5 | 15011.5 | 0 | 15011.5 | 27368.4 | 27368.4 |
| 37 | 15.0909 | 479961 | 44.6497 | Competent Rock | 10000 | 45 | 12470 | 23917.4 | 13917.4 | 0 | 13917.4 | 26235.8 | 26235.8 |
| 38 | 15.0909 | 459133 | 45.866 | Competent Rock | 10000 | 45 | 11896.3 | 22817.1 | 12817.2 | 0 | 12817.2 | 25078.6 | 25078.6 |
| 39 | 15.0909 | 436740 | 47.1096 | Competent Rock | 10000 | 45 | 11318.4 | 21708.6 | 11708.6 | 0 | 11708.6 | 23892.6 | 23892.6 |
| 40 | 15.0909 | 412671 | 48.3829 | Competent Rock | 10000 | 45 | 10734.6 | 20588.9 | 10588.9 | 0 | 10588.9 | 22672.3 | 22672.3 |
| 41 | 15.0909 | 386798 | 49.689 | Competent Rock | 10000 | 45 | 10143.2 | 19454.6 | 9454.63 | 0 | 9454.63 | 21410.4 | 21410.4 |
| 42 | 15.0909 | 358973 | 51.0313 | Competent Rock | 10000 | 45 | 9541.91 | 18301.4 | 8301.38 | 0 | 8301.38 | 20097.8 | 20097.8 |
| 43 | 15.0909 | 329022 | 52.4136 | Competent Rock | 10000 | 45 | 8927.82 | 17123.6 | 7123.57 | 0 | 7123.57 | 18722.3 | 18722.3 |
| 44 | 15.0909 | 296739 | 53.8408 | Competent Rock | 10000 | 45 | 8297.19 | 15914 | 5914.02 | 0 | 5914.02 | 17267.6 | 17267.6 |
| 45 | 15.0909 | 261880 | 55.3184 | Competent Rock | 10000 | 45 | 7645.25 | 14663.6 | 4663.59 | 0 | 4663.59 | 15712.3 | 15712.3 |
| 46 | 15.0909 | 224145 | 56.8535 | Competent Rock | 10000 | 45 | 6965.77 | 13360.3 | 3360.34 | 0 | 3360.34 | 14026.9 | 14026.9 |
| 47 | 15.0909 | 183167 | 58.4544 | Competent Rock | 10000 | 45 | 6250.56 | 11988.6 | 1988.58 | 0 | 1988.58 | 12170.4 | 12170.4 |
| 48 | 15.0909 | 138482 | 60.132 | Competent Rock | 10000 | 45 | 5488.68 | 10527.3 | 527.286 | 0 | 527.286 | 10084.8 | 10084.8 |
| 49 | 15.0909 | 89491.4 | 61.9003 | Competent Rock | 10000 | 45 | 4665.17 | 8947.79 | -1052.21 | 0 | -1052.21 | 7684.99 | 7684.99 |
| 50 | 22.991 | 48626.8 | 64.3137 | Overburden | 100 | 24 | 649.239 | 1245.24 | 2572.25 | 0 | 2572.25 | 3922.1 | 3922.1 |

## Interslice Data

**Global Minimum Query (spencer) - Safety Factor**: 1.918

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 202.621 | 538527 | 0 | 0 |
| 2 | 415.388 | 205.059 | 471962 | 475788 | 45.2313 |
| 3 | 430.776 | 207.741 | 555978 | 560485 | 45.2313 |
| 4 | 446.164 | 210.67 | 894710 | 901963 | 45.2313 |
| 5 | 461.552 | 213.847 | 972478 | 980360 | 45.2313 |
| 6 | 476.94 | 217.275 | 1.04458e+06 | 1.05305e+06 | 45.2314 |
| 7 | 492.328 | 220.956 | 1.22459e+06 | 1.23452e+06 | 45.2314 |
| 8 | 507.716 | 224.894 | 1.28745e+06 | 1.29788e+06 | 45.2311 |
| 9 | 523.104 | 229.091 | 1.35432e+06 | 1.3653e+06 | 45.2313 |
| 10 | 538.493 | 233.551 | 1.41109e+06 | 1.42253e+06 | 45.2313 |
| 11 | 553.881 | 238.277 | 1.46122e+06 | 1.47307e+06 | 45.2314 |
| 12 | 569.269 | 243.274 | 1.50758e+06 | 1.5198e+06 | 45.2313 |
| 13 | 584.657 | 248.545 | 1.54836e+06 | 1.56092e+06 | 45.2314 |
| 14 | 600.045 | 254.096 | 1.58315e+06 | 1.59598e+06 | 45.2312 |
| 15 | 615.433 | 259.931 | 1.61061e+06 | 1.62366e+06 | 45.2312 |
| 16 | 630.821 | 266.055 | 1.63211e+06 | 1.64534e+06 | 45.2313 |
| 17 | 646.209 | 272.475 | 1.64635e+06 | 1.65969e+06 | 45.2312 |
| 18 | 661.597 | 279.196 | 1.65155e+06 | 1.66494e+06 | 45.2313 |
| 19 | 676.985 | 286.225 | 1.65208e+06 | 1.66547e+06 | 45.2313 |
| 20 | 692.373 | 293.569 | 1.64063e+06 | 1.65393e+06 | 45.2313 |
| 21 | 707.761 | 301.236 | 1.623e+06 | 1.63616e+06 | 45.2314 |
| 22 | 723.149 | 309.234 | 1.59955e+06 | 1.61252e+06 | 45.2314 |
| 23 | 738.537 | 317.573 | 1.56213e+06 | 1.5748e+06 | 45.2314 |
| 24 | 753.925 | 326.262 | 1.52236e+06 | 1.5347e+06 | 45.2313 |
| 25 | 769.313 | 335.311 | 1.47086e+06 | 1.48279e+06 | 45.2314 |
| 26 | 784.702 | 344.732 | 1.41111e+06 | 1.42255e+06 | 45.2313 |
| 27 | 800.09 | 354.537 | 1.35104e+06 | 1.36199e+06 | 45.2312 |
| 28 | 815.478 | 364.74 | 1.27903e+06 | 1.2894e+06 | 45.2313 |
| 29 | 830.866 | 375.356 | 1.20481e+06 | 1.21458e+06 | 45.2314 |
| 30 | 846.254 | 386.4 | 1.12927e+06 | 1.13842e+06 | 45.2312 |
| 31 | 861.345 | 397.664 | 1.05269e+06 | 1.06122e+06 | 45.2312 |
| 32 | 876.435 | 409.376 | 972314 | 980195 | 45.2313 |
| 33 | 891.526 | 421.556 | 888880 | 896085 | 45.2313 |
| 34 | 906.617 | 434.226 | 803151 | 809661 | 45.2313 |
| 35 | 921.708 | 447.411 | 715934 | 721737 | 45.2313 |
| 36 | 936.799 | 461.137 | 628089 | 633180 | 45.2313 |
| 37 | 951.89 | 475.437 | 540534 | 544916 | 45.2313 |
| 38 | 966.981 | 490.345 | 454262 | 457944 | 45.2313 |
| 39 | 982.071 | 505.899 | 370352 | 373354 | 45.2313 |
| 40 | 997.162 | 522.144 | 289997 | 292348 | 45.2313 |
| 41 | 1012.25 | 539.131 | 214526 | 216265 | 45.2313 |
| 42 | 1027.34 | 556.919 | 145440 | 146619 | 45.2313 |
| 43 | 1042.43 | 575.575 | 84467.7 | 85152.4 | 45.2313 |
| 44 | 1057.53 | 595.181 | 33624.2 | 33896.7 | 45.2312 |
| 45 | 1072.62 | 615.83 | -4689.94 | -4727.96 | 45.2313 |
| 46 | 1087.71 | 637.639 | -27557.6 | -27780.9 | 45.2312 |
| 47 | 1102.8 | 660.748 | -31351.6 | -31605.8 | 45.2313 |
| 48 | 1117.89 | 685.33 | -11445.8 | -11538.5 | 45.2311 |
| 49 | 1132.98 | 711.607 | 38233.2 | 38543.1 | 45.2313 |
| 50 | 1148.07 | 739.871 | 125924 | 126944 | 45.2311 |
| 51 | 1171.06 | 787.671 | 0 | 0 | 0 |

## Entity Information

## Water Table

| X | Y |
|---|---|
| 0 | 334 |
| 520 | 334 |
| 1200 | 443.215 |

## Focus Search Line

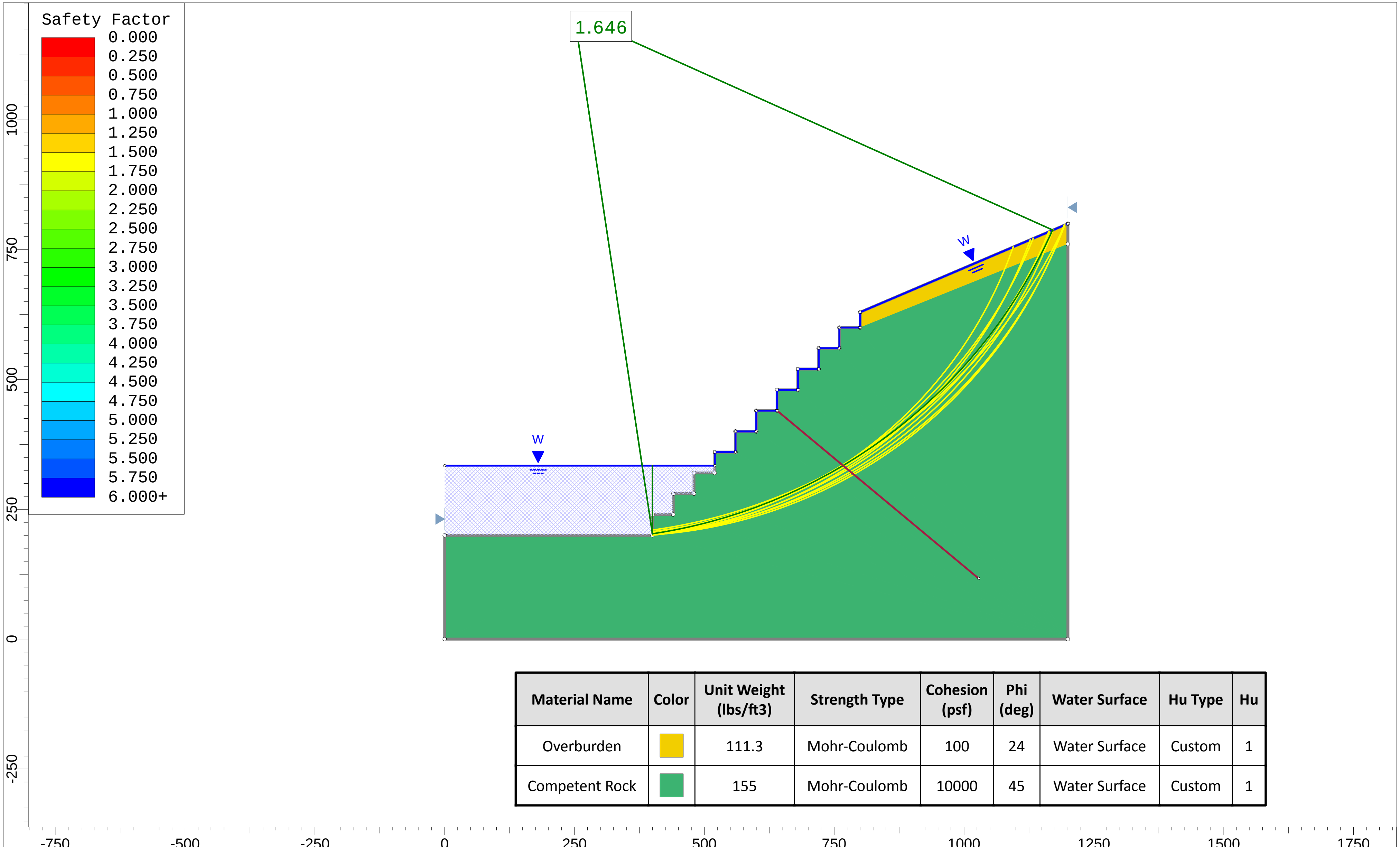
| X | Y |
|---|---|
| 640 | 440 |
| 1028.05 | 116.815 |

## External Boundary

| X | Y |
|---|---|
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

## Material Boundary

| X | Y |
|---|---|
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 10000 | 45 | Water Surface | Custom | 1 |

**BAJADA Geosciences, Inc.**

| | | | |
|---|---|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion | | |
| *Analysis Description* | Gross Stability, Static | | |
| *Drawn By* | J.Bianchin | *Scale* 1:3067 | *Company* Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 9:14:14 AM | | *File Name* A-A'StaticHighH20.slim |

SLIDEINTERPRET 8.023

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:01.421s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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 | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 10000 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## Global Minimums

### Method: spencer

| FS | 1.646190 |
|---|---|
| Center: | 249.636, 1201.423 |
| Radius: | 1010.057 |
| Left Slip Surface Endpoint: | 400.000, 202.621 |
| Right Slip Surface Endpoint: | 1171.062, 787.671 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 1171.062 787.671 |
| Resisting Moment: | 1.68796e+10 lb-ft |
| Driving Moment: | 1.02537e+10 lb-ft |
| Resisting Horizontal Force: | 1.38698e+07 lb |
| Driving Horizontal Force: | 8.4254e+06 lb |
| Total Slice Area: | 136298 ft2 |
| Surface Horizontal Width: | 771.062 ft |
| Surface Average Height: | 176.767 ft |

## Valid/Invalid Surfaces

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 555 |
| Number of Invalid Surfaces: | 4445 |

#### Error Codes:

Error Code -103 reported for 1118 surfaces

Error Code -108 reported for 6 surfaces
Error Code -111 reported for 658 surfaces
Error Code -112 reported for 1 surface
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

### Error Codes

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.64619

| 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 | 15.2668 | 175140 | 8.99965 | Competent Rock | 10000 | 45 | 16142 | 26572.8 | 24695.4 | 8122.61 | 16572.8 | 27252 | 19129.3 |
| 2 | 15.2668 | 169134 | 9.87758 | Competent Rock | 10000 | 45 | 9285.67 | 15286 | 13250.2 | 7964.23 | 5285.96 | 14867 | 6902.82 |
| 3 | 15.2668 | 184041 | 10.7579 | Competent Rock | 10000 | 45 | 14345.2 | 23615 | 21405.8 | 7790.79 | 13615 | 24131.3 | 16340.6 |
| 4 | 15.2668 | 211951 | 11.6407 | Competent Rock | 10000 | 45 | 11098.3 | 18269.9 | 15872 | 7602.16 | 8269.88 | 18158.4 | 10556.2 |
| 5 | 15.2668 | 204217 | 12.5264 | Competent Rock | 10000 | 45 | 10712.7 | 17635.2 | 15033.4 | 7398.2 | 7635.16 | 17413.5 | 10015.3 |
| 6 | 15.2668 | 238864 | 13.4151 | Competent Rock | 10000 | 45 | 14079.4 | 23177.4 | 20356.2 | 7178.77 | 13177.4 | 23714.3 | 16535.5 |
| 7 | 15.2668 | 243528 | 14.3071 | Competent Rock | 10000 | 45 | 12286.9 | 20226.6 | 17170.3 | 6943.68 | 10226.6 | 20303.8 | 13360.1 |
| 8 | 15.2668 | 245380 | 15.2027 | Competent Rock | 10000 | 45 | 12456.5 | 20505.8 | 17198.6 | 6692.77 | 10505.8 | 20583.5 | 13890.8 |
| 9 | 15.2668 | 305207 | 16.1021 | Competent Rock | 10000 | 45 | 13533.4 | 22278.6 | 20326.8 | 8048.23 | 12278.6 | 24233.6 | 16185.4 |
| 10 | 15.2668 | 294468 | 17.0056 | Competent Rock | 10000 | 45 | 13062.5 | 21503.4 | 19268.5 | 7765.05 | 11503.4 | 23263.5 | 15498.4 |
| 11 | 15.2668 | 332297 | 17.9135 | Competent Rock | 10000 | 45 | 12762.6 | 21009.7 | 20971.1 | 9961.4 | 11009.7 | 25096.6 | 15135.2 |
| 12 | 15.2668 | 365761 | 18.8261 | Competent Rock | 10000 | 45 | 13991.9 | 23033.4 | 22678.4 | 9645.03 | 13033.4 | 27448.8 | 17803.7 |
| 13 | 15.2668 | 353120 | 19.7436 | Competent Rock | 10000 | 45 | 13484.5 | 22198.1 | 21509.8 | 9311.68 | 12198.1 | 26349.5 | 17037.9 |
| 14 | 15.2668 | 424977 | 20.6664 | Competent Rock | 10000 | 45 | 14398.5 | 23702.6 | 25159.7 | 11457.1 | 13702.6 | 30590.7 | 19133.6 |
| 15 | 15.2668 | 420514 | 21.5949 | Competent Rock | 10000 | 45 | 14198.2 | 23373 | 24461.9 | 11088.8 | 13373.1 | 30081.9 | 18993.1 |
| 16 | 15.2668 | 432333 | 22.5294 | Competent Rock | 10000 | 45 | 14582 | 24004.7 | 24707.5 | 10702.7 | 14004.8 | 30756.3 | 20053.6 |
| 17 | 15.2668 | 485189 | 23.4703 | Competent Rock | 10000 | 45 | 14748.8 | 24279.3 | 27073.7 | 12794.3 | 14279.4 | 33477.5 | 20683.2 |
| 18 | 15.2668 | 469145 | 24.4179 | Competent Rock | 10000 | 45 | 14180.5 | 23343.8 | 25715 | 12371.2 | 13343.8 | 32152.9 | 19781.7 |
| 19 | 15.2668 | 514802 | 25.3727 | Competent Rock | 10000 | 45 | 14089.3 | 23193.7 | 27618.8 | 14425.1 | 13193.7 | 34300.7 | 19875.6 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | 15.2668 | 529525 | 26.3351 | Competent Rock | 10000 | 45 | 14550.2 | 23952.4 | 27915.9 | 13963.4 | 13952.5 | 35118.1 | 21154.7 |
| 21 | 15.2668 | 514989 | 27.3055 | Competent Rock | 10000 | 45 | 14080.3 | 23178.9 | 26660.7 | 13481.7 | 13179 | 33929.8 | 20448.1 |
| 22 | 15.2668 | 586867 | 28.2846 | Competent Rock | 10000 | 45 | 14779.5 | 24329.8 | 29805.4 | 15475.5 | 14329.9 | 37758.2 | 22282.7 |
| 23 | 15.2668 | 567022 | 29.2727 | Competent Rock | 10000 | 45 | 14167.7 | 23322.7 | 28274.9 | 14952.2 | 13322.7 | 36216.6 | 21264.4 |
| 24 | 15.2668 | 586046 | 30.2704 | Competent Rock | 10000 | 45 | 14743.4 | 24270.5 | 28677.7 | 14407.2 | 14270.5 | 37282.8 | 22875.6 |
| 25 | 15.2668 | 619492 | 31.2785 | Competent Rock | 10000 | 45 | 14242.8 | 23446.3 | 29782.2 | 16335.8 | 13446.4 | 38434.6 | 22098.8 |
| 26 | 15.2668 | 597100 | 32.2974 | Competent Rock | 10000 | 45 | 13619.9 | 22420.9 | 28166.3 | 15745.4 | 12420.9 | 36775.6 | 21030.2 |
| 27 | 15.2668 | 618826 | 33.3279 | Competent Rock | 10000 | 45 | 13118.8 | 21596.1 | 28694.9 | 17098.8 | 11596.1 | 37321.5 | 20222.7 |
| 28 | 15.2668 | 619525 | 34.3707 | Competent Rock | 10000 | 45 | 12950.1 | 21318.3 | 28184 | 16865.7 | 11318.3 | 37041.4 | 20175.7 |
| 29 | 15.2668 | 609465 | 35.4267 | Competent Rock | 10000 | 45 | 12507.3 | 20589.4 | 27196.4 | 16606.9 | 10589.5 | 36093.6 | 19486.7 |
| 30 | 15.2668 | 598396 | 36.4968 | Competent Rock | 10000 | 45 | 12063.6 | 19859 | 26180.5 | 16321.5 | 9859.04 | 35106.1 | 18784.6 |
| 31 | 15.2668 | 586274 | 37.5818 | Competent Rock | 10000 | 45 | 11619.4 | 19127.8 | 25136.1 | 16008.4 | 9127.75 | 34078.4 | 18070 |
| 32 | 15.2668 | 573055 | 38.6829 | Competent Rock | 10000 | 45 | 11175.1 | 18396.3 | 24062.6 | 15666.3 | 8396.28 | 33010 | 17343.7 |
| 33 | 15.2668 | 558687 | 39.8013 | Competent Rock | 10000 | 45 | 10731.1 | 17665.4 | 22959.3 | 15293.9 | 7665.39 | 31900.5 | 16606.6 |
| 34 | 15.2668 | 543113 | 40.9381 | Competent Rock | 10000 | 45 | 10287.9 | 16935.8 | 21825.5 | 14889.7 | 6935.79 | 30749.1 | 15859.4 |
| 35 | 15.2668 | 526271 | 42.0948 | Competent Rock | 10000 | 45 | 9845.96 | 16208.3 | 20660.4 | 14452.1 | 6208.31 | 29555.3 | 15103.2 |
| 36 | 15.2668 | 508092 | 43.2731 | Competent Rock | 10000 | 45 | 9405.85 | 15483.8 | 19463 | 13979.2 | 5483.8 | 28318.3 | 14339.1 |
| 37 | 15.2668 | 488495 | 44.4747 | Competent Rock | 10000 | 45 | 8968.13 | 14763.2 | 18232.2 | 13468.9 | 4763.29 | 27037.4 | 13568.5 |
| 38 | 15.2668 | 467394 | 45.7015 | Competent Rock | 10000 | 45 | 8533.39 | 14047.6 | 16966.5 | 12919 | 4047.55 | 25711.5 | 12792.5 |
| 39 | 15.2668 | 444687 | 46.9559 | Competent Rock | 10000 | 45 | 8102.31 | 13337.9 | 15664.6 | 12326.7 | 3337.94 | 24339.9 | 12013.2 |
| 40 | 15.2668 | 420260 | 48.2405 | Competent Rock | 10000 | 45 | 7675.61 | 12635.5 | 14324.6 | 11689.1 | 2635.47 | 22921.5 | 11232.4 |
| 41 | 15.2668 | 393980 | 49.5582 | Competent Rock | 10000 | 45 | 7254.11 | 11941.6 | 12944.2 | 11002.6 | 1941.63 | 21455.2 | 10452.6 |
| 42 | 15.2668 | 365695 | 50.9125 | Competent Rock | 10000 | 45 | 6838.69 | 11257.8 | 11521 | 10263.2 | 1257.78 | 19939.7 | 9676.54 |
| 43 | 15.2668 | 335226 | 52.3075 | Competent Rock | 10000 | 45 | 6430.33 | 10585.5 | 10051.7 | 9466.22 | 585.53 | 18373.9 | 8907.65 |
| 44 | 15.2668 | 302360 | 53.748 | Competent Rock | 10000 | 45 | 6030.15 | 9926.77 | 8532.81 | 8606.05 | -73.2397 | 16756.3 | 8150.23 |
| 45 | 15.2668 | 266843 | 55.2397 | Competent Rock | 10000 | 45 | 5639.41 | 9283.53 | 6959.52 | 7675.98 | -716.462 | 15085.6 | 7409.59 |
| 46 | 15.2668 | 228367 | 56.7898 | Competent Rock | 10000 | 45 | 5259.53 | 8658.18 | 5326.03 | 6667.86 | -1341.83 | 13360.3 | 6692.45 |
| 47 | 15.2668 | 186549 | 58.407 | Competent Rock | 10000 | 45 | 4892.14 | 8053.39 | 3625.03 | 5571.64 | -1946.61 | 11579.3 | 6007.61 |
| 48 | 15.2668 | 140909 | 60.1022 | Competent Rock | 10000 | 45 | 4539.12 | 7472.26 | 1846.87 | 4374.61 | -2527.74 | 9741.36 | 5366.75 |
| 49 | 15.2668 | 90822.5 | 61.89 | Competent Rock | 10000 | 45 | 4202.63 | 6918.32 | -21.3425 | 3060.34 | -3081.68 | 7846.18 | 4785.84 |
| 50 | 22.991 | 48626.8 | 64.3137 | Overburden | 100 | 24 | 122.85 | 202.234 | 1415.4 | 1185.78 | 229.619 | 1670.82 | 485.038 |

## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.64619

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 202.621 | 538527 | 0 | 0 |
| 2 | 415.267 | 205.039 | 449605 | 250285 | 29.1037 |
| 3 | 430.534 | 207.697 | 556164 | 309604 | 29.1037 |
| 4 | 445.8 | 210.598 | 897815 | 499793 | 29.1037 |
| 5 | 461.067 | 213.743 | 1.01736e+06 | 566339 | 29.1036 |
| 6 | 476.334 | 217.135 | 1.12994e+06 | 629010 | 29.1036 |
| 7 | 491.601 | 220.776 | 1.35566e+06 | 754663 | 29.1036 |
| 8 | 506.867 | 224.67 | 1.47641e+06 | 821885 | 29.1037 |
| 9 | 522.134 | 228.818 | 1.60138e+06 | 891449 | 29.1036 |
| 10 | 537.401 | 233.225 | 1.71843e+06 | 956613 | 29.1037 |
| 11 | 552.668 | 237.895 | 1.82792e+06 | 1.01756e+06 | 29.1037 |
| 12 | 567.934 | 242.83 | 1.9193e+06 | 1.06843e+06 | 29.1037 |
| 13 | 583.201 | 248.035 | 2.0149e+06 | 1.12165e+06 | 29.1037 |
| 14 | 598.468 | 253.514 | 2.10294e+06 | 1.17066e+06 | 29.1037 |
| 15 | 613.735 | 259.273 | 2.1779e+06 | 1.21239e+06 | 29.1037 |
| 16 | 629.001 | 265.316 | 2.24687e+06 | 1.25078e+06 | 29.1037 |
| 17 | 644.268 | 271.648 | 2.31306e+06 | 1.28763e+06 | 29.1037 |
| 18 | 659.535 | 278.277 | 2.35879e+06 | 1.31309e+06 | 29.1038 |
| 19 | 674.802 | 285.208 | 2.39708e+06 | 1.3344e+06 | 29.1037 |
| 20 | 690.068 | 292.448 | 2.41225e+06 | 1.34284e+06 | 29.1036 |
| 21 | 705.335 | 300.005 | 2.42345e+06 | 1.34908e+06 | 29.1037 |
| 22 | 720.602 | 307.887 | 2.42832e+06 | 1.35179e+06 | 29.1037 |
| 23 | 735.869 | 316.102 | 2.40914e+06 | 1.34111e+06 | 29.1036 |
| 24 | 751.135 | 324.66 | 2.38349e+06 | 1.32684e+06 | 29.1038 |
| 25 | 766.402 | 333.57 | 2.35307e+06 | 1.3099e+06 | 29.1037 |
| 26 | 781.669 | 342.845 | 2.29433e+06 | 1.2772e+06 | 29.1037 |
| 27 | 796.936 | 352.495 | 2.23048e+06 | 1.24166e+06 | 29.1037 |
| 28 | 812.202 | 362.534 | 2.14273e+06 | 1.19281e+06 | 29.1037 |
| 29 | 827.469 | 372.976 | 2.04617e+06 | 1.13905e+06 | 29.1036 |
| 30 | 842.736 | 383.836 | 1.94178e+06 | 1.08095e+06 | 29.1038 |
| 31 | 858.003 | 395.132 | 1.83026e+06 | 1.01886e+06 | 29.1036 |
| 32 | 873.269 | 406.881 | 1.71235e+06 | 953225 | 29.1037 |
| 33 | 888.536 | 419.105 | 1.58885e+06 | 884477 | 29.1037 |
| 34 | 903.803 | 431.825 | 1.46065e+06 | 813113 | 29.1038 |
| 35 | 919.07 | 445.067 | 1.32872e+06 | 739669 | 29.1037 |
| 36 | 934.336 | 458.859 | 1.19411e+06 | 664733 | 29.1037 |
| 37 | 949.603 | 473.232 | 1.05798e+06 | 588955 | 29.1038 |
| 38 | 964.87 | 488.222 | 921629 | 513050 | 29.1037 |
| 39 | 980.137 | 503.867 | 786480 | 437815 | 29.1037 |
| 40 | 995.403 | 520.213 | 654134 | 364142 | 29.1037 |
| 41 | 1010.67 | 537.312 | 526394 | 293031 | 29.1036 |
| 42 | 1025.94 | 555.224 | 405302 | 225622 | 29.1036 |
| 43 | 1041.2 | 574.018 | 293195 | 163215 | 29.1037 |
| 44 | 1056.47 | 593.777 | 192775 | 107314 | 29.1038 |
| 45 | 1071.74 | 614.596 | 107199 | 59675.5 | 29.1038 |
| 46 | 1087 | 636.595 | 40208.9 | 22383.4 | 29.1037 |
| 47 | 1102.27 | 659.916 | -3691.87 | -2055.18 | 29.1037 |
| 48 | 1117.54 | 684.738 | -18976.2 | -10563.6 | 29.1036 |
| 49 | 1132.8 | 711.29 | 1293.53 | 720.078 | 29.1037 |
| 50 | 1148.07 | 739.871 | 66073.4 | 36781.6 | 29.1037 |
| 51 | 1171.06 | 787.671 | 0 | 0 | 0 |

## Entity Information

### Water Table

| X | Y |
|---|---|
| 0 | 334 |
| 520 | 334 |
| 520 | 360 |
| 560 | 360 |
| 560 | 400 |
| 600 | 400 |
| 600 | 440 |
| 640 | 440 |
| 640 | 480 |
| 680 | 480 |
| 680 | 520 |
| 720 | 520 |
| 720 | 560 |
| 760 | 560 |
| 760 | 600 |
| 800 | 600 |
| 800 | 629.588 |
| 1200 | 800 |

## Focus Search Line

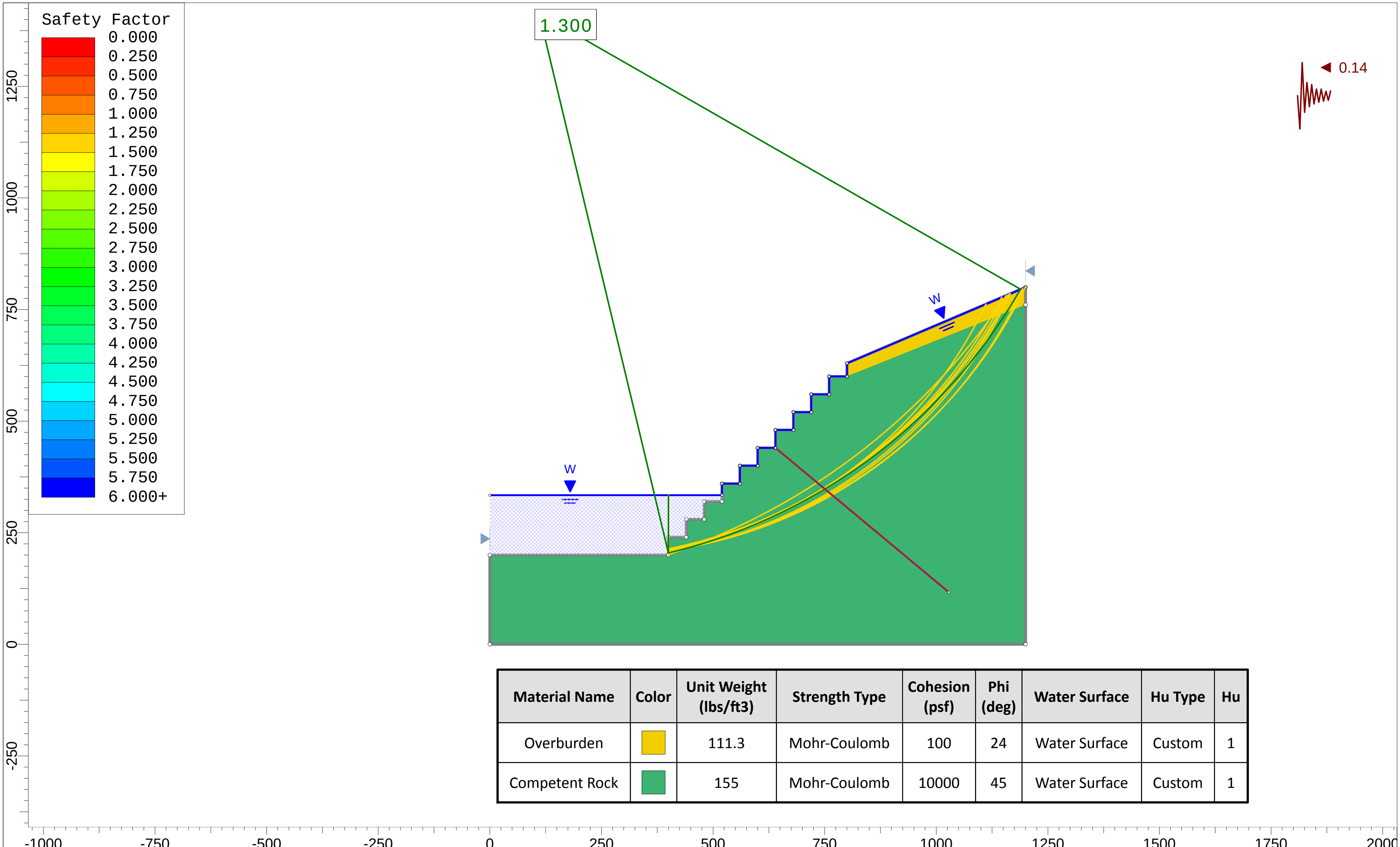
| X | Y |
|---|---|
| 640 | 440 |
| 1028.05 | 116.815 |

## External Boundary

| X | Y |
|---|---|
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

## Material Boundary

| X | Y |
|---|---|
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Hu Type | Hu |
|---|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 100 | 24 | Water Surface | Custom | 1 |
| Competent Rock | | 155 | Mohr-Coulomb | 10000 | 45 | Water Surface | Custom | 1 |

**BAJADA Geosciences, Inc.**

| | | | |
|---|---|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion | | |
| *Analysis Description* | Gross Stability, High Piezometric Surface, Pseudostatic | | |
| *Drawn By* J.Bianchin | *Scale* 1:3569 | *Company* | Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 9:14:14 AM | *File Name* | A-A'StaticHighH20PS.slim |

SLIDEINTERPRET 8.023

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:01.488s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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): 0.14

## *Materials*

| Property | Overburden | Competent Rock |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 155 |
| Cohesion [psf] | 100 | 10000 |
| Friction Angle [°] | 24 | 45 |
| Water Surface | Water Table | Water Table |
| Hu Value | 1 | 1 |

## *Global Minimums*

### Method: spencer

| FS | 1.299620 |
|---|---|
| Center: | 110.136, 1413.477 |
| Radius: | 1243.342 |
| Left Slip Surface Endpoint: | 400.000, 204.396 |
| Right Slip Surface Endpoint: | 1188.894, 795.268 |
| Left Slope Intercept: | 400.000 334.000 |
| Right Slope Intercept: | 1188.894 795.268 |
| Resisting Moment: | 1.82462e+10 lb-ft |
| Driving Moment: | 1.40397e+10 lb-ft |
| Resisting Horizontal Force: | 1.22737e+07 lb |
| Driving Horizontal Force: | 9.44412e+06 lb |
| Total Slice Area: | 124679 ft2 |
| Surface Horizontal Width: | 788.894 ft |
| Surface Average Height: | 158.043 ft |

## *Valid/Invalid Surfaces*

### Method: spencer

Number of Valid Surfaces: 298
Number of Invalid Surfaces: 4702

**Error Codes:**

Error Code -103 reported for 1118 surfaces
Error Code -108 reported for 14 surfaces
Error Code -111 reported for 908 surfaces
Error Code -114 reported for 2458 surfaces
Error Code -118 reported for 204 surfaces

**Error Codes**

The following errors were encountered during the computation:

-103 = Two surface / slope intersections, but one or more surface / nonslope external polygon intersections lie between them. This usually occurs when the slip surface extends past the bottom of the soil region, but may also occur on a benched slope model with two sets of Slope Limits.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-114 = Surface with Reverse Curvature.
-118 = Surface does not pass through the search focus

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.29962

| 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 | 15.7849 | 174936 | 13.8562 | Competent Rock | 10000 | 45 | 25158.8 | 32696.9 | 30662.8 | 7965.82 | 22697 | 36868.5 | 28902.7 |
| 2 | 15.7849 | 165141 | 14.6066 | Competent Rock | 10000 | 45 | 12245.4 | 15914.3 | 13630.4 | 7715.99 | 5914.37 | 16821.6 | 9105.57 |
| 3 | 15.7849 | 182046 | 15.3597 | Competent Rock | 10000 | 45 | 21705.3 | 28208.7 | 25661.1 | 7452.37 | 18208.7 | 31623.3 | 24171 |
| 4 | 15.7849 | 202388 | 16.1154 | Competent Rock | 10000 | 45 | 13920.6 | 18091.5 | 15266.3 | 7174.79 | 8091.47 | 19288.3 | 12113.5 |
| 5 | 15.7849 | 190952 | 16.8741 | Competent Rock | 10000 | 45 | 13336.6 | 17332.6 | 14215.7 | 6883.11 | 7332.57 | 18261.1 | 11378 |
| 6 | 15.7849 | 233439 | 17.6358 | Competent Rock | 10000 | 45 | 18898.8 | 24561.2 | 21138.4 | 6577.16 | 14561.2 | 27146.4 | 20569.2 |
| 7 | 15.7849 | 224860 | 18.4007 | Competent Rock | 10000 | 45 | 14776 | 19203.2 | 15459.9 | 6256.76 | 9203.19 | 20375.5 | 14118.7 |
| 8 | 15.7849 | 245169 | 19.1691 | Competent Rock | 10000 | 45 | 15958.6 | 20740.1 | 16661.8 | 5921.72 | 10740 | 22209.5 | 16287.8 |
| 9 | 15.7849 | 282081 | 19.941 | Competent Rock | 10000 | 45 | 15664.7 | 20358.1 | 17552.3 | 7194.24 | 10358.1 | 23235.6 | 16041.3 |
| 10 | 15.7849 | 267773 | 20.7168 | Competent Rock | 10000 | 45 | 15048.4 | 19557.2 | 16386.5 | 6829.3 | 9557.18 | 22077.8 | 15248.5 |
| 11 | 15.7849 | 337395 | 21.4965 | Competent Rock | 10000 | 45 | 15590 | 20261.1 | 19206.1 | 8945.08 | 10261.1 | 25346.1 | 16401 |
| 12 | 15.7849 | 335214 | 22.2804 | Competent Rock | 10000 | 45 | 15524.7 | 20176.2 | 18725.5 | 8549.33 | 10176.2 | 25086.4 | 16537.1 |
| 13 | 15.7849 | 351341 | 23.0688 | Competent Rock | 10000 | 45 | 16230.4 | 21093.4 | 19231.1 | 8137.79 | 11093.4 | 26143.6 | 18005.8 |
| 14 | 15.7849 | 400178 | 23.8618 | Competent Rock | 10000 | 45 | 15832.9 | 20576.7 | 20782.9 | 10206.2 | 10576.7 | 27786.4 | 17580.2 |
| 15 | 15.7849 | 382771 | 24.6597 | Competent Rock | 10000 | 45 | 15197.1 | 19750.5 | 19512.7 | 9762.25 | 9750.48 | 26489.7 | 16727.4 |
| 16 | 15.7849 | 442574 | 25.4627 | Competent Rock | 10000 | 45 | 15226.1 | 19788.1 | 21585.7 | 11797.6 | 9788.12 | 28836 | 17038.4 |
| 17 | 15.7849 | 443851 | 26.2712 | Competent Rock | 10000 | 45 | 15341.1 | 19937.6 | 21257.6 | 11320 | 9937.56 | 28830 | 17510 |
| 18 | 15.7849 | 450039 | 27.0853 | Competent Rock | 10000 | 45 | 15646.4 | 20334.4 | 21159.5 | 10825.1 | 10334.4 | 29161.1 | 18336 |
| 19 | 15.7849 | 502209 | 27.9053 | Competent Rock | 10000 | 45 | 15352.4 | 19952.3 | 22760.8 | 12808.4 | 9952.35 | 30891.3 | 18082.9 |
| 20 | 15.7849 | 481396 | 28.7317 | Competent | 10000 | 45 | 14716 | 19125.2 | 21402.7 | 12277.6 | 9125.14 | 29470.1 | 17192.5 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Rock | | | | | | | | | |
| 21 | 15.7849 | 531051 | 29.5646 | Competent Rock | 10000 | 45 | 14338 | 18634 | 22858.2 | 14224.2 | 8634.02 | 30991.6 | 16767.4 |
| 22 | 15.7849 | 535438 | 30.4044 | Competent Rock | 10000 | 45 | 14600.8 | 18975.5 | 22631.4 | 13655.9 | 8975.49 | 31199.2 | 17543.3 |
| 23 | 15.7849 | 531316 | 31.2516 | Competent Rock | 10000 | 45 | 14593.2 | 18965.6 | 22033.6 | 13068 | 8965.64 | 30889.6 | 17821.6 |
| 24 | 15.7849 | 586420 | 32.1064 | Competent Rock | 10000 | 45 | 14378.8 | 18687 | 23643.1 | 14956.1 | 8687.05 | 32665.2 | 17709.1 |
| 25 | 15.7849 | 561778 | 32.9693 | Competent Rock | 10000 | 45 | 13755.3 | 17876.7 | 22204.3 | 14327.7 | 7876.64 | 31126.6 | 16798.9 |
| 26 | 15.7849 | 574099 | 33.8407 | Competent Rock | 10000 | 45 | 12725.7 | 16538.6 | 22129.8 | 15591.2 | 6538.55 | 30662 | 15070.8 |
| 27 | 15.7849 | 580729 | 34.721 | Competent Rock | 10000 | 45 | 12769.3 | 16595.2 | 21934.6 | 15339.3 | 6595.27 | 30783.4 | 15444.1 |
| 28 | 15.7849 | 569708 | 35.6109 | Competent Rock | 10000 | 45 | 12315.2 | 16005 | 21070 | 15064.9 | 6005.08 | 29890.3 | 14825.4 |
| 29 | 15.7849 | 557773 | 36.5108 | Competent Rock | 10000 | 45 | 11869.2 | 15425.4 | 20192.7 | 14767.3 | 5425.38 | 28978.9 | 14211.6 |
| 30 | 15.7849 | 544894 | 37.4213 | Competent Rock | 10000 | 45 | 11431.6 | 14856.7 | 19302.2 | 14445.5 | 4856.71 | 28049 | 13603.5 |
| 31 | 15.7849 | 531035 | 38.3429 | Competent Rock | 10000 | 45 | 11002.7 | 14299.4 | 18398.2 | 14098.8 | 4299.37 | 27101 | 13002.2 |
| 32 | 15.7849 | 516159 | 39.2765 | Competent Rock | 10000 | 45 | 10583.1 | 13754 | 17480 | 13726.1 | 3753.95 | 26134.9 | 12408.8 |
| 33 | 15.7849 | 500226 | 40.2227 | Competent Rock | 10000 | 45 | 10173 | 13221 | 16547.4 | 13326.4 | 3221.02 | 25151.2 | 11824.8 |
| 34 | 15.7849 | 483190 | 41.1823 | Competent Rock | 10000 | 45 | 9772.95 | 12701.1 | 15599.8 | 12898.7 | 2701.12 | 24150.1 | 11251.4 |
| 35 | 15.7849 | 465004 | 42.1562 | Competent Rock | 10000 | 45 | 9383.55 | 12195 | 14636.6 | 12441.6 | 2195.03 | 23132 | 10690.4 |
| 36 | 15.7849 | 445612 | 43.1453 | Competent Rock | 10000 | 45 | 9005.38 | 11703.6 | 13657.3 | 11953.7 | 1703.61 | 22097.7 | 10144 |
| 37 | 15.7849 | 424958 | 44.1506 | Competent Rock | 10000 | 45 | 8639.13 | 11227.6 | 12661.2 | 11433.7 | 1227.52 | 21047.9 | 9614.24 |
| 38 | 15.7849 | 402975 | 45.1735 | Competent Rock | 10000 | 45 | 8285.58 | 10768.1 | 11647.8 | 10879.7 | 768.133 | 19983.7 | 9104.03 |
| 39 | 15.7849 | 379590 | 46.215 | Competent Rock | 10000 | 45 | 7945.61 | 10326.3 | 10616.3 | 10290 | 326.31 | 18906.3 | 8616.26 |
| 40 | 15.7849 | 354724 | 47.2767 | Competent Rock | 10000 | 45 | 7620.21 | 9903.38 | 9565.91 | 9662.56 | -96.6468 | 17817.1 | 8154.56 |
| 41 | 15.7849 | 328286 | 48.3602 | Competent Rock | 10000 | 45 | 7310.51 | 9500.89 | 8495.87 | 8994.99 | -499.122 | 16718.4 | 7723.38 |
| 42 | 15.7849 | 300174 | 49.4672 | Competent Rock | 10000 | 45 | 7017.81 | 9120.49 | 7405.22 | 8284.73 | -879.515 | 15612.5 | 7327.76 |
| 43 | 15.7849 | 270272 | 50.5998 | Competent Rock | 10000 | 45 | 6743.59 | 8764.1 | 6292.92 | 7528.84 | -1235.92 | 14502.6 | 6973.81 |
| 44 | 15.7849 | 238450 | 51.7605 | Competent Rock | 10000 | 45 | 6489.56 | 8433.96 | 5157.92 | 6723.95 | -1566.03 | 13393 | 6669.04 |
| 45 | 15.7849 | 204555 | 52.9518 | Competent Rock | 10000 | 45 | 6257.71 | 8132.65 | 3998.88 | 5866.21 | -1867.33 | 12288.6 | 6422.41 |
| 46 | 15.7849 | 168413 | 54.1769 | Competent Rock | 10000 | 45 | 6050.4 | 7863.22 | 2814.38 | 4951.16 | -2136.78 | 11196.3 | 6245.17 |
| 47 | 15.7849 | 129819 | 55.4394 | Competent Rock | 10000 | 45 | 5870.39 | 7629.27 | 1602.83 | 3973.56 | -2370.73 | 10125 | 6151.42 |
| 48 | 15.7849 | 88530.4 | 56.7438 | Competent Rock | 10000 | 45 | 5720.98 | 7435.1 | 362.345 | 2927.24 | -2564.89 | 9086.24 | 6159 |
| 49 | 15.6091 | 50435.2 | 58.0874 | Overburden | 100 | 24 | 282.077 | 366.593 | 2410.3 | 1811.52 | 598.779 | 2863.25 | 1051.73 |
| 50 | 15.6091 | 17219.6 | 59.4759 | Overburden | 100 | 24 | 0 | 0 | -78.6404 | 618.484 | -697.124 | -78.6404 | -697.124 |

## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.29962

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 400 | 204.396 | 524075 | 0 | 0 |
| 2 | 415.785 | 208.289 | 513104 | 406365 | 38.3783 |
| 3 | 431.57 | 212.403 | 639438 | 506419 | 38.3783 |
| 4 | 447.355 | 216.739 | 1.0391e+06 | 822944 | 38.3784 |
| 5 | 463.14 | 221.3 | 1.1675e+06 | 924628 | 38.3783 |
| 6 | 478.925 | 226.088 | 1.28987e+06 | 1.02154e+06 | 38.3782 |
| 7 | 494.709 | 231.106 | 1.53547e+06 | 1.21605e+06 | 38.3783 |
| 8 | 510.494 | 236.357 | 1.65709e+06 | 1.31237e+06 | 38.3783 |
| 9 | 526.279 | 241.844 | 1.78957e+06 | 1.41729e+06 | 38.3783 |
| 10 | 542.064 | 247.571 | 1.89589e+06 | 1.50149e+06 | 38.3782 |
| 11 | 557.849 | 253.541 | 1.99721e+06 | 1.58174e+06 | 38.3783 |
| 12 | 573.634 | 259.758 | 2.07574e+06 | 1.64393e+06 | 38.3783 |
| 13 | 589.419 | 266.225 | 2.15183e+06 | 1.70419e+06 | 38.3783 |
| 14 | 605.204 | 272.948 | 2.22858e+06 | 1.76498e+06 | 38.3783 |
| 15 | 620.989 | 279.93 | 2.27642e+06 | 1.80286e+06 | 38.3782 |
| 16 | 636.774 | 287.177 | 2.3204e+06 | 1.8377e+06 | 38.3784 |
| 17 | 652.558 | 294.693 | 2.33563e+06 | 1.84976e+06 | 38.3783 |
| 18 | 668.343 | 302.485 | 2.3491e+06 | 1.86043e+06 | 38.3784 |
| 19 | 684.128 | 310.557 | 2.36133e+06 | 1.87011e+06 | 38.3783 |
| 20 | 699.913 | 318.917 | 2.34217e+06 | 1.85494e+06 | 38.3783 |
| 21 | 715.698 | 327.57 | 2.32099e+06 | 1.83816e+06 | 38.3783 |
| 22 | 731.483 | 336.524 | 2.26743e+06 | 1.79575e+06 | 38.3784 |
| 23 | 747.268 | 345.787 | 2.21245e+06 | 1.7522e+06 | 38.3783 |
| 24 | 763.053 | 355.366 | 2.15648e+06 | 1.70788e+06 | 38.3784 |
| 25 | 778.838 | 365.27 | 2.06632e+06 | 1.63647e+06 | 38.3783 |
| 26 | 794.623 | 375.509 | 1.97663e+06 | 1.56544e+06 | 38.3783 |
| 27 | 810.408 | 386.092 | 1.86217e+06 | 1.47479e+06 | 38.3783 |
| 28 | 826.192 | 397.031 | 1.74173e+06 | 1.37941e+06 | 38.3784 |
| 29 | 841.977 | 408.336 | 1.61743e+06 | 1.28096e+06 | 38.3783 |
| 30 | 857.762 | 420.021 | 1.49004e+06 | 1.18007e+06 | 38.3782 |
| 31 | 873.547 | 432.099 | 1.36039e+06 | 1.07739e+06 | 38.3782 |
| 32 | 889.332 | 444.584 | 1.22936e+06 | 973619 | 38.3782 |
| 33 | 905.117 | 457.493 | 1.09787e+06 | 869481 | 38.3782 |
| 34 | 920.902 | 470.843 | 966898 | 765758 | 38.3783 |
| 35 | 936.687 | 484.653 | 837499 | 663278 | 38.3783 |
| 36 | 952.472 | 498.944 | 710787 | 562925 | 38.3783 |
| 37 | 968.257 | 513.739 | 587958 | 465648 | 38.3783 |
| 38 | 984.042 | 529.063 | 470299 | 372465 | 38.3783 |
| 39 | 999.826 | 544.943 | 359199 | 284476 | 38.3783 |
| 40 | 1015.61 | 561.412 | 256163 | 202875 | 38.3784 |
| 41 | 1031.4 | 578.504 | 162830 | 128958 | 38.3785 |
| 42 | 1047.18 | 596.259 | 80993.3 | 64144.6 | 38.3783 |
| 43 | 1062.97 | 614.719 | 12622.8 | 9996.94 | 38.3783 |
| 44 | 1078.75 | 633.936 | -40100.7 | -31758.7 | 38.3783 |
| 45 | 1094.54 | 653.966 | -74749.8 | -59200 | 38.3784 |
| 46 | 1110.32 | 674.877 | -88602.4 | -70170.8 | 38.3783 |
| 47 | 1126.11 | 696.745 | -78580.4 | -62233.6 | 38.3783 |
| 48 | 1141.89 | 719.66 | -41171.2 | -32606.6 | 38.3784 |
| 49 | 1157.68 | 743.73 | 27676.5 | 21919 | 38.3782 |
| 50 | 1173.28 | 768.795 | -35411.7 | -28045.2 | 38.3784 |
| 51 | 1188.89 | 795.268 | 0 | 0 | 0 |

## *Entity Information*

### Water Table

| X | Y |
| --- | --- |
| 0 | 334 |
| 520 | 334 |
| 520 | 360 |
| 560 | 360 |
| 560 | 400 |
| 600 | 400 |
| 600 | 440 |
| 640 | 440 |
| 640 | 480 |
| 680 | 480 |
| 680 | 520 |
| 720 | 520 |
| 720 | 560 |
| 760 | 560 |
| 760 | 600 |
| 800 | 600 |
| 800 | 629.588 |
| 1200 | 800 |

## Focus Search Line

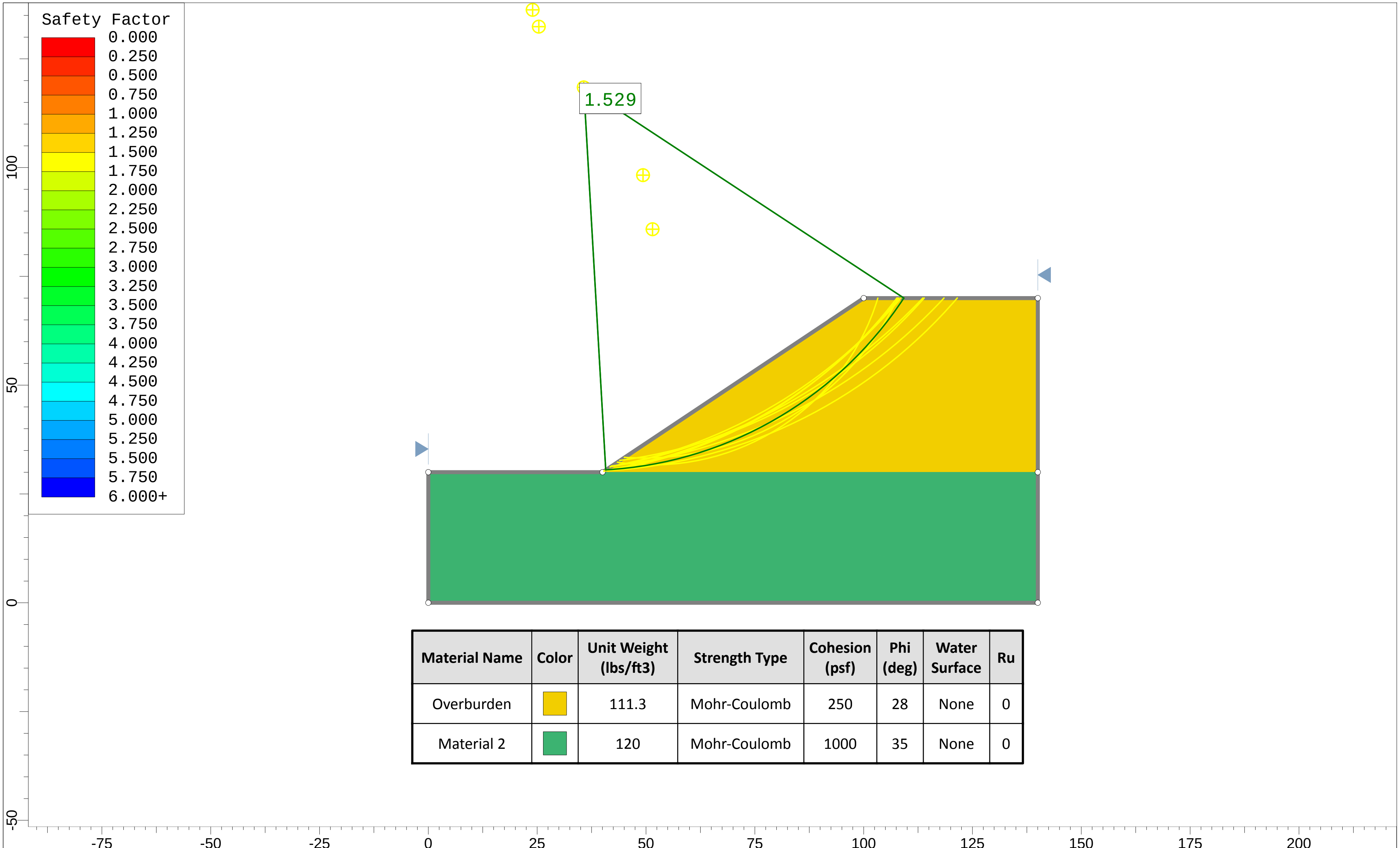
| X | Y |
| --- | --- |
| 640 | 440 |
| 1028.05 | 116.815 |

## External Boundary

| X | Y |
| --- | --- |
| 0 | 0 |
| 1200 | 0 |
| 1200 | 760.738 |
| 1200 | 800 |
| 800 | 629.588 |
| 800 | 600 |
| 760 | 600 |
| 760 | 560 |
| 720 | 560 |
| 720 | 520 |
| 680 | 520 |
| 680 | 480 |
| 640 | 480 |
| 640 | 440 |
| 600 | 440 |
| 600 | 400 |
| 560 | 400 |
| 560 | 360 |
| 520 | 360 |
| 520 | 320 |
| 480 | 320 |
| 480 | 280 |
| 440 | 280 |
| 440 | 240 |
| 400 | 240 |
| 400 | 200 |
| 0 | 200 |

## Material Boundary

| X | Y |
| --- | --- |
| 800 | 600 |
| 1200 | 760.738 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 250 | 28 | None | 0 |
| Material 2 | | 120 | Mohr-Coulomb | 1000 | 35 | None | 0 |

**BAJADA Geosciences, Inc.**

| | |
|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion |
| *Analysis Description* | Overburden Cut Inclination - 1.5:1 Slope |
| *Drawn By* | J. Bianchin |
| *Scale* | 1:366 |
| *Company* | Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 10:48:54 AM |
| *File Name* | OverburdenStatic1.5-1.slim |

SLIDEINTERPRET 8.026

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.026 |
| Compute Time: | 00h:00m:03.135s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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 | Overburden | Material 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 120 |
| Cohesion [psf] | 250 | 1000 |
| Friction Angle [°] | 28 | 35 |
| Water Surface | None | None |
| Ru Value | 0 | 0 |

## Global Minimums

### Method: spencer

| FS | 1.528980 |
|---|---|
| Center: | 35.689, 118.443 |
| Radius: | 88.096 |
| Left Slip Surface Endpoint: | 40.738, 30.492 |
| Right Slip Surface Endpoint: | 109.270, 70.000 |
| Resisting Moment: | 4.98879e+06 lb-ft |
| Driving Moment: | 3.26283e+06 lb-ft |
| Resisting Horizontal Force: | 48292.3 lb |
| Driving Horizontal Force: | 31584.7 lb |
| Total Slice Area: | 682.965 ft2 |
| Surface Horizontal Width: | 68.5319 ft |
| Surface Average Height: | 9.96565 ft |

## Valid/Invalid Surfaces

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 2899 |
| Number of Invalid Surfaces: | 2101 |

#### Error Codes:

Error Code -105 reported for 1 surface
Error Code -106 reported for 22 surfaces
Error Code -108 reported for 44 surfaces

Error Code -111 reported for 555 surfaces
Error Code -112 reported for 11 surfaces
Error Code -114 reported for 1468 surfaces

### Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.52898

| 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 | 1.37064 | 62.878 | 3.73229 | Overburden | 250 | 28 | 207.943 | 317.941 | 127.778 | 0 | 127.778 | 141.343 | 141.343 |
| 2 | 1.37064 | 186.994 | 4.62613 | Overburden | 250 | 28 | 241.351 | 369.021 | 223.846 | 0 | 223.846 | 243.376 | 243.376 |
| 3 | 1.37064 | 307.825 | 5.52111 | Overburden | 250 | 28 | 272.897 | 417.254 | 314.558 | 0 | 314.558 | 340.937 | 340.937 |
| 4 | 1.37064 | 425.356 | 6.41744 | Overburden | 250 | 28 | 302.642 | 462.734 | 400.095 | 0 | 400.095 | 434.135 | 434.135 |
| 5 | 1.37064 | 539.572 | 7.31535 | Overburden | 250 | 28 | 330.647 | 505.553 | 480.625 | 0 | 480.625 | 523.072 | 523.072 |
| 6 | 1.37064 | 650.453 | 8.21507 | Overburden | 250 | 28 | 356.965 | 545.793 | 556.306 | 0 | 556.306 | 607.841 | 607.841 |
| 7 | 1.37064 | 757.978 | 9.11684 | Overburden | 250 | 28 | 381.649 | 583.534 | 627.286 | 0 | 627.286 | 688.531 | 688.531 |
| 8 | 1.37064 | 862.123 | 10.0209 | Overburden | 250 | 28 | 404.746 | 618.848 | 693.702 | 0 | 693.702 | 765.222 | 765.222 |
| 9 | 1.37064 | 962.861 | 10.9275 | Overburden | 250 | 28 | 426.3 | 651.804 | 755.686 | 0 | 755.686 | 837.99 | 837.99 |
| 10 | 1.37064 | 1060.16 | 11.8368 | Overburden | 250 | 28 | 446.354 | 682.466 | 813.35 | 0 | 813.35 | 906.898 | 906.898 |
| 11 | 1.37064 | 1153.99 | 12.7492 | Overburden | 250 | 28 | 464.947 | 710.894 | 866.813 | 0 | 866.813 | 972.013 | 972.013 |
| 12 | 1.37064 | 1244.31 | 13.6649 | Overburden | 250 | 28 | 482.116 | 737.145 | 916.185 | 0 | 916.185 | 1033.4 | 1033.4 |
| 13 | 1.37064 | 1331.09 | 14.5842 | Overburden | 250 | 28 | 497.895 | 761.271 | 961.559 | 0 | 961.559 | 1091.1 | 1091.1 |
| 14 | 1.37064 | 1414.28 | 15.5073 | Overburden | 250 | 28 | 512.316 | 783.321 | 1003.03 | 0 | 1003.03 | 1145.18 | 1145.18 |
| 15 | 1.37064 | 1493.83 | 16.4346 | Overburden | 250 | 28 | 525.41 | 803.342 | 1040.68 | 0 | 1040.68 | 1195.66 | 1195.66 |
| 16 | 1.37064 | 1569.69 | 17.3663 | Overburden | 250 | 28 | 537.205 | 821.376 | 1074.6 | 0 | 1074.6 | 1242.61 | 1242.61 |
| 17 | 1.37064 | 1641.81 | 18.3028 | Overburden | 250 | 28 | 547.727 | 837.463 | 1104.85 | 0 | 1104.85 | 1286.03 | 1286.03 |
| 18 | 1.37064 | 1710.12 | 19.2443 | Overburden | 250 | 28 | 556.999 | 851.641 | 1131.52 | 0 | 1131.52 | 1325.97 | 1325.97 |
| 19 | 1.37064 | 1774.57 | 20.1914 | Overburden | 250 | 28 | 565.046 | 863.944 | 1154.66 | 0 | 1154.66 | 1362.46 | 1362.46 |
| 20 | 1.37064 | 1835.09 | 21.1442 | Overburden | 250 | 28 | 571.888 | 874.406 | 1174.34 | 0 | 1174.34 | 1395.52 | 1395.52 |
| 21 | 1.37064 | 1891.59 | 22.1031 | Overburden | 250 | 28 | 577.545 | 883.055 | 1190.6 | 0 | 1190.6 | 1425.16 | 1425.16 |
| 22 | 1.37064 | 1944 | 23.0687 | Overburden | 250 | 28 | 582.035 | 889.92 | 1203.52 | 0 | 1203.52 | 1451.4 | 1451.4 |
| 23 | 1.37064 | 1992.24 | 24.0412 | Overburden | 250 | 28 | 585.375 | 895.026 | 1213.11 | 0 | 1213.11 | 1474.24 | 1474.24 |
| 24 | 1.37064 | 2036.2 | 25.0211 | Overburden | 250 | 28 | 587.579 | 898.396 | 1219.46 | 0 | 1219.46 | 1493.71 | 1493.71 |
| 25 | 1.37064 | 2075.78 | 26.009 | Overburden | 250 | 28 | 588.662 | 900.053 | 1222.57 | 0 | 1222.57 | 1509.79 | 1509.79 |
| 26 | 1.37064 | 2110.89 | 27.0052 | Overburden | 250 | 28 | 588.638 | 900.015 | 1222.5 | 0 | 1222.5 | 1522.49 | 1522.49 |
| 27 | 1.37064 | 2141.39 | 28.0103 | Overburden | 250 | 28 | 587.516 | 898.3 | 1219.28 | 0 | 1219.28 | 1531.8 | 1531.8 |
| 28 | 1.37064 | 2167.16 | 29.0249 | Overburden | 250 | 28 | 585.307 | 894.923 | 1212.92 | 0 | 1212.92 | 1537.7 | 1537.7 |
| 29 | 1.37064 | 2188.07 | 30.0496 | Overburden | 250 | 28 | 582.02 | 889.897 | 1203.47 | 0 | 1203.47 | 1540.17 | 1540.17 |
| 30 | 1.37064 | 2203.95 | 31.085 | Overburden | 250 | 28 | 577.664 | 883.236 | 1190.94 | 0 | 1190.94 | 1539.21 | 1539.21 |
| 31 | 1.37064 | 2214.65 | 32.1318 | Overburden | 250 | 28 | 572.242 | 874.947 | 1175.35 | 0 | 1175.35 | 1534.76 | 1534.76 |
| 32 | 1.37064 | 2220 | 33.1908 | Overburden | 250 | 28 | 565.763 | 865.04 | 1156.72 | 0 | 1156.72 | 1526.82 | 1526.82 |
| 33 | 1.37064 | 2219.79 | 34.2627 | Overburden | 250 | 28 | 558.228 | 853.519 | 1135.06 | 0 | 1135.06 | 1515.32 | 1515.32 |
| 34 | 1.37064 | 2213.81 | 35.3485 | Overburden | 250 | 28 | 549.641 | 840.39 | 1110.36 | 0 | 1110.36 | 1500.23 | 1500.23 |
| 35 | 1.37064 | 2201.83 | 36.4491 | Overburden | 250 | 28 | 540.002 | 825.652 | 1082.64 | 0 | 1082.64 | 1481.48 | 1481.48 |
| 36 | 1.37064 | 2183.6 | 37.5655 | Overburden | 250 | 28 | 529.312 | 809.307 | 1051.9 | 0 | 1051.9 | 1459.02 | 1459.02 |
| 37 | 1.37064 | 2158.83 | 38.6989 | Overburden | 250 | 28 | 517.568 | 791.351 | 1018.13 | 0 | 1018.13 | 1432.77 | 1432.77 |
| 38 | 1.37064 | 2127.21 | 39.8506 | Overburden | 250 | 28 | 504.767 | 771.778 | 981.324 | 0 | 981.324 | 1402.64 | 1402.64 |
| 39 | 1.37064 | 2088.39 | 41.022 | Overburden | 250 | 28 | 490.903 | 750.581 | 941.455 | 0 | 941.455 | 1368.52 | 1368.52 |
| 40 | 1.37064 | 2041.99 | 42.2146 | Overburden | 250 | 28 | 475.97 | 727.749 | 898.515 | 0 | 898.515 | 1330.32 | 1330.32 |
| 41 | 1.37064 | 1987.57 | 43.4302 | Overburden | 250 | 28 | 459.958 | 703.267 | 852.473 | 0 | 852.473 | 1287.89 | 1287.89 |
| 42 | 1.37064 | 1924.64 | 44.6707 | Overburden | 250 | 28 | 442.855 | 677.117 | 803.292 | 0 | 803.292 | 1241.09 | 1241.09 |
| 43 | 1.37064 | 1852.66 | 45.9384 | Overburden | 250 | 28 | 424.646 | 649.276 | 750.929 | 0 | 750.929 | 1189.72 | 1189.72 |
| 44 | 1.37064 | 1730.38 | 47.2358 | Overburden | 250 | 28 | 399.277 | 610.487 | 677.978 | 0 | 677.978 | 1109.7 | 1109.7 |
| 45 | 1.37064 | 1502.8 | 48.5658 | Overburden | 250 | 28 | 359.217 | 549.235 | 562.779 | 0 | 562.779 | 969.74 | 969.74 |
| 46 | 1.37064 | 1260.07 | 49.9318 | Overburden | 250 | 28 | 318.312 | 486.692 | 445.153 | 0 | 445.153 | 823.586 | 823.586 |
| 47 | 1.37064 | 1005.1 | 51.3377 | Overburden | 250 | 28 | 277.139 | 423.74 | 326.758 | 0 | 326.758 | 673.151 | 673.151 |
| 48 | 1.37064 | 736.752 | 52.7882 | Overburden | 250 | 28 | 235.692 | 360.368 | 207.572 | 0 | 207.572 | 517.952 | 517.952 |
| 49 | 1.37064 | 453.643 | 54.2889 | Overburden | 250 | 28 | 193.96 | 296.56 | 87.5672 | 0 | 87.5672 | 357.38 | 357.38 |
| 50 | 1.37064 | 154.105 | 55.8465 | Overburden | 250 | 28 | 152.907 | 233.792 | -30.4836 | 0 | -30.4836 | 194.905 | 194.905 |

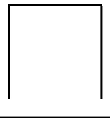
## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.52898

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40.738 | 30.492 | 0 | 0 | 0 |
| 2 | 42.1087 | 30.5814 | 273.073 | 132.256 | 25.8421 |
| 3 | 43.4793 | 30.6923 | 578.451 | 280.159 | 25.8421 |
| 4 | 44.85 | 30.8248 | 910.14 | 440.805 | 25.8421 |
| 5 | 46.2206 | 30.979 | 1262.52 | 611.472 | 25.8421 |
| 6 | 47.5912 | 31.155 | 1630.33 | 789.611 | 25.8421 |
| 7 | 48.9619 | 31.3528 | 2008.63 | 972.832 | 25.8421 |
| 8 | 50.3325 | 31.5728 | 2392.81 | 1158.9 | 25.8421 |
| 9 | 51.7031 | 31.815 | 2778.55 | 1345.73 | 25.8422 |
| 10 | 53.0738 | 32.0796 | 3161.82 | 1531.35 | 25.8421 |
| 11 | 54.4444 | 32.3669 | 3538.85 | 1713.96 | 25.8422 |
| 12 | 55.8151 | 32.677 | 3906.15 | 1891.85 | 25.8421 |
| 13 | 57.1857 | 33.0102 | 4260.45 | 2063.45 | 25.8421 |
| 14 | 58.5563 | 33.3669 | 4598.73 | 2227.29 | 25.8422 |
| 15 | 59.927 | 33.7472 | 4918.21 | 2382.02 | 25.8421 |
| 16 | 61.2976 | 34.1515 | 5216.3 | 2526.39 | 25.8421 |
| 17 | 62.6683 | 34.5801 | 5490.65 | 2659.27 | 25.8422 |
| 18 | 64.0389 | 35.0335 | 5739.12 | 2779.61 | 25.8422 |
| 19 | 65.4095 | 35.512 | 5959.75 | 2886.46 | 25.8421 |
| 20 | 66.7802 | 36.016 | 6150.8 | 2978.99 | 25.8421 |
| 21 | 68.1508 | 36.5461 | 6310.71 | 3056.44 | 25.8421 |
| 22 | 69.5215 | 37.1028 | 6438.13 | 3118.16 | 25.8422 |
| 23 | 70.8921 | 37.6865 | 6531.91 | 3163.58 | 25.8422 |
| 24 | 72.2627 | 38.2979 | 6591.05 | 3192.22 | 25.8421 |
| 25 | 73.6334 | 38.9377 | 6614.79 | 3203.72 | 25.8422 |
| 26 | 75.004 | 39.6065 | 6602.55 | 3197.79 | 25.8421 |
| 27 | 76.3746 | 40.305 | 6553.94 | 3174.25 | 25.8422 |
| 28 | 77.7453 | 41.0341 | 6468.78 | 3133 | 25.8421 |
| 29 | 79.1159 | 41.7946 | 6347.1 | 3074.07 | 25.8421 |
| 30 | 80.4866 | 42.5876 | 6189.13 | 2997.56 | 25.8421 |
| 31 | 81.8572 | 43.4139 | 5995.35 | 2903.71 | 25.8422 |
| 32 | 83.2278 | 44.2747 | 5766.44 | 2792.84 | 25.8421 |
| 33 | 84.5985 | 45.1714 | 5503.37 | 2665.43 | 25.8422 |
| 34 | 85.9691 | 46.105 | 5207.33 | 2522.05 | 25.8422 |
| 35 | 87.3398 | 47.0772 | 4879.82 | 2363.43 | 25.8422 |
| 36 | 88.7104 | 48.0896 | 4522.63 | 2190.43 | 25.8421 |
| 37 | 90.081 | 49.1438 | 4137.87 | 2004.08 | 25.8421 |
| 38 | 91.4517 | 50.2418 | 3728.03 | 1805.58 | 25.8421 |
| 39 | 92.8223 | 51.3859 | 3295.96 | 1596.32 | 25.8421 |
| 40 | 94.193 | 52.5783 | 2845 | 1377.91 | 25.8422 |
| 41 | 95.5636 | 53.8217 | 2378.94 | 1152.18 | 25.8421 |
| 42 | 96.9342 | 55.1192 | 1902.13 | 921.253 | 25.8422 |
| 43 | 98.3049 | 56.4742 | 1419.59 | 687.544 | 25.8421 |
| 44 | 99.6755 | 57.8905 | 937.037 | 453.832 | 25.8421 |
| 45 | 101.046 | 59.3725 | 478.539 | 231.769 | 25.8421 |
| 46 | 102.417 | 60.9253 | 96.1098 | 46.5485 | 25.8421 |
| 47 | 103.787 | 62.5549 | -193.778 | -93.852 | 25.8422 |
| 48 | 105.158 | 64.268 | -374.394 | -181.329 | 25.8421 |
| 49 | 106.529 | 66.073 | -426.595 | -206.611 | 25.8421 |
| 50 | 107.899 | 67.9796 | -328.191 | -158.952 | 25.8422 |
| 51 | 109.27 | 70 | 0 | 0 | 0 |

## Entity Information

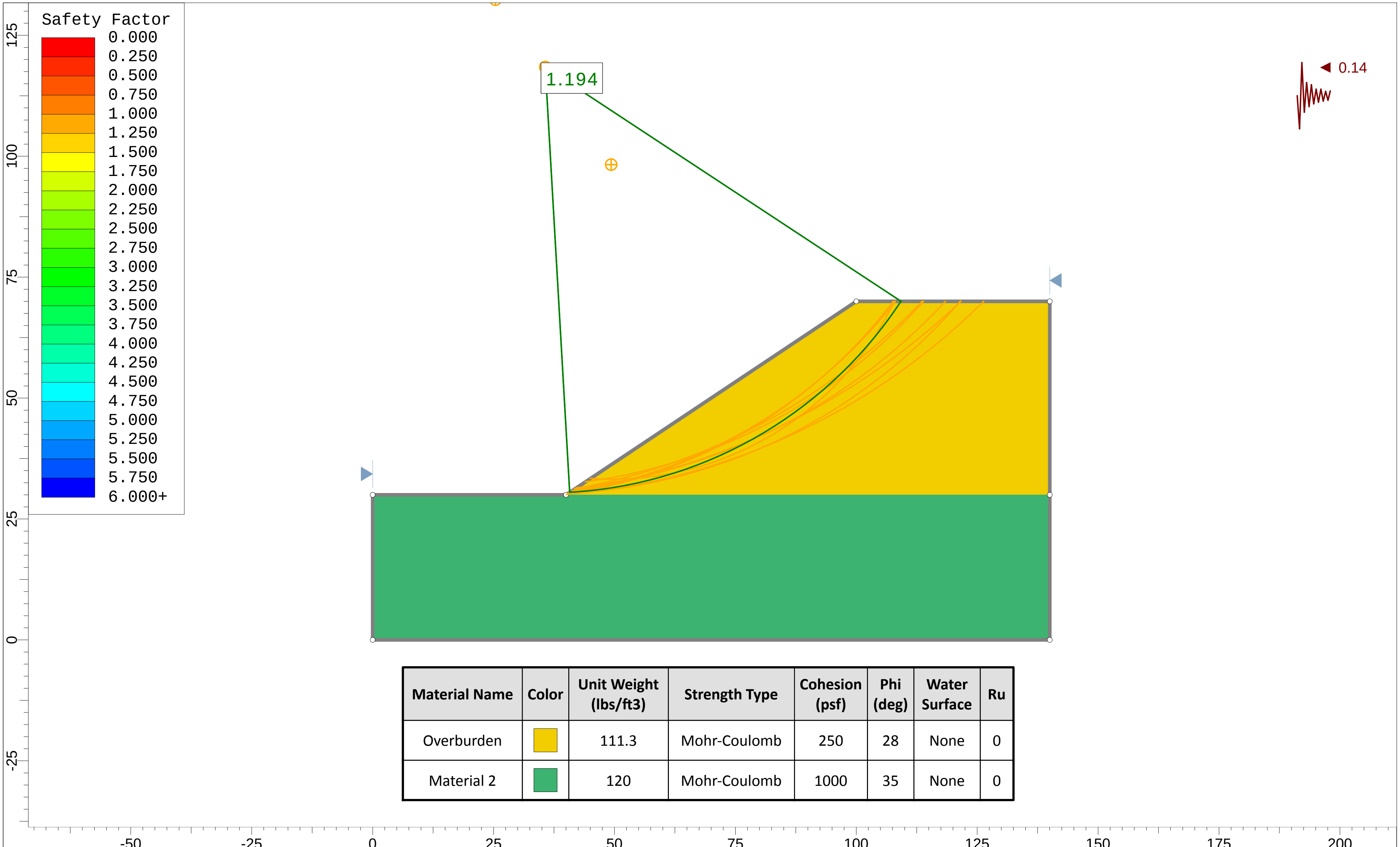
### External Boundary



| X | Y |
|---|---|
| 0 | 0 |
| 140 | 0 |
| 140 | 30 |
| 140 | 70 |
| 100 | 70 |
| 40 | 30 |
| 0 | 30 |

## Material Boundary

| X | Y |
|---|---|
| 40 | 30 |
| 140 | 30 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Overburden | | 111.3 | Mohr-Coulomb | 250 | 28 | None | 0 |
| Material 2 | | 120 | Mohr-Coulomb | 1000 | 35 | None | 0 |

**BAJADA Geosciences, Inc.**

SLIDEINTERPRET 8.026

| | |
|---|---|
| *Project* | Crystal Creek Aggregate Quarry Expansion |
| *Analysis Description* | Overburden Cut Inclination - 1.5:1 Slope, Pseudostatic |
| *Drawn By* | J. Bianchin |
| *Scale* | 1:329 |
| *Company* | Bajada Geosciences, Inc. |
| *Date* | 5/17/2019, 10:48:54 AM |
| *File Name* | OverburdenStatic1.5-1PS.slim |

# Slide Analysis Information

# Crystal Creek Aggregate Quarry Expansion

## Project Summary

| | |
|---|---|
| Slide Modeler Version: | 8.026 |
| Compute Time: | 00h:00m:02.947s |

## 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: | Slope Search |
| Number of Surfaces: | 5000 |
| Upper Angle [°]: | Not Defined |
| Lower Angle [°]: | Not Defined |
| Composite Surfaces: | Disabled |
| Reverse Curvature: | Invalid Surfaces |
| 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): 0.14

## Materials

| Property | Overburden | Material 2 |
|---|---|---|
| Color | | |
| Strength Type | Mohr-Coulomb | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 111.3 | 120 |
| Cohesion [psf] | 250 | 1000 |
| Friction Angle [°] | 28 | 35 |
| Water Surface | None | None |
| Ru Value | 0 | 0 |

## Global Minimums

### Method: spencer

| FS | 1.193830 |
|---|---|
| Center: | 35.689, 118.443 |
| Radius: | 88.096 |
| Left Slip Surface Endpoint: | 40.738, 30.492 |
| Right Slip Surface Endpoint: | 109.270, 70.000 |
| Resisting Moment: | 4.76964e+06 lb-ft |
| Driving Moment: | 3.99523e+06 lb-ft |
| Resisting Horizontal Force: | 46431.4 lb |
| Driving Horizontal Force: | 38892.7 lb |
| Total Slice Area: | 682.965 ft2 |
| Surface Horizontal Width: | 68.5319 ft |
| Surface Average Height: | 9.96565 ft |

## Valid/Invalid Surfaces

### Method: spencer

Number of Valid Surfaces: 2533
Number of Invalid Surfaces: 2467

#### Error Codes:

Error Code -105 reported for 1 surface

Error Code -106 reported for 22 surfaces
Error Code -108 reported for 12 surfaces
Error Code -111 reported for 959 surfaces
Error Code -112 reported for 5 surfaces
Error Code -114 reported for 1468 surfaces

### Error Codes

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.
-106 = Average slice width is less than 0.0001 * (maximum horizontal extent of soil region). This limitation is imposed to avoid numerical errors which may result from too many slices, or too small a slip region.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.

## *Slice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.19383

| 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 | 1.37064 | 62.878 | 3.73229 | Overburden | 250 | 28 | 304.21 | 363.175 | 212.851 | 0 | 212.851 | 232.696 | 232.696 |
| 2 | 1.37064 | 186.994 | 4.62613 | Overburden | 250 | 28 | 346.815 | 414.038 | 308.51 | 0 | 308.51 | 336.573 | 336.573 |
| 3 | 1.37064 | 307.825 | 5.52111 | Overburden | 250 | 28 | 386.416 | 461.315 | 397.426 | 0 | 397.426 | 434.778 | 434.778 |
| 4 | 1.37064 | 425.356 | 6.41744 | Overburden | 250 | 28 | 423.162 | 505.184 | 479.931 | 0 | 479.931 | 527.527 | 527.527 |
| 5 | 1.37064 | 539.572 | 7.31535 | Overburden | 250 | 28 | 457.19 | 545.807 | 556.331 | 0 | 556.331 | 615.023 | 615.023 |
| 6 | 1.37064 | 650.453 | 8.21507 | Overburden | 250 | 28 | 488.625 | 583.335 | 626.912 | 0 | 626.912 | 697.455 | 697.455 |
| 7 | 1.37064 | 757.978 | 9.11684 | Overburden | 250 | 28 | 517.587 | 617.911 | 691.939 | 0 | 691.939 | 774.999 | 774.999 |
| 8 | 1.37064 | 862.123 | 10.0209 | Overburden | 250 | 28 | 544.186 | 649.665 | 751.664 | 0 | 751.664 | 847.823 | 847.823 |
| 9 | 1.37064 | 962.861 | 10.9275 | Overburden | 250 | 28 | 568.525 | 678.722 | 806.311 | 0 | 806.311 | 916.074 | 916.074 |
| 10 | 1.37064 | 1060.16 | 11.8368 | Overburden | 250 | 28 | 590.701 | 705.196 | 856.102 | 0 | 856.102 | 979.902 | 979.902 |
| 11 | 1.37064 | 1153.99 | 12.7492 | Overburden | 250 | 28 | 610.802 | 729.194 | 901.233 | 0 | 901.233 | 1039.43 | 1039.43 |
| 12 | 1.37064 | 1244.31 | 13.6649 | Overburden | 250 | 28 | 628.915 | 750.817 | 941.898 | 0 | 941.898 | 1094.8 | 1094.8 |
| 13 | 1.37064 | 1331.09 | 14.5842 | Overburden | 250 | 28 | 645.116 | 770.159 | 978.279 | 0 | 978.279 | 1146.13 | 1146.13 |
| 14 | 1.37064 | 1414.28 | 15.5073 | Overburden | 250 | 28 | 659.481 | 787.308 | 1010.53 | 0 | 1010.53 | 1193.51 | 1193.51 |
| 15 | 1.37064 | 1493.83 | 16.4346 | Overburden | 250 | 28 | 672.078 | 802.347 | 1038.81 | 0 | 1038.81 | 1237.06 | 1237.06 |
| 16 | 1.37064 | 1569.69 | 17.3663 | Overburden | 250 | 28 | 682.972 | 815.352 | 1063.27 | 0 | 1063.27 | 1276.86 | 1276.86 |
| 17 | 1.37064 | 1641.81 | 18.3028 | Overburden | 250 | 28 | 692.224 | 826.398 | 1084.05 | 0 | 1084.05 | 1313.02 | 1313.02 |
| 18 | 1.37064 | 1710.12 | 19.2443 | Overburden | 250 | 28 | 699.892 | 835.552 | 1101.26 | 0 | 1101.26 | 1345.6 | 1345.6 |
| 19 | 1.37064 | 1774.57 | 20.1914 | Overburden | 250 | 28 | 706.029 | 842.879 | 1115.04 | 0 | 1115.04 | 1374.69 | 1374.69 |
| 20 | 1.37064 | 1835.09 | 21.1442 | Overburden | 250 | 28 | 710.686 | 848.438 | 1125.5 | 0 | 1125.5 | 1400.36 | 1400.36 |
| 21 | 1.37064 | 1891.59 | 22.1031 | Overburden | 250 | 28 | 713.91 | 852.287 | 1132.73 | 0 | 1132.73 | 1422.67 | 1422.67 |
| 22 | 1.37064 | 1944 | 23.0687 | Overburden | 250 | 28 | 715.745 | 854.478 | 1136.86 | 0 | 1136.86 | 1441.68 | 1441.68 |
| 23 | 1.37064 | 1992.24 | 24.0412 | Overburden | 250 | 28 | 716.233 | 855.061 | 1137.96 | 0 | 1137.96 | 1457.46 | 1457.46 |
| 24 | 1.37064 | 2036.2 | 25.0211 | Overburden | 250 | 28 | 715.414 | 854.083 | 1136.12 | 0 | 1136.12 | 1470.04 | 1470.04 |
| 25 | 1.37064 | 2075.78 | 26.009 | Overburden | 250 | 28 | 713.324 | 851.588 | 1131.42 | 0 | 1131.42 | 1479.47 | 1479.47 |
| 26 | 1.37064 | 2110.89 | 27.0052 | Overburden | 250 | 28 | 709.999 | 847.618 | 1123.95 | 0 | 1123.95 | 1485.8 | 1485.8 |
| 27 | 1.37064 | 2141.39 | 28.0103 | Overburden | 250 | 28 | 705.468 | 842.209 | 1113.78 | 0 | 1113.78 | 1489.05 | 1489.05 |
| 28 | 1.37064 | 2167.16 | 29.0249 | Overburden | 250 | 28 | 699.764 | 835.399 | 1100.97 | 0 | 1100.97 | 1489.26 | 1489.26 |
| 29 | 1.37064 | 2188.07 | 30.0496 | Overburden | 250 | 28 | 692.913 | 827.22 | 1085.59 | 0 | 1085.59 | 1486.44 | 1486.44 |
| 30 | 1.37064 | 2203.95 | 31.085 | Overburden | 250 | 28 | 684.941 | 817.703 | 1067.69 | 0 | 1067.69 | 1480.63 | 1480.63 |
| 31 | 1.37064 | 2214.65 | 32.1318 | Overburden | 250 | 28 | 675.873 | 806.877 | 1047.33 | 0 | 1047.33 | 1471.83 | 1471.83 |
| 32 | 1.37064 | 2220 | 33.1908 | Overburden | 250 | 28 | 665.728 | 794.766 | 1024.56 | 0 | 1024.56 | 1460.04 | 1460.04 |
| 33 | 1.37064 | 2219.79 | 34.2627 | Overburden | 250 | 28 | 654.529 | 781.396 | 999.412 | 0 | 999.412 | 1445.28 | 1445.28 |
| 34 | 1.37064 | 2213.81 | 35.3485 | Overburden | 250 | 28 | 642.291 | 766.786 | 971.931 | 0 | 971.931 | 1427.51 | 1427.51 |
| 35 | 1.37064 | 2201.83 | 36.4491 | Overburden | 250 | 28 | 629.029 | 750.954 | 942.16 | 0 | 942.16 | 1406.75 | 1406.75 |
| 36 | 1.37064 | 2183.6 | 37.5655 | Overburden | 250 | 28 | 614.758 | 733.916 | 910.113 | 0 | 910.113 | 1382.95 | 1382.95 |
| 37 | 1.37064 | 2158.83 | 38.6989 | Overburden | 250 | 28 | 599.487 | 715.685 | 875.829 | 0 | 875.829 | 1356.09 | 1356.09 |
| 38 | 1.37064 | 2127.21 | 39.8506 | Overburden | 250 | 28 | 583.224 | 696.27 | 839.312 | 0 | 839.312 | 1326.11 | 1326.11 |
| 39 | 1.37064 | 2088.39 | 41.022 | Overburden | 250 | 28 | 565.973 | 675.675 | 800.58 | 0 | 800.58 | 1292.95 | 1292.95 |
| 40 | 1.37064 | 2041.99 | 42.2146 | Overburden | 250 | 28 | 547.736 | 653.904 | 759.633 | 0 | 759.633 | 1256.54 | 1256.54 |
| 41 | 1.37064 | 1987.57 | 43.4302 | Overburden | 250 | 28 | 528.511 | 630.952 | 716.47 | 0 | 716.47 | 1216.78 | 1216.78 |
| 42 | 1.37064 | 1924.64 | 44.6707 | Overburden | 250 | 28 | 508.29 | 606.812 | 671.068 | 0 | 671.068 | 1173.55 | 1173.55 |
| 43 | 1.37064 | 1852.66 | 45.9384 | Overburden | 250 | 28 | 487.06 | 581.467 | 623.4 | 0 | 623.4 | 1126.68 | 1126.68 |
| 44 | 1.37064 | 1730.38 | 47.2358 | Overburden | 250 | 28 | 458.393 | 547.243 | 559.033 | 0 | 559.033 | 1054.67 | 1054.67 |
| 45 | 1.37064 | 1502.8 | 48.5658 | Overburden | 250 | 28 | 414.346 | 494.659 | 460.137 | 0 | 460.137 | 929.555 | 929.555 |
| 46 | 1.37064 | 1260.07 | 49.9318 | Overburden | 250 | 28 | 369.625 | 441.269 | 359.725 | 0 | 359.725 | 799.163 | 799.163 |
| 47 | 1.37064 | 1005.1 | 51.3377 | Overburden | 250 | 28 | 324.787 | 387.741 | 259.053 | 0 | 259.053 | 665.001 | 665.001 |
| 48 | 1.37064 | 736.752 | 52.7882 | Overburden | 250 | 28 | 279.761 | 333.986 | 157.956 | 0 | 157.956 | 526.369 | 526.369 |
| 49 | 1.37064 | 453.643 | 54.2889 | Overburden | 250 | 28 | 234.451 | 279.894 | 56.2232 | 0 | 56.2232 | 382.363 | 382.363 |
| 50 | 1.37064 | 154.105 | 55.8465 | Overburden | 250 | 28 | 188.534 | 225.077 | -46.8729 | 0 | -46.8729 | 231.031 | 231.031 |

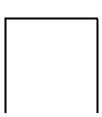
## *Interslice Data*

**Global Minimum Query (spencer) - Safety Factor**: 1.19383

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40.738 | 30.492 | 0 | 0 | 0 |
| 2 | 42.1087 | 30.5814 | 390.246 | 267.056 | 34.3849 |
| 3 | 43.4793 | 30.6923 | 806.483 | 551.898 | 34.3849 |
| 4 | 44.85 | 30.8248 | 1241.79 | 849.791 | 34.3849 |
| 5 | 46.2206 | 30.979 | 1689.81 | 1156.38 | 34.3848 |
| 6 | 47.5912 | 31.155 | 2144.7 | 1467.68 | 34.385 |
| 7 | 48.9619 | 31.3528 | 2601.11 | 1780.01 | 34.3849 |
| 8 | 50.3325 | 31.5728 | 3054.13 | 2090.02 | 34.3848 |
| 9 | 51.7031 | 31.815 | 3499.26 | 2394.64 | 34.3849 |
| 10 | 53.0738 | 32.0796 | 3932.43 | 2691.06 | 34.3848 |
| 11 | 54.4444 | 32.3669 | 4349.89 | 2976.75 | 34.3849 |
| 12 | 55.8151 | 32.677 | 4748.27 | 3249.37 | 34.3849 |
| 13 | 57.1857 | 33.0102 | 5124.52 | 3506.84 | 34.3848 |
| 14 | 58.5563 | 33.3669 | 5475.89 | 3747.29 | 34.3848 |
| 15 | 59.927 | 33.7472 | 5799.92 | 3969.04 | 34.3849 |
| 16 | 61.2976 | 34.1515 | 6094.44 | 4170.59 | 34.3849 |
| 17 | 62.6683 | 34.5801 | 6357.53 | 4350.63 | 34.3849 |
| 18 | 64.0389 | 35.0335 | 6587.54 | 4508.03 | 34.3849 |
| 19 | 65.4095 | 35.512 | 6783.04 | 4641.82 | 34.3849 |
| 20 | 66.7802 | 36.016 | 6942.86 | 4751.18 | 34.3849 |
| 21 | 68.1508 | 36.5461 | 7066.03 | 4835.47 | 34.3849 |
| 22 | 69.5215 | 37.1028 | 7151.81 | 4894.17 | 34.3849 |
| 23 | 70.8921 | 37.6865 | 7199.67 | 4926.93 | 34.3849 |
| 24 | 72.2627 | 38.2979 | 7209.31 | 4933.53 | 34.3849 |
| 25 | 73.6334 | 38.9377 | 7180.62 | 4913.89 | 34.3849 |
| 26 | 75.004 | 39.6065 | 7113.68 | 4868.08 | 34.3849 |
| 27 | 76.3746 | 40.305 | 7008.8 | 4796.31 | 34.3849 |
| 28 | 77.7453 | 41.0341 | 6866.48 | 4698.91 | 34.3848 |
| 29 | 79.1159 | 41.7946 | 6687.44 | 4576.39 | 34.3849 |
| 30 | 80.4866 | 42.5876 | 6472.6 | 4429.37 | 34.3849 |
| 31 | 81.8572 | 43.4139 | 6223.1 | 4258.63 | 34.3849 |
| 32 | 83.2278 | 44.2747 | 5940.31 | 4065.11 | 34.3849 |
| 33 | 84.5985 | 45.1714 | 5625.8 | 3849.89 | 34.3849 |
| 34 | 85.9691 | 46.105 | 5281.43 | 3614.23 | 34.3849 |
| 35 | 87.3398 | 47.0772 | 4909.29 | 3359.56 | 34.3849 |
| 36 | 88.7104 | 48.0896 | 4511.74 | 3087.5 | 34.3848 |
| 37 | 90.081 | 49.1438 | 4091.45 | 2799.89 | 34.3849 |
| 38 | 91.4517 | 50.2418 | 3651.4 | 2498.75 | 34.3849 |
| 39 | 92.8223 | 51.3859 | 3194.93 | 2186.37 | 34.3848 |
| 40 | 94.193 | 52.5783 | 2725.76 | 1865.31 | 34.3849 |
| 41 | 95.5636 | 53.8217 | 2248.08 | 1538.42 | 34.3849 |
| 42 | 96.9342 | 55.1192 | 1766.53 | 1208.88 | 34.3848 |
| 43 | 98.3049 | 56.4742 | 1286.36 | 880.287 | 34.3848 |
| 44 | 99.6755 | 57.8905 | 813.445 | 556.662 | 34.3849 |
| 45 | 101.046 | 59.3725 | 372.675 | 255.031 | 34.3848 |
| 46 | 102.417 | 60.9253 | 17.2179 | 11.7827 | 34.3849 |
| 47 | 103.787 | 62.5549 | -237.39 | -162.452 | 34.3848 |
| 48 | 105.158 | 64.268 | -375.539 | -256.991 | 34.3848 |
| 49 | 106.529 | 66.073 | -379.312 | -259.573 | 34.3848 |
| 50 | 107.899 | 67.9796 | -227.812 | -155.898 | 34.3849 |
| 51 | 109.27 | 70 | 0 | 0 | 0 |

## *Entity Information*

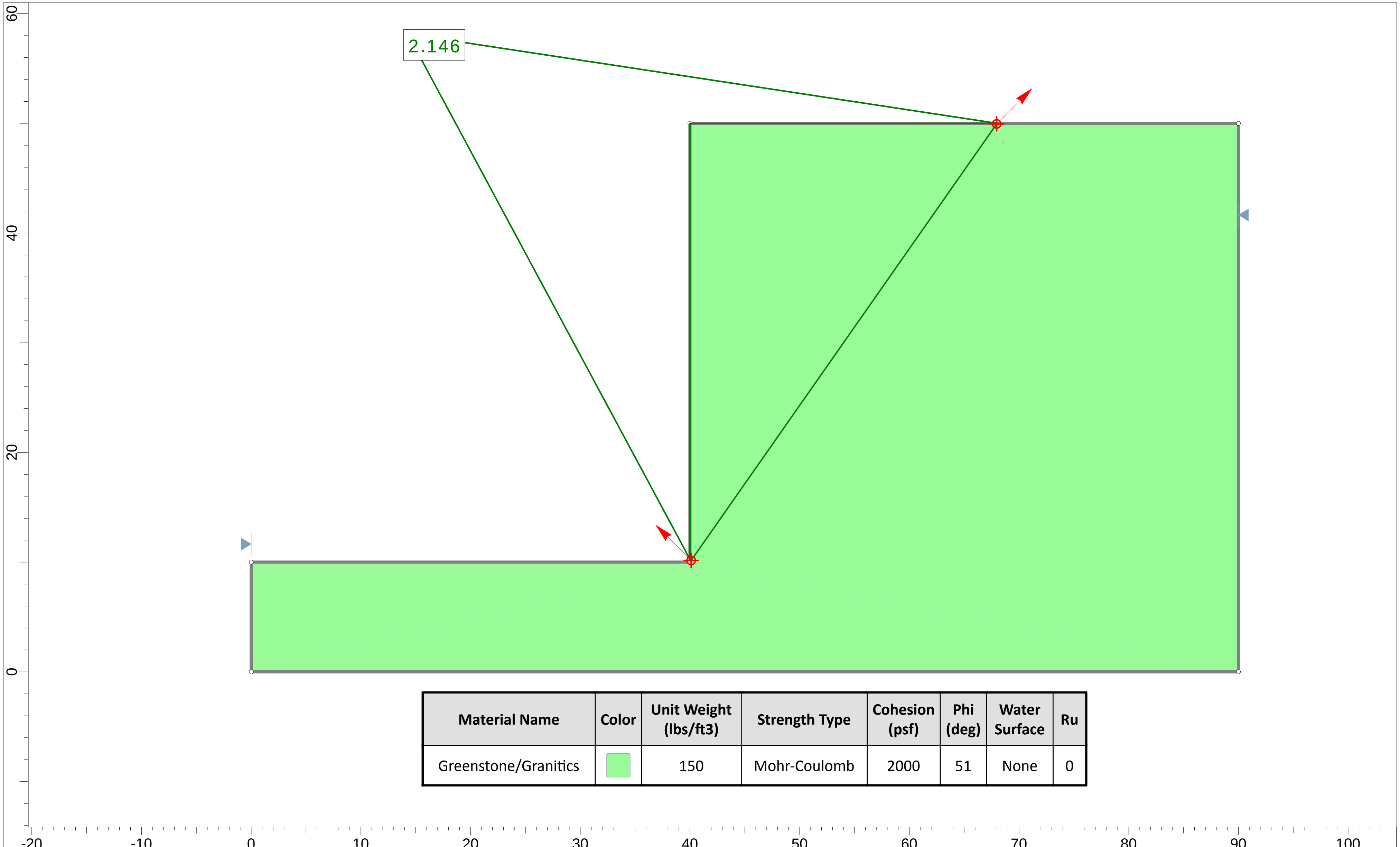
### External Boundary



| X | Y |
|---|---|
| 0 | 0 |
| 140 | 0 |
| 140 | 30 |
| 140 | 70 |
| 100 | 70 |
| 40 | 30 |
| 0 | 30 |

## Material Boundary

| X | Y |
|---|---|
| 40 | 30 |
| 140 | 30 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Greenstone/Granitics | | 150 | Mohr-Coulomb | 2000 | 51 | None | 0 |

**BAJADA Geosciences, Inc.**

SLIDEINTERPRET 8.023

| | |
|---|---|
| *Project* | Crystal Creek Quarry Expansion |
| *Analysis Description* | Planar Failure - Discontinuity at 55 degrees |
| *Drawn By* | J.Bianchin |
| *Scale* | 1:145 |
| *Company* | Bajada Geosciences, inc. |
| *Date* | 5-16-19 |
| *File Name* | 55deg.slmd |

# Slide Analysis Information

# 55deg

## Project Summary

| | |
|---|---|
| File Name: | 55deg.slmd |
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:02.646s |
| Project Title: | Crystal Creek Quarry Expansion |
| Analysis: | Planar Failure - Discontinuity at 55 degrees |
| Author: | J.Bianchin |
| Company: | Bajada Geosciences, inc. |
| Date Created: | 5-16-19 |

## 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** | |
| | Bishop simplified |
| | Janbu simplified |
| | 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: | Non-Circular Block Search |
| Number of Surfaces: | 5000 |
| Multiple Groups: | Disabled |
| Pseudo-Random Surfaces: | Enabled |
| Convex Surfaces Only: | Disabled |
| Left Projection Angle (Start Angle) [°]: | 135 |
| Left Projection Angle (End Angle) [°]: | 135 |
| Right Projection Angle (Start Angle) [°]: | 45 |
| Right Projection Angle (End Angle) [°]: | 45 |
| 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 | Greenstone/Granitics |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 150 |
| Cohesion [psf] | 2000 |
| Friction Angle [°] | 51 |
| Water Surface | None |
| Ru Value | 0 |

## Global Minimums

### Method: bishop simplified

| FS | 2.146330 |
|---|---|
| Axis Location: | 14.268, 58.147 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 68.017, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 68.017 50.000 |
| Resisting Moment: | 7.45506e+06 lb-ft |
| Driving Moment: | 3.4734e+06 lb-ft |
| Total Slice Area: | 559.987 ft2 |
| Surface Horizontal Width: | 28.017 ft |
| Surface Average Height: | 19.9874 ft |

### Method: janbu simplified

| FS | 2.371420 |
|---|---|
| Axis Location: | 14.268, 58.147 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 68.017, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 68.017 50.000 |
| Resisting Horizontal Force: | 93161.9 lb |
| Driving Horizontal Force: | 39285.3 lb |
| Total Slice Area: | 559.987 ft2 |
| Surface Horizontal Width: | 28.017 ft |
| Surface Average Height: | 19.9874 ft |

### Method: spencer

| FS | 2.993140 |
|---|---|
| Axis Location: | 14.268, 58.147 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 68.017, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 68.017 50.000 |
| Resisting Moment: | 8.41628e+06 lb-ft |
| Driving Moment: | 2.81185e+06 lb-ft |
| Resisting Horizontal Force: | 108502 lb |
| Driving Horizontal Force: | 36250.1 lb |
| Total Slice Area: | 559.987 ft2 |
| Surface Horizontal Width: | 28.017 ft |
| Surface Average Height: | 19.9874 ft |

## *Global Minimum Coordinates*

### Method: bishop simplified

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 67.9603 | 49.9433 |
| 68.017 | 50 |

### Method: janbu simplified

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 67.9603 | 49.9433 |
| 68.017 | 50 |

### Method: spencer

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 67.9603 | 49.9433 |
| 68.017 | 50 |

## *Valid/Invalid Surfaces*

### Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

### Method: janbu simplified

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

## *Slice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.14633**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 2000 | 51 | 10261 | 22023.4 | 16214.7 | 0 | 16214.7 | 5953.7 | 5953.7 |
| 2 | 0.580284 | 3432.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2380.97 | 5110.35 | 2518.71 | 0 | 2518.71 | 5920.1 | 5920.1 |
| 3 | 0.580284 | 3360.21 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2341.68 | 5026.01 | 2450.41 | 0 | 2450.41 | 5795.66 | 5795.66 |
| 4 | 0.580284 | 3288.05 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2302.38 | 4941.67 | 2382.11 | 0 | 2382.11 | 5671.23 | 5671.23 |
| 5 | 0.580284 | 3215.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2263.09 | 4857.33 | 2313.83 | 0 | 2313.83 | 5546.81 | 5546.81 |
| 6 | 0.580284 | 3143.74 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2223.79 | 4772.99 | 2245.53 | 0 | 2245.53 | 5422.37 | 5422.37 |
| 7 | 0.580284 | 3071.58 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2184.5 | 4688.65 | 2177.23 | 0 | 2177.23 | 5297.94 | 5297.94 |
| 8 | 0.580284 | 2999.42 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2145.2 | 4604.31 | 2108.93 | 0 | 2108.93 | 5173.51 | 5173.51 |
| 9 | 0.580284 | 2927.27 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2105.91 | 4519.98 | 2040.64 | 0 | 2040.64 | 5049.08 | 5049.08 |
| 10 | 0.580284 | 2855.11 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2066.62 | 4435.64 | 1972.34 | 0 | 1972.34 | 4924.65 | 4924.65 |
| 11 | 0.580284 | 2782.96 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2027.32 | 4351.3 | 1904.04 | 0 | 1904.04 | 4800.21 | 4800.21 |
| 12 | 0.580284 | 2710.8 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1988.03 | 4266.96 | 1835.74 | 0 | 1835.74 | 4675.78 | 4675.78 |
| 13 | 0.580284 | 2638.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1948.73 | 4182.62 | 1767.45 | 0 | 1767.45 | 4551.36 | 4551.36 |
| 14 | 0.580284 | 2566.49 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1909.44 | 4098.28 | 1699.16 | 0 | 1699.16 | 4426.92 | 4426.92 |
| 15 | 0.580284 | 2494.33 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1870.14 | 4013.94 | 1630.86 | 0 | 1630.86 | 4302.49 | 4302.49 |
| 16 | 0.580284 | 2422.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1830.85 | 3929.6 | 1562.56 | 0 | 1562.56 | 4178.06 | 4178.06 |
| 17 | 0.580284 | 2350.02 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1791.55 | 3845.26 | 1494.26 | 0 | 1494.26 | 4053.62 | 4053.62 |
| 18 | 0.580284 | 2277.86 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1752.26 | 3760.93 | 1425.97 | 0 | 1425.97 | 3929.2 | 3929.2 |
| 19 | 0.580284 | 2205.7 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1712.97 | 3676.59 | 1357.67 | 0 | 1357.67 | 3804.76 | 3804.76 |
| 20 | 0.580284 | 2133.55 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1673.67 | 3592.25 | 1289.38 | 0 | 1289.38 | 3680.34 | 3680.34 |
| 21 | 0.580284 | 2061.39 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1634.38 | 3507.91 | 1221.08 | 0 | 1221.08 | 3555.91 | 3555.91 |
| 22 | 0.580284 | 1989.24 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1595.08 | 3423.57 | 1152.79 | 0 | 1152.79 | 3431.47 | 3431.47 |
| 23 | 0.580284 | 1917.08 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1555.79 | 3339.23 | 1084.49 | 0 | 1084.49 | 3307.04 | 3307.04 |
| 24 | 0.580284 | 1844.92 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1516.49 | 3254.89 | 1016.19 | 0 | 1016.19 | 3182.61 | 3182.61 |
| 25 | 0.580284 | 1772.77 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1477.2 | 3170.55 | 947.896 | 0 | 947.896 | 3058.18 | 3058.18 |
| 26 | 0.580284 | 1700.61 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1437.9 | 3086.21 | 879.599 | 0 | 879.599 | 2933.74 | 2933.74 |
| 27 | 0.580284 | 1628.45 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1398.61 | 3001.88 | 811.303 | 0 | 811.303 | 2809.32 | 2809.32 |
| 28 | 0.580284 | 1556.3 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1359.31 | 2917.54 | 743.007 | 0 | 743.007 | 2684.88 | 2684.88 |
| 29 | 0.580284 | 1484.14 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1320.02 | 2833.2 | 674.711 | 0 | 674.711 | 2560.45 | 2560.45 |
| 30 | 0.580284 | 1411.98 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1280.73 | 2748.86 | 606.414 | 0 | 606.414 | 2436.02 | 2436.02 |
| 31 | 0.580284 | 1339.83 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1241.43 | 2664.52 | 538.118 | 0 | 538.118 | 2311.59 | 2311.59 |
| 32 | 0.580284 | 1267.67 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1202.14 | 2580.18 | 469.822 | 0 | 469.822 | 2187.16 | 2187.16 |
| 33 | 0.580284 | 1195.52 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1162.84 | 2495.84 | 401.526 | 0 | 401.526 | 2062.73 | 2062.73 |
| 34 | 0.580284 | 1123.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1123.55 | 2411.5 | 333.229 | 0 | 333.229 | 1938.3 | 1938.3 |
| 35 | 0.580284 | 1051.2 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1084.25 | 2327.16 | 264.933 | 0 | 264.933 | 1813.87 | 1813.87 |
| 36 | 0.580284 | 979.047 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1044.96 | 2242.83 | 196.637 | 0 | 196.637 | 1689.43 | 1689.43 |
| 37 | 0.580284 | 906.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1005.66 | 2158.49 | 128.34 | 0 | 128.34 | 1565 | 1565 |
| 38 | 0.580284 | 834.734 | 55.008 | Greenstone/Granitics | 2000 | 51 | 966.37 | 2074.15 | 60.0442 | 0 | 60.0442 | 1440.57 | 1440.57 |
| 39 | 0.580284 | 762.578 | 55.008 | Greenstone/Granitics | 2000 | 51 | 927.075 | 1989.81 | -8.25202 | 0 | -8.25202 | 1316.14 | 1316.14 |
| 40 | 0.580284 | 690.421 | 55.008 | Greenstone/Granitics | 2000 | 51 | 887.781 | 1905.47 | -76.5483 | 0 | -76.5483 | 1191.71 | 1191.71 |
| 41 | 0.580284 | 618.265 | 55.008 | Greenstone/Granitics | 2000 | 51 | 848.486 | 1821.13 | -144.845 | 0 | -144.845 | 1067.28 | 1067.28 |
| 42 | 0.580284 | 546.109 | 55.008 | Greenstone/Granitics | 2000 | 51 | 809.192 | 1736.79 | -213.141 | 0 | -213.141 | 942.848 | 942.848 |
| 43 | 0.580284 | 473.952 | 55.008 | Greenstone/Granitics | 2000 | 51 | 769.897 | 1652.45 | -281.437 | 0 | -281.437 | 818.416 | 818.416 |
| 44 | 0.580284 | 401.796 | 55.008 | Greenstone/Granitics | 2000 | 51 | 730.603 | 1568.12 | -349.734 | 0 | -349.734 | 693.985 | 693.985 |
| 45 | 0.580284 | 329.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 691.308 | 1483.78 | -418.029 | 0 | -418.029 | 569.554 | 569.554 |
| 46 | 0.580284 | 257.483 | 55.008 | Greenstone/Granitics | 2000 | 51 | 652.014 | 1399.44 | -486.326 | 0 | -486.326 | 445.123 | 445.123 |
| 47 | 0.580284 | 185.327 | 55.008 | Greenstone/Granitics | 2000 | 51 | 612.72 | 1315.1 | -554.622 | 0 | -554.622 | 320.692 | 320.692 |
| 48 | 0.580284 | 113.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 573.425 | 1230.76 | -622.919 | 0 | -622.919 | 196.26 | 196.26 |
| 49 | 0.580284 | 41.0141 | 55.008 | Greenstone/Granitics | 2000 | 51 | 534.131 | 1146.42 | -691.214 | 0 | -691.214 | 71.8296 | 71.8296 |
| 50 | 0.0567069 | 0.241176 | 45 | Greenstone/Granitics | 2000 | 51 | 593.381 | 1273.59 | -588.234 | 0 | -588.234 | 5.1476 | 5.1476 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 2.37142**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 2000 | 51 | 8238.65 | 19537.3 | 14201.5 | 0 | 14201.5 | 5962.8 | 5962.8 |
| 2 | 0.580284 | 3432.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2250.59 | 5337.09 | 2702.32 | 0 | 2702.32 | 5917.45 | 5917.45 |
| 3 | 0.580284 | 3360.21 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2213.45 | 5249.01 | 2630.99 | 0 | 2630.99 | 5793.06 | 5793.06 |
| 4 | 0.580284 | 3288.05 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2176.3 | 5160.93 | 2559.67 | 0 | 2559.67 | 5668.68 | 5668.68 |
| 5 | 0.580284 | 3215.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2139.16 | 5072.85 | 2488.34 | 0 | 2488.34 | 5544.28 | 5544.28 |
| 6 | 0.580284 | 3143.74 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2102.02 | 4984.77 | 2417.02 | 0 | 2417.02 | 5419.9 | 5419.9 |
| 7 | 0.580284 | 3071.58 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2064.88 | 4896.69 | 2345.69 | 0 | 2345.69 | 5295.51 | 5295.51 |
| 8 | 0.580284 | 2999.42 | 55.008 | Greenstone/Granitics | 2000 | 51 | 2027.73 | 4808.61 | 2274.36 | 0 | 2274.36 | 5171.13 | 5171.13 |
| 9 | 0.580284 | 2927.27 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1990.59 | 4720.52 | 2203.03 | 0 | 2203.03 | 5046.73 | 5046.73 |
| 10 | 0.580284 | 2855.11 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1953.45 | 4632.44 | 2131.71 | 0 | 2131.71 | 4922.35 | 4922.35 |
| 11 | 0.580284 | 2782.96 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1916.3 | 4544.36 | 2060.38 | 0 | 2060.38 | 4797.96 | 4797.96 |
| 12 | 0.580284 | 2710.8 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1879.16 | 4456.28 | 1989.06 | 0 | 1989.06 | 4673.57 | 4673.57 |
| 13 | 0.580284 | 2638.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1842.02 | 4368.2 | 1917.73 | 0 | 1917.73 | 4549.18 | 4549.18 |
| 14 | 0.580284 | 2566.49 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1804.88 | 4280.12 | 1846.41 | 0 | 1846.41 | 4424.8 | 4424.8 |
| 15 | 0.580284 | 2494.33 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1767.73 | 4192.04 | 1775.07 | 0 | 1775.07 | 4300.41 | 4300.41 |
| 16 | 0.580284 | 2422.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1730.59 | 4103.96 | 1703.75 | 0 | 1703.75 | 4176.03 | 4176.03 |
| 17 | 0.580284 | 2350.02 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1693.45 | 4015.88 | 1632.42 | 0 | 1632.42 | 4051.63 | 4051.63 |
| 18 | 0.580284 | 2277.86 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1656.31 | 3927.8 | 1561.1 | 0 | 1561.1 | 3927.25 | 3927.25 |
| 19 | 0.580284 | 2205.7 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1619.16 | 3839.72 | 1489.77 | 0 | 1489.77 | 3802.86 | 3802.86 |
| 20 | 0.580284 | 2133.55 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1582.02 | 3751.63 | 1418.45 | 0 | 1418.45 | 3678.47 | 3678.47 |
| 21 | 0.580284 | 2061.39 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1544.88 | 3663.55 | 1347.11 | 0 | 1347.11 | 3554.08 | 3554.08 |
| 22 | 0.580284 | 1989.24 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1507.73 | 3575.47 | 1275.79 | 0 | 1275.79 | 3429.7 | 3429.7 |
| 23 | 0.580284 | 1917.08 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1470.59 | 3487.39 | 1204.46 | 0 | 1204.46 | 3305.31 | 3305.31 |
| 24 | 0.580284 | 1844.92 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1433.45 | 3399.31 | 1133.14 | 0 | 1133.14 | 3180.92 | 3180.92 |
| 25 | 0.580284 | 1772.77 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1396.31 | 3311.23 | 1061.81 | 0 | 1061.81 | 3056.53 | 3056.53 |
| 26 | 0.580284 | 1700.61 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1359.16 | 3223.15 | 990.487 | 0 | 990.487 | 2932.15 | 2932.15 |
| 27 | 0.580284 | 1628.45 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1322.02 | 3135.07 | 919.16 | 0 | 919.16 | 2807.76 | 2807.76 |
| 28 | 0.580284 | 1556.3 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1284.88 | 3046.99 | 847.833 | 0 | 847.833 | 2683.38 | 2683.38 |
| 29 | 0.580284 | 1484.14 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1247.74 | 2958.91 | 776.507 | 0 | 776.507 | 2558.99 | 2558.99 |
| 30 | 0.580284 | 1411.98 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1210.59 | 2870.82 | 705.18 | 0 | 705.18 | 2434.6 | 2434.6 |
| 31 | 0.580284 | 1339.83 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1173.45 | 2782.74 | 633.854 | 0 | 633.854 | 2310.21 | 2310.21 |
| 32 | 0.580284 | 1267.67 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1136.31 | 2694.66 | 562.527 | 0 | 562.527 | 2185.82 | 2185.82 |
| 33 | 0.580284 | 1195.52 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1099.17 | 2606.58 | 491.201 | 0 | 491.201 | 2061.44 | 2061.44 |
| 34 | 0.580284 | 1123.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1062.02 | 2518.5 | 419.874 | 0 | 419.874 | 1937.05 | 1937.05 |
| 35 | 0.580284 | 1051.2 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1024.88 | 2430.42 | 348.548 | 0 | 348.548 | 1812.66 | 1812.66 |
| 36 | 0.580284 | 979.047 | 55.008 | Greenstone/Granitics | 2000 | 51 | 987.737 | 2342.34 | 277.221 | 0 | 277.221 | 1688.27 | 1688.27 |
| 37 | 0.580284 | 906.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 950.594 | 2254.26 | 205.895 | 0 | 205.895 | 1563.89 | 1563.89 |
| 38 | 0.580284 | 834.734 | 55.008 | Greenstone/Granitics | 2000 | 51 | 913.451 | 2166.18 | 134.568 | 0 | 134.568 | 1439.5 | 1439.5 |
| 39 | 0.580284 | 762.578 | 55.008 | Greenstone/Granitics | 2000 | 51 | 876.309 | 2078.1 | 63.2413 | 0 | 63.2413 | 1315.11 | 1315.11 |
| 40 | 0.580284 | 690.421 | 55.008 | Greenstone/Granitics | 2000 | 51 | 839.166 | 1990.02 | -8.0852 | 0 | -8.0852 | 1190.72 | 1190.72 |
| 41 | 0.580284 | 618.265 | 55.008 | Greenstone/Granitics | 2000 | 51 | 802.024 | 1901.93 | -79.4117 | 0 | -79.4117 | 1066.34 | 1066.34 |
| 42 | 0.580284 | 546.109 | 55.008 | Greenstone/Granitics | 2000 | 51 | 764.881 | 1813.85 | -150.738 | 0 | -150.738 | 941.949 | 941.949 |
| 43 | 0.580284 | 473.952 | 55.008 | Greenstone/Granitics | 2000 | 51 | 727.738 | 1725.77 | -222.064 | 0 | -222.064 | 817.562 | 817.562 |
| 44 | 0.580284 | 401.796 | 55.008 | Greenstone/Granitics | 2000 | 51 | 690.596 | 1637.69 | -293.391 | 0 | -293.391 | 693.174 | 693.174 |
| 45 | 0.580284 | 329.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 653.453 | 1549.61 | -364.718 | 0 | -364.718 | 568.786 | 568.786 |
| 46 | 0.580284 | 257.483 | 55.008 | Greenstone/Granitics | 2000 | 51 | 616.31 | 1461.53 | -436.045 | 0 | -436.045 | 444.398 | 444.398 |
| 47 | 0.580284 | 185.327 | 55.008 | Greenstone/Granitics | 2000 | 51 | 579.167 | 1373.45 | -507.371 | 0 | -507.371 | 320.01 | 320.01 |
| 48 | 0.580284 | 113.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 542.025 | 1285.37 | -578.698 | 0 | -578.698 | 195.623 | 195.623 |
| 49 | 0.580284 | 41.0141 | 55.008 | Greenstone/Granitics | 2000 | 51 | 504.882 | 1197.29 | -650.024 | 0 | -650.024 | 71.2354 | 71.2354 |
| 50 | 0.0567069 | 0.241176 | 45 | Greenstone/Granitics | 2000 | 51 | 556.186 | 1318.95 | -551.503 | 0 | -551.503 | 4.68225 | 4.68225 |

- **Global Minimum Query (spencer) - Safety Factor: 2.99314**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 2000 | 51 | 39613.2 | 118568 | 94394.8 | 0 | 94394.8 | 54781.6 | 54781.6 |
| 2 | 0.580284 | 3432.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1763.5 | 5278.4 | 2654.79 | 0 | 2654.79 | 5174.07 | 5174.07 |
| 3 | 0.580284 | 3360.21 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1737.33 | 5200.08 | 2591.37 | 0 | 2591.37 | 5073.28 | 5073.28 |
| 4 | 0.580284 | 3288.05 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1711.17 | 5121.76 | 2527.95 | 0 | 2527.95 | 4972.47 | 4972.47 |
| 5 | 0.580284 | 3215.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1685 | 5043.44 | 2464.53 | 0 | 2464.53 | 4871.67 | 4871.67 |
| 6 | 0.580284 | 3143.74 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1658.84 | 4965.13 | 2401.12 | 0 | 2401.12 | 4770.88 | 4770.88 |
| 7 | 0.580284 | 3071.58 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1632.67 | 4886.81 | 2337.69 | 0 | 2337.69 | 4670.08 | 4670.08 |
| 8 | 0.580284 | 2999.42 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1606.5 | 4808.49 | 2274.28 | 0 | 2274.28 | 4569.28 | 4569.28 |
| 9 | 0.580284 | 2927.27 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1580.34 | 4730.18 | 2210.85 | 0 | 2210.85 | 4468.48 | 4468.48 |
| 10 | 0.580284 | 2855.11 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1554.17 | 4651.86 | 2147.43 | 0 | 2147.43 | 4367.68 | 4367.68 |
| 11 | 0.580284 | 2782.96 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1528.01 | 4573.54 | 2084.01 | 0 | 2084.01 | 4266.88 | 4266.88 |
| 12 | 0.580284 | 2710.8 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1501.84 | 4495.22 | 2020.59 | 0 | 2020.59 | 4166.08 | 4166.08 |
| 13 | 0.580284 | 2638.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1475.68 | 4416.91 | 1957.17 | 0 | 1957.17 | 4065.28 | 4065.28 |
| 14 | 0.580284 | 2566.49 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1449.51 | 4338.59 | 1893.75 | 0 | 1893.75 | 3964.48 | 3964.48 |
| 15 | 0.580284 | 2494.33 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1423.34 | 4260.27 | 1830.34 | 0 | 1830.34 | 3863.69 | 3863.69 |
| 16 | 0.580284 | 2422.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1397.18 | 4181.96 | 1766.91 | 0 | 1766.91 | 3762.88 | 3762.88 |
| 17 | 0.580284 | 2350.02 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1371.02 | 4103.64 | 1703.5 | 0 | 1703.5 | 3662.09 | 3662.09 |
| 18 | 0.580284 | 2277.86 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1344.85 | 4025.32 | 1640.07 | 0 | 1640.07 | 3561.28 | 3561.28 |
| 19 | 0.580284 | 2205.7 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1318.68 | 3947 | 1576.65 | 0 | 1576.65 | 3460.49 | 3460.49 |
| 20 | 0.580284 | 2133.55 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1292.52 | 3868.69 | 1513.23 | 0 | 1513.23 | 3359.68 | 3359.68 |
| 21 | 0.580284 | 2061.39 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1266.35 | 3790.37 | 1449.81 | 0 | 1449.81 | 3258.89 | 3258.89 |
| 22 | 0.580284 | 1989.24 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1240.19 | 3712.05 | 1386.39 | 0 | 1386.39 | 3158.08 | 3158.08 |
| 23 | 0.580284 | 1917.08 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1214.02 | 3633.73 | 1322.97 | 0 | 1322.97 | 3057.29 | 3057.29 |
| 24 | 0.580284 | 1844.92 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1187.86 | 3555.42 | 1259.56 | 0 | 1259.56 | 2956.49 | 2956.49 |
| 25 | 0.580284 | 1772.77 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1161.69 | 3477.1 | 1196.13 | 0 | 1196.13 | 2855.69 | 2855.69 |
| 26 | 0.580284 | 1700.61 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1135.52 | 3398.78 | 1132.72 | 0 | 1132.72 | 2754.89 | 2754.89 |
| 27 | 0.580284 | 1628.45 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1109.36 | 3320.47 | 1069.29 | 0 | 1069.29 | 2654.09 | 2654.09 |
| 28 | 0.580284 | 1556.3 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1083.19 | 3242.15 | 1005.87 | 0 | 1005.87 | 2553.29 | 2553.29 |
| 29 | 0.580284 | 1484.14 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1057.03 | 3163.83 | 942.453 | 0 | 942.453 | 2452.49 | 2452.49 |
| 30 | 0.580284 | 1411.98 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1030.86 | 3085.51 | 879.032 | 0 | 879.032 | 2351.69 | 2351.69 |
| 31 | 0.580284 | 1339.83 | 55.008 | Greenstone/Granitics | 2000 | 51 | 1004.7 | 3007.2 | 815.613 | 0 | 815.613 | 2250.89 | 2250.89 |
| 32 | 0.580284 | 1267.67 | 55.008 | Greenstone/Granitics | 2000 | 51 | 978.531 | 2928.88 | 752.192 | 0 | 752.192 | 2150.09 | 2150.09 |
| 33 | 0.580284 | 1195.52 | 55.008 | Greenstone/Granitics | 2000 | 51 | 952.365 | 2850.56 | 688.773 | 0 | 688.773 | 2049.29 | 2049.29 |
| 34 | 0.580284 | 1123.36 | 55.008 | Greenstone/Granitics | 2000 | 51 | 926.2 | 2772.25 | 625.353 | 0 | 625.353 | 1948.5 | 1948.5 |
| 35 | 0.580284 | 1051.2 | 55.008 | Greenstone/Granitics | 2000 | 51 | 900.034 | 2693.93 | 561.932 | 0 | 561.932 | 1847.7 | 1847.7 |
| 36 | 0.580284 | 979.047 | 55.008 | Greenstone/Granitics | 2000 | 51 | 873.869 | 2615.61 | 498.513 | 0 | 498.513 | 1746.9 | 1746.9 |
| 37 | 0.580284 | 906.89 | 55.008 | Greenstone/Granitics | 2000 | 51 | 847.703 | 2537.3 | 435.092 | 0 | 435.092 | 1646.1 | 1646.1 |
| 38 | 0.580284 | 834.734 | 55.008 | Greenstone/Granitics | 2000 | 51 | 821.538 | 2458.98 | 371.673 | 0 | 371.673 | 1545.3 | 1545.3 |
| 39 | 0.580284 | 762.578 | 55.008 | Greenstone/Granitics | 2000 | 51 | 795.372 | 2380.66 | 308.253 | 0 | 308.253 | 1444.5 | 1444.5 |
| 40 | 0.580284 | 690.421 | 55.008 | Greenstone/Granitics | 2000 | 51 | 769.207 | 2302.34 | 244.833 | 0 | 244.833 | 1343.7 | 1343.7 |
| 41 | 0.580284 | 618.265 | 55.008 | Greenstone/Granitics | 2000 | 51 | 743.041 | 2224.03 | 181.413 | 0 | 181.413 | 1242.9 | 1242.9 |
| 42 | 0.580284 | 546.109 | 55.008 | Greenstone/Granitics | 2000 | 51 | 716.876 | 2145.71 | 117.992 | 0 | 117.992 | 1142.1 | 1142.1 |
| 43 | 0.580284 | 473.952 | 55.008 | Greenstone/Granitics | 2000 | 51 | 690.71 | 2067.39 | 54.5726 | 0 | 54.5726 | 1041.3 | 1041.3 |
| 44 | 0.580284 | 401.796 | 55.008 | Greenstone/Granitics | 2000 | 51 | 664.544 | 1989.07 | -8.84734 | 0 | -8.84734 | 940.502 | 940.502 |
| 45 | 0.580284 | 329.64 | 55.008 | Greenstone/Granitics | 2000 | 51 | 638.379 | 1910.76 | -72.2673 | 0 | -72.2673 | 839.702 | 839.702 |
| 46 | 0.580284 | 257.483 | 55.008 | Greenstone/Granitics | 2000 | 51 | 612.213 | 1832.44 | -135.687 | 0 | -135.687 | 738.903 | 738.903 |
| 47 | 0.580284 | 185.327 | 55.008 | Greenstone/Granitics | 2000 | 51 | 586.048 | 1754.12 | -199.107 | 0 | -199.107 | 638.104 | 638.104 |
| 48 | 0.580284 | 113.17 | 55.008 | Greenstone/Granitics | 2000 | 51 | 559.882 | 1675.81 | -262.527 | 0 | -262.527 | 537.305 | 537.305 |
| 49 | 0.580284 | 41.0141 | 55.008 | Greenstone/Granitics | 2000 | 51 | 533.717 | 1597.49 | -325.948 | 0 | -325.948 | 436.505 | 436.505 |
| 50 | 0.0567069 | 0.241176 | 45 | Greenstone/Granitics | 2000 | 51 | 562.379 | 1683.28 | -256.476 | 0 | -256.476 | 305.903 | 305.903 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.14633**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 2822.41 | 0 | 0 |
| 3 | 40.687 | 10.9814 | 2114.02 | 0 | 0 |
| 4 | 41.2672 | 11.8103 | 1439.47 | 0 | 0 |
| 5 | 41.8475 | 12.6393 | 798.77 | 0 | 0 |
| 6 | 42.4278 | 13.4683 | 191.919 | 0 | 0 |
| 7 | 43.0081 | 14.2973 | -381.084 | 0 | 0 |
| 8 | 43.5884 | 15.1262 | -920.238 | 0 | 0 |
| 9 | 44.1687 | 15.9552 | -1425.54 | 0 | 0 |
| 10 | 44.7489 | 16.7842 | -1897 | 0 | 0 |
| 11 | 45.3292 | 17.6132 | -2334.61 | 0 | 0 |
| 12 | 45.9095 | 18.4422 | -2738.37 | 0 | 0 |
| 13 | 46.4898 | 19.2711 | -3108.28 | 0 | 0 |
| 14 | 47.0701 | 20.1001 | -3444.34 | 0 | 0 |
| 15 | 47.6504 | 20.9291 | -3746.56 | 0 | 0 |
| 16 | 48.2306 | 21.7581 | -4014.93 | 0 | 0 |
| 17 | 48.8109 | 22.587 | -4249.44 | 0 | 0 |
| 18 | 49.3912 | 23.416 | -4450.11 | 0 | 0 |
| 19 | 49.9715 | 24.245 | -4616.93 | 0 | 0 |
| 20 | 50.5518 | 25.074 | -4749.91 | 0 | 0 |
| 21 | 51.1321 | 25.903 | -4849.03 | 0 | 0 |
| 22 | 51.7123 | 26.7319 | -4914.31 | 0 | 0 |
| 23 | 52.2926 | 27.5609 | -4945.73 | 0 | 0 |
| 24 | 52.8729 | 28.3899 | -4943.31 | 0 | 0 |
| 25 | 53.4532 | 29.2189 | -4907.04 | 0 | 0 |
| 26 | 54.0335 | 30.0478 | -4836.92 | 0 | 0 |
| 27 | 54.6138 | 30.8768 | -4732.96 | 0 | 0 |
| 28 | 55.1941 | 31.7058 | -4595.14 | 0 | 0 |
| 29 | 55.7743 | 32.5348 | -4423.48 | 0 | 0 |
| 30 | 56.3546 | 33.3637 | -4217.96 | 0 | 0 |
| 31 | 56.9349 | 34.1927 | -3978.6 | 0 | 0 |
| 32 | 57.5152 | 35.0217 | -3705.39 | 0 | 0 |
| 33 | 58.0955 | 35.8507 | -3398.34 | 0 | 0 |
| 34 | 58.6758 | 36.6797 | -3057.43 | 0 | 0 |
| 35 | 59.256 | 37.5086 | -2682.67 | 0 | 0 |
| 36 | 59.8363 | 38.3376 | -2274.07 | 0 | 0 |
| 37 | 60.4166 | 39.1666 | -1831.62 | 0 | 0 |
| 38 | 60.9969 | 39.9956 | -1355.32 | 0 | 0 |
| 39 | 61.5772 | 40.8245 | -845.171 | 0 | 0 |
| 40 | 62.1575 | 41.6535 | -301.174 | 0 | 0 |
| 41 | 62.7377 | 42.4825 | 276.672 | 0 | 0 |
| 42 | 63.318 | 43.3115 | 888.366 | 0 | 0 |
| 43 | 63.8983 | 44.1405 | 1533.91 | 0 | 0 |
| 44 | 64.4786 | 44.9694 | 2213.3 | 0 | 0 |
| 45 | 65.0589 | 45.7984 | 2926.54 | 0 | 0 |
| 46 | 65.6392 | 46.6274 | 3673.63 | 0 | 0 |
| 47 | 66.2195 | 47.4564 | 4454.56 | 0 | 0 |
| 48 | 66.7997 | 48.2853 | 5269.35 | 0 | 0 |
| 49 | 67.38 | 49.1143 | 6117.98 | 0 | 0 |
| 50 | 67.9603 | 49.9433 | 7000.46 | 0 | 0 |
| 51 | 68.017 | 50 | 0 | 0 | 0 |

- **Global Minimum Query (janbu simplified) - Safety Factor: 2.37142**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 2392.93 | 0 | 0 |
| 3 | 40.687 | 10.9814 | 1457.74 | 0 | 0 |
| 4 | 41.2672 | 11.8103 | 560.14 | 0 | 0 |
| 5 | 41.8475 | 12.6393 | -299.868 | 0 | 0 |
| 6 | 42.4278 | 13.4683 | -1122.29 | 0 | 0 |
| 7 | 43.0081 | 14.2973 | -1907.11 | 0 | 0 |
| 8 | 43.5884 | 15.1262 | -2654.35 | 0 | 0 |
| 9 | 44.1687 | 15.9552 | -3363.99 | 0 | 0 |
| 10 | 44.7489 | 16.7842 | -4036.04 | 0 | 0 |
| 11 | 45.3292 | 17.6132 | -4670.5 | 0 | 0 |
| 12 | 45.9095 | 18.4422 | -5267.37 | 0 | 0 |
| 13 | 46.4898 | 19.2711 | -5826.65 | 0 | 0 |
| 14 | 47.0701 | 20.1001 | -6348.33 | 0 | 0 |
| 15 | 47.6504 | 20.9291 | -6832.43 | 0 | 0 |
| 16 | 48.2306 | 21.7581 | -7278.93 | 0 | 0 |
| 17 | 48.8109 | 22.587 | -7687.84 | 0 | 0 |
| 18 | 49.3912 | 23.416 | -8059.16 | 0 | 0 |
| 19 | 49.9715 | 24.245 | -8392.89 | 0 | 0 |
| 20 | 50.5518 | 25.074 | -8689.03 | 0 | 0 |
| 21 | 51.1321 | 25.903 | -8947.58 | 0 | 0 |
| 22 | 51.7123 | 26.7319 | -9168.53 | 0 | 0 |
| 23 | 52.2926 | 27.5609 | -9351.9 | 0 | 0 |
| 24 | 52.8729 | 28.3899 | -9497.67 | 0 | 0 |
| 25 | 53.4532 | 29.2189 | -9605.85 | 0 | 0 |
| 26 | 54.0335 | 30.0478 | -9676.44 | 0 | 0 |
| 27 | 54.6138 | 30.8768 | -9709.44 | 0 | 0 |
| 28 | 55.1941 | 31.7058 | -9704.84 | 0 | 0 |
| 29 | 55.7743 | 32.5348 | -9662.66 | 0 | 0 |
| 30 | 56.3546 | 33.3637 | -9582.88 | 0 | 0 |
| 31 | 56.9349 | 34.1927 | -9465.51 | 0 | 0 |
| 32 | 57.5152 | 35.0217 | -9310.55 | 0 | 0 |
| 33 | 58.0955 | 35.8507 | -9118 | 0 | 0 |
| 34 | 58.6758 | 36.6797 | -8887.86 | 0 | 0 |
| 35 | 59.256 | 37.5086 | -8620.13 | 0 | 0 |
| 36 | 59.8363 | 38.3376 | -8314.8 | 0 | 0 |
| 37 | 60.4166 | 39.1666 | -7971.89 | 0 | 0 |
| 38 | 60.9969 | 39.9956 | -7591.38 | 0 | 0 |
| 39 | 61.5772 | 40.8245 | -7173.28 | 0 | 0 |
| 40 | 62.1575 | 41.6535 | -6717.59 | 0 | 0 |
| 41 | 62.7377 | 42.4825 | -6224.31 | 0 | 0 |
| 42 | 63.318 | 43.3115 | -5693.44 | 0 | 0 |
| 43 | 63.8983 | 44.1405 | -5124.97 | 0 | 0 |
| 44 | 64.4786 | 44.9694 | -4518.92 | 0 | 0 |
| 45 | 65.0589 | 45.7984 | -3875.27 | 0 | 0 |
| 46 | 65.6392 | 46.6274 | -3194.03 | 0 | 0 |
| 47 | 66.2195 | 47.4564 | -2475.2 | 0 | 0 |
| 48 | 66.7997 | 48.2853 | -1718.78 | 0 | 0 |
| 49 | 67.38 | 49.1143 | -924.768 | 0 | 0 |
| 50 | 67.9603 | 49.9433 | -93.1638 | 0 | 0 |
| 51 | 68.017 | 50 | 0 | 0 | 0 |

- **Global Minimum Query (spencer) - Safety Factor: 2.99314**

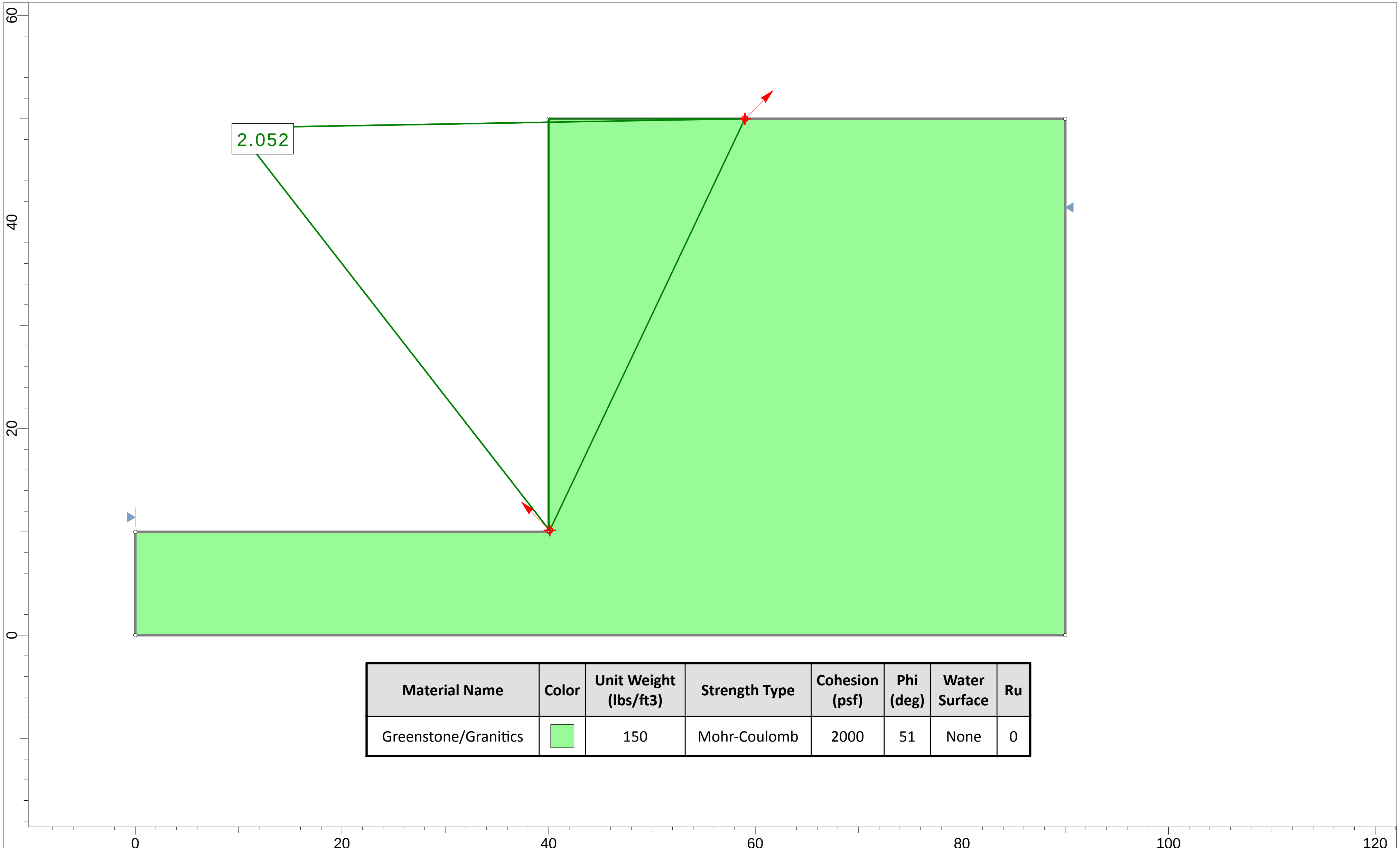
| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 14294.1 | 5227.53 | 20.0881 |
| 3 | 40.687 | 10.9814 | 13116.7 | 4796.93 | 20.0881 |
| 4 | 41.2672 | 11.8103 | 11976.7 | 4380 | 20.088 |
| 5 | 41.8475 | 12.6393 | 10874 | 3976.74 | 20.088 |
| 6 | 42.4278 | 13.4683 | 9808.73 | 3587.16 | 20.088 |
| 7 | 43.0081 | 14.2973 | 8780.85 | 3211.26 | 20.0881 |
| 8 | 43.5884 | 15.1262 | 7790.36 | 2849.02 | 20.088 |
| 9 | 44.1687 | 15.9552 | 6837.27 | 2500.47 | 20.0881 |
| 10 | 44.7489 | 16.7842 | 5921.56 | 2165.58 | 20.088 |
| 11 | 45.3292 | 17.6132 | 5043.25 | 1844.37 | 20.088 |
| 12 | 45.9095 | 18.4422 | 4202.32 | 1536.84 | 20.0881 |
| 13 | 46.4898 | 19.2711 | 3398.78 | 1242.97 | 20.088 |
| 14 | 47.0701 | 20.1001 | 2632.64 | 962.786 | 20.088 |
| 15 | 47.6504 | 20.9291 | 1903.89 | 696.273 | 20.088 |
| 16 | 48.2306 | 21.7581 | 1212.52 | 443.433 | 20.0881 |
| 17 | 48.8109 | 22.587 | 558.548 | 204.267 | 20.088 |
| 18 | 49.3912 | 23.416 | -58.0351 | -21.2241 | 20.088 |
| 19 | 49.9715 | 24.245 | -637.228 | -233.042 | 20.0881 |
| 20 | 50.5518 | 25.074 | -1179.03 | -431.185 | 20.0881 |
| 21 | 51.1321 | 25.903 | -1683.44 | -615.654 | 20.0881 |
| 22 | 51.7123 | 26.7319 | -2150.46 | -786.449 | 20.0881 |
| 23 | 52.2926 | 27.5609 | -2580.1 | -943.57 | 20.088 |
| 24 | 52.8729 | 28.3899 | -2972.34 | -1087.02 | 20.0881 |
| 25 | 53.4532 | 29.2189 | -3327.19 | -1216.79 | 20.088 |
| 26 | 54.0335 | 30.0478 | -3644.65 | -1332.89 | 20.088 |
| 27 | 54.6138 | 30.8768 | -3924.72 | -1435.31 | 20.088 |
| 28 | 55.1941 | 31.7058 | -4167.4 | -1524.06 | 20.088 |
| 29 | 55.7743 | 32.5348 | -4372.69 | -1599.14 | 20.088 |
| 30 | 56.3546 | 33.3637 | -4540.59 | -1660.54 | 20.088 |
| 31 | 56.9349 | 34.1927 | -4671.09 | -1708.27 | 20.088 |
| 32 | 57.5152 | 35.0217 | -4764.21 | -1742.33 | 20.0881 |
| 33 | 58.0955 | 35.8507 | -4819.94 | -1762.71 | 20.0881 |
| 34 | 58.6758 | 36.6797 | -4838.28 | -1769.41 | 20.088 |
| 35 | 59.256 | 37.5086 | -4819.22 | -1762.45 | 20.0881 |
| 36 | 59.8363 | 38.3376 | -4762.78 | -1741.8 | 20.088 |
| 37 | 60.4166 | 39.1666 | -4668.95 | -1707.49 | 20.0881 |
| 38 | 60.9969 | 39.9956 | -4537.72 | -1659.5 | 20.0881 |
| 39 | 61.5772 | 40.8245 | -4369.11 | -1597.83 | 20.088 |
| 40 | 62.1575 | 41.6535 | -4163.1 | -1522.49 | 20.088 |
| 41 | 62.7377 | 42.4825 | -3919.71 | -1433.48 | 20.088 |
| 42 | 63.318 | 43.3115 | -3638.92 | -1330.8 | 20.0881 |
| 43 | 63.8983 | 44.1405 | -3320.75 | -1214.44 | 20.0881 |
| 44 | 64.4786 | 44.9694 | -2965.18 | -1084.4 | 20.088 |
| 45 | 65.0589 | 45.7984 | -2572.23 | -940.692 | 20.088 |
| 46 | 65.6392 | 46.6274 | -2141.88 | -783.309 | 20.088 |
| 47 | 66.2195 | 47.4564 | -1674.14 | -612.252 | 20.088 |
| 48 | 66.7997 | 48.2853 | -1169.01 | -427.521 | 20.0881 |
| 49 | 67.38 | 49.1143 | -626.495 | -229.116 | 20.088 |
| 50 | 67.9603 | 49.9433 | -46.5867 | -17.0373 | 20.0881 |
| 51 | 68.017 | 50 | 0 | 0 | 0 |

## Entity Information

### Group: Group 1

#### Shared Entities

| Type | Coordinates | |
|---|---|---|
| | X | Y |
| External Boundary | 0 | 0 |
| | 90 | 0 |
| | 90 | 50 |
| | 40 | 50 |
| | 40 | 10 |
| | 0 | 10 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Greenstone/Granitics | | 150 | Mohr-Coulomb | 2000 | 51 | None | 0 |

**BAJADA Geosciences, Inc.**

| | | | |
|---|---|---|---|
| *Project* | Crystal Creek Quarry Expansion | | |
| *Analysis Description* | Planar Failure - Discontinuity at 65 degree | | |
| *Drawn By* J.Bianchin | *Scale* 1:154 | *Company* | Bajada Geosciences, Inc. |
| *Date* | 5-16-19 | *File Name* | 65deg.slmd |

SLIDEINTERPRET 8.023

# Slide Analysis Information

# 65deg

## Project Summary

| | |
|---|---|
| File Name: | 65deg.slmd |
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:00.286s |
| Project Title: | Crystal Creek Quarry Expansion |
| Analysis: | Planar Failure - Discontinuity at 65 degree |
| Author: | J.Bianchin |
| Company: | Bajada Geosciences, Inc. |
| Date Created: | 5-16-19 |

## 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** | |
| | Bishop simplified |
| | Janbu simplified |
| | 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: | Non-Circular Block Search |
| Number of Surfaces: | 5000 |
| Multiple Groups: | Disabled |
| Pseudo-Random Surfaces: | Enabled |
| Convex Surfaces Only: | Disabled |
| Left Projection Angle (Start Angle) [°]: | 135 |
| Left Projection Angle (End Angle) [°]: | 135 |
| Right Projection Angle (Start Angle) [°]: | 45 |
| Right Projection Angle (End Angle) [°]: | 45 |
| 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 | Greenstone/Granitics |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 150 |
| Cohesion [psf] | 2000 |
| Friction Angle [°] | 51 |
| Water Surface | None |
| Ru Value | 0 |

## Global Minimums

### Method: bishop simplified

| FS | 2.051790 |
|---|---|
| Axis Location: | 9.759, 49.130 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 59.000, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 59.000 50.000 |
| Resisting Moment: | 4.90376e+06 lb-ft |
| Driving Moment: | 2.38999e+06 lb-ft |
| Total Slice Area: | 380.672 ft2 |
| Surface Horizontal Width: | 19 ft |
| Surface Average Height: | 20.0354 ft |

### Method: janbu simplified

| | |
|---|---|
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

### Method: spencer

| | |
|---|---|
| Resisting Moment: | -0 lb-ft |
| Driving Moment: | 0 lb-ft |
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

## *Global Minimum Coordinates*

### Method: bishop simplified

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 59 | 50 |

## *Valid/Invalid Surfaces*

### Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

### Method: janbu simplified

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

#### Error Codes

*The following errors were encountered during the computation:*

-111 = safety factor equation did not converge

## *Slice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.05179**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 2000 | 51 | 11451.4 | 23495.9 | 17407 | 0 | 17407 | 5955.62 | 5955.62 |
| 2 | 0.385578 | 2281.14 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1999.87 | 4103.32 | 1703.23 | 0 | 1703.23 | 5921.13 | 5921.13 |
| 3 | 0.385578 | 2234.11 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1967.5 | 4036.9 | 1649.44 | 0 | 1649.44 | 5799.07 | 5799.07 |
| 4 | 0.385578 | 2187.07 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1935.12 | 3970.47 | 1595.66 | 0 | 1595.66 | 5677 | 5677 |
| 5 | 0.385578 | 2140.04 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1902.75 | 3904.05 | 1541.87 | 0 | 1541.87 | 5554.94 | 5554.94 |
| 6 | 0.385578 | 2093 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1870.38 | 3837.63 | 1488.09 | 0 | 1488.09 | 5432.88 | 5432.88 |
| 7 | 0.385578 | 2045.97 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1838.01 | 3771.21 | 1434.3 | 0 | 1434.3 | 5310.81 | 5310.81 |
| 8 | 0.385578 | 1998.94 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1805.64 | 3704.79 | 1380.51 | 0 | 1380.51 | 5188.75 | 5188.75 |
| 9 | 0.385578 | 1951.9 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1773.27 | 3638.37 | 1326.73 | 0 | 1326.73 | 5066.7 | 5066.7 |
| 10 | 0.385578 | 1904.87 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1740.89 | 3571.95 | 1272.94 | 0 | 1272.94 | 4944.63 | 4944.63 |
| 11 | 0.385578 | 1857.84 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1708.52 | 3505.52 | 1219.15 | 0 | 1219.15 | 4822.56 | 4822.56 |
| 12 | 0.385578 | 1810.8 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1676.15 | 3439.1 | 1165.36 | 0 | 1165.36 | 4700.49 | 4700.49 |
| 13 | 0.385578 | 1763.77 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1643.77 | 3372.68 | 1111.57 | 0 | 1111.57 | 4578.43 | 4578.43 |
| 14 | 0.385578 | 1716.73 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1611.4 | 3306.26 | 1057.79 | 0 | 1057.79 | 4456.37 | 4456.37 |
| 15 | 0.385578 | 1669.7 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1579.03 | 3239.84 | 1004 | 0 | 1004 | 4334.31 | 4334.31 |
| 16 | 0.385578 | 1622.67 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1546.66 | 3173.42 | 950.215 | 0 | 950.215 | 4212.25 | 4212.25 |
| 17 | 0.385578 | 1575.63 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1514.29 | 3107 | 896.428 | 0 | 896.428 | 4090.19 | 4090.19 |
| 18 | 0.385578 | 1528.6 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1481.91 | 3040.57 | 842.641 | 0 | 842.641 | 3968.11 | 3968.11 |
| 19 | 0.385578 | 1481.56 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1449.54 | 2974.15 | 788.854 | 0 | 788.854 | 3846.06 | 3846.06 |
| 20 | 0.385578 | 1434.53 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1417.17 | 2907.73 | 735.067 | 0 | 735.067 | 3723.99 | 3723.99 |
| 21 | 0.385578 | 1387.5 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1384.8 | 2841.31 | 681.28 | 0 | 681.28 | 3601.93 | 3601.93 |
| 22 | 0.385578 | 1340.46 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1352.42 | 2774.89 | 627.493 | 0 | 627.493 | 3479.87 | 3479.87 |
| 23 | 0.385578 | 1293.43 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1320.05 | 2708.47 | 573.706 | 0 | 573.706 | 3357.8 | 3357.8 |
| 24 | 0.385578 | 1246.4 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1287.68 | 2642.05 | 519.919 | 0 | 519.919 | 3235.74 | 3235.74 |
| 25 | 0.385578 | 1199.36 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1255.31 | 2575.63 | 466.132 | 0 | 466.132 | 3113.68 | 3113.68 |
| 26 | 0.385578 | 1152.33 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1222.93 | 2509.2 | 412.345 | 0 | 412.345 | 2991.62 | 2991.62 |
| 27 | 0.385578 | 1105.29 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1190.56 | 2442.78 | 358.558 | 0 | 358.558 | 2869.55 | 2869.55 |
| 28 | 0.385578 | 1058.26 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1158.19 | 2376.36 | 304.772 | 0 | 304.772 | 2747.49 | 2747.49 |
| 29 | 0.385578 | 1011.23 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1125.82 | 2309.94 | 250.983 | 0 | 250.983 | 2625.42 | 2625.42 |
| 30 | 0.385578 | 964.193 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1093.44 | 2243.52 | 197.197 | 0 | 197.197 | 2503.36 | 2503.36 |
| 31 | 0.385578 | 917.159 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1061.07 | 2177.1 | 143.41 | 0 | 143.41 | 2381.3 | 2381.3 |
| 32 | 0.385578 | 870.125 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 1028.7 | 2110.68 | 89.6231 | 0 | 89.6231 | 2259.24 | 2259.24 |
| 33 | 0.385578 | 823.091 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 996.327 | 2044.25 | 35.8362 | 0 | 35.8362 | 2137.17 | 2137.17 |
| 34 | 0.385578 | 776.058 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 963.955 | 1977.83 | -17.9509 | 0 | -17.9509 | 2015.11 | 2015.11 |
| 35 | 0.385578 | 729.024 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 931.582 | 1911.41 | -71.7378 | 0 | -71.7378 | 1893.05 | 1893.05 |
| 36 | 0.385578 | 681.99 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 899.21 | 1844.99 | -125.525 | 0 | -125.525 | 1770.98 | 1770.98 |
| 37 | 0.385578 | 634.956 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 866.837 | 1778.57 | -179.312 | 0 | -179.312 | 1648.92 | 1648.92 |
| 38 | 0.385578 | 587.922 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 834.465 | 1712.15 | -233.099 | 0 | -233.099 | 1526.86 | 1526.86 |
| 39 | 0.385578 | 540.889 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 802.093 | 1645.73 | -286.886 | 0 | -286.886 | 1404.79 | 1404.79 |
| 40 | 0.385578 | 493.855 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 769.72 | 1579.3 | -340.673 | 0 | -340.673 | 1282.73 | 1282.73 |
| 41 | 0.385578 | 446.821 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 737.348 | 1512.88 | -394.46 | 0 | -394.46 | 1160.67 | 1160.67 |
| 42 | 0.385578 | 399.787 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 704.976 | 1446.46 | -448.247 | 0 | -448.247 | 1038.61 | 1038.61 |
| 43 | 0.385578 | 352.753 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 672.603 | 1380.04 | -502.034 | 0 | -502.034 | 916.542 | 916.542 |
| 44 | 0.385578 | 305.72 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 640.231 | 1313.62 | -555.821 | 0 | -555.821 | 794.48 | 794.48 |
| 45 | 0.385578 | 258.686 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 607.859 | 1247.2 | -609.607 | 0 | -609.607 | 672.417 | 672.417 |
| 46 | 0.385578 | 211.652 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 575.486 | 1180.78 | -663.394 | 0 | -663.394 | 550.353 | 550.353 |
| 47 | 0.385578 | 164.618 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 543.114 | 1114.36 | -717.181 | 0 | -717.181 | 428.291 | 428.291 |
| 48 | 0.385578 | 117.584 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 510.741 | 1047.93 | -770.968 | 0 | -770.968 | 306.227 | 306.227 |
| 49 | 0.385578 | 70.5507 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 478.368 | 981.51 | -824.755 | 0 | -824.755 | 184.162 | 184.162 |
| 50 | 0.385578 | 23.5169 | 64.6325 | Greenstone/Granitics | 2000 | 51 | 445.996 | 915.09 | -878.542 | 0 | -878.542 | 62.1006 | 62.1006 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.05179**

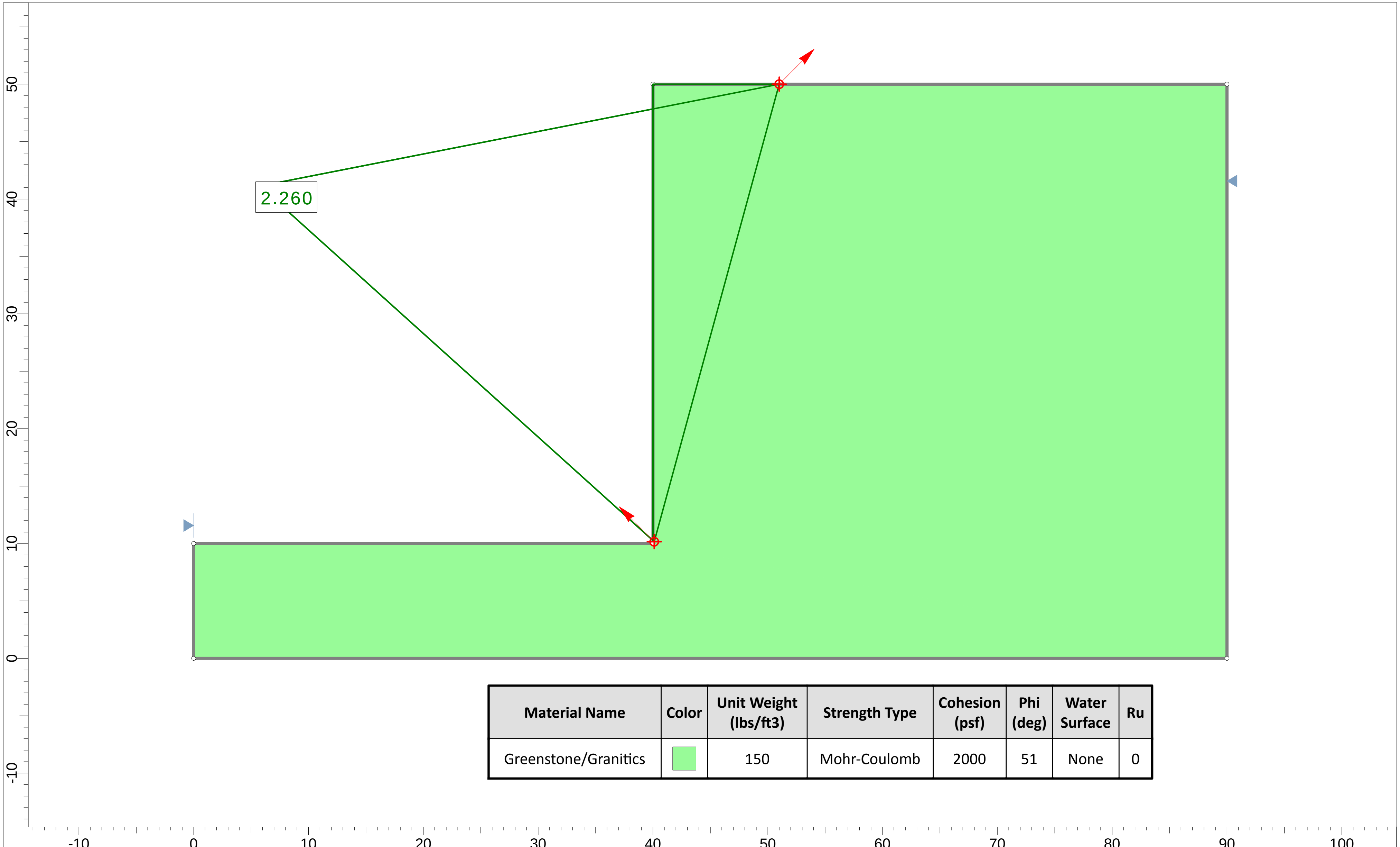
| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 3076.8 | 0 | 0 |
| 3 | 40.4922 | 10.9656 | 2461.9 | 0 | 0 |
| 4 | 40.8778 | 11.7788 | 1878.27 | 0 | 0 |
| 5 | 41.2634 | 12.592 | 1325.92 | 0 | 0 |
| 6 | 41.649 | 13.4052 | 804.836 | 0 | 0 |
| 7 | 42.0346 | 14.2185 | 315.029 | 0 | 0 |
| 8 | 42.4201 | 15.0317 | -143.506 | 0 | 0 |
| 9 | 42.8057 | 15.8449 | -570.767 | 0 | 0 |
| 10 | 43.1913 | 16.6581 | -966.755 | 0 | 0 |
| 11 | 43.5769 | 17.4713 | -1331.47 | 0 | 0 |
| 12 | 43.9624 | 18.2845 | -1664.91 | 0 | 0 |
| 13 | 44.348 | 19.0978 | -1967.08 | 0 | 0 |
| 14 | 44.7336 | 19.911 | -2237.98 | 0 | 0 |
| 15 | 45.1192 | 20.7242 | -2477.6 | 0 | 0 |
| 16 | 45.5048 | 21.5374 | -2685.95 | 0 | 0 |
| 17 | 45.8903 | 22.3506 | -2863.02 | 0 | 0 |
| 18 | 46.2759 | 23.1638 | -3008.83 | 0 | 0 |
| 19 | 46.6615 | 23.9771 | -3123.36 | 0 | 0 |
| 20 | 47.0471 | 24.7903 | -3206.61 | 0 | 0 |
| 21 | 47.4327 | 25.6035 | -3258.6 | 0 | 0 |
| 22 | 47.8182 | 26.4167 | -3279.31 | 0 | 0 |
| 23 | 48.2038 | 27.2299 | -3268.75 | 0 | 0 |
| 24 | 48.5894 | 28.0431 | -3226.91 | 0 | 0 |
| 25 | 48.975 | 28.8564 | -3153.8 | 0 | 0 |
| 26 | 49.3605 | 29.6696 | -3049.42 | 0 | 0 |
| 27 | 49.7461 | 30.4828 | -2913.77 | 0 | 0 |
| 28 | 50.1317 | 31.296 | -2746.84 | 0 | 0 |
| 29 | 50.5173 | 32.1092 | -2548.64 | 0 | 0 |
| 30 | 50.9029 | 32.9224 | -2319.17 | 0 | 0 |
| 31 | 51.2884 | 33.7357 | -2058.42 | 0 | 0 |
| 32 | 51.674 | 34.5489 | -1766.4 | 0 | 0 |
| 33 | 52.0596 | 35.3621 | -1443.11 | 0 | 0 |
| 34 | 52.4452 | 36.1753 | -1088.54 | 0 | 0 |
| 35 | 52.8307 | 36.9885 | -702.7 | 0 | 0 |
| 36 | 53.2163 | 37.8017 | -285.587 | 0 | 0 |
| 37 | 53.6019 | 38.615 | 162.798 | 0 | 0 |
| 38 | 53.9875 | 39.4282 | 642.457 | 0 | 0 |
| 39 | 54.3731 | 40.2414 | 1153.39 | 0 | 0 |
| 40 | 54.7586 | 41.0546 | 1695.59 | 0 | 0 |
| 41 | 55.1442 | 41.8678 | 2269.07 | 0 | 0 |
| 42 | 55.5298 | 42.681 | 2873.82 | 0 | 0 |
| 43 | 55.9154 | 43.4943 | 3509.85 | 0 | 0 |
| 44 | 56.301 | 44.3075 | 4177.14 | 0 | 0 |
| 45 | 56.6865 | 45.1207 | 4875.71 | 0 | 0 |
| 46 | 57.0721 | 45.9339 | 5605.56 | 0 | 0 |
| 47 | 57.4577 | 46.7471 | 6366.67 | 0 | 0 |
| 48 | 57.8433 | 47.5603 | 7159.06 | 0 | 0 |
| 49 | 58.2288 | 48.3736 | 7982.73 | 0 | 0 |
| 50 | 58.6144 | 49.1868 | 8837.66 | 0 | 0 |
| 51 | 59 | 50 | 0 | 0 | 0 |

## *Entity Information*

**Group: Group 1**

**Shared Entities**

| Type | Coordinates X | Coordinates Y |
|---|---|---|
| External Boundary | 0 | 0 |
| | 90 | 0 |
| | 90 | 50 |
| | 40 | 50 |
| | 40 | 10 |
| | 0 | 10 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Greenstone/Granitics | | 150 | Mohr-Coulomb | 2000 | 51 | None | 0 |

**BAJADA**
Geosciences, Inc.

SLIDEINTERPRET 8.023

| | |
|---|---|
| *Project* | Crystal Creek Quarry Expansion |
| *Analysis Description* | Planar Failure - Discontinuity at 75 degree |
| *Drawn By* J.Bianchin | *Scale* 1:139 |
| *Company* | Bajada Geosciences, Inc. |
| *Date* | 5-16-19 |
| *File Name* | 75deg.slmd |

# Slide Analysis Information

# 75deg

## Project Summary

| | |
|---|---|
| File Name: | 75deg.slmd |
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:00.288s |
| Project Title: | Crystal Creek Quarry Expansion |
| Analysis: | Planar Failure - Discontinuity at 75 degree |
| Author: | J.Bianchin |
| Company: | Bajada Geosciences, Inc. |
| Date Created: | 5-16-19 |

## 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** | |
| | Bishop simplified |
| | Janbu simplified |
| | 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: | Non-Circular Block Search |
| Number of Surfaces: | 5000 |
| Multiple Groups: | Disabled |
| Pseudo-Random Surfaces: | Enabled |
| Convex Surfaces Only: | Disabled |
| Left Projection Angle (Start Angle) [°]: | 135 |
| Left Projection Angle (End Angle) [°]: | 135 |
| Right Projection Angle (Start Angle) [°]: | 45 |
| Right Projection Angle (End Angle) [°]: | 45 |
| 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 | Greenstone/Granitics |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 150 |
| Cohesion [psf] | 2000 |
| Friction Angle [°] | 51 |
| Water Surface | None |
| Ru Value | 0 |

## Global Minimums

### Method: bishop simplified

| FS | 2.259910 |
|---|---|
| Axis Location: | 5.759, 41.130 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 51.000, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 51.000 50.000 |
| Resisting Moment: | 3.24504e+06 lb-ft |
| Driving Moment: | 1.43591e+06 lb-ft |
| Total Slice Area: | 221.281 ft2 |
| Surface Horizontal Width: | 11 ft |
| Surface Average Height: | 20.1165 ft |

### Method: janbu simplified

| | |
|---|---|
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

### Method: spencer

| | |
|---|---|
| Resisting Moment: | -0 lb-ft |
| Driving Moment: | 0 lb-ft |
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

## *Global Minimum Coordinates*

### Method: bishop simplified

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 51 | 50 |

## *Valid/Invalid Surfaces*

### Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

### Method: janbu simplified

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

#### Error Codes

*The following errors were encountered during the computation:*

-111 = safety factor equation did not converge

## *Slice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.25991**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 2000 | 51 | 9142 | 20660.1 | 15110.6 | 0 | 15110.6 | 5968.64 | 5968.64 |
| 2 | 0.222313 | 1315.24 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1373.17 | 3103.24 | 893.387 | 0 | 893.387 | 5916.42 | 5916.42 |
| 3 | 0.222313 | 1288.12 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1350.94 | 3053.01 | 852.71 | 0 | 852.71 | 5794.44 | 5794.44 |
| 4 | 0.222313 | 1261 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1328.72 | 3002.78 | 812.032 | 0 | 812.032 | 5672.45 | 5672.45 |
| 5 | 0.222313 | 1233.88 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1306.49 | 2952.54 | 771.354 | 0 | 771.354 | 5550.46 | 5550.46 |
| 6 | 0.222313 | 1206.76 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1284.26 | 2902.31 | 730.676 | 0 | 730.676 | 5428.47 | 5428.47 |
| 7 | 0.222313 | 1179.65 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1262.03 | 2852.08 | 689.999 | 0 | 689.999 | 5306.49 | 5306.49 |
| 8 | 0.222313 | 1152.53 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1239.8 | 2801.84 | 649.321 | 0 | 649.321 | 5184.5 | 5184.5 |
| 9 | 0.222313 | 1125.41 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1217.58 | 2751.61 | 608.642 | 0 | 608.642 | 5062.51 | 5062.51 |
| 10 | 0.222313 | 1098.29 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1195.35 | 2701.38 | 567.965 | 0 | 567.965 | 4940.53 | 4940.53 |
| 11 | 0.222313 | 1071.17 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1173.12 | 2651.14 | 527.287 | 0 | 527.287 | 4818.54 | 4818.54 |
| 12 | 0.222313 | 1044.05 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1150.89 | 2600.91 | 486.609 | 0 | 486.609 | 4696.55 | 4696.55 |
| 13 | 0.222313 | 1016.94 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1128.66 | 2550.68 | 445.932 | 0 | 445.932 | 4574.57 | 4574.57 |
| 14 | 0.222313 | 989.818 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1106.44 | 2500.45 | 405.254 | 0 | 405.254 | 4452.58 | 4452.58 |
| 15 | 0.222313 | 962.699 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1084.21 | 2450.21 | 364.576 | 0 | 364.576 | 4330.59 | 4330.59 |
| 16 | 0.222313 | 935.581 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1061.98 | 2399.98 | 323.898 | 0 | 323.898 | 4208.6 | 4208.6 |
| 17 | 0.222313 | 908.463 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1039.75 | 2349.75 | 283.221 | 0 | 283.221 | 4086.62 | 4086.62 |
| 18 | 0.222313 | 881.344 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 1017.53 | 2299.51 | 242.542 | 0 | 242.542 | 3964.63 | 3964.63 |
| 19 | 0.222313 | 854.226 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 995.297 | 2249.28 | 201.864 | 0 | 201.864 | 3842.64 | 3842.64 |
| 20 | 0.222313 | 827.108 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 973.069 | 2199.05 | 161.187 | 0 | 161.187 | 3720.66 | 3720.66 |
| 21 | 0.222313 | 799.99 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 950.841 | 2148.82 | 120.509 | 0 | 120.509 | 3598.67 | 3598.67 |
| 22 | 0.222313 | 772.871 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 928.614 | 2098.58 | 79.8312 | 0 | 79.8312 | 3476.68 | 3476.68 |
| 23 | 0.222313 | 745.753 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 906.386 | 2048.35 | 39.1534 | 0 | 39.1534 | 3354.7 | 3354.7 |
| 24 | 0.222313 | 718.635 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 884.158 | 1998.12 | -1.52445 | 0 | -1.52445 | 3232.71 | 3232.71 |
| 25 | 0.222313 | 691.516 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 861.93 | 1947.88 | -42.2023 | 0 | -42.2023 | 3110.72 | 3110.72 |
| 26 | 0.222313 | 664.398 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 839.702 | 1897.65 | -82.8801 | 0 | -82.8801 | 2988.74 | 2988.74 |
| 27 | 0.222313 | 637.28 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 817.475 | 1847.42 | -123.558 | 0 | -123.558 | 2866.75 | 2866.75 |
| 28 | 0.222313 | 610.161 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 795.247 | 1797.19 | -164.236 | 0 | -164.236 | 2744.76 | 2744.76 |
| 29 | 0.222313 | 583.043 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 773.019 | 1746.95 | -204.914 | 0 | -204.914 | 2622.78 | 2622.78 |
| 30 | 0.222313 | 555.925 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 750.791 | 1696.72 | -245.591 | 0 | -245.591 | 2500.79 | 2500.79 |
| 31 | 0.222313 | 528.807 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 728.563 | 1646.49 | -286.269 | 0 | -286.269 | 2378.8 | 2378.8 |
| 32 | 0.222313 | 501.688 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 706.335 | 1596.25 | -326.947 | 0 | -326.947 | 2256.81 | 2256.81 |
| 33 | 0.222313 | 474.57 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 684.107 | 1546.02 | -367.625 | 0 | -367.625 | 2134.83 | 2134.83 |
| 34 | 0.222313 | 447.452 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 661.879 | 1495.79 | -408.302 | 0 | -408.302 | 2012.84 | 2012.84 |
| 35 | 0.222313 | 420.333 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 639.652 | 1445.55 | -448.981 | 0 | -448.981 | 1890.85 | 1890.85 |
| 36 | 0.222313 | 393.215 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 617.424 | 1395.32 | -489.659 | 0 | -489.659 | 1768.87 | 1768.87 |
| 37 | 0.222313 | 366.097 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 595.196 | 1345.09 | -530.336 | 0 | -530.336 | 1646.88 | 1646.88 |
| 38 | 0.222313 | 338.979 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 572.968 | 1294.86 | -571.014 | 0 | -571.014 | 1524.89 | 1524.89 |
| 39 | 0.222313 | 311.86 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 550.741 | 1244.62 | -611.692 | 0 | -611.692 | 1402.91 | 1402.91 |
| 40 | 0.222313 | 284.742 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 528.513 | 1194.39 | -652.369 | 0 | -652.369 | 1280.92 | 1280.92 |
| 41 | 0.222313 | 257.624 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 506.285 | 1144.16 | -693.047 | 0 | -693.047 | 1158.93 | 1158.93 |
| 42 | 0.222313 | 230.505 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 484.057 | 1093.92 | -733.725 | 0 | -733.725 | 1036.95 | 1036.95 |
| 43 | 0.222313 | 203.387 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 461.829 | 1043.69 | -774.404 | 0 | -774.404 | 914.959 | 914.959 |
| 44 | 0.222313 | 176.269 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 439.602 | 993.46 | -815.08 | 0 | -815.08 | 792.974 | 792.974 |
| 45 | 0.222313 | 149.151 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 417.375 | 943.23 | -855.759 | 0 | -855.759 | 670.992 | 670.992 |
| 46 | 0.222313 | 122.032 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 395.144 | 892.99 | -896.437 | 0 | -896.437 | 548.993 | 548.993 |
| 47 | 0.222313 | 94.914 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 372.918 | 842.76 | -937.114 | 0 | -937.114 | 427.012 | 427.012 |
| 48 | 0.222313 | 67.7957 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 350.691 | 792.53 | -977.792 | 0 | -977.792 | 305.029 | 305.029 |
| 49 | 0.222313 | 40.6774 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 328.46 | 742.29 | -1018.47 | 0 | -1018.47 | 183.031 | 183.031 |
| 50 | 0.222313 | 13.5591 | 74.7104 | Greenstone/Granitics | 2000 | 51 | 306.233 | 692.06 | -1059.15 | 0 | -1059.15 | 61.0493 | 61.0493 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 2.25991**

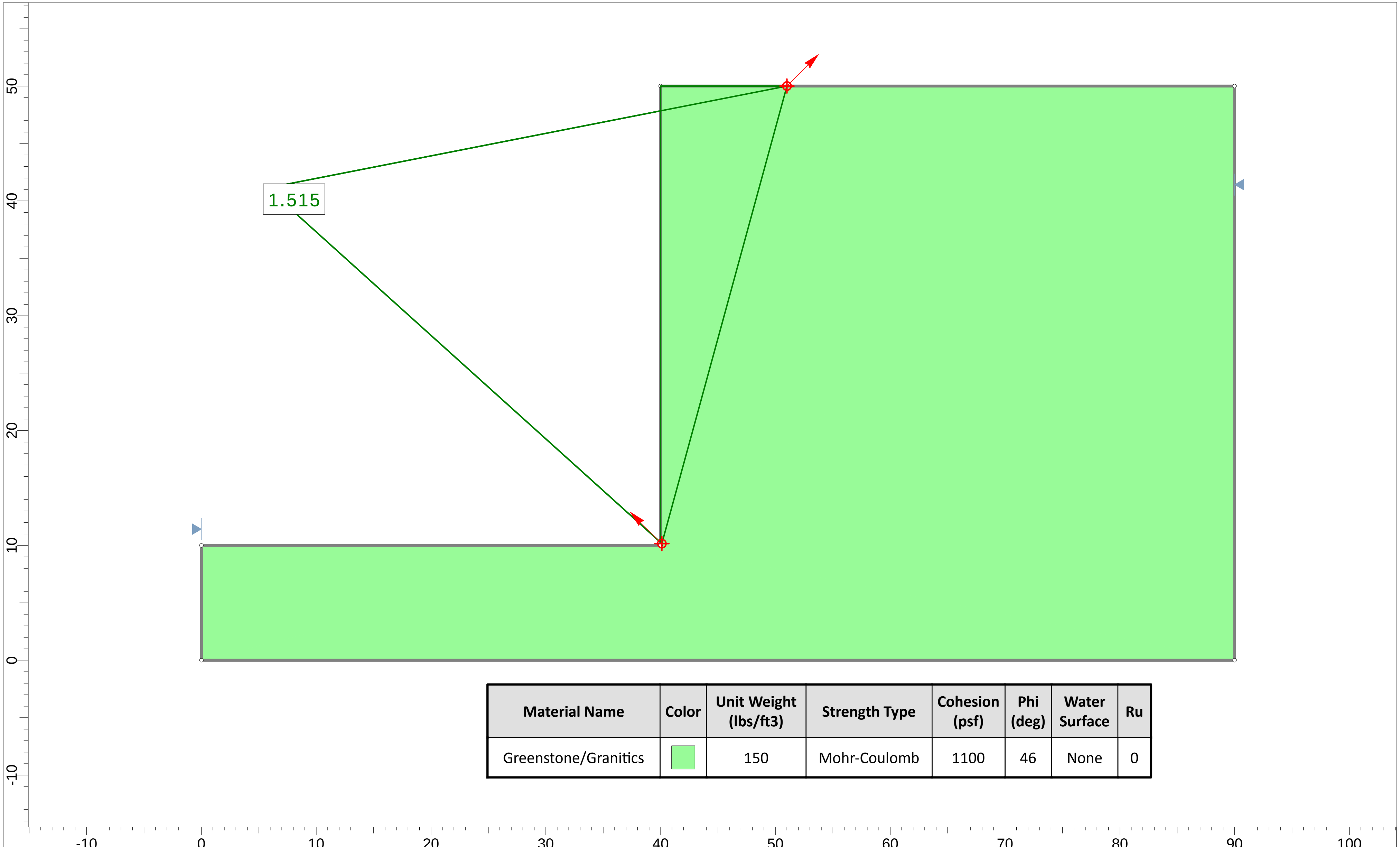
| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 2586.9 | 0 | 0 |
| 3 | 40.329 | 10.9656 | 2165.64 | 0 | 0 |
| 4 | 40.5513 | 11.7788 | 1772.51 | 0 | 0 |
| 5 | 40.7736 | 12.592 | 1407.53 | 0 | 0 |
| 6 | 40.9959 | 13.4052 | 1070.69 | 0 | 0 |
| 7 | 41.2182 | 14.2185 | 761.981 | 0 | 0 |
| 8 | 41.4405 | 15.0317 | 481.413 | 0 | 0 |
| 9 | 41.6629 | 15.8449 | 228.984 | 0 | 0 |
| 10 | 41.8852 | 16.6581 | 4.69415 | 0 | 0 |
| 11 | 42.1075 | 17.4713 | -191.457 | 0 | 0 |
| 12 | 42.3298 | 18.2845 | -359.47 | 0 | 0 |
| 13 | 42.5521 | 19.0978 | -499.345 | 0 | 0 |
| 14 | 42.7744 | 19.911 | -611.081 | 0 | 0 |
| 15 | 42.9967 | 20.7242 | -694.678 | 0 | 0 |
| 16 | 43.219 | 21.5374 | -750.136 | 0 | 0 |
| 17 | 43.4414 | 22.3506 | -777.456 | 0 | 0 |
| 18 | 43.6637 | 23.1638 | -776.638 | 0 | 0 |
| 19 | 43.886 | 23.9771 | -747.68 | 0 | 0 |
| 20 | 44.1083 | 24.7903 | -690.584 | 0 | 0 |
| 21 | 44.3306 | 25.6035 | -605.35 | 0 | 0 |
| 22 | 44.5529 | 26.4167 | -491.977 | 0 | 0 |
| 23 | 44.7752 | 27.2299 | -350.465 | 0 | 0 |
| 24 | 44.9976 | 28.0431 | -180.815 | 0 | 0 |
| 25 | 45.2199 | 28.8564 | 16.9742 | 0 | 0 |
| 26 | 45.4422 | 29.6696 | 242.902 | 0 | 0 |
| 27 | 45.6645 | 30.4828 | 496.968 | 0 | 0 |
| 28 | 45.8868 | 31.296 | 779.173 | 0 | 0 |
| 29 | 46.1091 | 32.1092 | 1089.52 | 0 | 0 |
| 30 | 46.3314 | 32.9224 | 1428 | 0 | 0 |
| 31 | 46.5537 | 33.7357 | 1794.62 | 0 | 0 |
| 32 | 46.7761 | 34.5489 | 2189.38 | 0 | 0 |
| 33 | 46.9984 | 35.3621 | 2612.28 | 0 | 0 |
| 34 | 47.2207 | 36.1753 | 3063.31 | 0 | 0 |
| 35 | 47.443 | 36.9885 | 3542.49 | 0 | 0 |
| 36 | 47.6653 | 37.8017 | 4049.8 | 0 | 0 |
| 37 | 47.8876 | 38.615 | 4585.25 | 0 | 0 |
| 38 | 48.1099 | 39.4282 | 5148.84 | 0 | 0 |
| 39 | 48.3322 | 40.2414 | 5740.57 | 0 | 0 |
| 40 | 48.5546 | 41.0546 | 6360.44 | 0 | 0 |
| 41 | 48.7769 | 41.8678 | 7008.45 | 0 | 0 |
| 42 | 48.9992 | 42.681 | 7684.59 | 0 | 0 |
| 43 | 49.2215 | 43.4943 | 8388.88 | 0 | 0 |
| 44 | 49.4438 | 44.3075 | 9121.3 | 0 | 0 |
| 45 | 49.6661 | 45.1207 | 9881.86 | 0 | 0 |
| 46 | 49.8884 | 45.9339 | 10670.6 | 0 | 0 |
| 47 | 50.1107 | 46.7471 | 11487.4 | 0 | 0 |
| 48 | 50.3331 | 47.5603 | 12332.4 | 0 | 0 |
| 49 | 50.5554 | 48.3736 | 13205.5 | 0 | 0 |
| 50 | 50.7777 | 49.1868 | 14106.7 | 0 | 0 |
| 51 | 51 | 50 | 0 | 0 | 0 |

## *Entity Information*

**Group: Group 1**

**Shared Entities**

| Type | Coordinates X | Coordinates Y |
|---|---|---|
| External Boundary | 0 | 0 |
| | 90 | 0 |
| | 90 | 50 |
| | 40 | 50 |
| | 40 | 10 |
| | 0 | 10 |




| Material Name | Color | Unit Weight (lbs/ft3) | Strength Type | Cohesion (psf) | Phi (deg) | Water Surface | Ru |
|---|---|---|---|---|---|---|---|
| Greenstone/Granitics | | 150 | Mohr-Coulomb | 1100 | 46 | None | 0 |

BAJADA Geosciences, Inc.

SLIDEINTERPRET 8.023

| | | | |
|---|---|---|---|
| Project | Crystal Creek Quarry Expansion | | |
| Analysis Description | Planar Failure - Discontinuity at 75 degree - Backcalculate Strength | | |
| Drawn By: J.Bianchin | Scale: 1:139 | Company | Bajada Geosciences, Inc. |
| Date | 5-16-19 | File Name | 75PlanarBackCalculate.slmd |

# Slide Analysis Information

# 75PlanarBackCalculate

## Project Summary

| | |
|---|---|
| File Name: | 75PlanarBackCalculate.slmd |
| Slide Modeler Version: | 8.023 |
| Compute Time: | 00h:00m:00.312s |
| Project Title: | Crystal Creek Quarry Expansion |
| Analysis: | Planar Failure - Discontinuity at 75 degree - Backcalculate Strength |
| Author: | J.Bianchin |
| Company: | Bajada Geosciences, Inc. |
| Date Created: | 5-16-19 |

## 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** | |
| | Bishop simplified |
| | Janbu simplified |
| | 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: | Non-Circular Block Search |
| Number of Surfaces: | 5000 |
| Multiple Groups: | Disabled |
| Pseudo-Random Surfaces: | Enabled |
| Convex Surfaces Only: | Disabled |
| Left Projection Angle (Start Angle) [°]: | 135 |
| Left Projection Angle (End Angle) [°]: | 135 |
| Right Projection Angle (Start Angle) [°]: | 45 |
| Right Projection Angle (End Angle) [°]: | 45 |
| 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 | Greenstone/Granitics |
|---|---|
| Color | |
| Strength Type | Mohr-Coulomb |
| Unit Weight [lbs/ft3] | 150 |
| Cohesion [psf] | 1100 |
| Friction Angle [°] | 46 |
| Water Surface | None |
| Ru Value | 0 |

## Global Minimums

### Method: bishop simplified

| FS | 1.514740 |
|---|---|
| Axis Location: | 5.759, 41.130 |
| Left Slip Surface Endpoint: | 40.000, 10.259 |
| Right Slip Surface Endpoint: | 51.000, 50.000 |
| Left Slope Intercept: | 40.000 50.000 |
| Right Slope Intercept: | 51.000 50.000 |
| Resisting Moment: | 2.05036e+06 lb-ft |
| Driving Moment: | 1.35361e+06 lb-ft |
| Total Slice Area: | 221.281 ft2 |
| Surface Horizontal Width: | 11 ft |
| Surface Average Height: | 20.1165 ft |

### Method: janbu simplified

| | |
|---|---|
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

### Method: spencer

| | |
|---|---|
| Resisting Moment: | -0 lb-ft |
| Driving Moment: | 0 lb-ft |
| Resisting Horizontal Force: | -0 lb |
| Driving Horizontal Force: | 0 lb |
| Total Slice Area: | 0 ft2 |
| Surface Horizontal Width: | 0 ft |
| Surface Average Height: | 0 ft |

## *Global Minimum Coordinates*

### Method: bishop simplified

| X | Y |
|---|---|
| 40 | 10.259 |
| 40.1067 | 10.1524 |
| 51 | 50 |

## *Valid/Invalid Surfaces*

### Method: bishop simplified

| | |
|---|---|
| Number of Valid Surfaces: | 5000 |
| Number of Invalid Surfaces: | 0 |

### Method: janbu simplified

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

### Method: spencer

| | |
|---|---|
| Number of Valid Surfaces: | 0 |
| Number of Invalid Surfaces: | 5000 |

#### Error Codes:

Error Code -111 reported for 5000 surfaces

#### Error Codes

*The following errors were encountered during the computation:*

-111 = safety factor equation did not converge

## *Slice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 1.51474**

| 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 | 0.106667 | 636.708 | -45 | Greenstone/Granitics | 1100 | 46 | 15246.1 | 23093.9 | 21239.3 | 0 | 21239.3 | 5993.16 | 5993.16 |
| 2 | 0.222313 | 1315.24 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1361.24 | 2061.92 | 928.919 | 0 | 928.919 | 5908.31 | 5908.31 |
| 3 | 0.222313 | 1288.12 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1337.44 | 2025.88 | 894.113 | 0 | 894.113 | 5786.46 | 5786.46 |
| 4 | 0.222313 | 1261 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1313.65 | 1989.84 | 859.308 | 0 | 859.308 | 5664.62 | 5664.62 |
| 5 | 0.222313 | 1233.88 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1289.86 | 1953.8 | 824.502 | 0 | 824.502 | 5542.77 | 5542.77 |
| 6 | 0.222313 | 1206.76 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1266.06 | 1917.75 | 789.695 | 0 | 789.695 | 5420.93 | 5420.93 |
| 7 | 0.222313 | 1179.65 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1242.27 | 1881.71 | 754.89 | 0 | 754.89 | 5299.08 | 5299.08 |
| 8 | 0.222313 | 1152.53 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1218.47 | 1845.67 | 720.084 | 0 | 720.084 | 5177.24 | 5177.24 |
| 9 | 0.222313 | 1125.41 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1194.68 | 1809.63 | 685.279 | 0 | 685.279 | 5055.39 | 5055.39 |
| 10 | 0.222313 | 1098.29 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1170.88 | 1773.58 | 650.474 | 0 | 650.474 | 4933.54 | 4933.54 |
| 11 | 0.222313 | 1071.17 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1147.09 | 1737.54 | 615.667 | 0 | 615.667 | 4811.7 | 4811.7 |
| 12 | 0.222313 | 1044.05 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1123.3 | 1701.5 | 580.861 | 0 | 580.861 | 4689.85 | 4689.85 |
| 13 | 0.222313 | 1016.94 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1099.5 | 1665.46 | 546.056 | 0 | 546.056 | 4568.01 | 4568.01 |
| 14 | 0.222313 | 989.818 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1075.71 | 1629.41 | 511.25 | 0 | 511.25 | 4446.16 | 4446.16 |
| 15 | 0.222313 | 962.699 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1051.91 | 1593.37 | 476.444 | 0 | 476.444 | 4324.32 | 4324.32 |
| 16 | 0.222313 | 935.581 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1028.12 | 1557.33 | 441.638 | 0 | 441.638 | 4202.47 | 4202.47 |
| 17 | 0.222313 | 908.463 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 1004.32 | 1521.29 | 406.833 | 0 | 406.833 | 4080.63 | 4080.63 |
| 18 | 0.222313 | 881.344 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 980.528 | 1485.24 | 372.027 | 0 | 372.027 | 3958.78 | 3958.78 |
| 19 | 0.222313 | 854.226 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 956.734 | 1449.2 | 337.222 | 0 | 337.222 | 3836.94 | 3836.94 |
| 20 | 0.222313 | 827.108 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 932.939 | 1413.16 | 302.415 | 0 | 302.415 | 3715.09 | 3715.09 |
| 21 | 0.222313 | 799.99 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 909.145 | 1377.12 | 267.61 | 0 | 267.61 | 3593.25 | 3593.25 |
| 22 | 0.222313 | 772.871 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 885.351 | 1341.08 | 232.804 | 0 | 232.804 | 3471.4 | 3471.4 |
| 23 | 0.222313 | 745.753 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 861.556 | 1305.03 | 197.999 | 0 | 197.999 | 3349.55 | 3349.55 |
| 24 | 0.222313 | 718.635 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 837.762 | 1268.99 | 163.193 | 0 | 163.193 | 3227.71 | 3227.71 |
| 25 | 0.222313 | 691.516 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 813.967 | 1232.95 | 128.386 | 0 | 128.386 | 3105.86 | 3105.86 |
| 26 | 0.222313 | 664.398 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 790.173 | 1196.91 | 93.5811 | 0 | 93.5811 | 2984.02 | 2984.02 |
| 27 | 0.222313 | 637.28 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 766.378 | 1160.86 | 58.7754 | 0 | 58.7754 | 2862.17 | 2862.17 |
| 28 | 0.222313 | 610.161 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 742.584 | 1124.82 | 23.9696 | 0 | 23.9696 | 2740.33 | 2740.33 |
| 29 | 0.222313 | 583.043 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 718.789 | 1088.78 | -10.8361 | 0 | -10.8361 | 2618.48 | 2618.48 |
| 30 | 0.222313 | 555.925 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 694.995 | 1052.74 | -45.6419 | 0 | -45.6419 | 2496.64 | 2496.64 |
| 31 | 0.222313 | 528.807 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 671.2 | 1016.69 | -80.4476 | 0 | -80.4476 | 2374.79 | 2374.79 |
| 32 | 0.222313 | 501.688 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 647.406 | 980.652 | -115.253 | 0 | -115.253 | 2252.95 | 2252.95 |
| 33 | 0.222313 | 474.57 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 623.611 | 944.609 | -150.059 | 0 | -150.059 | 2131.1 | 2131.1 |
| 34 | 0.222313 | 447.452 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 599.817 | 908.567 | -184.865 | 0 | -184.865 | 2009.25 | 2009.25 |
| 35 | 0.222313 | 420.333 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 576.022 | 872.524 | -219.671 | 0 | -219.671 | 1887.41 | 1887.41 |
| 36 | 0.222313 | 393.215 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 552.228 | 836.482 | -254.476 | 0 | -254.476 | 1765.56 | 1765.56 |
| 37 | 0.222313 | 366.097 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 528.434 | 800.44 | -289.282 | 0 | -289.282 | 1643.72 | 1643.72 |
| 38 | 0.222313 | 338.979 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 504.639 | 764.397 | -324.087 | 0 | -324.087 | 1521.87 | 1521.87 |
| 39 | 0.222313 | 311.86 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 480.845 | 728.355 | -358.894 | 0 | -358.894 | 1400.03 | 1400.03 |
| 40 | 0.222313 | 284.742 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 457.05 | 692.312 | -393.7 | 0 | -393.7 | 1278.18 | 1278.18 |
| 41 | 0.222313 | 257.624 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 433.256 | 656.27 | -428.505 | 0 | -428.505 | 1156.34 | 1156.34 |
| 42 | 0.222313 | 230.505 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 409.462 | 620.228 | -463.311 | 0 | -463.311 | 1034.49 | 1034.49 |
| 43 | 0.222313 | 203.387 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 385.667 | 584.185 | -498.116 | 0 | -498.116 | 912.646 | 912.646 |
| 44 | 0.222313 | 176.269 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 361.873 | 548.143 | -532.923 | 0 | -532.923 | 790.801 | 790.801 |
| 45 | 0.222313 | 149.151 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 338.078 | 512.1 | -567.728 | 0 | -567.728 | 668.954 | 668.954 |
| 46 | 0.222313 | 122.032 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 314.284 | 476.058 | -602.534 | 0 | -602.534 | 547.11 | 547.11 |
| 47 | 0.222313 | 94.914 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 290.489 | 440.016 | -637.339 | 0 | -637.339 | 425.266 | 425.266 |
| 48 | 0.222313 | 67.7957 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 266.695 | 403.973 | -672.145 | 0 | -672.145 | 303.419 | 303.419 |
| 49 | 0.222313 | 40.6774 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 242.9 | 367.931 | -706.951 | 0 | -706.951 | 181.574 | 181.574 |
| 50 | 0.222313 | 13.5591 | 74.7104 | Greenstone/Granitics | 1100 | 46 | 219.106 | 331.888 | -741.757 | 0 | -741.757 | 59.7275 | 59.7275 |

## *Interslice Data*

- **Global Minimum Query (bishop simplified) - Safety Factor: 1.51474**

| Slice Number | X coordinate [ft] | Y coordinate - Bottom [ft] | Interslice Normal Force [lbs] | Interslice Shear Force [lbs] | Interslice Force Angle [degrees] |
|---|---|---|---|---|---|
| 1 | 40 | 10.259 | 0 | 0 | 0 |
| 2 | 40.1067 | 10.1524 | 3894.34 | 0 | 0 |
| 3 | 40.329 | 10.9656 | 3442.02 | 0 | 0 |
| 4 | 40.5513 | 11.7788 | 3012.72 | 0 | 0 |
| 5 | 40.7736 | 12.592 | 2606.41 | 0 | 0 |
| 6 | 40.9959 | 13.4052 | 2223.12 | 0 | 0 |
| 7 | 41.2182 | 14.2185 | 1862.83 | 0 | 0 |
| 8 | 41.4405 | 15.0317 | 1525.55 | 0 | 0 |
| 9 | 41.6629 | 15.8449 | 1211.27 | 0 | 0 |
| 10 | 41.8852 | 16.6581 | 920.003 | 0 | 0 |
| 11 | 42.1075 | 17.4713 | 651.74 | 0 | 0 |
| 12 | 42.3298 | 18.2845 | 406.484 | 0 | 0 |
| 13 | 42.5521 | 19.0978 | 184.234 | 0 | 0 |
| 14 | 42.7744 | 19.911 | -15.0095 | 0 | 0 |
| 15 | 42.9967 | 20.7242 | -191.246 | 0 | 0 |
| 16 | 43.219 | 21.5374 | -344.477 | 0 | 0 |
| 17 | 43.4414 | 22.3506 | -474.701 | 0 | 0 |
| 18 | 43.6637 | 23.1638 | -581.919 | 0 | 0 |
| 19 | 43.886 | 23.9771 | -666.13 | 0 | 0 |
| 20 | 44.1083 | 24.7903 | -727.334 | 0 | 0 |
| 21 | 44.3306 | 25.6035 | -765.533 | 0 | 0 |
| 22 | 44.5529 | 26.4167 | -780.724 | 0 | 0 |
| 23 | 44.7752 | 27.2299 | -772.91 | 0 | 0 |
| 24 | 44.9976 | 28.0431 | -742.089 | 0 | 0 |
| 25 | 45.2199 | 28.8564 | -688.261 | 0 | 0 |
| 26 | 45.4422 | 29.6696 | -611.427 | 0 | 0 |
| 27 | 45.6645 | 30.4828 | -511.586 | 0 | 0 |
| 28 | 45.8868 | 31.296 | -388.739 | 0 | 0 |
| 29 | 46.1091 | 32.1092 | -242.886 | 0 | 0 |
| 30 | 46.3314 | 32.9224 | -74.0257 | 0 | 0 |
| 31 | 46.5537 | 33.7357 | 117.841 | 0 | 0 |
| 32 | 46.7761 | 34.5489 | 332.714 | 0 | 0 |
| 33 | 46.9984 | 35.3621 | 570.593 | 0 | 0 |
| 34 | 47.2207 | 36.1753 | 831.479 | 0 | 0 |
| 35 | 47.443 | 36.9885 | 1115.37 | 0 | 0 |
| 36 | 47.6653 | 37.8017 | 1422.27 | 0 | 0 |
| 37 | 47.8876 | 38.615 | 1752.18 | 0 | 0 |
| 38 | 48.1099 | 39.4282 | 2105.09 | 0 | 0 |
| 39 | 48.3322 | 40.2414 | 2481.01 | 0 | 0 |
| 40 | 48.5546 | 41.0546 | 2879.93 | 0 | 0 |
| 41 | 48.7769 | 41.8678 | 3301.86 | 0 | 0 |
| 42 | 48.9992 | 42.681 | 3746.8 | 0 | 0 |
| 43 | 49.2215 | 43.4943 | 4214.74 | 0 | 0 |
| 44 | 49.4438 | 44.3075 | 4705.69 | 0 | 0 |
| 45 | 49.6661 | 45.1207 | 5219.65 | 0 | 0 |
| 46 | 49.8884 | 45.9339 | 5756.61 | 0 | 0 |
| 47 | 50.1107 | 46.7471 | 6316.58 | 0 | 0 |
| 48 | 50.3331 | 47.5603 | 6899.56 | 0 | 0 |
| 49 | 50.5554 | 48.3736 | 7505.54 | 0 | 0 |
| 50 | 50.7777 | 49.1868 | 8134.53 | 0 | 0 |
| 51 | 51 | 50 | 0 | 0 | 0 |

## *Entity Information*

### Group: Group 1

**Shared Entities**

| Type | Coordinates X | Coordinates Y |
|---|---|---|
| External Boundary | 0 | 0 |
| | 90 | 0 |
| | 90 | 50 |
| | 40 | 50 |
| | 40 | 10 |
| | 0 | 10 |

LAWRENCE
& ASSOCIATES
ENGINEERS & GEOLOGISTS

006005.01

# HYDROLOGIC EVALUATION

# FOR

# PROPOSED QUARRY CHANGES

# CRYSTAL CREEK AGGREGATES

**AUGUST 2022**

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## INTRODUCTION

This report presents a hydrologic evaluation of the proposed quarry expansion at the Crystal Creek Aggregates (CCA) facility on Iron Mountain Road, Redding, California (**Figures 1** and **2**).

Existing CCA plant facilities include a rock crushing/screening plant, washing operation, mobile office trailer, truck scales, diesel-fuel storage tanks (1,000 and 20,000 gallons), one waste-oil tank (350 gallons), two motor oil tanks and one lubricating oil tank (90 gallons each), and five settling and two recycle ponds.

The proposed changes include an increase in the total annual amount of aggregate to be processed from 250,000 to 500,000 tons. The existing Concrete Recycle Area location and operation, for which an administrative permit was issued and subsequently reissued by the County due to the Carr Fire, is proposed to be removed as a Project component. The estimated 2.80-acre Concrete Recycle Area is proposed to be used for aggregate stockpiling.

The amount of aggregate mined will be increased, as will the yearly blasting maximums. The hours of operation will stay the same as currently permitted. The height of the Quarry high walls and bench widths will be increased as will the lake size and depth upon reclamation of the site. The estimated amount of aggregate proposed to be mined will increase from 15.92 million tons to 25.4 million tons. The estimated life of the mining operation will increase from the end of Year 2072 by 27 years to end of the Year 2101.

The existing approved Use Permit Area of 110.69-acres and the existing approved 110.69-acre Reclamation Plan Area will be maintained.

The scope of work included site visits, review of reports prepared by others related to geologic conditions, estimation of existing and future water budgets for the new lake and site changes, evaluation of potential impacts from changes in the water budget, and evaluation of potential water-quality impacts from the expanded operations. Existing and future site plans, and the size and volume for the proposed quarry excavation, were supplied by Mr. Duane Miller, PE, on behalf of Crystal Creek Aggregates.

The work was conducted by Ms. Bonnie Lampley, California Certified Hydrogeologist (CHG 626).

## SUMMARY

### *NEW LAKE WATER LEVELS*

After filling, the new lake would overflow in average years, and would have minimal to no overflow in dry years (**Figures 10** and **11**). The water level would vary seasonally by less than 5 feet.

Changing the runoff factor has some effect on model results; if only 10% of the runoff is routed to the lake, seasonal water-level changes will be similar and it will not dry out in the summer.

Modeling results are more sensitive to changing the leakage factor. If the leakage factor is increased by an order of magnitude (to 0.003 feet/day), the water levels would show more variability, with the variation less than 10 feet. If the leakage factor is increased by two orders of magnitude (to 0.03 feet/day), the new lake may dry out seasonally. Although the permeability of the material that will form the base of the lake is unknown, it is unlikely to be as permeable as 0.03 feet/day ($1 \times 10^{-5}$ cm/sec). Existing ponds at the site do not dry out over the summer. This implies either groundwater contribution to maintaining water levels or low permeability to prevent leakage of collected surface water (more likely the latter, based on observations of the amount of groundwater seepage in June 2019).

### *WATER BUDGET*

The major changes to the water budget are as follows:

- Increase in water stored in Site water bodies. The increase would range from approximately 500 to 3,100 acre-feet more than currently held.
- More total inflow to the system because of the larger area (new lake surface) that receives direct precipitation. The increase could be approximately 40 acre-feet per year.

  Even though the overall area of the quarry + upland watershed remains the same, the relative change in percent covered by the open water body means there is more direct precipitation (vs. watershed runoff) into the system. This is because there is less total evapotranspiration and infiltration losses in the watershed because of the smaller relative area.

  Also, because there is less total “undeveloped” watershed, the amount of upland runoff into the system will be between approximately 75 and 100 acre-feet per year less.
- Leakage to groundwater will be higher in the future, because of the greater area of the new lake relative to the existing ponds. The total leakage, however, will remain an insignificant percentage of the total water budget.
- More evaporation because of the greater surface area of the new lake. The increase could be approximately 65 to 130 acre-feet per year.

- Less offsite runoff (denoted as "overflow" in the figures in **Appendix D**) in both drought average periods. The decrease could average approximately 75 acre-feet/year.

The decrease in offsite runoff during droughts represents approximately 25% less runoff to the tributary to Middle Creek. This would represent a net 1.4% reduction flow to Middle Creek below CCA (25% less off-site discharge over 5.5% of the total Middle Creek drainage area). The reduction in off-site discharge would occur only during the wet season.

Changes in inflow from groundwater, are assumed to be minimal. Because of the nature of the geologic materials (relatively impermeable hard rock with few open fractures), it is unlikely that the new lake would act as a groundwater sink. Some groundwater seepage zones may be intercepted by the expanded excavation, but the probability that more seepage zones than are currently observed will be encountered at depth is unlikely in that fractures generally become less prevalent with depth and the existing seepage zones are associated with the contact between the weathered overburden and more competent bedrock.

### *WATER QUALITY*

Water management and stormwater-runoff control in the future will be done similarly to the current operations. During mining in each phase, runoff from the disturbed areas will be routed to temporary detention basins within the phase footprint, as has been done historically and currently.

Groundwater inflow into each phase also will be routed to the temporary detention basins, as currently done. Once excavation in a phase proceeds such that deeper basins are developed, groundwater seepage into the basin will be pumped out for discharge to either temporary basins or existing ponds. Groundwater production from mined areas is not expected to be greater than current seepage rates because as the quarry is deepened, the potential for groundwater occurrence decreases.

Overall, there will be less offsite discharge once the new lake is developed than currently occurs.

Runoff from the new batch plant will be routed to Recycle Pond #1, similarly to the runoff from the existing crushing and screening plant. If the Recycle Ponds discharge, it is routed through the Settling Ponds, eventually to be discharged from Settling Pond #3, along with all other site stormwater that potentially flows to Middle Creek.

There is no evidence that historic runoff from CCA has adversely affected surface-water quality in Middle Creek, and there is evidence of other influences that affect the creek's water quality.

Therefore, it is unlikely that future operations will adversely affect water quality in Middle Creek.

# SITE SETTING

## *EXISTING PONDS AND DRAINAGE*

**Figure 2** shows the existing site plan, with an emphasis on drainage features and ponds; **Figure 4** shows a schematic diagram of the existing drainages and water-management features.

Drainage and water is managed by a network of ponds, ditches, and piping. The major source of process water for the Facility is from upland runoff to Ponds #4 and #5. These two ponds are hydraulically connected in the subsurface through a layer of crushed rock approximately 10 feet thick. The two ponds receive runoff from the upland hills west of the Plant Area, from the Existing Quarry, and from the Plant Area (equipment storage, stockpile areas, concrete recycle area, and topsoil stockpile area). **Table 1** shows the characteristics of the existing ponds:

**TABLE 1. EXISTING POND CHARACTERISTICS**

| Ponds | Comment | Area | Depth | Volume |
|---|---|---|---|---|
| | | acres | feet | acre-feet |
| Settling Pond 1 | Usually dry in dry season | 0.5 | 15 | 3 |
| Settling Pond 2 | Usually dry in dry season | 0.2 | 15 | 1 |
| Settling Pond 3 | Always contains water | 0.5 | 15 | 2 |
| Existing Pond 4 | Always contains water | 1.9 | 25 | 14 |
| Existing Pond 5 | Always contains water | 2.2 | 30 | 24 |
| Recycle Ponds | Always contain water | 0.5 | 15 | 3 |
| | TOTALS | 5.8 | | 46 |

During regular operations, water is pumped from Pond #5 to Settling Pond #1 and Recycle Pond #2. During storm events, water can be released as needed from Pond #4 through a slide gate. Stormwater released from Pond #4 is routed through a 36-inch corrugated metal pipe (CMP) culvert to the drainage ditch immediate east of Settling Ponds #2 and #3; the valve at the point of discharge of the 36-inch CMP to the ditch is always closed, and only opened during large storm events. Just south of Settling Pond #3, the small drainage ditch connects with a larger drainage ditch; the larger ditch discharges to Middle Creek near where Iron Mountain Road crosses Middle Creek.

Water from Pond #4 is routed to Recycle Pond #2 from Settling Pond #1; Recycle Pond #2 also receives overflow from Recycle Pond #1. During operations, water for aggregate washing is pumped from Recycle Pond #2 by two centrifugal pumps (one 4-inch and one six-inch). If needed, make-up water for aggregate washing is provided by Shasta Community Services District (SCSD; formerly water was provided by Keswick CSD which is now part of SCSD). Typical usage is 1,000 gallons/eight-hour shift, up to 12 hours/day. This equates to approximately one gallon per minute on a daily basis (1,000 gallons/8 hours = 125 gallons/hour x 12 hours = 1,500 gallons ÷ 1440 minutes/day).

The used wash water that has passed over the aggregate is returned to Recycle Pond #1 after the addition of flocculent to aid in settling the fine particulates. Approximately every three days, the fine material that is washed off the aggregate and into Recycle Pond #1 is cleaned out and moved to an overburden pile, to be used in Site reclamation in the future. Washed aggregate is stored in various Stockpile Areas, in the eastern part of the Site.

The two Recycle Ponds are connected by a 48-inch corrugated metal pipe (CMP). Recycle Pond #2 can overflow to a ditch which routes discharge to Settling Pond #1. Settling Ponds #1, #2, and #3 are connected in series, with Pond #3 the farthest downgradient. Settling Pond #3 discharge to the small ditch along the eastern side of the ponds, and thence to the larger ditch that is tributary to Middle Creek.

### PROPOSED LAKE AND DRAINAGE

**Figure 3** shows the proposed drainage features; **Figure 5** shows a schematic diagram of the proposed drainages and water-management features.

Drainage features in the Plant Area (eastern portion of the Site) will remain the same, with the Recycle Ponds, Settling Ponds #1, #2, and #3, and Ponds #4 and #5 unchanged. Drainage in the Mining Area (west of the Plant Area) will be modified because of the expansion of the quarry footprint. Overall drainage areas will remain the same, but the distribution of the drainage will change.

Water-supply to, and runoff from, the new batch plant will be routed to and from the Recycle Ponds, similar to the water management for the existing crushing plant.

**Figure 6** shows the general overall future drainage areas for the Site. For the Site as a whole, the existing and future total drainage area are the same. For modeling purposes (discussed below), L&A divided the Site into three areas:

- New Lake drainage area (45.1 acres) which represents the area upgradient of the quarry excavation.
- Quarry Excavation area (51.2 acres) which represents the area of the proposed excavation, including the New Lake. Within this area, the New Lake will cover 35.64 acres at its water-surface elevation of 736 feet MSL.
- Site Area Not Draining to Quarry (84.5 acres) which represents the remainder of the Site, including the Plant Area.

Note that these areas do not correspond to specific Project areas referenced in other documents because some of the drainage areas extend beyond the CCA property boundary and the drainage boundaries do not necessarily correspond to Project areas defined in the Reclamation Plan, for example.

### *Regional Hydrologic Setting*

The Site is located within the Middle Creek watershed, along the northern boundary (**Figure 1**). To the north is the Rock Creek watershed. The Middle Creek watershed covers 2,890 acres (the area was scaled from the USGS topographic map using AutoCAD v. 2018).

The drainage area of the quarry area (both existing and proposed) is approximately 160 acres. The CCA drainage area represents approximately 5.5% of the Middle Creek drainage area. Drainage from the CCA site eventually enters Middle Creek approximately 1.3 miles upstream of its confluence with the Sacramento River.

### *Regional and Local Hydrogeologic Setting*

#### *Geology*

The following description of the regional and local geology is taken from the Geotechnical Report (Bajada Geosciences, April 2020, as revised August 2022). **Appendix A** contains the geologic and lineation maps, and geologic cross sections, from that report.

The Site is located in the eastern Klamath Mountains within the Klamath Mountains geomorphic Geologic Province of California. The Klamath Mountains form a geologic province that extends from northern California to Southern Oregon. In California, the Klamath Mountains province extends from the Pacific Ocean to the Great Valley.

The quarry is located within the Eastern Klamath terrane of the Klamath Mountains geomorphic Geologic Province, and is about 180- to 400-million years old (Silurian-Devonian to Jurassic). The Eastern Klamath terrane is composed of three subterranes - Redding, Trinity, and Yreka subterranes. The Redding subterrane consists of Mississippian to Devonian-age metavolcanic and metasedimentary rocks. Formations within the Redding subterrane consist of the Baird, Bragdon, and Kennett Formations, the Mule Mountain stock, Balaklala Rhyolite, and Copley Greenstone. Those formations are locally faulted into place. Superjacent rocks consist of alluvium, colluvium, local terrace, and landslide deposits.

The existing quarry highwalls expose Mule Mountain Stock (Dmm), Copley Greenstone (Dc), and epidote and/or chloritic amphibolite (Da). These materials are unconformably in contact in some locations and have been juxtaposed by faulting in other locations. In areas outside of the active quarry face, Dmm and Dc are visible in outcrop, as float on the ground surface, and exposed within scoured drainages.

Granitics of the Mule Mountain Stock consist of granodiorite, albite granite, and trondhjemite that increase in hardness and competency and decrease in weathering with depth. Regolithic and saprolitic soils associated with weathering produce overburden thicknesses ranging from a few feet to over 20 feet. Below the overburden, weathering decreases from highly weathered to fresh over thicknesses ranging from about 5 to 20 feet. These zones of weathering are often observed penetrating relatively fresh rocks along discontinuities. Moderately weathered to fresh Mule Mountain Stock ranges from weak rock to strong rock.

The Copley greenstone is generally hard, dense, and locally has been sulfide enriched to exhibit pyrite mineralization. Generally, the greenstone observed within the quarry ranges from medium strong to very strong

Copley greenstone is massive to moderately fractured with persistent discontinuities that are moderately to very widely spaced, partially open to tight, undulating to planar, and generally rough. Few open apertures were observed, and those present were filled with calcium carbonate, epidote, and quartz. Some discontinuity planes appeared to have a relatively thin coating of iron oxide, zinc oxide, calcium carbonate or other coatings. Few discontinuities were observed to be open and unfilled except where prior blasting and mining had occurred.

Faulting and lineations in the existing quarry area trend generally east-west (see the lineation map in **Appendix A**).

### *HYDROGEOLOGY*

Groundwater in the Site vicinity can occur in the small areas of alluvial deposits in stream bottoms, in weathering zones atop bedrock, and within the bedrock (hard rock). In hard rock, groundwater occupies openings made by faulting or fracturing, known as secondary porosity. Groundwater does not occur within the rock itself, as in sedimentary deposits (alluvial material and to a lesser degree, weathered bedrock), where groundwater occupies the spaces between particles, known as primary porosity. Generally, the porosity of hard rocks is much less than in sedimentary rocks: Porosity in sedimentary rocks typically ranges between 30 and 60% and in hard rocks similar to those in the Project vicinity (granitics and greenstone) it can be as low as 1 to 2%, although weathered zones can have porosities similar to sedimentary rocks.

Related to porosity is a characteristic known as hydraulic conductivity. A material has high hydraulic conductivity if there are many connected pore spaces or large fractures; that is, groundwater can move more rapidly through these kinds of materials. A material has low hydraulic conductivity if the pore spaces are not well connected, continuous, or large. Groundwater cannot move easily through these kinds of materials.

Based on the description of the rocks in the quarry area, it is likely that both the porosity and hydraulic conductivity of the quarry rocks are low. The Geotechnical Report describes that the fractures, where present, are partially open to tight, with few observed to be open. Most are filled with calcium carbonate, epidote, and quartz.

Groundwater seepage was observed in only two locations within the existing quarry area, along fault planes and near the weathered-fresh bedrock interface (**Figure 2** shows seepage locations in June 2019). CCA staff report that Ponds #4, #5, and Settling Pond #3 remain full year round, without addition of water. This suggests that, at least in part, groundwater seepage occurs year round and helps maintain lake water levels, in that there is no surface-water runoff from the uplands in the summer.

Well logs for water wells in the vicinity of the Site, on file with the Department of Water Resources (DWR), show similar geologic materials as described in the Geotechnical Report (although the driller's descriptions often mislabel rock types). **Figure 7** shows a map of the vicinity wells, for logs that had sufficient location information. There were 28 wells of record in the DWR database. All of the wells of record are located to the north (within the Rock Creek drainage) and to the south of the Site (mostly in the Salt Creek drainage). There appear to be only four wells of record within the Middle Creek drainage, in the Site vicinity (numbers 405981, 485937, 705923, and 957748). These wells are all located close to Middle Creek, south to southwest of the Site and approximately one-half to one mile away from the Site.

Based on the geologic mapping of the Site in the Geotechnical Report, we assume that the predominant direction of groundwater movement is to the east, following the trend of the faults and lineations, and the general fall of the topography towards the Sacramento River. Based on this, there are no groundwater wells downgradient of the Site.

Potable water in the vicinity, and at the Site, is provided by the Shasta CSD (and previously, the Keswick CSD, which is now part of the Shasta CSD). **Figure 8** shows a map of the potable water suppliers in the vicinity.

## WATER-BUDGET

To evaluate the various potential hydrologic impacts from the expanded quarry operations, L&A developed a hydraulic-capacity model (in an Excel™ spreadsheet) that accounts for daily inflows to and outflows from the new lake, the quarry area, and the plant area. The model uses various inputs (precipitation, evaporation, rock characteristics, drainage areas, etc.) to estimate how water will move onto the Site, through the new lake, and into the subsurface. Model outputs can be plotted vs. time to show potential seasonal changes in various factors (*e.g.*, lake depth, run on, runoff, evaporation, etc.).

The modeling evaluated each of the three phases, which will have the following approximate areas:

| | | |
|---|---|---|
| Phase 1 | 22.66 acres | 43% of area |
| Phase 2 | 21.26 acres | 40% of area |
| Phase 3 | 8.82 acres | 17% of area |

The modeling used the following logic:

- The maximum lake depth is assumed to be 96 feet, based on a base elevation of 640 feet MSL and a design high-water level of 736 feet MSL. **Appendix C** shows the calculations for volume vs. depth and volume vs. area used in the model, for the entire new lake and for each of the proposed phases.
- Starting storage (in acre-feet) for each day equals the final storage from the previous day.
- Total daily inflow is calculated by adding the direct precipitation (maximum lake area in acres × daily precipitation in feet), groundwater inflow (if used), and stormwater inflow (in acre-feet). The stormwater inflow is routed through the phases based on which phases are

operational.

In years 1 through 20, it is assumed that only Phase 1 will be active; therefore, in those years, all upland runoff is routed to Phase 1.

In years 20 through 40, it is assumed that Phase 1 will be completed and Phase 2 will be active; therefore, in those years, upland runoff is routed to Phase 2 based on its relative size to the other phases. The remaining upland runoff is routed to Phase 1. The overflow from Phase 2 also is routed to Phase 1 because the outlet for the quarry area will be within the Phase 1 footprint.

In years 40 through 50, it is assumed that Phase 3 will be actively mined; in those years upland runoff is routed to each phase based on its relative size. Overflow from Phases 2 and 3 is routed through Phase 1.

In years 50+, it is assumed that the quarrying will be completed and the entire lake will be established.

- Total daily outflow is the evaporation (area covered by water × daily evaporation rate in feet) and leakage, assumed to be 0.0003 feet/day ($1 \times 10^{-7}$ cm/sec).
- The daily net change in storage is calculated by subtracting the outflow from the inflow. The net change then is subtracted from the beginning storage to yield the final storage at the end of each day. If final storage is greater than the maximum allowable volume, the volume difference spills out of the lake.

Several model runs were performed, as follows, with the estimated time frame for each phase's operation based on a total operating period of 50 years, approximately apportioned by the relative size of each phase:

| | |
|---|---|
| Years 1 – 20 | Phase 1 only |
| Years 21 – 40 | Phase 2, with overflow passed to the Phase 1 area |
| Years 41 – 50 | Phases 2 and 3, with overflow passed to the Phase 1 area |

Phase 1 receives the overflow from the other two phases because the outlet for the future quarry lake will be in the Phase 1 area.

### *INPUT VARIABLES*

#### *PRECIPITATION*

Precipitation values were taken from daily precipitation recorded at Whiskeytown for the period water year 1997 to date.[1] Both the entire data set and a subset of the data representing drought conditions were used in the modeling. The drought subset was selected using a graph of the cumulative departure from average water-year precipitation (**Figure 9**). For a cumulative

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[1] California Data Exchange Center; http://cdec.water.ca.gov/dynamicapp/QueryDaily?s=WHI&d=03-Jul-2019+12:36 .

departure analysis, the average precipitation for the entire period is calculated, and then the departure or difference in annual precipitation from the average is calculated for each water year. The departure from average annual precipitation is cumulated. This cumulative value then is plotted vs. water year. A downward trend of cumulative departure indicates a period during which precipitation was less than average. Conversely, an upward trend indicates a period during which precipitation was greater than average. A period of average precipitation is one in which the beginning and ending cumulative values are the same. The period 2007 to 2017 was taken as the subset for drought modeling because the period had an extended dry period.

The annual average precipitation at Whiskeytown is 60.8 inches; the annual average drought period precipitation used in the model was 44.2 inches.

#### GROUNDWATER

The model assumes a steady 10 gpm of groundwater inflow, although eliminating groundwater inflow does not substantially change modeling results. In the predictive modeling, it is assumed that 10 gpm of groundwater inflow will be routed through the quarry to maintain pond levels in the Plant Area.

#### STORMWATER

Stormwater inflow to the model is calculated from the various watershed areas, as shown in **Figure 4**. Stormwater inflow to the lake was calculated to be 50% of the total rainfall on the watershed above the lake; that is, for each day of the modeling period in which there was rain, the rainfall amount was multiplied by 45.1 acres and then by 0.5. Stormwater runoff from the Plant area was calculated similarly. The model, however, does not route Plant Area stormwater through each of the Plant ponds; rather, the total storage of the ponds is added together, for ease of calculation.

#### EVAPORATION

Evaporation was based on typical values of reference evapotranspiration as published by the California Department of Water Resources, August 2008, *Estimating Irrigation Water Needs of Landscape Plantings in California*, Appendix A – Table 1, Zone 14. Zone 14 encompasses the Sacramento Valley and the eastern foothills of the Coast Range, including the southwestern portion of Shasta County.

#### LEAKAGE

A relatively slow leakage (hydraulic conductivity) of 0.0003 feet per day ($1 \times 10^{-7}$ cm/sec) was assumed for the bottom of the lake, based on the description of the geologic materials and the fact that the existing lakes retain water year-round without water addition during the dry season.

### MODELING RESULTS

**Appendix D** contains graphs of the results of pond modeling for each phase in 20-year time increments. It is unknown exactly how each phase will be configured; therefore, the modeling for the various phases should be considered approximate. **Figures 10** and **11** show graphs of the results for the entire new lake in years 50+, for average and drought scenarios, respectively. On these figures, the thick blue line is the pond depth, the thin red line is inflow, and the medium dashed blue line is overflow.

#### *NEW LAKE WATER LEVELS*

After filling, it would overflow in average years, and would have minimal to no overflow in dry years (**Figures 10** and **11**). The water level would vary seasonally by less than 5 feet.

Changing the runoff factor has some effect on model results; if only 10% of the runoff is routed to the lake, seasonal water-level changes will be similar and it will not dry out in the summer.

Modeling results are more sensitive to changing the leakage factor. If the leakage factor is increased by an order of magnitude (to 0.003 feet/day), the water levels would show more variability, with the variation less than 10 feet. If the leakage factor is increased by two orders of magnitude (to 0.03 feet/day), the new lake may dry out seasonally. Although the permeability of the material that will form the base of the lake is unknown, it is unlikely to be as permeable as 0.03 feet/day ($1 \times 10^{-5}$ cm/sec). Existing ponds at the site do not dry out over the summer. This implies either groundwater contribution to maintaining water levels or low permeability to prevent leakage of collected surface water (more likely the latter, based on observations of the amount of groundwater seepage in June 2019).

#### *CHANGES IN WATER BUDGET*

To evaluate how operation of the new lake may change the overall Site water budget, the daily values were aggregated to yearly totals for the various modeling scenarios and phases. **Appendix E** contains the summary sheets of those calculations.

**Table 2** summarizes the yearly totals to overall annual averages, to compare pre-Project and post-Project water budgets.

The major changes to the water budget are as follows:

- Increase in water stored in Site water bodies. The increase would range from approximately 500 to 3,100 acre-feet more than currently held.
- More total inflow to the system because of the larger area (new lake surface) that receives direct precipitation. The increase could be approximately 40 acre-feet per year.

  Even though the overall area of the quarry + upland watershed remains the same, the relative change in percent covered by the open water body means there is more direct precipitation (vs. watershed runoff) into the system. This is because there is less total evapotranspiration and infiltration losses in the watershed because of the smaller relative area.

  Also, because there is less total “undeveloped” watershed, the amount of upland runoff into the system will be between approximately 75 and 100 acre-feet per year less.

- Leakage to groundwater will be higher in the future, because of the greater area of the new lake relative to the existing ponds. The total leakage, however, will remain an insignificant percentage of the total water budget.
- More evaporation because of the greater surface area of the new lake. The increase could be approximately 65 to 130 acre-feet per year.
- Less offsite runoff (denoted as "overflow" in the figures in **Appendix D**) in both drought average periods. The decrease could average approximately 75 acre-feet/year.

**TABLE 2. ESTIMATED ANNUAL CHANGES IN WATER BUDGET**

| WATER-BUDGET ITEM | AVERAGE | | | DROUGHT | | |
|---|---|---|---|---|---|---|
| | EXISTING | FUTURE | DIFFERENCE | EXISTING | FUTURE | DIFFERENCE |
| Direct Precipitation on Water Bodies | 59 | 198 | 138 | 58 | 189 | 132 |
| Runoff to Ponds/Lake | 325 | 232 | -93 | 293 | 218 | -76 |
| TOTAL INFLOW | 400 | 446 | 46 | 367 | 423 | 56 |
| Leakage | 2 | 5 | 3 | 1 | 4 | 3 |
| Evaporation | 53 | 117 | 65 | 53 | 184 | 131 |
| Overflow from Site | 337 | 260 | -77 | 309 | 235 | -74 |
| TOTAL OUTFLOW | 397 | 449 | 52 | 364 | 423 | 59 |

The decrease in offsite runoff during droughts represents approximately 25% less runoff to the tributary to Middle Creek. This would represent a net 1.4% reduction flow to Middle Creek below CCA (25% less off-site discharge over 5.5% of the total Middle Creek drainage area). The reduction in off-site discharge would occur only during the wet season.

Changes in inflow from groundwater, are assumed to be minimal. Because of the nature of the geologic materials (relatively impermeable hard rock with few open fractures), it is unlikely that the new lake would act as a groundwater sink. Some groundwater seepage zones may be intercepted by the expanded excavation, but the probability that more seepage zones than are currently observed will be encountered at depth is unlikely in that fractures generally become less prevalent with depth and the existing seepage zones are associated with the contact between the weathered overburden and more competent bedrock.

## WATER-QUALITY

Water quality at the Facility has been regulated by the Central Valley Regional Water Quality Control Board (CVRWQCB) through a series of permits over the years. Prior to 2015, the Facility was regulated under National Pollution Discharge Elimination System (NPDES) permits, which were renewed every five years. The last NPDES permit was rescinded in 2015, and the

Facility currently is covered under the General Industrial Stormwater Permit (GISP). Monitoring of pond and runoff water quality was, and is, conducted under all of these permits; **Appendix F** contains summaries of the monitoring programs under the various permits.

Factors that can influence the water quality of stormwater runoff or stored water at the Facility include natural and man-made sources of particulates or chemicals. Natural sources of particulates are undeveloped or unpaved areas; currently, the main area of undeveloped runoff area is the upland watershed above the quarry area.

Potential water-quality contaminants have been described in two reports:

- Potential salinity-related water-quality issues and their control are described in the *Salinity Evaluation and Minimization Plan* (Salinity Plan).[2]
- Potential issues related to chemicals and fuels used and stored at the Facility are described in the *Spill Prevention Control and Countermeasures Plan (SPCCP)*.[3]

Because issues related to the use, storage, and control of man-made chemicals at the Facility have been discussed in the above-referenced reports, they will not be discussed herein. Evaluation of potential impacts of stormwater runoff from the Facility have not previously been presented, and are discussed herein.

Stormwater runoff from the Facility is routed through the various ponds, with all but a small portion eventually discharged from Settling Pond #3 (see description of water management, pages 4 and 5 of this report). Stormwater from Pond #4 can be routed around the Settling Ponds and discharged directly to the ditch that is tributary to Middle Creek, but this has seldom occurred (pers. comm., J. Comingdeer to B. Lampley, 2020).

Sampling of discharge from Settling Pond #3 and Middle Creek (the receiving water) was conducted between 2004 and 2014, under previous NPDES permits. Sampling of Middle Creek is no longer required under the GISP. To assess whether Facility discharge may affect water quality in Middle Creek, **Appendix E** contains data tables of water-quality testing results from Settling Pond #3, and the upstream and downstream points on Middle Creek; data were provided by CCA staff. **Table 3** summarizes the differences in upstream vs. downstream values in Middle Creek, and offsite discharge (from Settling Pond #3 only; there are no data from the direct discharge from Pond 4 because that discharge point is so infrequently used).

[2] Land Designers, Inc., February 2013, *Salinity Evaluation and Minimization Plan*.

[3] Land Designers, Inc., June 2018, *Spill Prevention Control and Countermeasures Plan (SPCCP) for Crystal Creek Aggregates, Redding, California*.

## TABLE 3. COMPARISON OF WATER QUALITY OF OFFSITE DISCHARGE VS. MIDDLE CREEK

| **Parameter** | **Differences** |
|---|---|
| Specific conductance (µmhos/cm) | Samples from 2008 - 2012; SP#3 always higher than M.C.; downstream M.C. usually slightly higher than upstream M.C., with one exception. |
| Total dissolved solids (mg/L) | Samples from 2010 - 2012; SP#3 always higher than M.C.; downstream M.C. slightly higher than upstream M.C. |
| pH (units) | Samples from 2004 - 2014; SP#3 usually lower than M.C.; downstream M.C. higher than upstream M.C. |
| Total suspended solids (mg/L) | Samples from 2004 - 2014; SP#3 sometimes higher, sometimes lower than M.C.; downstream M.C. sometimes higher than upstream M.C. and CCA runoff. |
| Settleable solids (mg/L) | Samples from 2004 – 2009; all points non-detected. |
| Turbidity | Samples from 2004 - 2014; SP#3 always higher than M.C.; downstream M.C. sometimes higher than upstream M.C. |
| Hardness (mg/L) | Samples from 2004 - 2012; SP#3 always higher than M.C.; downstream M.C. sometimes higher than upstream M.C. |
| Aluminum (µg/L) | One sample, 2012; SP#3 higher than M.C. upstream, but M.C. downstream significantly higher than SP#3 and upstream M.C. |
| Arsenic (µg/L) | One sample, 2006; SP#3 (0.5) higher than M.C. upstream (0.3), M.C. downstream (0.4) higher than upstream M.C. |
| Cadmium (µg/L) | One sample, 2006; SP#3 and M.C. upstream nondetected, M.C. downstream (1.45) higher than upstream M.C. |
| Chromium (µg/L) | One sample, 2006; SP#3 (1.5) higher than M.C. upstream (0.9), M.C. downstream (1.1) higher than upstream M.C. |
| Copper (µg/L) | Two samples, 2006; SP#3 (2.5-3.9) higher than M.C. upstream (1.4-1.8), M.C. downstream the same as upstream M.C. |
| Iron (µg/L) | One sample, 2012; SP#3 higher than M.C. upstream, but M.C. downstream significantly higher than upstream M.C. |
| Lead (µg/L) | Two samples, 2006 & 2012; SP#3 lower than M.C. upstream. |
| Manganese (µg/L) | One sample, 2012; SP#3 (112) higher than M.C. upstream (8.1), M.C. downstream (84.4) higher than upstream M.C. |
| Mercury (µg/L) | One sample, 2006; SP#3 (2.05) lower than M.C. upstream (2.61), M.C. downstream (2.49) lower than upstream M.C. |
| Nickel (µg/L) | One sample, 2006; SP#3 (0.8) higher than M.C. upstream (0.3), M.C. downstream the same as upstream M.C. |
| Silver (µg/L) | One sample, 2006; SP#3 (0.8) lower than M.C. upstream and downstream. |
| Zinc (µg/L) | Samples from 2005 - 2009; SP#3 always higher than M.C.; downstream M.C. sometimes higher and sometimes lower than upstream M.C. |

The higher pH sometimes observed in the downstream vs. upstream samples from Middle Creek suggests that there are influences other than CCA runoff on the downstream water quality. Because the CCA runoff samples usually are of lower pH than the Middle Creek samples, it is not possible that the CCA runoff is causing the higher pH in the downstream samples.

Likewise, TSS in downstream samples was periodically higher than in both CCA runoff and upstream samples. This implies an additional source of TSS beyond CCA runoff.

Hardness was always higher in the CCA runoff than in the upstream Middle Creek samples, and the downstream Middle Creek samples were higher than the upstream samples. This suggests that CCA could have affected the hardness in Middle Creek, but it is not clear that the upstream vs. downstream differences can be attributed solely to CCA in light of the evidence that there are other influences, also.

The limited data on metals suggests that there was generally no impact on Middle Creek from CCA runoff. If there were impacts, they were slight. Note that metals derived from runoff from the existing mines in the upland watershed have been accounted for in the historic data.

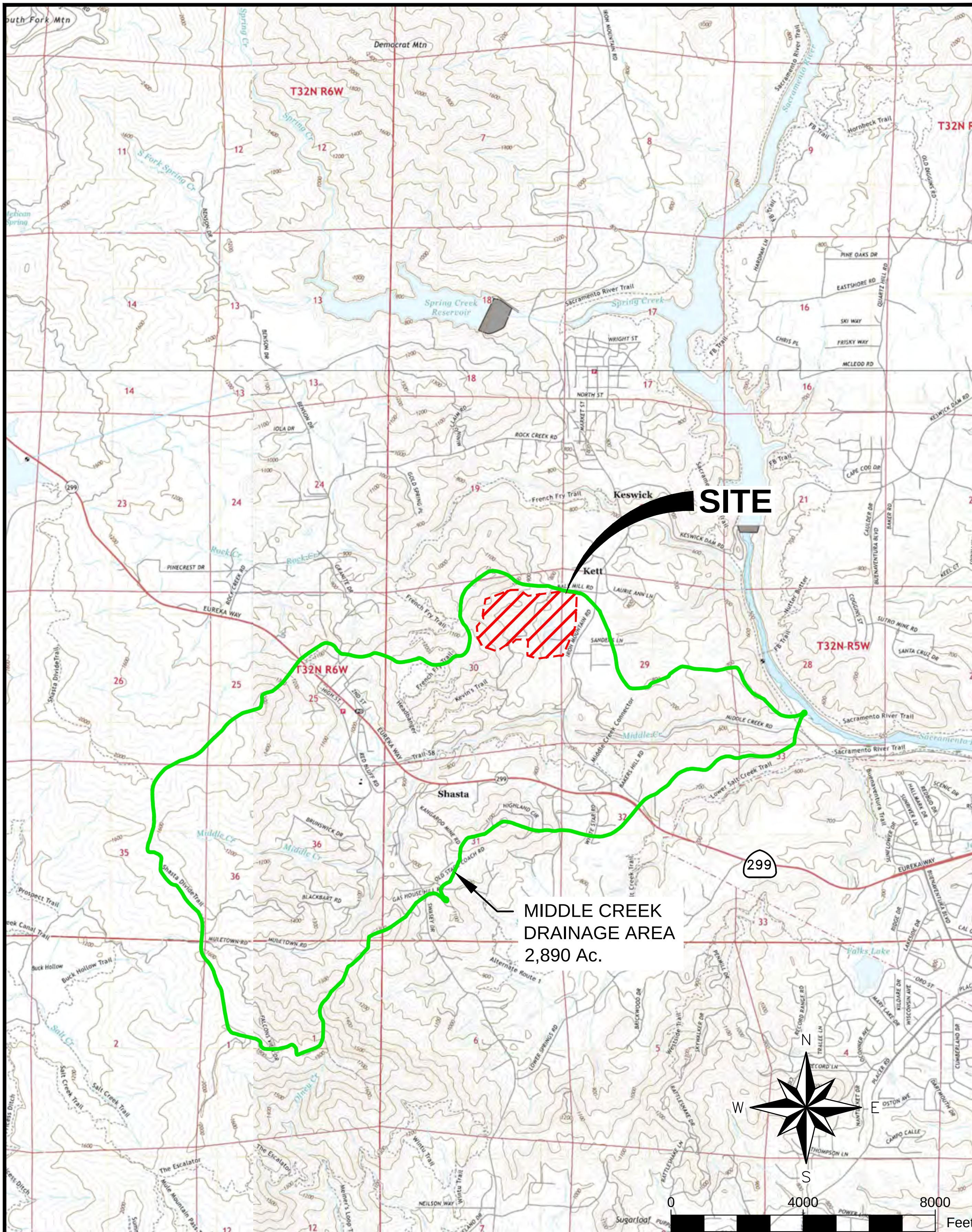
Therefore, it does not appear that historic runoff from CCA has adversely affected surface-water quality in Middle Creek, and there is evidence of other influences that affect the creek's water quality.

Water management and stormwater-runoff control in the future will be done similarly to the current operations. During each phase, runoff from the disturbed areas will be routed to temporary detention basins within the phase footprint, as has been done historically and currently.

Groundwater inflow into each phase also will be routed to the temporary detention basins, as currently done. Once excavation in a phase proceeds such that deeper basins are developed, groundwater seepage into the basin will be pumped out for discharge to either temporary basins or existing ponds. Groundwater production from mined areas is not expected to be greater than current seepage rates because as the quarry is deepened, the potential for groundwater occurrence decreases.

Overall, there will be less offsite discharge once the new lake is completed than currently occurs (**Table 2**, page 12).

Therefore, it is unlikely that future operations will adversely affect offsite runoff.

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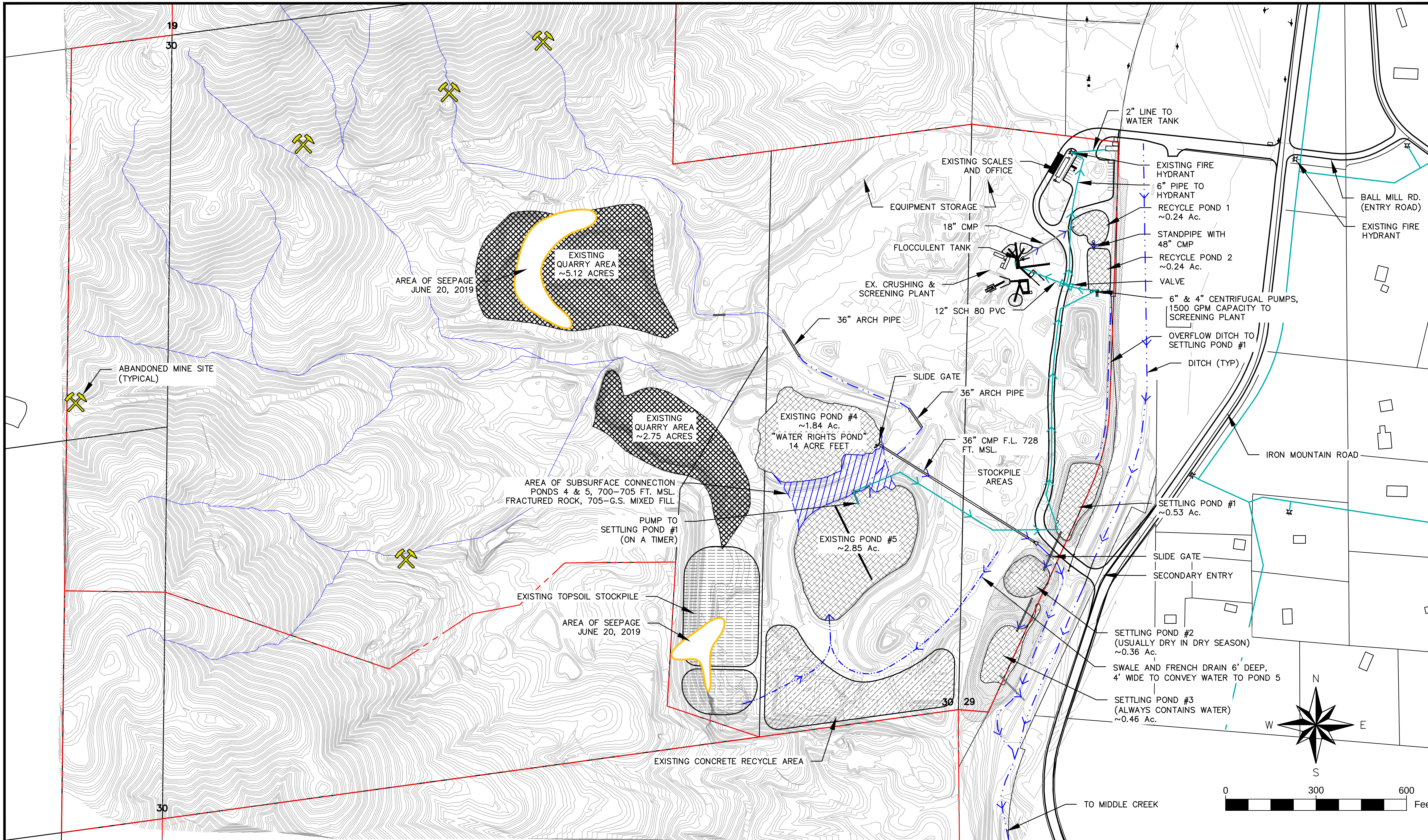
# SITE LOCATION MAP

MAP ADAPTED FROM U.S.G.S. 7.5-MINUTE TOPOGRAPHIC QUADS: REDDING, WHISKEYTOWN, SHASTA DAM AND IGO, CA.

| PROJECT NAME: | PROJECT NO: | DATE: |
|---|---|---|
| QUARRY ANALYSIS | 006005.01 | 5/1/2020 |
| CLIENT: CRYSTAL CRK. AGG. | DRAWN BY: J. BEERS | FIGURE 1 |
| SCALE: 1" = 4,000' | CHECKED BY: B. LAMPLEY | |

p:\006005.00_crystal creek aggregate\site_loc.dwg J.R.B. 5/1/2020

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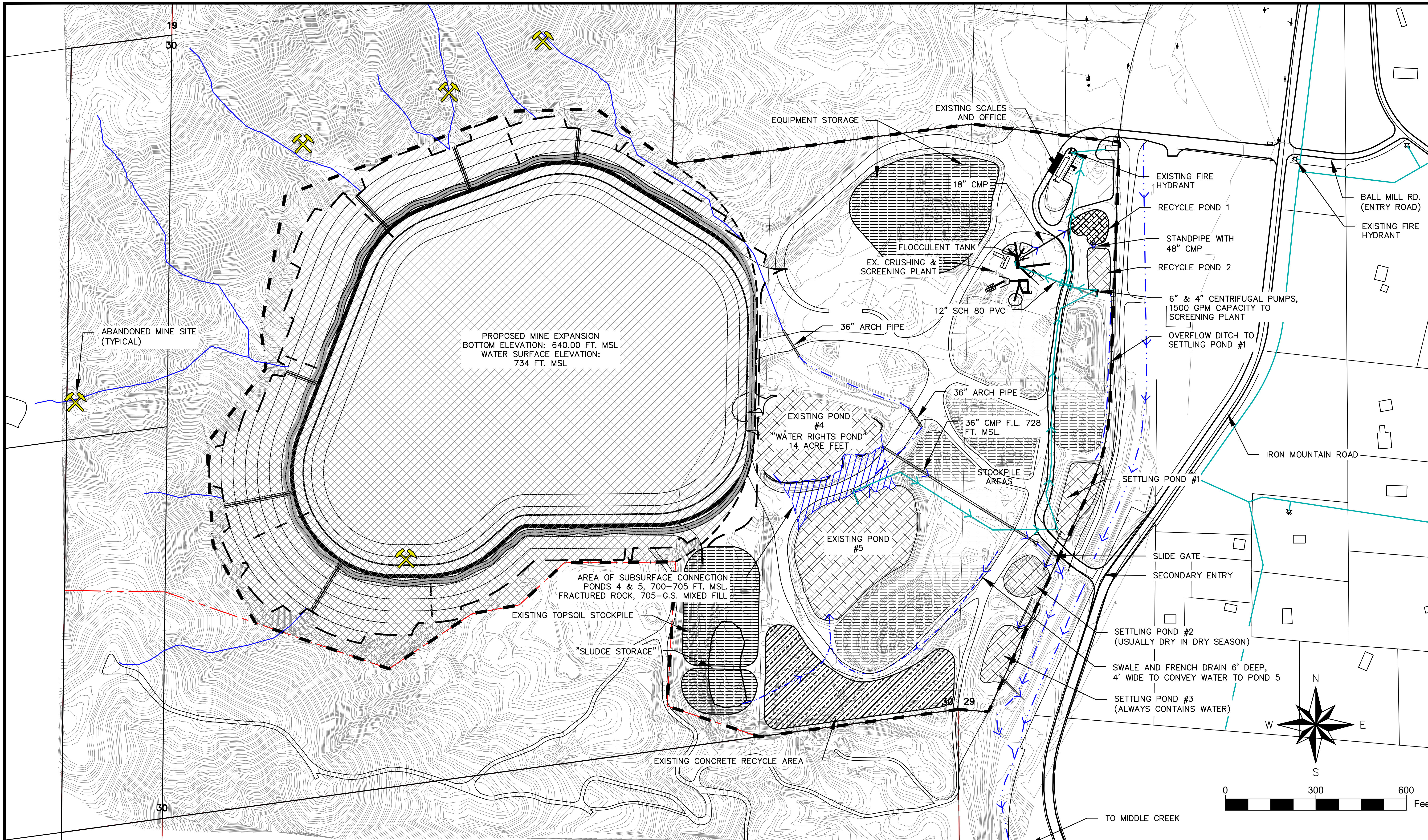
EXISTING SITE PLAN SHOWING DRAINAGES AND POND AREAS

| QUARRY ANALYSIS | PROJECT NO: 006005.01 | SCALE: 1" = 300' |
|---|---|---|
| CRYSTAL CREEK AGGREGATE | DRAWN BY: J. BEERS | DATE: 12/2/2020 |
| | CHECKED BY: B. LAMPLEY | FIGURE 2 |

p:\006005.00_crystal creek aggregate\site5.dwg J.R.B. 12/2/2020

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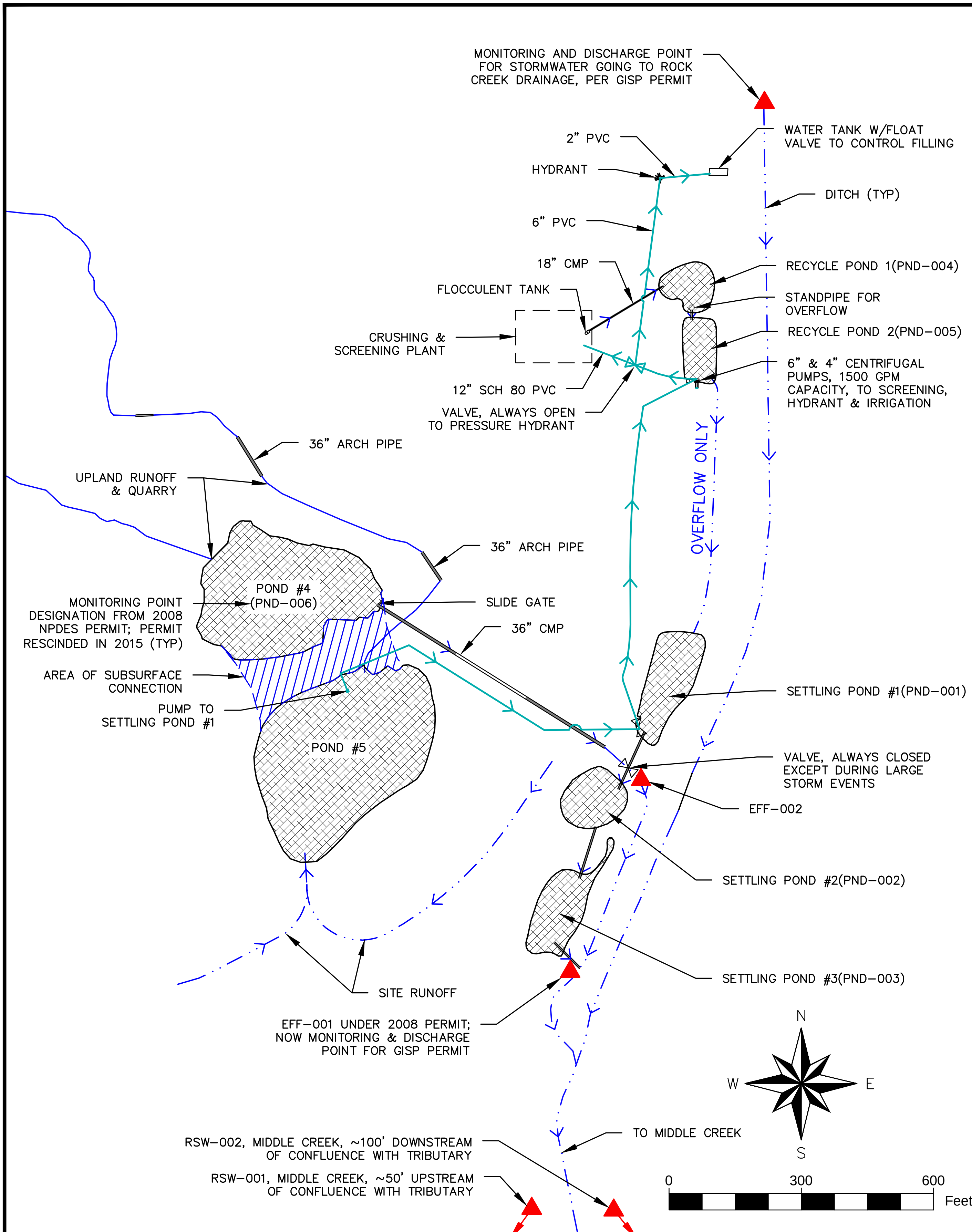
PROPOSED SITE PLAN

| QUARRY ANALYSIS | PROJECT NO: 006005.01 | SCALE: 1" = 300' |
|---|---|---|
| CRYSTAL CREEK AGGREGATE | DRAWN BY: J. BEERS | DATE: 12/6/2022 |
| | CHECKED BY: B. LAMPLEY | FIGURE 3 |

p:\006005.00_crystal creek aggregate\site_prop3.dwg J.R.B. 12/6/2022

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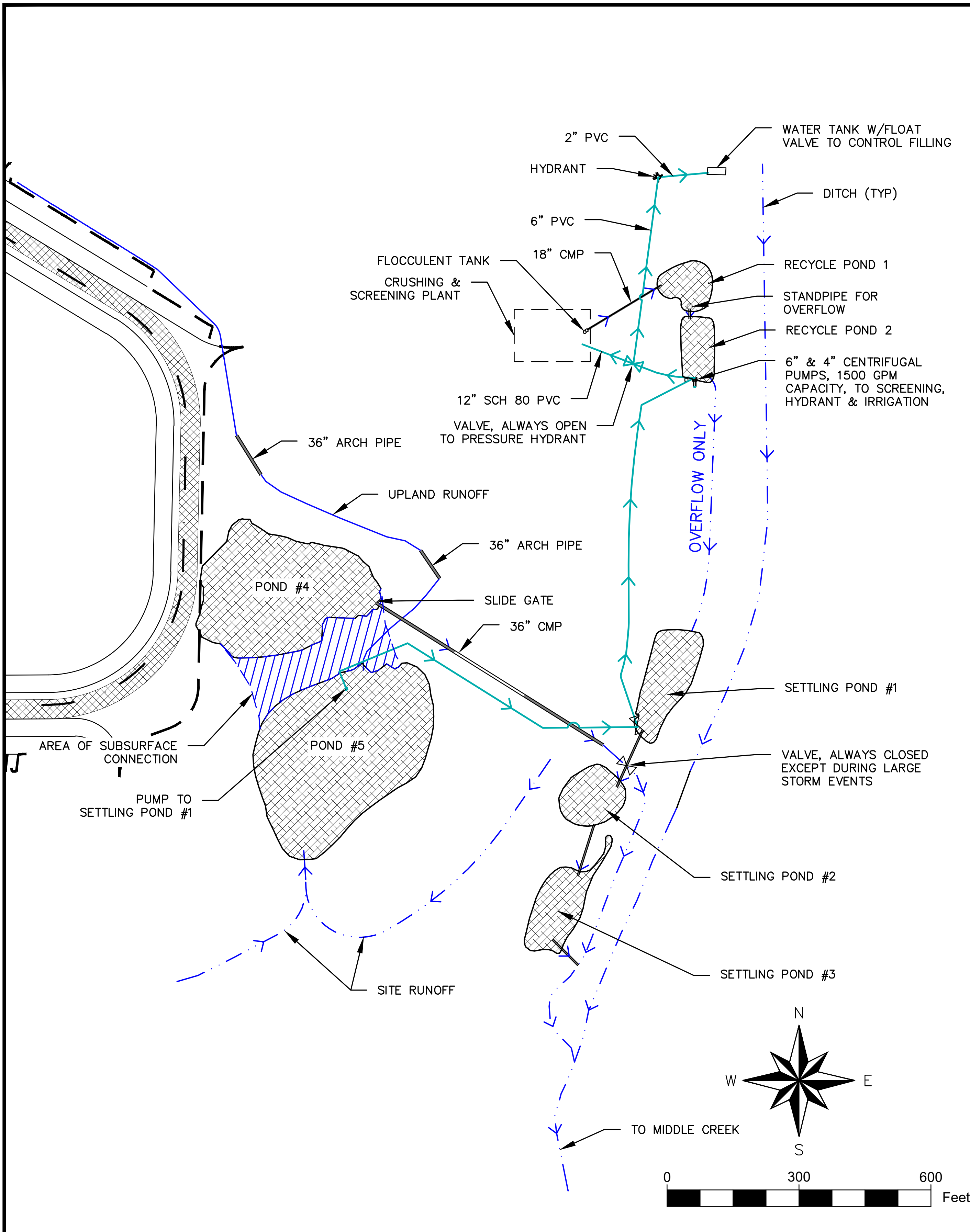
# EXISTING DRAINAGE/WATER MANAGEMENT SCHEMATIC

| PROJECT NAME: | PROJECT NO: | DATE: |
|---|---|---|
| QUARRY ANALYSIS | 006005.01 | 12/1/2020 |
| CLIENT: C.C. AGG. | DRAWN BY: J. BEERS | FIGURE 4 |
| SCALE: 1" = 300' | CHECKED BY: B. LAMPLEY | |

p:\006005.00_crystal creek aggregate\site5_drain_schem_ex.dwg J.R.B. 12/1/2020

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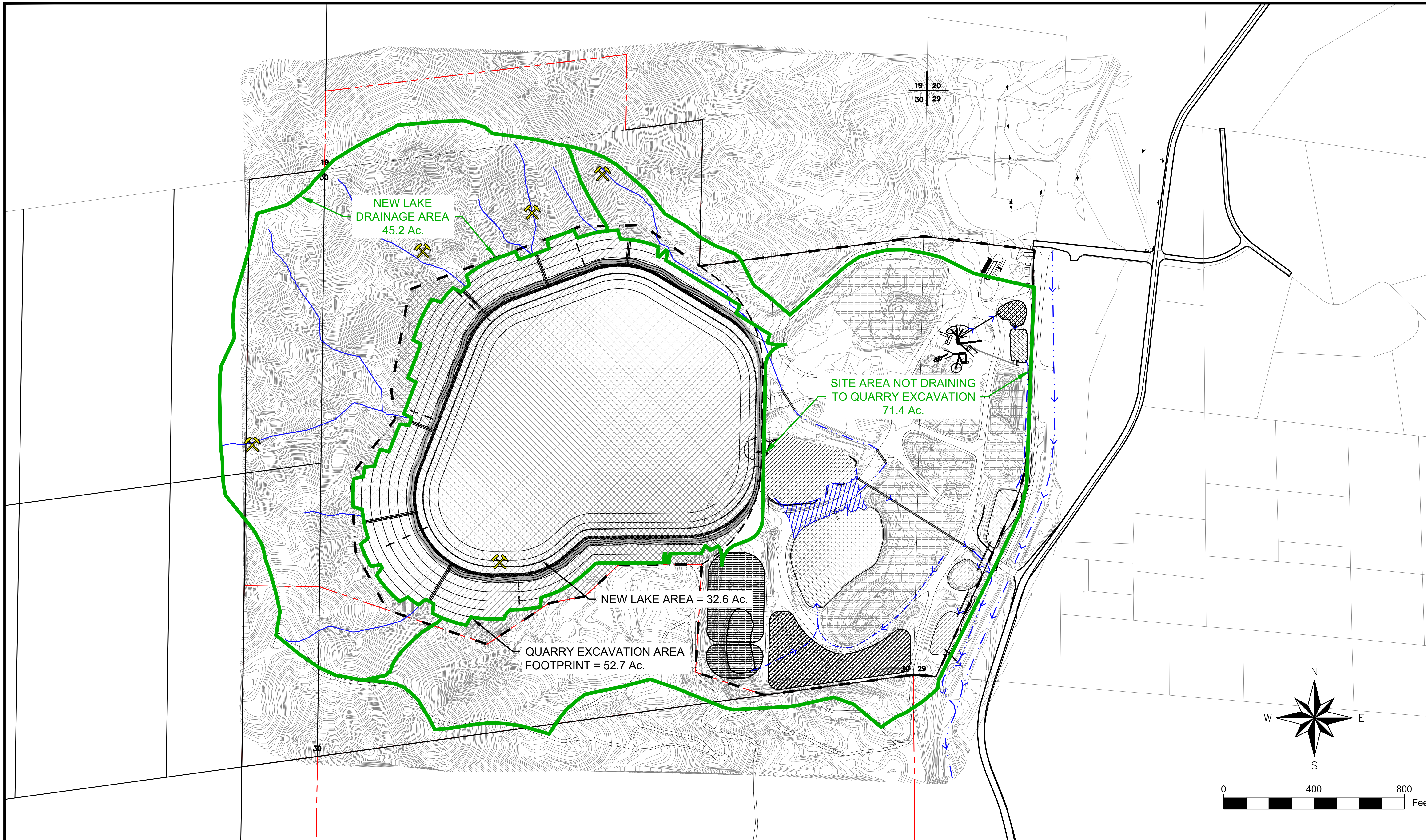
# PROPOSED DRAINAGE/WATER MANAGEMENT SCHEMATIC

| PROJECT NAME: | PROJECT NO: | DATE: |
|---|---|---|
| QUARRY ANALYSIS | 006005.01 | 12/6/2022 |
| CLIENT: C.C. AGG. | DRAWN BY: J. BEERS | FIGURE 5 |
| SCALE: 1" = 300' | CHECKED BY: B. LAMPLEY | |

p:\006005.00_crystal creek aggregate\site6_drain_schem.dwg J.R.B. 12/6/2022

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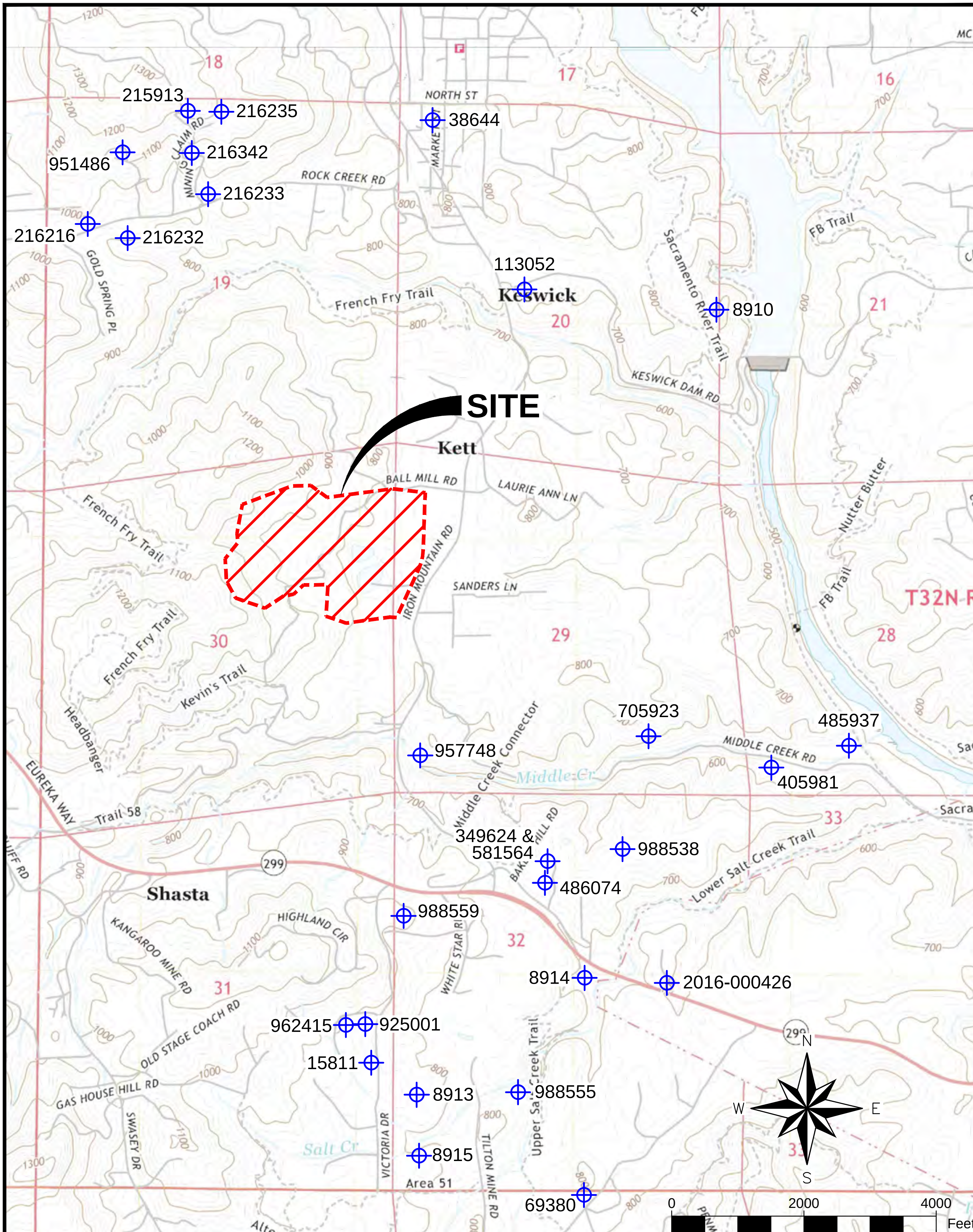
GENERAL SITE DRAINAGE AREAS

QUARRY ANALYSIS

CRYSTAL CREEK AGGREGATE

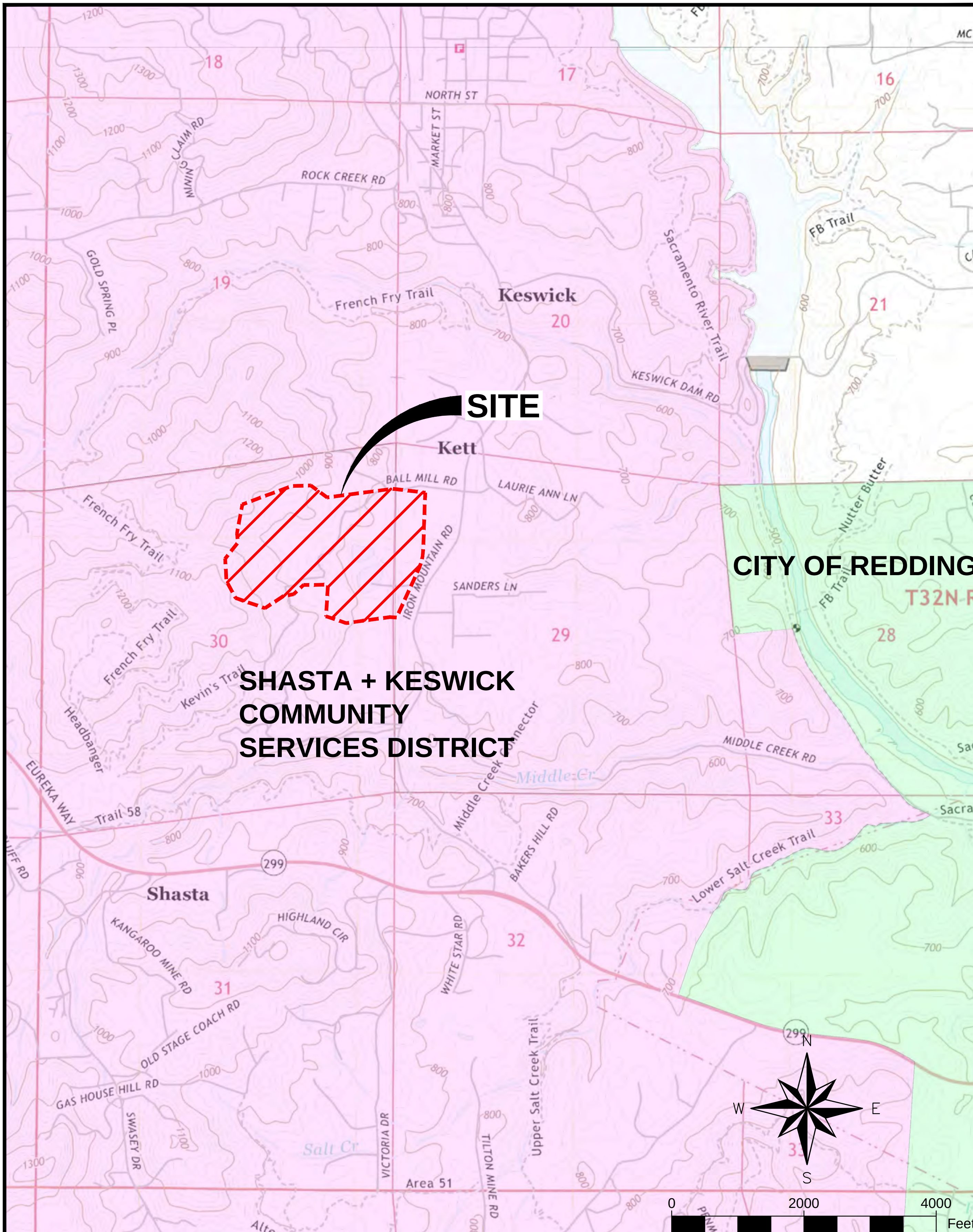
| | |
|---|---|
| PROJECT NO: 006005.01 | SCALE: 1" = 400' |
| DRAWN BY: J. BEERS | DATE: 12/6/2022 |
| CHECKED BY: B. LAMPLEY | FIGURE 6 |

p:\006005.00_crystal creek aggregate\site_drain3.dwg J.R.B. 12/6/2022




| | | | |
|---|---|---|---|
| LAWRENCE & ASSOCIATES ENGINEERS & GEOLOGISTS | WELLS OF RECORD IN THE VICINITY | PROJECT NAME: QUARRY ANALYSIS | PROJECT NO: 006005.01 | DATE: 11/20/2020 |
| | | CLIENT: CRYSTAL CRK. AGG. | DRAWN BY: J. BEERS | FIGURE 7 |
| | | SCALE: 1" = 2,000' | CHECKED BY: B. LAMPLEY | |

p:\006005.00_crystal creek aggregate\wells_vicinity.dwg J.R.B. 11/20/2020




# VICINITY POTABLE WATER SUPPLIERS

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| PROJECT NAME: | PROJECT NO: | DATE: |
|---|---|---|
| QUARRY ANALYSIS | 006005.01 | 11/20/2020 |
| CLIENT: | DRAWN BY: | FIGURE 8 |
| CRYSTAL CRK. AGG. | J. BEERS | |
| SCALE: | CHECKED BY: | |
| 1" = 2,000' | B. LAMPLEY | |

p:\006005.00_crystal creek aggregate\water_suppliers.dwg J.R.B. 11/20/2020

# CUMULATIVE DEPARTURE GRAPH & DATA

| Water Year | Precipi-tation inches | Departure From Average inches | Cumulative Departure inches |
|---|---|---|---|
| 1960 | | | 0 |
| 1961 | 47.53 | -13.91 | -13.91 |
| 1962 | 55.41 | -6.03 | -19.94 |
| 1963 | 61.45 | 0.01 | -19.93 |
| 1964 | 38.35 | -23.09 | -43.02 |
| 1965 | 73.36 | 11.92 | -31.10 |
| 1966 | 51.14 | -10.30 | -41.40 |
| 1967 | 73.86 | 12.42 | -28.98 |
| 1968 | 46.17 | -15.27 | -44.25 |
| 1969 | 76.44 | 15.00 | -29.25 |
| 1970 | 70.92 | 9.48 | -19.77 |
| 1971 | 65.06 | 3.62 | -16.15 |
| 1972 | 36.59 | -24.85 | -41.00 |
| 1973 | 67.62 | 6.18 | -34.82 |
| 1974 | 99.52 | 38.08 | 3.26 |
| 1975 | 62.49 | 1.05 | 4.31 |
| 1976 | 38.88 | -22.56 | -18.25 |
| 1977 | 27.05 | -34.39 | -52.64 |
| 1978 | 91.89 | 30.45 | -22.19 |
| 1979 | 40.3 | -21.14 | -43.33 |
| 1980 | 60.51 | -0.93 | -44.26 |
| 1981 | 58.41 | -3.03 | -47.29 |
| 1982 | 92.13 | 30.69 | -16.60 |
| 1983 | 122.4 | 60.96 | 44.36 |
| 1984 | 61.79 | 0.35 | 44.71 |
| 1985 | 46.11 | -15.33 | 29.38 |
| 1986 | 75.55 | 14.11 | 43.49 |
| 1987 | 36.8 | -24.64 | 18.85 |
| 1988 | 50.88 | -10.56 | 8.29 |
| 1989 | 57.37 | -4.07 | 4.22 |
| 1990 | 37.72 | -23.72 | -19.50 |
| 1991 | 34.44 | -27.00 | -46.49 |
| 1992 | 52.81 | -8.63 | -55.12 |
| 1993 | 77.15 | 15.71 | -39.41 |
| 1994 | 39.87 | -21.57 | -60.98 |
| 1995 | 106.54 | 45.10 | -15.88 |
| 1996 | 65.95 | 4.51 | -11.37 |
| 1997 | 76.29 | 14.85 | 3.48 |
| 1998 | 115.36 | 53.92 | 57.40 |
| 1999 | 59.51 | -1.93 | 55.47 |
| 2000 | 73.08 | 11.64 | 67.11 |
| 2001 | 44.83 | -16.61 | 50.50 |
| 2002 | 59.02 | -2.42 | 48.08 |
| 2003 | 74.61 | 13.17 | 61.25 |
| 2004 | 57.64 | -3.80 | 57.45 |
| 2005 | 65.8 | 4.36 | 61.81 |
| 2006 | 88.49 | 27.05 | 88.86 |
| 2007 | 39.82 | -21.62 | 67.24 |
| 2008 | 36.74 | -24.70 | 42.54 |
| 2009 | 59.36 | -2.08 | 40.46 |
| 2010 | 75.51 | 14.07 | 54.53 |
| 2011 | 73.09 | 11.65 | 66.18 |
| 2012 | 45.94 | -15.50 | 50.68 |
| 2013 | 43.57 | -17.87 | 32.81 |
| 2014 | 34.42 | -27.02 | 5.79 |
| 2015 | 52.74 | -8.70 | -2.91 |
| 2016 | 63.78 | 2.34 | -0.57 |
| 2017 | 90.05 | 28.61 | 28.04 |
| 2018 | 36.65 | -24.79 | 3.25 |
| 2019 | 87.46 | 26.02 | 29.27 |
| 2020 | 32.17 | -29.27 | 0.00 |

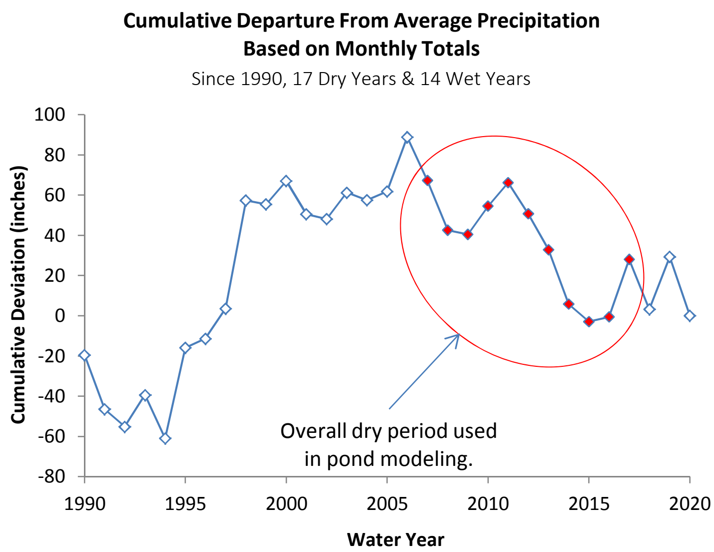
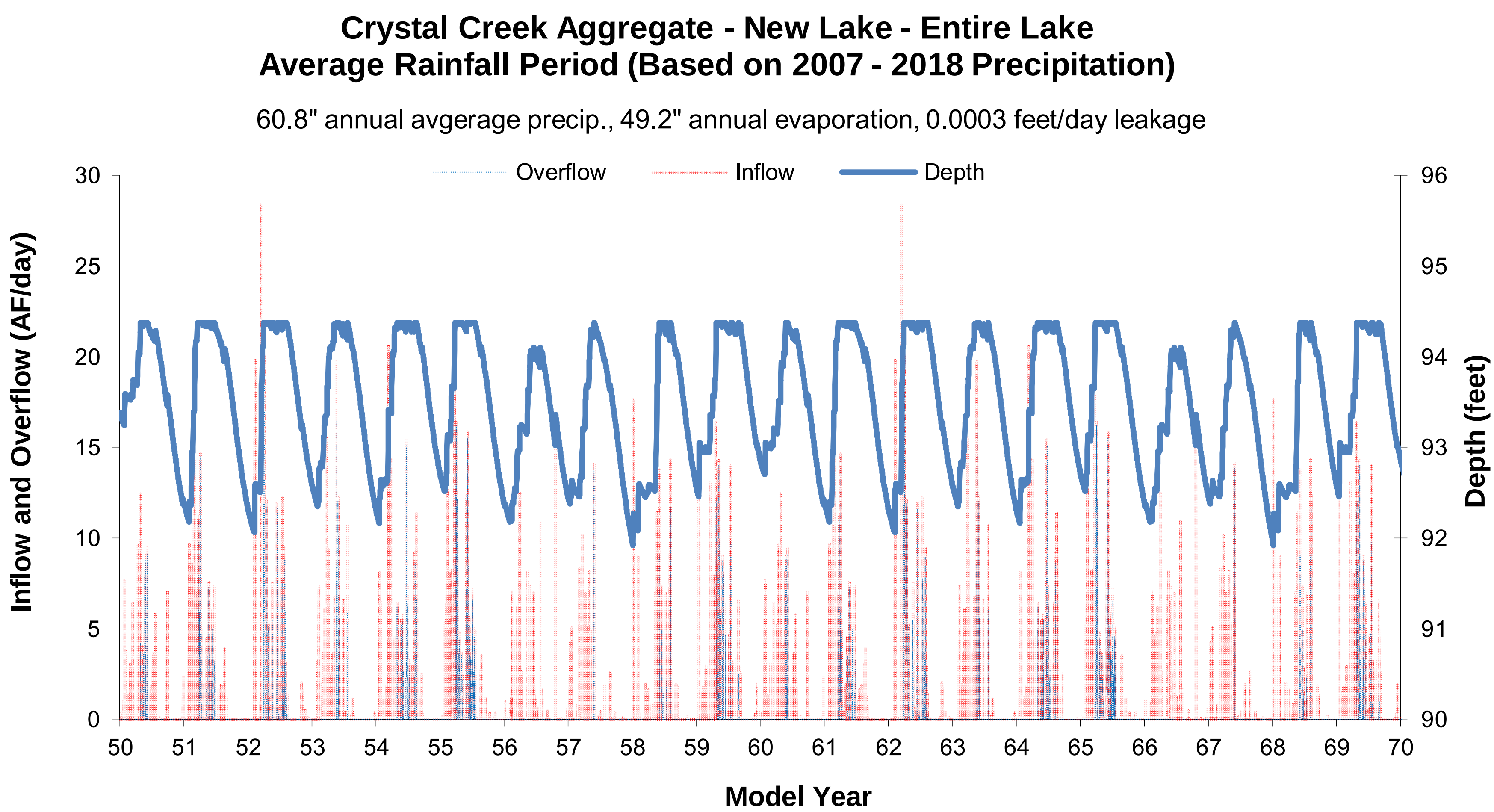



FIGURE 9



Crystal Creek Aggregate - New Lake - Entire Lake
Average Rainfall Period (Based on 2007 - 2018 Precipitation)
60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Model Year
0
5
10
15
20
25
30
90
91
92
93
94
95
96
50
51
52
53
54
55
56
57
58
59
60
61
62
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68
69
70


FIGURE 10

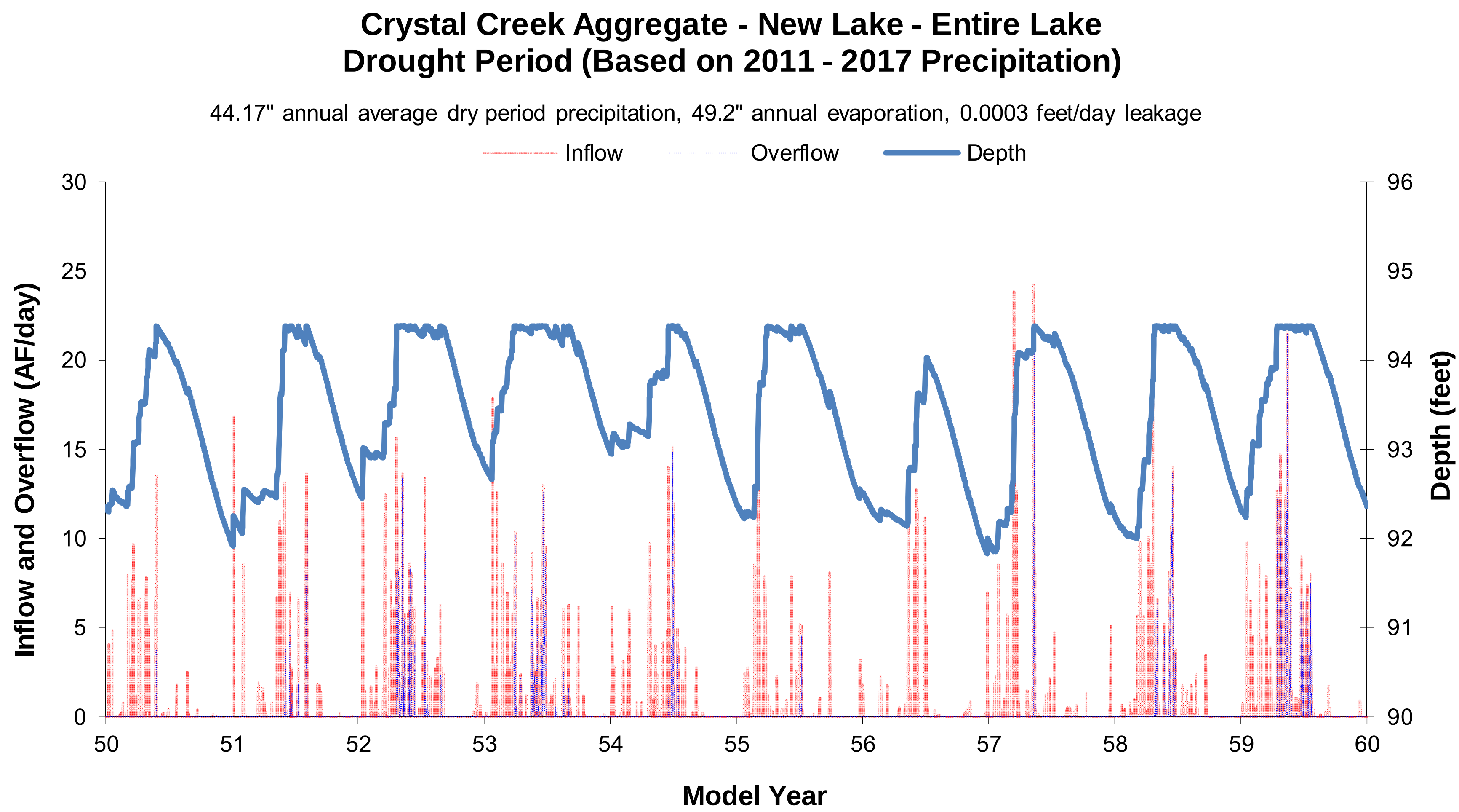
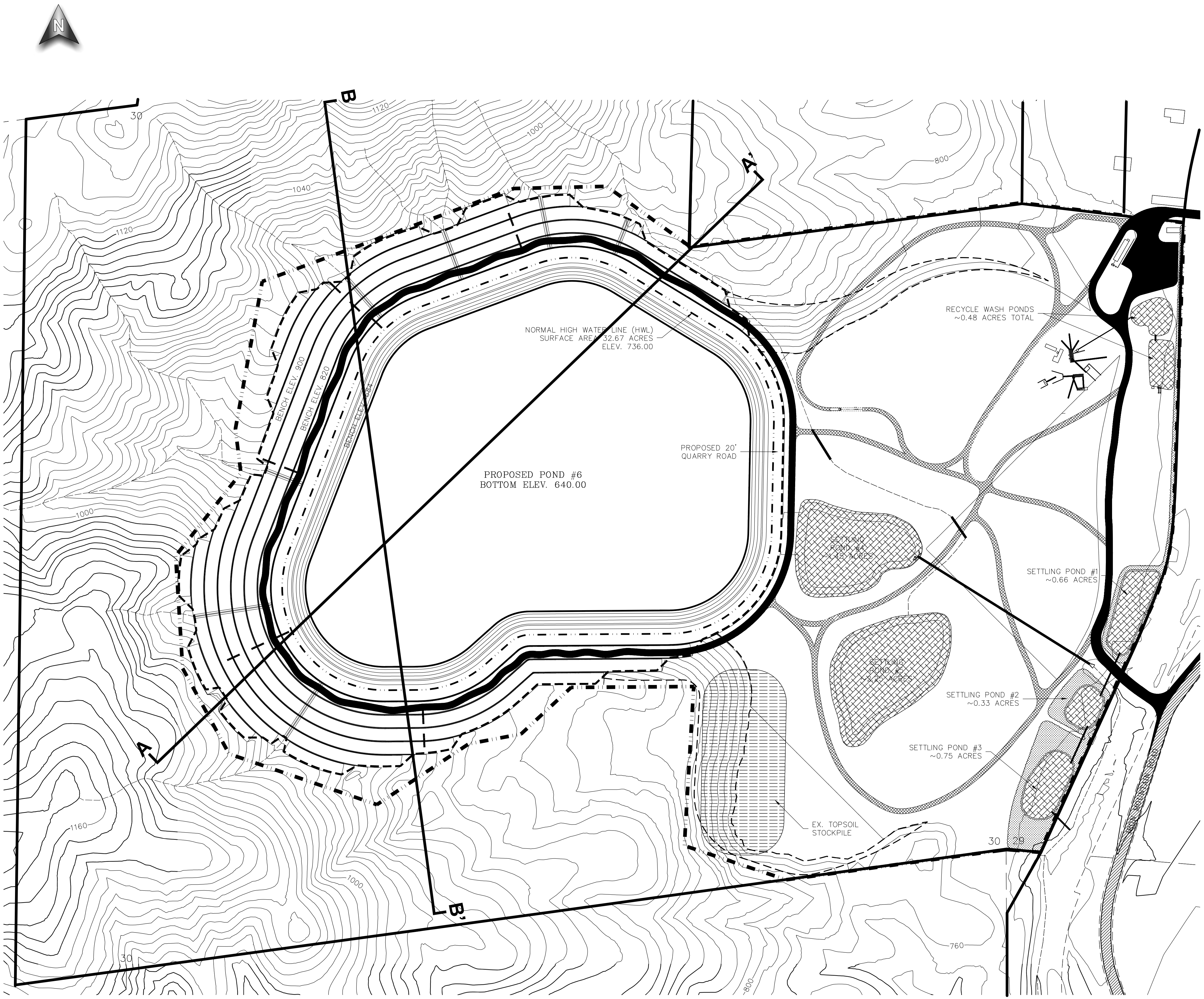

Crystal Creek Aggregate - New Lake - Entire Lake
Drought Period (Based on 2011 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Model Year
0
5
10
15
20
25
30
90
91
92
93
94
95
96
50
51
52
53
54
55
56
57
58
59
60

FIGURE 11

# APPENDIX A

## GEOLOGIC & LINEATION MAPS

FROM: BAJADA GEOSCIENCES, GEOTECHNICAL REPORT




Map from Duane Miller Engineering (2020)

B B' Cross Sections
see Plates 5.1 & 5.2

0 150 300
Scale: 1"=300'
1:3,600

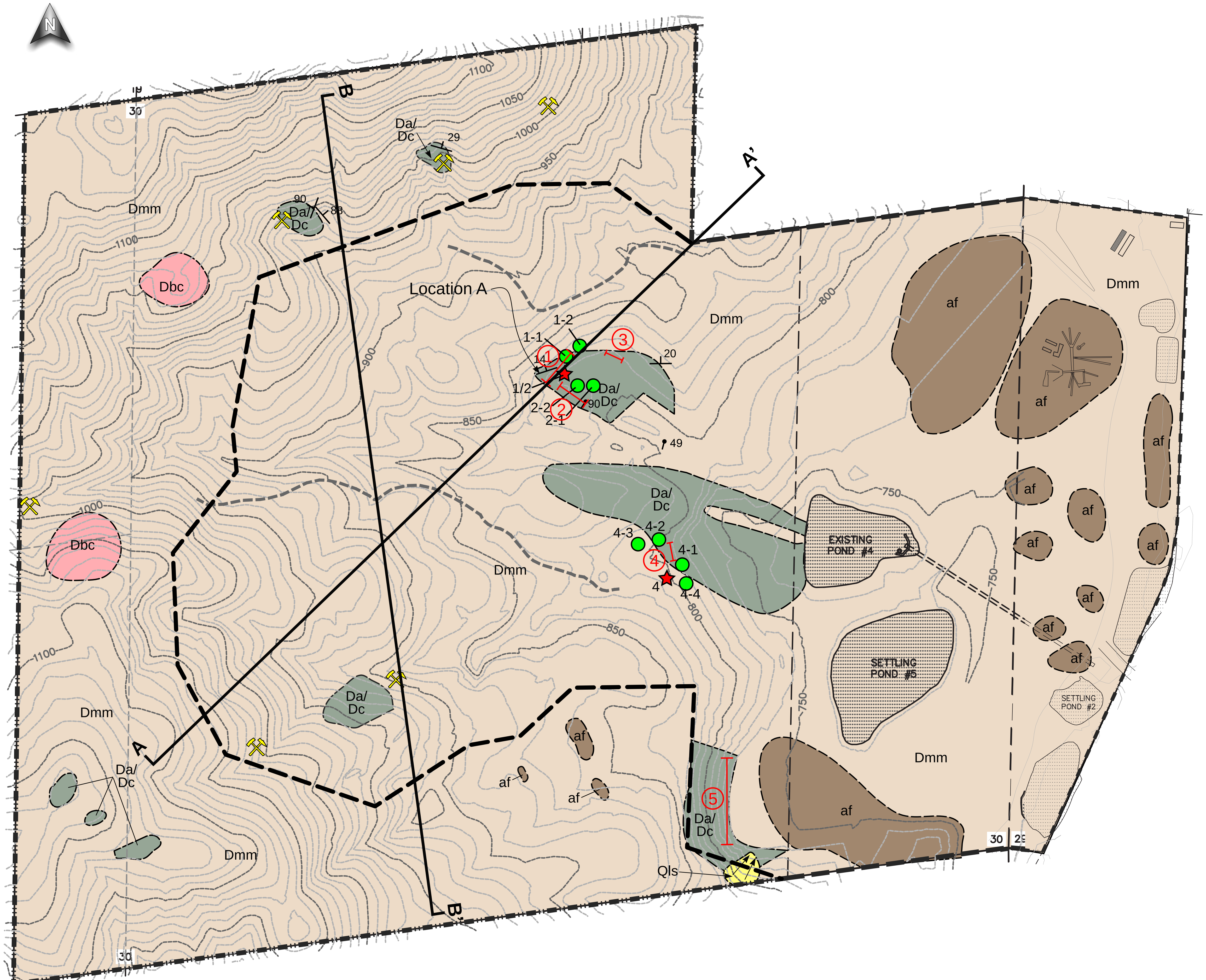
**PROPOSED MINE CONFIGURATION**

Crystal Creek Aggregates Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No.
2

BAJADA Geosciences, Inc.

Project no.
1901.0114




| | |
|---|---|
| af | Artificial Fill/Stockpiles |
| Qls | Landslide Deposits |
| Dmm | Mule Mountain Stock |
| Dbc | Balaklala Rhyolite |
| Da/ Dc | Epidote/Chloritic Amphibolite, Copley Greenstone, & Gabbro |

Abandoned Mine Site

Formation Contact
Dashed where inferred

75 Fault/Lineation
Dashed where inferred, ball & bar indicate measured fault plane dip direction & magnitude

20 Strike & Dip Orientation at Contacts & Marker Beds

4-4 Sample location for rock unconfined compressive strength

4 Sample location for Naturally Occurring Asbestos (NOA)

5 Sites 1 through 6 - areas where discontinuities were mapped during this study

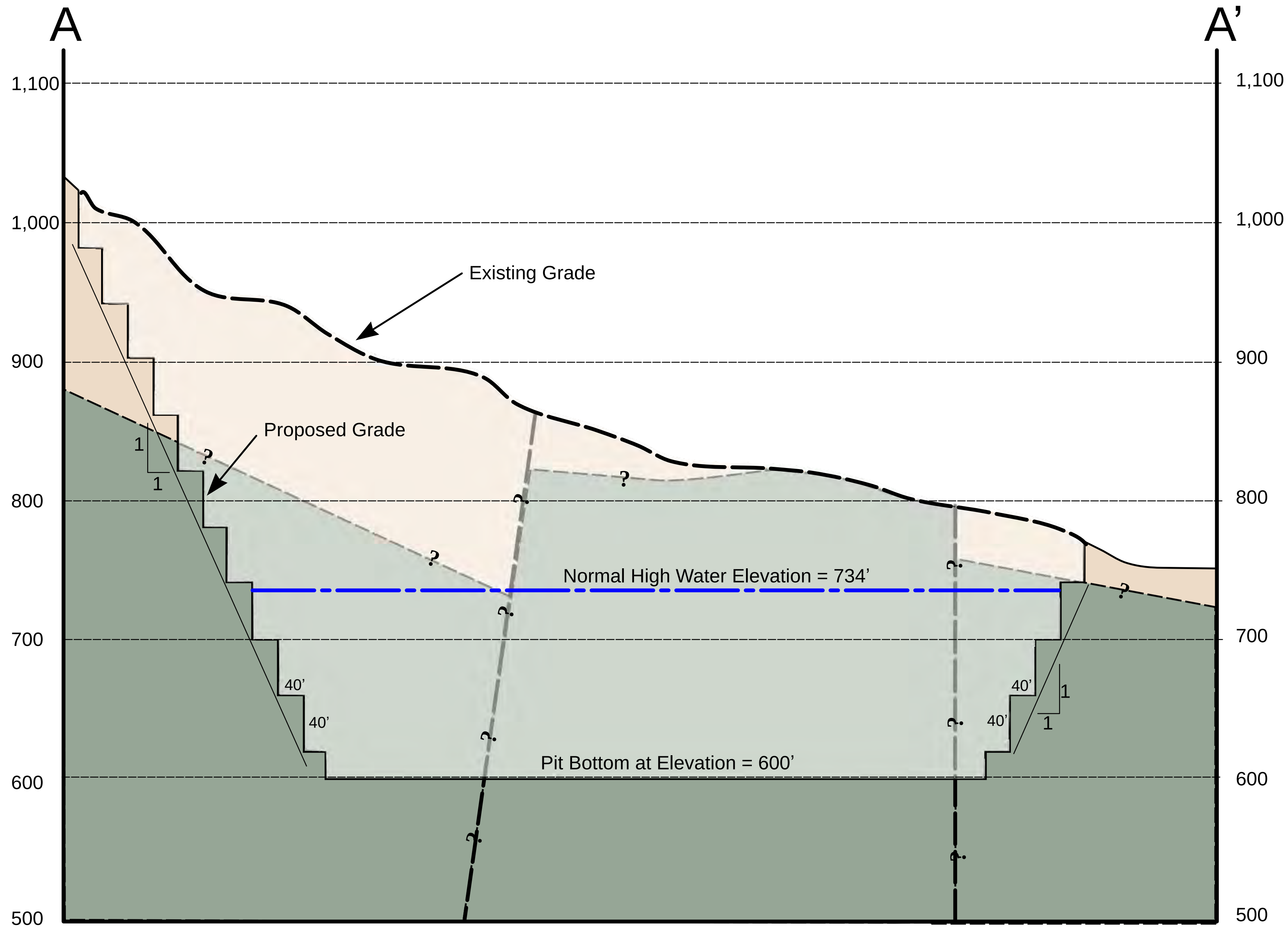
0 150 300

Scale: 1"=300'
1:3,600

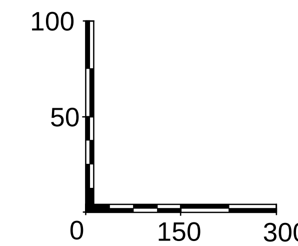
Base map from Duane K. Miller Civil Engineer (2020)

**GEOLOGIC MAP**

| | |
|---|---|
| Crystal Creek Aggregates Quarry<br>Amendment to Reclamation Plan<br>Proposed Quarry Expansion<br>Shasta County, California | Plate No.<br>3 |
| BAJADA Geosciences, Inc. | Project no.<br>1901.0114 |

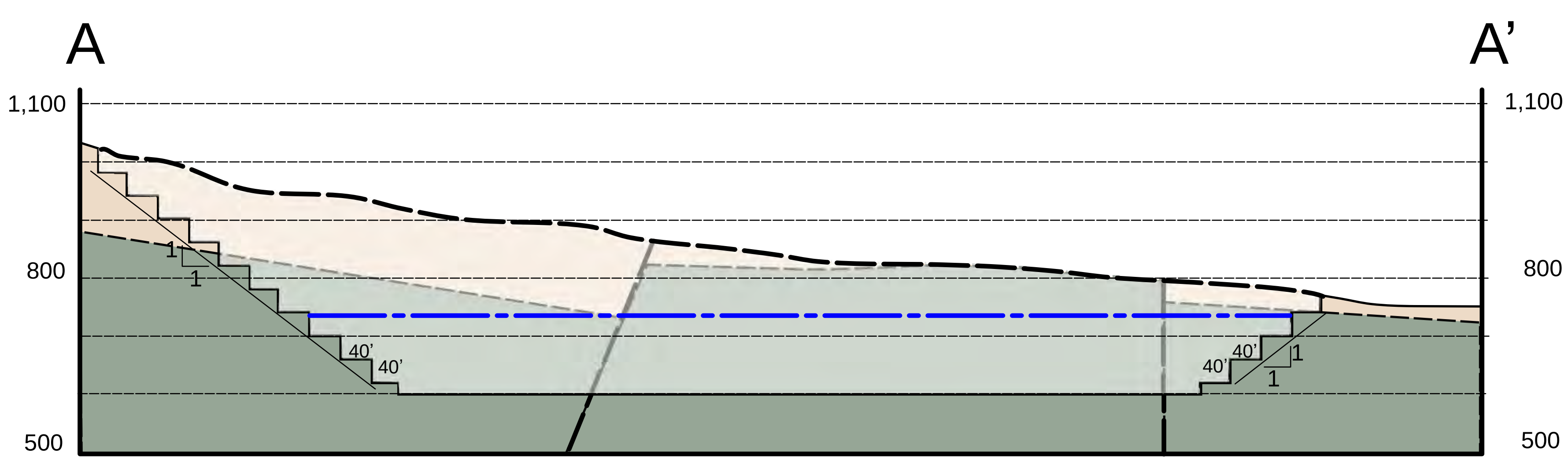


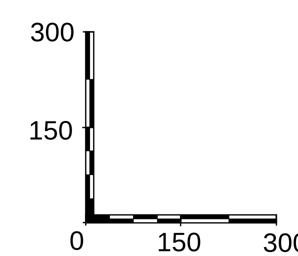

| | |
|---|---|
| af | Artificial Fill/Stockpiles |
| Qls | Landslide Deposits |
| Dmm | Mule Mountain Stock |
| Dbc | Balaklala Rhyolite |
| Da/Dc | Epidote/Chloritic Amphibolite & Copley Greenstone |




Scale:
Horizontal:1"=300'
Vertical: 1"=100'
Vertical Exaggeration 3x

No subsurface information was available for this quarry. Projections of subsurface geological conditions are conjecture and subject to change as the quarry is mined and further mapping performed.




Scale:
Horizontal:1"=300'
Vertical: 1"=300'
No Vertical Exaggeration

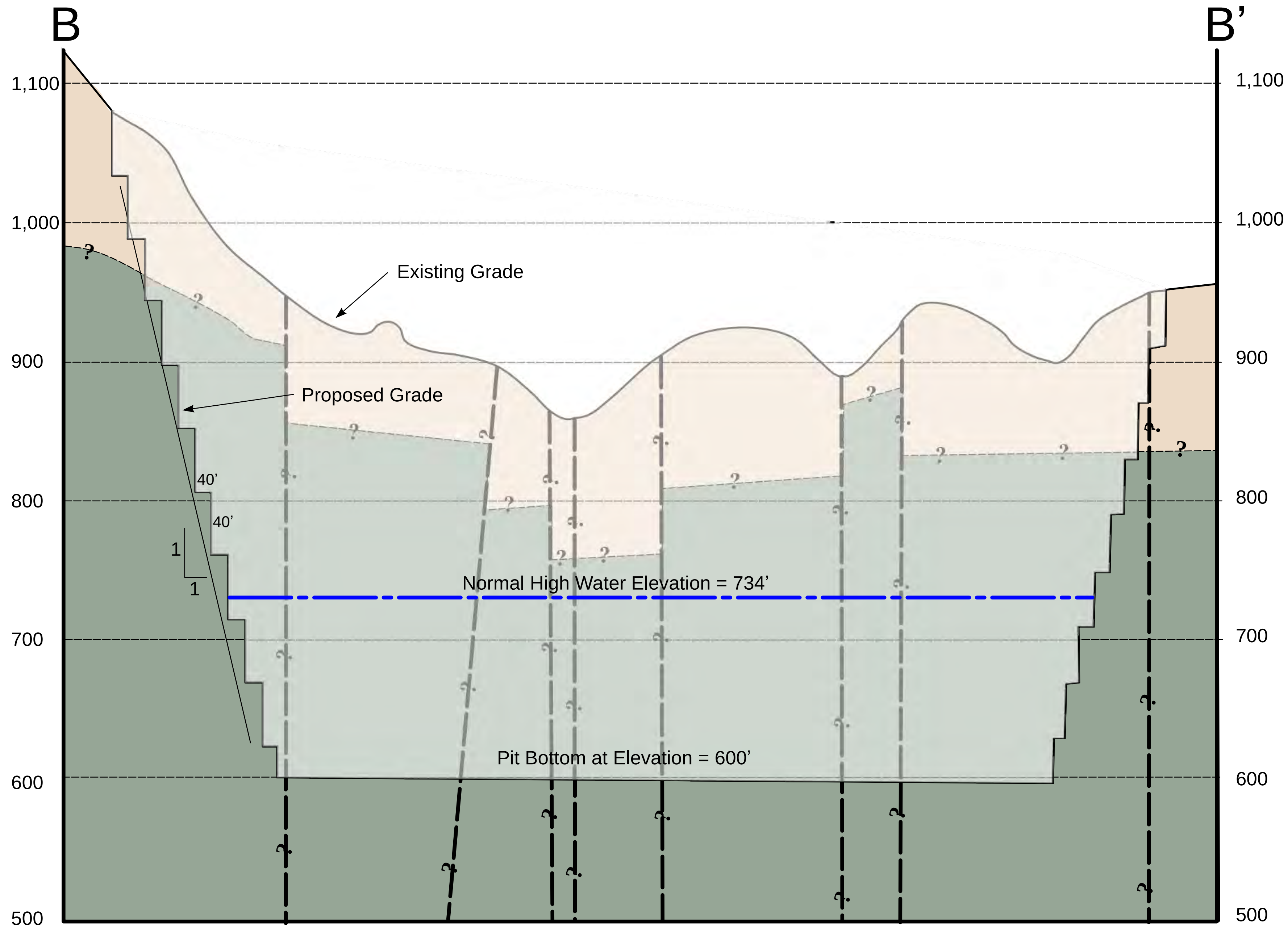
**GEOTECHNICAL SECTION A-A'**

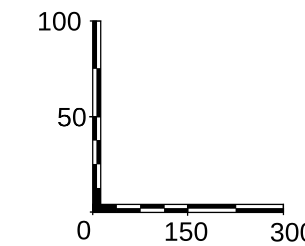
Crystal Creek Aggregate Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 5.1

BAJADA Geosciences, Inc.

Project no. 1901.0114

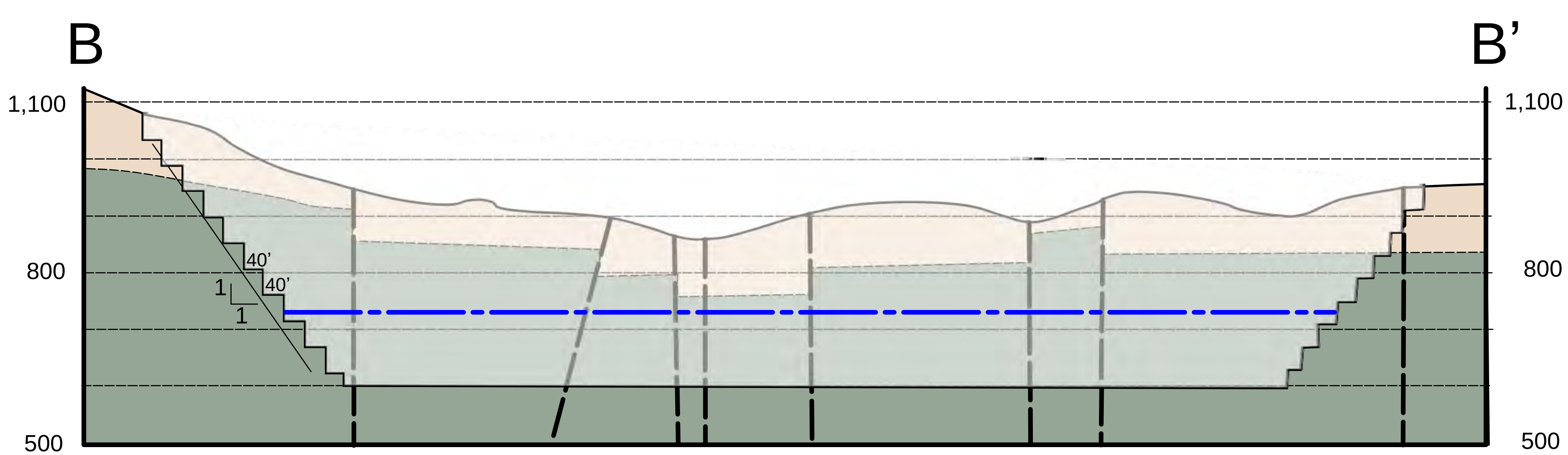


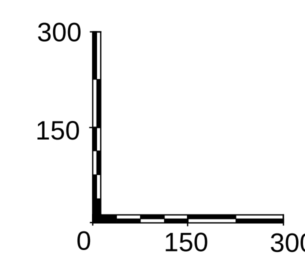




Scale:
Horizontal:1"=300'
Vertical: 1"=100'
Vertical Exaggeration 3x

| | |
|---|---|
| af | Artificial Fill/Stockpiles |
| Qls | Landslide Deposits |
| Dmm | Mule Mountain Stock |
| Dbc | Balaklala Rhyolite |
| Da/ Dc | Epidote/Chloritic Amphibolite & Copley Greenstone |

No subsurface information was available for this quarry. Projections of subsurface geological conditions are conjecture and subject to change as the quarry is mined and further mapping performed.




Scale:
Horizontal:1"=300'
Vertical: 1"=300'
No Vertical Exaggeration

**GEOTECHNICAL SECTION B-B'**

Crystal Creek Aggregate Quarry
Amendment to Reclamation Plan
Proposed Quarry Expansion
Shasta County, California

Plate No. 5.2

BAJADA Geosciences, Inc.

Project no. 1901.0114

# APPENDIX B

## VICINITY WELL LOGS

32N/05W-19 M

**ORIGINAL**

**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
**WATER WELL DRILLERS REPORT**

*Do not fill in*

No. 215953

Not Intent No.

Loca. Permit No. or Date 8306

State Well No.

Other Well No.

Off Rock Creek Road

**(2) LOCATION OF WELL** (See instructions):

County Shsta Owner's Well Number WW-1

Well address if different from above Gold Rush Road Keswick

Township 32 N Range 5 W Section 19

Distance from cities, roads, railroads, fences, etc.

Parcel# 065-220-49

WELL LOCATION SKETCH: See Map Attached

**(3) TYPE OF WORK:**
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**
Domestic ☐
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other Monitoirng ☒

**(5) EQUIPMENT:**
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

**(6) GRAVEL PACK:**
Yes ☐ No ☒ Size
Diameter of bore 6 1/8
Packed from to ft.

**(7) CASING INSTALLED:**
Steel ☒ Plastic ☒ Concrete ☐

**(8) PERFORATIONS:**
Type of perforation or size of screen

| | From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|---|
| St | 0 | 25 | 6 5/8 | .188 | 139 | 159 | |
| PVC | 0 | 150 | 4 | 40 | | | |

**(9) WELL SEAL:**
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ft.
Method of sealing Bentonite

**(10) WATER LEVELS:**
Depth of first water, if known 40 85 ft.
Standing level after well completion ft.

**(11) WELL TESTS:**
Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 40 ft. At end of test 40 ft
Discharge 30 gal/min after 1½ hours Water temperature
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

**(12) WELL LOG:** Total depth 160 ft. Depth of completed well 159 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 80 | Overburden Rddish dirt |
| 80 | 87 | Blue Shale |
| 87 | 100 | Blue shale |
| 100 | 123 | Fractured blue shale |
| 123 | 130 | Hard gray shale |
| 130 | 140 | Color change brown |
| 140 | 150 | Blue gray shale |
| 150 | 160 | Hard blue gray shale |

APR 0 1988

Work started 2-8- 19 88 Completed 2-9- 19 88

**WELL DRILLER'S STATEMENT:** 01382

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED (Well Driller)

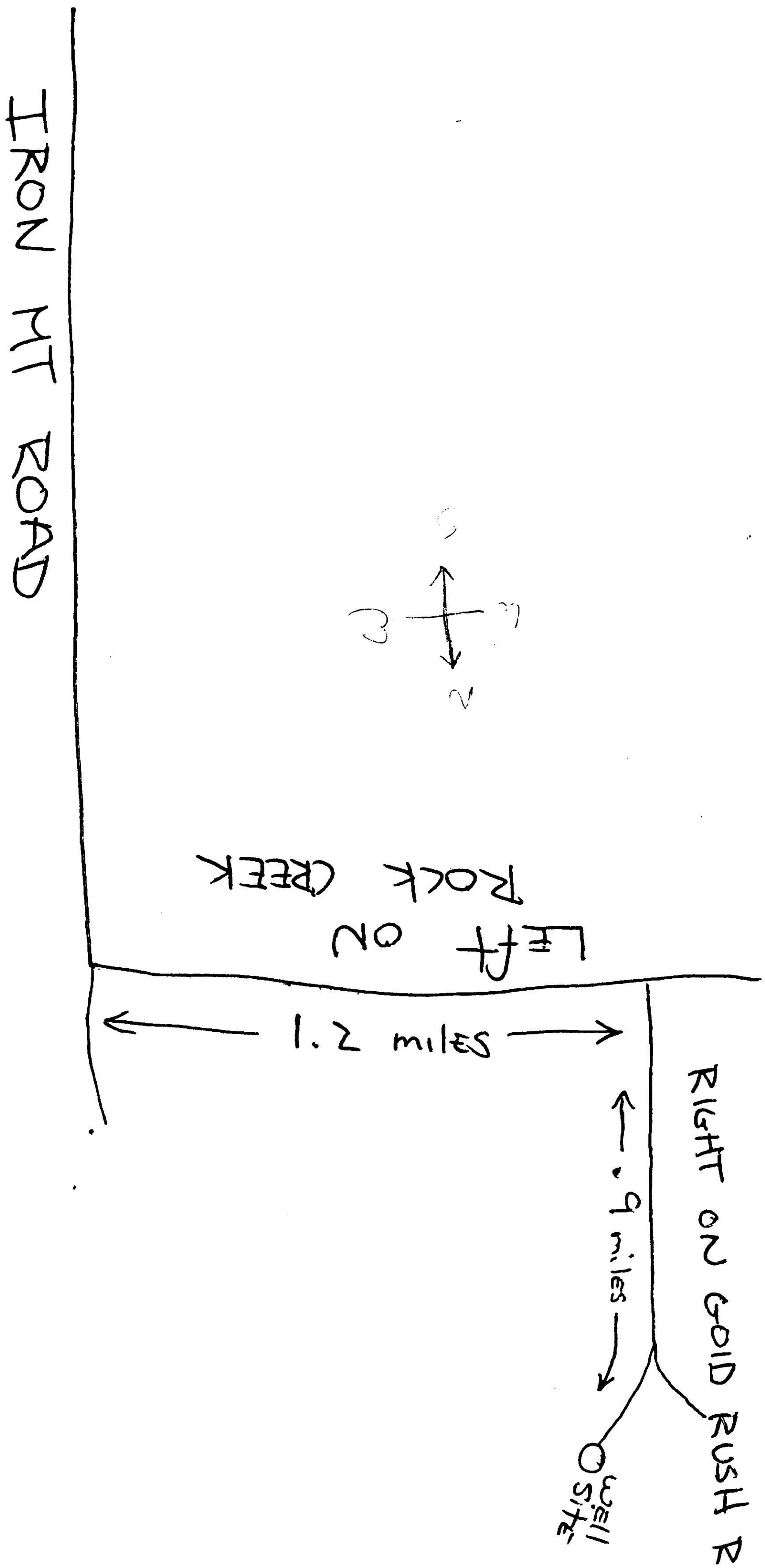
NAME Diamond Core Drilling, Inc. (Person, firm, or corporation) (Typed or printed)

Address 10556 Petunia Lane

City Palo Cedro, CA 96073 Zip

License No. 512406 Date of this report 2-18-88

DWR 188 (REV. 7-76) **IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM**


IRON MT ROAD
LEFT ON ROCK CREEK
1.2 miles
RIGHT ON GOLD RUSH RD
.9 miles
Well Site

32N/05W - 19M

**ORIGINAL**

**File with DWR**

Noti[illegible] Intent No.

Local Permit No. or Date

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# WATER WELL DRILLERS REPORT

*Do not fill in*

No. 216216

State Well No.

Other Well No.

Off Rock Creek Road

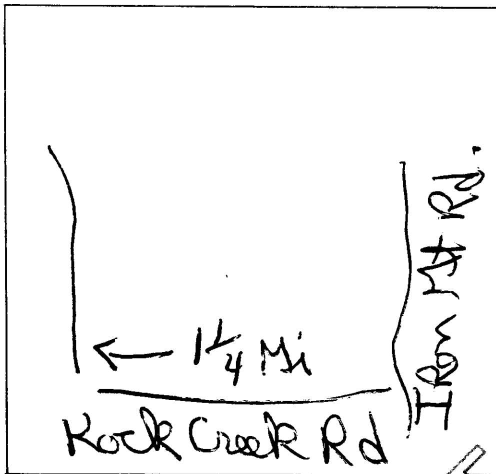
**(2) LOCATION OF WELL** (See instructions):

County Shasta Owner's Well Number

Well address if different from above

Township 32N Range 5W Section 19

Distance from cities, roads, railroads, fences, etc. Assessor's Parcel #65-22-58




WELL LOCATION SKETCH

**(3) TYPE OF WORK:**

New Well ☒ Deepening ☐

Reconstruction ☐

Reconditioning ☐

Horizontal Well ☐

Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**

Domestic ☒

Irrigation ☐

Industrial ☐

Test Well ☐

Stock ☒

Municipal ☐

Other ☐

**(5) EQUIPMENT:**

Rotary ☒ Reverse ☐

Cable ☐ Air ☒

Other ☐ Bucket ☐

**(6) GRAVEL PACK:**

Yes ☐ No ☒ Size

Diameter of bore

Packed from ___ to ___ ft.

**(7) CASING INSTALLED:**

Steel ☒ Plastic ☐ Concrete ☐

**(8) PERFORATIONS:**

Type of perforation or size of screen DTH Perf

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| 0 | 120 | 6 5/8 | .188 | 100 | 120 | |

**(9) WELL SEAL:**

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 0-20' ft.

Were strata sealed against pollution? Yes ☒ No ☐ Interval ___ ft.

Method of sealing Grout

**(10) WATER LEVELS:**

Depth of first water, if known 84 ft.

Standing level after well completion 20 ft.

**(11) WELL TESTS:**

Was well test made? Yes ☒ No ☐ If yes, by whom? Driller

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test 20 ft. At end of test 20 ft

Discharge 32 gal/min after 1/2 hours Water temperature

Chemical analysis made? Yes ☐ No ☒ If yes, by whom?

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

**(12) WELL LOG:** Total depth 130 ft. Depth of completed well 130 ft.

| from ft. to ft. | Formation (Describe by color, character, size or material) |
|---|---|
| 0 - 30 | Overburden-Red clay |
| 30 - 42 | Weathered Shale |
| 42 - 74 | Fractured shale |
| 74 - 86 | Blue-green shale |
| 86 - 103 | Fractured shale |
| 103 - 110 | Fractured shale quarts and weathered |
| - | shale |
| 110 - 120 | Fractured shale with small |
| - | quarts seams |
| 120 - 130 | shale |

FEB 5 1986

Work started 1/2 19 86 Completed 1/3 19 86

**WELL DRILLER'S STATEMENT:** 01382

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED [signature] (Well Driller)

NAME Diamond Core Drilling (Person, firm, or corporation) (Typed or printed)

Address 10556 Petunia Lane

City Palo Cedro, CA Zip 96073

License No. 404778 Date of this report 1/7/86



DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

32N/05W-19M

**ORIGINAL**
**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
# WATER WELL DRILLERS REPORT

*Do not fill in*
No. 216232

Not Intent No. ____
Local Permit No. or Date 7731

State Well No. ____
Other Well No. ____

**(12) WELL LOG:** Total depth 180 ft. Depth of completed well 180 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 6 | Overburden |
| 6 | 22 | Highly fractured, weathered shale |
| 22 | 40 | Highly fractured shale with quartz |
| 40 | 46 | Highly weathered shale with quartz |
| 46 | 60 | Fractured blue shale |
| 60 | 104 | Hard dense blue shale |
| 104 | 122 | Hard dense blue shale with quartz |
| | | seams |
| 122 | 148 | hard dense blue shale |
| 148 | 154 | Fractured blue shale |
| 154 | 180 | Hard dense blue shale |

**(2) LOCATION OF WELL** (See instructions):
County Shasta Owner's Well Number [redacted]
Well address if different from above Rock Ck. Rd.
Township 32N Range 5W Section 19
Distance from cities, roads, railroads, fences, etc. ____
Assessor's parcel no. 065-220-33

See map attached

WELL LOCATION SKETCH

**(3) TYPE OF WORK:**
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

**(5) EQUIPMENT:**
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

**(6) GRAVEL PACK:**
Yes ☐ No ☒ Size ____
Diameter of bore ____
Packed from ____ to ____ ft.

**(7) CASING INSTALLED:**
Steel ☒ Plastic ☐ Concrete ☐

| From ft. | To ft. | Dia. in. | Gage or Wall |
|---|---|---|---|
| 0 | 63 | 6 5/8 | .188 |

**(8) PERFORATIONS:**
Type of perforation or size of screen ____

| From ft. | To ft. | Slot size |
|---|---|---|
| | | |

**(9) WELL SEAL:**
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ____ ft.
Method of sealing Bentonite--cement cap

**(10) WATER LEVELS:**
Depth of first water, if known 46 ft.
Standing level after well completion 10 ft.

**(11) WELL TESTS:**
Was well test made? Yes ☒ No ☐ If yes, by whom? Driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test ____ ft. At end of test ____ ft
Discharge 12 gal/min after 1 hours Water temperature ____
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ____
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

JUN 2 1986

Work started 2-11 1986 Completed 2-15 1986

**WELL DRILLER'S STATEMENT:** 01382
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*
SIGNED [signature] (Well Driller)
NAME Diamond Core Drilling
(Person, firm, or corporation) (Typed or printed)
Address 10556 Petunia Lane
City Palo Cedro, CA Zip 96073
License No. 404778 Date of this report 3/4/86

32N/05W - 19M

**ORIGINAL**

**File with DWR**

Not[illegible] Intent No.

Local Permit No. or Date 7732

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# WATER WELL DRILLERS REPORT

*Do not fill in*

No. 216233

State Well No.

Other Well No.

**(2) LOCATION OF WELL** (See instructions):

County Shasta Owner's Well Number

Well address if different from above Rock Creek Rd

Township 32N Range 5W Section 19

Distance from cities, roads, railroads, fences, etc.
Parcel # 065-220-54

Map attached

WELL LOCATION SKETCH

**(3) TYPE OF WORK:**

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**

Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

**(5) EQUIPMENT:**

Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

**(6) GRAVEL PACK:**

Yes ☐ No ☒ Size
Diameter of bore
Packed from ___ to ___ ft.

**(7) CASING INSTALLED:**

Steel ☒ Plastic ☐ Concrete ☐

**(8) PERFORATIONS:**

Type of perforation or size of screen

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| 0 | 33 | 6 5/8" | .188 | | | |

**(9) WELL SEAL:**

Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ___ ft.
Method of sealing grout

**(10) WATER LEVELS:**

Depth of first water, if known 46 ft.
Standing level after well completion 10 ft.

**(11) WELL TESTS:**

Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test ___ ft. At end of test ___ ft
Discharge 5 gal/min after 1 hours Water temperature
Chemical analysis made? Yes ☐ No ☒ If yes, by whom?
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

**(12) WELL LOG:** Total depth ___ ft. Depth of completed well ___ ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 5 | overburden |
| 5 | 20 | Weathered shale |
| 20 | 40 | fractured shale w/quarts |
| 40 | 52 | fractured shale |
| 52 | 55 | highly fractured shale |
| 55 | 63 | fractured shale |
| 63 | 70 | shale and quartz |
| 70 | 103 | shale |
| 103 | 110 | fractured shale |
| 110 | 120 | shale |
| 120 | 180 | fractured shale |
| 180 | 220 | shale |
| 220 | 244 | fractured shale |
| 244 | 310 | hard dense gray shale & quartz |

JUN 2 1986

Work started 02-17-86 19 Completed 02-21 1986

**WELL DRILLER'S STATEMENT:** 01382

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED [signature] (Well Driller)

NAME Diamond Core Drilling
(Person, firm, or corporation) (Typed or printed)

Address 10556 Petunia Ln

City Palo Cedro Ca Zip 96073

License No. 404778 Date of this report 03-31-86



DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

32N/05W-19M

**ORIGINAL**
**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
# WATER WELL DRILLERS REPORT

*Do not fill in*
No. 216235

State Well No. ____
Other Well No. ____

Notice of Intent No. ____
Local Permit No. or Date 7735

Off Rock Creek Road

(2) **LOCATION OF WELL** (See instructions):
County Shasta Owner's Well Number 4
Well address if different from above Mining Claim Rd
Township 32N Range 5W Section 19
Distance from cities, roads, railroads, fences, etc.
Parcel #065-220-68

**WELL LOCATION SKETCH**
see map attached

(3) **TYPE OF WORK:**
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) **PROPOSED USE:**
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☒
Municipal ☐
Other ☐

(5) **EQUIPMENT:**
Rotary ☒ Reverse ☐
Cable ☐ Air ☐
Other ☐ Bucket ☐

(6) **GRAVEL PACK:**
Yes ☐ No ☒ Size ____
Diameter of bore ____
Packed from ____ to ____ ft.

(7) **CASING INSTALLED:**
Steel ☒ Plastic ☐ Concrete ☐

(8) **PERFORATIONS:** None
Type of perforation or size of screen

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| 0 | 51 | 6 5/8" | .188 & .250 wall | | | |
| | | | | | | |
| | | | | | | |

(9) **WELL SEAL:**
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ____ ft.
Method of sealing grout

(10) **WATER LEVELS:**
Depth of first water, if known 125 ft.
Standing level after well completion 56 ft.

(11) **WELL TESTS:**
Was well test made? Yes ☒ No ☐ If yes, by whom? driller
Type of test Pump ☐ Bailer ☐ Air lift ☐
Depth to water at start of test 70 ft. At end of test 56 ft
Discharge 20 gal/min after 1 hours Water temperature ____
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ____
Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) **WELL LOG:** Total depth 140 ft. Depth of completed well ____ ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 35 | Overburden |
| 35 | 46 | Highly weathered shale |
| 46 | 125 | Shale |
| 125 | 132 | Fractured Shale |
| 132 | 140 | Shale |

CONFIDENTIAL
NOT FOR PUBLIC USE
WATER CODE SEC. 13752

JUN 2 1986

Work started 04-03 1986 Completed 04-04 1986

**WELL DRILLER'S STATEMENT:** 01382
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*
SIGNED ____ (Well Driller)
NAME Diamond Core Drilling
(Person, firm, or corporation) (Typed or printed)
Address 10556 Petunia Lane
City Palo Cedro Ca Zip 96073
License No. 404778 Date of this report 04-14-86

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

32N/05W-19M

**ORIGINAL**
**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
# WATER WELL DRILLERS REPORT

*Do not fill in*
No. 216342

State Well No.
Other Well No.

Notice of Intent No.
Loc[illegible] mit No. or Date 8611

Off Rock Creek Road

**(2) LOCATION OF WELL** (See instructions):
County Shasta Owner's Well Number 1
Well address if different from above Mining Claim Road Shasta County
Township 32 N Range 5 W Section 19
Distance from cities, roads, railroads, fences, etc.
Parcel # 365-73 -

See Map Attached

WELL LOCATION SKETCH

**(3) TYPE OF WORK:**
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Stock ☒
Municipal ☐
Other ☐

**(5) EQUIPMENT:**
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

**(6) GRAVEL PACK:**
Yes ☐ No ☒ Size
Diameter of bore
Packed from to ft.

**(7) CASING INSTALLED:**
Steel ☒ Plastic ☐ Concrete ☐

**(8) PERFORATIONS:**
Type of perforation or size of screen

| | From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|---|
| Steel | 0 | 47' | 6 5/8 | 188 | | | |
| | | | | | | | |
| | | | | | | | |

**(9) WELL SEAL:**
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 20' ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ft.
Method of sealing Bentonite

**(10) WATER LEVELS:**
Depth of first water, if known 120' ft.
Standing level after well completion ft.

**(11) WELL TESTS:**
Was well test made? Yes ☒ No ☐ If yes, by whom? Driller
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 40 ft. At end of test 40 ft
Discharge 9 gal/min after 1 hours Water temperature
Ch[illegible]l analysis made? Yes ☐ No ☒ If yes, by whom?
Wa[illegible]ectric log made? Yes ☐ No ☒ If yes, attach copy to this report

**(12) WELL LOG:** Total depth 160 ft. Depth of completed well 160 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 47 | Fractured Shale |
| 47 | 160 | Blue Gray Shale |

MAR 8 1989

Work started 1-3 1989 Completed 1-4 1989

**WELL DRILLER'S STATEMENT:** 1382
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED K. Oglvie
(Well Driller)

NAME Diamond Core Drilling Inc
(Person, firm, or corporation) (Typed or printed)
Address 10556 Petunia LN
City PALO Cedro Ca Zip 96073
License No. 512406 Date of this report 1-25-89

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM


well
House Pad
mining clam rd
Rock Creek rd

ORIGINAL
File with DWR
Page 1 of 1
Owner's Well No. WW-
Date Work Began 4/2/12 , Ended 4/3/12
Local Permit Agency County Environmental Health
Permit No. WTR12-107 Permit Date 3/20/12

RECEIVED
APR 9 2012
DWR-NO. DIS

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
Refer to Instruction Pamphlet
No. 0951468

DWR USE ONLY — DO NOT FILL IN
32N/05W+19
STATE WELL NO./STATION NO.
LATITUDE | LONGITUDE
APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD Air-Rotary FLUID

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|---|
| 0 | 9 | Tan Silt |
| 9 | 33 | Tan very weathered bedrock |
| 33 | 67 | light brownweathered bedrock |
| 67 | 74 | Light brown and grey weathered bedrock |
| 74 | 118 | Light grey bedrock - (Rhyolite) |
| 118 | 122 | Light grey Rhyolite fractured H20 zone |
| 122 | 146 | Light grey Rhyolite |

TOTAL DEPTH OF BORING 146 (Feet)
TOTAL DEPTH OF COMPLETED WELL 146 (Feet)

## WELL OWNER

Off Rock Creek Road

## WELL LOCATION

Address Gold Rush Dr.
City Keswick
County Shasta
APN Book 065 Page 220 Parcel 001
Township 32N Range 5W Section 19
Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC.

## LOCATION SKETCH

NORTH / WEST / EAST / SOUTH

SEE ATTACHED MAP

Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.

## ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

## USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial
MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 60' (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 41.62TOC (Ft.) & DATE MEASURED 4/3/12
ESTIMATED YIELD * 24 (GPM) & TEST TYPE Air lift
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
* May not be representative of a well's long-term yield.

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| ~~+1.5~~ | ~~33~~ | ~~10"~~ | ~~X~~ | | | | ~~Steel~~ | ~~6 5/8"~~ | ~~.188~~ | |
| ~~6~~ | ~~106~~ | | | | | | | | | |
| +1.5 | 27 | 10" | X | | | | Steel | 6 5/8" | .188 | |
| 27 | 33 | 7.5" | X | | | | Steel | 6 5/8" | .188 | |
| 33 | 146 | 6 1/8" | | | | | OPEN HOLE | | | |
| 6 | 106 | | X | | | | PVC | 4" | Sch 40 | |
| 106 | 146 | | | X | | | PVC | 4" | Sch 40 | .032 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 27 | | X | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
X Other See Map
ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.
NAME Diamond Core Drilling, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)
P.O. Box 491925 Redding, CA 96049
ADDRESS CITY STATE ZIP
Signed [signature] 4/4/12 512406
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER


Buggie WW-1
Surprise Ln
Rock Creek Rd
© 2012 Google
Imagery Date: 7/27/2011
1994

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
# DIVISION OF WATER RESOURCES

SHEET 1

**Do Not Fill In**
State Well No.
Other Well No.
Region

# WATER WELL DRILLERS REPORT 8910

(Sections 7076, 7077, 7078, Water Code)

(1) **Driller:**
Name Leo Foster
Address 2355 Calif. St.
Redding Calif.
License No. 110880 Classification C 57

Owner
Name
Address

(2) **Proposed use or uses** (*check*):
Domestic ✓ Municipal ☐
Irrigation ☐ Industrial ☐
Domestic and Irrigation ☐ Test well ☐
Other

(3) **Equipment used** (*check*):
Rotary ☐
Cable ☑
Dug well ☐
Other

(4) **Type of work** (*check*):
New well ✓ Reconditioning of well ☐
Deepening existing well ☐

(5) **Well log:**
Total depth of well 162 ft.

Give details of formations penetrated, such as silt, peat, muck, sand, gravel, clay, shale, sandstone, hardpan, rock. Include size of gravel (diameter) and sand (fine, medium, coarse), color of material, structure (loose, packed, cemented, soft, hard, brittle).

| Depth From Ground Surface | | |
|---|---|---|
| 1 ft. to 45 ft. | | clay boulders |
| 45 " " 121 " | | blue clay |
| 121 " " 128 " | | cement gravel |
| 128 " " 160 " | | blue clay |
| 160 " " 162 " | | blue sand |

If additional space is required, continue on DWR Form No. 246—Supplement, and attach to respective report copies.

(6) **Casing left in well:**

| LENGTH FT. | DIAMETER INCHES | SINGLE, DOUBLE, WELDED, OTHER | LBS. PER FOOT OR GAGE OF CASING | SEATING BELOW GROUND SURFACE, FT. |
|---|---|---|---|---|
| 96 | 6 | Single weld | 12 ga. | 95 |

Type and size of shoe or well ring 5/8 Welded joints—☑ Yes ☐ No

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

# WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

SHEET 2

*Do Not Fill In*
State Well No.
Other Well No.
Region

**(7) Perforations:**

Type of perforator used Round
Perforated 70 ft. to 96 ft. Hole size 1/2 No. of holes 375

**(8) Water levels:**

Depth at which water first encountered 121 ft.
Depth to water before perforating ft.
Depth to water after perforating 65 ft.
Note any change in water level while drilling

**(9) Well pumping test:** Bailer

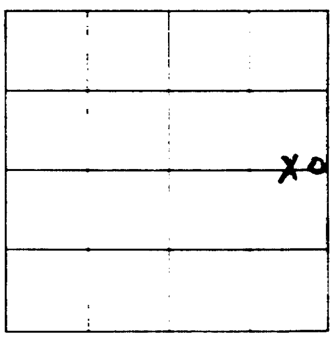
Date of test 6-13 By whom Leo Foster
Depth to water when test started 65 ft.
G.P.M. at beginning of test 3
Drawdown from standing level 160 ft.
G.P.M. at completion of test 3
Drawdown at completion of test 160 ft.
Length of time tested 1 hr.
Temperature of water 68
Was gas present in water? ☐ Yes ☒ No

**(10) General:**

Was well gravel packed? NO Size of rock Thickness of pack
Was a surface sanitary seal provided? NO
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, attach detailed description.
Strata sealed
Was analysis made of water? ☐ Yes ☒ No If yes, attach copy.
Was electric log made of well? ☐ Yes ☒ No If yes, attach copy.
**If well abandoned, was it plugged and sealed?**
Method of plugging and sealing

**(11) Location:**

North




1 MILE

Section No. 20
Township T32N
Range R5W
Base & Meridian M.D.B.M.
Show location of well in Section, thus (X)
Distances to section lines from well, N or S 2500 ft. and E or W 200 ft.
Show location of nearest known well, thus (O)
Distance to nearest known well 225 ft.

**(12) Time of work:**

Work started date 6-5 Completed date 6-13
Date of this report 7-3-50

WELL DRILLER'S STATEMENT:

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

[SIGNED] Leo Foster

By owner

License No. 110880 Classification C57

Dated 7-3, 1950

D.W.R. FORM No. 246 REGIONAL WATER POLLUTION CONTROL BOARD COPY 23972 3-50 40M QUIN SPO

32N05W20

**ORIGINAL**

**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
**DEPARTMENT OF WATER RESOURCES**
# WATER WELL DRILLERS REPORT

*Do not fill in*

**No. 113052**

Not… Intent No. ______

Local …mit No. or Date ______

State Well No. ______

Other Well No. ______

**(2) LOCATION OF WELL** (See instructions):

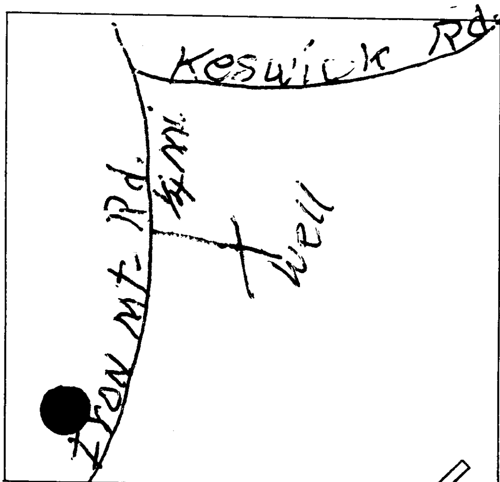
County Shasta Owner's Well Number ______

Well address if different from above SAME

Township 32 N Range R6 5 Section 20

Distance from cities, roads, railroads, fences, etc.

100' EAST Iron Mt. Rd.




WELL LOCATION SKETCH

**(3) TYPE OF WORK:**

New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

**(4) PROPOSED USE:**

Domestic ☐
Irrigation ☒
Industrial ☐
Test Well ☐
Stock ☐
Municipal ☐
Other ☐

**(5) EQUIPMENT:**

Rotary ☐ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

**(6) GRAVEL PACK:**

Yes ☐ No ☒ Size ______
Diameter of bore ______
Packed from ______ to ______ ft.

**(7) CASING INSTALLED:**

Steel ☒ Plastic ☐ Concrete ☐

**(8) PERFORATIONS:**

Type of perforation or size of screen ______

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| 0 | 44 | 5/8 | 12 | NO | | |

**(9) WELL SEAL:**

Was surface sanitary seal provided? Yes ☐ No ☐ If yes, to depth 38 ft.

Were strata sealed against pollution? Yes ☐ No ☒ Interval ______ ft.

Method of sealing Bento

**(10) WATER LEVELS:**

Depth of first water, if known NO ft.

Standing level after well completion Flows ft.

**(11) WELL TESTS:**

Was well test made? Yes ☐ No ☒ If yes, by whom? ______

Type of test Pump ☐ Bailer ☐ Air lift ☒

Depth to water at start of test NO ft. At end of test ? ft

Discharge 2 gal/min after Flow hours Water temperature 61

Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

**(12) WELL LOG:** Total depth 85 ft. Depth of completed well 55 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 34 | Shale RK. |
| 34 | 60 | Broken Blue RK. |
| 60 | 85 | Green RK. Clay Sand |

FEB 1 1984

Work started ______ 19 ______ Completed 4/7/83

**WELL DRILLER'S STATEMENT:**

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED Leo Foster 480
(Well Driller)

NAME Leo Foster
(Person, firm, or corporation) (Typed or printed)

Address 7021 Eastside Rd.

City Anderson Cal. Zip 96007

License No. 110880 Date of this report 4/30/83

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No.________
(Insert appropriate number)

# WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

## STATE OF CALIFORNIA

Do Not Fill In
№ 38644
State Well No.
Other Well No. 32N/5W-24

In Keswick Town

**(2) LOCATION OF WELL:**
County SHASTA Owner's number, if any—
R. F. D. or Street No. LOT 1+2 BLOCK 20
JONES SUBDIVISION TO SOUTH PARK

**(3) TYPE OF WORK (check):**
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
*If abandonment, describe material and procedure in Item 11.*

**(4) PROPOSED USE (check):**
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

**(5) EQUIPMENT:**
Rotary ☐
Cable ☒
Dug Well ☐

**(6) CASING INSTALLED:**
SINGLE ☒ DOUBLE ☐

| From | to | Diam. | Gage or Wall |
|---|---|---|---|
| 0 ft. | 48 ft. | 12 | |

If gravel packed

| Diameter of Bore | from ft. | to ft. |
|---|---|---|
| | | |

Type and size of shoe or well ring 4X5/8X16
Size of gravel:
Describe joint BUTT WELD

**(7) PERFORATIONS:**
Type of perforator used BURNED
Size of perforations 3/8" ROUND in., length, by in.
From 32 ft. to 48 ft. 6 Perf. per row 4 Rows per ft.

**(8) CONSTRUCTION:**
Was a surface sanitary seal provided? ☐ Yes ☒ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, note depth of strata
From ft. to ft.
Method of Sealing

**(9) WATER LEVELS:**
Depth at which water was first found 32 ft.
Standing level before perforating ft.
Standing level after perforating 10' ft.

**(10) WELL TESTS:**
Was a pump test made? ☒ Yes ~~No~~ If yes, by whom?
Yield: 5 gal./min. with 19' ft. draw down after 2 hrs.
Temperature of water 64° Was a chemical analysis made? ☐ Yes ☒ No
Was electric log made of well? ☐ Yes ☒ No

**(11) WELL LOG:**
Total depth 48' ft. Depth of completed well 48 ft.
Formation: *Describe by color, character, size of material, and structure.*

| ft. | to ft. | |
|---|---|---|
| 0 | 28 | Yello Clay + Gravel |
| 28 | 36 | Rock Quartz Granite |
| 36 | 44 | BLUE CLAY DECOMP QUARTZ GRANITE |
| 44 | 48 | QUARTZ SAND + BLUE GRAVEL |
| 48' | | A BLUE DIORITE FAULT. |

Work started 4/23, 1957 Completed 5/1 1957

**WELL DRILLER'S STATEMENT:**
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

NAME SABINE + LUSSO 522
(Person, firm, or corporation) (Typed or printed)
Address 1427 CONTINENTAL
Redding CALIF
[SIGNED] Arthur Sabine
Well Driller
License No. 159635 Dated 5/13, 1957

95689 3-54 50M QUIN SPO DWR FORM NO. 246 (REV. 3-54)

**ORIGINAL**
**File with DWR**

Page 1 of 1

Owner's Well No. ____________

Date Work Began 9-29-92   Ended 9-29-92

Local Permit Agency Shasta County Health Dept.

Permit No. 10274   Permit Date 9-10-92

RECEIVED OCT 20 1992 D.W.R.

STATE OF CALIFORNIA

# WELL COMPLETION REPORT

Refer to Instruction Pamphlet

No. 405981

DWR USE ONLY — DO NOT FILL IN

32N/05W-29M

STATE WELL NO. STATION NO.

LATITUDE | LONGITUDE

APN TRS OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER 111 (Ft.) BELOW SURFACE

| DEPTH FROM SURFACE Ft. to Ft. | | DESCRIPTION (Describe material, grain size, color, etc.) |
|---|---|---|
| 0 | 8 | Yellow clay & rock |
| 8 | 107 | Blue clay & rock |
| 107 | 108 | Red clay |
| 108 | 111 | Blue rock |
| 111 | 120 | Gravel |

TOTAL DEPTH OF BORING ________ (Feet)

TOTAL DEPTH OF COMPLETED WELL 120 (Feet)

## WELL OWNER

East End of Middle Creek

## WELL LOCATION

Address 16553 Middle Creek Rd.

City Redding

County Shasta

APN Book 063 Page 720 Parcel 04

Township 32N Range 05W Section 29

Latitude ______ NORTH DEG MIN SEC   Longitude ______ WEST DEG MIN. SEC.

## LOCATION SKETCH

NORTH

WEST

EAST

SOUTH

*Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.*
*PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

X NEW WELL

MODIFICATION REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

## PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Air rotary   FLUID quick foam

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 0 (Ft.) & DATE MEASURED 9-29-92

ESTIMATED YIELD* 25 (GPM) & TEST TYPE air lift

TEST LENGTH ______ (Hrs.) TOTAL DRAWDOWN ______ (Ft.)

** May not be representative of a well's long-term yield.*

## CASING(S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 78 | 6-5/8 | | | | | steel | 6 | 10 | |
| 70 | 120 | 6-5/8 | | | | | pvc liner | 4 | | |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 25 | X | | | |

NOV 25 1992

## ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ________

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME W. S. Heitman (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)   936

15030 McCoy Rd.   Red Bluff, Ca. 96080

ADDRESS   CITY   STATE   ZIP

Signed W. S. Heitman (WELL DRILLER/AUTHORIZED REPRESENTATIVE)   9-30-92 (DATE SIGNED)   324874 (C-57 LICENSE NUMBER)

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

RECEIVED

OCT 2 0 1992

D.W.R.

**ORIGINAL**
**File with DWR**

Page 1 of 1

Owner's Well No. ____

Date Work Began 9-29-92  Ended 9-29-92

Local Permit Agency Shasta County Health Dept.

Permit No 10274  Permit Date 9-10-92

STATE OF CALIFORNIA

# WELL COMPLETION REPORT

*Refer to Instruction Pamphlet*

No. 405984

DWR USE ONLY — DO NOT FILL IN

32N/05W-29M

STATE WELL NO./STATION NO.

LATITUDE  LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ___ (Ft.) BELOW SURFACE

| DEPTH FROM SURFACE Ft. to Ft. | | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|---|
| 0 | 160 | Concrete |
| | | Well Destruction |

TOTAL DEPTH OF BORING ____ (Feet)

TOTAL DEPTH OF COMPLETED WELL ____ (Feet)

## WELL OWNER

CITY  STATE  ZIP

## WELL LOCATION

Address ____

City ____

County ____

APN Book ____ Page ____ Parcel ~~[illegible]~~

Township 32N Range 05W Section 29

Latitude ____ NORTH (DEG. MIN. SEC.) Longitude ____ WEST (DEG. MIN. SEC.)

## LOCATION SKETCH

NORTH

[illegible] take 299 W.E toward Old Shasta to [illegible] go north to Middle Creek Rd - [illegible] site to 1st [illegible] on site

WEST  EAST

SOUTH

*Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.*
*PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

___ NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

X DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

## PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

___ Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD ____ FLUID ____

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____

ESTIMATED YIELD* ____ (GPM) & TEST TYPE ____

TEST LENGTH ____ (Hrs.) TOTAL DRAWDOWN ____ (Ft.)

** May not be representative of a well's long-term yield.*

## CASING(S)

| DEPTH FROM SURFACE Ft. to Ft. | BORE-HOLE DIA. (Inches) | TYPE (✓) BLANK | SCREEN | CONDUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|
| | | | | |

NOV 2 5 1992

## ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ____

*ATTACH ADDITIONAL INFORMATION IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME W. S. Heitman  936
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

15030 McCoy Rd.  Red Bluff, Ca. 96080
ADDRESS  CITY  STATE  ZIP

Signed W.S. Heitman  10-1-92  324874
WELL DRILLER/AUTHORIZED REPRESENTATIVE  DATE SIGNED  C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

**ORIGINAL**
**File with DWR**

RECEIVED SEP 24 1993 D.W.R.

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 485937

DWR USE ONLY — DO NOT FILL IN
32N/05W-29M
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Page 1 of 1
Owner's Well No. 1
Date Work Began 09/03/93 Ended 09/08/93
Local Permit Agency
Permit No. 10567 Permit Date

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER 180 (Ft.) BELOW SURFACE

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|---|
| 0 | 25 | BROWN CLAY AND BROKEN ROCK |
| 25 | 150 | BROWN BROKEN ROCK |
| 150 | 220 | GREEN BROKEN ROCK |

TOTAL DEPTH OF BORING 220 (Feet)
TOTAL DEPTH OF COMPLETED WELL 220 (Feet)

## WELL OWNER

Far Eastern End of Middle Creek

## WELL LOCATION

Address 1 MIDDLE CREEK RD
City REDDING
County SHASTA
APN Book 065 Page 320 Parcel 10
Township 32N Range 05W Section 29
Latitude ___ NORTH DEG. MIN. SEC. Longitude ___ WEST DEG. MIN. SEC.

## LOCATION SKETCH

NORTH
WEST EAST
SOUTH

*Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.*
***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

## PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
X Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD AIR FLUID

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 5 (Ft.) & DATE MEASURED
ESTIMATED YIELD* ___ (GPM) & TEST TYPE
TEST LENGTH ___ (Hrs.) TOTAL DRAWDOWN ___ (Ft.)
* *May not be representative of a well's long-term yield.*

## CASING(S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL/GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 200 | 8 | X | | | | STEEL | 6 | .156 | |
| 200 | 220 | 8 | | X | | | STEEL | 6 | .156 | 1/8 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 22 | | X | | |

SEP 24 1993

TURNER DRILLING
714-350 U.S. Hwy. 395 E Susanville CA 96130

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other
*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Turner Drilling (PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED) 1485
714-350 US Hwy 395 E Susanville CA 96130
ADDRESS CITY STATE ZIP
Signed Naomi Turner 9-18-93 532037
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

**ORIGINAL**
**File with DWR**

RECEIVED
OCT 04 1999

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 705923

Page 1 of 1

**Owner's Well No.** WW-2

Date Work Began 8-05-99, Ended 8-06-99

Local Permit Agency Shasta County Environmental Health

Permit No. WTR99-193 Permit Date 7-27-99

DWR USE ONLY — DO NOT FILL IN

32N/05W-29M

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD air rotary FLUID none

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|---|
| 0 | 10 | Weathered tan rock |
| 10 | 70 | Fractured green rock |
| 70 | 140 | Green rock w/fractured zones |

TOTAL DEPTH OF BORING 140 (Feet)

TOTAL DEPTH OF COMPLETED WELL 140 (Feet)

## WELL OWNER

CITY STATE ZIP

## WELL LOCATION

Address 16390 Middle Creek Road

City Old Shasta

County Shasta

APN Book 065 Page 320 Parcel 10

Township 32N Range 5W Section 29

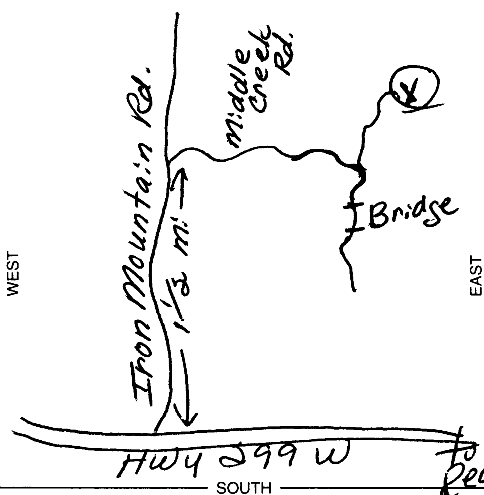
Latitude ___ NORTH DEG. MIN. SEC. Longitude ___ WEST DEG. MIN. SEC.

## LOCATION SKETCH

NORTH

WEST

EAST




SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary.* ***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

## PLANNED USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 80 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 34 (Ft.) & DATE MEASURED 8-06-99

ESTIMATED YIELD * 60 (GPM) & TEST TYPE air lift

TEST LENGTH 2 (Hrs.) TOTAL DRAWDOWN ___ (Ft.)

** May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 22 | 10 | x | | | | Steel | 6 | .188 | |
| 22 | 25 | 7½ | x | | | | Steel | 6 | .188 | |
| 0 | 22 | 10 | x | | | | PVC | 4 | Sch40 | |
| 22 | 25 | 7½ | x | | | | PVC | 4 | Sch40 | |
| 25 | 120 | 6¼ | x | | | | PVC | 4 | Sch40 | |
| 120 | 140 | 6¼ | | x | | | PVC | 4 | Sch40 | .040 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 22 | | x | | Granular & chips |

OCT 13 1999

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

*NAME* Diamond Core Drilling, Inc.
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

P.O. Box 491925 Redding CA 96049
ADDRESS CITY STATE ZIP

*Signed* [signature] 9-21-99 512406
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

**ORIGINAL**
**File with DWR**

Page 1 of 4

Owner's Well No. 1

Date Work Began 12-11-06, Ended 12-12-06

Local Permit Agency Shasta

Permit No. 06-390 Permit Date 12-5-06

STATE OF CALIFORNIA

# WELL COMPLETION REPORT

*Refer to Instruction Pamphlet*

No. 0957748

DWR USE ONLY — DO NOT FILL IN

STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) ___ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD ______ FLUID ______

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION *Describe material, grain size, color, etc.* |
|---|---|---|
| 0 | 2 | Brown soil |
| 2 | 24 | Fractured Granit |
| 24 | 155 | Blue Granit |
| 155 | 160 | Fractured Granit |

TOTAL DEPTH OF BORING 160 (Feet)

TOTAL DEPTH OF COMPLETED WELL 160 (Feet)

## WELL OWNER

## WELL LOCATION

Address 16073 Middle Crk Rd

City Shasta

County Shasta

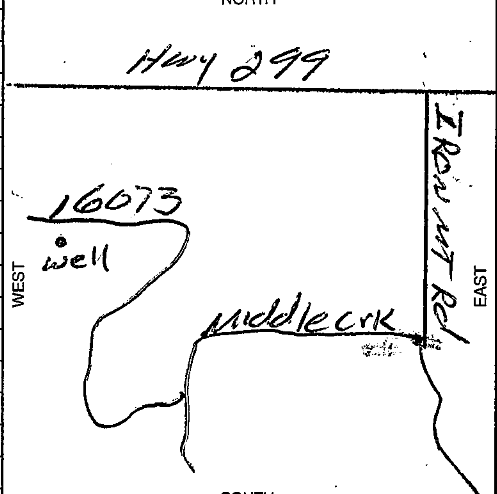
APN Book ____ Page ____ Parcel 065-320-022-000

Township 32N Range 5W Section 29

Lat ___ N DEG. MIN. SEC. Long ___ W DEG. MIN. SEC.

## LOCATION SKETCH

NORTH




WEST EAST SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

## USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 155 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 5' (Ft.) & DATE MEASURED 12-~~5~~ 12-06

ESTIMATED YIELD * 80-100 (GPM) & TEST TYPE Air

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

* *May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 28 | 10" | ✓ | | | | Steel | 6 | .188 | |
| 24 | 120 | 6" | ✓ | | | | P.V.C | 4 | Sch 40 | |
| 120 | 160 | 6" | | ✓ | | | P.V.C | 4 | Sch 40 | 48x4 x40 4 Rows |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 20 | | ✓ | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ______

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Shasta Drilling
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16602 Vladimir CT Redding CA 96001
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR

12-14-06 DATE SIGNED

813776 C-57 LICENSE NUMBER

# SHASTA COUNTY DEPARTMENT OF RESOURCE MANAGEMENT
## ENVIRONMENTAL HEALTH DIVISION

1855 Placer Street, Suite 201, Redding, CA 96001 Telephone (530) 225-5787 FAX (530) 225-5413

BP # 06-2470
# WTR 06-390

Fee $240.97

## APPLICATION FOR WATER WELL PERMIT

**LOCATION OF PROPERTY**
Street or Road 16023 Middle Creek Road
Assessor's Parcel Number 065-720-022-000

LOT SIZE ____ x ____ or acreage 16

PROPERTY OWNER

**TYPE OF WORK**
☒ New Well ☐ Deepening ☐ Destroying ☐ Reconditioning

**PROPOSED USE** * REQUIRED ANNULAR SEAL DEPTH
☒ Domestic .......... 20 foot minimum
☐ Agricultural .......... 20 foot minimum
☐ Industrial .......... 50 foot minimum
☐ Public .......... 50 foot minimum
☐ Monitoring .......... Varies, attach schematic.
☐ Other ________ .......... Varies, attach schematic.

* Alternate seal depth may be required by site conditions or as noted in conditions below. Minimum thickness of annular space seal is 2 inches.

**WELL CONTRACTOR**
Name Shasta Drilling
Mailing Address
City, State, Zip Code Redding, Ca. 96001
Telephone 530-229-9120
License # 813776

PLOT PLAN is to be submitted on 8½ x 11 sheet according to the attached instructions and show all requested information.

DIRECTIONS TO LOCATE PROPERTY are to be provided on the back of this application or the back of the plot plan. Directions must be adequate for staff to locate property.

WELL NUMBER (If applicable): ________

**SIGNATURE OF CONTRACTOR (if applicant is contractor)**
I certify that I am licensed under the provisions of Division 3, Chapter 9 of the Business and Professions Code, and my license is in full force and effect. License # ________
I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction.

SIGNATURE OF CONTRACTOR DATE

**SIGNATURE OF OWNER (required on all applications)**
I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction, and hereby authorize representatives of SHASTA COUNTY to enter the property for inspection purposes.
By signing this application I agree to defend, indemnify, and hold the county harmless from any claim, action, or proceeding brought to attack, set aside, void or annul the county's approval of this application.
I understand that the Shasta County Department of Resource Management, in releasing this permit for the immediate construction of a water well does not guarantee the issuance of any other development permits or land use request for this property.

Judy Ashwood 12/4/06
SIGNATURE OF OWNER DATE

Received by Adam Date 12/4/06 Fee $ 240.97 Receipt # R0606961

Granted by James Ames with the following and any attached conditions. Date 12/05/06

Permission is hereby granted for the above well work in accordance with all State and County laws and standards as provided in Shasta County Code, Sections 8.56.010 - 8.56.130 and any conditions as set forth in this permit.
☒ Well is to be located a minimum of 50 feet from any sewer, septic tank, or pit privy and a minimum of 100 feet from any structure or facility designed to allow sewage to percolate into the ground. ☐ This permit is subject to the attached conditions if box is marked.

Final inspection by ________ Date ________

Inspection Notes: ________

Completion Notice Received: Date ________ Well Depth ________ Casing Depth ________ Estimated g.p.m. ________

01/20/2006

ORIGINAL
File Original, Duplicate and Triplicate with the REGIONAL WATER POLLUTION CONTROL BOARD No. 5
(Insert appropriate number)

# WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

## STATE OF CALIFORNIA

LOCATION CHECKED
Do Not Fill In
No. 15811
State Well No.
Other Well No. 32N/5W-31 or 32

Victoria Highlands

(2) LOCATION OF WELL:
County Shasta Owner's number, if any—
R. F. D. or Street No. 10156 Victoria Dr., Redding 96099
Tower Springs Sub'
Hwy 299 West Bet Redding + Shasta

(3) TYPE OF WORK (check):
New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

(4) PROPOSED USE (check):
Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

(5) EQUIPMENT:
Rotary ☐
Cable ☒
Dug Well ☐

(6) CASING INSTALLED:
SINGLE ☒ DOUBLE ☐

| From ft. | to ft. | Diam. | Gage or Wall |
|---|---|---|---|
| 0 | 14 | 8 | 12 |

If gravel packed

| Diameter of Bore | from ft. | to ft. |
|---|---|---|
| | | |

Type and size of shoe or well ring None
Size of gravel:
Describe joint welded

(7) PERFORATIONS:
Type of perforator used Torch Cut
Size of perforations 3/8 Round in., length, by in.

| From ft. | to ft. | Perf. per row | Rows per ft. |
|---|---|---|---|
| 40 | 60 | 4 | 4 |

(8) CONSTRUCTION:
Was a surface sanitary seal provided? ☐ Yes ☐ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata
From ft. to ft.
Method of Sealing

(9) WATER LEVELS:
Depth at which water was first found 40 ft.
Standing level before perforating 24 ft.
Standing level after perforating 24 ft.

(10) WELL TESTS:
Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☐ No

(11) WELL LOG:
Total depth 84 ft. Depth of completed well 84 ft.
Formation: Describe by color, character, size of material, and structure.

| ft. | to ft. | |
|---|---|---|
| 0 | 36 | Clay & Gravel |
| 36 | 40 | Gravel |
| 40 | 84 | Rock |

Bailed app't 10 gal minute
40 ft draw down

Work started June 27 1963. Completed June 29 1963

WELL DRILLER'S STATEMENT:
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME FRED WILLIAMS 537
(Person, firm, or corporation) (Typed or printed)
Address Rt 2, Box 8624
Anderson Calif
[Signed] Fred Williams
Well Driller
License No. 117416 Dated July 5 63

Section 7076.1, Water Code

95689 3-54 50M QUIN SPO
DWR FORM NO. 246 (REV. 3-54)

ORIGINAL
File Original, Duplicate and Triplicate with the
REGIONAL WATER POLLUTION
CONTROL BOARD No. 5
(Insert appropriate number)

# WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

STATE OF CALIFORNIA

Do Not Fill In
№ 69380
State Well No.
Other Well No. 32N/5W-31

Lower Springs Road

## (2) LOCATION OF WELL:

County Shasta Owner's number, if any—
R. F. D. or Street No.

## (3) TYPE OF WORK (check):

New well ☒ Deepening ☐ Reconditioning ☐ Abandon ☐
If abandonment, describe material and procedure in Item 11.

## (4) PROPOSED USE (check):

Domestic ☒ Industrial ☐ Municipal ☐
Irrigation ☐ Test Well ☐ Other ☐

## (5) EQUIPMENT:

Rotary ☐
Cable ☒
Dug Well ☐

## (6) CASING INSTALLED:

SINGLE ☒ DOUBLE ☐

| From ft. | to ft. | Diam. | Gage or Wall |
|---|---|---|---|
| 0 | 64 | 8 | 12 |
| 2 | 70 | 6 | 12 |

If gravel packed

| Diameter of Bore | from ft. | to ft. |
|---|---|---|
| | | |

Type and size of shoe or well ring None
Size of gravel:
Describe joint welded

## (7) PERFORATIONS:

Type of perforator used torch cut
Size of perforations 3/8 Round in., length, by in.

| From ft. | to ft. | Perf. per row | Rows per ft. |
|---|---|---|---|
| 62 | 70 | 10 | 10 |
| 40 | 62 | 5 | 5 |

## (8) CONSTRUCTION:

Was a surface sanitary seal provided? ☐ Yes ☐ No To what depth ft.
Were any strata sealed against pollution? ☐ Yes ☐ No If yes, note depth of strata
From ft. to ft.
Method of Sealing

## (9) WATER LEVELS:

Depth at which water was first found 43 ft.
Standing level before perforating 30 ft.
Standing level after perforating 30 ft.

## (10) WELL TESTS:

Was a pump test made? ☐ Yes ☐ No If yes, by whom?
Yield: gal./min. with ft. draw down after hrs.
Temperature of water Was a chemical analysis made? ☐ Yes ☐ No
Was electric log made of well? ☐ Yes ☐ No

## (11) WELL LOG:

Total depth 70 ft. Depth of completed well 70 ft.
Formation: Describe by color, character, size of material, and structure.

| ft. | to ft. | |
|---|---|---|
| 0 | 40 | Sand Shirt clay |
| 40 | 64 | Sand Stone |
| 64 | 70 | blue Granite |

Bailed apr 8 gal minute

CONFIDENTIAL
Section 7076, Water Code

Work started Sept 28 1961. Completed Oct 2 1961

WELL DRILLER'S STATEMENT: 537
This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.
NAME FRED WILLIAMS
(Person, firm, or corporation) (Typed or printed)
Address Rt 2. Box 5624,
Anderson Calif
[SIGNED] Fred Williams
Well Driller
License No. 117416 Dated Oct 9, 1961

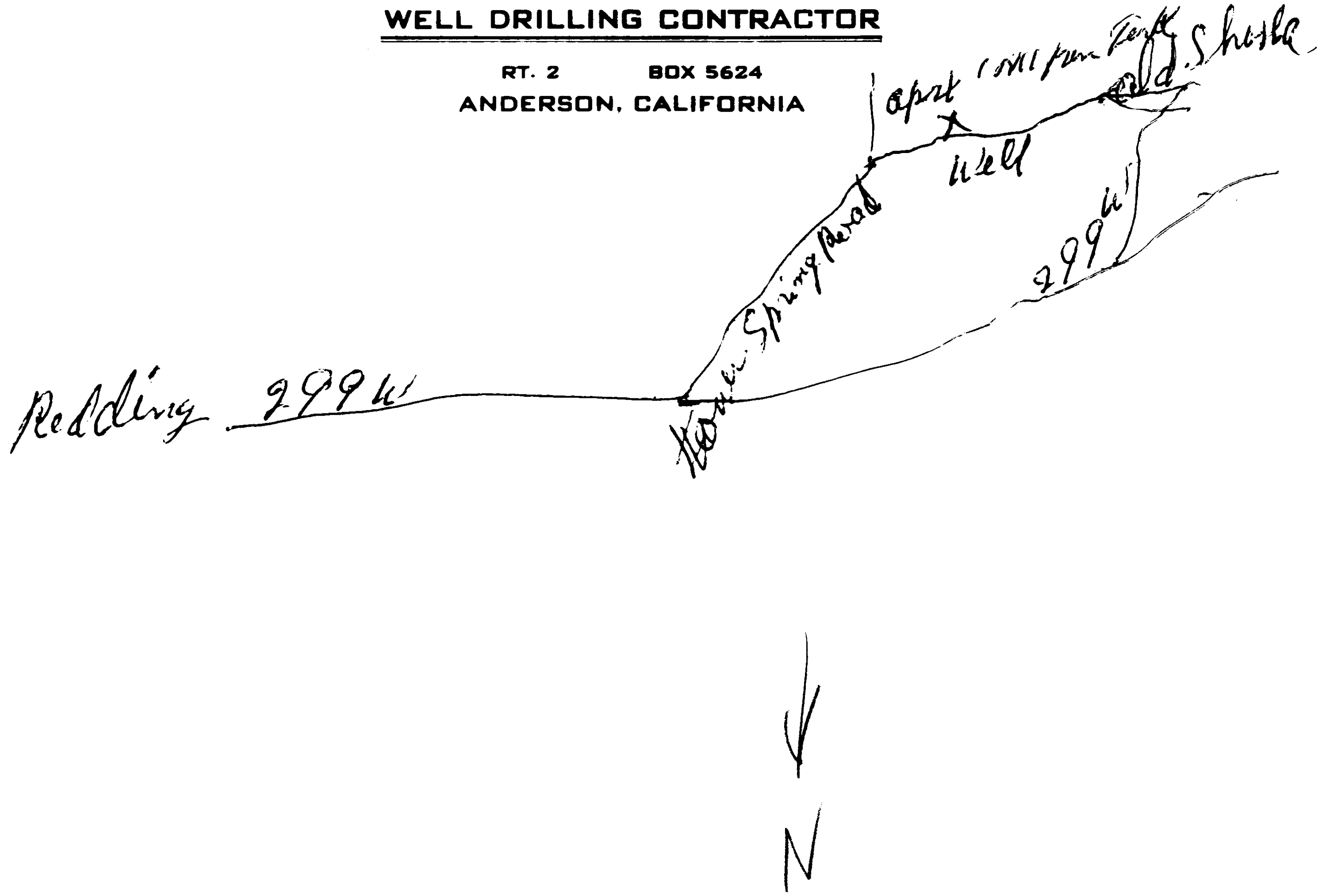
57025 6-57 50M QUIN △ SPO DWR 188 (REV. 3-54)

PHONE: CHESTNUT 3-3931
REDDING, CALIFORNIA

# Fred Williams

## WELL DRILLING CONTRACTOR

RT. 2 BOX 5624
ANDERSON, CALIFORNIA



32N/5W-31

**ORIGINAL**

**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
# WATER WELL DRILLERS REPORT

*Do not fill in*

No. 116007

State Well No. ______

Other Well No. ______

e of Intent No. ______

Local Permit No. or Date ______

' 1 mile NNW of Grant School

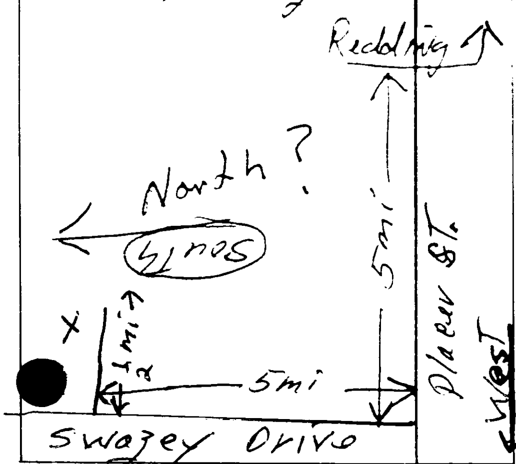
(2) **LOCATION OF WELL** See instructions

County Shasta Owner's Well Number ______

Well address if different from above Delano Road.

Township ______ Range ______ Section ______

Distance from cities, roads, railroads, fences, etc. Approx 5 miles from Corner of Swazey Drive and Placer St. on Swazey Drive then ½ mile West on Delano Rd.




WELL LOCATION SKETCH

(3) **TYPE OF WORK:**

| | |
|---|---|
| New Well | ☑ |
| Deepening | ☐ |
| Reconstruction | ☐ |
| Reconditioning | ☐ |
| Horizontal Well | ☐ |
| Destruction ☐ (Describe destruction materials and procedures in Item 12) | |

(4) **PROPOSED USE:**

| | |
|---|---|
| Domestic | ☑ |
| Irrigation | ☐ |
| Industrial | ☐ |
| Test Well | ☐ |
| Stock | ☐ |
| Municipal | ☐ |
| Other | ☐ |

(5) **EQUIPMENT:**

Rotary ☐ Reverse ☐
Cable ☑ Air ☐
Other ☐ Bucket ☐

(6) **GRAVEL PACK:**

Yes ☐ No ☐ Size None
Diameter of bore ______
Packed from ______ to ______ ft.

(7) **CASING INSTALLED:**

Steel ☑ Plastic ☐ Concrete ☐

(8) **PERFORATIONS:**

Type of perforation or size of screen None

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| 0 | 60 | 8" | 12 | None | | |
| | | | | | | |
| | | | | | | |

(9) **WELL SEAL:**

Was surface sanitary seal provided? Yes ☑ No ☐ If yes, to depth 38' ft.

Were strata sealed against pollution? Yes ☐ No ☑ Interval ______ ft.

Method of sealing Drill Cuttings and Dell

(10) **WATER LEVELS:**

Depth of first water, if known 55 ft.

Standing level after well completion 55' ft.

(11) **WELL TESTS:**

Was well test made? Yes ☑ No ☐ If yes, by whom? Driller

Type of test Pump ☐ Bailer ☑ Air lift ☐

Depth to water at start of test 55' ft. At end of test 95' ft

Discharge 7 gal/min after 1 hours Water temperature ______

Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______

Was electric log made? Yes ☐ No ☒ If yes, attach copy to this report

(12) **WELL LOG:** Total depth 100 ft. Depth of completed well 100 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 5 | red clay |
| 5 | 25 | brown clay and hard pan |
| 25 | 39 | decomposed rock |
| 39 | 55 | medium hard granite |
| 55 | 100 | hard gray granite |

Work started 1/19 1977 Completed 1/26 1977

**WELL DRILLER'S STATEMENT:**

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

SIGNED Robert McCullough (Well Driller)

NAME C. ROBERT McCULLOUGH 501

(Person, firm, or corporation) (Typed or printed) Licensed Drilling Contractor

Address P. O. BOX 3117

City REDDING, CALIF. 96001 Zip ______

License No. 182392 Date of this report ______

DWR 188 (REV. 7-76) IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

**ORIGINAL**
**File with DWR** SEP 0 3 2014

Page 1 of 4

**Owner's Well No.** 1

Date Work Began 8-27-14, Ended 8-27-14

Local Permit Agency Shasta

Permit No. 14-256 Permit Date 6-27-14

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 0952001

DWR USE ONLY — DO NOT FILL IN

32N/05W-31A
STATE WELL NO./STATION NO.

LATITUDE LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Air FLUID ______

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION *Describe material, grain size, color, etc.* |
|---|---|---|
| 0 | 15 | Red soil |
| 15 | 80 | Fractured granit |
| 80 | 100 | Blue granit |

TOTAL DEPTH OF BORING 100 (Feet)

TOTAL DEPTH OF COMPLETED WELL 100 (Feet)

## WELL OWNER

Victoria Drive

## WELL LOCATION

Address Same

City ______

County ______

APN Book ___ Page ___ Parcel 204-130-010

Township 32N Range 05W Section 31

Lat ___ DEG. ___ MIN. ___ SEC. N Long ___ DEG. ___ MIN. ___ SEC. W

## LOCATION SKETCH

NORTH

WEST EAST

SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

## USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 80 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 20' (Ft.) & DATE MEASURED 8-27-14

ESTIMATED YIELD * 20 (GPM) & TEST TYPE Air

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)

** May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 24 | 10" | | | | | | | | |
| 24 | ~~80~~ 60 | 6 | ✓ | | | | steel | 6 | .188 | |
| ~~80~~ | ~~100~~ | ~~6~~ | | | | | | | | |
| 60 | 80 | 6 | ✓ | | | | pvc | 4 | sch40 | |
| 80 | 100 | 6 | | ✓ | | | pvc | 4 | sch40 | .030x40 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 24 | | ✓ | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ______

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Shasta Drilling inc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16602 Vladimir CT Redding CA 96001
ADDRESS CITY STATE ZIP

Signed [signature] 8-27-14 895374
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

SHASTA COUNTY DEPARTMENT OF RESOURCE MANAGEMENT
ENVIRONMENTAL HEALTH DIVISION

1855 Placer Street, Suite 201, Redding, CA 96001 Telephone (530) 225-5787 FAX (530) 225-5413

ehd.co.shasta.ca.us

# BP ________

Fee $287.17

# APPLICATION FOR WATER WELL PERMIT

# WTR ________

APPLICANT (Must be licensed contractor or property owner.)

PROPERTY OWNER SAME ↑
Name ________
Mailing Address ________
City, State, Zip Code ________
Telephone ________
EMail Address ________

WELL CONTRACTOR
Name Shasta Drilling, INC
Mailing Address 16602 Vladimir Court
City, State, Zip Code REDDING CA 96001
Telephone 530-229-9120
EMail Address ________
License # 995374

PLOT PLAN is to be submitted on 8½ x 11 sheet according to the Sample Plot Plan instructions and show all requested information.

DIRECTIONS TO LOCATE PROPERTY are to be provided on the back of this application or the back of the plot plan. Directions must be adequate for staff to locate property.

WELL NUMBER (If applicable): 1

SIGNATURE OF CONTRACTOR (if applicant is contractor)
I certify that I am licensed under the provisions of Division 3, Chapter 9 of the Business and Professions Code, and my license is in full force and effect. License # ________
I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction.

________ SIGNATURE OF CONTRACTOR ________ DATE

LOCATION OF PROPERTY
Street or Road 16200 Victoria Dr
Assessor's Parcel Number 204-130-010

LOT SIZE 1.1 x ____ or acreage

TYPE OF WORK
☒ New Well ☐ Deepening ☐ Destroying ☐ Reconditioning

PROPOSED USE * REQUIRED ANNULAR SEAL DEPTH
☒ Domestic .......... 20 foot minimum
☐ Agricultural .......... 20 foot minimum
☐ Industrial .......... 50 foot minimum
☐ Public .......... 50 foot minimum
☐ Monitoring .......... Varies, attach schematic.
☐ Other ________ .......... Varies, attach schematic.

* Alternate seal depth may be required by site conditions or as noted in conditions below. Minimum thickness of annular space seal is 2 inches.

Proof of legal creation is required on undeveloped properties.

SIGNATURE OF OWNER (required on all applications)
I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction, and hereby authorize representatives of SHASTA COUNTY to enter the property for inspection purposes.
By signing this application I agree to defend, indemnify, and hold the county harmless from any claim, action, or proceeding brought to attack, set aside, void or annul the county's approval of this application.
I understand that the Shasta County Department of Resource Management, in releasing this permit for the immediate construction of a water well does not guarantee the issuance of any other development permits or land use request for this property.

[signature] 6-23-14
SIGNATURE OF OWNER DATE

Received by ____ Date ____ Fee $ ____ Receipt # ____ Pre-Permit Insp Required? Y N
Legal Creation verified ________ Pre-permit Inspection by ____ Notes ________

Granted by ________ with the following and any attached conditions. Date ________

Permission is hereby granted for the above well work in accordance with all State and County laws and standards as provided in Shasta County Code, Sections 8.56.010 - 8.56.130 and any conditions as set forth in this permit.

☒ Well is to be located a minimum of 50 feet from any sewer, septic tank, or pit privy and a minimum of 100 feet from any structure or facility designed to allow sewage to percolate into the ground. ☐ This permit is subject to the attached conditions if box is marked.

Final inspection by ________ Date ________

Inspection Notes: ________

Completion Notice Received: Date ________ Well Depth ________ Casing Depth ________ Estimated g.p.m. ________

FEB 2014

5/22/09

**ORIGINAL**
**File with DWR**



STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 0962415

Owner's Well No. 1
Date Work Began 5-18-09, Ended 5-18-09
Local Permit Agency Shasta
Permit No. ______ Permit Date ______

| DWR USE ONLY – DO NOT FILL IN | |
|---|---|
| STATE WELL NO./STATION NO. | 32N/05W-31 |
| LATITUDE | LONGITUDE |
| APN/TRS/OTHER | |

## GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)
DRILLING METHOD ______ FLUID ______

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION *Describe material, grain size, color, etc.* |
|---|---|---|
| 0 | 6 | Brown soil |
| 6 | 38 | Fractured Granit |
| 38 | 57 | Granit |
| 57 | 61 | Fractured Granit |
| 61 | 75 | Granit |
| 75 | 86 | Fractured Granit |
| 86 | 100 | Granit |

TOTAL DEPTH OF BORING 100 (Feet)
TOTAL DEPTH OF COMPLETED WELL 100 (Feet)



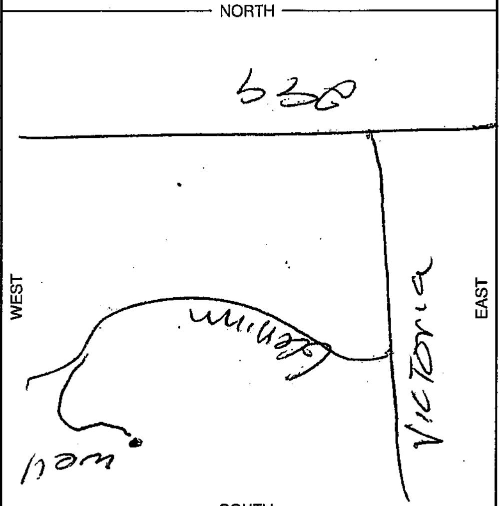
Ganim Lane, Victoria Higlands

## WELL LOCATION

Address same Ganim Ln
City
County
APN Book 204 Page 130 Parcel 009
Township 32N Range 5W Section 31
Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

## LOCATION SKETCH

NORTH




WEST EAST

SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary.* ***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

✓ NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

## USES (✓)

WATER SUPPLY
✓ Domestic ___ Public
✓ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 12 (Ft.) BELOW SURFACE
DEPTH OF STATIC WATER LEVEL 5 (Ft.) & DATE MEASURED 5-18-08
ESTIMATED YIELD * 30 (GPM) & TEST TYPE air
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN N/A (Ft.)
** May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 23 | 10" | | | | | | | | |
| 23 | 40 | 6" | ✓ | | | | steel | 6 | .188 | |
| 40 | 60 | 6" | ✓ | | | | P.V.C | 4 | sch40 | |
| 60 | 100 | 6" | | ✓ | | | P.V.C | 4 | sch40 | .030x40 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 23 | | ✓ | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ______

ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Shasta Drilling inc
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

16602 Vladimir CT Redding CA 96001
ADDRESS CITY STATE ZIP

Signed [signature] 5-18-09 895374
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

# SHASTA COUNTY DEPARTMENT OF RESOURCE MANAGEMENT
## ENVIRONMENTAL HEALTH DIVISION

1855 Placer Street, Suite 201, Redding, CA 96001 Telephone (530) 225-5787 FAX (530) 225-5413
www.co.shasta.ca.us/Departments/Resourcemgmt/drm/ehmain.htm

BP # ____

Fee $265.35 **APPLICATION FOR WATER WELL PERMIT** # WTR 09-106

**LOCATION OF PROPERTY**
Street or Road GANIM LANE
Assessor's Parcel Number 204-130-009

**LOT SIZE** ___ x ___ *or* acreage 2.0

**TYPE OF WORK**
☒ New Well ☐ Deepening ☐ Destroying ☐ Reconditioning

**PROPOSED USE** | * **REQUIRED ANNULAR SEAL DEPTH**
- ☐ Domestic .................. 20 foot minimum
- ☒ Agricultural .................. 20 foot minimum
- ☐ Industrial .................. 50 foot minimum
- ☐ Public .................. 50 foot minimum
- ☐ Monitoring .................. Varies, attach schematic.
- ☐ Other ________ .......... Varies, attach schematic.

* Alternate seal depth may be required by site conditions or as noted in conditions below. Minimum thickness of annular space seal is 2 inches.

**ROPERTY OWNER**
ame SAME
ailing Address ____
ity, State, Zip Code ____
elephone ____

**/ELL CONTRACTOR**
ame SHASTA DRILLING
ailing Address 16602 VLADIMIR COURT
ity, State, Zip Code REDDING, CA. 96001
elephone 530-229-9120
cense # 895374

LOT PLAN is to be submitted on 8½ x 11 sheet according to the tached instructions and show all requested information.

IRECTIONS TO LOCATE PROPERTY are to be provided on e back of this application or the back of the plot plan. Directions ust be adequate for staff to locate property.

/ELL NUMBER (if applicable): ____

**SIGNATURE OF CONTRACTOR (if applicant is contractor)**

I certify that I am licensed under the provisions of Division 3, Chapter 9 of the Business and Professions Code, and my license is in full force and effect. License # ____

I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction.

SIGNATURE OF CONTRACTOR ____ DATE ____

**SIGNATURE OF OWNER (required on all applications)**

I certify that I have read this application and the above information is correct. I agree to comply with all Shasta County Ordinances and State Laws relating to this construction, and hereby authorize representatives of SHASTA COUNTY to enter the property for inspection purposes.

By signing this application I agree to defend, indemnify, and hold the county harmless from any claim, action, or proceeding brought to attack, set aside, void or annul the county's approval of this application.

I understand that the Shasta County Department of Resource Management, in releasing this permit for the immediate construction of a water well does not guarantee the issuance of any other development permits or land use request for this property.

Gary L. Larson 4/20/09
SIGNATURE OF OWNER DATE

eceived by BS Date 4/20/09 Fee $ 265.35 Receipt # R0901091

ranted by M Cramer with the following and any attached conditions. Date 4/22/09

ermission is hereby granted for the above well work in accordance with all State and County laws and standards as provided in Shasta County ode, Sections 8.56.010 - 8.56.130 and any conditions as set forth in this permit.
Well is to be located a minimum of 50 feet from any sewer, septic tank, or pit privy and a minimum of 100 feet from any structure or facility signed to allow sewage to percolate into the ground. ☐ This permit is subject to the attached conditions if box is marked.

nal inspection by ____ Date ____

spection Notes: ____

ompletion Notice Received: Date ____ Well Depth ____ Casing Depth ____ Estimated g.p.m. ____

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS

# DIVISION OF WATER RESOURCES

SHEET 1

*Do Not Fill In*

State Well No.
Other Well No.
Region

# WATER WELL DRILLERS REPORT

8913

(Sections 7076, 7077, 7078, Water Code)

08540

(1) **Driller:**
Name Frost Thompson Ton
Address PO 942 Redding Calif
License No. 116336 Classification C57

(2) **Proposed use or uses** *(check)*:
Domestic [X] Municipal [ ]
Irrigation [ ] Industrial [ ]
Domestic and Irrigation [ ] Test well [ ]
Other

(3) **Equipment used** *(check)*:
Rotary [ ]
Cable [X]
Dug well [ ]
Other

**Owner**
Name
Address

(4) **Type of work** *(check)*:
New well [ ] Reconditioning of well [ ]
Deepening existing well [X]

(5) **Well log:**
Total depth of well 44 ft.

Give details of formations penetrated, such as silt, peat, muck, sand, gravel, clay, shale, sandstone, hardpan, rock. Include size of gravel (diameter) and sand (fine, medium, coarse), color of material, structure (loose, packed, cemented, soft, hard, brittle).

| Depth From Ground Surface | | |
|---|---|---|
| 0 ft. to 23 ft. | Was a dug well | |
| 23 ft. to 44 ft. | gravel & sand — Medium gravel 3" | |

CONFIDENTIAL
Section 7076.1, Water Code

If additional space is required, continue on DWR Form No. 246—Supplement, and attach to respective report copies.

(6) **Casing left in well:**

| LENGTH FT. | DIAMETER INCHES | SINGLE, DOUBLE, WELDED, OTHER | LBS. PER FOOT OR GAGE OF CASING | SEATING BELOW GROUND SURFACE FT. |
|---|---|---|---|---|
| 44 | 8 | Single | 12 Ga. | 43' 6" |

Type and size of shoe or well ring 5/8 X 4 Welded joints—[X] Yes [ ] No

D.W.R. FORM NO. 246

REGIONAL WATER POLLUTION CONTROL BOARD COPY

23971 3-50 40M QUIN

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

SHEET 2

**Do Not Fill In**
State Well No. [illegible] 1/5W-32 A1
Other Well No.
Region 5

# WATER WELL DRILLERS REPORT

**(Sections 7076, 7077, 7078, Water Code)**

**(7) Perforations:**
Type of perforator used Burnt holes
Perforated 32 ft. to 44 ft. Hole size 3/8 No. of holes 18 per ft.

**(8) Water levels:**
Depth at which water first encountered 25 ft.
Depth to water before perforating ft.
Depth to water after perforating ft.
Note any change in water level while drilling
[redacted]

**(9) Well pumping test:**
Date of test July 10 By whom Water Bailer
Depth to water when test started 25 ft.
G.P.M. at beginning of test 15
Drawdown from standing level 7 ft.
G.P.M. at completion of test 15
Drawdown at completion of test 7 ft.
Length of time tested 45 min.
Temperature of water 62
Was gas present in water? ☐ Yes ☒ No

Was well gravel packed? No Size of rock Thickness of pack
Was a surface sanitary seal provided?
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, attach detailed description.
Strata sealed
Was analysis made of water? ☐ Yes ☒ No If yes, attach copy.
Was electric log made of well? ☐ Yes ☒ No If yes, attach copy.
If well abandoned, was it plugged and sealed?
Method of plugging and sealing

CONFIDENTIAL
Section 7076.[illegible], Water C[illegible]

**(11) Location:**

North

OX

1 MILE

Section No. 32
Township 32 N.
Range 5 W.
Base & Meridian 122° 21' Mt. Diablo Meridian
Show location of well in Section, thus (X)
Distances to section lines from well. N or S 1500 ft.
and E or W 1000 ft.
Show location of nearest known well, thus (O)
Distance to nearest known well 100 ft.

**(12) Time of work:**
Work started date July 8 Completed date July 10
Date of this report Aug 14

WELL DRILLER'S STATEMENT:
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

[SIGNED] Forest Thompson & Son
Well Driller
By Forest Thompson
License No. 116336 Classification C57
Dated Aug 14, 1950

D.W.R. FORM NO. 246

REGIONAL WATER POLLUTION CONTROL BOARD COPY

23972 3-50 40M [illegible] SPO

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P O BOX 1079
SACRAMENTO 5 CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

SHEET 1

**Do Not Fill In**
State Well No.
Other Well No.
Region

# WATER WELL DRILLERS REPORT

(Sections 7076, 7077, 7078, Water Code)

8914

(1) **Driller:**
Name Forest Thompson & Son
Address P.O. Box 942
Ridge...
License No. 16335 Classification C57

(2) **Proposed use or uses** *check*:
Domestic ☐ Municipal ☐
Irrigation ☐ Industrial ☐
Domestic and Irrigation ☒ Test well ☐
Other

(3) **Equipment used** *(check)*:
Rotary ☐
Cable ☒
Dug well ☐
Other

**Owner**
Name
Address

(4) **Type of work** *check*:
New well ☒ Reconditioning of well ☐
Deepening existing well ☐

(5) **Well log:**
Total depth of well 48 ft.

Give details of formations penetrated, such as silt, peat, muck, sand, gravel, clay, shale, sandstone, hardpan, rock. Include size of gravel (diameter) and sand (fine, medium, coarse), color of material, structure (loose, packed, cemented, soft, hard, brittle).

| Depth From Ground Surface | | |
|---|---|---|
| 0 ft. to 4 ft. | Top soil |
| 4 ft. to 36 ft. | tight Clay some gravel No water |
| 36 ft. to 45 ft. | ~~Gravel with some water~~ Gravel with some Clay carring water |
| 45 ft. to 48 ft. | tight Blue Clay trace of gravel |

If additional space is required, continue on DWR Form No. 246—Supplement, and attach to respective report copies.

(6) **Casing left in well:**

| LENGTH FT. | DIAMETER INCHES | SINGLE, DOUBLE, WELDED, OTHER | LBS. PER FOOT OR GAGE OF CASING | SEATING BELOW GROUND SURFACE FT. |
|---|---|---|---|---|
| 48 | 6 | single welded | 12 ga. | 47 1/2 |

Type and size of shoe or well ring 4 X 5/8 Welded joints ☒ Yes ☐ No

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

SHEET 2

# WATER WELL DRILLERS REPORT

Sections 7076, 7077, 7078, Water Code

*Do Not Fill In*
State Well No.
Other Well No.
Region

**(7) Perforations:**

Type of perforator used Burnt holes
Perforated 32 ft. to 48 ft. Hole size 3/4 No. of holes 15 Per ft.

**(8) Water levels:**

Depth at which water first encountered 36 ft.
Depth to water before perforating ft.
Depth to water after perforating ft.
Note any change in water level while drilling no

**(9) Well pumping test:**

Date of test May 30 By whom Bailer test
Depth to water when test started 20 ft.
G.P.M. at beginning of test 15
Drawdown from standing level 18 ft.
G.P.M. at completion of test 15
Drawdown at completion of test 18 ft.
Length of time tested 1 hr.
Temperature of water 62
Was gas present in water? ☐ Yes ☒ No

**(10) General:**

Was well gravel packed? no Size of rock Thickness of pack
Was a surface sanitary seal provided? Clay packed
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, attach detailed description.
Strata sealed
Was analysis made of water? ☐ Yes ☒ No If yes, attach copy.
Was electric log made of well? ☐ Yes ☒ No If yes, attach copy.
If well abandoned, was it plugged and sealed?
Method of plugging and sealing

**(11) Location:**

North

X O

1 MILE

Base mt Diablo

Section No. 32
Township 32 North
Range 5 W
Base & Meridian
Show location of well in Section, thus (X)
Distances to section lines from well, N or S 2000 ft. and E or W 2000 ft.
Show location of nearest known well, thus (O)
Distance to nearest known well 150 ft.

**(12) Time of work:**

Work started date May 29 Completed date May 30
Date of this report June 7

**WELL DRILLER'S STATEMENT:**

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

[SIGNED] Forest Thompson & son
Well Driller

By Forest Thompson

License No. 116331 Classification C57

Dated June 7, 1950

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
# DIVISION OF WATER RESOURCES

SHEET 1

**Do Not Fill In**
State Well No.
Other Well No.
Report

# WATER WELL DRILLERS REPORT

8915

Sections 7076, 7077, 7078 Water Code

**(1) Driller:**
Name **A. W. MINOR**
Address **1727 Magnolia Street**
**Redding, California**
License No. **116889** Classification **C 57**

505

**(2) Proposed use or uses (check):**
Domestic X
Irrigation
Domestic and Irrigation
Other
Municipal
Industrial
Test well

**(3) Equipment used (check):**
Rotary ☐
Cable X
Dug well ☐
Other

**Owner:**
Name
Address

**(4) Type of work (check):**
New well X
Reconditioning of well ☐
Deepening existing well ☐

**(5) Well log:**
Total depth of well **52** ft.

Give details of formations penetrated, such as silt, peat, muck, sand, gravel, clay, shale, sandstone, hardpan, rock. Include size of gravel (diameter) and sand (fine, medium, coarse), color of material, structure (loose, packed, cemented, soft, hard, brittle).

| Depth From Ground Surface | | Formations |
|---|---|---|
| 0 ft. | to 16 ft. | Gravel-Loam loose |
| 16 " | " 21 " | Clay packed |
| 21 " | " 29 " | Gravel ½"-Sand coarse |
| 29 ~~32~~ " | " 37 " | Hardpan cemented |
| 37 " | " 52 " | Gravel ½" to 1½" Sand coarse |

CONFIDENTIAL

If additional space is required, continue on DWR Form No. 246—Supplement, and attach to respective report copies.

**(6) Casing left in well:**

| LENGTH FT. | DIAMETER INCHES | SINGLE, DOUBLE, WELDED, OTHER | LBS. PER FOOT OR GAGE OF CASING | SEATING BELOW GROUND SURFACE, FT |
|---|---|---|---|---|
| 52 | 6" | Single | 12 gage | ground surface |

Type and size of shoe or well ring **5/8** Welded joints—X Yes ☐ No

D.W.R. FORM NO. 246

REGIONAL WATER POLLUTION CONTROL BOARD COPY

23971 3-50 40M QUIN SPO

ORIGINAL
File Original, Duplicate and Triplicate with the
DIVISION OF WATER RESOURCES
P. O. BOX 1079
SACRAMENTO 5, CALIFORNIA

SHEET 2

Do Not Fill In
State Well No.
Other Well No.
Report

# WATER WELL DRILLERS REPORT

Sections 7076, 7077, 7078, Water Code

**(7) Perforations:**

Type of perforator used: Machine perforated

Perforated 32 ft. to 52 ft. Hole size 3/8 No. of holes 29 per ft.

**(8) Water levels:**

Depth at which water first encountered 16 ft.
Depth to water before perforating ft.
Depth to water after perforating 9 ft.
Note any change in water level while drilling

**(9) Well pumping test:**

Date of test By whom
Depth to water when test started ft.
G.P.M. at beginning of test
Drawdown from standing level ft.
G.P.M. at completion of test
Drawdown at completion of test ft.
Length of time tested
Temperature of water
Was gas present in water? ☐ Yes ☐ No

**(10) General:**

CONFIDENTIAL
Section 7076.1, Water Code

Was well gravel packed? Size of rock ~~Thickness of pack~~
Was a surface sanitary seal provided?
Were any strata sealed against pollution? ☐ Yes ☒ No If yes, attach detailed description.
Strata sealed
Was analysis made of water? ☐ Yes ☒ No If yes, attach copy.
Was electric log made of well? ☐ Yes ☒ No If yes, attach copy.
If well abandoned, was it plugged and sealed?
Method of plugging and sealing

**(11) Location:**

North

| |
|---|
| |
| |
| |
| 0x |

1 MILE

Section No. 32
Township 32N
Range 5 W
Base & Meridian Mt. Diablo
Show location of well in Section, thus (X)
Distances to section lines from well, ~~N~~ or S 975 ft. and ~~E~~ or W 1025 ft.
Show location of nearest known well, thus (O)
Distance to nearest known well 180 ft.

**(12) Time of work:**

Work started date 10-9-50 Completed date 10-11-50
Date of this report 11-18-50

WELL DRILLER'S STATEMENT:

*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

[SIGNED] A. W. Miner
Well Driller

By

License No. 116889 Classification C 57

Dated Nov. 18, 1950

Sully
50

D.W.R. FORM NO. 246 REGIONAL WATER POLLUTION CONTROL BOARD COPY 23972 3-50 40M 2UIN SPO

32N/05W - 32M

**ORIGINAL**
**File with DWR**

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# WATER WELL DRILLERS REPORT

*Do not fill in*

No. 349624

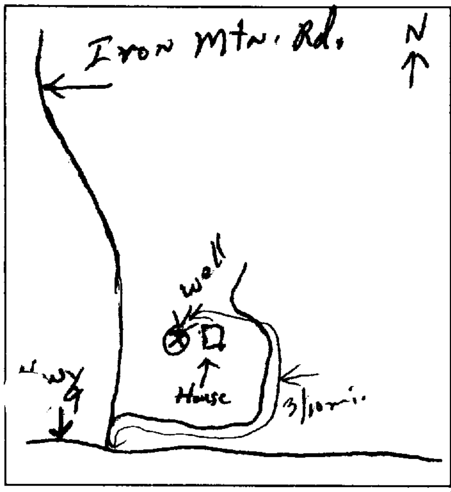
...e of Intent No. ______
Local Permit No. or Date 9311

AP 204-060-06

State Well No. ______
Other Well No. ______

(1
Ac
Ci

(2) LOCATION OF WELL (See instructions):
County Shasta Owner's Well Number 2
Well address if different from above ______
Township 32N Range 5W Section 32
Distance from cities, roads, railroads, fences, etc. 3/10 mi. From Hwy 299 to drill site.




WELL LOCATION SKETCH

(3) TYPE OF WORK:
New Well ☒ Deepening ☐
Reconstruction ☐
Reconditioning ☐
Horizontal Well ☐
Destruction ☐ (Describe destruction materials and procedures in Item 12)

(4) PROPOSED USE:
Domestic ☒
Irrigation ☐
Industrial ☐
Test Well ☐
Municipal ☐
Other ☐
(Describe)

(5) EQUIPMENT:
Rotary ☒ Reverse ☐
Cable ☐ Air ☒
Other ☐ Bucket ☐

(6) GRAVEL PACK:
Yes ☐ No ☒ Size ______
Diameter of bore 6 3/4"
Packed from ______ to ______ ft.

(7) CASING INSTALLED:
Steel ☒ Plastic ☐ Concrete ☐

(8) PERFORATIONS: None
Type of perforation or size of screen

| From ft. | To ft. | Dia. in. | Gage or Wall | From ft. | To ft. | Slot size |
|---|---|---|---|---|---|---|
| -1 | 35 | 6 5/8" | .188 | | | |
| | | | | | | |
| | | | | | | |

(9) WELL SEAL:
Was surface sanitary seal provided? Yes ☒ No ☐ If yes, to depth 23 ft.
Were strata sealed against pollution? Yes ☐ No ☐ Interval ______ ft.
Method of sealing Dry Bentonite

(10) WATER LEVELS:
Depth of first water, if known — ft.
Standing level after well completion 84 ft.

(11) WELL TESTS:
Was well test made? Yes ☒ No ☐ If yes, by whom? us
Type of test Pump ☐ Bailer ☐ Air lift ☒
Depth to water at start of test 84 ft. At end of test 250 ft.
Discharge 3 gal/min after 1 hours Water temperature ______
Chemical analysis made? Yes ☐ No ☒ If yes, by whom? ______
Was electric log made Yes ☐ No ☒ If yes, attach copy to this report

(12) WELL LOG: Total depth 262 ft. Completed depth 262 ft.

| from ft. | to ft. | Formation (Describe by color, character, size or material) |
|---|---|---|
| 0 | 34 | weathered greenstone |
| | | |
| 34 | 262 | Fresh greenstone |

SEP 11 1990

Work started 8-20 1990 Completed 8-21 1990

WELL DRILLER'S STATEMENT: 457
*This well was drilled under my jurisdiction and this report is true to the best of my knowledge and belief.*

Signed Don Ackley (Well Driller)
NAME DON'S DRILLING CO. (Person, firm, or corporation) (Typed or printed)
Address Rt. 2 Box 27983
City SHINGLETOWN, CA 96088 ZIP ______
(916) 474-5300
License No. 279177 Date of this report 8-22-90

**ORIGINAL**
**File with DWR**

RECEIVED DEC 0 1992 D.W.R.

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
Refer to Instruction Pamphlet

No. 486074

DWR USE ONLY — DO NOT FILL IN
32N/05W-32M
STATE WELL NO./STATION NO.
LATITUDE LONGITUDE
APN/TRS/OTHER

Page 1 of 1
Owner's Well No. 2
Date Work Began 9-30-92, Ended 10-1-92
Local Permit Agency Shasta Co. Health Dept.
Permit No. 10295 Permit Date 9-23-92

## GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER 75 (Ft.) BELOW SURFACE

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION (Describe material, grain size, color, etc.) |
|---|---|---|
| 0 | 36 | Brown clay, [weathered rock] |
| 36 | 258 | green Rhyolite with quartz seams |

TOTAL DEPTH OF BORING 258 (Feet)
TOTAL DEPTH OF COMPLETED WELL 258 (Feet)

## WELL OWNER

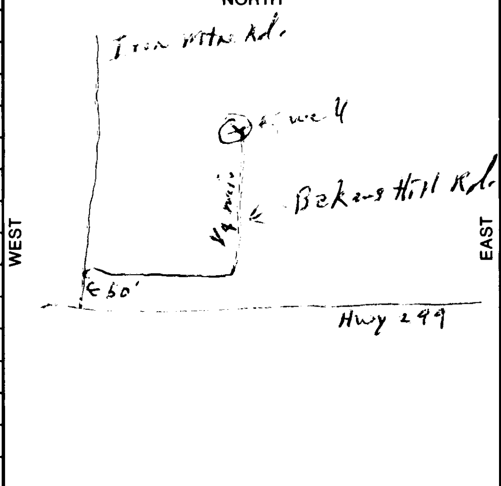
CITY STATE ZIP

## WELL LOCATION

Address Same
City Redding
County Shasta
APN Book 204 Page 060 Parcel 03
or Township 32N Range 05W Section 32
or Latitude ___ DEG. MIN. SEC. NORTH Longitude ___ DEG. MIN. SEC. WEST

## LOCATION SKETCH

NORTH




WEST EAST

SOUTH

*Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.*
***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

X NEW WELL
MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)
___ DESTROY (*Describe Procedures and Materials Under "GEOLOGIC LOG"*)

## PLANNED USE(S) (✓)

___ MONITORING
WATER SUPPLY
X Domestic
___ Public
___ Irrigation
___ Industrial
___ "TEST WELL"
___ CATHODIC PROTECTION
___ OTHER (Specify)

DRILLING METHOD Air Rotary FLUID water

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL 36 (Ft.) & DATE MEASURED 10-1-92
ESTIMATED YIELD* 18 (GPM) & TEST TYPE Air lift.
TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN 200 (Ft.) Est.
** May not be representative of a well's long-term yield.*

## CASING(S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL/GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 41 | 10" | ✓ | | | | A53A | 6 1/8" | .134 | |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 20 | | ✓ | | |

DEC 18 1992

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Don's Drilling Co. Inc. 457
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

27983 Camino Real Shingletown Ca. 96088
ADDRESS CITY STATE ZIP

Signed Don Ackley 10-1-92 641500
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

**ORIGINAL**
**File with DWR**

Page 1 of 1

Owner's Well No. ____

RECEIVED SEP 09 1994

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 581564

DWR USE ONLY — DO NOT FILL IN

32N/05W-32M

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

Date Work Began 8-22-94 Ended 8-23-94

Local Permit Agency S. D.W.R. Co.

Permit No. 10936 Permit Date 8-25-94

## GEOLOGIC LOG

ORIENTATION (✓) ✓ VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DEPTH TO FIRST WATER ____ (Ft.) BELOW SURFACE

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION *Describe material, grain size, color, etc.* |
|---|---|---|
| 262 | 498 | Hard Rhyolite with quartz |
| | | seams 450-498 |

TOTAL DEPTH OF BORING 498 (Feet)

TOTAL DEPTH OF COMPLETED WELL 498 (Feet)

## WELL OWNER

## WELL LOCATION

Address Same

City

County Shasta

APN Book 204 Page 060 Parcel 06

or

Township 32N Range 05W Section 32 M

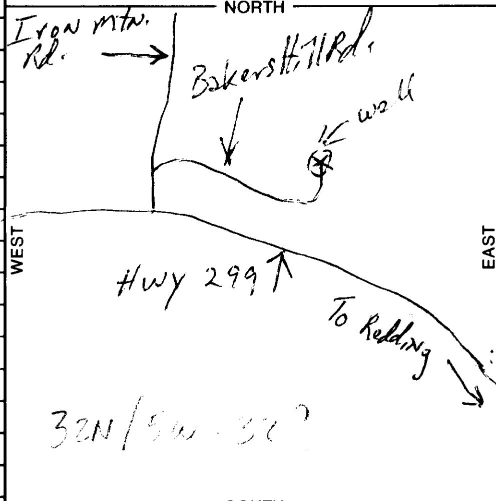
or

Latitude ____ NORTH Longitude ____ WEST

DEG. MIN. SEC. DEG. MIN. SEC.

## LOCATION SKETCH

NORTH




SOUTH

*Illustrate or Describe Distance of Well from Landmarks such as Roads, Buildings, Fences, Rivers, etc.*
***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

___ NEW WELL

MODIFICATION/REPAIR

X Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

## PLANNED USE(S) (✓)

___ MONITORING

WATER SUPPLY

X Domestic

___ Public

___ Irrigation

___ Industrial

___ "TEST WELL"

___ CATHODIC PROTECTION

___ OTHER (Specify)

DRILLING METHOD Air Rotary FLUID water

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH OF STATIC WATER LEVEL ____ (Ft.) & DATE MEASURED ____

ESTIMATED YIELD* 1 1/2 (GPM) & TEST TYPE Air lift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN — (Ft.)

* *May not be representative of a well's long-term yield.*

## CASING(S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| None added | | | | | | | | | | |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| None added | | | | | |

SEP 21 1994

## ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ____

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Don's Drilling Co. Inc 457
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

22983 Camino Real Shingletown Ca. 96088
ADDRESS CITY STATE ZIP

Signed Don Ackley 8-25-94 641500
WELL DRILLER/AUTHORIZED REPRESENTATIVE DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 7-90

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

ORIGINAL
File with DWR

Page ___ of ___

Owner's Well No. 1

Date Work Began ____________, Ended 10-7-15.

Local Permit Agency SHASTA COUNTY

Permit No. 15-164 Permit Date 9-17-15

DEC 07 2015

STATE OF CALIFORNIA

# WELL COMPLETION REPORT

*Refer to Instruction Pamphlet*

No. 0988538

DWR USE ONLY — DO NOT FILL IN

32N/05W-32

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AIR ROTARY FLUID ______

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|---|
| 0 | 3 | Soil + Bolders |
| 3 | 22 | BROWN SHALE |
| 22 | 35 | FRACTURED BROWN Rock |
| 35 | 405 | GREEN GRANITE |
| W | | |
| 60 | | |
| 205 | | |
| ~~348~~ | 348 | |

TOTAL DEPTH OF BORING 405 (Feet)

TOTAL DEPTH OF COMPLETED WELL 405 (Feet)

## WELL OWNER

[redacted]

## WELL LOCATION

Address BAKER HILL RD

City REDDING

County SHASTA

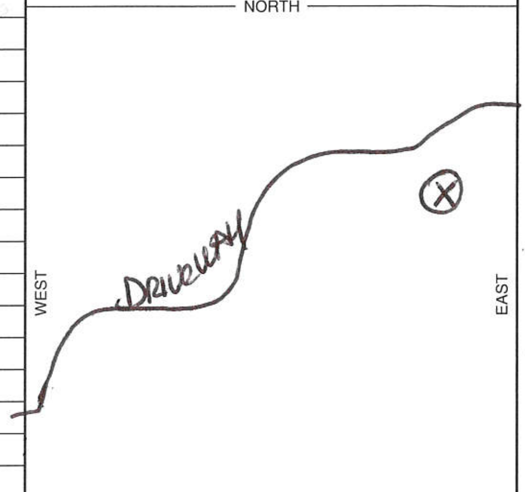
APN Book 204 Page 040 Parcel 005

Township ______ Range ______ Section ______

Lat ___ ___ ___ N DEG. MIN. SEC. Long ___ ___ ___ W DEG. MIN. SEC.

## LOCATION SKETCH

NORTH




WEST EAST

SOUTH

*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary.* ***PLEASE BE ACCURATE & COMPLETE.***

## ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR

___ Deepen

___ Other (Specify)

___ DESTROY *(Describe Procedures and Materials Under "GEOLOGIC LOG")*

## USES (✓)

WATER SUPPLY

X Domestic ___ Public

___ Irrigation ___ Industrial

MONITORING ___

TEST WELL ___

CATHODIC PROTECTION ___

HEAT EXCHANGE ___

DIRECT PUSH ___

INJECTION ___

VAPOR EXTRACTION ___

SPARGING ___

REMEDIATION ___

OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 60 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 100 (Ft.) & DATE MEASURED 10-7-15

ESTIMATED YIELD * 8 (GPM) & TEST TYPE AIR LIFT

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN NA (Ft.)

** May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 38 | 10" | X | | | | Steel | 6" | 134 | NO |
| 38 | 405 | 6" | | | | | | | | |
| 5 | 405 | | | | | | PVC | 4" | Sch 40 | Certaloc |
| 345 | 405 | | | X | | | PVC | 4" | Sch 40 | .032 FACTORY |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 29 | | X | | |

## ATTACHMENTS (✓)

___ Geologic Log

___ Well Construction Diagram

___ Geophysical Log(s)

___ Soil/Water Chemical Analyses

___ Other ______

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME STEVEN FOSTER Well Drilling
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

1021 EASTSIDE RD ANDERSON CA 96007
ADDRESS CITY STATE ZIP

Signed [signature] ______ 373681
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED C-57 LICENSE NUMBER

DWR 188 REV. 05-03

IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM

OSP 03 78836

**ORIGINAL**
**File with DWR**

NOV 0 7 2014

Page ___ of ___

Owner's Well No. I

Date Work Began ________ Ended 9-25-14

Local Permit Agency SHASTA CO

Permit No. 14-273 Permit Date 7-15-14

STATE OF CALIFORNIA

# WELL COMPLETION REPORT

*Refer to Instruction Pamphlet*

No. 0988555

DWR USE ONLY — DO NOT FILL IN

32N/05W-32 . .

STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD Air Rotary FLUID

| DEPTH FROM SURFACE Ft. | to Ft. | DESCRIPTION *Describe material, grain size, color, etc.* |
|---|---|---|
| 0 | 2 | Soil & Cobbles |
| 2 | 45 | BROWN Shale |
| 45 | 54 | BROWN & GREEN Shale |
| 54 | 264 | GREEN GRANITE |
| W | | |
| 80 | | |
| 145 | | |
| 225 | | |

TOTAL DEPTH OF BORING 264 (Feet)

TOTAL DEPTH OF COMPLETED WELL 264 (Feet)

Off Tilton Mine Road, Lower Springs

## WELL LOCATION

Address SAME

City

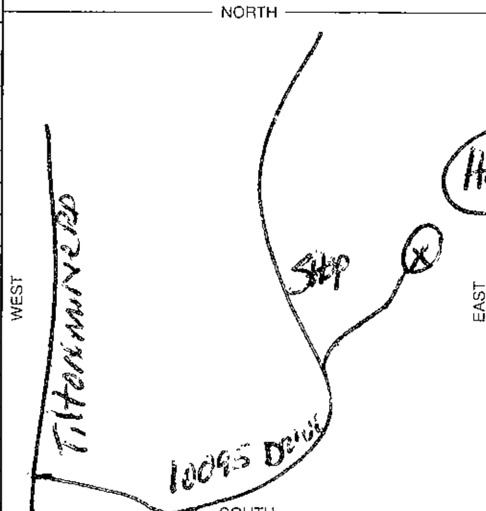
County SHASTA

APN Book 204 Page 530 Parcel 014

Township ___ Range ___ Section ___

Lat ___ DEG. MIN. SEC. N Long ___ DEG. MIN. SEC. W

## LOCATION SKETCH




*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

## USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 80 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 50 (Ft.) & DATE MEASURED 9-25-14

ESTIMATED YIELD * 10 (GPM) & TEST TYPE Air Lift

TEST LENGTH NR (Hrs.) TOTAL DRAWDOWN NA (Ft.)

* *May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. | to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 29 | 10" | X | | | | Steel | 6" | 134 | |
| 29 | 264 | 6" | | | | | | | | |
| 4 | 264 | | | | | | PVC | 4" | Sch40 | Cortalok |
| 204 | 264 | | | X | | | PVC | 4" | Sch40 | .032 |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. | to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|---|
| 0 | 23 | | X | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ___

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Steven Foster Well Drilling
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

7021 Eastside Rd Anderson CA 96007
ADDRESS CITY STATE ZIP

Signed [signature]
C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED

373681
C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

ORIGINAL
File with DWR

SEP 24 2014

Page ___ of ___

Owner's Well No. I

Date Work Began ________, Ended Aug 11-14

Local Permit Agency SHASTA CO

Permit No. 14-262 Permit Date 7-9-14

STATE OF CALIFORNIA
# WELL COMPLETION REPORT
*Refer to Instruction Pamphlet*

No. 0988559

DWR USE ONLY — DO NOT FILL IN

32N | 05W | 32 | STATE WELL NO./STATION NO.

LATITUDE | LONGITUDE

APN/TRS/OTHER

## GEOLOGIC LOG

ORIENTATION (✓) X VERTICAL ___ HORIZONTAL ___ ANGLE ___ (SPECIFY)

DRILLING METHOD AirRotary FLUID ________

| DEPTH FROM SURFACE Ft. to Ft. | DESCRIPTION Describe material, grain size, color, etc. |
|---|---|
| 0 - 6 | Soil |
| 6 - 29 | D.G. |
| 29 - 225 | Green & White Granit |
| 225 - 270 | Green Granit |
| 270 - 285 | Soft White Granit |
| 285 - 330 | Soft Green Granit |
| 330 - 365 | Green Granit |
| 365 - 385 | Soft Green & White Granit |
| 385 - 426 | Green Granit |
| Water | |
| 355 | |
| 185 | |
| 225 | |

TOTAL DEPTH OF BORING 426 (Feet)

TOTAL DEPTH OF COMPLETED WELL 426 (Feet)

Victoria Highlands

## WELL LOCATION

Address Same

City ________

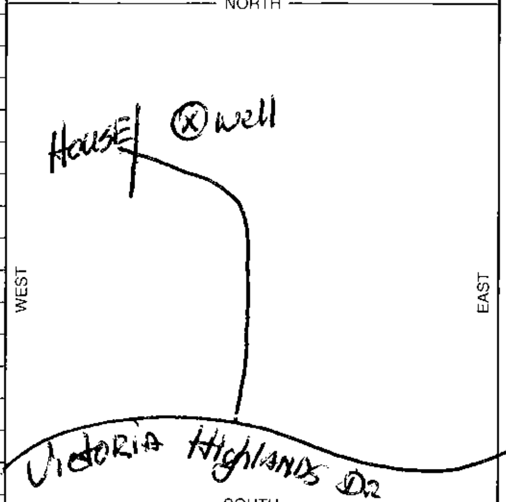
County Shasta

APN Book 204 Page 050 Parcel 027

Township 32N Range 05W Section 32

Lat ___ DEG. ___ MIN. ___ SEC. N Long ___ DEG. ___ MIN. ___ SEC. W

## LOCATION SKETCH




*Illustrate or Describe Distance of Well from Roads, Buildings, Fences, Rivers, etc. and attach a map. Use additional paper if necessary. PLEASE BE ACCURATE & COMPLETE.*

## ACTIVITY (✓)

X NEW WELL

MODIFICATION/REPAIR
___ Deepen
___ Other (Specify)

___ DESTROY (Describe Procedures and Materials Under "GEOLOGIC LOG")

## USES (✓)

WATER SUPPLY
X Domestic ___ Public
___ Irrigation ___ Industrial

MONITORING ___
TEST WELL ___
CATHODIC PROTECTION ___
HEAT EXCHANGE ___
DIRECT PUSH ___
INJECTION ___
VAPOR EXTRACTION ___
SPARGING ___
REMEDIATION ___
OTHER (SPECIFY) ___

## WATER LEVEL & YIELD OF COMPLETED WELL

DEPTH TO FIRST WATER 185 (Ft.) BELOW SURFACE

DEPTH OF STATIC WATER LEVEL 150 (Ft.) & DATE MEASURED 8-11-14

ESTIMATED YIELD * 5 (GPM) & TEST TYPE Air Lift

TEST LENGTH 1 (Hrs.) TOTAL DRAWDOWN NA (Ft.)

* *May not be representative of a well's long-term yield.*

## CASING (S)

| DEPTH FROM SURFACE Ft. to Ft. | BORE-HOLE DIA. (Inches) | BLANK | SCREEN | CON-DUCTOR | FILL PIPE | MATERIAL / GRADE | INTERNAL DIAMETER (Inches) | GAUGE OR WALL THICKNESS | SLOT SIZE IF ANY (Inches) |
|---|---|---|---|---|---|---|---|---|---|
| 0 - 29 | 10" | X | | | | Steel | 6" | 134 | |
| 29 - 426 | 6" | | | | | | | | Certa |
| 6 - 426 | | | | | | PVC | 4" | Sch 40 | loc |
| ~~348 - 420~~ | | | X | | | PVC | 4" | Sch 40 | .032 |
| 343 - 423 | | | X | | | | | Factory | Perf. |

## ANNULAR MATERIAL

| DEPTH FROM SURFACE Ft. to Ft. | CE-MENT (✓) | BEN-TONITE (✓) | FILL (✓) | FILTER PACK (TYPE/SIZE) |
|---|---|---|---|---|
| 0 - 23 | | X | | |

## ATTACHMENTS (✓)

___ Geologic Log
___ Well Construction Diagram
___ Geophysical Log(s)
___ Soil/Water Chemical Analyses
___ Other ________

*ATTACH ADDITIONAL INFORMATION, IF IT EXISTS.*

## CERTIFICATION STATEMENT

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief.

NAME Steven Foster Well Drilling
(PERSON, FIRM, OR CORPORATION) (TYPED OR PRINTED)

7021 Eastside Rd Anderson CA 96007
ADDRESS CITY STATE ZIP

Signed [signature] C-57 LICENSED WATER WELL CONTRACTOR DATE SIGNED 373681 C-57 LICENSE NUMBER

DWR 188 REV. 05-03 IF ADDITIONAL SPACE IS NEEDED, USE NEXT CONSECUTIVELY NUMBERED FORM OSP 03 78836

State of California

# Well Completion Report

**Form DWR 188 Complete 1/21/2016**

**WCR2016-000426**

Owner's Well Number: WW-1 | Date Work Began: 12/14/2015 | Date Work Ended: 12/15/2015

Local Permit Agency: Shasta County Environmental Health

Secondary Permit Agency: | Permit Number: WTR15-229 | Permit Date: 11/24/2015

## Well Owner (must remain confidential pursuant to Water Code 13752)

Name: XXXXXXXXXXXXXXXXXXXX

Mailing Address: XXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXX

City: XXXXXXXXXXXXXXXXXXXX State: XX Zip: XXXXX

## Planned Use and Activity

Activity: Drill and Destroy

Planned Use: Destruction

## Well Location

Address: 100 New Found WAY

City: Redding Zip: 96002 County: Shasta

| | Deg. | Min. | Sec. | |
|---|---|---|---|---|
| Latitude | 40 | 35 | 10.59 | N |
| Longitude | -122 | 27 | 6.20 | W |

Dec. Lat.: 40.5873912 Dec. Long.: -122.4559088

Vertical Datum: Horizontal Datum: WGS84

Location Accuracy: Location Determination Method:

APN: 204-660-008-000

Township: 32 N

Range: 05 W

Section: 32

Baseline Meridian:

Ground Surface Elevation: 729

Elevation Accuracy: 30 Ft

Elevation Determination Method: GPS with WAAS

## Borehole Information

Orientation: Vertical Specify:

Drilling Method: Downhole Rotary Hammer Drilling Fluid: Air

Total Depth of Boring: 486 Feet

Total Depth of Completed Well: Feet

## Water Level and Yield of Completed Well

Depth to first water: (Feet below surface)

Depth to Static Water Level: (Feet) Date Measured:

Estimated Yield*: (GPM) Test Type:

Test Length: (Hours) Total Drawdown: (feet)

*May not be representative of a well's long term yield.

## Geologic Log - Free Form

| Depth from Surface Feet to Feet | | Description |
|---|---|---|
| 0 | 2 | Reddish brown silty clay |
| 2 | 8 | Lt. brown silty clay |
| 8 | 25 | Lt. brown weathered greenstone |
| 25 | 486 | Greenstone |

## Casings

| Casing # | Depth from Surface Feet to Feet | | Casing Type | Material | Casings Specificatons | Wall Thickness (inches) | Outside Diameter (inches) | Screen Type | Slot Size if any (inches) | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

## Annular Material

| Depth from Surface Feet to Feet | | Fill | Fill Type Details | Filter Pack Size | Description |
|---|---|---|---|---|---|
| | | | | | |

**Destruction Details:**
Well unsuccessful, no production- Back filled w/clean native material to 27'. Filled with bentonite chips 27 ' to 19', granular bentonite 19' to surface.

**Other Observations:**

## Borehole Specifications

| Depth from Surface Feet to Feet | | Borehole Diameter (inches) |
|---|---|---|
| | | |

## Certification Statement

I, the undersigned, certify that this report is complete and accurate to the best of my knowledge and belief

Name DIAMOND CORE DRILLING INC
Person, Firm or Corporation

| P O BOX 491925 | REDDING | CA | 96049 |
|---|---|---|---|
| Address | City | State | Zip |

Signed *electronic signature received* 01/18/2016 512406
C-57 Licensed Water Well Contractor | Date Signed | C-57 License Number

## Attachments

Cory McCandliss Well Site.pdf - Location Map

## DWR Use Only

| CSG # | State Well Number | Site Code | Local Well Number |
|---|---|---|---|
| | | | |

N W

**Latitude Deg/Min/Sec** **Longitude Deg/Min/Sec**

TRS:

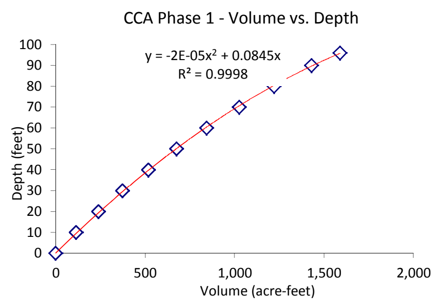
APN:

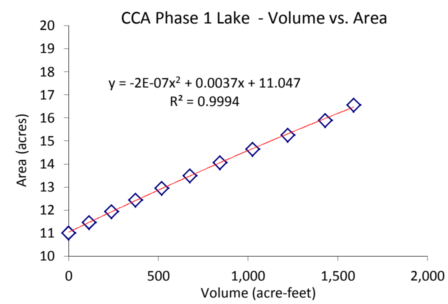
# APPENDIX C

## NEW LAKE & PHASE CHARACTERISTICS

**PHASE 1**

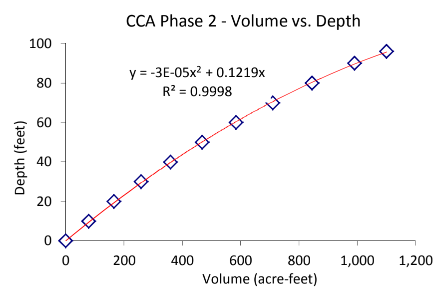
| Elevation | Incremental | Area | Volume |
|---|---|---|---|
| feet MSL | feet | acres | acre feet |
| 640 | 0 | 11.01 | 0 |
| 650 | 10 | 11.47 | 115 |
| 660 | 20 | 11.95 | 239 |
| 670 | 30 | 12.44 | 373 |
| 680 | 40 | 12.96 | 518 |
| 690 | 50 | 13.50 | 675 |
| 700 | 60 | 14.07 | 844 |
| 710 | 70 | 14.65 | 1,026 |
| 720 | 80 | 15.26 | 1,221 |
| 730 | 90 | 15.90 | 1,431 |
| 736 | 96 | 16.56 | 1,590 |

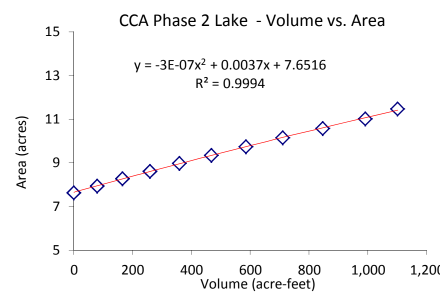



**PHASE 2**

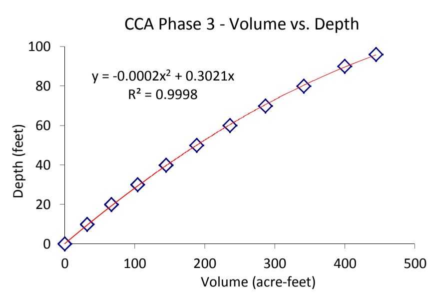
| Elevation | Incremental Depth | Area | Volume |
|---|---|---|---|
| feet MSL | feet | acres | acre feet |
| 640 | 0 | 7.63 | 0 |
| 650 | 10 | 7.94 | 79 |
| 660 | 20 | 8.27 | 165 |
| 670 | 30 | 8.62 | 259 |
| 680 | 40 | 8.98 | 359 |
| 690 | 50 | 9.35 | 468 |
| 700 | 60 | 9.74 | 585 |
| 710 | 70 | 10.15 | 710 |
| 720 | 80 | 10.57 | 846 |
| 730 | 90 | 11.01 | 991 |
| 736 | 96 | 11.47 | 1,101 |

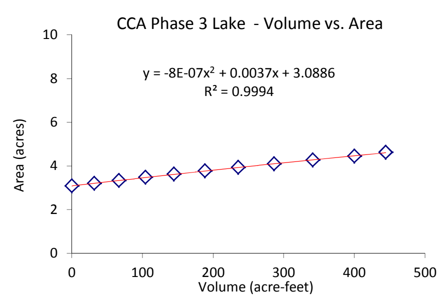



**PHASE 3**

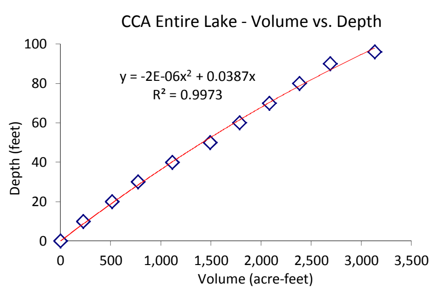
| Elevation | Incremental Depth | Area | Volume |
|---|---|---|---|
| feet MSL | feet | acres | acre feet |
| 640 | 0 | 3.08 | 0 |
| 650 | 10 | 3.21 | 32 |
| 660 | 20 | 3.34 | 67 |
| 670 | 30 | 3.48 | 104 |
| 680 | 40 | 3.62 | 145 |
| 690 | 50 | 3.78 | 189 |
| 700 | 60 | 3.93 | 236 |
| 710 | 70 | 4.10 | 287 |
| 720 | 80 | 4.27 | 341 |
| 730 | 90 | 4.44 | 400 |
| 736 | 96 | 4.63 | 444 |

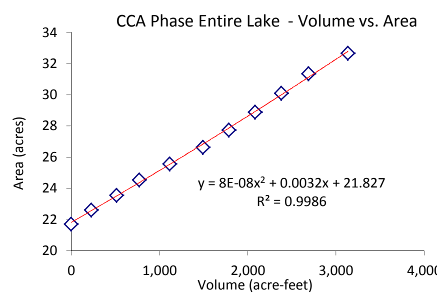


**ENTIRE LAKE**

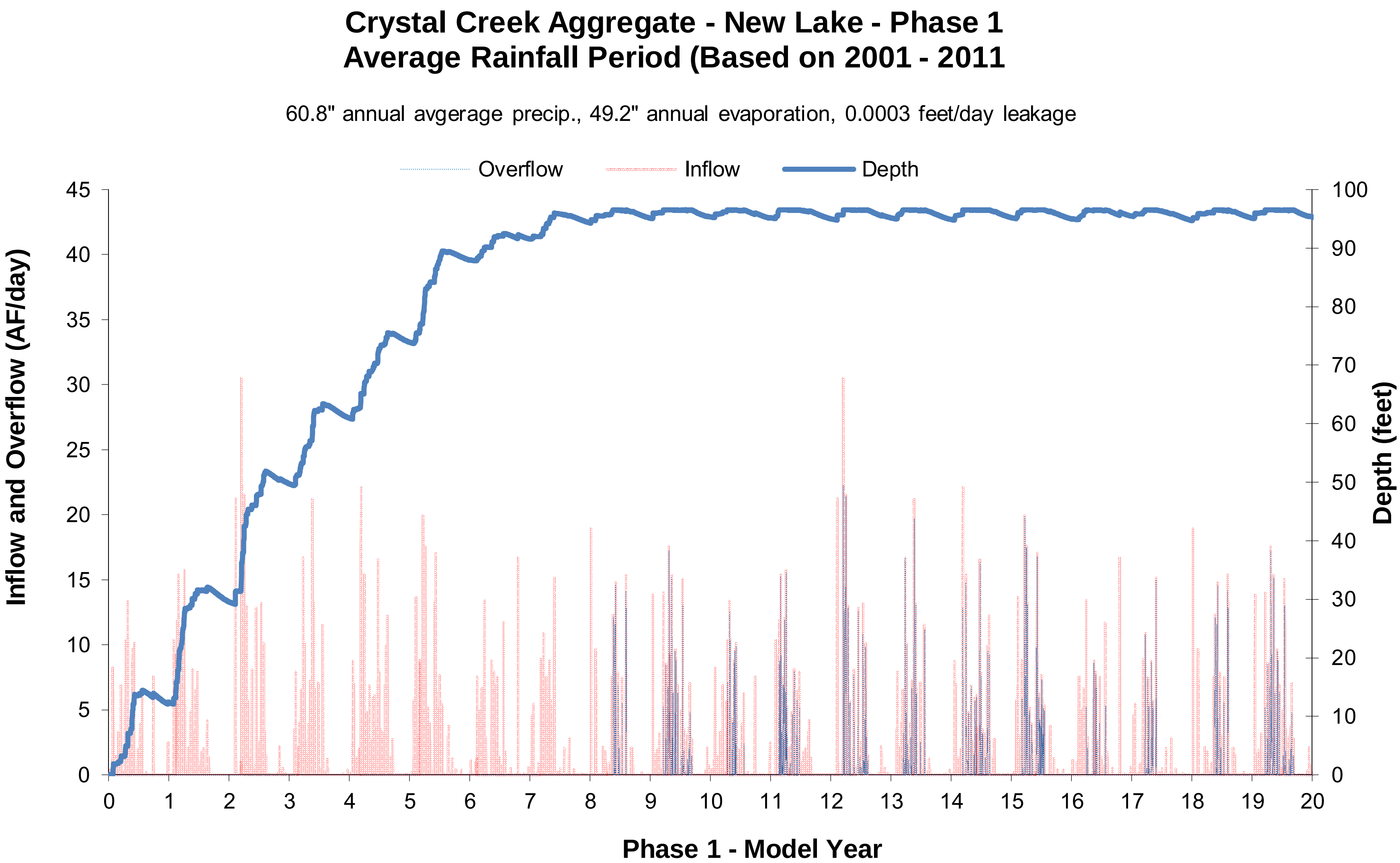
| Elevation | Incremental Depth | Area | Volume |
|---|---|---|---|
| feet MSL | feet | acres | acre feet |
| 640 | 0 | 21.71 | 0 |
| 650 | 10 | 22.62 | 226 |
| 660 | 20 | 23.56 | 514 |
| 670 | 30 | 24.54 | 773 |
| 680 | 40 | 25.56 | 1,115 |
| 690 | 50 | 26.63 | 1,492 |
| 700 | 60 | 27.74 | 1,788 |
| 710 | 70 | 28.90 | 2,085 |
| 720 | 80 | 30.10 | 2,383 |
| 730 | 90 | 31.35 | 2,691 |
| 736 | 96 | 32.66 | 3,135 |



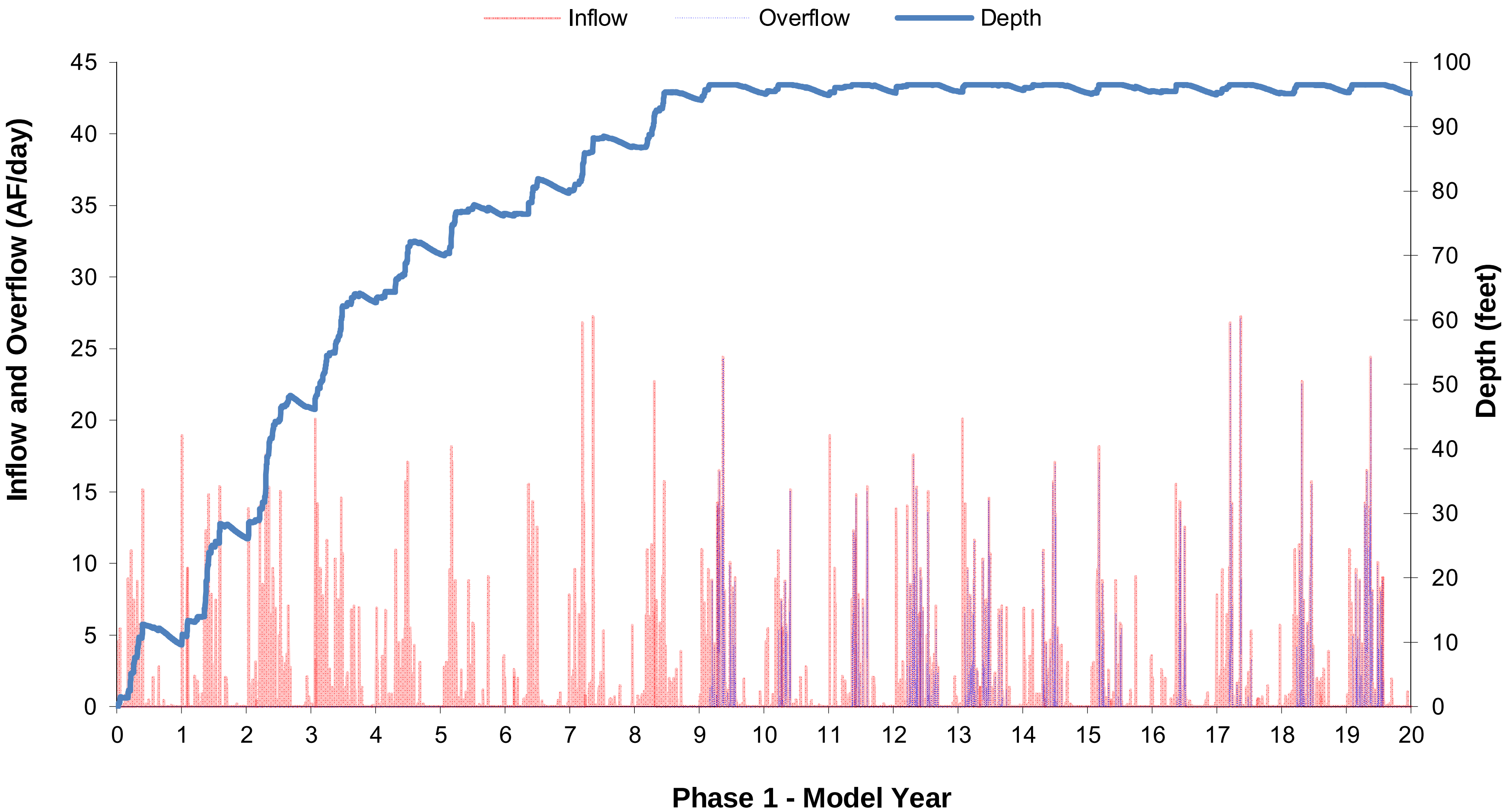
# APPENDIX D

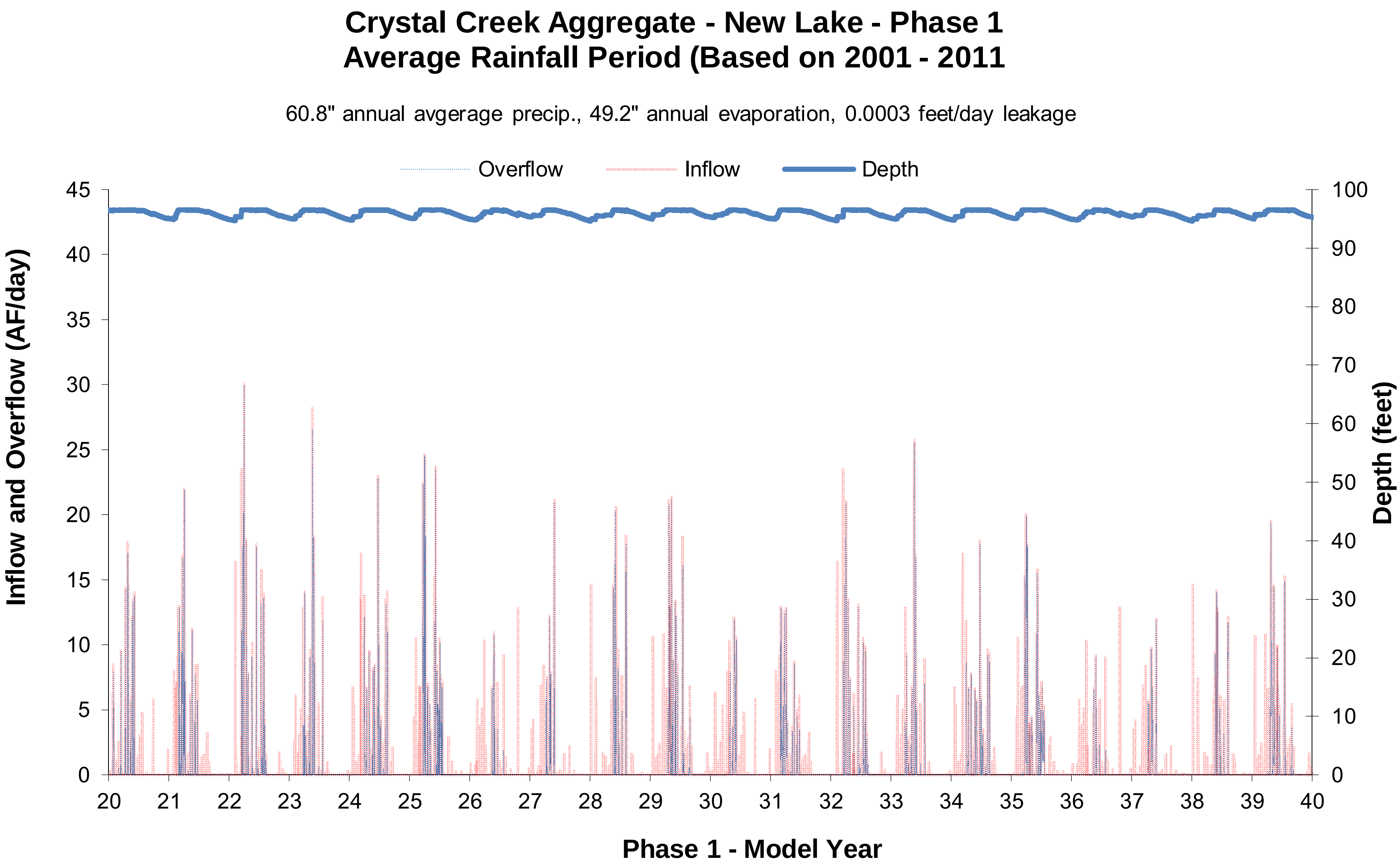
## WATER-BUDGET MODELING OUTPUT GRAPHS


Crystal Creek Aggregate - New Lake - Phase 1
Average Rainfall Period (Based on 2001 - 2011
60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 1 - Model Year
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20

# Crystal Creek Aggregate - New Lake - Phase 1
# Drought Period (Based on 2007 - 2017 Precipitation)

44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage




Crystal Creek Aggregate - New Lake - Phase 1
Average Rainfall Period (Based on 2001 - 2011
60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 1 - Model Year
0
5
10
15
20
25
30
35
40
45
0
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20
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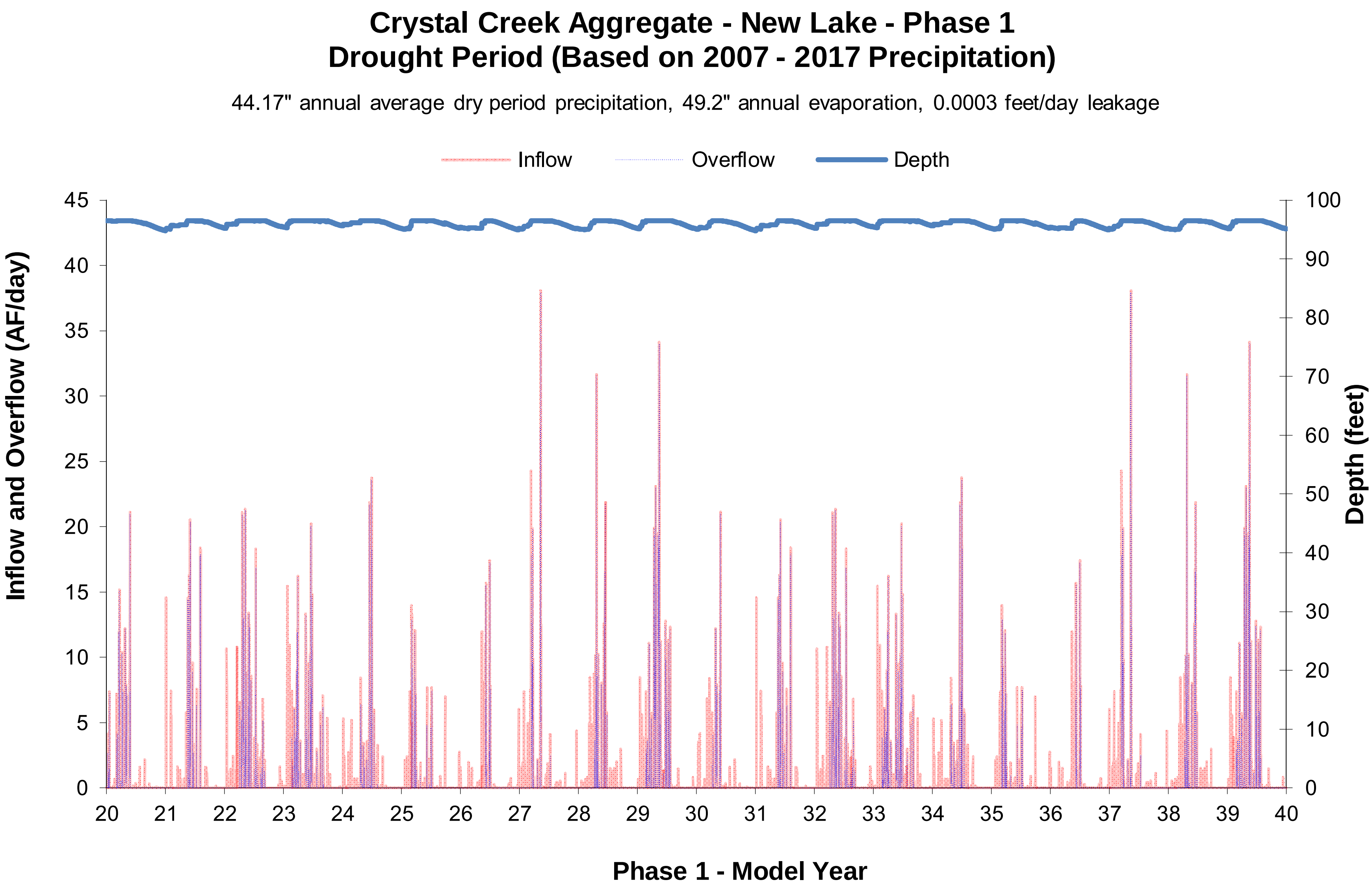
Crystal Creek Aggregate - New Lake - Phase 1
Drought Period (Based on 2007 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 1 - Model Year
0
5
10
15
20
25
30
35
40
45
0
10
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70
80
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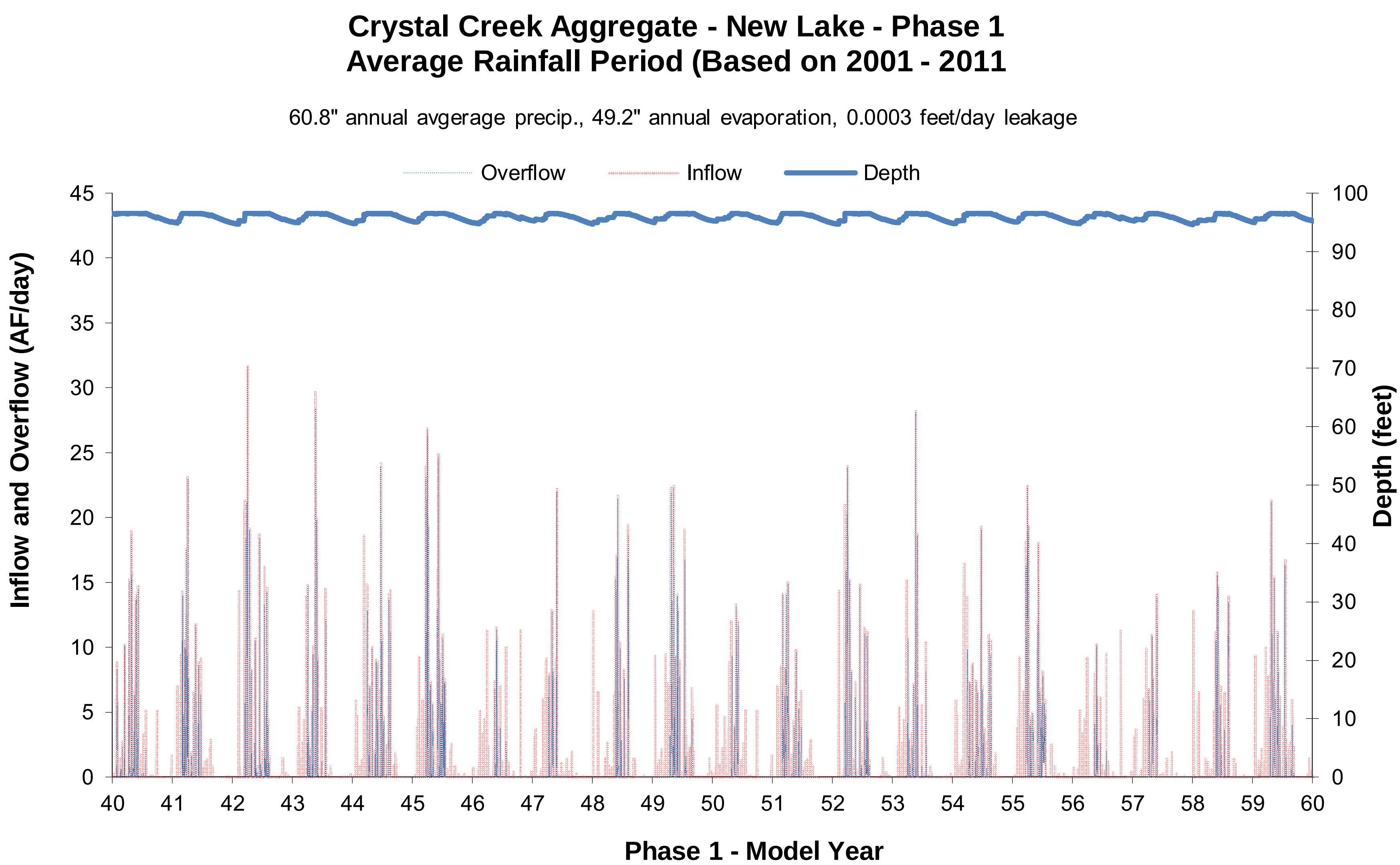
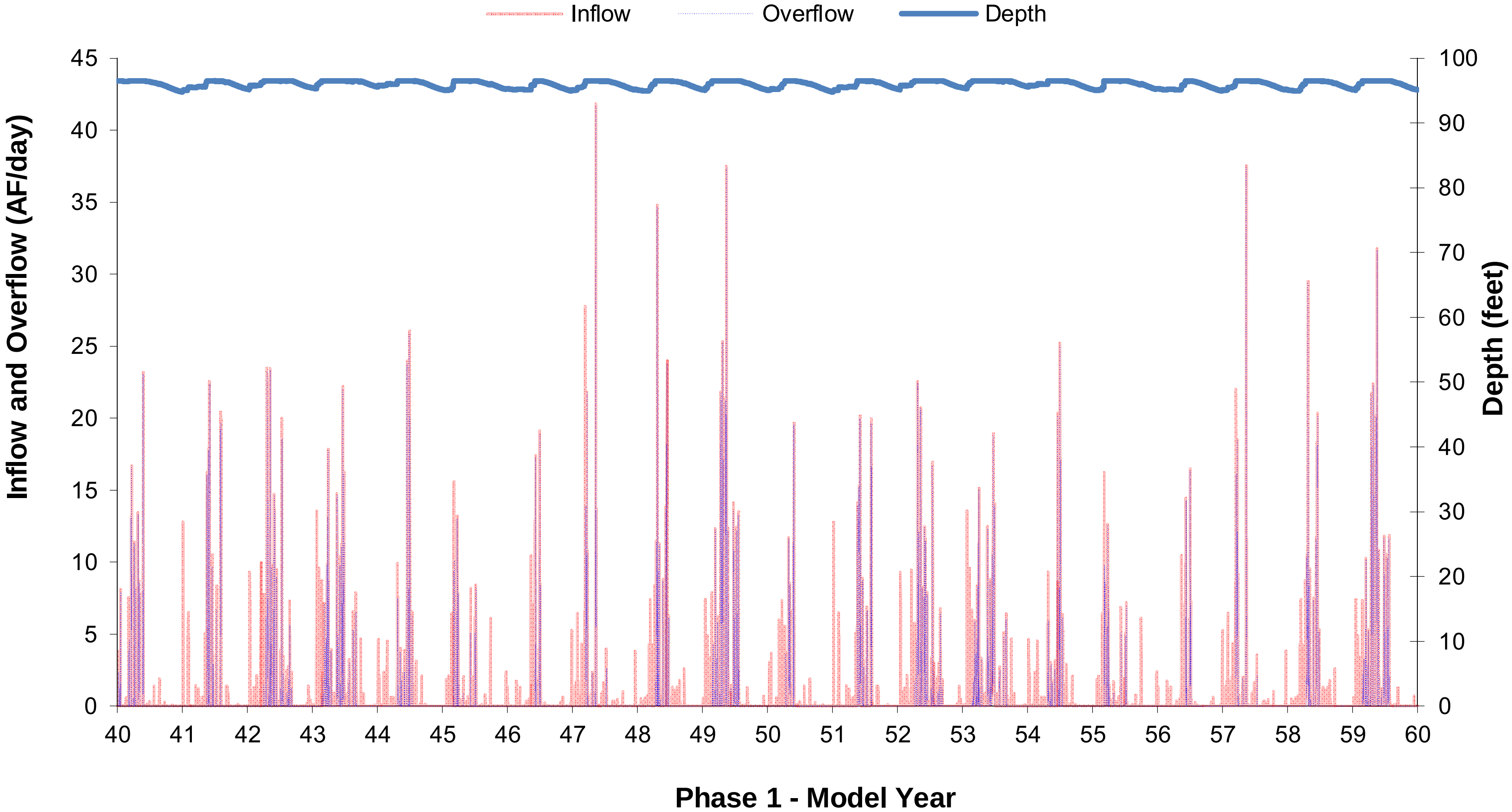

Crystal Creek Aggregate - New Lake - Phase 1
Average Rainfall Period (Based on 2001 - 2011
60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 1 - Model Year
0
5
10
15
20
25
30
35
40
45
0
10
20
30
40
50
60
70
80
90
100
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

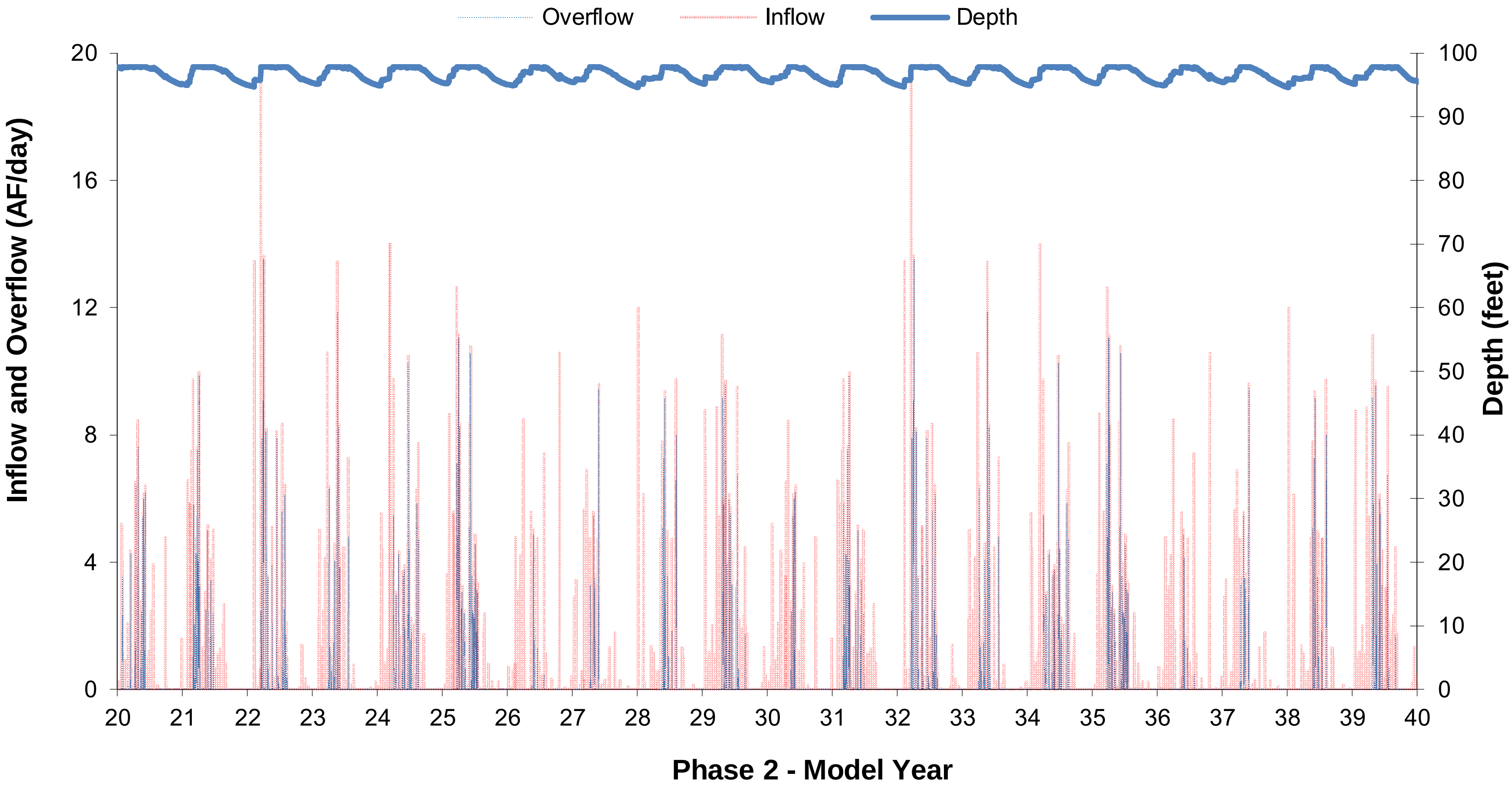
# Crystal Creek Aggregate - New Lake - Phase 1
# Drought Period (Based on 2007 - 2017 Precipitation)

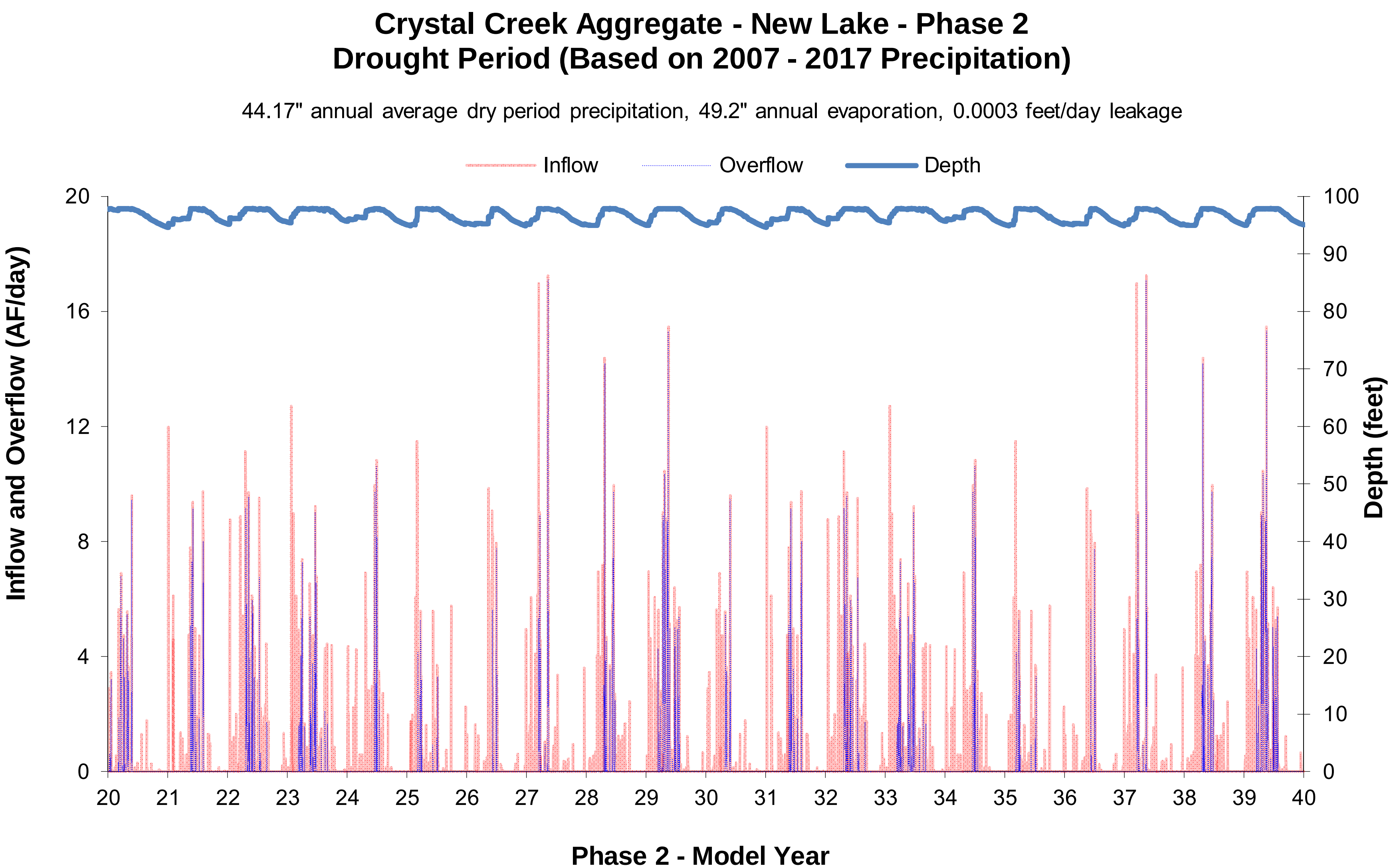
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage



# Crystal Creek Aggregate - New Lake - Phase 2
# Average Rainfall Period (Based on 2001 - 2011

60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage




Crystal Creek Aggregate - New Lake - Phase 2
Drought Period (Based on 2007 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 2 - Model Year
0
4
8
12
16
20
0
10
20
30
40
50
60
70
80
90
100
20
21
22
23
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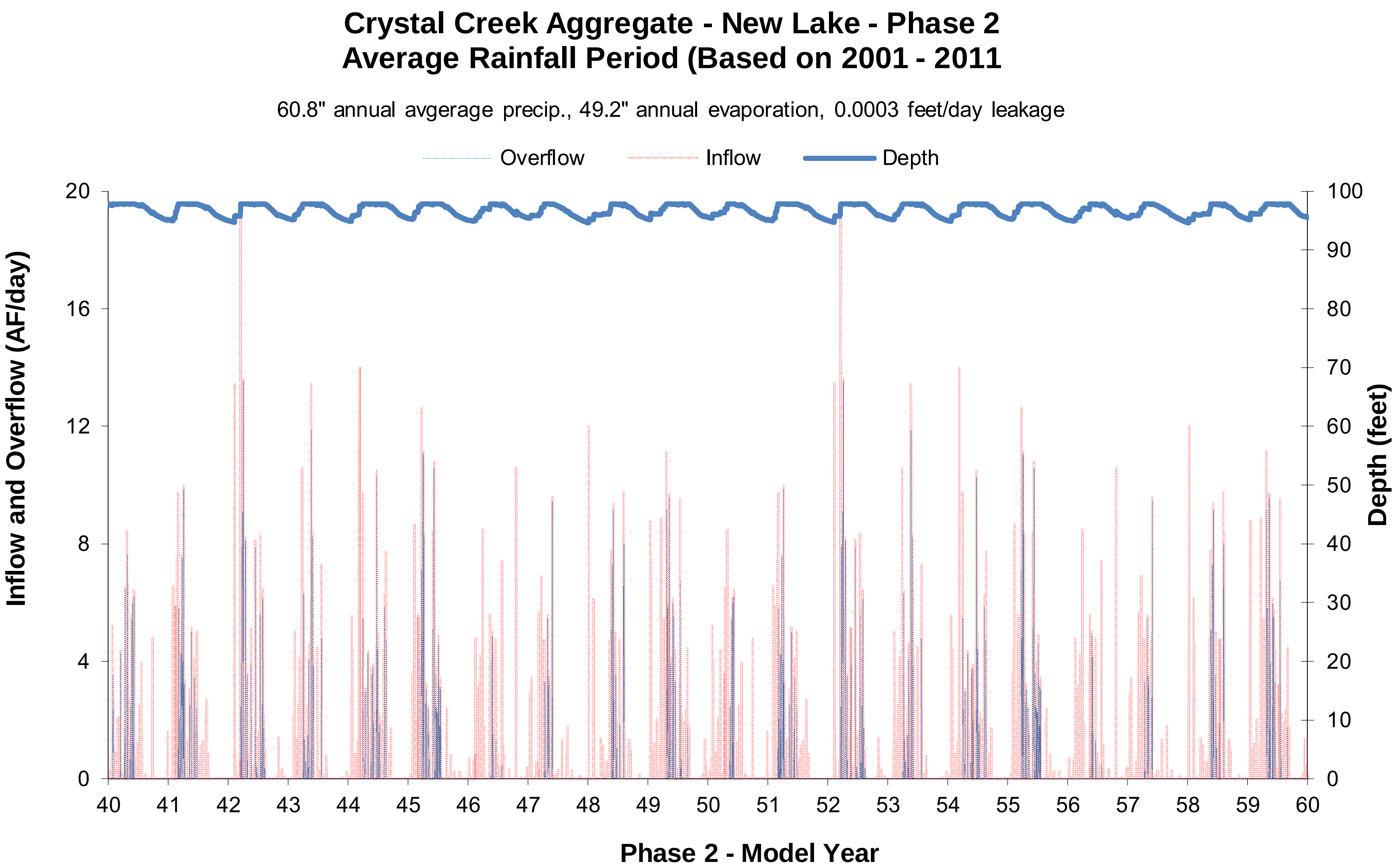
Crystal Creek Aggregate - New Lake - Phase 2
Average Rainfall Period (Based on 2001 - 2011
60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 2 - Model Year
0
4
8
12
16
20
0
10
20
30
40
50
60
70
80
90
100
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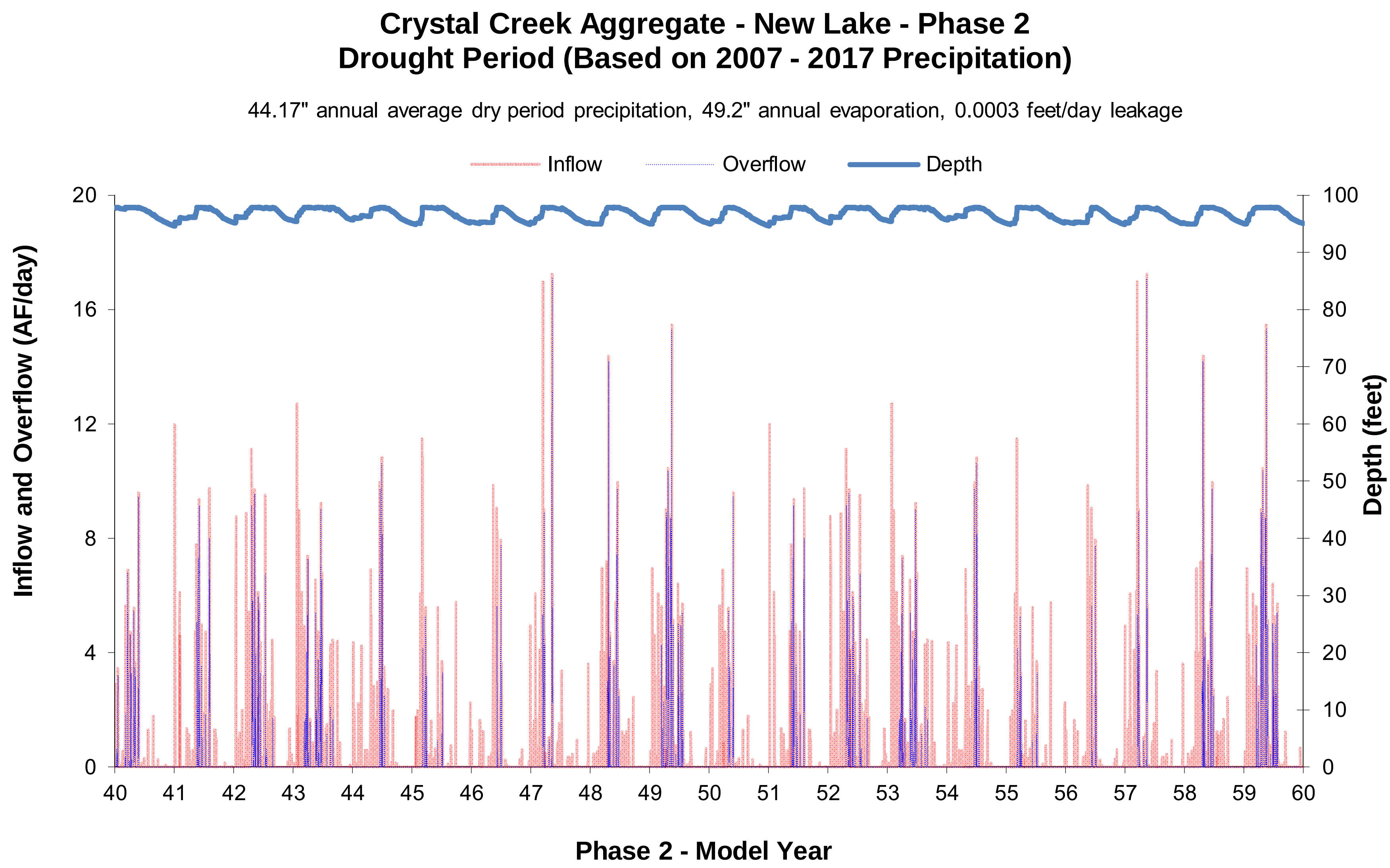

Crystal Creek Aggregate - New Lake - Phase 2
Drought Period (Based on 2007 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 2 - Model Year
0
4
8
12
16
20
0
10
20
30
40
50
60
70
80
90
100
40
41
42
43
44
45
46
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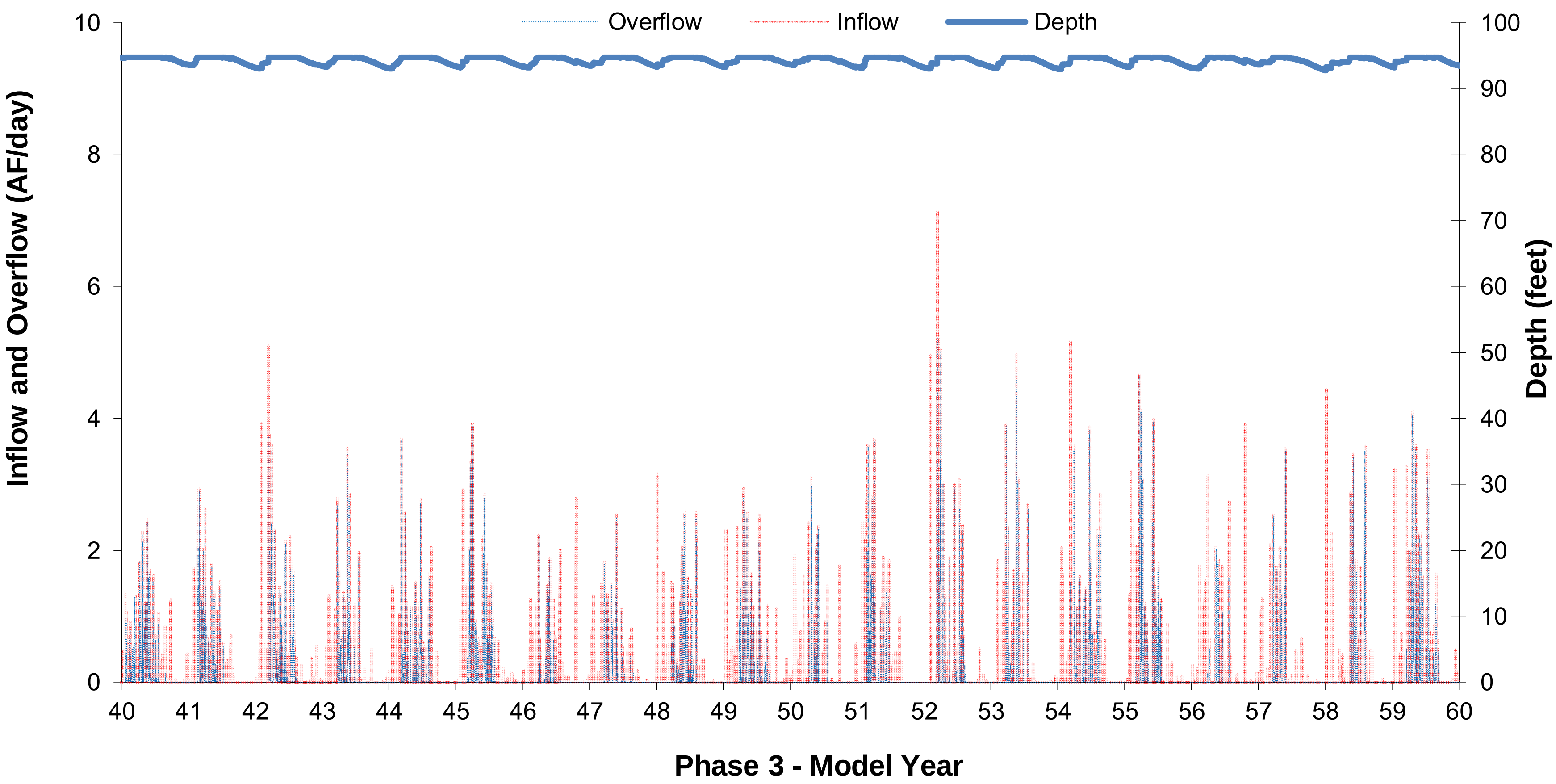
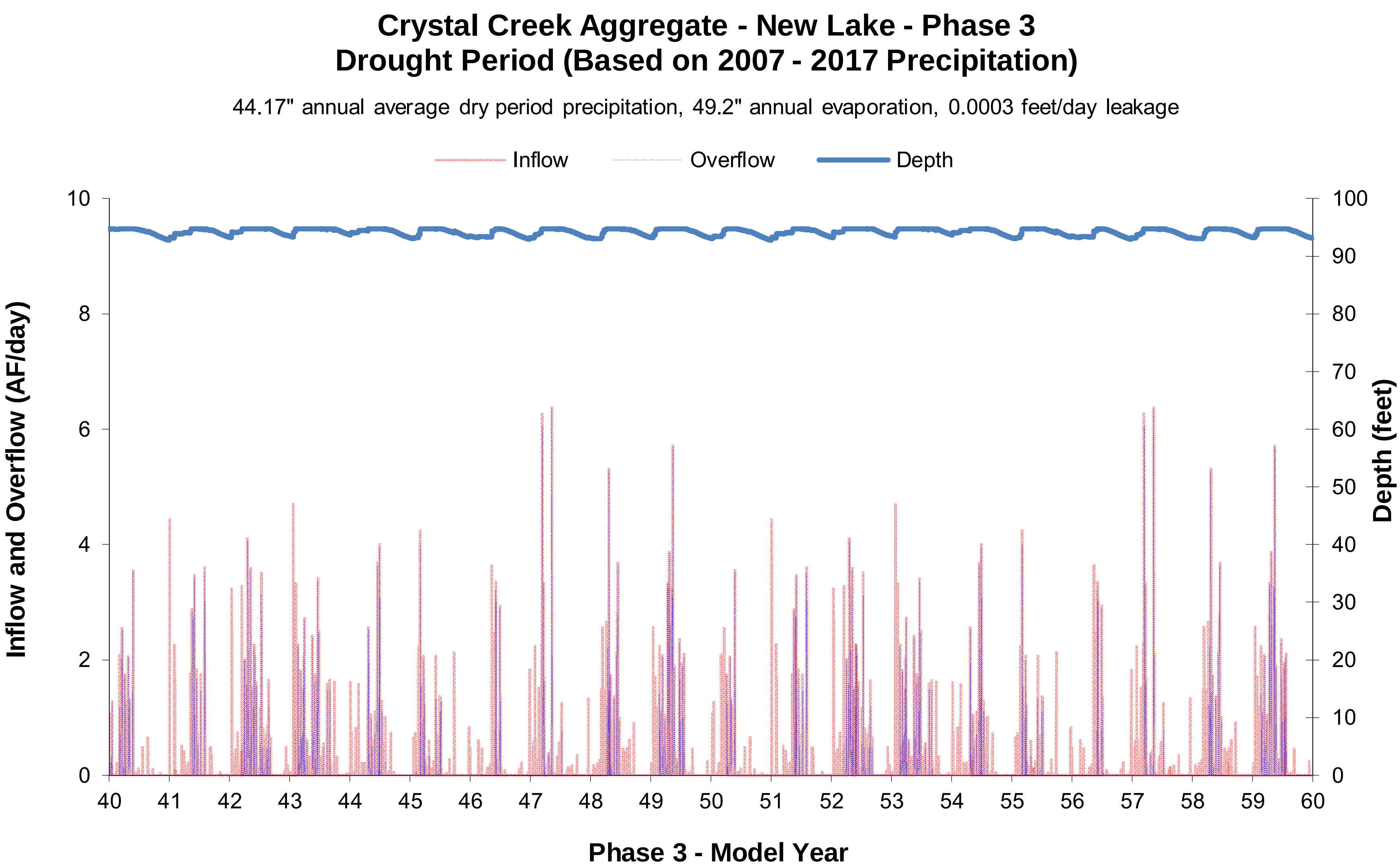
48
49
50
51
52
53
54
55
56
57
58
59
60

## Crystal Creek Aggregate - New Lake - Phase 3
## Average Rainfall Period (Based on 2001 - 2011

60.8" annual avgerage precip., 49.2" annual evaporation, 0.0003 feet/day leakage





Crystal Creek Aggregate - New Lake - Phase 3
Drought Period (Based on 2007 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Phase 3 - Model Year
0
2
4
6
8
10
0
10
20
30
40
50
60
70
80
90
100
40
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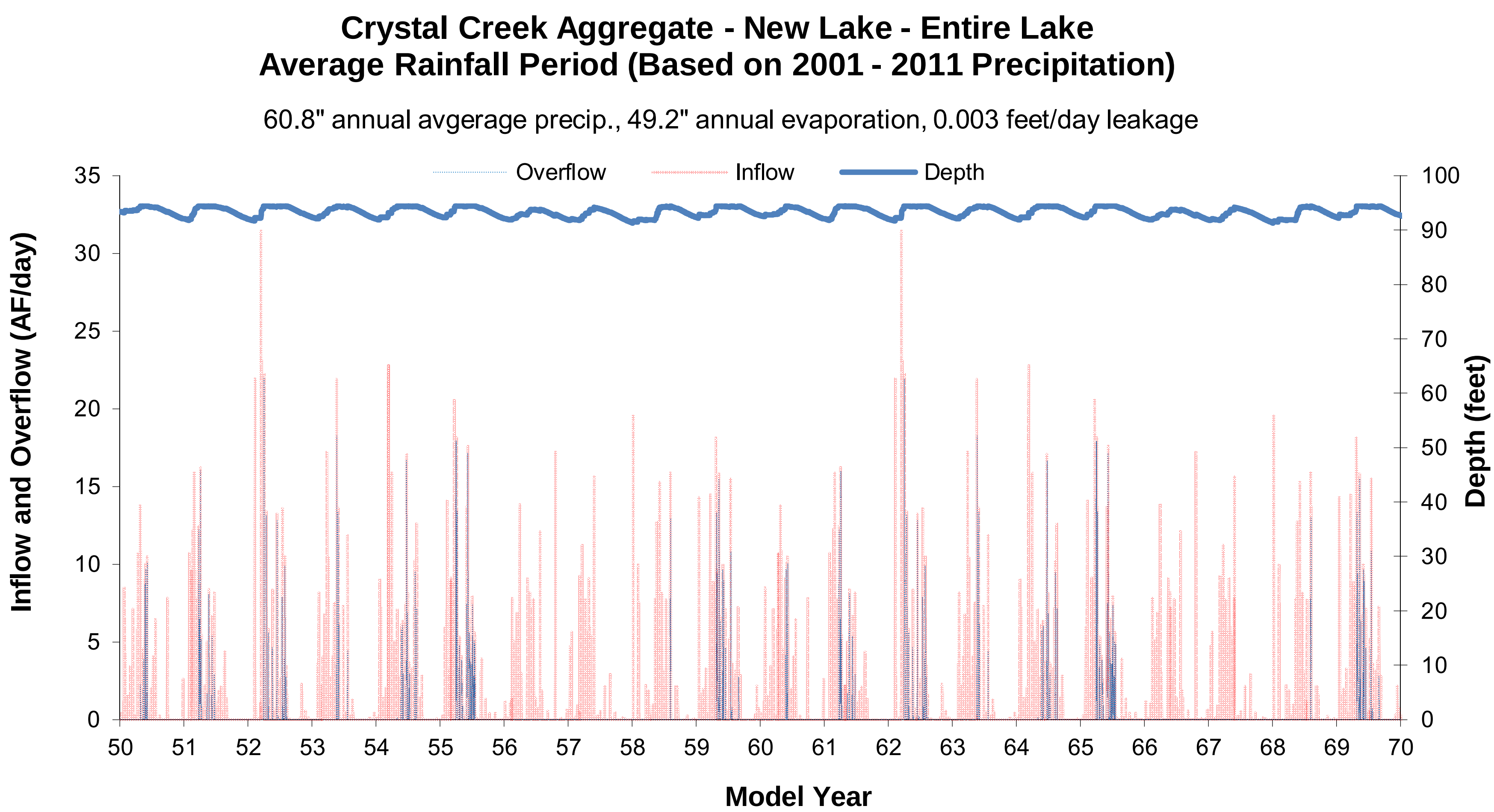
Crystal Creek Aggregate - New Lake - Entire Lake
Average Rainfall Period (Based on 2001 - 2011 Precipitation)
60.8" annual avgerage precip., 49.2" annual evaporation, 0.003 feet/day leakage
Overflow
Inflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Model Year
0
5
10
15
20
25
30
35
0
10
20
30
40
50
60
70
80
90
100
50
51
52
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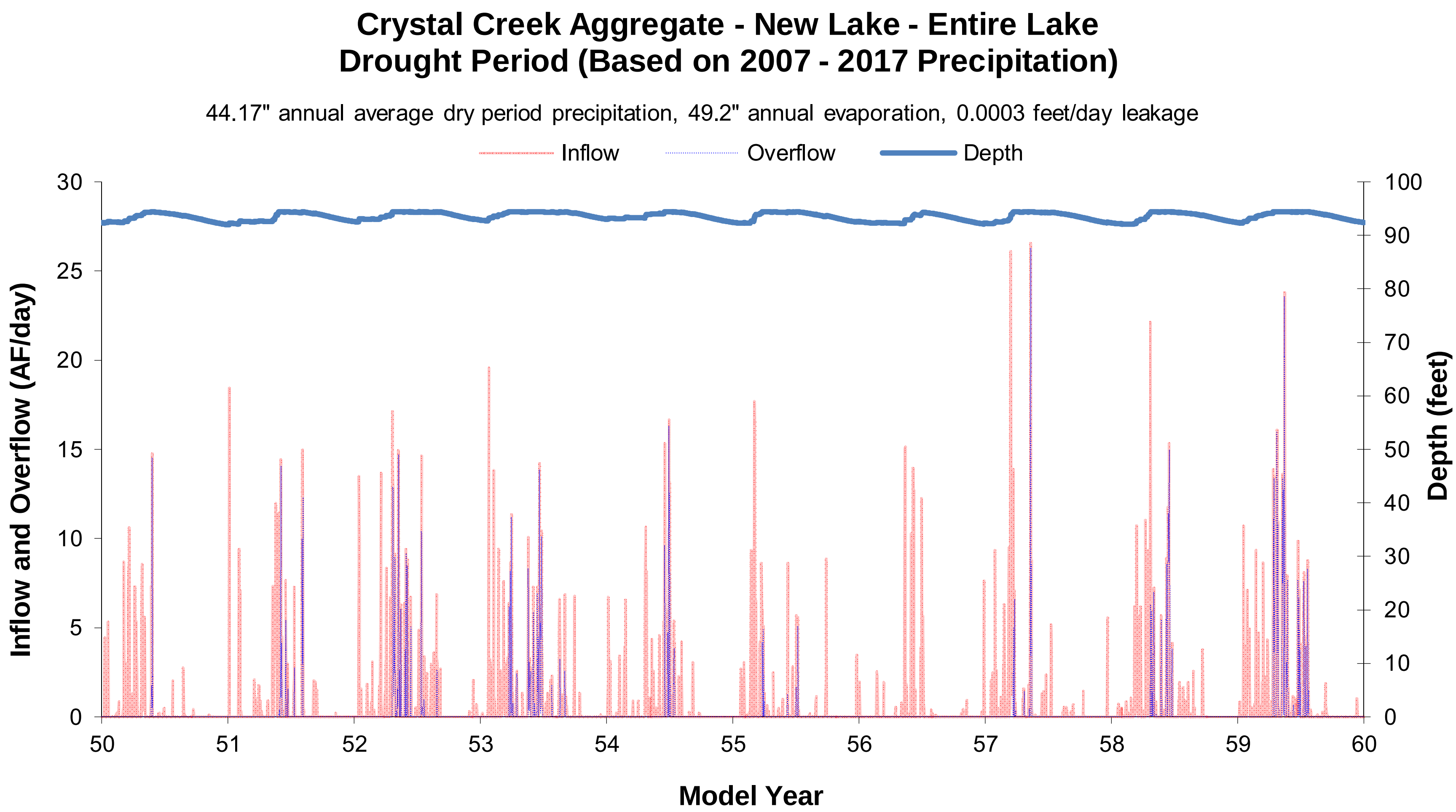
66
67
68
69
70



Crystal Creek Aggregate - New Lake - Entire Lake
Drought Period (Based on 2007 - 2017 Precipitation)
44.17" annual average dry period precipitation, 49.2" annual evaporation, 0.0003 feet/day leakage
Inflow
Overflow
Depth
Inflow and Overflow (AF/day)
Depth (feet)
Model Year
0
5
10
15
20
25
30
0
10
20
30
40
50
60
70
80
90
100
50
51
52
53
54
55
56
57
58
59
60

# APPENDIX E

## WATER-BUDGET MODELING ANNUAL SUMMARIES

# WATER BALANCE SUMMARY
## CLEAR CREEK AGGREGATE LAKE MODELING

### ENTIRE LAKE - DRY PERIOD - YEARS 51 - 60

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 3099 |
| 51 | 102 | 55 | 157 | 4 | 156 | 17 | 177 | 3079 | 3079 |
| 52 | 161 | 87 | 249 | 4 | 156 | 59 | 219 | 3109 | 3109 |
| 53 | 210 | 113 | 323 | 4 | 156 | 149 | 309 | 3123 | 3123 |
| 54 | 203 | 110 | 313 | 4 | 157 | 145 | 305 | 3130 | 3130 |
| 55 | 128 | 69 | 197 | 4 | 156 | 65 | 225 | 3102 | 3102 |
| 56 | 121 | 65 | 186 | 4 | 156 | 21 | 181 | 3107 | 3107 |
| 57 | 96 | 52 | 147 | 4 | 156 | 0 | 159 | 3095 | 3095 |
| 58 | 146 | 79 | 226 | 4 | 156 | 64 | 224 | 3096 | 3096 |
| 59 | 177 | 96 | 273 | 4 | 156 | 110 | 270 | 3099 | 3099 |
| 60 | 250 | 135 | 385 | 4 | 156 | 225 | 385 | 3099 | 3099 |

### ENTIRE LAKE - AVERAGE PERIOD - YEARS 51 - 70

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 3150 |
| 51 | 122 | 77 | 198 | 36 | 156 | 71 | 263 | 3085 | 3085 |
| 52 | 169 | 106 | 275 | 36 | 156 | 86 | 278 | 3082 | 3082 |
| 53 | 215 | 136 | 350 | 36 | 156 | 142 | 334 | 3098 | 3098 |
| 54 | 153 | 97 | 250 | 36 | 156 | 74 | 265 | 3083 | 3083 |
| 55 | 191 | 120 | 311 | 36 | 156 | 96 | 289 | 3105 | 3105 |
| 56 | 244 | 154 | 398 | 36 | 156 | 224 | 416 | 3086 | 3086 |
| 57 | 111 | 70 | 180 | 36 | 156 | 0 | 192 | 3075 | 3075 |
| 58 | 102 | 64 | 166 | 36 | 156 | 0 | 191 | 3050 | 3050 |
| 59 | 161 | 102 | 263 | 36 | 156 | 24 | 216 | 3097 | 3097 |
| 60 | 210 | 132 | 342 | 36 | 157 | 133 | 326 | 3113 | 3113 |

# WATER BALANCE SUMMARY
## CRYSTAL CREEK AGGREGATE QUARRY EXPANSION

### PHASE 1 - DRY PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | Overflow From Phases 2 and/or 3 | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | | 1590 |
| 41 | 69 | 39 | 107 | 215 | 2 | 78 | 194 | 274 | 1532 | 1532 |
| 42 | 110 | 63 | 99 | 271 | 2 | 78 | 177 | 256 | 1546 | 1546 |
| 43 | 143 | 81 | 165 | 389 | 2 | 78 | 303 | 383 | 1553 | 1553 |
| 44 | 138 | 79 | 157 | 374 | 2 | 78 | 289 | 369 | 1558 | 1558 |
| 45 | 87 | 49 | 80 | 217 | 2 | 78 | 151 | 230 | 1544 | 1544 |
| 46 | 82 | 47 | 55 | 184 | 2 | 78 | 100 | 180 | 1548 | 1548 |
| 47 | 65 | 37 | 36 | 138 | 2 | 78 | 64 | 143 | 1543 | 1543 |
| 48 | 100 | 57 | 101 | 257 | 2 | 78 | 178 | 258 | 1542 | 1542 |
| 49 | 120 | 69 | 139 | 328 | 2 | 78 | 247 | 327 | 1543 | 1543 |
| 50 | 170 | 97 | 237 | 503 | 2 | 78 | 426 | 505 | 1541 | 1541 |

### PHASE 1 - AVERAGE PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | Overflow From Phases 2 and/or 3 | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | | 1590 |
| 41 | 83 | 47 | 131 | 261 | 2 | 92 | 215 | 310 | 1541 | 1541 |
| 42 | 115 | 65 | 131 | 311 | 2 | 91 | 224 | 317 | 1535 | 1535 |
| 43 | 146 | 83 | 177 | 406 | 2 | 91 | 306 | 399 | 1542 | 1542 |
| 44 | 104 | 59 | 111 | 274 | 2 | 89 | 191 | 282 | 1534 | 1534 |
| 45 | 130 | 74 | 140 | 344 | 2 | 93 | 238 | 334 | 1544 | 1544 |
| 46 | 166 | 94 | 230 | 491 | 2 | 91 | 405 | 498 | 1537 | 1537 |
| 47 | 75 | 43 | 39 | 157 | 2 | 89 | 54 | 145 | 1549 | 1549 |
| 48 | 69 | 40 | 65 | 174 | 2 | 86 | 105 | 192 | 1530 | 1530 |
| 49 | 110 | 63 | 112 | 284 | 2 | 90 | 181 | 274 | 1541 | 1541 |
| 50 | 143 | 81 | 153 | 377 | 2 | 94 | 274 | 370 | 1548 | 1548 |

# WATER BALANCE SUMMARY
## CRYSTAL CREEK AGGREGATE QUARRY EXPANSION

### PHASE 2 - DRY PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 1101 |
| 41 | 65 | 37 | 102 | 2 | 80 | 76 | 158 | 1045 | 1045 |
| 42 | 103 | 59 | 162 | 2 | 84 | 65 | 152 | 1055 | 1055 |
| 43 | 134 | 76 | 210 | 2 | 91 | 111 | 204 | 1061 | 1061 |
| 44 | 129 | 74 | 203 | 2 | 93 | 106 | 202 | 1062 | 1062 |
| 45 | 81 | 46 | 128 | 2 | 85 | 51 | 138 | 1052 | 1052 |
| 46 | 77 | 44 | 121 | 2 | 82 | 34 | 117 | 1056 | 1056 |
| 47 | 61 | 35 | 96 | 2 | 74 | 21 | 97 | 1055 | 1055 |
| 48 | 93 | 53 | 147 | 2 | 79 | 69 | 149 | 1053 | 1053 |
| 49 | 113 | 64 | 177 | 2 | 80 | 96 | 179 | 1051 | 1051 |
| 50 | 160 | 91 | 250 | 2 | 83 | 165 | 250 | 1052 | 1052 |

### PHASE 2 - AVERAGE PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 1101 |
| 41 | 78 | 44 | 122 | 2 | 86 | 81 | 169 | 1054 | 1054 |
| 42 | 108 | 61 | 169 | 2 | 82 | 88 | 172 | 1051 | 1051 |
| 43 | 137 | 78 | 215 | 2 | 82 | 125 | 209 | 1057 | 1057 |
| 44 | 98 | 56 | 153 | 2 | 81 | 77 | 159 | 1051 | 1051 |
| 45 | 122 | 69 | 191 | 2 | 86 | 96 | 184 | 1058 | 1058 |
| 46 | 156 | 89 | 244 | 2 | 83 | 165 | 250 | 1052 | 1052 |
| 47 | 71 | 40 | 111 | 2 | 85 | 17 | 104 | 1059 | 1059 |
| 48 | 65 | 37 | 102 | 2 | 75 | 39 | 116 | 1045 | 1045 |
| 49 | 103 | 59 | 162 | 2 | 84 | 65 | 152 | 1055 | 1055 |
| 50 | 134 | 76 | 210 | 2 | 91 | 111 | 204 | 1061 | 1061 |

# WATER BALANCE SUMMARY
## CRYSTAL CREEK AGGREGATE QUARRY EXPANSION

### PHASE 3 - DRY PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow to Phase 1 Outlet | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 444 |
| 41 | 27 | 11 | 38 | 0 | 22 | 31 | 53 | 429 | 429 |
| 42 | 43 | 17 | 60 | 0 | 22 | 33 | 56 | 433 | 433 |
| 43 | 55 | 22 | 78 | 1 | 22 | 54 | 76 | 434 | 434 |
| 44 | 54 | 21 | 75 | 1 | 22 | 51 | 73 | 436 | 436 |
| 45 | 34 | 13 | 47 | 0 | 22 | 29 | 51 | 432 | 432 |
| 46 | 32 | 13 | 45 | 0 | 22 | 21 | 43 | 434 | 434 |
| 47 | 25 | 10 | 35 | 0 | 22 | 15 | 37 | 432 | 432 |
| 48 | 39 | 15 | 54 | 0 | 22 | 32 | 54 | 432 | 432 |
| 49 | 47 | 19 | 66 | 0 | 22 | 43 | 65 | 432 | 432 |
| 50 | 66 | 26 | 93 | 0 | 22 | 72 | 94 | 431 | 431 |

### PHASE 3 - AVERAGE PERIOD - YEARS 41 - 50

| Model Year | Direct Precip | Runoff | TOTAL INFLOW | Leakage | Evaporation | Overflow to Phase 1 Outlet | TOTAL OUTFLOW | BALANCE | CHECK (STORAGE FROM MODEL) |
|---|---|---|---|---|---|---|---|---|---|
| | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet | acre-feet |
| | | | | | | | | | 444 |
| 41 | 32 | 32 | 64 | 1 | 22 | 50 | 72 | 436 | 436 |
| 42 | 45 | 17 | 62 | 0 | 22 | 43 | 65 | 432 | 432 |
| 43 | 57 | 20 | 76 | 0 | 22 | 52 | 74 | 434 | 434 |
| 44 | 41 | 13 | 53 | 0 | 22 | 34 | 56 | 431 | 431 |
| 45 | 50 | 18 | 68 | 0 | 22 | 44 | 66 | 434 | 434 |
| 46 | 65 | 23 | 87 | 0 | 22 | 65 | 88 | 433 | 433 |
| 47 | 29 | 16 | 45 | 0 | 22 | 22 | 44 | 434 | 434 |
| 48 | 27 | 20 | 47 | 0 | 22 | 26 | 48 | 433 | 433 |
| 49 | 43 | 26 | 68 | 0 | 22 | 46 | 69 | 433 | 433 |
| 50 | 55 | 12 | 67 | 1 | 22 | 42 | 65 | 436 | 436 |

# APPENDIX F

## MONITORING DATA TABLES

# WATER-QUALITY TESTING RESULTS
# DISCHARGE FROM SETTLING POND #3 AND MIDDLE CREEK UPSTREAM & DOWNSTREAM

| | Flow (CFS) | | | SC (umhos/cm) | | | TDS (mg/L) | | | pH (units) | | | TSS (mg/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down |
| | | | | | | | | | | | | | | | |
| 12/30/04 | | | | | | | | | | 7.42 | 7.37 | 7.46 | 15 | <2 | 2 |
| 01/13/05 | | | | | | | | | | | | | | | |
| 05/15/06 | | | | | | | | | | 7.20 | 7.55 | 7.61 | 2 | <2 | <2 |
| 05/15/06 | | | | | | | | | | | | | | | |
| 01/04/08 | | | | 193 | | | | | | | | | | | |
| 02/23/09 | | | | | | | | | | 7.21 | 7.58 | 7.60 | 2 | <2 | <2 |
| 02/23/09 | | | | | | | | | | | | | | | |
| 03/03/10 | | | | 247 | 74 | 104 | 171 | 63 | 74 | | | | | | |
| 12/30/11 | | | | 638 | 84 | 248 | | | | | | | | | |
| 01/23/12 | | | | | | | | | | 7.77 | 7.66 | 7.65 | <2 | <2 | <2 |
| 02/29/12 | | | | | | | | 77 | 100 | | | | | | |
| 03/13/12 | | | | 579 | 119 | 146 | 398 | | | 7.96 | 7.92 | 7.76 | <2 | 4 | 66 |
| 03/23/12 | | | | | | | | | | 7.78 | 7.85 | 7.87 | <2 | <2 | <2 |
| 03/28/12 | | | | | 73 | 68 | | | | 7.77 | 7.69 | 7.76 | 5 | 8 | 5 |
| 11/30/12 | | | | | | | 261 | 63 | | | | | 10.3 | 3.2 | |
| 12/05/12 | | | | | | | | | | | | | <2 | <2 | |
| 12/14/12 | | | | | | | | | | | | | <2 | <2 | |
| 12/21/12 | | | | | | | | | | | | | 7.0 | 3.7 | |
| 12/26/12 | | | | | | | 238 | 64 | | | | | 6.8 | <2 | |
| 01/03/13 | 0.44 | 5.38 | 5.60 | | | | | | | 8.22 | 8.42 | | <2 | <2 | |
| 01/10/13 | 0.10 | 3.28 | 3.36 | | | | | | | 7.85 | 8.36 | | 2.2 | <2 | |
| 01/17/13 | 0.05 | 2.23 | 2.24 | | | | | | | 7.93 | 7.93 | | 2.8 | <2 | |
| 01/24/13 | 0.03 | 1.18 | 1.16 | | | | | | | 7.89 | 7.99 | | <2 | <2 | |
| 01/31/13 | 0.02 | 1.18 | 1.16 | | | | | | | 7.94 | 8.02 | | <2 | <2 | |
| 03/06/14 | 8.20 | 17.40 | 20.40 | | | | | | | 6.85 | 7.84 | 8.04 | <2 | 3.2 | 3.3 |
| 03/10/14 | 0.44 | 8.50 | 9.30 | | | | | | | 7.16 | 7.88 | 8.06 | <2 | <2 | <2 |
| 04/01/14 | 0.28 | 2.23 | 2.24 | | | | | | | 7.04 | 7.62 | 8.07 | <2 | <2 | <2 |

# WATER-QUALITY TESTING RESULTS
# DISCHARGE FROM SETTLING POND #3 AND MIDDLE CREEK UPSTREAM & DOWNSTREAM

| | Settleable Solids (mg/L) | | | Turbidity (NTU) | | | Hardness (mg/L) | | | Aluminum (ug/L) | | | Arsenic (ug/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down |
| | | | | | | | | | | | | | | | |
| 12/30/04 | <0.1 | <0.1 | <0.1 | 25.9 | 5.4 | 5.84 | 73 | 32 | 28 | | | | | | |
| 01/13/05 | | | | | | | 41 | 29 | 29 | | | | | | |
| 05/15/06 | <0.1 | <0.1 | <0.1 | 2.14 | 0.59 | 0.90 | 63 | 28 | 31 | | | | 0.5 | 0.3 | 0.4 |
| 05/15/06 | | | | | | | | | | | | | | | |
| 01/04/08 | | | | | | | | | | | | | | | |
| 02/23/09 | <0.1 | <0.1 | <0.1 | 13.1 | 5.37 | 7.23 | 59 | 22 | 31 | | | | | | |
| 02/23/09 | | | | | | | | | | | | | | | |
| 03/03/10 | | | | | | | | | | | | | | | |
| 12/30/11 | | | | | 9.2 | 8.5 | | | | | | | 0.2 | | |
| 01/23/12 | <0.1 | | | 3.8 | | | | | | | | | | | |
| 02/29/12 | | | | | 2.2 | 55.2 | | | | | | | 0.3 | 0.4 | |
| 03/13/12 | <0.1 | | | 0.7 | | | | | | 13.4 | 62.7 | 2020 | | | |
| 03/23/12 | <0.1 | | | 0.8 | 0.6 | 0.7 | | | | | | | | | |
| 03/28/12 | <0.1 | | | 10.7 | 9.2 | 8.6 | 208 | 28 | 25 | | | | | | |
| 11/30/12 | | | | | | | | | | | | | | | |
| 12/05/12 | | | | | | | | | | | | | | | |
| 12/14/12 | | | | | | | | | | | | | | | |
| 12/21/12 | | | | | | | | | | | | | | | |
| 12/26/12 | | | | | | | 169 | 29 | | | | | | | |
| 01/03/13 | <0.1 | | | 13.02 | 0.32 | | | | | | | | | | |
| 01/10/13 | <0.1 | | | 2.18 | 0.25 | | | | | | | | | | |
| 01/17/13 | <0.1 | | | 0.97 | 0.22 | | 250 | 34 | | | | | | | |
| 01/24/13 | <0.1 | | | 1.01 | 0.23 | | | | | | | | | | |
| 01/31/13 | <0.1 | | | 0.56 | 0.17 | | | | | | | | | | |
| 03/06/14 | <0.1 | | | 11.12 | 4.81 | 6.07 | | | | | | | | | |
| 03/10/14 | <0.1 | | | 9.18 | 0.96 | 1.23 | | | | | | | | | |
| 04/01/14 | | | | 9.47 | 1.43 | 1.77 | | | | | | | | | |

# WATER-QUALITY TESTING RESULTS
# DISCHARGE FROM SETTLING POND #3 AND MIDDLE CREEK UPSTREAM & DOWNSTREAM

| | Cadmium (ug/L) | | | Chromium (ug/L) | | | Copper (ug/L) | | | Iron (ug/L) | | | Lead (ug/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down |
| | | | | | | | | | | | | | | | |
| 12/30/04 | | | | | | | | | | | | | | | |
| 01/13/05 | | | | | | | | | | | | | | | |
| 05/15/06 | <0.05 | <0.05 | 1.45 | 1.5 | 0.9 | 1.1 | 3.9 | 1.8 | 1.8 | | | | <0.1 | 0.2 | |
| 05/15/06 | | | | | | | 2.5 | 1.4 | 1.4 | | | | | | |
| 01/04/08 | | | | | | | | | | | | | | | |
| 02/23/09 | | | | | | | | | | | | | | | |
| 02/23/09 | | | | | | | | | | | | | | | |
| 03/03/10 | | | | | | | | | | | | | | | |
| 12/30/11 | 0.05 | | | <0.1 | | | 2 | | | | | | <0.1 | | |
| 01/23/12 | | | | | | | | | | | | | | | |
| 02/29/12 | <0.05 | <0.05 | | <0.1 | <0.1 | | 1.9 | 3.4 | | | | | <0.1 | 0.2 | |
| 03/13/12 | | | | | | | | | | 160 | 148 | 2990 | | | |
| 03/23/12 | | | | | | | | | | | | | | | |
| 03/28/12 | | | | | | | | | | | | | | | |
| 11/30/12 | | | | | | | | | | | | | | | |
| 12/05/12 | | | | | | | | | | | | | | | |
| 12/14/12 | | | | | | | | | | | | | | | |
| 12/21/12 | | | | | | | | | | | | | | | |
| 12/26/12 | 0.10 | <0.05 | | | | | 5.9 | 2.2 | | | | | | | |
| 01/03/13 | | | | | | | | | | | | | | | |
| 01/10/13 | | | | | | | | | | | | | | | |
| 01/17/13 | <0.05 | <0.05 | | | | | 2.8 | 1.9 | | | | | | | |
| 01/24/13 | | | | | | | | | | | | | | | |
| 01/31/13 | | | | | | | | | | | | | | | |
| 03/06/14 | | | | | | | | | | | | | | | |
| 03/10/14 | | | | | | | | | | | | | | | |
| 04/01/14 | | | | | | | | | | | | | | | |

## WATER-QUALITY TESTING RESULTS
## DISCHARGE FROM SETTLING POND #3 AND MIDDLE CREEK UPSTREAM & DOWNSTREAM

| | Manganese (ug/L) | | | Mercury (ug/L) | | | Nickel (ug/L) | | | Silver (ug/L) | | | Zinc (ug/L) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down | Pond 3 Out | M.C. Up | M.C. Down |
| 12/30/04 | | | | | | | | | | | | | | | |
| 01/13/05 | | | | | | | | | | | | | 42 | 6 | 8 |
| 05/15/06 | | | | 2.05 | 2.61 | 2.49 | 0.8 | 0.3 | 0.3 | 0.14 | 0.38 | 0.16 | 26.7 | 3.3 | 3.8 |
| 05/15/06 | | | | | | | | | | | | | 33.9 | 10 | 8.9 |
| 01/04/08 | | | | | | | | | | | | | | | |
| 02/23/09 | | | | | | | | | | | | | 35 | 7.0 | 6.9 |
| 02/23/09 | | | | | | | | | | | | | 27.4 | 2.6 | 4.5 |
| 03/03/10 | | | | | | | | | | | | | | | |
| 12/30/11 | | | | 1.49 | | | 2.3 | | | <0.10 | | | 68.9 | | |
| 01/23/12 | | | | | | | | | | | | | | | |
| 02/29/12 | | | | 0.79 | 4.02 | | 2 | 0.4 | | <0.10 | <0.10 | | 55.3 | 3.4 | |
| 03/13/12 | 112 | 8.1 | 84.4 | | | | | | | | | | | | |
| 03/23/12 | | | | | | | | | | | | | | | |
| 03/28/12 | | | | | | | | | | | | | | | |
| 11/30/12 | | | | | | | | | | | | | | | |
| 12/05/12 | | | | | | | | | | | | | | | |
| 12/14/12 | | | | | | | | | | | | | | | |
| 12/21/12 | | | | | | | | | | | | | | | |
| 12/26/12 | | | | | | | | | | | | | 53.1 | 3.2 | |
| 01/03/13 | | | | | | | | | | | | | | | |
| 01/10/13 | | | | | | | | | | | | | | | |
| 01/17/13 | | | | | | | | | | | | | 35.3 | 3.1 | |
| 01/24/13 | | | | | | | | | | | | | | | |
| 01/31/13 | | | | | | | | | | | | | | | |
| 03/06/14 | | | | | | | | | | | | | | | |
| 03/10/14 | | | | | | | | | | | | | | | |
| 04/01/14 | | | | | | | | | | | | | | | |

# Crystal Creek Aggregate
# Monitoring

## R5-2002-0160

| Parameter | Frequency |
|---|---|
| Precipitation | Daily |
| Sedimentation Ponds | |
| Liquid depth | Weekly |
| Freeboard | |
| Discharge | |
| Settling Agent | |
| D-001 (pond effluent) | |
| Flow | Daily if precip >1", biweekly if continuous discharge |
| pH | |
| Settleable solids | |
| TSS | |
| Turbidity | |
| Zinc (total & dissolved) | Monthly |
| Hardness | |
| Priority poll. metals | 2x year |
| Acute toxicity | Annually |
| R-1, R-2 (Middle Creek) | |
| pH | Daily if precip >1", biweekly if continuous Q |
| TSS | |
| Turbidity | |
| Hardness | Monthly |
| Zinc (total & dissolved) | |
| Priority poll. metals | 2x year |

**Table E-1. Monitoring Station Locations**

| Discharge Point Name | Monitoring Location Name | Monitoring Location Description (include Latitude and Longitude when available) |
|---|---|---|
| SW-001 | EFF-001 | Outfall from Pond #3<br>Latitude 40° 36' 17" N, Longitude 122° 27' 47" W. |
| SW-002 | EFF-002 | Stormwater discharge to Rock Creek |
| | RSW-001 | Middle Creek, approximately 50 feet above the confluence of unnamed tributary and Middle Creek. |
| | RSW-002 | Middle Creek, approximately 100 feet downstream of confluence of unnamed tributary and Middle Creek. |
| Settling Basin #1 | PND-001 | Settling Pond #1 south of recycle ponds and north of by-pass culvert. |
| Settling Basin #2 | PND-002 | Settling Pond #2 south of recycle ponds and south of by-pass culvert. |
| Settling Basin #3 | PND-003 | Settling Pond #3 south of Settling Pond #3. |
| North Recycle Pond | PND-004 | East of processing plant |
| South Recycle Pond | PND-005 | East of processing plant and south of the North Recycle Pond |
| Water Rights Pond | PND-006 | East side of quarry, between north and south haul roads |

**Table E-2. Effluent Monitoring Location EFF-001**

| Parameter | Units | Sample Type | Minimum Sampling Frequency | Required Analytical Test Method and (Minimum Level, units), respectively |
|---|---|---|---|---|
| Estimated Flow | gal/min | Visual | Weekly during discharge[1, 7, 8] | |
| Turbidity | NTU | Grab | Weekly during discharge[1, 7, 8] | |
| pH | units | Grab | Weekly during discharge[1, 7, 8] | |
| Settleable Solids | mL/L | Grab | Weekly during discharge[1, 7, 8] | |
| Total Suspended Solids | mg/L | Grab | Weekly during discharge[1, 8] | |
| Cadmium, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Copper, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Zinc, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Hardness | mg/L | Grab | Monthly during discharge[1, 6, 8] | |
| Alkalinity | mg/L | Grab | Monthly during discharge[1, 6, 8] | |
| Electrical Conductivity @ 25°C | umhos/cm | Grab | Annually | |
| Aluminum | ug/L | Grab | Annually | |
| Iron | ug/L | Grab | Annually | |
| Manganese | ug/L | Grab | Annually | |
| Total Dissolved Solids | mg/L | Grab | Annually | |
| Oil & Grease | mg/L | Grab | Annually | |
| Acute Toxicity | % Survival | Grab | Annually | |
| Priority Pollutant Metals [2, 3] | ug/L | Grab | Annually | |
| Chronic Toxicity | % Survival | Grab | Bi-annually | |
| Priority Pollutants [2,4,5] | ug/L | Grab | Bi-annually | |

(1) Initial samples shall be collected during daylight hours during the first discharge after the dry season.
(2) Detection limits shall be at or below the lowest minimum level (ML) published in Appendix 4 of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Plan or SIP).
(3) Antimony, arsenic, beryllium, cadmium, chromium III, chromium IV, copper, lead, mercury (EPA Method 1669/1631), nickel, selenium, silver, thallium, zinc, and cyanide.
(4) Priority Pollutants – one set during 1st 2-years of the permit, and one set during the 2nd 2-years of the permit.
(5) 126 Priority Pollutants except asbestos, and dioxins/furans.
(6) Samples shall be collected during the first rainfall event that produces ½-inch or greater precipitation per day (if one occurs during the month).
(7) Daily when rainfall events produce a ½-inch or greater precipitation per day, up to a total of four samples per calendar week.
(8) Sampling (routine sampling) other than when a ½-inch or greater precipitation per day occurs is only required during 15 October through 15 May.

**Table E-4. Receiving Water Monitoring Requirements (RSW-001 and RSW-002)**

| Parameter | Units | Sample Type | Minimum Sampling Frequency | Required Analytical Test Method and (Minimum Level, units), respectively |
|---|---|---|---|---|
| Estimated Flow | gal/min | Visual | Weekly during discharge[1, 7, 8] | |
| Turbidity | NTU | Grab | Weekly during discharge[1, 7, 8] | |
| pH | units | Grab | Weekly during discharge[1, 7, 8] | |
| Total Suspended Solids | mg/L | Grab | Weekly during discharge[1, 8] | |
| Cadmium, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Copper, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Zinc, dissolved | ug/L | Grab | Monthly during discharge[1, 6, 8] | |
| Hardness | mg/L | Grab | Monthly during discharge[1, 6, 8] | |
| Electrical Conductivity @ 25°C | umhos/cm | Grab | Annually | |
| Aluminum | ug/L | Grab | Annually | |
| Iron | ug/L | Grab | Annually | |
| Manganese | ug/L | Grab | Annually | |
| Total Dissolved Solids | mg/L | Grab | Annually | |
| Priority Pollutant Metals [2, 3] | ug/L | Grab | Annually | |
| Priority Pollutants [2,4,5] | ug/L | Grab | Bi-annually | |

(1) Initial samples shall be collected during daylight hours during the first discharge after the dry season.
(2) Detection limits shall be at or below the lowest minimum level (ML) published in Appendix 4 of the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (State Implementation Plan or SIP).
(3) Antimony, arsenic, beryllium, cadmium, chromium III, chromium IV, copper, lead, mercury (EPA Method 1669/1631), nickel, selenium, silver, thallium, zinc, and cyanide.
(4) Priority Pollutants – one set during 1st 2-years of the permit, and one set during the 2nd 2-years of the permit.
(5) 126 Priority Pollutants except asbestos, and dioxins/furans.
(6) Samples shall be collected during the first rainfall event that produces ½-inch or greater precipitation per day (if one occurs during the month).
(7) Daily when rainfall events produce a ½-inch or greater precipitation per day, up to a total of four samples per calendar week.
(8) Sampling (routine sampling) other than when a ½-inch or greater precipitation per day occurs is only required during 15 October through 15 May.

### A. Recycle and Settling Ponds

The Discharger shall monitor the recycle ponds (PND-004 and PND-005) and sedimentation ponds (PND-001 through PND-003) as follows:

**Table E-5. Recycle and Sedimentations Ponds**

| Constituent | Units | Sample Type | Minimum Sampling Frequency | Reporting Frequency |
|---|---|---|---|---|
| Freeboard | Feet, inches | Visual | Weekly | Monthly |
| Liquid depth | Feet, inches | Visual | Weeklt | Monthly |
| Discharge | Yes/No | Visual | Weekly | Monthly |
| Settling Agent Used | Yes/No | Document | Weekly | Monthly |

### B. Precipitation Monitoring

The daily precipitation at the Crystal Creek Aggregate, Inc. facility shall be recorded on weekdays and weekends. The reading shall be taken at the same time each day and submitted as follows:

| Constituent | Units | Type of Sample | Sampling Frequency | Reporting Frequency |
|---|---|---|---|---|
| Precipitation | Inches (+/-0.1) | Visual | Daily | Monthly |

117 Meyers Street, Suite 120, Chico CA 95928

# BIOLOGICAL RESOURCES ASSESSMENT

Terrestrial and Aquatic Wildlife and Botanical Resources

## Crystal Creek Aggregate Mine

Shasta County, California

**October 2022**

Prepared for:
**Crystal Creek Aggregates**
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# BIOLOGICAL RESOURCES ASSESSMENT

## Crystal Creek Aggregate Mine

**Project Location:**
Shasta County, California
Sections 29 & 30, Township 32N, Range 05W

## INTRODUCTION

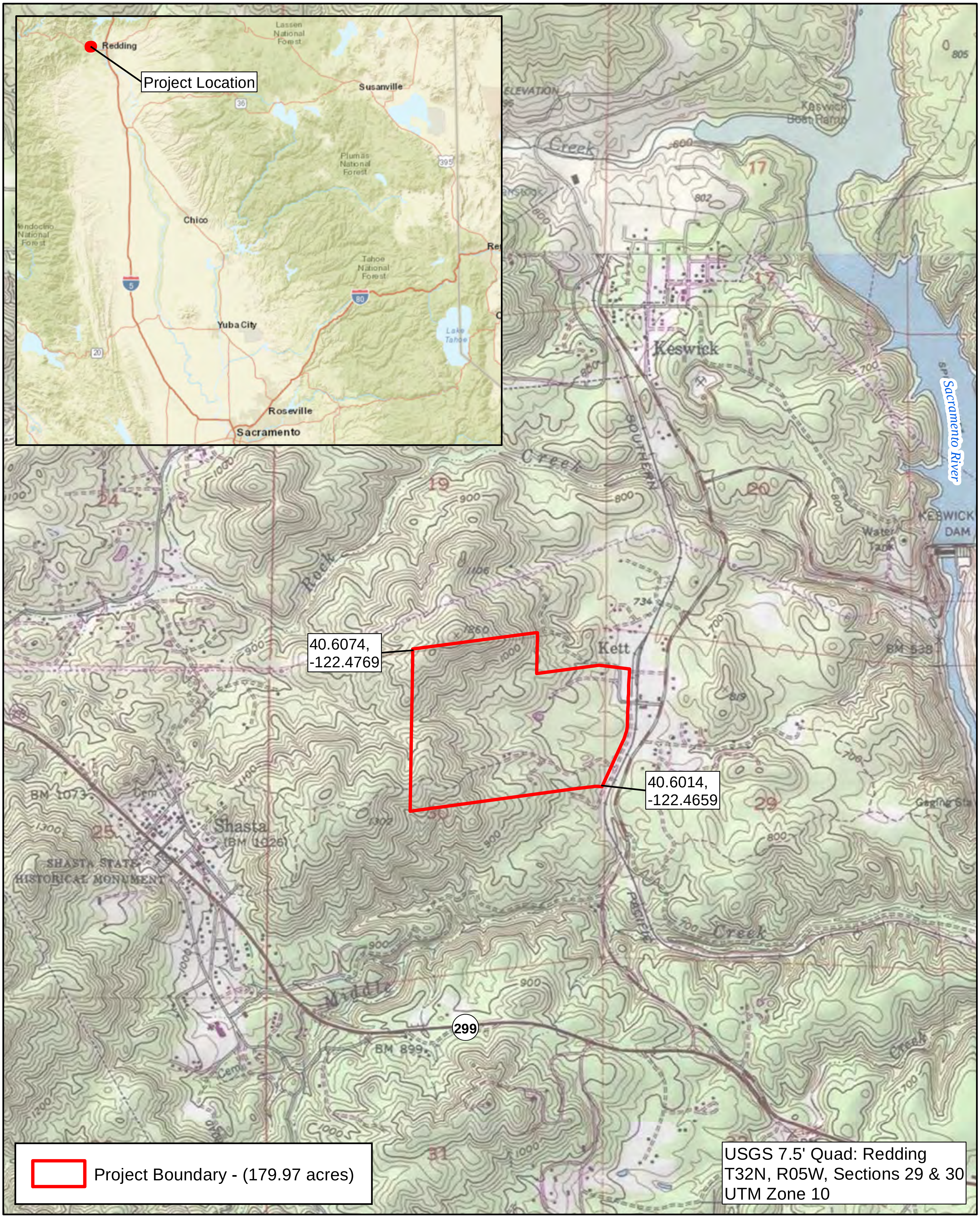
### Purpose and Overview

The purpose of this biological resources assessment (BRA) is to document the endangered, threatened, sensitive, and rare species and their habitats that occur or may occur in the approximately 179.97-acre biological survey area (BSA) of the Crystal Creek Aggregate Mine Use Permit Amendment project (Project), located west of Redding in unincorporated Shasta County, California (**Figure 1**). The BSA includes the active mine including the aggregate plant (Mine), approximately 110 acres, and adjacent Mineral Resource Area (MRA), approximately 70 acres (**Figure 2**). This BRA also describes potential Project-related impacts to sensitive biological resources, including wetlands and waters. The Mine is located off of Iron Mountain Road, just east of Whiskeytown Lake.

The BSA is the area where biological surveys are conducted (**Figure 2**). Gallaway Enterprises conducted biological and botanical habitat assessments in the BSA to evaluate site conditions and potential for biological and botanical species to occur. Other primary references consulted include species lists and information gathered from the United States Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC), National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW) California Natural Diversity Database (CNDDB), the California Native Plant Society (CNPS) inventory of rare and endangered plants, and literature review. The results of the BRA are the findings of habitat assessments and surveys and recommendations for avoidance and minimization that have incorporated the measures found within the existing Reclamation Plan Amendment and Use Permit.

### Project Location and Environmental Setting

The BSA is located within the United States Geological Survey (USGS) Redding quadrangle, Assessor Parcel Numbers (APNs) 065-250-002, 065-250-024, 065-250-025, and 065-260-010, within Sections 29 and 30 of Township 32N, Range 05W (latitude 40.603699, longitude -122.468794), and is positioned within the foothills at the transition between the northern Sacramento Valley and the Klamath Mountains in unincorporated Shasta County. The BSA is located approximately 2 miles west of the City of Redding. The site can be reached via State Route 299 West to Iron Mountain Road, then following Iron Mountain Road




NORTH

1:24,000

0 0.25 0.5 Miles

Data Sources: ESRI, Shasta County, USGS, DKM Engineering

Crystal Creek Aggregate Mine
Regional Location
Figure 1

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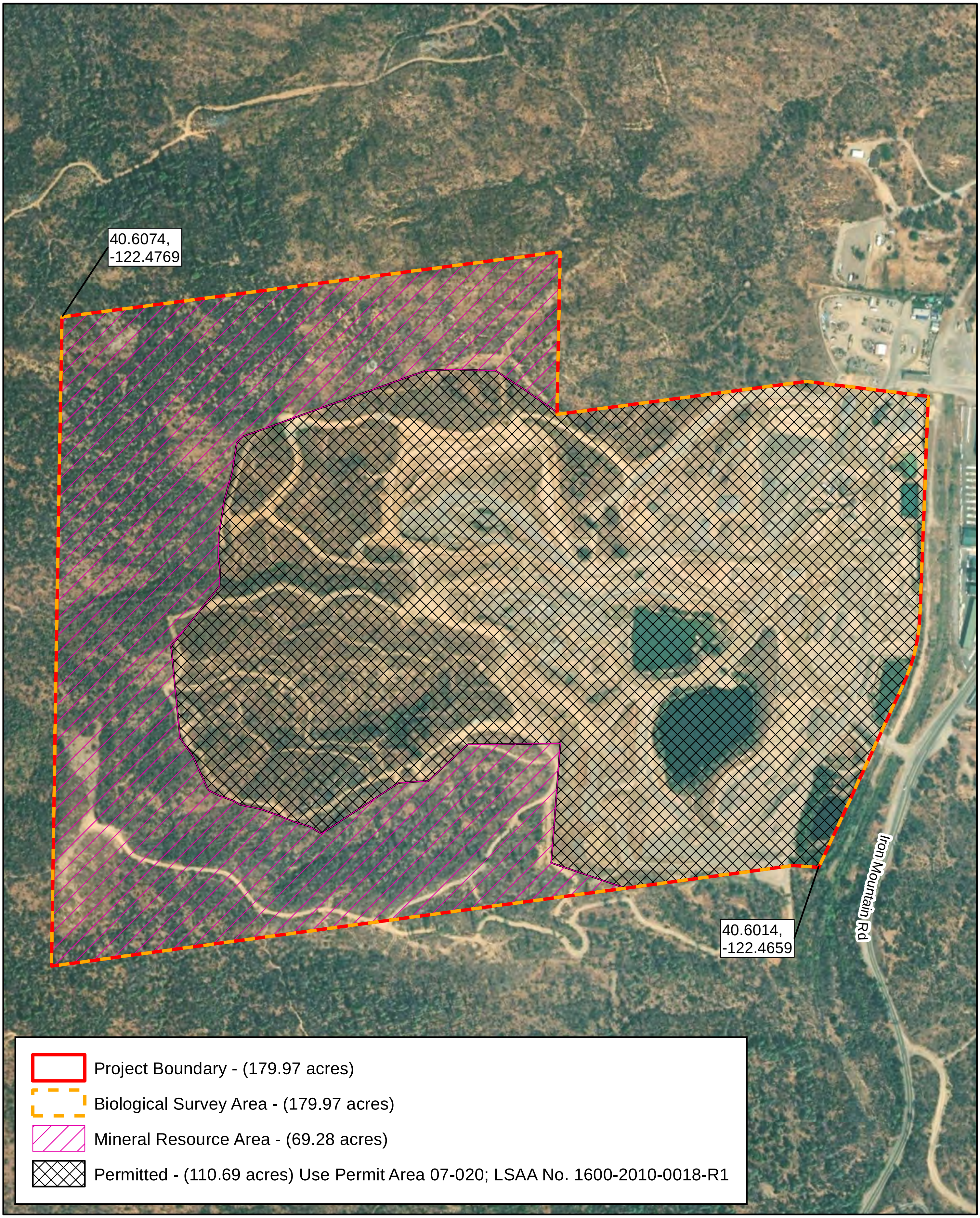
GE: #22-050 Map Date: 05/13/2022




NORTH

1:6,000

0 200 400 Feet

Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Biological Survey Area
Figure 2

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GE: #22-050 Map Date: 08/18/2022

approximately 1 mile north to the property entrance on the west side of the road. To the west of the BSA is the Whiskeytown National Recreation Area and to the east is the City of Redding, California. The BSA is located within the burn scar of the Carr Fire and is composed of the barren, active aggregate mine and surrounding natural land. The surrounding natural land is composed of hilly to very steep mixed chaparral and montane hardwood-conifer habitat that is still currently in a state of regeneration after the fire. Incidental to the existing and historic mining operation on the site was the construction of multiple excavated ponds and pits. Further, numerous drainages occur on the site, the majority of which are ephemeral drainages that form along the steep hillsides. A steep ridgeline occurs along the western and northern boundary; as such, all but a few ephemeral drainages located in the southwestern corner of the site boundary flow to the east and into the controlled mining ponds.

The average annual precipitation is 63.24 inches, and the average annual temperature is 60.75° F in the region where the BSA is located (WRCC 2022). The elevation of the BSA ranges from 740 to 1190 feet above sea level. The site contains slopes ranging from 0 to 50 percent. Soils within the BSA are rocky and sandy loams with a restrictive bedrock layer ranging from 0 to 54 inches deep.

## Project Description

The Crystal Creek Aggregates (CCA) mining operation is an existing aggregate quarry in Shasta County, California, initially established in 1990. The Mine was established and operated by Jerry Comingdeer, owner of Crystal Creek Aggregate, Inc. In October 2021, he sold the 179.97 acres of land and associated Mine to Tullis, Inc. (Tullis), who renamed the operation to Crystal Creek Aggregates. Existing land uses within the Mine include an aggregate processing facility, along with numerous material stockpiles located on the eastern side of the Mine. Ancillary activities to these uses include, but are not limited to, an office, scales, equipment storage area, recycle ponds, and settling ponds. Currently, in the southern portion of this area there is a recycle site for the storing and processing of used concrete and rubble from the Carr Fire. This is a temporary use, whereby the concrete and rubble are crushed into a road base product. This activity will cease when all the used concrete and rubble is processed.

The current mining activities within the Mine area are permitted under Shasta County Use Permit Amendment 07-020 and Reclamation Plan Amendment 07-002. An amendment to these existing documents is currently proposed. The goal of the proposed Use Permit and Reclamation Plan Amendments is to increase the life of the Mine and to be an all-round aggregate extraction and materials processing operation. The Mine must be diverse enough to meet the needs of most construction projects requiring aggregate products. The Reclamation Plan Amendment does not propose any changes to the limits of the currently approved Mine area. The Use Permit Amendment expands the existing approved Use Permit area from 110.69 acres by 69.28 acres for a total of 179.97 acres; however, the additional 69.28 acres is proposed as a Mineral Resource Area (MRA). Proposed uses within the MRA include, but are not limited to, providing limited existing access to and from the mining area, particularly for vegetation clearance and fire protection services; providing a shaded fuel break; and partially serving to buffer lands to the south, west, and north from noise, light, and other mining-related activities.

The Mine operator has found that he cannot provide significant amounts of aggregate for large construction projects since the current Use Permit limits the annual tonnage of processed aggregate to 250,000 tons (125,000 cubic yards). The operator must have the ability to satisfy both existing clients and also large projects that require tens of thousands of tons of aggregate material, which is not feasible under current permit conditions.

The need for future increased mine production decreases the life of the Mine under current permit conditions. The Mine owner needs a sufficient quantity of available material to meet demand without having to periodically apply to the County for additional use permit and reclamation plan amendments to meet anticipated demand. This location is an identified and proven source of concrete grade aggregate close to main population centers and highways in Shasta County. The Mine is a valuable resource to the community at a countywide level. Permitting a longer mining life that increases the volume of material assures that this resource is available to meet future County construction needs.

The total area of the property on which the Mine is located is 179.97 acres which is the BSA for the project. The acreage of the Mine currently approved under the Use Permit and Reclamation Plan is 110.69 acres, which includes a 53.38-acre plant area and a 57.31-acre active mining area. These acreages will remain unchanged in the amended Reclamation Plan. The maximum anticipated depth of mining at the lowest point in the finished quarry will be 640 feet mean sea level (MSL) at the bottom of the proposed pond. The maximum yearly extraction is expected to be 500,000 cubic yards of aggregate.

As previously noted, the mining operation began in 1990. The ending date for the proposed Use Permit and Reclamation Plan Amendments is estimated to be December 31, 2101. The actual termination date of the mining operation is when the 12,680,000 cubic yards of material are extracted. Proposed land uses after reclamation are "Industrial" and "Mineral Resource."

**Summary of Major Changes to Existing Approved Reclamation Plan**

The following is a list of the major changes to the existing Reclamation Plan.

1. The volume of aggregate to be extracted is increasing from 7,960,000 cubic yards to 12,680,000 cubic yards, an increase of 4,720,000 cubic yards.
2. Pond #6 as depicted in the proposed Use Permit and Reclamation Plan Amendment in the quarry is increasing in surface area from 23.49 surface acres to 32.67 surface acres, an increase of 9.18 acres.
3. The depth of the active mining area is increased by 60 feet from a bottom elevation of 700 feet to 640 feet in Pond #6.
4. The typical quarry benches are increasing from 24 feet high and 30 feet wide to 40 feet high and 40 feet wide. However, around the pond perimeter the maximum quarry bench size will be 44 feet high and 60 feet wide. The quarry face between benches is going from 1-$^1$A:1 to 1:1.

5. The Revegetation Plan is revised to make the Mine more resistant to wildland fires. The Mine was in one of the main paths of the Carr Fire, which burned 229,651 acres in Shasta and Trinity Counties.
6. Increase in permitted blasting days from 12 to 24 per year.

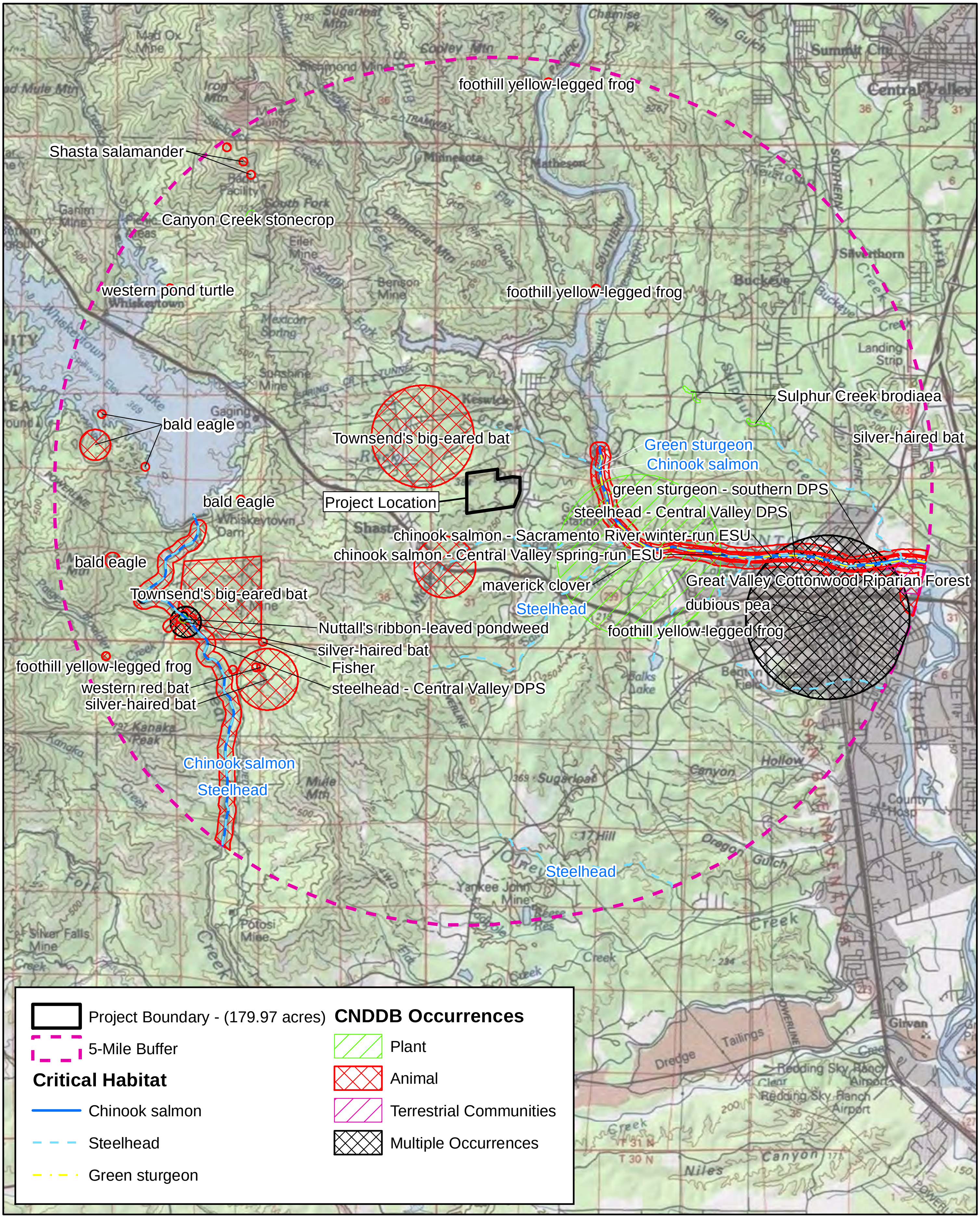
The Use Permit Amendment prepared for CCA includes a Comprehensive Project Plan Overview, the existing and proposed Use Permit Plans, and Use Permit Details such as the existing office, scales, and the crushing, screening and wash plant. The Reclamation Plan Amendment includes the existing and proposed Mining Plan, Phasing Plan, Mining area cross-sections, and proposed Reclamation Plan. A detailed, phased re-vegetation plan with associated success criteria are also included in the Mining and Reclamation Plan Amendment.

# METHODS

## References Consulted

Gallaway Enterprises obtained lists of special-status species that occur in the vicinity of the BSA. The CNDDB Geographic Information System (GIS) database was also consulted and showed special-status species within a 5-mile radius of the BSA (**Figure 3**). Other primary sources of information regarding the occurrence of state or federally listed threatened, endangered, proposed, and candidate species and their habitats within the BSA used in the preparation of this BRA are:

- The USFWS IPaC Official Species List for the Project area, July 8, 2020, Consultation Code 08ESMF00-2020-SLI-2334 and updated on May 13, 2022, Project Code: 2022-0042796 (**Appendix A: Official Species Lists**);
- The results of a species record search of the CDFW CNDDB, RareFind 5, for the 7.5-minute USGS Whiskeytown (4012265), Shasta Dam (4012264), Project City (4012263), Igo (4012255), Redding (4012254), and Enterprise (4012253) quadrangles (**Appendix A: Official Species Lists**);
- The CNPS Inventory of Rare and Endangered Vascular Plants of California for the 7.5-minute USGS Whiskeytown (4012265), Shasta Dam (4012264), Project City (4012263), Igo (4012255), Redding (4012254), and Enterprise (4012253) quadrangles (**Appendix A: Official Species Lists**);
- USFWS Critical Habitat Portal, June 1, 2020 and May 13, 2022;
- Results from North State Resources 2006 botanical surveys and 2007 wildlife assessments for the Mine site;
- Results from multiple field surveys conducted by Wildland Resource Managers (WRM) within the Mine site between April and June 2019;
- Results from the protocol-level surveys and habitat assessment conducted by Gallaway Enterprises on May 21 and 27 and June 2 and 4, 2020 and April 28, 2022 (**Appendix B: Observed Species Lists**); and
- Results from the Delineation of Aquatic Resources conducted by Gallaway Enterprises on May 21 and 27 and June 2 and 4, 2020 and April 28, 2022.




NORTH

1:96,000

0 0.5 1 Miles

Data Sources: ESRI, Shasta County, USGS, CNDDB, USFWS, NMFS

Crystal Creek Aggregate Mine
CNDDB Occurrences and Critical Habitat
Figure 3

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## Special-Status Species

Special-status species that are considered in this BRA are those that fall into one of the following categories:

- Listed as threatened or endangered, or are proposed or candidates for listing under the California Endangered Species Act (CESA, 14 California Code of Regulations 670.5) or the Federal Endangered Species Act (ESA, 50 Code of Federal Regulations 17.12);
- Listed as a Species of Special Concern (SSC) by CDFW or protected under the California Fish and Game Code (CFGC) (i.e., Fully Protected Species);
- Ranked by the CNPS as 1A, 1B, or 2;
- Protected under the Migratory Bird Treaty Act (MBTA);
- Protected under the Bald and Golden Eagle Protection Act; or
- Species that are otherwise protected under policies or ordinances at the local or regional level as required by the California Environmental Quality Act (CEQA, §15380).

## Critical Habitat

The ESA requires that critical habitat be designated for all species listed under the ESA. Critical habitat is designated for areas that provide essential habitat elements that enable a species' survival, and which are occupied by the species during the species' listing under the ESA. For the purposes of designating critical habitat only, habitat is the abiotic and biotic setting that currently or periodically contains the resources and conditions necessary to support one or more life processes of a species.

The USFWS Critical Habitat Portal was accessed on June 1, 2020 and May 13, 2022 to determine if critical habitat occurs within the BSA. Appropriate Federal Registers were also used to confirm the presence or absence of critical habitat.

## Sensitive Natural Communities

Sensitive Natural Communities (SNCs) are monitored by CDFW with the goal of preserving these areas of habitat that are rare or ecologically important. Many SNCs are designated as such because they represent a historical landscape and are typically preserved as valued components of California's diverse habitat assemblage.

## Waters of the United States

A delineation of waters of the United States was conducted within the BSA on May 27 and June 2 and 4, 2020 and April 28, 2022. The delineation is pending a jurisdictional determination from the US Army Corps of Engineers (Corps).

## Habitat Assessments

Habitat assessments were conducted by Gallaway Enterprises staff on May 21 and 27 and June 2 and 4, 2020 and April 28, 2022. A wildlife habitat assessment was conducted by Senior Biologist Dan Machek on June 4, 2020. Senior Botanist Elena Gregg conducted a botanical habitat assessment and protocol-level rare plant surveys within the BSA on May 21 and 27 and June 2 and 4, 2020 and was assisted by Botanist

Constantin Raether. An additional site visit was conducted on April 28, 2022 by Elena Gregg, and assisted by Botanist Chris Belko, to reassess habitat conditions.

Habitat assessments for botanical and wildlife species were conducted to determine the suitable habitat elements for special-status species within the BSA. The habitat assessment was conducted by walking the entire BSA, where accessible, and recording specific habitat types and elements (**Figure 4**). If habitat was observed for special-status species it was then evaluated for quality based on vegetation composition and structure, physical features (e.g., soils, elevation), micro-climate, surrounding area, presence of predatory species and available resources (e.g., prey items, nesting substrates), and land use patterns. A list of wildlife species observed within the BSA is included in **Appendix B**.

### Rare Plant Survey

Protocol-level rare plant surveys and habitat evaluations for rare plants were conducted on May 21 and 27 and June 2 and 4, 202 and April 28, 2022. The surveys and evaluations were conducted by walking meandering transects though the entire BSA and taking inventory of observed botanical species. The protocol-level surveys were conducted for species with blooming periods that overlapped the survey dates. Complete lists of the plant species observed within the BSA is included in **Appendix B**.

## RESULTS

### Habitats

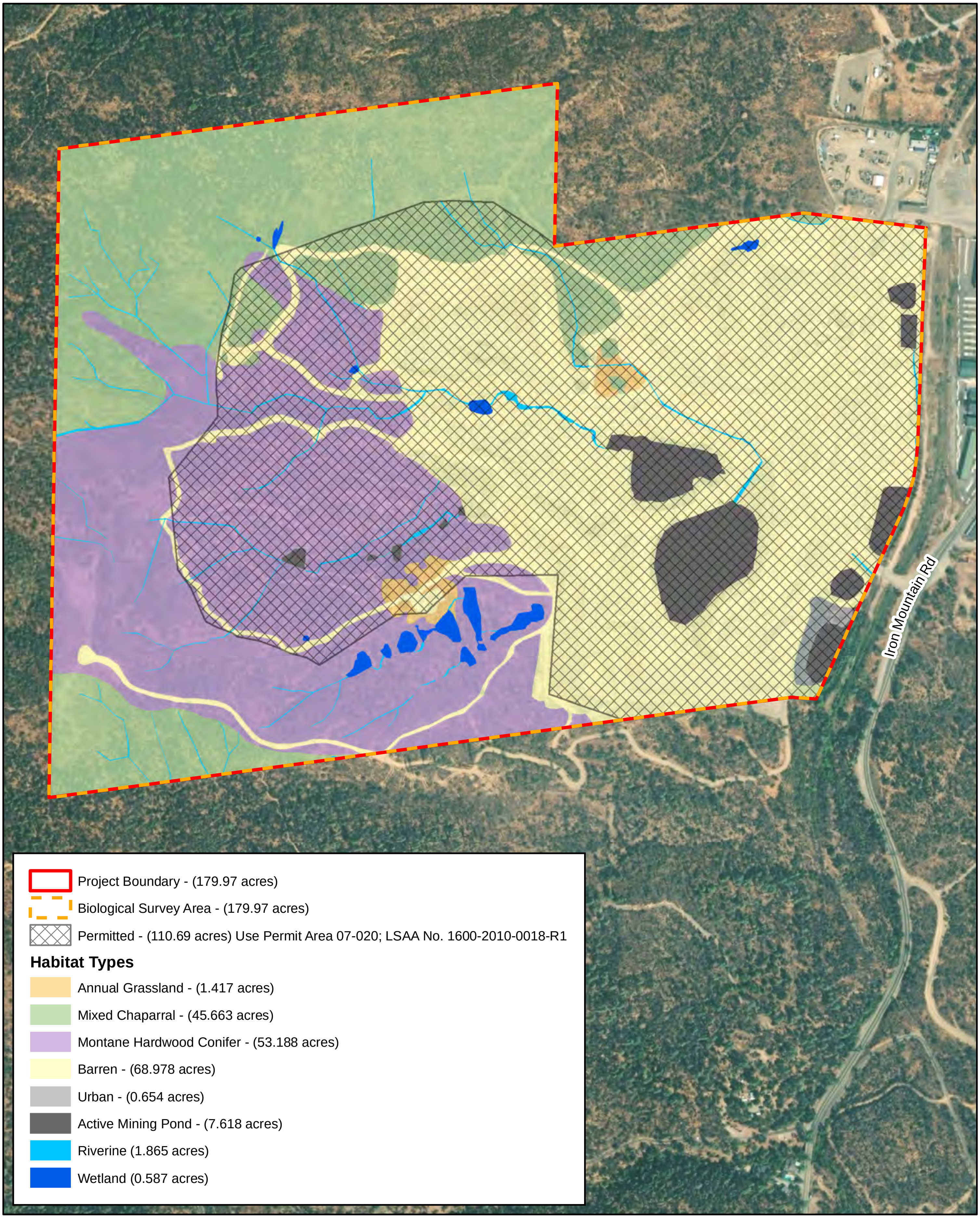
A map depicting the different habitat types present as of the date of this report within the BSA is provided as **Figure 4**. These habitat types are described further below. The habitats depicted within the existing Use Permit area of the Mine are actively being altered pursuant to the Use Permit. The proposed Amendments to the Use Permit and Reclamation Plan will not alter or expand the existing limits of impact.

#### Montane Hardwood-Conifer

The MRA and areas currently outside of the active mining area are co-dominated by montane hardwood-conifer woodland. This habitat type is typically diverse in structure, with a mix of hardwoods, conifers, and shrubs. Historically the tree canopy varied from moderately dense to sparse but following the Carr Fire, the tree canopy has been decimated and is now fairly sparse with many standing dead trees. The tree layer present is composed of black oaks (*Quercus kelloggii*), knobcone pine (*Pinus attenuata*) and ponderosa pine (*Pinus ponderosa*). The shrub component is composed of toyon (*Heteromeles arbutifolia*), whiteleaf manazanita (*Arctostaphylos vicida*), coffeeberry (*Frangula californica*) and snowdrop bush (*Styrax redivivus*).

#### Mixed Chaparral

The MRA and areas currently outside of the active mining area are co-dominated by mixed chaparral habitat. Prior to the Carr Fire, it was evident that the mixed chaparral habitat present was dominated by a dense shrub layer of whiteleaf manzanita; however, post-fire, the dominate shrub observed was toyon. Whiteleaf manazanita, coffeeberry and snowdrop bush were also present with an understory layer comprised of lemmon's ceanothus (*Ceanothus lemmonii*), poison oak (*Toxicodendron diversilobum*), silver




NORTH

1:6,000

0 250 500 Feet

Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Habitat Types
Figure 4

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hairgrass (*Aira caryophyllea*), goldwire (*Hypericum concinnum*), medusahead (*Elymus caput-medusae*), tall willowherb (*Epilobium brachycarpum*), Spanish lotus (*Acmispon americanus*), wild oats (*Avena barbata*), six-weeks fescue (*Festuca myuros*), winter vetch (*Vicia villosa*) and prickly lettuce (*Lactuca serriola*). Mixed chaparral habitat provides escapement and nesting areas, and food, shelter, and water for a variety of species of resident and migrating wildlife species.

**Annual Grassland**

Annual grassland habitat occurs in only a few small areas within the BSA where a historic residence was once located and where the area was disturbed from historic mining activities. Annual grassland habitats and species composition depend largely on annual precipitation, fire regimes, and grazing practices (Mayer and Laudenslayer 1988). Species observed in the annual grasslands in the BSA include rip-gut brome (*Bromus diandrus*), wild oat, silver hairgrass, soft chess (*Bromus hordeaceus*), Spanish lotus, six-weeks fescue, winter vetch, prickly lettuce and medusahead. Most wildlife species use grassland habitat for foraging, but generally require some other habitat characteristic such as rocky out crops, cliffs, caves, or ponds in order to find shelter and cover for escapement. Some rodents, such as ground squirrels (*Otospermophilus beecheyi*), utilize annual grasslands for burrowing.

**Riverine**

Riverine habitat is characterized by intermittent or continually running water. There are many ephemeral drainages within the BSA as well as three intermittent drainages. The ephemeral drainages only function to convey precipitation during the wet season. The three intermittent drainages are seep fed and convey water during winter and into the early summer months. Later in the year, flows subside and only portions of these drainages contain low amounts of water while other sections dry completely. All of the drainages converge from the north and south into a central channel which flows east into Pond #4. Its substrate is composed of stone and cobble, and abundant vegetation, including patches of riparian vegetation, was present within the streambed of only the intermittent drainages. Riverine habitat provides food for waterfowl, herons (*Ardeidae* sp.), and many species of insectivorous birds, hawks, and their prey.

**Lacustrine – Wetlands and Active Mining Ponds**

Lacustrine habitats are inland depressions or dammed riverine channels containing standing water (Cowardin 1979 cited in Mayer and Laudenslayer 1988). Within the BSA lacustrine habitat includes natural wetlands, historic mining ponds and active mining ponds. The natural wetlands observed included seeps and seasonal wetlands. The historic mining ponds are small ponds that were constructed as part of the historic mining operations that took place on the site in the 1960s and have since been undisturbed and function currently as naturalized wetlands. All of the active mining ponds are man-made incidental to the ongoing mining operations and either have controlled outfalls or have no direct or natural connection to a tributary and are completely isolated. Some of the ponds are perennial while some dry during the summer months. There is 1.58 acres of wetlands, including the historic mining ponds, within the BSA and 6.95 acres of active mining ponds. The typical dominant vegetation found within the various wetlands present within the Mine included a variety of rushes (*Juncus* sp.), Mediterranean barley (*Hordeum marinum* ssp. *gussoneanum*), perennial ryegrass (*Festuca perennis*), hawkbit (*Leontodon saxatilis*), seep monkeyflower (*Erythranthe guttata*), sweet vernal grass (*Anthoxanthum odoratum*), Fremont cottonwood (*Populus fremontii*) saplings and various willow species (*Salix* sp.). Lacustrine habitat provides breeding and foraging habitat for a number of amphibians, reptiles, and birds.

**Barren**

Barren habitat is typified by non-vegetated soil, rock, and gravel. The entire active mine area as well as the various dirt access roads within the BSA are barren. The barren habitat type typically provides low quality habitat to wildlife. Some ground-nesting birds, such as killdeer (*Charadrius vociferus*), will nest in gravelly, barren substrate.

## Critical Habitat

There is no designated critical habitat within the BSA. Although the one controlled outfall present within the BSA is hydrologically connected to an unnamed tributary of Middle Creek, which is designated as critical habitat for steelhead, none of the drainages within the BSA can support anadromous fishes and there are barriers present which prevent occurrences, even during high flow events.

## Sensitive Natural Communities

No CDFW-designated SNCs occur within the BSA.

## Wildlife Migration Corridors

Although CDFW has several riparian corridors mapped adjacent to the BSA; there are no CDFW designated corridors that overlap the BSA (**Appendix D: CDFW Designated Wildlife Corridors**). California Department of Fish and Wildlife-mapped riparian corridors are named water features from the National Hydrography Dataset (NHD) that connect landscape blocks for the northern Sierra Nevada foothills wildlife connectivity project. The existing reclamation area is actively being mined and thus has continuously and regularly been disturbed. The additional mining activities proposed in Use Permit and Reclamation Plan Amendments will not expand the existing Mine boundary; therefore, there will be no impacts to adjacent wildlife corridors. Proposed activities in the currently-undisturbed MRA will be limited to access and fuel reduction, with no lasting impacts anticipated.

## Impacts to Off-site Habitat

The proposed project is not anticipated to impact off-site habitats or species. Measures for the spread of bullfrogs from the site are included in the recommendations section. Downstream impacts from water quality will be mitigated for through the implementation of the site-specific Storm Water pollution Prevention Plan (SWPPP) and General Industrial Stormwater Permit.

## Special-Status Species

A summary of special-status species assessed for potential occurrence within the BSA based on the USFWS IPaC Species List, NOAA-NMFS species list, CNDDB species list, and the CNPS inventory of rare and endangered plants within the Whiskeytown (4012265), Shasta Dam (4012264), Project City (4012263), Igo (4012255), Redding (4012254), and Enterprise (4012253) USGS 7.5-minute quadrangles, and their potential to occur within the BSA are described in **Table 1**. Potential for occurrence was determined by reviewing database queries from federal and state agencies and performing field surveys to evaluate habitat characteristics.

**Table 1. Special-status species and Sensitive Natural Communities and their potential to occur in the BSA of the Crystal Creek Aggregate Mine, Shasta County, CA**

| **Common Name** *(Scientific Name)* | **Status** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **SENSITIVE NATURAL COMMUNITIES** | | | |
| **Great Valley Cottonwood Riparian Forest** | _/SNC/_ | Riparian forest. | None. There is no designated Great Valley Cottonwood Riparian Forest within the BSA. |
| **Great Valley Valley Oak Riparian Forest** | _/SNC/_ | Riparian forest. | None. There is no designated Great Valley Oak Riparian Forest within the BSA. |
| **Great Valley Willow Scrub** | _/SNC/_ | Riparian scrub. | None. There is no designated Great Valley Willow Scrub within the BSA. |
| **PLANTS** | | | |
| **Canyon Creek stonecrop** (*Sedum obtusatum* ssp. *paradisum*) | _/_/1B.3 | Rock faces and in crevices of exposed granite. (Blooming Period [BP]: May – Jun) | None. No suitable rock habitat present and not observed during protocol-level surveys. |
| **Dubious pea** (*Lathyrus sulphureus* var. *argillaceus*) | _/_/3 | Cismontane woodland. (BP: Apr – May) | None. Not observed during protocol-level surveys. |
| **Henderson's bent grass** (*Agrostis hendersonii*) | _/_/3.2 | Moist places in grassland or vernal pool habitat. (BP: Apr – Jun) | None. Not observed during protocol-level surveys. |
| **Legenere** (*Legenere limosa*) | _/_/1B.1 | Vernal pools. (BP: Apr – Jun) | None. There is no vernal pool habitat present and not observed during protocol-level surveys. |
| **Maverick clover** (*Trifolium piorkowskii*) | _/_/1B.2 | Shallow vernal depressions on volcanic flats or the open banks of intermittent or perennial streams in the foothills of Shasta County. (BP: Apr – May) | None. Not observed during protocol-level surveys. |
| **Nuttall's ribbon-leaved pondweed** (*Potamogeton epihydrus*) | _/_/2B.2 | Assorted shallow freshwater marshes and swamps. (BP: [Jun]Jul – Sep) | None. Not observed during protocol-level surveys. |

| **Common Name** *(Scientific Name)* | **Status** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **PLANTS** | | | |
| **Red Bluff dwarf rush** (*Juncus leiospermus* var. *leiospermus*) | _/_/1B.1 | Vernal pools and vernally mesic sites. (BP: Mar – Jun) | None. There is no vernal pool habitat present and not observed during protocol-level surveys. |
| **Sanford's arrowhead** (*Sagittaria sanfordii*) | _/_/1B.2 | In standing or slow-moving freshwater ponds, marshes, and ditches. (BP: May – Oct [Nov]) | None. Not observed during protocol-level surveys. |
| **Shasta huckleberry** (*Vaccinium shastense* ssp. *shastense*) | _/_/1B.3 | Microhabitat is acidic, mesic; often streambanks; sometimes seeps, rocky outcrops, roadsides, and disturbed areas. (BP: Dec – May [Sep]) | None. Not observed during protocol-level surveys. |
| **Shasta snow-wreath** (*Neviusia cliftonii*) | _/SC/1B.2 | In the mountains around Lake Shasta on shaded, north facing, or sheltered canyons. Often found by stream sides, sometimes on limestone or volcanic soils. (BP: Apr – Jun) | None. Not observed during protocol-level surveys. |
| **Silky cryptantha** (*Cryptantha crinita*) | _/_/1B.2 | Gravelly streambeds and wetland swales. (BP: Apr – May) | None. There is no suitable habitat within the drainages present and not observed during protocol-level surveys. |
| **Slender Orcutt grass** (*Orcuttia tenuis*) | FT/SE/1B.1 | Deep vernal pools. (BP: May – Sep [Oct]) | None. There is no vernal pool habitat present within the BSA and the species was not observed during the protocol-level rare plant survey. |
| **Sulphur Creek brodiaea** (*Brodiaea matsonii*) | _/_/1B.1 | Streambanks. In cracks and crevices of metamorphic amphibolite schist. (BP: May – Jun) | None. Not observed during protocol-level surveys. |
| **INVERTEBRATES** | | | |
| **Monarch butterfly** *(Danaus plexippus)* | FC/_/_ | Egg and larval stage dependent upon milkweed. Adults migrate seasonally, amassing in in dense tree canopies; e.g., eucalyptus. | None. The is no suitable habitat within the BSA. No milkweed plants were observed within the BSA. |

| **Common Name** *(Scientific Name)* | **Status** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **INVERTEBRATES** | | | |
| **Valley elderberry longhorn beetle** (*Desmocerus californicus dimorphus*) | FT/_/_ | Blue elderberry shrubs; usually associated with riparian areas. | None. No elderberry shrubs were observed within the BSA. |
| **Vernal pool fairy shrimp** *(Branchinecta lynchi)* | FT/_/_ | Vernal pools and seasonally ponded areas. | None. There are no vernal pools nor features with suitable hydrology within the BSA. |
| **Vernal pool tadpole shrimp** *(Lepidurus packardi)* | FE/_/_ | Deep vernal pools. | None. There are no vernal pools nor features with suitable hydrology within the BSA. |
| **FISH** | | | |
| **Chinook salmon** Central Valley spring-run Evolutionarily Significant Unit (ESU) *(Oncorhynchus tshawytscha)* | FT/ST/_ | Sacramento River and its tributaries. | None. None of the intermittent drainages in the BSA contain suitable habitat elements for this species and barriers to fish are present in the form of controlled outfalls/culverts. |
| **Chinook salmon** Sacramento River winter-run ESU *(Oncorhynchus tshawytscha)* | FE/SE/_ | Sacramento River and its tributaries. | None. None of the intermittent drainages in the BSA contain suitable habitat elements for this species and barriers to fish are present in the form of controlled outfalls/culverts. |
| **Green sturgeon** Southern Distinct Population Segment (DPS) *(Acipenser medirostris)* | FT/_/_ | Spawns in the Sacramento, Feather and Yuba Rivers, site fidelity. Non spawning adults occupy marine/estuarine waters. Delta Estuary is important for rearing juveniles. | None. None of the intermittent drainages in the BSA contain suitable habitat elements for this species and barriers to fish are present in the form of controlled outfalls/culverts. |
| **Steelhead** Central Valley DPS *(Oncorhynchus mykiss irideus)* | FT/_/_ | Sacramento and San Joaquin rivers and their tributaries. | None. None of the intermittent drainages in the BSA contain suitable habitat elements for this species and barriers to fish are present in the form of controlled outfalls/culverts. |

| **Common Name** *(Scientific Name)* | **<u>Status</u>** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **FISH** | | | |
| **Delta smelt** *(Hypomesus transpacificus)* | FT/SE/_ | Found only from the San Pablo Bay upstream through the Delta in Contra Costa, Sacramento, San Joaquin, Solano, and Yolo Counties. | <u>None</u>. None of the intermittent drainages in the BSA contain suitable habitat elements for this species and barriers to fish are present in the form of controlled outfalls/culverts. |
| **HERPTILES** | | | |
| **Foothill yellow-legged frog** Northwest/North Coast Clade (*Rana boylii*) | _/SSC/_ | Perennial, shallow streams and riffles with rocky substrates and partial shade; commonly found in canyons and narrow streams. | <u>None</u>. The drainages within the BSA do not provide the sufficient hydroperiod for breeding, nor suitable habitat components for overwintering (i.e., woody debris, root wads, undercut banks, clumps of sedges, and large boulders) (USFWS 2021). |
| **Pacific tailed frog** (*Ascaphus truei*) | _/SSC/_ | Perennial montane streams. Tadpoles require water below 15 degrees Celsius. | <u>None</u>. The intermittent drainages within the BSA are too shallow and warm to support this species. |
| **Shasta salamander** (*Hydromantes shastae*) | _/ST/_ | Occurs in rocky, limestone talus near Lake Shasta. | <u>None</u>**.** No suitable habitat occurs within the BSA and the BSA is located outside of the known range of this species (Gogol-Prokurat 2016). |
| **Western pond turtle** (*Emys marmorata*) | _/SSC/_ | Bodies of water with deep pools, emergent vegetation for foraging and cover, and locations for basking and nesting. | **<u>Known</u>**. Species has been observed in one of the historic perennial ponds present in the BSA. |
| **Western spadefoot** (*Spea hammondii*) | _/SSC/_ | Occurs primarily in grassland habitats. Vernal pools and seasonal drainages are typically used for breeding and egg-laying. | <u>None</u>. A sizeable bullfrog (*Lithobates catesbeianus*) population was observed within the active mining ponds in the BSA. The ponds are regularly disturbed, and the adjacent uplands are highly compacted and/or heavily vegetated (USFWS 2005). There are no CNDDB occurrences within 5 miles of the BSA. |

| **Common Name** *(Scientific Name)* | **Status** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **BIRDS** | | | |
| **Tricolored blackbird** *(Agelaius tricolor)* | _/ST/_ | Colonial nester in large freshwater marshes. Requires open, accessible water source and does most of its foraging in open habitats such as farm fields, pastures, cattle pens, large lawns. | None. There is a lack of nesting habitat due to the vegetation management activities conducted in the mining ponds and no suitable foraging habitat with abundant insect prey populations within or adjacent to the BSA. |
| **Bald eagle** *(Haliaeetus leucocephalus)* | _/SE, FP/_ | Coasts, large lakes, and river systems with open forests with large trees and snags. | None. There is no suitable habitat present within the BSA. |
| **Bank swallow** (*Riparia riparia*) | _/ST/_ | Requires vertical banks or cliffs with fine-textured sandy soils near streams, rivers, lakes, ocean to dig nesting burrow. | None. There is no suitable habitat present within the BSA. |
| **Northern spotted owl** (*Strix occidentalis caurina*) | FT/ST/_ | Forests characterized by dense canopy closure of mature and old-growth trees, abundant logs, standing snags, and live trees with broken tops. | None. There is no suitable habitat present within the BSA. |
| **MAMMALS** | | | |
| **Fisher** West Coast DPS *(Pekania pennanti)* | _/SSC/_ | Intermediate to large-tree stages of coniferous forests and deciduous-riparian areas with high percent canopy closure. Uses cavities, snags, logs and rocky areas for cover and denning. Needs large areas of mature, dense forest. | None. There is no suitable habitat present within the BSA. |

| **Common Name** *(Scientific Name)* | **Status** Fed/State/CNPS | **Associated Habitats** | **Potential for Occurrence** |
|---|---|---|---|
| **MAMMALS** | | | |
| **Pallid bat** *(Antrozous pallidus)* | _/SSC/_ | Rocky outcroppings to open, sparsely vegetated grasslands with nearby water source. Day and night roosts include crevices in rocky outcrops and cliffs, caves, mines, trees (e.g., cavities and exfoliating bark), and various human structures (i.e., bridges). | <u>Low</u>. Mature trees with exfoliating bark and large cavities within the BSA could potentially provide day-roosting habitat within the BSA. There are no CNDDB occurrences of this species within 5 miles of the BSA. |
| **Townsend's big-eared bat** *(Corynorhinus townsendii)* | _/SSC/_ | Roost in caves and cave-like cavities, occasionally in bridges. | <u>Low</u>. One small historic mine tunnel occurs within the BSA that could potentially provide marginal habitat for this species. |
| **Western red bat** *(Lasiurus blossevillii)* | _/SSC/_ | Riparian areas dominated by walnuts, oaks, willows, cottonwoods, and sycamores where they roost in these broad-leafed trees. | <u>None</u>. Few broad-leaved trees occur within the BSA, the majority of which were burned in the Carr Fire. |

| **CODE DESIGNATIONS** | |
|---|---|
| **FE or FT** = Federally listed as Endangered or Threatened<br>**FC** = Federal Candidate Species<br><br>**SE or ST=** State Listed as Endangered or Threatened<br>**SC** = State Candidate Species<br>**SSC** = State Species of Special Concern<br>**FP** = State Fully Protected Species<br>**SNC** = CDFW Sensitive Natural Community | **CNPS California Rare Plant Rank (CRPR):**<br>**CRPR 1B** = Rare or Endangered in California or elsewhere<br>**CRPR 2** = Rare or Endangered in California, more common elsewhere<br>**CRPR 3** = More information is needed<br>**CRPR 4** = Plants with limited distribution<br><br>**0.1** = Seriously Threatened<br>**0.2** = Fairly Threatened<br>**0.3** = Not very Threatened |

***Potential for Occurrence:*** for plants it is considered the potential to occur during the survey period; for birds and bats it is considered the potential to breed, forage, roost, or over-winter in the BSA during migration. Any bird or bat species could fly over the BSA, but this is not considered a potential occurrence. The categories for the potential for occurrence include:

**<u>None:</u>** The species or natural community is known not to occur and has no potential to occur in the BSA based on sufficient surveys, the lack suitable habitat, and/or the BSA is well outside of the known distribution of the species.

**<u>Low:</u>** Potential habitat in the BSA is sub-marginal and/or the species is known to occur in the vicinity of the BSA.

**<u>Moderate:</u>** Suitable habitat is present in the BSA and/or the species is known to occur in the vicinity of the BSA. Pre-construction surveys may be required.

**<u>High:</u>** Habitat in the BSA is highly suitable for the species and there are reliable records close to the BSA, but the species was not observed. Pre-construction surveys required, with the exception of indicators for foraging habitat.

**<u>Known:</u>** Species was detected in the BSA, or a recent reliable record exists for the BSA.

## Endangered, Threatened, and Rare Plants

There were no endangered, threatened, or rare plants observed within the BSA during the protocol-level rare plant surveys conducted on May 21 and 27 and June 2 and 4, 2020 and April 28, 2022**.** A complete list of plant species observed within the BSA during protocol-level surveys can be found in **Appendix B**. Additionally, no special-status botanical species were observed within the site during surveys conducted by North State Resources in 2006, nor during surveys conducted by WRM in 2019.

## Endangered, Threatened, and Special Status Wildlife

A wildlife habitat assessment was conducted within the BSA on June 4, 2020. The following special-status species have potential to occur within the BSA based on the presence of suitable habitat and/or known records of species occurrence within the vicinity of the BSA.

One SSC, the western pond turtle, was observed within the BSA. Additionally, potentially suitable habitat was identified for pallid bat, Townsend's big-eared bat, and various avian species protected under the MBTA. A complete list of wildlife species observed within the BSA can be found in **Appendix B**. No special-status wildlife species were observed within the site by North State Resources in 2007 nor by WRM in 2019.

### Western pond turtle

The western pond turtle is a SSC in California. Western pond turtles are drab, darkish-colored turtles with a yellowish to cream colored head. They range from the Washington Puget Sound to Baja California. Suitable aquatic habitats include slow-moving to stagnant water, such as backwaters and ponded areas of rivers and creeks, semi-permanent to permanent ponds, and irrigation ditches. Preferred habitats include features such as hydrophytic vegetation for foraging and cover and basking areas to regulate body temperature. In early spring through early summer, female turtles begin to move over land in search for nesting sites. Eggs are laid on the banks of slow-moving streams and are known to travel up to 400 meters from aquatic habitat into upland areas to nest (Reese and Welsh 1997). The female digs a hole approximately 4 inches deep and lays up to eleven (11) eggs. Afterwards, the eggs are covered with sediment and are left to incubate under the warm soils. Eggs are typically laid between March and August (Zeiner et al. 1990). Current threats facing the western pond turtle include loss of suitable aquatic habitats due to rapid changes in water regimes and removal of hydrophytic vegetation.

**CNDDB occurrences**

There are two (2) CNDDB occurrences of western pond turtle within 5 miles of the BSA (#605, #713), the closest being located approximately 3.5 miles southwest of the BSA.

**Status of western pond turtle occurring within the BSA**

Western pond turtles are known to bask on banks and woody debris, such as logs, along the sides of perennial aquatic features. They are also known to travel up to 400 meters from aquatic habitat into upland areas to nest (Reese and Welsh 1997), and they may aestivate in upland areas along intermittent drainages for several months during dry periods (Belli 2015). During the field surveys conducted, a few western pond turtles were observed within the perennial historic created ponds in the MRA (where no mining or project related impacts will occur), including PO15 and PO16 (**Appendix C: Draft Delineation of Aquatic Resources Impacts Map**). When water is present all of the manmade ponds in the BSA provide suitable habitat for western pond turtles; however, due to regular disturbance and steeply engineered banks, the active mining ponds do not provide high-quality habitat for western pond turtles.

**Pallid bat**

Pallid bats are designated as a CDFW SSC. Pallid bats roost alone, in small groups (2 to 20 bats), or gregariously (hundreds of individuals). Day and night roosts include crevices in rocky outcrops and cliffs, caves, mines, trees (e.g., basal hollows of coast redwoods and giant sequoias, bole cavities of oaks, exfoliating Ponderosa pine and valley oak bark, deciduous trees in riparian areas, and fruit trees in orchards), and various human structures such as bridges (especially wooden and concrete girder designs), barns, porches, bat boxes, and human-occupied as well as vacant buildings. Roosts generally have unobstructed entrances and exits, are high above the ground, warm, and inaccessible to terrestrial predators. However, this species has also been found roosting on or near the ground under burlap sacks, stone piles, rags, and baseboards. Lewis (1996) found that pallid bats have low roost fidelity and both pregnant and lactating pallid bats changed roosts an average of once every 1.4 days throughout the summer. Overwintering roosts have relatively cool, stable temperatures and are located in protected structures beneath the forest canopy or on the ground, out of direct sunlight. In other parts of the species' range, males and females have been found hibernating alone or in small groups, wedged deeply into narrow fissures in mines, caves, and buildings. At low latitudes, outdoor winter activity has been reported at temperatures between –5 and 10 °C.

**CNDDB Occurrences**

There are four (4) CNDDB occurrences of pallid bat in Shasta County. Three (3) of the occurrences positively identify bridges as the known roost sites and the fourth occurrence does not describe a roost site or type. The nearest CNDDB occurrence (#111) is just over 5 miles to the west of the BSA, under the Brandy Creek bridge on Kennedy Memorial Drive.

**Status of pallid bat occurring in the BSA**

Mature oak trees within the BSA that contain suitable habitat elements (e.g., cavities, peeling bark) may provide suitable day-roosting habitat; however, there very few large oak trees present, and the few large oak trees present have largely been impacted by the Carr Fire, resulting in poor quality of habitat within the site. Due to the small amount of potentially suitable habitat present and the lack of CNDDB occurrences within 5 miles, there is low potential for pallid bats to occur within the BSA.

**Townsend's big-eared bat**

Townsend's big-eared bat is designated as a SSC. This bat is distinguished by its bilateral nose bumps and large ears (WBWG 2022). This bat requires large cavities for roosting; these may include abandoned buildings and mines, caves, and basal cavities of trees. During the summer, males and females occupy separate roosting sites; males are typically solitary, while females form maternity colonies, where they raise their pups. Maternity colonies form between March and June (based on local climactic factors), with a single pup born between May and July (WBWG 2022). A maternity colony may range in size from 12 bats to 200, although in the eastern United States, colonies of 1,000 or more have been formed. During the winter, these bats hibernate, often when temperatures are around 32 to 53°F. Hibernation occurs in tightly packed clusters, which could possibly help stabilize body temperatures against the cold. Males often hibernate in warmer places than females and are more easily aroused and active in winter than females. This species has 2-3 feeding periods between dark and dawn, with periods of rest in between. They rest in areas different from where they roost during the day (Schwartz et al. 2016).

**CNDDB Occurrences**
The nearest CNDDB occurrence (#494) is located just northwest of the BSA and was observed in 1997 at the Rock Creek Mine.

**Status of Townsend's big-eared bat occurring within the BSA**
The BSA is the site of a historic and active mining operation. The historic mining activities included some tunneling and excavation. One (1) small tunnel was observed within the Mine during the field survey (**Appendix E: Site Photos**). Due to the small size of the tunnel and the noise and disturbance from the adjacent active mining, there is a low potential for Townsend's big-eared bats to occur within the tunnel in the BSA.

**Migratory birds and raptors**

Nesting birds are protected under the MBTA (16 USC 703) and the CFGC (§3503). The MBTA (16 USC §703) prohibits the killing of migratory birds or the destruction of their occupied nests and eggs except in accordance with regulations prescribed by the USFWS. The bird species covered by the MBTA includes nearly all of those that breed in North America, excluding introduced (i.e., exotic) species (50 Code of Federal Regulations §10.13). Activities that involve the removal of vegetation including trees, shrubs, grasses, and forbs or ground disturbance has the potential to affect bird species protected by the MBTA.

The CFGC (§3503.5) states that it is "unlawful to take, possess, or destroy any birds in the order Falconiformes (hawks, eagles, and falcons) or Strigiformes (owls) 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." Take includes the disturbance of an active nest resulting in the abandonment or loss of young. The CFGC (§3503) also states that "it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto."

**CNDDB occurrences**
The majority of migratory birds and raptors protected under the MBTA and CFGC are not recorded on the CNDDB because they are abundant and widespread.

**Status of migratory birds and raptors occurring in the BSA**
There is suitable nesting habitat for avian species within and adjacent to the BSA.

## REGULATORY FRAMEWORK

The following describes federal, state, and local environmental laws and policies that may be relevant if the BSA were to be developed or modified.

## Federal

### Waters of the United States, Clean Water Act (§404)

The US Army Corps of Engineers (Corps) and the U.S. Environmental Protection Agency (EPA) regulate the discharge of dredged or fill material into jurisdictional waters of the United States, under the Clean Water Act (§404). The term "waters of the United States" is an encompassing term that includes "wetlands" and "other waters." Wetlands have been defined for regulatory purposes as follows: "those 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). Wetlands generally include swamps, marshes, bogs, and similar areas." Other waters of the United States are seasonal or perennial water bodies, including Lake, stream channels, drainages, ponds, and other surface water features, that exhibit an ordinary high-water mark but lack positive indicators for one or more of the three wetland parameters (i.e., hydrophytic vegetation, hydric soil, and wetland hydrology) (33 CFR 328.4).

The Corps may issue either individual permits on a case-by-case basis or general permits on a program level. General permits are pre-authorized and are issued to cover similar activities that are expected to cause only minimal adverse environmental effects. Nationwide permits are general permits issued to cover particular fill activities. All nationwide permits have general conditions that must be met for the permits to apply to a particular project, as well as specific conditions that apply to each nationwide permit.

### Clean Water Act (§401)

The Clean Water Act (§401) requires water quality certification and authorization for placement of dredged or fill material in wetlands and Other Waters of the United States. In accordance with the Clean Water Act (§401), criteria for allowable discharges into surface waters have been developed by the State Water Resources Control Board, Division of Water Quality. The resulting requirements are used as criteria in granting National Pollutant Discharge Elimination System (NPDES) permits or waivers, which are obtained through the Regional Water Quality Control Board (RWQCB) per the Clean Water Act (§402). Any activity or facility that will discharge waste (such as soils from construction) into surface waters, or from which waste may be discharged, must obtain an NPDES permit or waiver from the RWQCB. The RWQCB evaluates an NPDES permit application to determine whether the proposed discharge is consistent with the adopted water quality objectives of the basin plan.

### Migratory Bird Treaty Act

The MBTA (16 USC §703) prohibits the killing of migratory birds or the destruction of their occupied nests and eggs except in accordance with regulations prescribed by the USFWS. The bird species covered by the MBTA includes nearly all of those that breed in North America, excluding introduced (i.e., exotic) species (50 Code of Federal Regulations §10.13).

### Federal Endangered Species Act

The United States Congress passed the ESA in 1973 to protect species that are endangered or threatened with extinction. The ESA is intended to operate in conjunction with the National Environmental Policy Act (NEPA) to help protect the ecosystems upon which endangered and threatened species depend.

Under the ESA, species may be listed as either "endangered" or "threatened." Endangered means a species is in danger of extinction throughout all or a significant portion of its range. Threatened means a species is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. All species of plants and animals, except non-native species and pest insects, are eligible for listing as endangered or threatened. The USFWS also maintains a list of "candidate" species. Candidate species are species for which there is enough information to warrant proposing them for listing, but that have not yet been proposed. "Proposed" species are those that have been proposed for listing but have not yet been listed.

The ESA makes it unlawful to "take" a listed animal without a permit. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Through regulations, the term "harm" is defined as "an act which actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering."

## State of California Regulations

### California Endangered Species Act

The CESA is similar to the ESA but pertains to state-listed endangered and threatened species. The CESA requires state agencies to consult with the CDFW when preparing documents to comply with the CEQA. The purpose is to ensure that the actions of the lead agency do not jeopardize the continued existence of a listed species or result in the destruction, or adverse modification of habitat essential to the continued existence of those species. In addition to formal listing under the federal and state endangered species acts, "Species of Special Concern" (SSC) receive consideration by CDFW. Species of Special Concern are those whose numbers, reproductive success, or habitat may be threatened.

### California Fish and Game Code (§3503.5)

The CFGC (§3503.5) states that it is "unlawful to take, possess, or destroy any birds in the order Falconiformes (hawks, eagles, and falcons) or Strigiformes (all owls except barn owls) 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." Take includes the disturbance of an active nest resulting in the abandonment or loss of young. The CFGC (§3503) also states that "it is unlawful to take, possess, or needlessly destroy the nest or eggs of any bird, except as otherwise provided by this code or any regulation made pursuant thereto."

## California Migratory Bird Protection Act

The CMBPA amends the CFGC (§3513) to mirror the provisions of the MBTA and allow the State of California to enforce the prohibition of take or possession of any migratory nongame bird as designated in the federal MBTA, including incidental take.

Activities that involve the removal of vegetation including trees, shrubs, grasses, and forbs or ground disturbance have the potential to affect bird species protected by the MBTA and CFGC. Thus, vegetation removal and ground disturbance in areas with breeding birds should be conducted outside of the breeding season (approximately March 1 through August 31). If vegetation removal or ground-disturbing activities are conducted during the breeding season, then a qualified biologist must determine if there are any nests of bird species protected under the MBTA and CFGC present in the Project area prior to commencement of vegetation removal or ground-disturbing activities. If active nests are located or presumed present, then appropriate avoidance measures (e.g., spatial or temporal buffers) must be implemented.

## California Environmental Quality Act Guidelines (§15380)

Although threatened and endangered species are protected by specific federal and state statutes, CEQA Guidelines §15380(d) provides that a species not listed on the federal or state list of protected species may be considered rare or endangered if the species can be shown to meet certain specified criteria. These criteria have been modeled based on the definition in the ESA and the section of the CFGC dealing with rare, threatened, and endangered plants and animals. The CEQA Guidelines (§15380) allows a public agency to undertake a review to determine if a significant effect on species that have not yet been listed by either the USFWS or CDFW (e.g. candidate species, species of concern) would occur. Thus, CEQA provides an agency with the ability to protect a species from a project's potential impacts until the respective government agencies have an opportunity to designate the species as protected, if warranted.

## Lake and Streambed Alteration Agreement, CFGC (§1602)

The CDFW is a trustee agency that has jurisdiction under the CFGC (§1600 et seq.). The CFGC (§1602), requires that a state or local government agency, public utility, or private entity must notify CDFW if a proposed Project will "substantially divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river, stream, or lake designated by the department, or use any material from the streambeds, except when the department has been notified pursuant to §1602." If an existing fish or wildlife resource may be substantially adversely affected by the activity, CDFW may propose reasonable measures that will allow protection of those resources. If these measures are agreeable to the parties involved, they may enter into an agreement with CDFW identifying the approved activities and associated mitigation measures.

## Rare and Endangered Plants

The CNPS maintains a list of plant species native to California with low population numbers, limited distribution, or otherwise threatened with extinction. This information is published in the Inventory of Rare and Endangered Vascular Plants of California. Potential impacts to populations of CNPS California Rare Plant Rank (CRPR) plants receive consideration under CEQA review. The CNPS CRPR categorizes plants as follows:

- Rank 1A: Plants presumed extinct in California;
- Rank 1B: Plants rare, threatened, or endangered in California or elsewhere;
- Rank 2A: Plants presumed extirpated or extinct in California, but not elsewhere;
- Rank 2B: Plants rare, threatened, or endangered in California, but more numerous elsewhere;
- Rank 3: Plants about which we need more information; and
- Rank 4: Plants of limited distribution.

The California Native Plant Protection Act (CFGC §1900-1913) prohibits the taking, possessing, or sale within the state of any plants with a state designation of rare, threatened, or endangered as defined by CDFW. An exception to this prohibition allows landowners, under specific circumstances, to take listed plant species, provided that the owners first notify CDFW and give the agency at least 10 days to retrieve (and presumably replant) the plants and/or seeds before they are destroyed. CFGC §1913 exempts from the ‘take’ prohibition “the removal of endangered or rare native plants from a canal, lateral channel, building site, or road, or other right of way.”

# CONCLUSIONS AND RECOMMENDATIONS

## Endangered, Threatened, and Rare Plants

There are no special-status botanical species present within the BSA; therefore, there will be no effects to botanical species or their habitats and no further avoidance and minimization measures are proposed.

## Endangered, Threatened, and Special-status Wildlife

The following are the recommended and existing minimization and mitigation measures to reduce or eliminate current and future Mine-associated impacts to special-status wildlife species. These proposed measures are based on the existing Reclamation Plan Amendment and Use Permit conditions and comments received from CDFW on October 29, 2019 and may be amended or superseded by the Mine expansion-specific permits issued by the regulatory agencies.

**<u>Western pond turtle</u>**

- To the extent practicable, project activities in western pond turtle habitat shall be conducted during the dry season to reduce the likelihood of the presence of western pond turtles in project areas.
- If a western pond turtle is encountered, activities in the vicinity shall cease until appropriate protective measures have been implemented or it has been determined that the turtle will not be harmed. Any western pond turtles encountered shall be allowed to move away on their own or shall be relocated to suitable habitat by a qualified biologist.
- Any trapped, injured, or killed pond turtles shall be reported immediately to the California Department of Fish and Wildlife.

- Escape ramps shall be installed on all reclamation ponds to allow wildlife to exit the steep walled ponds. The ramps will be mechanically cut into the banks of the ponds using heavy equipment. Dimensions of the ramps will be a minimum of 12 inches wide and will not exceed a 2:1 slope.

**Pallid bat**

- Mature trees shall be removed and/or felled between September 1 and March 15, outside of the bat maternity season. Trees should be removed at dusk to minimize impacts to roosting bats.

**Townsend's big-eared bat**

- If Mine expansion activities include disturbance, demolition, or removal of any existing historic tunnels within the BSA, this work shall be initiated outside of the bat maternity season (March 16 – August 31).
- Prior to conducting any Mine expansion activities within the existing tunnels, a qualified biologist will conduct a roosting bat pre-construction survey, where accessible, within 7 days prior to the start of mining activities.
- If Townsend's big-eared or other bat species are observed utilizing the Mine expansion area, CDFW will be consulted before construction activities commence. Bats may need to be humanely evicted if adverse impacts are anticipated to occur.

**Migratory birds and raptors**

- Activities including site-grubbing and vegetation removal shall be initiated outside of the bird nesting season (February 1 – August 31).
- If site-grubbing and/or vegetation removal cannot be initiated outside of the bird nesting season, then the following will occur:
  - A qualified biologist will conduct a pre-construction survey within 250 feet of the proposed disturbance area, where accessible, within 7 days prior to the start of mining activities.
  - If an active nest (i.e., containing egg[s] or young) is observed within the proposed disturbance area or adjacent to the area where impacts could occur, then the qualified biologist will establish a species protection buffer. The species protection buffer will be defined by the qualified biologist based on the species, nest type, and tolerance to disturbance. Construction activity shall be prohibited within the buffer zones until the young have fledged or the nest fails as determined by a qualified biologist. Nests shall be monitored by a qualified biologist once per week and a report submitted to the CEQA lead agency weekly.

## Control of Invasives

The following are the recommended minimization and mitigation measures to further reduce or eliminate the spread of invasives and toxic materials to off-site habitats from Mine-associated activities. These proposed measures may be amended or superseded by the Mine-specific permits issued by the regulatory agencies.

### Bullfrog Management

The active mining ponds contained a healthy population of bullfrogs. Bullfrogs are an invasive species in California and should be removed from natural habitats whenever possible. However, resource agencies agree that bullfrog management needs to be conducted on a watershed level to be effective. The most effective way to remove bullfrogs from a site is to dewater all breeding habitat for a minimum of 2 years. Given the shallow depth of groundwater recharge of the current ponds, dewatering habitat is not a feasible option for bullfrog management; therefore, bullfrog management will focus on controlling the spread of this species to offsite habitat. Since there are only a couple outfalls/culverts that flow offsite into an unnamed tributary of Middle Creek, the following measure is recommended to manage the potential spread of any bullfrogs offsite.

- All controlled outfalls/culverts leaving the site will have screens installed over them to prevent all life stages of bullfrogs from accidentally discharging offsite. The screen mesh will be ½” or smaller to prevent larvae from passing through.

## Water Quality

The Mine operates under a General Industrial Stormwater Permit (Order No. 2014-0057- DWQ) issued by the State Water Resources Control Board. The permit requires the operator to perform stormwater quality monitoring, water testing, and reporting certain stormwater discharges from the property. Since permitted, CCA has undertaken required water quality monitoring and testing in compliance with National Pollutant Discharge Elimination System (NPDES) permit conditions. Stormwater flows from the amendment area contain industrial activities and are therefore covered under the General Industrial Stormwater Permit.

## Other Natural Resources

### Oak Woodland

Oaks within the BSA were largely devastated by the Carr Fire. The few live black oaks remaining on the site are in various states of health. If protected oaks will be removed as a part of vegetation removal activities, then mitigation for impacts to living oaks within the BSA may be required by Shasta County.

### Waters of the United States and Waters of the State

Per the active Use Permit (07-020) and the previous Lake and Streambed Alteration Agreement obtained for the Mine (LSAA No. 1600-2012-0018-R1), onsite mitigation was approved to compensate for impacts to wetlands. Since the Use Permit Amendment is not proposing any changes to the previously approved limits of mining activities, no changes to the proposed onsite mitigation previously approved is anticipated. No impacts to aquatic resources are anticipated within the Mineral Resource Area (**Appendix C: Draft Delineation of Aquatic Resources Impacts Map**). Two on-site mitigation measures are proposed. The first is creating a meandering intermittent drainage course within the bench area around proposed Pond #6 with planting of riparian vegetation within and along the drainage course which also extends into the edges of Pond #6, creating 4.45 acres of riparian habitat. Secondly, Pond #6 will create a 32.67-acre freshwater body. The new pond area is 32.23 acres larger than the existing 0.438 acres of ponds being removed via excavation. Pond #6 will have a shallow edge environment transitioning into the deeper pond water area.

Activities that occur within the ordinary high-water mark and/or result in fill or discharge to any waters of the U.S will need to comply with all applicable CWA and CFGC regulations. This will require the following permits to be obtained, unless already obtained or approved under the existing mining permits:

- Authorization under a Nationwide Permit or Individual Permit from the Corps (Clean Water Act §404) must be obtained prior to any discharge of fill material into waters of the U.S.
- A Lake and Streambed Alteration Agreement must be obtained from the CDFW (CFGC §1602) prior to any activities that would obstruct the flow of or alter the bed, channel, or bank of any perennial, intermittent or ephemeral creeks. The active Lake or Streambed Alteration Agreement (No. 1600-2010-0018-R1) for this project expired on December 31, 2014. A current Lake and Streambed Alteration Agreement will need to be obtained if there are any ongoing impacts to CDFW jurisdictional drainage features.
- Authorization under a water quality certification must be obtained by the Regional Water Quality Control Board (Clean Water Act §401) prior to any discharge of dredged or fill material into waters of the State.

# REFERENCES


Baldwin, B. G., D. H. Goldman, D. J. Keil, R. Patterson, T. J. Rosatti, and D. H. Wilken, editors. 2012. The Jepson Manual: vascular plants of California, second edition. University of California Press, Berkeley.

Belli, Joseph Paul, "Movements, Habitat Use, and Demography of Western Pond Turtles in an Intermittent Central California Stream" (2015). Master's Theses. 4624. DOI: https://doi.org/10.31979/etd.b9sq-ak47, https://scholarworks.sjsu.edu/etd_theses/4624

California Native Plant Society, Rare Plant Program. 2022. Rare Plant Inventory (online edition, v9-01 1.5). Website https://www.rareplants.cnps.org [accessed 13 May 2022].

California Natural Diversity Database (CNDDB). 2022. Rarefind 5. California Department of Fish and Wildlife. Sacramento, California [accessed 13 May 2022].

Gogol-Prokurat, Melanie. 2016. Shasta Salamander Range - CWHR A024 [ds1153]. California Department of Fish and Wildlife. Biogeographic Information and Observation System (BIOS). Retrieved May 17, 2022 from https://apps.wildlife.ca.gov/bios/

Lewis, Susan. 1996. Low Roost-Site Fidelity in Pallid Bats: Associated Factors and Effect on Group Stability. Behavioral Ecology and Sociobiology Vol. 39, No. 5, pp. 335-344.

Mayer, K. E. and Laudenslayer, W. F. 1988. A Guide to Wildlife Habitats of California. State of California, Resources Agency, Department of Fish and Game. Sacramento, CA. 166 pp.

North State Resources, Inc. 2007. Special-Status Wildlife Assessment for the Crystal Creek Aggregate Phase II Project.

Reese, D.A. and Welsh, H.H. 1997. Use of Terrestrial Habitat by Western Pond Turtles, *Clemmys marmorata*: Implications for Management. USDA Forest Service. PSW Redwood Science Laboratory, Arcata, California.

Schwartz, C. W., et al. 2016. The Wild Mammals of Missouri. University of Missouri Press and Department of Conservation.

U.S. Fish and Wildlife Service (USFWS). 1998. Recovery plan for the Shasta crayfish (*Pacifastacus fortis*). U.S. Fish and Wildlife Service, Portland, Oregon. 153 pp.

USFWS. 2005. Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon. U.S. Fish and Wildlife Service; Portland, Oregon.

USFWS. 2021. Species status assessment report for the foothill yellow-legged frog (*Rana boylii*), Version 2.0. October 2021. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California.

Western Bat Working Group (WBWG). 2022. Western Bat Species Accounts. Available: http://wbwg.org/western-bat-species [17 May 2022].

Western Regional Climate Center (WRCC). 2022. Period of Record Monthly Climate Summary for Whiskeytown RSVR, California (049621). Online access.

Wildland Resource Managers. 2019. Biological Review: Crystal Creek Aggregate Mine Expansion Addendum, Shasta County, California.

Zeiner, D.C., W.F. Laudenslayer, Jr., K.E. Mayer, and M. White, eds. 1990. California's Wildlife. Vol. I-III. California Department of Fish and Game, Sacramento, California.

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# Appendix A

Official Species Lists

# Selected Elements by Common Name

## California Department of Fish and Wildlife

## California Natural Diversity Database

**Query Criteria:** Quad<span style='color:Red'> IS </span>(Whiskeytown (4012265)<span style='color:Red'> OR </span>Shasta Dam (4012264)<span style='color:Red'> OR </span>Project City (4012263)<span style='color:Red'> OR </span>Igo (4012255)<span style='color:Red'> OR </span>Redding (4012254)<span style='color:Red'> OR </span>Enterprise (4012253))

| Species | Element Code | Federal Status | State Status | Global Rank | State Rank | Rare Plant Rank/CDFW SSC or FP |
|---|---|---|---|---|---|---|
| **Antioch Dunes anthicid beetle**<br>*Anthicus antiochensis* | IICOL49020 | None | None | G1 | S3 | |
| **bald eagle**<br>*Haliaeetus leucocephalus* | ABNKC10010 | Delisted | Endangered | G5 | S3 | FP |
| **bank swallow**<br>*Riparia riparia* | ABPAU08010 | None | Threatened | G5 | S2 | |
| **California linderiella**<br>*Linderiella occidentalis* | ICBRA06010 | None | None | G2G3 | S2S3 | |
| **Canyon Creek stonecrop**<br>*Sedum paradisum ssp. paradisum* | PDCRA0A0U3 | None | None | G3G4T3 | S3 | 1B.3 |
| **chinook salmon - Central Valley spring-run ESU**<br>*Oncorhynchus tshawytscha pop. 11* | AFCHA0205L | Threatened | Threatened | G5T2Q | S2 | |
| **chinook salmon - Sacramento River winter-run ESU**<br>*Oncorhynchus tshawytscha pop. 7* | AFCHA0205B | Endangered | Endangered | G5T1Q | S1 | |
| **dubious pea**<br>*Lathyrus sulphureus var. argillaceus* | PDFAB25101 | None | None | G5T1T2Q | S1S2 | 3 |
| **Fisher**<br>*Pekania pennanti* | AMAJF01020 | None | None | G5 | S2S3 | SSC |
| **foothill yellow-legged frog**<br>*Rana boylii* | AAABH01050 | None | Endangered | G3 | S3 | SSC |
| **great egret**<br>*Ardea alba* | ABNGA04040 | None | None | G5 | S4 | |
| **Great Valley Cottonwood Riparian Forest**<br>*Great Valley Cottonwood Riparian Forest* | CTT61410CA | None | None | G2 | S2.1 | |
| **Great Valley Valley Oak Riparian Forest**<br>*Great Valley Valley Oak Riparian Forest* | CTT61430CA | None | None | G1 | S1.1 | |
| **Great Valley Willow Scrub**<br>*Great Valley Willow Scrub* | CTT63410CA | None | None | G3 | S3.2 | |
| **green sturgeon - southern DPS**<br>*Acipenser medirostris pop. 1* | AFCAA01031 | Threatened | None | G2T1 | S1 | |
| **Henderson's bent grass**<br>*Agrostis hendersonii* | PMPOA040K0 | None | None | G2Q | S2 | 3.2 |
| **kneecap lanx**<br>*Lanx patelloides* | IMGASL7030 | None | None | G2? | S2 | |
| **legenere**<br>*Legenere limosa* | PDCAM0C010 | None | None | G2 | S2 | 1B.1 |
| **long-eared myotis**<br>*Myotis evotis* | AMACC01070 | None | None | G5 | S3 | |

| Species | Element Code | Federal Status | State Status | Global Rank | State Rank | Rare Plant Rank/CDFW SSC or FP |
|---|---|---|---|---|---|---|
| **maverick clover**<br>*Trifolium piorkowskii* | PDFAB40410 | None | None | G2 | S2 | 1B.2 |
| **northern clarkia**<br>*Clarkia borealis ssp. borealis* | PDONA05062 | None | None | G4T4 | S4 | 4.3 |
| **Nuttall's ribbon-leaved pondweed**<br>*Potamogeton epihydrus* | PMPOT03080 | None | None | G5 | S2S3 | 2B.2 |
| **Oregon shoulderband**<br>*Helminthoglypta hertleini* | IMGASC2280 | None | None | G3Q | S1S2 | |
| **Pacific tailed frog**<br>*Ascaphus truei* | AAABA01010 | None | None | G4 | S3S4 | SSC |
| **pallid bat**<br>*Antrozous pallidus* | AMACC10010 | None | None | G4 | S3 | SSC |
| **Red Bluff dwarf rush**<br>*Juncus leiospermus var. leiospermus* | PMJUN011L2 | None | None | G2T2 | S2 | 1B.1 |
| **Sacramento anthicid beetle**<br>*Anthicus sacramento* | IICOL49010 | None | None | G1 | S4 | |
| **Sanford's arrowhead**<br>*Sagittaria sanfordii* | PMALI040Q0 | None | None | G3 | S3 | 1B.2 |
| **Shasta chaparral**<br>*Trilobopsis roperi* | IMGASA2030 | None | None | G2 | S1 | |
| **Shasta hesperian**<br>*Vespericola shasta* | IMGASA4070 | None | None | G3 | S3 | |
| **Shasta huckleberry**<br>*Vaccinium shastense ssp. shastense* | PDERI181Z1 | None | None | G4T3 | S3 | 1B.3 |
| **Shasta salamander**<br>*Hydromantes shastae* | AAAAD09030 | None | Threatened | G3 | S3 | |
| **Shasta snow-wreath**<br>*Neviusia cliftonii* | PDROS14020 | None | Candidate Endangered | G2 | S2 | 1B.2 |
| **silky cryptantha**<br>*Cryptantha crinita* | PDBOR0A0Q0 | None | None | G2 | S2 | 1B.2 |
| **silver-haired bat**<br>*Lasionycteris noctivagans* | AMACC02010 | None | None | G3G4 | S3S4 | |
| **slender Orcutt grass**<br>*Orcuttia tenuis* | PMPOA4G050 | Threatened | Endangered | G2 | S2 | 1B.1 |
| **slender silver moss**<br>*Anomobryum julaceum* | NBMUS80010 | None | None | G5? | S2 | 4.2 |
| **steelhead - Central Valley DPS**<br>*Oncorhynchus mykiss irideus pop. 11* | AFCHA0209K | Threatened | None | G5T2Q | S2 | |
| **Sulphur Creek brodiaea**<br>*Brodiaea matsonii* | PMLIL0C0H0 | None | None | G1 | S1 | 1B.1 |
| **Townsend's big-eared bat**<br>*Corynorhinus townsendii* | AMACC08010 | None | None | G4 | S2 | SSC |

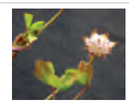
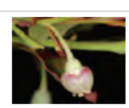
| Species | Element Code | Federal Status | State Status | Global Rank | State Rank | Rare Plant Rank/CDFW SSC or FP |
|---|---|---|---|---|---|---|
| **tricolored blackbird**<br>*Agelaius tricolor* | ABPBXB0020 | None | Threatened | G1G2 | S1S2 | SSC |
| **valley elderberry longhorn beetle**<br>*Desmocerus californicus dimorphus* | IICOL48011 | Threatened | None | G3T2T3 | S3 | |
| **vernal pool fairy shrimp**<br>*Branchinecta lynchi* | ICBRA03030 | Threatened | None | G3 | S3 | |
| **vernal pool tadpole shrimp**<br>*Lepidurus packardi* | ICBRA10010 | Endangered | None | G4 | S3S4 | |
| **Wawona riffle beetle**<br>*Atractelmis wawona* | IICOL58010 | None | None | G3 | S1S2 | |
| **western pearlshell**<br>*Margaritifera falcata* | IMBIV27020 | None | None | G4G5 | S1S2 | |
| **western pond turtle**<br>*Emys marmorata* | ARAAD02030 | None | None | G3G4 | S3 | SSC |
| **western red bat**<br>*Lasiurus blossevillii* | AMACC05060 | None | None | G4 | S3 | SSC |
| **western spadefoot**<br>*Spea hammondii* | AAABF02020 | None | None | G2G3 | S3 | SSC |
| **Wintu sideband**<br>*Monadenia troglodytes wintu* | IMGASC7092 | None | None | G1G2T1T2 | S1S2 | |
| **Yuma myotis**<br>*Myotis yumanensis* | AMACC01020 | None | None | G5 | S4 | |

**Record Count: 51**

## Search Results

**11** matches found. Click on scientific name for details

Search Criteria: CRPR is one of [**1A:1B:2A:2B**] , Quad is one of [**4012265:4012264:4012254:4012263:4012255:4012253**]

| SCIENTIFIC NAME | ▲ COMMON NAME | BLOOMING PERIOD | FED LIST | STATE LIST | CA RARE PLANT RANK | PHOTO |
|---|---|---|---|---|---|---|
| *Sedum paradisum* ssp. *paradisum* | Canyon Creek stonecrop | May-Jun | None | None | 1B.3 |  ©2018 Julie Kierstead Nelson |
| *Legenere limosa* | legenere | Apr-Jun | None | None | 1B.1 |  ©2000 John Game |
| *Trifolium piorkowskii* | maverick clover | Apr-May | None | None | 1B.2 |  ©2018 Al Keuter |
| *Potamogeton epihydrus* | Nuttall's ribbon-leaved pondweed | (Jun)Jul-Sep | None | None | 2B.2 |  Louis-M. Landry, 2010 |
| *Juncus leiospermus* var. *leiospermus* | Red Bluff dwarf rush | Mar-Jun | None | None | 1B.1 |  ©2016 Dylan Neubauer |
| *Sagittaria sanfordii* | Sanford's arrowhead | May-Oct(Nov) | None | None | 1B.2 |  ©2013 Debra L. Cook |
| *Vaccinium shastense* ssp. *shastense* | Shasta huckleberry | (Jun-Sep)Dec-May | None | None | 1B.3 |  © 2016 Steve |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | Matson |
| *Neviusia cliftonii* | Shasta snow-wreath | Apr-Jun | None | CC | 1B.2 |  ©2008 Steve Matson |
| *Cryptantha crinita* | silky cryptantha | Apr-May | None | None | 1B.2 |  ©2009 Sierra Pacific Industries |
| *Orcuttia tenuis* | slender Orcutt grass | May-Sep(Oct) | FT | CE | 1B.1 |  © 2013 Justy Leppert |
| *Brodiaea matsonii* | Sulphur Creek brodiaea | May-Jun | None | None | 1B.1 |  ©2016 Len Lindstrand III |

Showing 1 to 11 of 11 entries

**Suggested Citation:**
California Native Plant Society, Rare Plant Program. 2022. Rare Plant Inventory (online edition, v9-01 1.5). Website https://www.rareplants.cnps.org [accessed 12 August 2022].

| | |
|---|---|
| **From:** | Brittany Reaves |
| **To:** | NMFS SpeciesList - NOAA Service Account |
| **Subject:** | Crystal Creek Aggregate Mine |
| **Date:** | Wednesday, May 25, 2022 3:23:26 PM |

Crystal Creek Aggregate Mine

Quad Name **Redding**

Quad Number **40122-E4**

## ESA Anadromous Fish

SONCC Coho ESU (T) -
CCC Coho ESU (E) -
CC Chinook Salmon ESU (T) -
CVSR Chinook Salmon ESU (T) - **X**
SRWR Chinook Salmon ESU (E) - **X**
NC Steelhead DPS (T) -
CCC Steelhead DPS (T) -
SCCC Steelhead DPS (T) -
SC Steelhead DPS (E) -
CCV Steelhead DPS (T) - **X**
Eulachon (T) -
sDPS Green Sturgeon (T) - **X**

## ESA Anadromous Fish Critical Habitat

SONCC Coho Critical Habitat -
CCC Coho Critical Habitat -
CC Chinook Salmon Critical Habitat -
CVSR Chinook Salmon Critical Habitat - **X**
SRWR Chinook Salmon Critical Habitat - **X**
NC Steelhead Critical Habitat -
CCC Steelhead Critical Habitat -
SCCC Steelhead Critical Habitat -
SC Steelhead Critical Habitat -
CCV Steelhead Critical Habitat - **X**
Eulachon Critical Habitat -
sDPS Green Sturgeon Critical Habitat - **X**

## ESA Marine Invertebrates

Range Black Abalone (E) -
Range White Abalone (E) -

## ESA Marine Invertebrates Critical Habitat

Black Abalone Critical Habitat -

**ESA Sea Turtles**

East Pacific Green Sea Turtle (T) -
Olive Ridley Sea Turtle (T/E) -
Leatherback Sea Turtle (E) -
North Pacific Loggerhead Sea Turtle (E) -

**ESA Whales**

Blue Whale (E) -
Fin Whale (E) -
Humpback Whale (E) -
Southern Resident Killer Whale (E) -
North Pacific Right Whale (E) -
Sei Whale (E) -
Sperm Whale (E) -

**ESA Pinnipeds**

Guadalupe Fur Seal (T) -
Steller Sea Lion Critical Habitat -

**Essential Fish Habitat**

Coho EFH -
Chinook Salmon EFH - **X**
Groundfish EFH -
Coastal Pelagics EFH -
Highly Migratory Species EFH -

**MMPA Species (See list at left)**

**ESA and MMPA Cetaceans/Pinnipeds**

**See list at left and consult the NMFS Long Beach office 562-980-4000**

MMPA Cetaceans -
MMPA Pinnipeds -

**Brittany Reaves**
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# United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish And Wildlife Office
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
Phone: (916) 414-6600 Fax: (916) 414-6713

In Reply Refer To: August 12, 2022
Project Code: 2022-0042796
Project Name: Crystal Creek Aggregate Mine

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated 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 (Act) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

New information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Please feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, 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 Act, 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 enclosed list.

The purpose of the Act 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 Act 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 (or other undertakings having similar physical impacts) 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. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

If a Federal 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

**Migratory Birds**: In addition to responsibilities to protect threatened and endangered species under the Endangered Species Act (ESA), there are additional responsibilities under the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act (BGEPA) to protect native birds from project-related impacts. Any activity, intentional or unintentional, resulting in take of migratory birds, including eagles, is prohibited unless otherwise permitted by the U.S. Fish and Wildlife Service (50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)). For more information regarding these Acts see https://www.fws.gov/birds/policies-and-regulations.php.

The MBTA has no provision for allowing take of migratory birds that may be unintentionally killed or injured by otherwise lawful activities. It is the responsibility of the project proponent to comply with these Acts by identifying potential impacts to migratory birds and eagles within applicable NEPA documents (when there is a federal nexus) or a Bird/Eagle Conservation Plan (when there is no federal nexus). Proponents should implement conservation measures to avoid or minimize the production of project-related stressors or minimize the exposure of birds and their resources to the project-related stressors. For more information on avian stressors and recommended conservation measures see https://www.fws.gov/birds/bird-enthusiasts/threats-to-birds.php.

In addition to MBTA and BGEPA, Executive Order 13186: *Responsibilities of Federal Agencies to Protect Migratory Birds*, obligates all Federal agencies that engage in or authorize activities that might affect migratory birds, to minimize those effects and encourage conservation measures that will improve bird populations. Executive Order 13186 provides for the protection of both migratory birds and migratory bird habitat. For information regarding the implementation of Executive Order 13186, please visit https://www.fws.gov/birds/policies-and-regulations/executive-orders/e0-13186.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Code in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

# 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:

**Sacramento Fish And Wildlife Office**
Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846
(916) 414-6600

# Project Summary

Project Code: 2022-0042796
Project Name: Crystal Creek Aggregate Mine
Project Type: Surface Extraction - Non Energy Materials
Project Description: mining
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@40.60422895,-122.47072967435363,14z


Counties: Shasta County, California

# Endangered Species Act Species

There is a total of 6 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.

---

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.

## Birds

| NAME | STATUS |
|---|---|
| Northern Spotted Owl *Strix occidentalis caurina*<br>There is **final** critical habitat for this species. The location of the critical habitat is not available.<br>Species profile: https://ecos.fws.gov/ecp/species/1123 | Threatened |

## Fishes

| NAME | STATUS |
|---|---|
| Delta Smelt *Hypomesus transpacificus*<br>There is **final** critical habitat for this species. The location of the critical habitat is not available.<br>Species profile: https://ecos.fws.gov/ecp/species/321 | Threatened |

## Insects

| NAME | STATUS |
|---|---|
| Monarch Butterfly *Danaus plexippus*<br>No critical habitat has been designated for this species.<br>Species profile: https://ecos.fws.gov/ecp/species/9743 | Candidate |
| Valley Elderberry Longhorn Beetle *Desmocerus californicus dimorphus*<br>There is **final** critical habitat for this species. The location of the critical habitat is not available.<br>Species profile: https://ecos.fws.gov/ecp/species/7850 | Threatened |

## Crustaceans

| NAME | STATUS |
|---|---|
| Vernal Pool Fairy Shrimp *Branchinecta lynchi*<br>There is **final** critical habitat for this species. The location of the critical habitat is not available.<br>Species profile: https://ecos.fws.gov/ecp/species/498 | Threatened |
| Vernal Pool Tadpole Shrimp *Lepidurus packardi*<br>There is **final** critical habitat for this species. The location of the critical habitat is not available.<br>Species profile: https://ecos.fws.gov/ecp/species/2246 | Endangered |

## Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

# IPaC User Contact Information

Agency: Gallaway Enterprises
Name: Brittany Reaves
Address: 117 Meyers Street, Suite 120
City: Chico
State: CA
Zip: 95928
Email brittany@gallawayenterprises.com
Phone: 5303329909

# Appendix B

Observed Species Lists

| Plant Species Observed within the BSA on May 21 & 27 and June 2 & 4, 2020 | |
|---|---|
| **Scientific Name** | **Common Name** |
| *Acmispon americanus* | Spanish lotus |
| *Aesculus californica* | California buckeye |
| *Agoseris grandiflora* | Large-flowered agoseris |
| *Agrostis avenacea* | Pacific bentgrass |
| *Ailanthus altissima* | Tree-of-heaven |
| *Aira caryophyllea* | Silver hairgrass |
| *Alisma lanceolatum* | Lance-leaved water plantain |
| *Allium amplectens* | Clasping onion |
| *Anaphalis margaritacea* | Pearly everlasting |
| *Anthoxanthum odoratum* | Sweet vernal grass |
| *Arctostaphylos manzanita ssp. manzanita* | Big manzanita |
| *Arctostaphylos viscida ssp. viscida* | White-leaved manzanita |
| *Aspidotis densa* | Lace fern |
| *Avena barbata* | Wild oats |
| *Avena fatua* | Wild oats |
| *Brachypodium distachyon* | False brome |
| *Briza maxima* | Greater quaking-grass |
| *Briza minor* | Lesser quaking-grass |
| *Brodiaea coronaria* | Harvest brodiaea |
| *Bromus spp.* | Brome |
| *Bromus diandrus* | Rip-gut brome |
| *Bromus hordeaceus* | Soft chess |
| *Bromus madritensis ssp. rubens* | Red brome |
| *Calycanthus occidentalis* | Western spicebush |
| *Calystegia occidentalis ssp. occidentalis* | Western morning glory |
| *Carex barbarae* | Valley sedge |
| *Castilleja attenuata* | Valley tassels |
| *Ceanothus lemmonii* | Lemmon's ceanothus |
| *Centaurea solstitialis* | Yellow star thistle |
| *Centaurium tenuiflorum* | June centaury |
| *Cercis occidentalis* | Western redbud |
| *Chlorogalum pomeridianum var. pomeridianum* | Wavyleaf soap-plant |
| *Cichorium intybus* | Chicory |
| *Cirsium occidentale* | Western snowy thistle |
| *Cirsium vulgare* | Bull thistle |
| *Convulvulus arvensis* | Bindweed |
| *Crassula aquatica* | Aquatic pygmyweed |
| *Crucianella angustifolia* | Crosswort |
| *Cryptantha intermedia* | Common cryptantha |
| *Cynodon dactylon* | Bermuda grass |
| *Cyperus eragrostis* | Tall nutsedge |
| *Cytisus scoparius* | Scotch broom |
| *Daucus carota* | Queen Anne's-lace |

| **Scientific Name** | **Common Name** |
|---|---|
| *Dichelostemma multiflorum* | Round-toothed ookow |
| *Drymocallis glandulosa* | Sticky cinquefoil |
| *Dysphania botrys* | Jerusalem oak goosefoot |
| *Eleocharis macrostachya* | Pale spike-rush |
| *Elymus caput-medusae* | Medusahead |
| *Elymus multisetus* | Big squirreltail grass |
| *Epilobium brachycarpum* | Tall willowherb |
| *Erigeron canadensis* | Canada horseweed |
| *Eriophyllum lanatum var. grandiflorum* | Large-flowered wooly sunflower |
| *Erodium botrys* | Long-beaked stork's-bill |
| *Erythranthe guttata* | Seep monkeyflower |
| *Euphorbia maculata* | Spotted spurge |
| *Euthamia occidentalis* | Western goldentop |
| *Festuca bromoides* | Six-weeks fescue |
| *Festuca myuros* | Rattail fescue |
| *Festuca perennis* | Rye-grass |
| *Frangula californica* | California coffeeberry |
| *Galium aparine* | Bedstraw |
| *Galium parisiense* | Wall bedstraw |
| *Galium porrigens* | Climbing bedstraw |
| *Gastridium phleoides* | Nitgrass |
| *Githopsis specularioides* | Common bluecup |
| *Gnaphalium palustre* | Western marsh cudweed |
| *Gratiola ebracteata* | Common hedge hyssop |
| *Heteromeles arbutifolia* | Toyon |
| *Hordeum marinum* ssp. *gussoneanum* | Mediterranean barley |
| *Hordeum murinum* | Wall hare barley |
| *Hypericum concinnum* | Gold wire |
| *Hypericum perforatum* | Klamathweed |
| *Hypochaeris glabra* | Smooth cat's ear |
| *Iris spp.* | Iris |
| *Juncus balticus ssp. ater* | Baltic rush |
| *Juncus bufonius* | Toadrush |
| *Juncus effusus* | Pacific rush |
| *Juncus oxymeris* | Pointed rush |
| *Juncus xiphioides* | Iris-leaved rush |
| *Lactuca serriola* | Prickly lettuce |
| *Leontodon saxatilis* | Hawkbit |
| *Linum bienne* | Pale flax |
| *Logfia gallica* | Narrowleaf cottonrose |
| *Lonicera interrupta* | Chaparral honeysuckle |
| *Lupinus bicolor* | Annual lupine |
| *Lysimachia arvensis* | Scarlet pimpernel |
| *Lythrum hyssopifolia* | Hyssop loosestrife |
| *Madia gracilis* | Slender tarweed |

| Scientific Name | Common Name |
|---|---|
| *Mentha pulegium* | Pennyroyal |
| *Minuartia douglasii* | Douglas' sandwort |
| *Mollugo verticillata* | Indian chickweed |
| *Navarretia intertexta ssp. intertexta* | Needle-leaved navarretia |
| *Odontostomum hartwegii* | Hartweg's odontostomum |
| *Panicum acuminatum* | Western panicgrass |
| *Papaver rhoeas* | Corn poppy |
| *Paspalum dilatatum* | Dallisgrass |
| *Pellaea mucronata* | Bird's foot fern |
| *Pentagramma triangularis ssp. triangularis* | Gold-backed fern |
| *Petrorhgia dubia* | Grass-pink |
| *Pinus attenuata* | Knobcone pine |
| *Pinus ponderosa* | Ponderosa pine |
| *Pinus sabiniana* | Gray pine |
| *Plagiobothrys stipitatus* var. *micranthus* | Small-flowered popcornflower |
| *Plantago lanceolata* | English plantain |
| *Polypogon monspeliensis* | Rabbitsfoot grass |
| *Populus fremontii* | Fremont's cottonwood |
| *Quercus berberidifolia* | Scrub oak |
| *Quercus douglasii* | Blue oak |
| *Quercus kelloggii* | California black oak |
| *Ranunculus aquatilis* | Broad-leaved water buttercup |
| *Robinia pseudoacacia* | Black locust |
| *Rubus armeniacus* | Himalayan blackberry |
| *Rumex crispus* | Curly dock |
| *Rumex pulcher* | Fiddle dock |
| *Salix exigua* | Sandbar willow |
| *Salix lasiandra* | Pacific willow |
| *Salix lasiolepis* | Arroyo willow |
| *Scutellaria siphocampyloides* | Gray leaved skullcap |
| *Senecio vulgaris* | Old-man-in-the-Spring |
| *Silene gallica* | Common catchfly |
| *Solanum parishii* | Parish's nightshade |
| *Solidago velutina ssp. californica* | California goldenrod |
| *Sonchus asper* | Sow thistle |
| *Spergularia rubra* | Ruby sandspurry |
| *Spiranthes porrifolia* | Creamy ladies tresses |
| *Stipa pulchra* | Purple needlegrass |
| *Styrax redivivus* | California snowdrop bush |
| *Torilis arvensis* | Hedge parsley |
| *Toxicodendron diversilobum* | Poison oak |
| *Tragopogon sp.* | Salsify |
| *Trifolium arvense* | Rabbitfoot clover |
| *Trifolium glomeratum* | Sessile-headed clover |
| *Trifolium hirtum* | Rose clover |

| **Scientific Name** | **Common Name** |
|---|---|
| *Trifolium willdenovii* | Wildcat clover |
| *Typha latifolia* | Cattails |
| *Verbascum blattaria* | Moth mullein |
| *Verbascum thapsus* | Woolly mullein |
| *Veronica peregrina* ssp. *xalapensis* | Purslane speedwell |
| *Vicia sativa* | Garden vetch |
| *Vicia villosa* | Winter vetch |
| *Vitis californica* | Wild grape |
| *Woodwardia fimbriata* | Giant chain fern |
| *Wyethia spp.* | Narrow leaf mule ears |

| Wildlife Observed within the BSA | |
|---|---|
| **Common Name** | ***Scientific Name*** |
| **Birds** | |
| Red-winged blackbird | *Agelaius phoeniceus* |
| Brown headed cow bird | *Molothrus ater* |
| Turkey vulture | *Cathartes aura* |
| Ash-throated flycatcher | *Myiarchus cinerascens* |
| California quail | *Callipepla californica* |
| American crow | *Corvus brachyrhynchos* |
| Red-tail hawk | *Buteo jamaicensis* |
| American goldfinch | *Spinus tristis* |
| Band-tailed pigeon | *Patagioneas fasciata* |
| Scrub Jay | *Aphelocoma californica* |
| White breasted nuthatch | *Sitta carolinensis* |
| Oak titmouse | *Baelophus inornatus* |
| **Insects** | |
| Honey bee | *Apis mellifera* |
| **Amphibians/Reptiles** | |
| Western pond turtle | *Emys marmorata* |
| Northwestern fence lizard | *Sceloporus occidentalis occidentalis* |
| American bullfrog | *Lithobates catesbeianus* |
| Northern pacific treefrog | *Pseudacris regilla* |
| **Fish** | |
| Bass | *Micropterus spp.* |
| **Mammals** | |
| Coyote | *Canis latrans* |
| Black-tailed jackrabbit | *Lepus californicus* |

# Appendix C

Draft Delineation of Aquatic Resources Impacts Map

Project Boundary - (179.97 acres)
25 Foot Contours
Limits of Final Grading
Erosional - ER# - (0.253 acres)
Active Mining - (75.89 acres)
Mineral Resource Area - (69.28 acres)
Permitted- (110.69 acres)

## Aquatic Resources - (10.070 acres)

### Other Waters - OW# - (9.483 acres)

Ditch - D# - (0.066 acres)
Ephemeral - E# - (1.217 acres)
Intermittent - OW# - (0.529 acres)
Intermittent (Isolated) - I# - (0.053 acres)
Pond - PO# - (7.618 acres)

### Wetland Features - WF# - (0.587 acres)

Seasonal Wetland - WF# - (0.587 acres)

## Impacts to Aquatic Resources - (0.747 acres)

### Other Waters - OW# - (0.725 acres)

Ephemeral - E# - (0.301 acres)
Intermittent - OW# - (0.186 acres)
Intermittent (Isolated) - I# - (0.044 acres)
Pond - PO# - (0.243 acres)

### Wetland Features - WF# - (0.022 acres)

Seasonal Wetland - WF# - (0.022 acres)

**Impacts to Aquatic Resources**

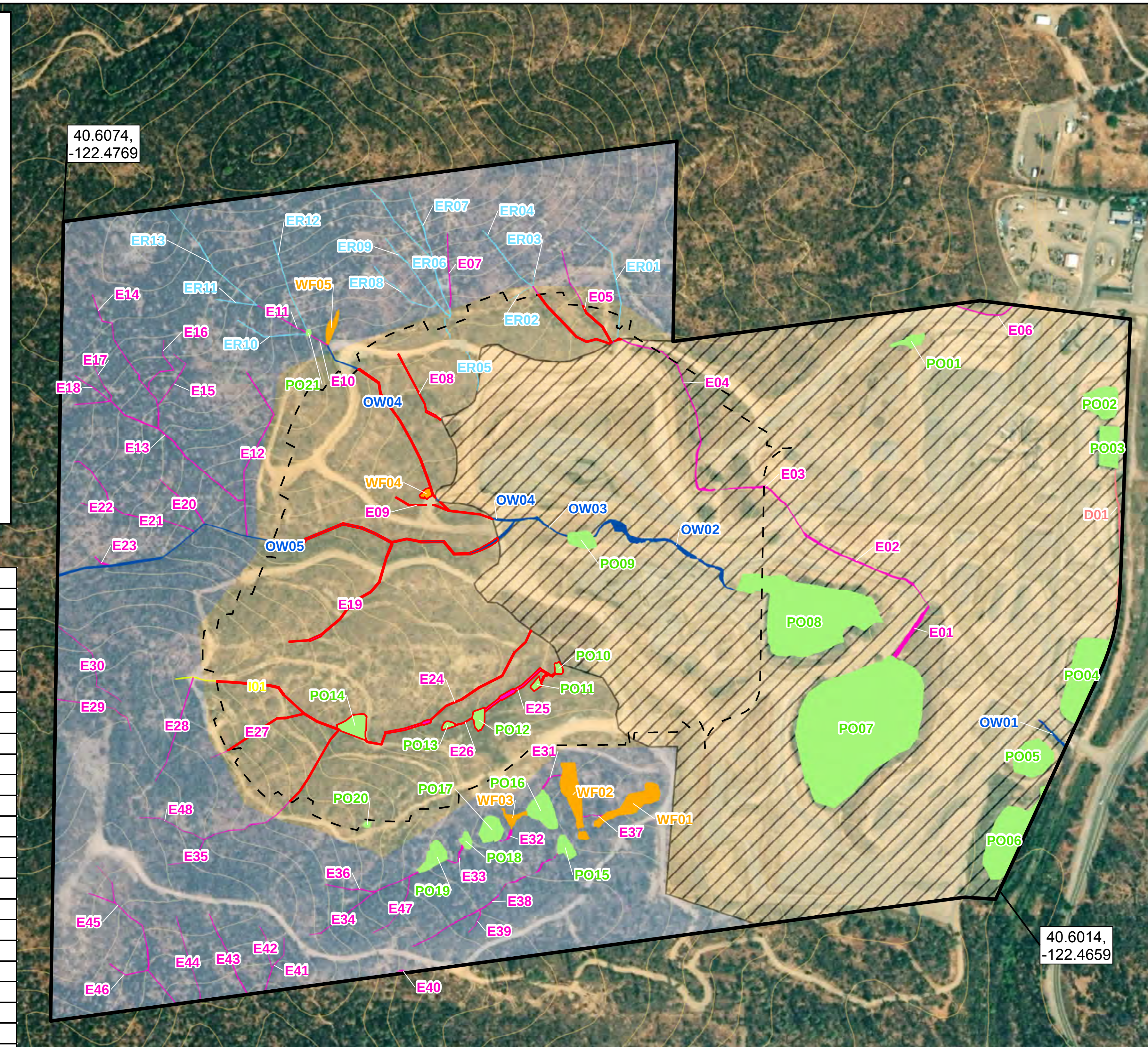
**Wetland Features**

| Label | Cowardin | Description | Location (Lat, Long) | | Width* | Length (ft) | Area (sq ft) | Acres |
|---|---|---|---|---|---|---|---|---|
| WF04 | PEM | Seasonal Wetland | 40.605013 | -122.472637 | N/A | N/A | 962.9 | 0.022 |
| | | | | | | Wetland Features Impact Totals = | 962.9 | 0.022 |

**Other Waters**

| Label | Cowardin | Description | Location (Lat, Long) | | Width* | Length (ft) | Area (sq ft) | Acres |
|---|---|---|---|---|---|---|---|---|
| E04 | R6 | Ephemeral | 40.606527 | -122.470952 | 65.1 | 308.6 | 1143.8 | 0.026 |
| E05 | R6 | Ephemeral | 40.606532 | -122.470637 | 14.8 | 153.0 | 593.8 | 0.014 |
| E08 | R6 | Ephemeral | 40.605905 | -122.47272 | 29.3 | 254.7 | 738.9 | 0.017 |
| E09 | R6 | Ephemeral | 40.604914 | -122.472702 | 19.3 | 179.1 | 429.4 | 0.010 |
| E19 | R6 | Ephemeral | 40.604039 | -122.473521 | 71.1 | 465.4 | 2110.9 | 0.048 |
| E24 | R6 | Ephemeral | 40.603152 | -122.472362 | 73.6 | 647.4 | 2956.0 | 0.068 |
| E25 | R6 | Ephemeral | 40.603277 | -122.471557 | 45.7 | 263.6 | 2604.3 | 0.060 |
| E26 | R6 | Ephemeral | 40.602975 | -122.472182 | 6.7 | 59.2 | 117.5 | 0.003 |
| E27 | R6 | Ephemeral | 40.602912 | -122.474508 | 27.4 | 274.2 | 862.1 | 0.020 |
| E35 | R6 | Ephemeral | 40.602574 | -122.473929 | 11.8 | 282.8 | 796.2 | 0.018 |
| I01 | R4 | Intermittent (Isolated) | 40.603178 | -122.474354 | 60.4 | 428.8 | 1756.7 | 0.040 |
| OW04 | R4 | Intermittent | 40.605444 | -122.472783 | 101.2 | 656.0 | 2646.9 | 0.061 |
| OW05 | R4 | Intermittent | 40.604598 | -122.473021 | 88.5 | 734.2 | 4697.0 | 0.108 |
| PO10 | PUB | Pond | 40.603459 | -122.471078 | N/A | N/A | 880.3 | 0.020 |
| PO13 | PUB | Pond | 40.602946 | -122.472371 | N/A | N/A | 803.9 | 0.018 |
| PO14 | PUB | Pond | 40.602934 | -122.473461 | N/A | N/A | 5265.5 | 0.121 |
| PO18 | PUB | Pond | 40.603314 | -122.471337 | N/A | N/A | 915.5 | 0.021 |
| PO19 | PUB | Pond | 40.603006 | -122.472007 | N/A | N/A | 2251.5 | 0.052 |
| | | | | | | Other Waters Impact Totals = | 31570.2 | 0.725 |
| | | | | | | Aquatic Resources Impact Totals = | 32533.1 | 0.747 |

*Widths are represented as averges




The features represented on this graphic are considered preliminary until written verification by the USACE.

Coordinate System: NAD 1983 California State Plane I (Feet)
Projection: Lambert Conformal Conic
Datum: North American 1983
Vertical Datum: NAVD 88

Made in accordance with the Updated Map & Drawing Standards for the South Pacific Division Regulatory Program

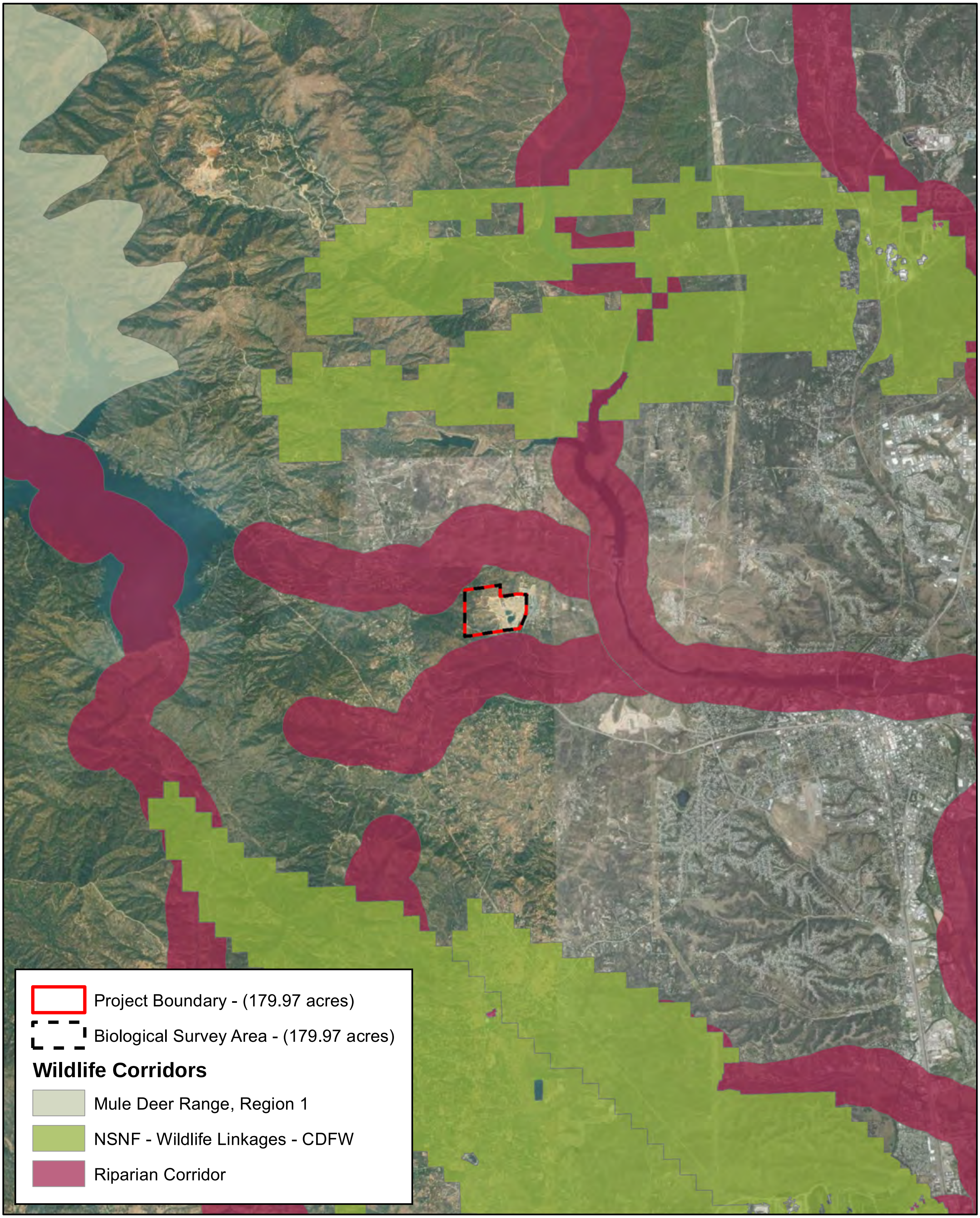
NORTH
1:4,800 1 inch = 400 feet
0 200 400 Feet
Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Impacts to Aquatic Resources
Appendix C

Delineation by: E. Gregg
Map by: A. McLaughlin
GE: #22-050
gallaway ENTERPRISES
Map Date: 09/28/2022

# Appendix D

CDFW-Designated Wildlife Corridors




NORTH

1:84,200

0 0.5 1 Miles

Data Sources: ESRI, CDFW, CNDDB, Maxar 09/15/2021, City of Redding 05/27/2020

Crystal Creek Aggregate Mine
CDFW-Designated Wildlife Corridors
Appendix D

gallaway ENTERPRISES

GE: #22-050 Map Date: 05/25/2022

# Appendix E

Site Photos Taken June 2 and 4, 2020

**Project Site Photographs Taken June 2 and 4, 2020**

Pond where western pond turtle was observed

Overview of intermittent drainage

One of the patches of black oaks that were decimated by the Carr Fire

Overview of active mine area

Overview of mixed chaparral habitat

Historic mine tunnel in BSA

**Project Site Photographs Taken April 28, 2022**

Mining area with active mining ponds

Barren roadway adjacent to burnt trees

Regenerating mixed chaparral

gallaway ENTERPRISES

# DRAFT DELINEATION OF AQUATIC RESOURCES

## Crystal Creek Aggregate Mine

Shasta County, California

**September 2022**


Prepared for:

**Crystal Creek Aggregates**

Attn: Chris Handley

P.O. Box 493416

Redding, CA 96049

Prepared by:

**Gallaway Enterprises**

117 Meyers Street, Suite 120

Chico CA 95928

(530) 332-9909

www.gallawayenterprises.com

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# DRAFT DELINEATION OF AQUATIC RESOURCES,

Crystal Creek Aggregate Mine, Shasta County, California

## Introduction and Project Location

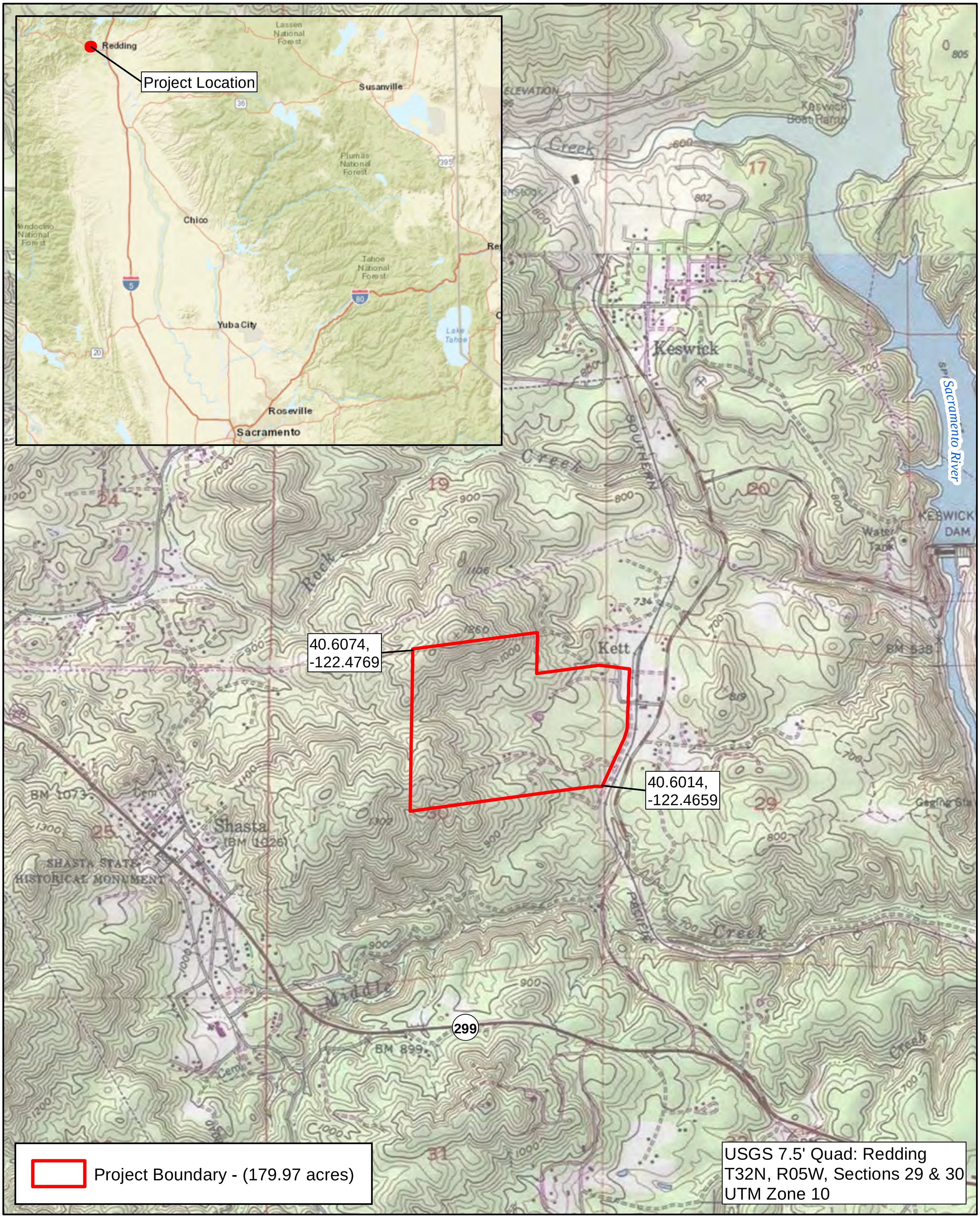
Gallaway Enterprises conducted a delineation of aquatic resources, including waters of the United States (WOTUS) and waters of the State (WOTS), for the Crystal Creek Aggregate Mine Use Permit Amendment project (Project) site consisting of 179.97 acres off of Iron Mountain Road in unincorporated Shasta County, California (**Figure 1 and 2**). The Project site is composed of the existing permitted mining area including the active mining and aggregate plant (Mine), approximately 110 acres, and adjacent Mineral Resource Area (MRA), approximately 70 acres (**Figure 2**). The Project site is located within the United States Geological Survey (USGS) Redding Quadrangle, primarily within Section 30, Township 32 N, Range 5 W.

Access to the site is from Highway 299 traveling west from Redding, CA. Take Highway 299 for approximately 3.5 miles west of Redding and then turn right onto Iron Mountain Road. Continue on Iron Mountain Road for 1.4 miles and the mine entrance occurs on the west side of the road.

A survey of WOTUS was originally conducted on May 27 and June 2 and 4, 2020, by senior botanist Elena Gregg. An additional field survey was conducted on April 28, 2022 to document current site conditions and assess the site per the current definition of WOTUS. Data regarding the location and extent of WOTUS and other aquatic resources were collected using a Trimble Geo Explorer 6000 Series GPS Receiver. The survey involved an examination of botanical resources, soils, hydrological features, and determination of wetland characteristics based on the *United States Army Corps of Engineers Wetlands Delineation Manual* (1987) (1987 Delineation Manual); the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region* (2008) (Arid West Manual); the *U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook* (2007); the *Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States* (2008), and the *2020 Arid West Regional Wetland Plant List* and the *2020 National Wetland Plant List.* Gallaway Enterprises have prepared this report in compliance with the Minimum Standards for Acceptance of Aquatic Resources Delineation Reports (January 2016).

### Environmental Setting and Site Conditions

The Project site is located within the foothills at the transition between the northern Sacramento Valley and the Klamath Mountains in unincorporated Shasta County. To the west of the Project site is the Whiskeytown National Recreation Area and to the east is the City of Redding, California. The site is located within the burn scar of the Carr Fire and is composed of the barren active aggregate mine and surrounding natural land. The surrounding natural land is hilly to very steep mixed chaparral and montane hardwood-conifer habitat that is currently in a state of regeneration after the fire. Incidental to the existing and historic mining operation on the site was the construction of multiple excavated ponds and pits. Further, numerous drainages occur on the site, the majority of which are ephemeral drainages that form along the steep hillsides. A steep ridgeline occurs along the western and northern boundary, as such, all but a few ephemeral drainages located in the southwestern corner of the site boundary flow to the east and into the controlled active mining ponds. The current mining activities within the Mine area are permitted under Shasta County Use Permit Amendment 07-020 and Reclamation Plan Amendment 07-002. An amendment to these existing documents is currently proposed. The Use Permit and Reclamation Plan Amendments do not propose any changes to the limits of the currently approved/permitted Mine area.




NORTH

1:24,000

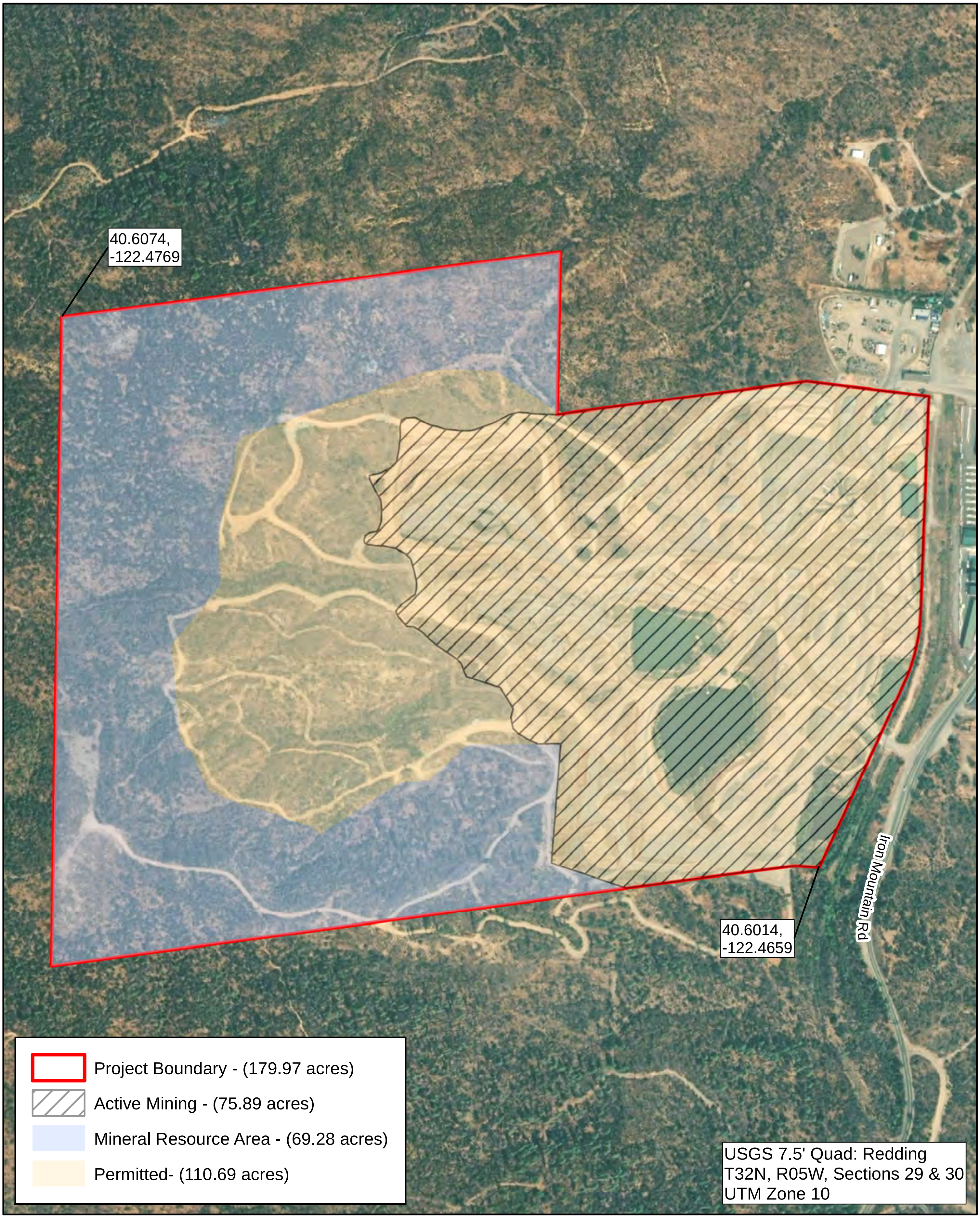
0 0.25 0.5 Miles

Data Sources: ESRI, Shasta County, USGS, DKM Engineering

Crystal Creek Aggregate Mine
Regional Location
Figure 1

gallaway ENTERPRISES

GE: #22-050 Map Date: 05/13/2022




NORTH

1:6,000

0 200 400 Feet

Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Project Location
Figure 2

gallaway ENTERPRISES

GE: #22-050 Map Date: 09/27/2022

The average annual precipitation is 33.68 inches and the average annual temperature is 62.45° F (WRCC 2022) in the region where the Project is located. The elevation of the Project site ranges from 740 to 1190 feet above sea level. The Project site contained slopes ranging from 0 to 50 percent. Soils within the site were rocky and sandy loams with a restrictive bedrock layer ranging from 0 to 54 inches deep.

## Survey Methodology

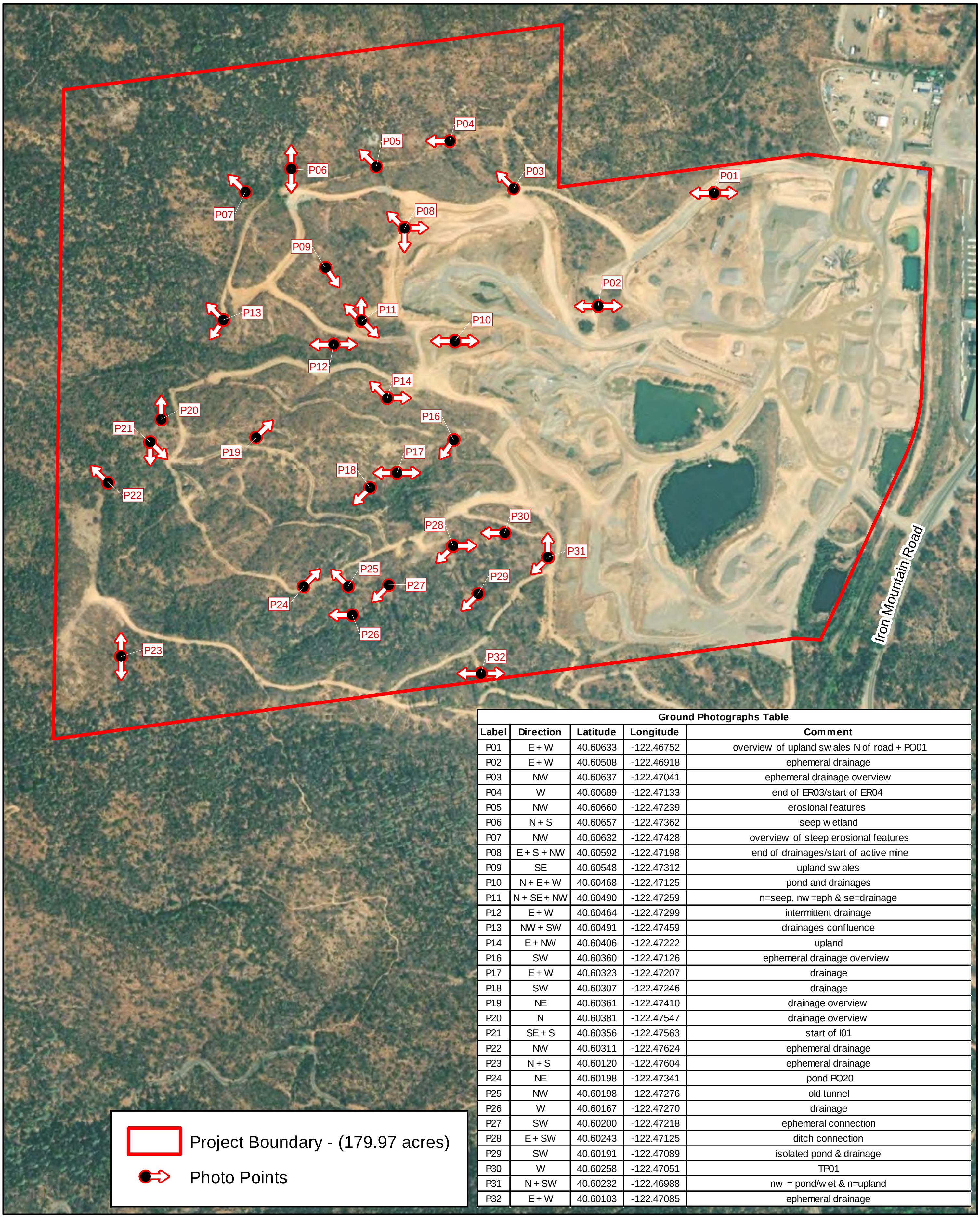
The entire Project site was traversed by Gallaway Enterprises staff on May 27 and June 2 and 4, 2020 and on April 28, 2022 to identify any potentially jurisdictional features. The survey, mapping efforts, and report production were performed according to the current valid legal definitions of WOTUS in effect as of September 20, 2021. The boundaries of non-tidal, non-wetland waters, when present, were delineated at the ordinary high water mark (OHWM) as defined in 33 Code of Federal Regulations (CFR) 328.3. The OHWM represents the limit of United States Army Corps of Engineers (Corps) jurisdiction over non-tidal waters (e.g., streams and ponds) in the absence of adjacent wetlands (33 CFR 328.04) (Curtis, et. al. 2011). Historic aerial photographs available on Google Earth were analyzed prior to conducting the field visit. Areas identified as having potential wetland or unusual signatures on historical aerial photos were assessed in the field to determine the current conditions.

Field data were entered onto data sheets using the most current format (**Appendix A**). Wetland perimeters based on the 1987 Delineation Manual and the Arid West Manual were recorded and defined according to their topographic and hydrologic orientation. Sample points were established for each wetland and the corresponding upland zone. Test pit sampling was performed in areas displaying wetland signatures on past aerial photographs and problem areas. Test pit sampling points involved physical sampling of soils and vegetation, and investigation regarding hydrological connectivity. Only areas exhibiting the necessary wetland parameters according to the 1987 Delineation Manual and Arid West Manual on the date surveyed were mapped as wetlands. Photographs were taken to show wetland features, test pit areas, and/or areas identified as having unusual aerial signatures. The locations of the photo points are depicted in **Figure 3** and the associated photographs are provided at the end of the report.

Many of the terms used throughout this report have specific meanings relating to the federal wetland delineation process. Term definitions are based on the Corps 1987 Delineation Manual*; the Arid West Manual; Field Guide to the Identification of the Ordinary High Water Mark* (OHWM) in the *Arid West Region of the Western United States*, (Lichvar and McColley 2008) and the Corps *Jurisdictional Determination Form Instructional Guidebook* (2007). The terms defined below have specific meaning relating to the delineation of WOTUS as prescribed by §404 of the Clean Water Act (CWA) and described in 33 CFR Part 328 and 40 CFR Parts 110, 112, and 116, and 122.

### Determination of Hydrophytic Vegetation

The presence of hydrophytic vegetation was determined using the methods outlined in the 1987 Delineation Manual and the Arid West Manual. Areas were considered to have positive indicators of hydrophytic vegetation if they pass the dominance test, meaning more than 50 percent of the dominant species are obligate wetland, facultative wetland and facultative plants. Plant species were identified to the lowest taxonomy possible. Plant indicator status was determined by reviewing the 2020 Arid West Region Wetland Plant List and the 2020 National Wetland Plant List. In situations where dominance can be misleading due to seasonality, the prevalence index will be used to determine hydrophytic status of the community surrounding sample sites.




| Ground Photographs Table | | | | |
|---|---|---|---|---|
| **Label** | **Direction** | **Latitude** | **Longitude** | **Comment** |
| P01 | E + W | 40.60633 | -122.46752 | overview of upland swales N of road + PO01 |
| P02 | E + W | 40.60508 | -122.46918 | ephemeral drainage |
| P03 | NW | 40.60637 | -122.47041 | ephemeral drainage overview |
| P04 | W | 40.60689 | -122.47133 | end of ER03/start of ER04 |
| P05 | NW | 40.60660 | -122.47239 | erosional features |
| P06 | N + S | 40.60657 | -122.47362 | seep wetland |
| P07 | NW | 40.60632 | -122.47428 | overview of steep erosional features |
| P08 | E + S + NW | 40.60592 | -122.47198 | end of drainages/start of active mine |
| P09 | SE | 40.60548 | -122.47312 | upland swales |
| P10 | N + E + W | 40.60468 | -122.47125 | pond and drainages |
| P11 | N + SE + NW | 40.60490 | -122.47259 | n=seep, nw=eph & se=drainage |
| P12 | E + W | 40.60464 | -122.47299 | intermittent drainage |
| P13 | NW + SW | 40.60491 | -122.47459 | drainages confluence |
| P14 | E + NW | 40.60406 | -122.47222 | upland |
| P16 | SW | 40.60360 | -122.47126 | ephemeral drainage overview |
| P17 | E + W | 40.60323 | -122.47207 | drainage |
| P18 | SW | 40.60307 | -122.47246 | drainage |
| P19 | NE | 40.60361 | -122.47410 | drainage overview |
| P20 | N | 40.60381 | -122.47547 | drainage overview |
| P21 | SE + S | 40.60356 | -122.47563 | start of I01 |
| P22 | NW | 40.60311 | -122.47624 | ephemeral drainage |
| P23 | N + S | 40.60120 | -122.47604 | ephemeral drainage |
| P24 | NE | 40.60198 | -122.47341 | pond PO20 |
| P25 | NW | 40.60198 | -122.47276 | old tunnel |
| P26 | W | 40.60167 | -122.47270 | drainage |
| P27 | SW | 40.60200 | -122.47218 | ephemeral connection |
| P28 | E + SW | 40.60243 | -122.47125 | ditch connection |
| P29 | SW | 40.60191 | -122.47089 | isolated pond & drainage |
| P30 | W | 40.60258 | -122.47051 | TP01 |
| P31 | N + SW | 40.60232 | -122.46988 | nw = pond/wet & n=upland |
| P32 | E + W | 40.60103 | -122.47085 | ephemeral drainage |

NORTH

1:6,000

0 250 500 Feet

Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Ground Photographs Map
Figure 3

gallaway ENTERPRISES

GE: #22-050 Map Date: 05/13/2022

***Plant indicator status categories:***

*Obligate wetland plants* (OBL) – plants that occur almost always (estimated probability 99%) in wetlands under normal conditions, but which may also occur rarely (estimated probability 1%) in non-wetlands.

*Facultative wetland plants* (FACW) - plants that usually occur (estimated probability 67% to 99%) in wetlands under normal conditions, but also occur (estimated probability 1% to 33%) in non-wetlands.

*Facultative plants* (FAC) – Plants with a similar likelihood (estimated probability 33% to 67%) of occurring in both wetlands and non-wetlands.

*Facultative upland plants* (FACU) – Plants that occur sometimes (estimated probability1% to 33%) in wetlands, but occur more often (estimated probability 67% to 99%) in non-wetlands.

*Obligate upland plants* (UPL) – Plants that occur rarely (estimated probability 1%) in wetlands, but occur almost always (estimated probability 99%) in non-wetlands under natural conditions.

## Determination of Hydric Soils

Soil survey information was reviewed for the current site condition. Field samples were evaluated by using the Munsell soil color chart (2009 Edition), hand texturing, and assessing soil features (e.g. oxidized root channels, evidence of hardpan, Mn and Fe concretions). Information regarding local soil and series descriptions is provided in **Appendix B.** Several test pits (**Appendix A**) were dug within portions of the site that demonstrated wetland signatures in historic aerial photographs but did not meet the wetland test parameters upon investigation in the field. The current Natural Resources Conservation Service (NRCS) *Field Indicators of Hydric Soils in the United States, Version 8.2* (NRCS 2018) was used in conjunction with the Arid West Manual to determine the presence of hydric soil indicators.

## Determination of Wetland Hydrology

Wetland hydrology was determined to be present if a site supported one or more of the following characteristics:

- Landscape position and surface topography (e.g. position of the site relative to an up-slope water source, location within a distinct wetland drainage pattern, and concave surface topography),
- Inundation or saturation for a long duration either inferred based on field indicators or observed during repeated site visits, and
- Residual evidence of ponding or flooding resulting in field indicators such as scour marks, sediment deposits, algal matting, surface soil cracks and drift lines.

The presence of water or saturated soil for approximately 12% or 14 consecutive days during the growing season typically creates anaerobic conditions in the soil, and these conditions affect the types of plants that can grow and the types of soils that develop (Wetland Training Institute 1995).

Historic aerial photographs were analyzed to look for primary and secondary wetland hydrology indicators of inundation or saturation. The historic aerial imagery reviewed was the public, readily available imagery provided on Google Earth (1994-2018). If aerial signatures demonstrated the presence of surface water on 1 or more of the historic aerial photographs viewed, inundation and a primary indicator of wetland hydrology was determined to be present. Saturation, a secondary indicator of wetland hydrology, was determined to be present if saturation, “darker patches within the field,” were observed on 1 or more historic aerial photographs viewed and the presence of hydric soils was confirmed in these areas during the field survey.

## Determination of Ordinary High Water Mark

Gallaway utilized methods consistent with the Arid West Manual and *Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States,* (Lichvar and McColley 2008*)* to determine the OHWM. The lateral extents of non-tidal water bodies (e.g. intermittent and ephemeral streams) were based on the OHWM, which is "the line on the shore established by the fluctuations of water" (Corps 2005). The OHWM was determined based on multiple observed physical characteristics of the area, which can include scour, multiple observed flow events (from current and historical aerial photos), shelving, and changes in the character of soil, presence of mature vegetation, deposition, and topography. Due to the wide extent of some floodplains, adjacent riparian scrub areas characterized by hydric soils, hydrophytic vegetation, and hydrology may be included within the OHWM of a non-tidal water body (Curtis, et. al. 2011). Inclusion of minor special aquatic areas is an acceptable practice as outlined in the Arid West Manual.

***OHWM Transects:***

Representative OHWM widths measured in the field in feet as required by the Corps *Updated Map and Drawing Standards for the South Pacific Division Regulatory Program (2016)* and presented as an average for the entire drainage. These transect measurements are used to ensure that the other waters of the United States identified within the area surveyed are mapped and calculated at the appropriate average width for each channel segment based on the Corps definition of OHWM as defined in the Arid West OHWM Field Guide and the Ordinary High Water Mark Identification RGL 05-05 (2005) (RGL 05-05). At the transect line Gallaway used multiple observed physical indicators in determining the OHWM. The lateral extents of the transect lines identify the location of the OHWM where benches, drift, exposed root hairs, changes in substrate/particle size, and, if appropriate, changes in vegetation were observed.

## Determination of Wetland Boundaries in Difficult Wetland Situations

The difficult wetland situation procedures for determining hydrophytic vegetation were used when mapping the boundary of wetlands within the Project site due to the extreme drought conditions experienced in California in 2021 and the winter of 2021/2022 (NOAA 2022). To aid in the determination, spatial patterns, analysis of aerial photographs, topography, and landscape position were used in conjunction with vegetation data to determine the wetland boundary. Areas where wetland vegetation or wetland hydrology was lacking but where the landscape position was likely to concentrate water were closely inspected. Gallaway Enterprises mapped these areas as wetlands if hydric soil indicators were detected and at least one other hydric indicator was present (i.e. wetland hydrology or hydrophytic vegetation).

## Aquatic Resource Boundary Determination and Acreage Calculation

Most of the feature boundaries were previously mapped within the Project site by Wildland Resource Managers in 2019. Gallaway Enterprises used the shapefiles from this previous mapping effort to assess, update and verify the extent of current aquatic resources within the Project site. The wetland-upland boundary was determined based on the presence or inference of positive indicators of all mandatory criteria. Soil samples were taken within wetland and upland areas. The site was traversed on foot to identify wetland features and boundaries. The spatial data obtained by Gallaway Enterprises during the preparation of this wetland delineation was collected using a Trimble Geo Explorer 6000 Series GPS Receiver. No readings were taken with fewer than 5 satellites. Point data locations were recorded for at least 25 seconds at a rate of 1 position per second. Area and line data were recorded at a rate of 1 position per second while walking at a slow pace. All GPS data were differentially corrected for maximum accuracy. In some cases, when visual errors and degrees of precision are identified due to environmental factors negatively influencing the precision of the GPS instrument (i.e. dense tree cover, steep topography, and other factors affecting satellite connection) mapping procedures utilized available topographic and aerial imagery datasets in order to improve accuracy in feature alignment and location.

### Non-Wetland and Non-Jurisdictional Feature Boundary Determination

Areas were determined to be non-wetlands if they did not meet the necessary wetland test parameters (hydrophytic vegetation, hydric soil, and wetland hydrology) (33 CFR 328.4) and were determined to be potentially non-jurisdictional if they were consistent with the description of non-jurisdictional features as presented in the *Corps Jurisdictional Determination Form Instructional Guidebook* (2007).

There were a number of areas that exhibited wetland or drainage signatures within the Project site, however, based on the visual assessment and data collected at these locations the areas lacked the necessary parameters and were not mapped as features. A few of these areas exhibited wetland signatures, but test pit data collected at these locations determine that they lacked the necessary wetland parameters to be considered wetland features (see TP01-TP03 on **Figure 4** and in **Appendix A**). There were also numerous upland swales present within the Project site that lacked an OHWM and were dominated by upland vegetation. Photo points were taken to document the lack of OHWM and wetland parameters that was typical within these upland swales (**Figure 3**).

Numerous erosional features occur within the Project site (ER01-ER13 on **Figure 4**). These features occur within dirt access roads or occur on extremely steep hillsides and are characterized by eroded, unstable banks and a bed with scour. Further, no evidence of an OHWM was observed within these erosional features. As such, these features meet the definition of non-jurisdictional erosional features per the *Corps Jurisdictional Determination Form Instructional Guidebook*.

There were also a number of features that met the parameters of a wetland or OW but were consistent with the description of non-jurisdictional features per the *Corps Jurisdictional Determination Form Instructional Guidebook* within the Project area. **Table 1** summarizes the potentially non-jurisdictional features within the Project site. Multiple ponds and pits excavated in upland incidental to mining are present within the site and are isolated features (**Figure 4**). These ponds, some of which currently function as seasonal wetlands, were created by the historic mining operations conducted in the 1960's (PO10-PO20 and WF01-WF03) or more recently as part of the existing and currently active mining operation (PO01-PO09). The ponds used in the current and ongoing mining operation (PO01-PO09) are regularly managed for vegetation and are engineered to be isolated in order to control runoff and function as sediment ponds. Water from PO07 is pumped into PO03 as makeup water for evaporation that occurs in PO03. Water from PO03 is pumped into the wash plant on the site. There are three controlled outfalls that, when in use/opened, flow into OW01 or the offsite unnamed tributary of Middle Creek. These controlled outfalls include: the culvert C01 that transports water from PO08 to OW01; the culvert C04 that transports water from PO06 into an offsite tributary of Middle Creek; and the culvert C03 that has a slide gate that outfalls into OW01. As such, all of these ponds within the Project site meet the definition of a non-jurisdictional WOTUS. There is also one ephemeral ditch (D01) that was created in upland to be used as an emergency overflow ditch. Due to the function of this ditch and the fact that it is not within or a realignment of a natural drainage, this ditch meets the definition of a non-jurisdictional WOTUS.

There is also one intermittent drainage (I01) and 18 ephemeral drainages present within the Project site, (E07, E08, E24-E28, E31-E39, E47 and E48) that do not have a direct hydrologic connection to a TNW. As such, even though these drainages meet the definition of an intermittent or ephemeral, they may not be considered jurisdictional due to their isolated nature.

Finally, there are four intermittent drainages (OW04-OW05), 21 ephemeral drainages (E01-E06 and E09-E23), two wetlands (WF04 and WF05), and one pond (PO21) that all drain into one of the active mining

- Project Boundary - (179.97 acres)
- 25 Foot Contours
- Culvert - C#
- Flow Direction
- Photo Points* - P#
- Erosional - ER# - (0.253 acres)
- Active Mining - (75.89 acres)
- Mineral Resource Area - (69.28 acres)
- Permitted- (110.69 acres)

**Data Points**

- Test Pit - TP#
- Upland - U#
- Wetland - W#

**Aquatic Resources - (10.070 acres)**

**Other Waters - OW# - (9.483 acres)**

- Ditch - D# - (0.066 acres)
- Ephemeral - E# - (1.217 acres)
- Intermittent - OW# - (0.529 acres)
- Intermittent (Isolated) - I# - (0.053 acres)
- Pond - PO# - (7.618 acres)

**Wetland Features - WF# - (0.587 acres)**

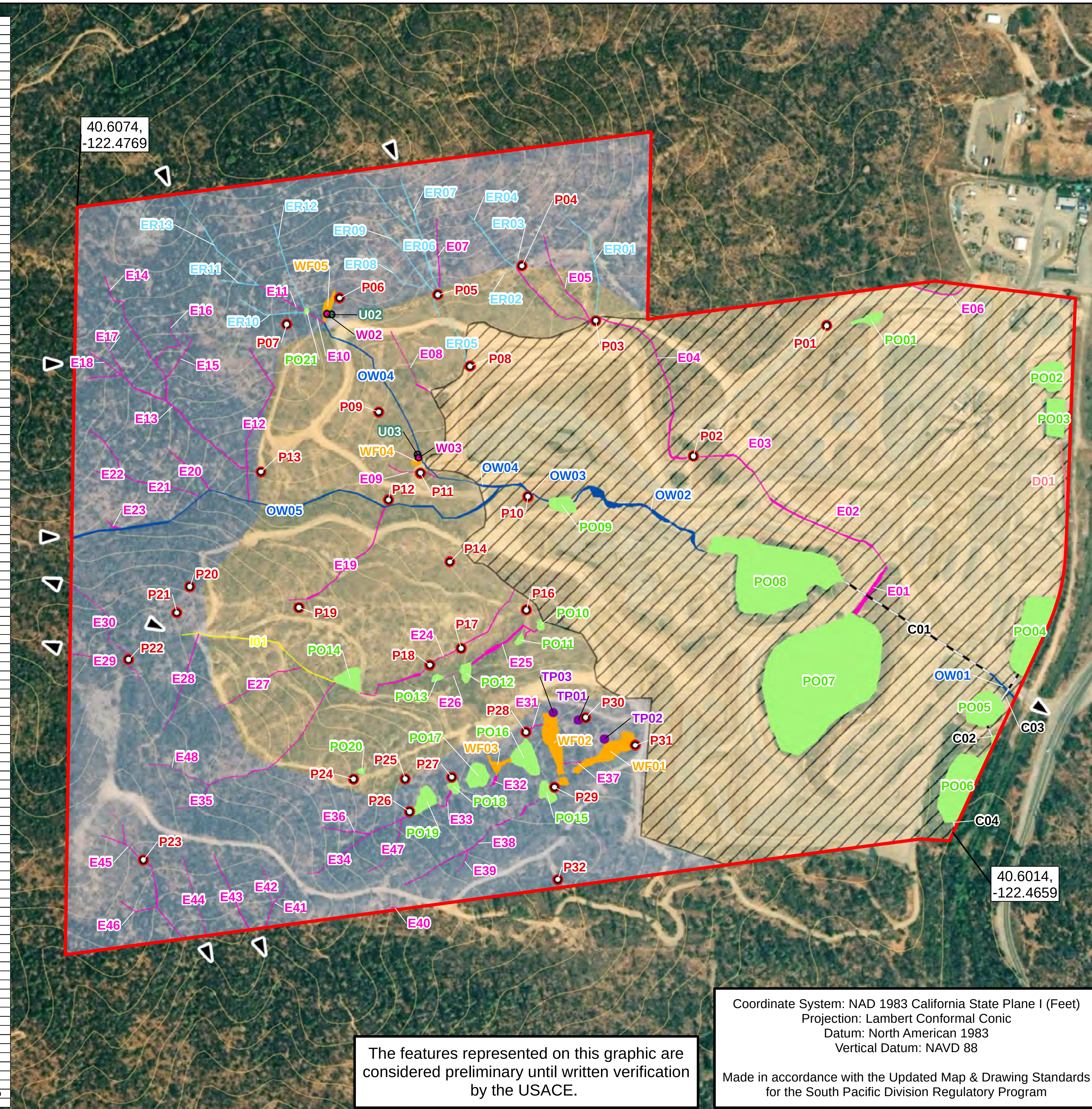
- Seasonal Wetland - WF# - (0.587 acres)

*See Figure 3, Ground Photographs Map, for additional information on Photo Points.

**Draft Delineation of Aquatic Resources**

| Label | Cowardin | Description | Location (Lat, Long) | | Width* | Length (ft) | Area (sq ft) | Acres |
|---|---|---|---|---|---|---|---|---|
| **Active Mining** | | | | | | | | |
| **Other Waters** | | | | | | | | |
| D01 | R4 | Ditch | 40.604593 | -122.464525 | 19.9 | 467.2 | 2885.3 | 0.066 |
| E01 | R6 | Ephemeral | 40.603786 | -122.466961 | 15.6 | 200.9 | 2656.3 | 0.061 |
| E02 | R6 | Ephemeral | 40.604418 | -122.467543 | 43.3 | 474.2 | 2842.6 | 0.065 |
| E03 | R6 | Ephemeral | 40.605099 | -122.469019 | 137.7 | 445.3 | 2887.3 | 0.066 |
| E04 | R6 | Ephemeral | 40.606256 | -122.470266 | 116.1 | 435.4 | 1937.5 | 0.044 |
| E05 | R6 | Ephemeral | 40.606732 | -122.470797 | 1.9 | 4.0 | 6.7 | 0.000 |
| E06 | R6 | Ephemeral | 40.606641 | -122.466121 | 36.6 | 196.3 | 826.7 | 0.019 |
| OW01 | R4 | Intermittent | 40.602896 | -122.465282 | 9.5 | 126.6 | 914.1 | 0.021 |
| OW02 | R4 | Intermittent | 40.604567 | -122.469920 | 81.9 | 495.6 | 6943.1 | 0.159 |
| OW03 | R4 | Intermittent | 40.604717 | -122.471183 | 13.8 | 120.2 | 728.9 | 0.017 |
| OW04 | R4 | Intermittent | 40.605418 | -122.472657 | 38.0 | 338.3 | 1030.4 | 0.024 |
| OW05 | R4 | Intermittent | 40.604533 | -122.474275 | 13.0 | 82.5 | 705.8 | 0.016 |
| PO01 | PUB | Pond | 40.606395 | -122.466973 | 43.7 | 119.0 | 2866.0 | 0.066 |
| PO02 | PUB | Pond | 40.605861 | -122.464720 | 105.3 | 113.9 | 9356.7 | 0.215 |
| PO03 | PUB | Pond | 40.605467 | -122.464643 | 65.5 | 136.0 | 8446.8 | 0.194 |
| PO04 | PUB | Pond | 40.603419 | -122.464930 | 104.8 | 312.1 | 24592.6 | 0.565 |
| PO05 | PUB | Pond | 40.602676 | -122.465514 | 112.1 | 136.3 | 12369.1 | 0.284 |
| PO06 | PUB | Pond | 40.601961 | -122.465808 | 107.1 | 355.5 | 24689.9 | 0.567 |
| PO07 | PUB | Pond | 40.602954 | -122.467573 | 348.4 | 526.5 | 137201.2 | 3.150 |
| PO08 | PUB | Pond | 40.603956 | -122.468151 | 262.4 | 492.1 | 73423.3 | 1.686 |
| PO09 | PUB | Pond | 40.604607 | -122.470810 | 60.8 | 95.3 | 4467.4 | 0.103 |
| | | | | | | **Active Mining Other Waters Totals =** | **321777.6** | **7.387** |
| | | | | | | **Aquatic Resources Totals =** | **321777.6** | **7.387** |
| **Permitted** | | | | | | | | |
| **Wetland Features** | | | | | | | | |
| **Label** | **Cowardin** | **Description** | **Location (Lat, Long)** | | **Width*** | **Length (ft)** | **Area (sq ft)** | **Acres** |
| WF04 | PUB | Seasonal Wetland | 40.605013 | -122.472637 | N/A | N/A | 962.8 | 0.022 |
| | | | | | | **Permitted Wetland Features Totals =** | **962.8** | **0.022** |
| **Other Waters** | | | | | | | | |
| E04 | R6 | Ephemeral | 40.606256 | -122.470266 | 70.5 | 338.0 | 1273.8 | 0.029 |
| E05 | R6 | Ephemeral | 40.606732 | -122.470797 | 18.2 | 223.2 | 809.0 | 0.019 |
| E08 | R6 | Ephemeral | 40.605905 | -122.47272 | 29.3 | 254.7 | 738.9 | 0.017 |
| E09 | R6 | Ephemeral | 40.604914 | -122.472702 | 19.3 | 179.1 | 429.4 | 0.010 |
| E12 | R6 | Ephemeral | 40.605388 | -122.474656 | 7.5 | 39.9 | 121.8 | 0.003 |
| E19 | R6 | Ephemeral | 40.604039 | -122.473521 | 71.1 | 465.4 | 2110.9 | 0.048 |
| E24 | R6 | Ephemeral | 40.603152 | -122.472362 | 73.6 | 647.4 | 2956.0 | 0.068 |
| E25 | R6 | Ephemeral | 40.603277 | -122.471557 | 45.7 | 263.6 | 2604.3 | 0.060 |
| E26 | R6 | Ephemeral | 40.602975 | -122.472182 | 6.7 | 59.2 | 117.5 | 0.003 |
| E27 | R6 | Ephemeral | 40.602878 | -122.474584 | 27.8 | 305.7 | 941.5 | 0.022 |
| E35 | R6 | Ephemeral | 40.601781 | -122.475354 | 21.8 | 356.4 | 1004.8 | 0.023 |
| I01 | R4 | Intermittent (Isolated) | 40.603218 | -122.474586 | 65.8 | 471.7 | 1935.5 | 0.044 |
| OW04 | R4 | Intermittent | 40.605418 | -122.472657 | 101.2 | 754.7 | 3191.3 | 0.073 |
| OW05 | R4 | Intermittent | 40.604533 | -122.474275 | 88.5 | 781.4 | 4890.5 | 0.112 |
| PO10 | PUB | Pond | 40.603459 | -122.471078 | 27.4 | 40.6 | 880.3 | 0.020 |
| PO13 | PUB | Pond | 40.602946 | -122.472371 | 23.7 | 46.8 | 803.9 | 0.018 |
| PO14 | PUB | Pond | 40.602934 | -122.473461 | 86.8 | 98.7 | 5265.5 | 0.121 |
| PO18 | PUB | Pond | 40.603314 | -122.471337 | 27.5 | 47.2 | 915.5 | 0.021 |
| PO19 | PUB | Pond | 40.603006 | -122.472007 | 41.2 | 77.6 | 2251.5 | 0.052 |
| PO20 | PUB | Pond | 40.602054 | -122.473311 | 21.9 | 28.0 | 484.0 | 0.011 |
| | | | | | | **Permitted Other Waters Totals =** | **33725.9** | **0.774** |
| | | | | | | **Aquatic Resources Totals =** | **34688.7** | **0.796** |
| **Mineral Resource Area** | | | | | | | | |
| **Wetland Features** | | | | | | | | |
| **Label** | **Cowardin** | **Description** | **Location (Lat, Long)** | | **Width*** | **Length (ft)** | **Area (sq ft)** | **Acres** |
| WF01 | PUB | Seasonal Wetland | 40.602259 | -122.470198 | N/A | N/A | 9827.3 | 0.226 |
| WF02 | PUB | Seasonal Wetland | 40.602331 | -122.470898 | N/A | N/A | 10566.9 | 0.243 |
| WF03 | PUB | Seasonal Wetland | 40.602124 | -122.471602 | N/A | N/A | 1930.2 | 0.044 |
| WF05 | PUB | Seasonal Wetland | 40.606485 | -122.473758 | N/A | N/A | 2288.6 | 0.053 |
| | | | | | | **Mineral Resource Area Wetland Features Totals =** | **24613.1** | **0.565** |
| **Other Waters** | | | | | | | | |
| E04 | R6 | Ephemeral | 40.606256 | -122.470266 | 2.2 | 4.5 | 5.7 | 0.000 |
| E05 | R6 | Ephemeral | 40.606732 | -122.470797 | 7.9 | 124.4 | 373.7 | 0.009 |
| E07 | R6 | Ephemeral | 40.606982 | -122.472385 | 9.1 | 245.8 | 879.6 | 0.020 |
| E10 | R6 | Ephemeral | 40.606373 | -122.473897 | 4.2 | 64.9 | 226.4 | 0.005 |
| E11 | R6 | Ephemeral | 40.606481 | -122.474161 | 3.8 | 182.4 | 623.6 | 0.014 |
| E12 | R6 | Ephemeral | 40.605388 | -122.474656 | 91.4 | 533.5 | 2208.7 | 0.051 |
| E13 | R6 | Ephemeral | 40.605454 | -122.475702 | 73.9 | 633.2 | 2811.2 | 0.065 |
| E14 | R6 | Ephemeral | 40.606157 | -122.476116 | 41.0 | 486.6 | 1679.4 | 0.039 |
| E15 | R6 | Ephemeral | 40.606009 | -122.475605 | 49.0 | 175.9 | 590.6 | 0.014 |
| E16 | R6 | Ephemeral | 40.606119 | -122.475746 | 65.3 | 167.0 | 633.1 | 0.015 |
| E17 | R6 | Ephemeral | 40.605965 | -122.476420 | 12.3 | 124.3 | 313.5 | 0.007 |
| E18 | R6 | Ephemeral | 40.605941 | -122.476558 | 7.7 | 140.9 | 415.7 | 0.010 |
| E20 | R6 | Ephemeral | 40.604917 | -122.475455 | 17.4 | 206.8 | 757.3 | 0.017 |
| E21 | R6 | Ephemeral | 40.604895 | -122.476104 | 73.6 | 450.9 | 1776.8 | 0.041 |
| E22 | R6 | Ephemeral | 40.604892 | -122.476523 | 8.5 | 95.0 | 189.2 | 0.004 |
| E23 | R6 | Ephemeral | 40.604387 | -122.476441 | 13.2 | 57.3 | 264.7 | 0.006 |
| E27 | R6 | Ephemeral | 40.602878 | -122.474584 | 2.0 | 31.7 | 63.4 | 0.001 |
| E28 | R6 | Ephemeral | 40.602945 | -122.475531 | 15.5 | 356.9 | 1155.0 | 0.027 |
| E29 | R6 | Ephemeral | 40.603086 | -122.476511 | 51.8 | 271.0 | 737.9 | 0.017 |
| E30 | R6 | Ephemeral | 40.603479 | -122.476562 | 48.1 | 327.4 | 705.4 | 0.016 |
| E31 | R6 | Ephemeral | 40.602459 | -122.471173 | 20.3 | 79.9 | 405.2 | 0.009 |
| E32 | R6 | Ephemeral | 40.601963 | -122.471652 | 19.5 | 54.7 | 407.8 | 0.009 |
| E33 | R6 | Ephemeral | 40.601782 | -122.472243 | 32.2 | 69.9 | 514.9 | 0.012 |
| E34 | R6 | Ephemeral | 40.601378 | -122.473301 | 23.7 | 409.2 | 1277.0 | 0.029 |
| E35 | R6 | Ephemeral | 40.601781 | -122.475354 | 44.2 | 378.0 | 1001.7 | 0.023 |
| E36 | R6 | Ephemeral | 40.601483 | -122.473502 | 9.0 | 166.0 | 495.2 | 0.011 |
| E37 | R6 | Ephemeral | 40.602145 | -122.470668 | 7.6 | 65.9 | 185.8 | 0.004 |
| E38 | R6 | Ephemeral | 40.601375 | -122.471896 | 27.9 | 560.2 | 1929.0 | 0.044 |
| E39 | R6 | Ephemeral | 40.601199 | -122.472023 | 10.9 | 84.5 | 225.2 | 0.005 |
| E40 | R6 | Ephemeral | 40.600749 | -122.472884 | 8.5 | 40.3 | 176.1 | 0.004 |
| E41 | R6 | Ephemeral | 40.600773 | -122.474390 | 21.9 | 188.5 | 511.0 | 0.012 |
| E42 | R6 | Ephemeral | 40.600962 | -122.474480 | 12.4 | 141.6 | 292.1 | 0.007 |
| E43 | R6 | Ephemeral | 40.600866 | -122.474918 | 9.1 | 290.4 | 997.4 | 0.023 |
| E44 | R6 | Ephemeral | 40.600835 | -122.475384 | 10.0 | 283.9 | 596.9 | 0.014 |
| E45 | R6 | Ephemeral | 40.601052 | -122.476019 | 84.4 | 512.7 | 1934.6 | 0.044 |
| E46 | R6 | Ephemeral | 40.600736 | -122.476108 | 30.2 | 125.4 | 407.0 | 0.009 |
| E47 | R6 | Ephemeral | 40.601325 | -122.472941 | 37.7 | 217.4 | 519.1 | 0.012 |
| E48 | R6 | Ephemeral | 40.602037 | -122.475597 | 20.8 | 220.8 | 442.0 | 0.010 |
| I01 | R4 | Intermittent (Isolated) | 40.603218 | -122.474586 | 12.5 | 93.0 | 371.2 | 0.009 |
| OW04 | R4 | Intermittent | 40.605418 | -122.472657 | 4.9 | 25.5 | 123.9 | 0.003 |
| OW05 | R4 | Intermittent | 40.604533 | -122.474275 | 86.8 | 664.7 | 4501.1 | 0.103 |
| PO11 | PUB | Pond | 40.601916 | -122.472148 | 40.7 | 60.9 | 1701.7 | 0.039 |
| PO12 | PUB | Pond | 40.601771 | -122.472524 | 73.0 | 117.5 | 5254.3 | 0.121 |
| PO15 | PUB | Pond | 40.601861 | -122.470984 | 56.6 | 85.9 | 3212.8 | 0.074 |
| PO16 | PUB | Pond | 40.602187 | -122.471249 | 96.9 | 122.3 | 7768.0 | 0.178 |
| PO17 | PUB | Pond | 40.602015 | -122.471857 | 74.9 | 95.3 | 5459.4 | 0.125 |
| PO21 | PUB | Pond | 40.606441 | -122.474027 | 19.2 | 20.8 | 325.2 | 0.007 |
| | | | | | | **Mineral Resource Area Other Waters Totals =** | **57446.6** | **1.319** |
| | | | | | | **Wetland Features Totals =** | **25576.1** | **0.587** |
| | | | | | | **Other Waters Totals =** | **413077.3** | **9.483** |
| | | | | | | **Aquatic Resources Totals =** | **4386553.3** | **10.070** |

*Widths are represented as averges




The features represented on this graphic are considered preliminary until written verification by the USACE.

Coordinate System: NAD 1983 California State Plane I (Feet)
Projection: Lambert Conformal Conic
Datum: North American 1983
Vertical Datum: NAVD 88

Made in accordance with the Updated Map & Drawing Standards for the South Pacific Division Regulatory Program

NORTH

1:4,800 1 inch = 400 feet

0 200 400 Feet

Data Sources: ESRI, Shasta County, Maxar 09/15/2021

Crystal Creek Aggregate Mine
Draft Delineation of Aquatic Resources
Figure 4

Delineation by: E. Gregg
Map by: A. McLaughlin

gallaway ENTERPRISES

GE: #22-050 Map Date: 09/23/2022

**Table 1. Summary of Potentially Non-Jurisdictional Features within the Crystal Creek Aggregate Mine Project.**

| Feature Number(s) | Non-Jurisdictional Rationale |
|---|---|
| ER01 – ER13 | Erosional drainage that lacks an OHWM |
| PO01 | Isolated pond |
| PO02 – PO09 | Active mining pond |
| PO10 – PO20 | Historic mining ponds that are isolated |
| WF01 – WF03 | Seasonal wetlands that are isolated |
| I01 | Intermittent drainage that lacks a surface hydrological connection to a TNW |
| E07, E08, E24 – E28, E31 – E39, E47, E48 | Ephemeral drainage that lacks a surface hydrological connection to a TNW |
| D01 | Man-made ditch created completely in upland habitat for detention pond overflow conveyance |
| E01-E06, E09-E23, WF04-WF05, PO21, and OW02-OW05 | Aquatic features that may lack a hydrologic connection/significant nexus to a TNW due to the presence of controlled/managed outfalls |

detention ponds (PO02, PO07 or PO08) that may be considered potentially non-jurisdictional due to the presence of controlled/managed outfalls that limit their hydrologic connection to OW01.

To confirm the jurisdictional status of WOTUS within the Project site, a significant nexus determination would need to be conducted by the Corps.

## Results

**Table 2** summarizes the area calculations for the pre-jurisdictional features within the Project site. A complete Draft Delineation of Aquatic Resources map, utilizing a 1" to 400' scale, is included as **Figure 4**.

**Table 2. Draft Delineation of Aquatic Resources Acreage Table for the Crystal Creek Aggregate Mine Project.**

| Draft Delineation of Aquatic Resources | | | | | | |
|---|---|---|---|---|---|---|
| Wetland Features | | | | | | |
| Label | Cowardin | Description | Width | Length (ft) | Area (sq ft) | Acres |
| WF01 | PUB | Seasonal Wetland | N/A | N/A | 9827.4 | 0.226 |
| WF02 | PUB | Seasonal Wetland | N/A | N/A | 10567.0 | 0.243 |
| WF03 | PUB | Seasonal Wetland | N/A | N/A | 1930.2 | 0.044 |
| WF04 | PUB | Seasonal Wetland | N/A | N/A | 962.9 | 0.022 |
| WF05 | PUB | Seasonal Wetland | N/A | N/A | 2288.6 | 0.053 |
| **Wetland Features Totals =** | | | | | 25576.1 | **0.587** |
| Other Waters | | | | | | |
| D01 | R4 | Ditch | 6.2 | 467.2 | 2885.3 | 0.066 |
| E01 | R6 | Ephemeral | 3.6 | 744.5 | 2656.3 | 0.061 |
| E02 | R6 | Ephemeral | 70.5 | 40.3 | 2842.6 | 0.065 |

| Label | Cowardin | Description | Width | Length (ft) | Area (sq ft) | Acres |
|---|---|---|---|---|---|---|
| E03 | R6 | Ephemeral | 52.8 | 54.7 | 2887.3 | 0.066 |
| E04 | R6 | Ephemeral | 46.0 | 69.9 | 3217.0 | 0.074 |
| E05 | R6 | Ephemeral | 4.2 | 283.9 | 1189.4 | 0.027 |
| E06 | R6 | Ephemeral | 5.0 | 166.0 | 826.7 | 0.019 |
| E07 | R6 | Ephemeral | 4.0 | 217.4 | 879.6 | 0.020 |
| E08 | R6 | Ephemeral | 5.9 | 125.4 | 739.0 | 0.017 |
| E09 | R6 | Ephemeral | 0.8 | 512.8 | 429.5 | 0.010 |
| E10 | R6 | Ephemeral | 1.6 | 141.6 | 226.4 | 0.005 |
| E11 | R6 | Ephemeral | 3.3 | 188.6 | 623.6 | 0.014 |
| E12 | R6 | Ephemeral | 8.0 | 290.4 | 2330.5 | 0.054 |
| E13 | R6 | Ephemeral | 5.0 | 560.2 | 2811.2 | 0.065 |
| E14 | R6 | Ephemeral | 4.9 | 343.7 | 1679.5 | 0.039 |
| E15 | R6 | Ephemeral | 7.0 | 84.5 | 590.6 | 0.014 |
| E16 | R6 | Ephemeral | 1.8 | 356.9 | 633.1 | 0.015 |
| E17 | R6 | Ephemeral | 0.9 | 337.0 | 313.5 | 0.007 |
| E18 | R6 | Ephemeral | 0.9 | 465.4 | 415.7 | 0.010 |
| E19 | R6 | Ephemeral | 4.0 | 533.5 | 2110.9 | 0.048 |
| E20 | R6 | Ephemeral | 1.2 | 633.2 | 757.3 | 0.017 |
| E21 | R6 | Ephemeral | 3.7 | 486.6 | 1776.8 | 0.041 |
| E22 | R6 | Ephemeral | 1.1 | 175.9 | 189.2 | 0.004 |
| E23 | R6 | Ephemeral | 1.6 | 167.0 | 264.7 | 0.006 |
| E24 | R6 | Ephemeral | 23.8 | 124.3 | 2956.1 | 0.068 |
| E25 | R6 | Ephemeral | 18.5 | 140.9 | 2604.3 | 0.060 |
| E26 | R6 | Ephemeral | 0.6 | 206.8 | 117.5 | 0.003 |
| E27 | R6 | Ephemeral | 2.2 | 450.9 | 1004.9 | 0.023 |
| E28 | R6 | Ephemeral | 12.2 | 95.0 | 1155.0 | 0.027 |
| E29 | R6 | Ephemeral | 3.0 | 245.8 | 737.9 | 0.017 |
| E30 | R6 | Ephemeral | 2.6 | 271.0 | 705.4 | 0.016 |
| E31 | R6 | Ephemeral | 0.6 | 710.9 | 405.2 | 0.009 |
| E32 | R6 | Ephemeral | 7.1 | 57.3 | 407.8 | 0.009 |
| E33 | R6 | Ephemeral | 1.6 | 327.4 | 515.0 | 0.012 |
| E34 | R6 | Ephemeral | 5.0 | 254.7 | 1277.0 | 0.029 |
| E35 | R6 | Ephemeral | 10.2 | 196.3 | 2006.4 | 0.046 |
| E36 | R6 | Ephemeral | 0.8 | 647.4 | 495.1 | 0.011 |
| E37 | R6 | Ephemeral | 1.0 | 182.4 | 185.8 | 0.004 |
| E38 | R6 | Ephemeral | 29.7 | 64.9 | 1929.1 | 0.044 |
| E39 | R6 | Ephemeral | 2.8 | 79.9 | 225.2 | 0.005 |
| E40 | R6 | Ephemeral | 0.4 | 409.2 | 176.1 | 0.004 |
| E41 | R6 | Ephemeral | 7.8 | 65.9 | 511.4 | 0.012 |
| E42 | R6 | Ephemeral | 1.6 | 179.1 | 292.1 | 0.007 |
| E43 | R6 | Ephemeral | 3.8 | 263.6 | 997.4 | 0.023 |

| Label | Cowardin | Description | Width | Length (ft) | Area (sq ft) | Acres |
|---|---|---|---|---|---|---|
| E44 | R6 | Ephemeral | 10.1 | 59.2 | 596.9 | 0.014 |
| E45 | R6 | Ephemeral | 9.6 | 201.0 | 1934.9 | 0.044 |
| E46 | R6 | Ephemeral | 0.9 | 474.2 | 407.0 | 0.009 |
| E47 | R6 | Ephemeral | 1.2 | 445.3 | 519.1 | 0.012 |
| E48 | R6 | Ephemeral | 2.0 | 220.8 | 442.0 | 0.010 |
| I01 | R4 | Intermittent (Isolated) | 2.6 | 885.8 | 2306.6 | 0.053 |
| OW01 | R4 | Intermittent | 7.2 | 126.6 | 914.1 | 0.021 |
| OW02 | R4 | Intermittent | 57.8 | 120.2 | 6943.1 | 0.159 |
| OW03 | R4 | Intermittent | 1.5 | 495.6 | 728.9 | 0.017 |
| OW04 | R4 | Intermittent | 2.9 | 1496.7 | 4345.7 | 0.100 |
| OW05 | R4 | Intermittent | 18.1 | 559.2 | 10097.4 | 0.232 |
| PO01 | PUB | Pond | N/A | N/A | 2866.0 | 0.066 |
| PO02 | PUB | Pond (Active Mining) | N/A | N/A | 9356.7 | 0.215 |
| PO03 | PUB | Pond (Active Mining) | N/A | N/A | 8446.9 | 0.194 |
| PO04 | PUB | Pond (Active Mining) | N/A | N/A | 24592.7 | 0.565 |
| PO05 | PUB | Pond (Active Mining) | N/A | N/A | 12369.1 | 0.284 |
| PO06 | PUB | Pond (Active Mining) | N/A | N/A | 24814.7 | 0.570 |
| PO07 | PUB | Pond (Active Mining) | N/A | N/A | 137201.8 | 3.150 |
| PO08 | PUB | Pond (Active Mining) | N/A | N/A | 73423.6 | 1.686 |
| PO09 | PUB | Pond (Active Mining) | N/A | N/A | 4467.4 | 0.103 |
| PO10 | PUB | Pond (Historic Mining) | N/A | N/A | 880.3 | 0.020 |
| PO11 | PUB | Pond (Historic Mining) | N/A | N/A | 1701.8 | 0.039 |
| PO12 | PUB | Pond (Historic Mining) | N/A | N/A | 5254.3 | 0.121 |
| PO13 | PUB | Pond (Historic Mining) | N/A | N/A | 803.9 | 0.018 |
| PO14 | PUB | Pond (Historic Mining) | N/A | N/A | 5265.5 | 0.121 |
| PO15 | PUB | Pond (Historic Mining) | N/A | N/A | 3212.8 | 0.074 |
| PO16 | PUB | Pond (Historic Mining) | N/A | N/A | 7768.1 | 0.178 |
| PO17 | PUB | Pond (Historic Mining) | N/A | N/A | 5459.5 | 0.125 |
| PO18 | PUB | Pond (Historic Mining) | N/A | N/A | 915.5 | 0.021 |
| PO19 | PUB | Pond (Historic Mining) | N/A | N/A | 2251.5 | 0.052 |
| PO20 | PUB | Pond (Historic Mining) | N/A | N/A | 484.0 | 0.011 |
| PO21 | PUB | Pond | N/A | N/A | 325.1 | 0.007 |
| | | | | **Other Waters Totals =** | 413077.3 | **9.483** |
| | | | | **Aquatic Resources Totals =** | 438653.3 | **10.070** |

### Waters of the United States: Other Waters

There are 76 drainage and/or pond features identified within the Project site, but only 10 of these features meet the definition of potentially jurisdictional "other waters of the United States" (OW) within the Project site (**Figure 4**). The area and linear footage data associated with all 76 features are provided in **Table 1**. The rationale for the remaining 66 features meeting the definition of potentially non-jurisdictional features is summarized in **Table 1**. Other waters of the United States are seasonal or perennial water bodies, including lakes, stream channels, ephemeral and intermittent drainages, ponds, and other surface water features that exhibit an ordinary high-water mark but lack positive indicators for one or more of the three wetland parameters (hydrophytic vegetation, hydric soil, and wetland hydrology) (33 CFR 328.4). The boundaries of all other waters identified within the Project site were delineated based on the observed OHWM, including physical characteristics such as natural lines impressed on the bank, shelving, changes in the character of the soil, the destruction of terrestrial vegetation, debris lines and other appropriate indicators.

One potentially jurisdictional OW feature has been identified as intermittent drainage feature (OW01) and nine have been identified as ephemeral drainages (E29, E30, and E40-E46). All drainages are unnamed features. The intermittent drainage feature is classified by the Corps as a Relatively Permanent Water (RPW). The ephemeral drainages identified on the Project site are classified as Non-Relatively Permanent Waters (NRPW). Non-Relatively Permanent Waters are defined as tributaries that typically flow for less than 3 months of the year and have a documented hydrologic connection to a Traditionally Navigable Water (TNW). Relatively Permanent Waters are defined as tributaries that typically flow for more than 3 months of the year and have a documented hydrologic connection to a TNW. All of these drainages have a documented hydrologic connection to a TNW. The OW features identified within the Project site were observed to contain an OHWM and appropriate morphology of bed, bank and scour.

### Waters of the United States: Wetlands

A total of five wetlands (WF01-WF05) occur within the Project site, which have been characterized as seasonal wetlands (**Figure 4**). However, none of these wetlands meet the definition of potentially jurisdictional WOTUS. Seasonal wetlands are depressional features that typically stay ponded or saturated into the early summer months. Of the five seasonal wetlands present in the Project site, three are completely isolated (WF01-WF03), and two (WF04 and WF05) are directly connected to an intermittent drainage (OW04). However, OW04 may be considered non-jurisdictional due to the presence of controlled outfalls that may limit hydrologic connectivity to a TNW. The wetlands identified within the Project site exhibited all necessary wetland parameters (**Appendix A**).

During the aerial photography review of the Project site conducted prior to the field visit, a few areas were identified that exhibited swale-like or unusual signatures. Where aerial photographs identified unusual signatures, but were found to lack wetland parameters when ground-truthed, representative test pits and/or photographs were taken (**Appendix A**, **Figure 4**). Photo points were taken at test pits, wetlands and other locations throughout the Project site to depict the current site conditions (**Figure 3**).

### Soils

Gallaway collected soil data at various locations throughout the Project site. Field observations of soil characteristics included soil color, texture, structure, and the visual assessment of soil features (e.g. the presence, or absence of redoximorphic features and the depth of restrictive layers such as hardpans). Gallaway's soil texture evaluations rendered gravely and clay loams. Iron concentrations and depletions were found along root channels, pore spaces, and as soft masses in the soil matrix at varying depths within the surface horizons. Field observations of soil characteristics at the test pit sites are included in the data sheet forms presented in **Appendix A**.

The geographic region in which the Project is found is often characterized as having a naturally occurring deep hardpan, or duripan that undulates throughout the region. Duripans restrict root growth, limit water infiltration, and result in a perching of the water table in certain locations where topography allows. Within the Project site, the duripan is typically found at a depth ranging from 0 to 54 inches and is composed of lithic or paralithic bedrock. The depth of the hand dug soil pits were dug deep enough to determine or rule out the presence/absence of hydric soil indicators.

Gallaway queried the National Cooperative Soil Survey database to further evaluate the current soil conditions. A copy of the soil survey map and a description of mapped soil units for the Project site are included as **Appendix B**. A total of three soil map units occur within the Project site. The map units are listed below in **Table 3**. Based on Gallaway's review none of the soil map units identified within the Project site contain hydric components. A copy of the soil survey map and a description of mapped soil units for the Project site are included as **Appendix B**.

**Table 3. Soil Map Units, NRCS hydric soil designation, and approximate totals for the Crystal Creek Aggregate Mine Project.**

| Map Unit Symbol | Map Unit Name | % Hydric Component in Map Unit | Landform of Hydric Component | % Map Unit in Site |
|---|---|---|---|---|
| **DfD2** | Diamond Springs very stony sandy loam, 8 to 30 percent slopes, eroded | N/A | N/A | 49.1% |
| **DgE2** | Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, eroded | N/A | N/A | 4.4% |
| **DgE3** | Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, severely eroded | N/A | N/A | 46.5% |

## Vegetation

During the site visit, the identifiable vegetation within the upland portions of the Project site included a sparse overstory of black oaks (*Quercus kelloggii*) (NL), knobcone pine (*Pinus attenuata*) (UPL), ponderosa pine (*Pinus ponderosa*) (UPL), toyon (*Heteromeles arbutifolia*) (UPL), whiteleaf manazanita (*Arctostaphylos vicida*) (UPL), coffeeberry (*Frangula californica*) (UPL) and snowdrop bush (*Styrax redivivus*) (UPL). The understory in the upland habitat was dominated by lemmon's ceanothus (*Ceanothus lemmonii*) (UPL), poison oak (*Toxicodendron diversilobum*) (NL), silver hairgrass (*Aira caryophyllea*) (FACU), goldwire (*Hypericum concinnum*) (UPL), medusahead (*Elymus caput-medusae*) (UPL), tall willowherb (*Epilobium brachycarpum*) (FAC), Spanish lotus (*Acmispon americanus*) (FACU), wild oats (*Avena barbata*) (UPL), six-weeks fescue (*Festuca myuros*) (FACU), winter vetch (*Vicia villosa*) (NL) and prickly lettuce (*Lactuca serriola*) (FACU). The typical dominant vegetation found within the various wetlands present within the Project site included a variety of rushes (*Juncus* sp.) (FACW), Mediterranean barley (*Hordeum marinum ssp. gussoneanum*) (FAC), perennial ryegrass, hawkbit (*Leontodon saxatilis*) (FACU), seep monkeyflower (*Erythranthe guttata*) (OBL), sweet vernal grass (*Anthoxanthum odoratum*) (FAC) and various willow species (*Salix* sp.) (FACW).

## Hydrology

Hydrology within the Project site is influenced solely by precipitation and localized runoff including hillside seeps. The intermittent drainages present within the Project are fed by seeps and numerous ephemeral drainages drain into these intermittent drainages. The intermittent drainages have historically been diverted into the ponds on the site that are incidental to the mining operation. Due to the need for the mine operation to control and filter any localized runoff, the intermittent drainages present no longer have a natural direct hydrologic connection to downgradient creeks. Middle Creek occurs to the south of the Project site but the release of water from the Project site into an offsite unnamed tributary of Middle Creek is managed through a series of settling ponds and gated culverts. Due to the managed nature of these outfalls, all of the aquatic resources that are connected to these active mining detention ponds (PO06-PO08) may be considered isolated and, thus, non-jurisdictional WOTUS. There are also a number of highly isolated aquatic features within the Project site that meet the definition of non-jurisdictional per the *Corps Jurisdictional Determination Form Instructional Guidebook* due to the lack of a significant nexus. These isolated aquatic features include one intermittent drainage (I01), numerous ephemeral drainages that are completely isolated to the Project site (E07, E08, E24-E28, E31-E39, E47 and E48), a man-made ephemeral ditch (D01), and isolated ponds/wetlands that were historically constructed incidental to the mining operation (PO10-PO20). To confirm the jurisdictional status of WOTUS within the Project site, a significant nexus determination would need to be conducted by the Corps.

The ephemeral drainages that flow offsite to the south (E40-E46) and west (E29 and E30) and the intermittent drainage OW01 all flow directly into unnamed tributaries of Middle Creek. Middle Creek is a direct tributary of the Sacramento River, a TNW. Therefore, these drainages all meet the definition of jurisdictional WOTUS.

Flowing water was observed only within OW02, OW03 and OW05 during the June 2020 field visits.

**Site Photos Taken on June 2 and 4, 2020 and April 28, 2022**

P01 – PO01 looking E (taken 2022)

P02 – E04 looking W (taken 2020)

P01 – Upland swales/road looking W (taken 2022)

P03 – E05 looking NW (taken 2022)

P02 – E03 looking E (taken 2022)

P04 – end of ER03/start of E04 looking W (taken 2022)

P05 – Erosional features looking NW (taken 2022)

P07 – Overview of erosional features looking NW (taken 2022)

P06 – WF05 looking S (taken 2020)

P08 – ER05 looking NW (taken 2022)

P06 – WF05 looking N (taken 2020)

P08 – Overview of active mine area looking S (taken 2022)


P08 – Overview of active mine area looking E (taken 2022)


P10 – Confluence of OW04 and OW05 looking W (taken 2022)


P09 – Upland swale looking SE (taken 2022)


P11 – E09 looking NW (taken 2022)


P10 – PO09 looking E (taken 2022)


P11 – WF04 looking N (taken 2022)

P11 – E09/OW04 looking SE (taken 2022)

P13 – E12/OW05 looking SW (taken 2022)

P12 – Confluence of OW05 & E19 looking W (taken 2020)

P13 – E12/E13 looking NW (taken 2022)

P12 – OW05 looking E (taken 2020)

P14 – Upland swale looking slightly NW (taken 2022)

P14 – Upland swale looking E (taken 2022)

P17 – E24 looking W (taken 2020)

P16 – Overview of E25 looking SW (taken 2022)

P18 – E24 looking slightly SW (taken 2020)

P17 – E24 looking E (taken 2020)

P19– E19 looking NE (taken 2020)

P20 – Overview of ephemeral/erosional drainages looking N (taken 2020)

P22 – E29 and E30 looking NW (taken 2020)

P21 – Start of I01 looking S (taken 2020)

P23 – E45 looking N (taken 2020)

P21 – Overview of I01 looking SE (taken 2020)

P23 – E45 looking S (taken 2020)

P24 – PO20 looking NE (taken 2022)

P27 – PO18 and E33 looking SW (taken 2020)

P25 – Old mine tunnel looking NW (taken 2020)

P28 – E31/PO16 looking SW (taken 2020)

P26 – E34 looking W (taken 2020)

P28 – E31 looking E (taken 2020)

P29 – PO15 looking SW (taken 2020)

P31 – Upland looking N (taken 2020)

P30 – TP01 looking W (taken 2020)

P32 – Upland swale looking W (taken 2020)

P31 – WF01 looking SW (taken 2020)

P32 – Upland swale looking E (taken 2020)

## Glossary

**Abutting:** When referring to wetlands that are adjacent to a tributary, abutting defines those wetlands that are not separated from the tributary by an upland feature, such as a berm or dike.

**Adjacent:** Adjacent as used in "Adjacent to traditional navigable water," is defined in Corps and EPA regulations as "bordering, contiguous, or neighboring." Wetlands separated from other waters of the U.S. by man-made dikes or barriers, natural river berms, beach dunes and the like are 'adjacent wetlands. A wetland "abuts" a tributary if it is not separated from the tributary by uplands, a berm, dike, or similar feature.

While all wetlands that meet the agencies' definitions are considered adjacent wetlands, only those adjacent wetlands that have a continuous surface connection because they directly abut the tributary (e.g., they are not separated by uplands, a berm, dike, or similar feature) are considered jurisdictional under the plurality standard. (CWA Jurisdiction Following Rapanos v US and Carabell v US 12-02-08).

The regulations define "adjacent" as follows: "[t]he term adjacent means bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are 'adjacent wetlands.'" Under this definition, a wetland does not need to meet all criteria to be considered adjacent. The agencies consider wetlands to be bordering, contiguous, or neighboring, and therefore "adjacent" if at least one of following three criteria is satisfied:

(1) There is an unbroken surface or shallow sub-surface hydrologic connection between the wetland and jurisdictional waters; or

(2) The wetlands are physically separated from jurisdictional waters by "manmade dikes or barriers, natural river berms, beach dunes, and the like;" or,

(3) Where a wetland's physical proximity to a jurisdictional water is reasonably close, that wetland is "neighboring" and thus adjacent. For example, wetlands located within the riparian area or floodplain of a jurisdictional water will generally be considered neighboring, and thus adjacent. One test for whether a wetland is sufficiently proximate to be considered "neighboring" is whether there is a demonstrable ecological interconnection between the wetland and the jurisdictional waterbody. For example, if resident aquatic species (e.g., amphibians, reptiles, fish, mammals, or waterfowl) rely on both the wetland and the jurisdictional waterbody for all or part of their life cycles (e.g., nesting, rearing, feeding, etc.), that may demonstrate that the wetland is neighboring and thus adjacent. The agencies recognize that as the distance between the wetland and jurisdictional water increases, the potential ecological interconnection between the waters is likely to decrease.

The agencies will also continue to assert jurisdiction over wetlands "adjacent" to traditional navigable waters as defined in the agencies' regulations. Under EPA and Corps regulations and as used in this guidance, "adjacent" means "bordering, contiguous, or neighboring." Finding a continuous surface connection is not required to establish adjacency under this definition. The Rapanos decision does not affect the scope of jurisdiction over wetlands that are adjacent to traditional navigable waters. The agencies will assert jurisdiction over those adjacent wetlands that have a continuous surface connection with a relatively permanent, non-navigable tributary, without the legal obligation to make a significant nexus finding.

**Atypical situation (significantly disturbed):** In an atypical (significantly disturbed) situation, recent human activities or natural events have created conditions where positive indicators for hydrophytic vegetation, hydric soil, or wetland hydrology are not present or observable.

**Channel.** "An open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri 1960:5).

**Channel bank.** The sloping land bordering a channel. The bank has steeper slope than the bottom of the channel and is usually steeper than the land surrounding the channel.

**Cobbles.** Rock fragments 7.6 cm (3 inches) to 25 .4 cm (10 inches) in diameter.

**Debris flow**. A moving mass of rock fragments, soil, and mud where more than 50% of the particles are larger than sand-sized.

**Ditch.** A constructed or excavated channel used to convey water.

**Drift.** Organic debris oriented to flow direction(s) (larger than small twigs).

**Ephemeral stream.** An ephemeral stream has flowing water only in direct response to precipitation events in a typical year. Ephemeral streambeds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.

**Facultative wetland (FACW).** Wetland indicator category; species usually occurs in wetlands (estimated probability 67–99%) but occasionally found in non-wetlands.

**Flat.** A level landform composed of unconsolidated sediments usually mud or sand. Flats may be irregularly shaped or elongate and continuous with the shore, whereas bars are generally elongate, parallel to the shore, and separated from the shore by water.

**Gravel.** A mixture composed primarily of rock fragments 2mm (0 .08 inch) to 7.6 cm (3 inches) in diameter. Usually contains much sand.

**Growing season.** The frost-free period of the year (see U.S. Department of Interior, National Atlas 1970:110-111 for generalized regional delineation).

**Herbaceous.** With the characteristics of an herb; a plant with no persistent woody stem above ground.

**Hydric soil**. Soil is hydric that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic (oxygen-depleted) conditions in its upper part (i.e., within the shallow rooting zone of herbaceous plants).

**Hydrophyte**, **hydrophytic.** Any plant growing in water or on a substrate that is at least periodically deficient in oxygen as a result of excessive water content.

**Intermittent stream.** An intermittent stream has flowing water during certain times of the year and more than in direct response from precipitation, when elevated groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water.

**Jurisdictional Waters**. Features that meet the definition of waters of the Unites States provided below and that fall under Corps regulations pursuant to Section 404 of the CWA are considered jurisdictional features.

**Litter.** Organic debris oriented to flow direction(s) (small twigs and leaves).

**Man-induced wetlands.** A man-induced wetland is an area that has developed at least some characteristics of naturally occurring wetlands due to either intentional or incidental human activities.

**Non-Relatively Permanent Water:** A non-relatively permanent water (NRPW) is defined as a tributary that is not a TNW and that typically flows for periods for less than 3 months. NRPWs are jurisdictional when they have a documented significant nexus to TNWs. All NRPWs must also contain appropriate morphology of bed, bank and scour and be clearly connected to a TNW.

**Normal circumstances.** This term refers to the soil and hydrologic conditions that are normally present, without regard to whether the vegetation has been removed.

**Obligate hydrophytes.** Species that are found only in wetlands e.g., cattail (*Typha latifolia*) as opposed to ubiquitous species that grow either in wetland or on upland-e .g., red maple (*Acer rubrum*).

**Obligate wetland (OBL).** Wetland indicator category; species occurs almost always (estimated probability 99%) under natural conditions in wetlands.

**Other Waters of the United States.** Other waters of the United States are seasonal or perennial water bodies, including lakes, stream channels, drainages, ponds, and other surface water features, that exhibit an ordinary high-water mark but lack positive indicators for one or more of the three wetland parameters (hydrophytic vegetation, hydric soil, and wetland hydrology) (33 CFR 328.4).

**Palustrine** the Palustrine System includes all nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean derived salts is below 0.5 parts per thousand. It also includes wetlands lacking such vegetation, but with all of the following four characteristics: (1) area less than 8 ha (20 acres); (2) active wave-formed or bedrock shoreline features lacking; (3) water depth in the deepest part of basin less than 2 m (6.6 feet) at low water; and (4) salinity due to ocean-derived salts is less than 0.5 parts per thousand.

**Perennial stream.** A perennial stream has flowing water year-round during atypical year. The water table is located above the stream bed for most of the year. Groundwater is the primary source of water for stream flow. Runoff from rainfall is a supplemental source of water for stream flow.

**Ponded**. Ponding is a condition in which free water covers the soil surface (e.g., in a closed depression) and is removed only by percolation, evaporation, or transpiration.

**Problem area**. Problem areas are those where one or more wetland parameters may be lacking because of normal seasonal or annual variations in environmental conditions that result from causes other than human activities or catastrophic natural events**.**

**Relatively Permanent Waters of the U.S**. Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months).

**Scour.** Soil and debris movement.

**Sheetflow.** Overland flow occurring in a continuous sheet; a relatively high-frequency, low-magnitude event.

**Shrub.** A woody plant which at maturity is usually less than 6 m(20 feet) tall and generally exhibits several erect, spreading, or prostrate stems and has a bushy appearance ; e.g., speckled alder (*Alnus rugosa*) or buttonbush (*Cephalanthus occidentalis*).

**Succession.** Changes in the composition or structure of an ecological community.

**Traditional Navigable Waters (TNWs).**"[a]ll waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide." These waters are referred to in this guidance as traditional navigable waters. The traditional navigable waters include all of the "navigable waters of the United States," as defined in 33 C.F.R. Part 329 and by numerous decisions of the federal courts, plus all other waters that are navigable-in-fact (for example, the Great Salt Lake, UT, and Lake Minnetonka, MN). Thus, the traditional navigable waters include, but are not limited to, the “navigable waters of the United States” within the meaning of Section 10 of the Rivers and Harbors Act of 1899 (also known as “Section 10 waters”).

**Tree.** A woody plant which at maturity is usually 6 m (20 feet) or more in height and generally has a single trunk, unbranched for 1 m or more above the ground, and a more or less definite crown; e.g., red maple (*Acer rubrum*), northern white cedar (*Thuja occidentalis*).

**Typical Year.** Defined by the EPA and Corps as meaning when precipitation and other climactic variables are within the normal periodic range for the geographic area based on a rolling thirty-year period.

**Water table.** The upper surface of a zone of saturation. No water table exists where that surface is formed by an impermeable body.

**Waters of the United States (WOTUS)**. This is the encompassing term for areas under federal jurisdiction pursuant to Section 404 of the CWA. Waters of the United States are divided into “wetlands” and “other waters of the United States.”

**Watershed (drainage basin)**. An area of land that drains to a single outlet and is separated from other watersheds by a divide.

**Wetland**. Wetlands are defined as “areas that are inundated or saturated by surface or ground water 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 [b], 40 CFR 230.3). To be considered under potential federal jurisdiction, a wetland must support positive indicators for hydrophytic vegetation, hydric soil, and wetland hydrology.

**Woody plant.** A seed plant (gymnosperm or angiosperm) that develops persistent, hard, fibrous tissues, basically xylem; e.g., trees and shrubs.

**Xeric**. Relating or adapted to an extremely dry habitat.

## References


Cheatham, N.H., and J.R. Haller. 1975. An annotated list of California habitat types. Univ. of California Natural Land and Water Reserve System, unpubl. manuscript.

Cowardin, Lewis M., Virginia Carter, Francis C. Golet and Edward T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C.

Curtis, Katherine E., Robert W. Lichvar. 2010. Updated Datasheet for the Identification of the Ordinary High Water Mark (OHWM) in the Arid West Region of the Western United States. ERDC/CRREL TN-10-1. U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH

Curtis, Katherine E., Robert W. Lichvar, Lindsey E. Dixon. 2011. Ordinary High Flows and the Stage-Discharge Relationship in the Arid West Region (Technical Report). U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH

Environmental Laboratory 1987. U.S. Army Corps of Engineers wetlands delineation manual. (Technical Report Y-87-1). U.S. Army Waterways Experiment Station. Vicksburg, MS.

Lichvar, R.W., and J.S. Wakeley, ed. 2004. Review of Ordinary High Water Mark indicators for delineating arid streams in the southwestern United States. ERDC/CRREL TR-04-1. Hanover, NH: U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory. (http://www.crrel.usace.army.mil/techpub/CRREL _Reports/reports/TR04-21.pdf).

Lichvar, R.W., D. Finnegan, M. Ericsson, and W. Ochs. 2006. Distribution of Ordinary High Water Mark (OHWM) indicators and their reliability in identifying the limits of "Waters of the United States" in arid southwestern channels. ERDC/CRREL TR-06-5. Hanover, NH: U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory. (http://www.crrel.usace.army.mil/techpub/CRREL_Reports/ reports/TR06-5.pdf).

Lichvar, R.W. and S.M. McColley. 2008. A Field Guide to the Identification of the Ordinary High Water Mark (OHWM) in the Western Region of the Western United States. ERDC/CRREL TR-08-12. Hanover, NH: U.S. Army Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. State of California 2016 Wetland Plant List: The National Wetland Plant List: 2016 wetland ratings. Phytoneuron 2016-30: 1-17. U.S. Army Corps of Engineers. ISSN 2153 733X.

Mayer, K.E. and W.F. Laudenslayer. 1988. A Guide to Wildlife Habitats of California. California Department of Forestry and Fire Protection. Sacramento, CA.

National Oceanic and Atmospheric Administration (NOAA). 2022. National Integrated Drought Information System. U.S. Drought Monitor. Accessed online through the U.S. Drought Portal (www.drought.gov).

Natural Resources Conservation Service (NRCS). 2019. Custom Soil Resource Report for Shasta County Area, California. Accessed through the NRCS Web Soil Survey website (http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm).

Soil Survey Staff. 2010. Keys to Soil Taxonomy, 11th ed. USDA-Natural Resources Conservation Service, Washington, DC.

U.S. Army Corps of Engineers (Corps). 2007. U.S. Army Corps of Engineers Jurisdictional Determination Form Instructional Guidebook. Prepared jointly by the U.S. Army Corps of Engineers and the Environmental Protection Agency. May 30, 2007.

U.S. Army Corps of Engineers (Corps). 2008. Regional supplement to the Corps of Engineers Wetland Delineation Manual: Arid West Region. J.S. Wakeley, R.W. Lichvar, and C.V. Noble, ed. ERDC/EL TR-06-16. Vicksburg, MS: U.S. Army Engineer Research and Development Center, Environmental Laboratory.

U.S. Army Corps of Engineers, South Pacific Division. 2001. Final summary report: Guidelines for jurisdictional determinations for water of the United States in the arid Southwest. San Francisco, CA: U.S. Army Corps of Engineers, South Pacific Division. (http://www.spl.usace.army.mil/regulatory/lad.htm).

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/

United States Department of Agriculture, Natural Resources Conservation Service. 2018. Field Indicators of Hydric Soils in the United States, Version 8.2. L.M. Vasilas, G.W. Hurt, and J.F. Berkowitz (eds.). USDA, NRCS, in cooperation with the National Technical Committee for Hydric Soils.

Western Regional Climate Center, Desert Research Institute. 2022. http://www.wrcc.dri.edu. Local Climate Summary for the Redding Muni AP, California (047304) NOAA Cooperative Station.

Wetland Training Institute. 1995. Field guide for wetland delineation: 1987 Corps of Engineers manual. (WTI 95-3). Poolsville, MD.

# Appendix A: Wetland Delineation Data Sheets

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine | City/County: Shasta County | Sampling Date: 6-2-20

Applicant/Owner: Crystal Creek Aggregate, Inc. | State: CA | Sampling Point: TP01

Investigator(s): E. Gregg | Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): sloped | Slope (%): 3

Subregion (LRR): C - Mediterranean California | Lat: 40.602553 | Long: -122.470598 | Datum: NAD 83

Soil Map Unit Name: Diamond Springs very rocky sandy loam, 30-50% slopes, severely eroded | NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes (●) No ( ) (If no, explain in Remarks.)

Are Vegetation [X] Soil [ ] or Hydrology [ ] significantly disturbed? Are "Normal Circumstances" present? Yes (●) No ( )

Are Vegetation [ ] Soil [ ] or Hydrology [ ] naturally problematic? (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | Yes | No |
|---|---|---|
| Hydrophytic Vegetation Present? | ● | |
| Hydric Soil Present? | | ● |
| Wetland Hydrology Present? | | ● |

**Is the Sampled Area within a Wetland?** Yes ( ) No (●)

Remarks: Low rainfall year. Within the Carr Fire burn scar. Disturbance in this portion of the project site are historical and are thus "normal circumstances." Area was historically disturbed when the old mining ponds were excavated. Area is sloped at the base of one of the pond berms.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | % | | |
| **Herb Stratum** | | | |
| 1. *Juncus xiphoides* | 30 | Yes | OBL |
| 2. *Anthoxanthum odoratum* | 40 | Yes | FAC |
| 3. *Acmispon americanus* | 10 | No | FAC |
| 4. *Leontodon saxatilis* | 10 | No | FACU |
| 5. *Lactuca serriola* | 10 | No | FACU |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| Total Cover: | 100 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 0 % | % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100.0 % (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 30 | x 1 = | 30 |
| FACW species | | x 2 = | 0 |
| FAC species | 50 | x 3 = | 150 |
| FACU species | 20 | x 4 = | 80 |
| UPL species | | x 5 = | 0 |
| Column Totals: | 100 (A) | | 260 (B) |

Prevalence Index = B/A = 2.60

**Hydrophytic Vegetation Indicators:**

- [X] Dominance Test is >50%
- [X] Prevalence Index is ≤3.0[1]
- [ ] Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** Yes (●) No ( )

Remarks:

## SOIL

Sampling Point: TP01

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-5 | 10YR 3/4 | 96 | 2.5YR 3/4 | 4 | C | PL | coarse sandy loam | |
| 5-10 | 10YR 5/3 | 68 | 2.5YR 4/6 | 25 | C | M | coarse sandy loam | few Mn stains present |
| | | | 10YR 6/6 | 7 | C | PL | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains

[2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: cobble

Depth (inches): 10

**Hydric Soil Present?** Yes ○ No ◉

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators. Does not meet any hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ○ | No ◉ | Depth (inches): |
| Water Table Present? | Yes ○ | No ◉ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ○ | No ◉ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ○ **No** ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Only sheetflow patterns were present. No other wetland hydrology indicators were observed.

## WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine | City/County: Shasta County | Sampling Date: 6-2-20

Applicant/Owner: Crystal Creek Aggregate, Inc. | State: CA | Sampling Point: TP02

Investigator(s): E. Gregg | Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): sloped | Slope (%): 3

Subregion (LRR): C - Mediterranean California | Lat: 40.602374 | Long: -122.470271 | Datum: NAD 83

Soil Map Unit Name: Diamond Springs very rocky sandy loam, 30-50% slopes, severely eroded | NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ◉ No ○ (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ◉ No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

### SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | Yes | No |
|---|---|---|
| Hydrophytic Vegetation Present? | ◉ | ○ |
| Hydric Soil Present? | ○ | ◉ |
| Wetland Hydrology Present? | ○ | ◉ |

**Is the Sampled Area within a Wetland?** Yes ○ No ◉

Remarks: Low rainfall year. Within the Carr Fire burn scar. Disturbance in this portion of the project site are historical and are thus "normal circumstances." Area was historically disturbed when the old mining ponds were excavated. Area is sloped adjacent to one of the man-made wetlands/ponds.

### VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | % | | |
| **Herb Stratum** | | | |
| 1. *Anthoxanthum odoratum* | 20 | Yes | FAC |
| 2. *Juncus xiphoides* | 15 | Yes | OBL |
| 3. *Acmispon americanus* | 15 | Yes | FAC |
| 4. *Leontodon saxatilis* | 15 | Yes | FACU |
| 5. *Linum bienne* | 15 | Yes | Not Listed |
| 6. *Elymus caput-medusae* | 10 | No | UPL |
| 7. *Plantago lanceolata* | 5 | No | FAC |
| 8. *Briza maxima* | 5 | No | UPL |
| Total Cover: | 100 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 0 % | % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 60.0 % (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 15 | x 1 = | 15 |
| FACW species | | x 2 = | 0 |
| FAC species | 40 | x 3 = | 120 |
| FACU species | 15 | x 4 = | 60 |
| UPL species | 30 | x 5 = | 150 |
| Column Totals: | 100 (A) | | 345 (B) |

Prevalence Index = B/A = 3.45

**Hydrophytic Vegetation Indicators:**

- ☒ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** Yes ◉ No ○

Remarks:

## SOIL

Sampling Point: TP02

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-5 | 10YR 3/4 | 96 | 2.5YR 3/4 | 4 | C | PL | coarse sandy loam | |
| 5-10 | 10YR 5/3 | 68 | 2.5YR 4/6 | 25 | C | M | coarse sandy loam | few Mn stains present |
| | | | 10YR 6/6 | 7 | C | PL | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains [2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: cobble

Depth (inches): 10

**Hydric Soil Present?** **Yes** ○ **No** ◉

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators. Does not meet any hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ○ | No ◉ | Depth (inches): |
| Water Table Present? | Yes ○ | No ◉ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ○ | No ◉ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ○ **No** ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Only sheetflow patterns were present. No other wetland hydrology indicators were observed.

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine | City/County: Shasta County | Sampling Date: 6-2-20

Applicant/Owner: Crystal Creek Aggregate, Inc. | State: CA | Sampling Point: TP03

Investigator(s): E. Gregg | Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): convex | Slope (%): 0.5

Subregion (LRR): C - Mediterranean California | Lat: 40.60262 | Long: -122.470914 | Datum: NAD 83

Soil Map Unit Name: Diamond Springs very rocky sandy loam, 30-50% slopes, severely eroded | NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes (•) No ( ) (If no, explain in Remarks.)

Are Vegetation [X] Soil [ ] or Hydrology [ ] significantly disturbed? Are "Normal Circumstances" present? Yes (•) No ( )

Are Vegetation [ ] Soil [ ] or Hydrology [ ] naturally problematic? (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes ( ) | No (•) |
| Hydric Soil Present? | Yes ( ) | No (•) |
| Wetland Hydrology Present? | Yes ( ) | No (•) |

**Is the Sampled Area within a Wetland?** Yes ( ) No (•)

Remarks: Low rainfall year. Within the Carr Fire burn scar. Disturbance in this portion of the project site are historical and are thus "normal circumstances." Area was historically disturbed when the old mining ponds were excavated. Area is adjacent to one of the man-made wetlands/ponds.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | % | | |
| **Herb Stratum** | | | |
| 1. *Acmispon americanus* | 35 | Yes | FAC |
| 2. *Anthoxanthum odoratum* | 15 | Yes | FAC |
| 3. *Briza maxima* | 15 | Yes | UPL |
| 4. *Lactuca serriola* | 15 | Yes | FACU |
| 5. *Elymus caput-medusae* | 10 | No | UPL |
| 6. *Festuca perennis* | 5 | No | FAC |
| 7. *Bromus diandrus* | 5 | No | UPL |
| 8. | | | |
| Total Cover: | 100 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 0 % | % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

| | | |
|---|---|---|
| Number of Dominant Species That Are OBL, FACW, or FAC: | 2 | (A) |
| Total Number of Dominant Species Across All Strata: | 4 | (B) |
| Percent of Dominant Species That Are OBL, FACW, or FAC: | 50.0 % | (A/B) |

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | | x 1 = | 0 |
| FACW species | | x 2 = | 0 |
| FAC species | 55 | x 3 = | 165 |
| FACU species | 15 | x 4 = | 60 |
| UPL species | 30 | x 5 = | 150 |
| Column Totals: | 100 (A) | | 375 (B) |

Prevalence Index = B/A = 3.75

**Hydrophytic Vegetation Indicators:**

- Dominance Test is >50%
- Prevalence Index is ≤3.0[1]
- [ ] Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** Yes ( ) No (•)

Remarks:

## SOIL

Sampling Point: TP03

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-8 | 10YR 5/4 | 100 | | | | | coarse sandy loam | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains [2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: dense gravel

Depth (inches): 8

**Hydric Soil Present?** Yes ○ No ◉

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators. Does not meet any hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

Surface Water Present? Yes ○ No ◉ Depth (inches):

Water Table Present? Yes ○ No ◉ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ○ No ◉ Depth (inches):

**Wetland Hydrology Present?** Yes ○ No ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No wetland hydrology indicators were observed.

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine    City/County: Shasta County    Sampling Date: 6-4-20

Applicant/Owner: Crystal Creek Aggregate, Inc.    State: CA    Sampling Point: W02

Investigator(s): E. Gregg    Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope    Local relief (concave, convex, none): concave    Slope (%): 2

Subregion (LRR): C - Mediterranean California    Lat: 40.606416    Long: -122.473774    Datum: NAD 83

Soil Map Unit Name: Diamond Springs very stony sandy loam, 8-30% slopes, eroded    NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ◉ No ○ (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ◉ No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes ◉ | No ○ |
| Hydric Soil Present? | Yes ◉ | No ○ |
| Wetland Hydrology Present? | Yes ◉ | No ○ |

**Is the Sampled Area within a Wetland?** **Yes** ◉ **No** ○

Remarks: Low rainfall year. Within the Carr Fire burn scar. This location is a hillslope seep wetland.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. *Salix lasiolepis* | 40 | Yes | FACW |
| 2. *Ailanthus altissima* | 10 | No | FACU |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | 50 % | | |
| **Herb Stratum** | | | |
| 1. *Typha sp.* | 25 | Yes | OBL |
| 2. *Juncus effusus* | 25 | Yes | FACW |
| 3. *Vitis californica* | 20 | Yes | FACU |
| 4. *Acmispon americanus* | 15 | No | FACW |
| 5. *Rubus armeniacus* | 10 | No | FAC |
| 6. *Paspalum dilatatum* | 5 | No | FAC |
| 7. | | | |
| 8. | | | |
| Total Cover: | 100 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 0 %    % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

| | | |
|---|---|---|
| Number of Dominant Species That Are OBL, FACW, or FAC: | 3 | (A) |
| Total Number of Dominant Species Across All Strata: | 4 | (B) |
| Percent of Dominant Species That Are OBL, FACW, or FAC: | 75.0 % | (A/B) |

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | 25 | x 1 = | 25 |
| FACW species | 80 | x 2 = | 160 |
| FAC species | 15 | x 3 = | 45 |
| FACU species | 30 | x 4 = | 120 |
| UPL species | | x 5 = | 0 |
| Column Totals: | 150 (A) | | 350 (B) |

Prevalence Index = B/A = 2.33

**Hydrophytic Vegetation Indicators:**

- ☒ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** **Yes** ◉ **No** ○

Remarks:

## SOIL

Sampling Point: W02

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-8 | 10YR 5/4 | 70 | 5YR 4/6 | 20 | C | PL | coarse sandy loam | |
| | 10YR 4/1 | 10 | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains
[2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☒ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: dense gravel

Depth (inches): 8

**Hydric Soil Present?** **Yes** ◉ **No** ○

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☒ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☒ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☒ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

Surface Water Present? Yes ○ No ◉ Depth (inches):

Water Table Present? Yes ○ No ◉ Depth (inches):

Saturation Present? (includes capillary fringe) Yes ○ No ◉ Depth (inches):

**Wetland Hydrology Present?** **Yes** ◉ **No** ○

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine | City/County: Shasta County | Sampling Date: 6-4-20

Applicant/Owner: Crystal Creek Aggregate, Inc. | State: CA | Sampling Point: U02

Investigator(s): E. Gregg | Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): none/sloped | Slope (%): 2

Subregion (LRR): C - Mediterranean California | Lat: 40.60641 | Long: -122.473715 | Datum: NAD 83

Soil Map Unit Name: Diamond Springs very stony sandy loam, 8-30% slopes, eroded | NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ◉ No ○ (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ◉ No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | Yes | No |
|---|---|---|
| Hydrophytic Vegetation Present? | ○ | ◉ |
| Hydric Soil Present? | ○ | ◉ |
| Wetland Hydrology Present? | ○ | ◉ |

**Is the Sampled Area within a Wetland?** **Yes** ○ **No** ◉

Remarks: Low rainfall year. Within the Carr Fire burn scar. This location was relatively flat on a slight slope adjacent to a swale/seep wetland.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. *Heteromeles arbutifolia* | 15 | Yes | UPL |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | 15 % | | |
| **Herb Stratum** | | | |
| 1. *Avena barbata* | 40 | Yes | UPL |
| 2. *Festuca myuros* | 25 | Yes | Not Listed |
| 3. *Lactuca serriola* | 20 | Yes | FACU |
| 4. *Acmispon americanus* | 10 | No | FAC |
| 5. *Vitis californica* | 5 | No | FACU |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| Total Cover: | 100 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum ___ % | % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

| | | |
|---|---|---|
| Number of Dominant Species That Are OBL, FACW, or FAC: | 0 | (A) |
| Total Number of Dominant Species Across All Strata: | 4 | (B) |
| Percent of Dominant Species That Are OBL, FACW, or FAC: | 0.0 % | (A/B) |

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | | x 1 = | 0 |
| FACW species | | x 2 = | 0 |
| FAC species | 10 | x 3 = | 30 |
| FACU species | 25 | x 4 = | 100 |
| UPL species | 80 | x 5 = | 400 |
| Column Totals: | 115 (A) | | 530 (B) |

Prevalence Index = B/A = 4.61

**Hydrophytic Vegetation Indicators:**

- Dominance Test is >50%
- Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** **Yes** ○ **No** ◉

Remarks:

## SOIL

Sampling Point: U02

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-8 | 10YR 5/4 | 100 | | | | | coarse sandy loam | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains [2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: dense gravel

Depth (inches): 8

**Hydric Soil Present?** **Yes** ○ **No** ◉

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators. Does not meet any hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ○ | No ◉ | Depth (inches): |
| Water Table Present? | Yes ○ | No ◉ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ○ | No ◉ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ○ **No** ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No wetland hydrology indicators were observed.

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine | City/County: Shasta County | Sampling Date: 6-4-20

Applicant/Owner: Crystal Creek Aggregate, Inc. | State: CA | Sampling Point: W03

Investigator(s): E. Gregg | Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope | Local relief (concave, convex, none): sloped | Slope (%): 4

Subregion (LRR): C - Mediterranean California | Lat: 40.605047 | Long: -122.472617 | Datum: NAD 83

Soil Map Unit Name: Diamond Springs very stony sandy loam, 8-30% slopes, eroded | NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ◉ No ○ (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☐ or Hydrology ☐ significantly disturbed? Are "Normal Circumstances" present? Yes ◉ No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic? (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | | |
|---|---|---|
| Hydrophytic Vegetation Present? | Yes ◉ | No ○ |
| Hydric Soil Present? | Yes ◉ | No ○ |
| Wetland Hydrology Present? | Yes ◉ | No ○ |

**Is the Sampled Area within a Wetland?** **Yes** ◉ **No** ○

Remarks: Low rainfall year. Within the Carr Fire burn scar. This location is a hillslope seep wetland.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. *Calycanthus occidentalis* | 20 | Yes | FAC |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | 20 % | | |
| **Herb Stratum** | | | |
| 1. *Woodwardia fimbriata* | 40 | Yes | FACW |
| 2. *Acmispon americanus* | 20 | Yes | FAC |
| 3. *Juncus tenuis* | 10 | No | FACW |
| 4. *Cyperus eragrostis* | 5 | No | FACW |
| 5. *Festuca perennis* | 5 | No | FAC |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| Total Cover: | 80 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 0 % | % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

| | | |
|---|---|---|
| Number of Dominant Species That Are OBL, FACW, or FAC: | 3 | (A) |
| Total Number of Dominant Species Across All Strata: | 3 | (B) |
| Percent of Dominant Species That Are OBL, FACW, or FAC: | 100.0 % | (A/B) |

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | | x 1 = | 0 |
| FACW species | 55 | x 2 = | 110 |
| FAC species | 45 | x 3 = | 135 |
| FACU species | | x 4 = | 0 |
| UPL species | | x 5 = | 0 |
| Column Totals: | 100 (A) | | 245 (B) |

Prevalence Index = B/A = 2.45

**Hydrophytic Vegetation Indicators:**

- ☒ Dominance Test is >50%
- ☒ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** **Yes** ◉ **No** ○

Remarks:

## SOIL

Sampling Point: W03

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-8 | 10YR 5/4 | 20 | 5YR 4/6 | 20 | C | PL | coarse sandy loam | |
| | 10YR 4/1 | 60 | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains [2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: dense gravel

Depth (inches): 8

**Hydric Soil Present?** **Yes** ◉ **No** ○

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☒ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☒ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☒ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ○ | No ◉ | Depth (inches): |
| Water Table Present? | Yes ○ | No ◉ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ○ | No ◉ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ◉ **No** ○

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

# WETLAND DETERMINATION DATA FORM - Arid West Region

Project/Site: Crystal Creek Aggregate Mine    City/County: Shasta County    Sampling Date: 6-4-20

Applicant/Owner: Crystal Creek Aggregate, Inc.    State: CA    Sampling Point: U03

Investigator(s): E. Gregg    Section, Township, Range: Section 30, Township 32N, Range 5W

Landform (hillslope, terrace, etc.): hillslope    Local relief (concave, convex, none): convex    Slope (%): 1

Subregion (LRR): C - Mediterranean California    Lat: 40.605077    Long: -122.472629    Datum: NAD 83

Soil Map Unit Name: Diamond Springs very stony sandy loam, 8-30% slopes, eroded    NWI classification: N/A

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ◉ No ○ (If no, explain in Remarks.)

Are Vegetation ☒ Soil ☐ or Hydrology ☐ significantly disturbed?    Are "Normal Circumstances" present? Yes ◉ No ○

Are Vegetation ☐ Soil ☐ or Hydrology ☐ naturally problematic?    (If needed, explain any answers in Remarks.)

## SUMMARY OF FINDINGS - Attach site map showing sampling point locations, transects, important features, etc.

| | Yes | No |
|---|---|---|
| Hydrophytic Vegetation Present? | ○ | ◉ |
| Hydric Soil Present? | ○ | ◉ |
| Wetland Hydrology Present? | ○ | ◉ |

**Is the Sampled Area within a Wetland?** **Yes** ○ **No** ◉

Remarks: Low rainfall year. Within the Carr Fire burn scar. This location is a convex area above/adjacent to a hillslope seep.

## VEGETATION

| Tree Stratum (Use scientific names.) | Absolute % Cover | Dominant Species? | Indicator Status |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| Total Cover: | % | | |
| **Sapling/Shrub Stratum** | | | |
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
| 5. | | | |
| Total Cover: | % | | |
| **Herb Stratum** | | | |
| 1. *Acmispon americanus* | 35 | Yes | FAC |
| 2. *Festuca myuros* | 25 | Yes | Not Listed |
| 3. *Lactuca serriola* | 10 | No | FACU |
| 4. *Leontodon saxatilis* | 10 | No | FACU |
| 5. *Hypericum perforatum* | 5 | No | FACU |
| 6. | | | |
| 7. | | | |
| 8. | | | |
| Total Cover: | 85 % | | |
| **Woody Vine Stratum** | | | |
| 1. | | | |
| 2. | | | |
| Total Cover: | % | | |

% Bare Ground in Herb Stratum 15 %    % Cover of Biotic Crust 0 %

**Dominance Test worksheet:**

Number of Dominant Species That Are OBL, FACW, or FAC: 1 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 50.0 % (A/B)

**Prevalence Index worksheet:**

| Total % Cover of: | | Multiply by: | |
|---|---|---|---|
| OBL species | | x 1 = | 0 |
| FACW species | | x 2 = | 0 |
| FAC species | 35 | x 3 = | 105 |
| FACU species | 25 | x 4 = | 100 |
| UPL species | 25 | x 5 = | 125 |
| Column Totals: | 85 (A) | | 330 (B) |

Prevalence Index = B/A = 3.88

**Hydrophytic Vegetation Indicators:**

- ☐ Dominance Test is >50%
- ☐ Prevalence Index is ≤3.0[1]
- ☐ Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present.

**Hydrophytic Vegetation Present?** **Yes** ○ **No** ◉

Remarks:

## SOIL

Sampling Point: U03

**Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)**

| Depth (inches) | Matrix Color (moist) | Matrix % | Redox Features Color (moist) | Redox Features % | Type[1] | Loc[2] | Texture | Remarks |
|---|---|---|---|---|---|---|---|---|
| 0-8 | 10YR 5/4 | 100 | | | | | coarse sandy loam | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix. CS=Covered or Coated Sand Grains [2] Location: PL=Pore Lining, M=Matrix.

**Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)**

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR C**)
- ☐ 1 cm Muck (A9) (**LRR D**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Vernal Pools (F9)

**Indicators for Problematic Hydric Soils:** [3]

- ☐ 1 cm Muck (A9) (**LRR C**)
- ☐ 2 cm Muck (A10) (**LRR B**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

[3] Indicators of hydrophytic vegetation and wetland hydrology must be present. unless distributed or problematic

**Restrictive Layer (if present):**

Type: dense gravel

Depth (inches): 8

**Hydric Soil Present?** **Yes** ○ **No** ◉

Remarks: Soil pit dug deep enough to determine the presence/absence of hydric soil indicators. Does not meet any hydric soil indicators.

## HYDROLOGY

**Wetland Hydrology Indicators:**

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1) (**Nonriverine**)
- ☐ Sediment Deposits (B2) (**Nonriverine**)
- ☐ Drift Deposits (B3) (**Nonriverine**)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Biotic Crust (B12)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Plowed Soils (C6)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (2 or more required)

- ☐ Water Marks (B1) (**Riverine**)
- ☐ Sediment Deposits (B2) (**Riverine**)
- ☐ Drift Deposits (B3) (**Riverine**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)

**Field Observations:**

| | | | |
|---|---|---|---|
| Surface Water Present? | Yes ○ | No ◉ | Depth (inches): |
| Water Table Present? | Yes ○ | No ◉ | Depth (inches): |
| Saturation Present? (includes capillary fringe) | Yes ○ | No ◉ | Depth (inches): |

**Wetland Hydrology Present?** **Yes** ○ **No** ◉

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No wetland hydrology indicators were observed.

## Appendix B: NRCS Soils Map and Soil Series Description

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

# Shasta County Area, California

## Crystal Creek Aggregate Mine


June 11, 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


Map Scale: 1:7,350 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 350, 700, 1400, 2100

Map projection: Web Mercator   Corner coordinates: WGS84   Edge tics: UTM Zone 10N WGS84

## 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 1:20,000.

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: Shasta County Area, California
Survey Area Data: Version 14, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 12, 2010—Jul 22, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Map Unit Symbol | Map Unit Name | Acres in AOI | Percent of AOI |
|---|---|---|---|
| DfD2 | Diamond Springs very stony sandy loam, 8 to 30 percent slopes, eroded | 85.6 | 49.1% |
| DgE2 | Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, eroded | 7.7 | 4.4% |
| DgE3 | Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, severely eroded | 81.2 | 46.5% |
| **Totals for Area of Interest** | | **174.6** | **100.0%** |

# Map Unit Descriptions

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.

# Shasta County Area, California

## DfD2—Diamond Springs very stony sandy loam, 8 to 30 percent slopes, eroded

### Map Unit Setting

*National map unit symbol:* hfn7
*Elevation:* 1,000 to 4,000 feet
*Mean annual precipitation:* 40 inches
*Mean annual air temperature:* 54 degrees F
*Frost-free period:* 140 to 240 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Diamond springs and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Diamond Springs

#### Setting

*Landform:* Mountains
*Landform position (two-dimensional):* Shoulder, backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Residuum weathered from metavolcanics

#### Typical profile

*H1 - 0 to 10 inches:* very stony sandy loam
*H2 - 10 to 15 inches:* sandy loam
*H3 - 15 to 29 inches:* sandy clay loam
*H4 - 29 to 50 inches:* sandy loam
*H5 - 50 to 54 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 8 to 30 percent
*Percent of area covered with surface fragments:* 5.0 percent
*Depth to restrictive feature:* 50 to 54 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* High
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 6.2 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 6s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

**Minor Components**

**Kanaka**

*Percent of map unit:* 10 percent
*Hydric soil rating:* No

**Unnamed**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

## DgE2—Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, eroded

**Map Unit Setting**

*National map unit symbol:* hfn8
*Elevation:* 1,000 to 4,000 feet
*Mean annual precipitation:* 40 inches
*Mean annual air temperature:* 54 degrees F
*Frost-free period:* 140 to 240 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Diamond springs and similar soils:* 70 percent
*Rock outcrop:* 15 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Diamond Springs**

**Setting**

*Landform:* Mountains
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Residuum weathered from metavolcanics

**Typical profile**

*H1 - 0 to 10 inches:* very stony sandy loam
*H2 - 10 to 15 inches:* sandy loam
*H3 - 15 to 29 inches:* sandy clay loam
*H4 - 29 to 50 inches:* sandy loam
*H5 - 50 to 54 inches:* weathered bedrock

**Properties and qualities**

*Slope:* 30 to 50 percent
*Depth to restrictive feature:* 50 to 54 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Moderate (about 6.2 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 7s
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

**Description of Rock Outcrop**

**Setting**

*Landform:* Mountains
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Residuum weathered from metavolcanics

**Typical profile**

*H1 - 0 to 4 inches:* unweathered bedrock

**Properties and qualities**

*Slope:* 30 to 50 percent
*Depth to restrictive feature:* 0 to 4 inches to lithic bedrock
*Natural drainage class:* Excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* Low to very high (0.01 to 19.98 in/hr)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 8s
*Hydric soil rating:* No

**Minor Components**

**Kanaka**

*Percent of map unit:* 10 percent
*Hydric soil rating:* No

**Goulding**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Aiken**

*Percent of map unit:* 2 percent
*Hydric soil rating:* No

## DgE3—Diamond Springs very rocky sandy loam, 30 to 50 percent slopes, severely eroded

### Map Unit Setting

*National map unit symbol:* hfn9
*Elevation:* 1,000 to 4,000 feet
*Mean annual precipitation:* 40 inches
*Mean annual air temperature:* 54 degrees F
*Frost-free period:* 140 to 240 days
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Diamond springs and similar soils:* 70 percent
*Rock outcrop:* 15 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Diamond Springs

#### Setting

*Landform:* Mountains
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Concave
*Across-slope shape:* Concave
*Parent material:* Residuum weathered from metavolcanics

#### Typical profile

*H1 - 0 to 2 inches:* very stony sandy loam
*H2 - 2 to 7 inches:* sandy loam
*H3 - 7 to 21 inches:* sandy clay loam
*H4 - 21 to 30 inches:* sandy loam
*H5 - 30 to 34 inches:* weathered bedrock

#### Properties and qualities

*Slope:* 30 to 50 percent
*Depth to restrictive feature:* 30 to 34 inches to paralithic bedrock
*Natural drainage class:* Well drained
*Runoff class:* Very high
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.06 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Available water storage in profile:* Low (about 4.0 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 7e
*Hydrologic Soil Group:* C
*Hydric soil rating:* No

**Description of Rock Outcrop**

**Setting**

*Landform:* Mountains
*Landform position (two-dimensional):* Backslope
*Landform position (three-dimensional):* Mountainflank
*Down-slope shape:* Concave
*Across-slope shape:* Convex
*Parent material:* Residuum weathered from metavolcanics

**Typical profile**

*H1 - 0 to 4 inches:* unweathered bedrock

**Properties and qualities**

*Slope:* 30 to 50 percent
*Depth to restrictive feature:* 0 to 4 inches to lithic bedrock
*Natural drainage class:* Excessively drained
*Capacity of the most limiting layer to transmit water (Ksat):* Low to very high (0.01 to 19.98 in/hr)
*Available water storage in profile:* Very low (about 0.0 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 8s
*Hydric soil rating:* No

**Minor Components**

**Kanaka**

*Percent of map unit:* 10 percent
*Hydric soil rating:* No

**Goulding**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Aiken**

*Percent of map unit:* 2 percent
*Hydric soil rating:* No

# References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf