Crawford & Associates, Inc.
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Taber Since 1954
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October 11, 2017
CAInc File No. 16-337.6

Mr. Howard Dashiell, PE
Mendocino County Department of Transportation
340 Lake Mendocino Drive
Ukiah, CA 95482

Subject: **Geotechnical Memorandum**
Peachland Road (CR 128) Failure at MP 0.95
Mendocino County, California

Dear Mr. Dashiell,

Crawford & Associates, Inc. (CAInc) prepared this Geotechnical Memorandum for the Peachland Road Failure at Milepost (MP) 0.95 in accordance with Project Work Order No. 6 under Mendocino County Board of Supervisors (BOS) Agreement 16-099 and Mendocino County Department of Transportation (MCDOT) Agreement 16-0048, made on December 06, 2016. This memo provides repair alternatives and recommendations for permanent road repair with a soldier pile tieback wall.

Please contact us if you have questions or require additional information.

Sincerely,

**Crawford & Associates, Inc.,**

Ryan Houghton, PE
*Project Engineer*

*Reviewed By,*

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# 1 INTRODUCTION

This Geotechnical Memorandum summarizes the results of our geotechnical investigation completed at the Peachland Road (CR 128) Failure at MP 0.95. This work was completed in accordance with Work Order No. 6 agreement with Mendocino County Department of Transportation (MCDOT) and summarizes the site earth materials and their properties, evaluates alternative repair options, and provides recommendations for permanent repair with a soldier pile tieback wall.

# 2 GEOTECHNICAL SERVICES

To prepare this report, Crawford & Associates (CAInc):

- Discussed the project with MCDOT.
- Reviewed published topographic, geologic, landslide, and seismic mapping of the site.
- Reviewed MCDOT survey data, received via electronic transfer on September 7, 2017.
- Performed surface geologic reconnaissance of the site and immediate vicinity.
- Drilled and sampled two roadway-level test borings on August 23-24, 2017.
- Performed laboratory testing and geotechnical engineering analysis in support of the recommendations contained herein.

# 3 PROJECT DESCRIPTION

## 3.1 PROJECT LOCATION

The project is located on Peachland Road (CR 128) at MP 0.95, approximately 2.5 miles northwest of Boonville, off of SR 128. Site latitude is approximately 39.042303° and longitude -123.380535°, per Google Earth. See Figure 1 for Vicinity Map.

## 3.2 SITE DESCRIPTION

Peachland Road at this location traverses a steep, southeast-facing slope approximately 200-250 feet above Con Creek. The road is unpaved, approximately 15-16 feet wide on either side of failure and 8-10 feet wide within the failure area. The road alignment at the failure location is a sharp, concave curve, with reversing curvature at each end. The inboard cut-slope is about 10-15 feet high, with slopes of 1:1 or steeper. The outer fill section is estimated to be 5-15 feet deep. Approximate site elevation is 680 feet per USGS topographic mapping; a topographic survey by MCDOT [1] used an assumed elevation 1000.00 (CP 1) for this project and the site area elevation ranges between 1000 and 1018.

The subject road failure is approximately 130 feet in length, and has caused a complete loss of the outer half of the road over the entire failure length. The failure created a steep head scarp approximate 15-20 feet high, with scarp slopes ranging from about 0.5:1 just below the road surface and flattening to 1:1 at the base.

The road gradient, based on the MCDOT topography survey, ascends 9-12% from south to north. Surface runoff is collected in an unlined ditch on the inboard side of the road, which conveys runoff water south of the failure area. Drain rock has been placed within the ditch to increase the road width to allow large vehicles to drive through failure area. No sloughing of the inboard cut slope was observed at the site.

[1] CAD drawings of Topographic Survey completed by MCDOT received electronically on 09/07/2017

See Figure 1 for the regional topography in the vicinity of the site and Figure 2 for local site topography and location of the borings.

# 4 GEOLOGIC SETTING

## 4.1 REGIONAL GEOLOGY

The project site lies within the Coast Ranges Geomorphic Province, characterized by a series of northwest trending mountain ranges sub-parallel to the San Andres Fault. The Coast Ranges is composed of thick Mesozoic and Cenozoic sedimentary strata. The northern Coast Ranges are dominated by the irregular, knobby, landslide-topography of the Franciscan Complex. Regional geologic mapping[2] shows the site as being primarily underlain by Cretaceous age Undivided Sedimentary Rocks (K), which consist of marine sandstone, shale, and conglomerate. Additionally, the site is mapped at the periphery of an outcrop of Jurassic-Cretaceous age Franciscan Volcanic and Metavolcanic Rocks (KJfv), which consists of "greenstone".

See Figure 3 for a Regional Geologic Map.

## 4.2 SITE GEOLOGY AND LANDSLIDE MAPPING

Published local geologic and landslide mapping of the Boonville SW (Philo)[3] 7.5-minute quadrangle shows the site underlain by Tertiary-Cretaceous age Coastal Belt Franciscan (TKfs) rock, described as well-consolidated, clastic sedimentary rocks (sandstone and shale with minor amounts of limestone and conglomerate), with areas of sheared shale. An outcrop of serpentinite is mapped just southwest of the site vicinity. There is a mapped dormant debris slide near the project's location. Additionally, there are mapped areas of "disrupted ground" and small-scale slides around the project vicinity.

Cut-slopes in the project vicinity revealed fractured sandstone of variable weathering, consistent with the geologic mapping of the area. There was no observable slope distress upslope of the road or other evidence to suggest larger-scale, "global" instability at the site. No springs or green vegetation was observed during our site investigation (August 2017) to suggest shallow ground water at the site.

See Figure 4 for local Landslide and Geology Mapping.

## 4.3 FAULTS AND SEISMIC ACTIVITY

Based on California Geologic Survey (CGS) fault data[4], the nearest faults to the site are unnamed Pre-Quaternary faults (no activity in last 1.6 million years) located approximately 1.3 miles northeast and 2.0 miles southwest of the site. The nearest active faults (defined as surface displacement within the last 11,000 years) are the north section of the Maacama Fault Zone, located approximately 13.0 miles northeast of the site, and the north coast section of the San Andreas Fault Zone, located approximately 15.6 miles southwest of the site. The USGS assigns a probabilistic peak ground acceleration (PGA) of approximately 0.48g[5] to this site.

[2] Jennings, C.W. and Strand, R.G. (1960), Geologic Map of California: Ukiah Sheet, California Division of Mines and Geology, Scale 1:250,000
[3] Manson, M.W. (1984), Geology and Geomorphic Features Related to Landsliding, Boonville SW (Philo) 7.5' Quadrangle, OFR 84-43, California Division of Mines and Geology, Scale 1:24,000
[4] California Geologic Survey, 2010 Fault Activity Map of California, GIS data
[5] USGS Unified Hazard Tool (2014 data), assuming Site Class C and return period of 975 years (5% in 50 year event)

See Figure 5 for Fault Activity Map.

# 5 SUBSURFACE CONDITIONS

## 5.1 EXPLORATION

CAInc retained Geo-Ex Subsurface Exploration to drill and sample two roadway-level test borings (B1 and B2) to a maximum depth of 49.5 feet below the ground surface (bgs), corresponding to a minimum elevation of 967.6 feet. Drilling was conducted from 08/23/17 to 08/24/17. See Figure 2 for the Exploration Location Map.

Geo-Ex used a CME 45 high-torque track-mounted drill rig to complete the test borings using 4" solid-stem auger and 3.8" rotary wash drilling equipment. Auger refusal was reached in the rock unit of B1 and B2 at 18 feet and 20 feet bgs respectively. Drilling was noted as becoming "hard" (typically characterized as near maximum drill rig effort and audible drill chatter/screeching) within B1 and B2 at 17 feet and 23 feet bgs, respectively. There was a 5 foot section of soft rock identified in B1 between depths of 24 feet and 29 feet, interpreted as decomposed sandstone/shale.

Soil/weathered rock samples were recovered by means of a 2.0-inch O.D. "Standard Penetration" split-spoon sampler with 1.4-inch stainless steel liners and a 3.0-inch O.D. "Modified California" split-spoon sampler with 2.4-inch stainless steel liners. Both samplers were advanced with standard 350 ft-lb striking force using a 140 lb. automatic hammer and a drop height of 30 inches. An energy hammer analysis was not performed specific to this project/site, but a calibration test performed on 10/16/2015 indicates an efficiency of 75%. Sampler penetration resistance was recorded to provide a field measure of relative densities and can be correlated to soils strength and bearing characteristics. The field-recorded (uncorrected) blow counts are shown on the boring logs provided in Appendix A.

CAInc logged the test borings consistent with the Unified Soil Classification System (USCS) and the Caltrans 2010 Logging Manual. Selected portions of recovered soil drive samples were retained in sealed containers for laboratory testing and reference. Groundwater observations were recorded during drilling operations when encountered. At completion, the borings were cement grout backfilled per Mendocino County Environmental Health Division requirements.

## 5.2 SOIL DESCRIPTION

Based on the test boring data, we divide the subsurface soils into two general material units, as described in Table 1 below. Refer to the boring logs in Appendix A for more specific soil/rock descriptions, boring details and elevations.

**Table 1: Subsurface Soils**

| Unit | Location | Elevation (ft) | Soil Description |
|---|---|---|---|
| 1 | B1/B2 | Surface to 996/994 | **Fill and/or Native Residual Soil, Weak Rock** - stiff to medium dense, brown to light brown, sandy lean clay with gravel to clayey sand with gravel (*fill and/or residual soil*); also brown to dark brown, decomposed to very intensely weathered sandstone (*weak rock*); Pocket Penetrometer[1] (PP) tests on weak rock samples all were +4.5 tsf; field SPT Blow Counts[2] (N) ranges from 16-30 blows per foot (bpf). |
| 2 | B1/B2 | 996/994 to 967.5 | **Weathered Rock** –brown to light gray, very intensely to intensely weathered, very intensely to intensely fractured sandstone; PP tests on samples typically +4.5 tsf with N>50 bpf (typically reaching blow count refusal[2]); B1 contained a discontinuous 5' layer from Elev. 976 to 971 of very soft, gray decomposed rock (Clayey Sand matrix), which had N = 8. |

Note: 1. Pocket Penetrometer (PP) is a field measure for approximating the unconfined compressive strength of soil.
2. Field SPT Blow Counts (N) is a measure of Standard Penetration Test blows per foot. Refusal defined as 50 blows in less than 6".

### 5.3 GROUNDWATER

Free groundwater was not encountered in either of the test borings within the augered portion of the holes (depth 18-20 feet). Potential groundwater could not be recorded below the augered portions due to the use of rotary wash drilling technique. During the wet season water will potential perch above the rock unit at variable depths. We do not expect significant groundwater within the upper 50 feet of the rock unit, except locally within fractured and/or decomposed sections during the winter months. Groundwater levels in general will fluctuate due to changes in precipitation, seasonal fluctuations, and other factors.

## 6 LABORATORY TESTING

CAInc completed the following laboratory tests on representative soil samples obtained from the test borings:

- Moisture Content/Unit Weight (ASTM D2216/2937)
- Particle Size Analysis (ASTM D422)
- Plasticity Index (ASTM D4318)
- Unconfined Compression (ASTM D2166)
- Sulfate/Chloride Content (CTM 417/422)
- pH/Minimum Resistivity (CTM 643)

Table 2 below summarizes the material properties determined from lab testing of the underlying soil/rock units.

**Table 2: Material Properties**

| Material Unit | In-Situ Densities (Total - pcf) | Moisture Content (%) |
|---|---|---|
| 1 | 92.0 | 6.2 |
| 2 | 115.9 – 161.5 (Avg. = 138.5) | 2.5 – 10.0 (Avg. = 5.8) |

Three unconfined compression tests were completed on samples of weathered rock and resulted in a range of 274 psf to 2,275 psf. The lower value was from the soft 5' layer in B1 mentioned above. Neglecting the soft layer, the average unconfined compressive strength was 2,016 psf. Pocket penetrometer tests were consistently greater than 4.5 tsf on samples of weathered rock (tested within confinement of the steel sample liners).

A chemical analysis was completed on one sample for corrosion potential. See Table 3 below for summary of test results.

**Table 3: Soil Corrosion Test Summary**

| Boring-Sample No. | Depth (ft) | pH | Minimum Resistivity (ohm-cm) | Chloride Content (ppm) | Sulfate Content (ppm) |
|---|---|---|---|---|---|
| B2-1 | 6 | 6.65 | 3,750 | 2.0 | 5.9 |

According to Caltrans Corrosion Guidelines, a site is considered to be corrosive to foundation elements (concrete/steel) if one or more of the following conditions exist: Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 2000 ppm, minimal resistivity of 1000 ohm-cm or less, or the pH is 5.5 or less. Based on the test results above and Caltrans guidelines, site soils are considered non-corrosive to concrete/steel foundation elements. These tests are only an indicator of soil corrosivity and the designer should consult with a corrosion engineer if these values are considered significant.

See Appendix B for a complete summary of Laboratory Testing Results.

## 7 CONCLUSIONS

The road failure occurred primarily within residual soil, fill material, and highly weathered/weak rock. We conclude the primary causes of slope failure to be the inherent weakness of the fill and outer slope rock, the high degree of saturation from seasonal storm water infiltration during this past very wet winter, and erosion of the fill slope by surface runoff. Without remedial work, expect additional slope movement during future wet seasons, with possible progression both head-ward and laterally.

In analyzing potential repair options, we considered a tieback Soldier Pile wall; a Mechanically Stabilized Earth (MSE) wall; and RSP Fill Slope for permanent repair. The following summarizes the key elements of each option.

**1. Soldier Pile Tieback Wall:**

- Drill vertical soldier piles and anchor piles into the weathered rock.
- Install tiebacks from soldier piles to anchor piles for control of lateral stresses.
- Construct lagging and/or facing elements to support backfill.
- Install sub-drainage behind the wall for control of hydrostatic forces.
- Install trenched under-drain along inboard side of road to intercept shallow subsurface water.
- Control surface runoff to direct water away from the slide area, such as with an AC dike.
- Reconstruct pavement section.

**2. Mechanically Stabilized Earth (MSE) Wall:**

- Excavate and remove disturbed slide materials within the wall area.

- Establish base of wall into the intact sedimentary rock, as verified by CAInc.
- Construct the wall and new embankment using new cut from the excavation.
- Install sub-drainage behind the wall, with gravity relief.
- Install trenched under-drain along inboard side of road to intercept shallow subsurface water.
- Control surface runoff to direct water away from the slide area, such as with an AC dike.
- Reconstruct pavement section.

**3. RSP (Rock Slope Protection) Fill Slope:**

- Excavate a minimum 8-foot wide key at the base of the slope, with minimum 2 feet embedment into intact rock and temporary back-slope about 0.75:1.
- Place rock slope protection (e.g. 1-ton rock) with filter fabric backing and a 1:1 finished slope.
- Provide toe drain with gravity outlet.
- Control surface runoff to direct water away from the slide area, such as with an AC dike.
- Reconstruction pavement section.

We consider other options less appropriate for this site. The existing slopes are too steep for a typical 2:1 (H:V) reconstructed embankment section. Rigid wall systems, such as reinforced concrete cantilever wall, are not recommended due to height requirements and limited tolerance for movement. Significant road realignment and/or significant grade changes are not viable due to the existing curvature and high cuts already present at the site.

# 8 RECOMMENDATIONS

We recommend the soldier pile tieback wall as the preferred repair option. This option will achieve secure support within the rock and provide lateral resistance to active pressures. Additionally, this option will limit the environmental impact downslope of the failure. See Figure 6 for typical section of a tieback wall.

The MSE wall and RSP Fill options would be at least 25 foot high in order to fully engage the stable Unit 2 rock, thus require significant excavations likely extending beyond the County Right-of-Way, as well as having a greater environmental impact within the project vicinity. Additionally, they may require a road closure to construct, which is not feasible due to a lack of detour options.

The following summarizes our recommended active and passive Equivalent Fluid Pressures (EFP) for design of the soldier pile tieback wall. Include traffic loading in determination of design wall pressures.

- An active EFP of 40 pcf/ft for imported structural backfill meeting Caltrans 2015 Specifications[6]
- An active EFP of 50 pcf/ft for native backfill materials
- A passive EFP of 500 pcf/ft for the weathered rock unit

The passive resistance of the piles embedded into weathered rock can be applied to an effective pile width of 3x the pile diameter, provided that the pile spacing is greater than the effective pile width.

We consider cast-in-drilled-hole (CIDH) piles with a minimum diameter of 24 inches appropriate for this project. For design, consider the piles essentially "fixed" at 3 feet below the rock line. Provide additional lateral capacity by installing an H-pile "core", or other reinforcement, within the pile excavations. Place

[6] Material assumed to be fully drained with unit weight of 120 pcf and friction angle of 34 deg. per Caltrans

concrete in clean, dry excavations, as soon as possible after completion of drilling. We expect that groundwater seepage into the pile excavations can be controllable by pumping, if necessary, for dry-season construction (e.g., late summer to early fall).

Retain the backfill between the soldier piles with wood lagging and/or concrete facing placed between the H-pile flanges. Provide wall drainage by means of either (1) a permeable material section (e.g., Class-2 Permeable Material per Caltrans Section 68), wrapped in filter fabric, (2) permeable backfill (e.g., clean drain rock) with filter fabric backing, or (3) prefabricated drainage panel attached behind the wall. Provide a perforated gravity drainpipe located behind the bottom of the wall.

We recommend the soldier piles achieve a minimum 20 feet of embedment below the pile fixity point into the weathered rock unit. The wall length will be approximately 153 feet and should extend a minimum of 10 feet beyond the extents of the slide limits. For a wall positioned as shown in Figure 6, the estimated rock surface near the center of the slide is elevation 994 feet (per assumed project datum), corresponding to a minimum pile tip elevation of 971 feet. Minimum pile tip elevation assumes 3 feet from estimated rock line to pile fixity point and 20 feet of embedment. Based on our boring data, we recommend pile tip elevations at 971 feet from the center of the slide to the south end, and transition linearly from 971 feet to 980 feet from the center of the slide to the north end.

Resist lateral wall forces with horizontal tieback rods connected to CIDH anchor piles drilled along the inboard side of the road. Embed the anchor piles a minimum of 15 feet below the pile fixity point into the weathered rock unit. The estimated rock surface below the inboard edge of the road at the center of the slide is at elevation 1005 feet, corresponding to a minimum pile tip elevation of 987 feet. Pile tip elevations meeting the embedment criteria can transition linearly from 977 feet at the south extent to 992 feet at the north extent.

Variations in the rock surface may be nonlinear and change abruptly; therefore, the final tip elevations should be made on the basis of specific field review by a CAInc representative.

We recommend construction of a trenched under-drain (e.g., per Caltrans “Standard Plans”) along the inner road area to intercept shallow seepage. Construct the under-drain to minimum depth 5 feet below road grade and backfill with permeable material enclosed in filter fabric. Place low permeability soil (compacted structure backfill or cohesive native soil) within the uppermost 6 inches to prevent surface water from entering the under-drain. See Figure 6 for typical section of tieback wall.

## 9 RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risks of costly design, construction, and maintenance problems can be significantly lowered by retaining the geotechnical engineer of record to provide additional services during design and construction.

For this project, CAInc should be retained to:

- Review and provide comments on the civil plans, grading/foundation plans, and specifications prior to construction.
- Monitor construction to check and document our report assumptions. At a minimum, CAInc should monitor initial pile excavations and sub-drainage requirements.
- Update this report if design changes occur, two years or more lapses between this report and construction, and/or site conditions have changed.

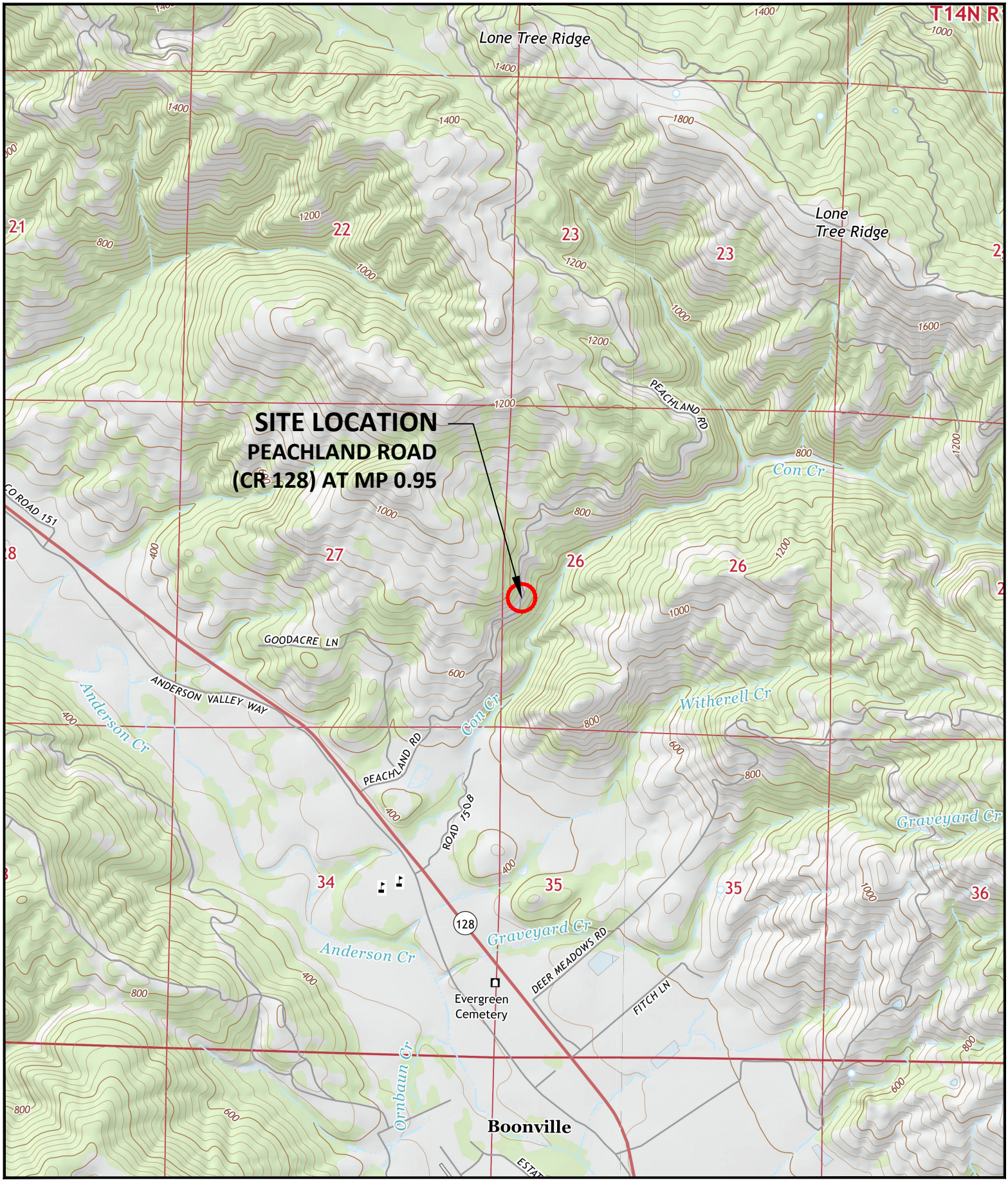
## 10 LIMITATIONS

CAInc performed these services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. This report is based on the current site and project conditions and should be used only for the evaluation and design of repair alternative for the Peachland Road slope failure at MP 0.95.

It is assumed the soil/rock and groundwater conditions interpreted/encountered in the borings provided in Appendix A are representative of the subsurface conditions at the site. Actual conditions between explorations could be different. The interface shown between soil/rock materials on the boring logs is approximate. The transition between materials may be abrupt or gradual. Recommendations are based on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions.

Modern design and construction is complex and it is common to experience changes and delays. The owner should set aside a reasonable contingency fund based on complexities and cost estimates to cover changes and delays.

## FIGURES




NORTH

**Map Sources:**

*1. USGS 7.5' Topographic Maps 2015, Philo, Mendocino County, California, Scale 1:24000*

*2. USGS 7.5' Topographic Maps 2015, Boonville, Mendocino County, California, Scale 1:24000*

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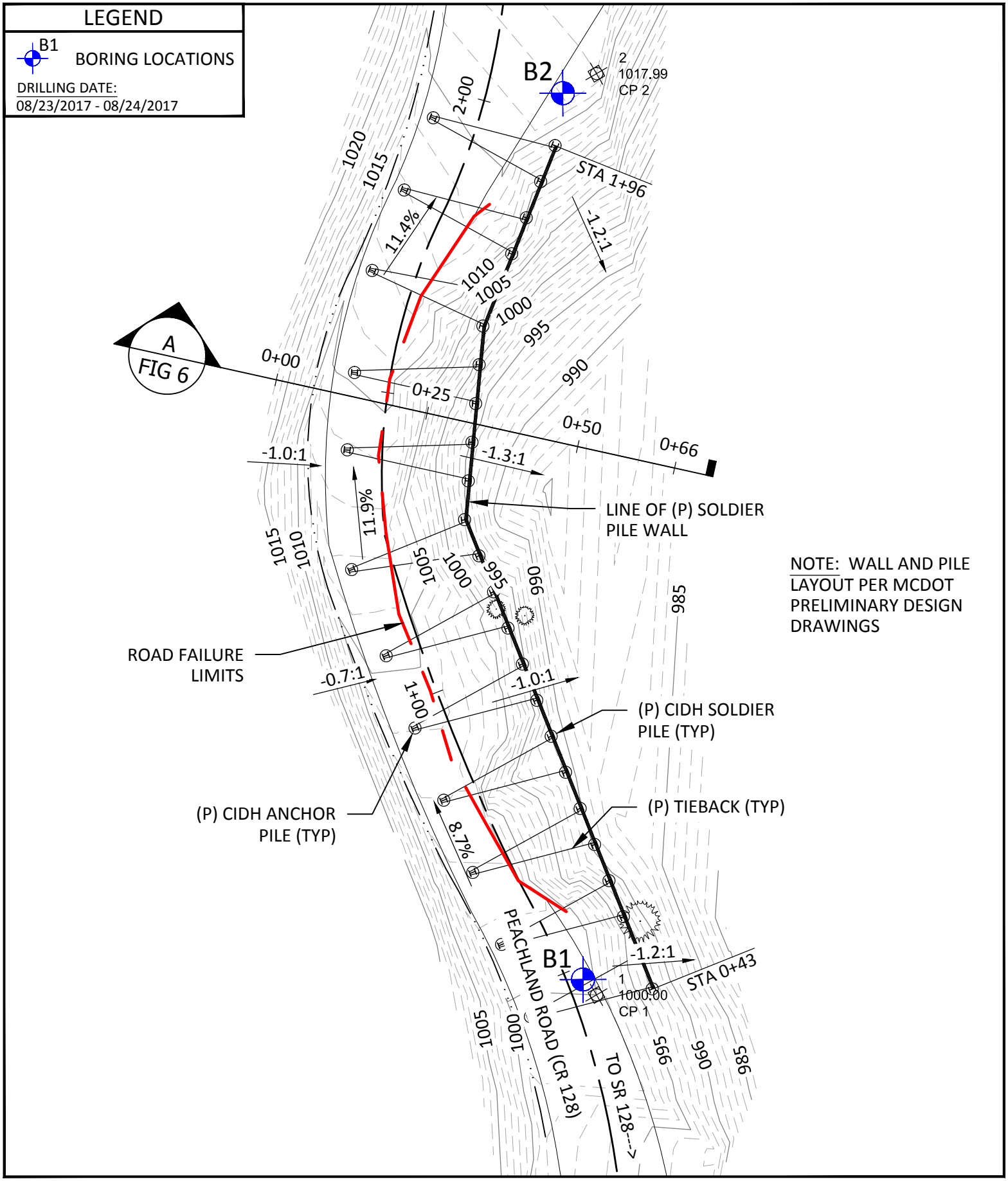
GEOTECHNICAL INVESTIGATION
PEACHLAND ROAD (CR 128)
FAILURE AT MP 0.95

MENDOCINO COUNTY, CA

**Figure 1**
Vicinity Map

Proj. No: 16-337.6
Scale: 1" = 2,000'
Date: 09/22/2017

Path: \\psf\Home\Box\Projects\16-337.X Mendocino 2016 Quadrennial Support Project\16-337.6 Peachland Road (CR 128) at MP 0.95\CAD\16-337.6-Peachland Road at MP 0.95.dwg Plot Date: Sep 18, 2017 at 3:56pm




NORTH

**Map Source:**
*Base map provided by MCDOT via electronic transfer, 09/07/2017*

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PEACHLAND ROAD (CR 128)
FAILURE AT MP 0.95

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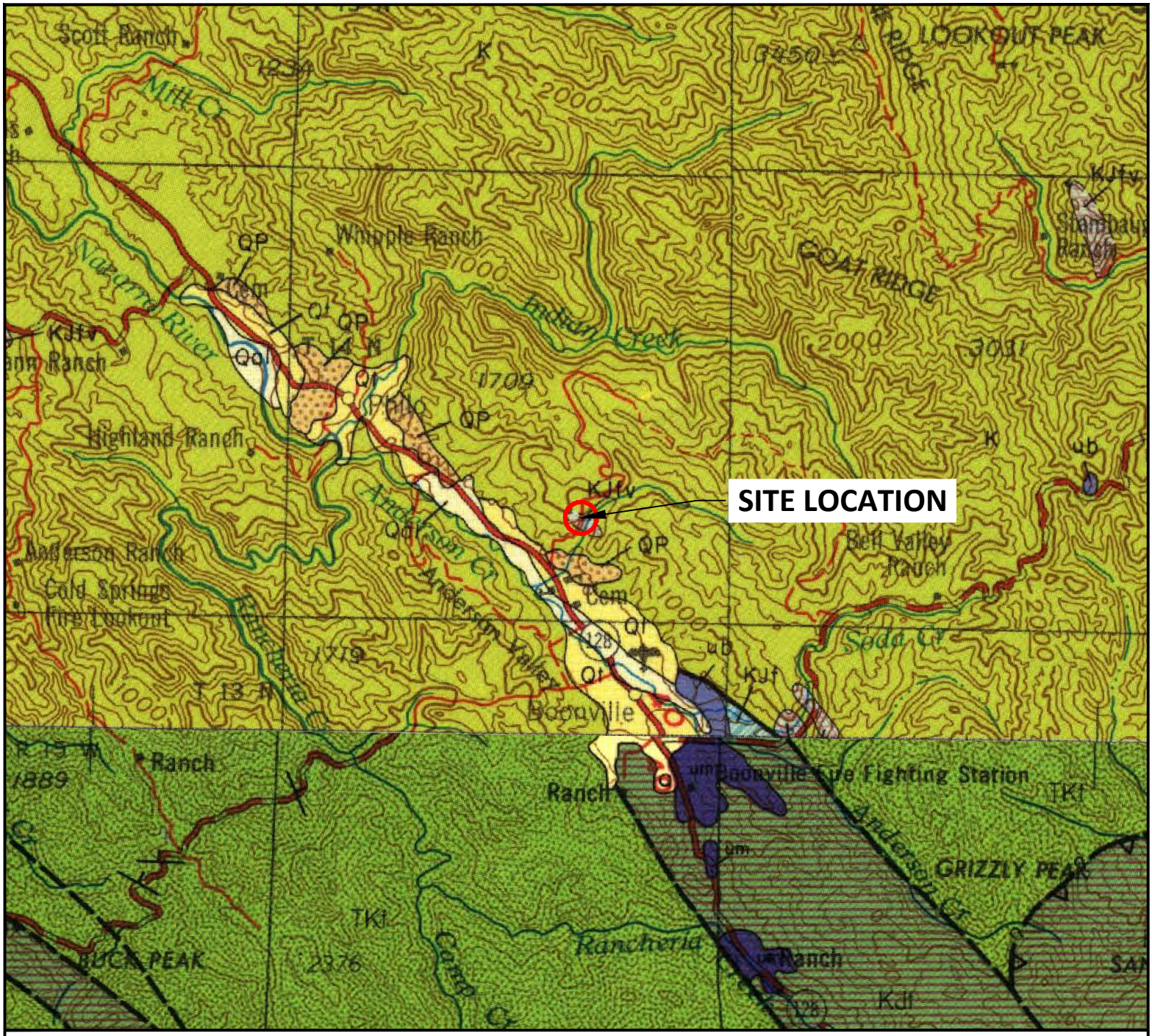
**Figure 2**
Exploration Location Map

Proj. No: 16-337.6
Scale: 1" = 20'
Date: 09/22/2017

Path: \\psf\Home\Box\Projects\16-337.X Mendocino 2016 Quadrennial Support Project\16-337.6 Peachland Road (CR 128) at MP 0.95\CAD\16-337.6-Peachland Road at MP 0.95.dwg Plot Date: Oct 09, 2017 at 5:17pm




# LEGEND

## Geologic Formations

QP — **Non-marine Sedimentary Rocks (Pliocene-Pleistocene) -** *cache formation (laucustrine and fluvial deposits), unnamed Plio-Pleistocene deposits bordering alluviated valleys in Mendocino County*

K — **Undivided Marine Sedimentary Rocks (Cretaceous) -** *sandstone, shale, and conglomerate*

KJfv — **Franciscan Volcanic and Metavolcanic Rocks (Jurassic-Cretaceous) -** *greenstone of the Franciscan formation, includes some rocks which may not be Franciscan*

**CONTACT**
*(Dashed where approximately located, gradational or inferred)*

**FAULT**
*(Dashed where approximately located)*

NORTH

**Map Sources:**
*1. Jennings, C.W. and Strand, R.G., 1960, Geologic Map of California, Ukiah Sheet, California Division of Mines and Geology, Scale 1:250,000*
*2. Wagner, D.L. and Bortugno, E.J., 1982, Geologic Map of the Santa Rosa Quadrangle, Regional Map Series, Map No. 2A, California Division of Mines and Geology, Scale 1:250,000*

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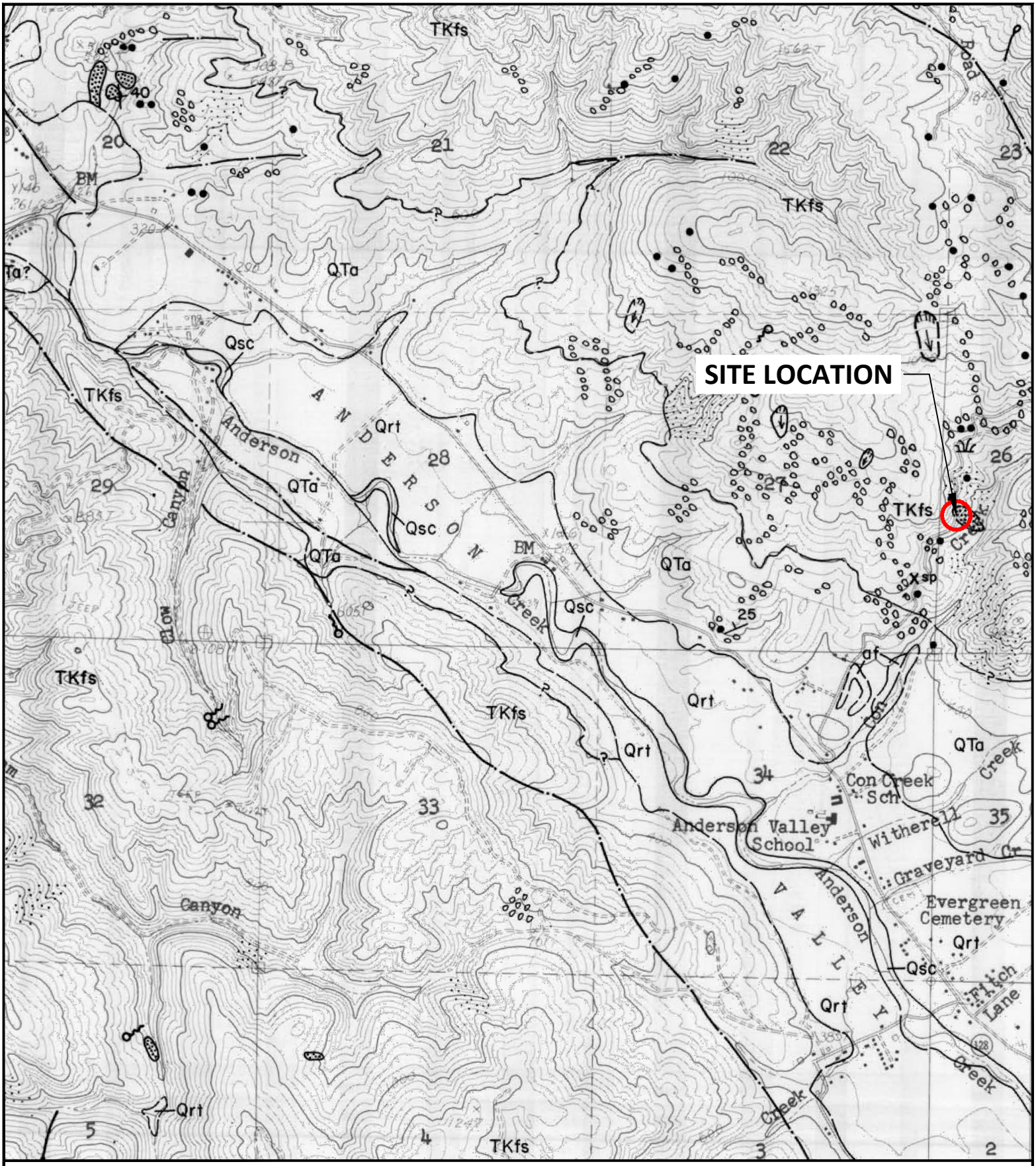
**Figure 3**
Regional Geologic Map

Proj. No: 16-337.6
Scale: 1" = 10,000'
Date: 09/22/2017




SEE FIGURE 4B FOR MAP LEGEND

NORTH

**Map Source:**
*Manson, M.W., 1984, Geology and Geomorphic Features Related to Landsliding, Boonville SW (Philo) 7.5' Quadrangle, OFR 84-43, California Division of Mines and Geology, Scale 1:24000*

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**Figure 4A**
Landslide and Geologic Map

Proj. No: 16-337.6
Scale: 1" = 2,000'
Date: 09/22/2017

Path: \\psf\Home\Box\Projects\16-337.X Mendocino 2016 Quadrennial Support Project\16-337.6 Peachland Road (CR 128) at MP 0.95\CAD\16-337.6-Peachland Road at MP 0.95.dwg Plot Date: Sep 19, 2017 at 12:12pm

TRANSLATIONAL/ROTATIONAL SLIDE: relatively cohesive slide mass with a failure plane that is deep-seated in comparison to that of a debris slide of similar areal extent; sense of motion along slide plane is linear in a translational slide and arcuate or "rotational" in a rotational slide; complex versions with rotational heads and translational movement or earthflows downslope are common; translational movement along a planar joint or bedding discontinuity may be referred to as a block glide; indicates scarp, indicates direction of movement; solid where active, dashed where dormant, queried where uncertain.

EARTHFLOW: mass movement resulting from slow to rapid flowage of saturated soil and debris in a semiviscous, highly plastic state; after initial failure, the flow may move, or creep, seasonally in response to destabilizing forces; indicates scarp, indicates direction of movement; solid where active, dashed where dormant.

DEBRIS SLIDE: unconsolidated rock, colluvium, and soil that has moved slowly to rapidly downslope along a relatively steep (generally greater than 65 percent), shallow translational failure plane; forms steep, unvegetated scars in the head region and irregular hummocky deposits (when present) in the toe region; scars likely to ravel and remain unvegetated for many years; revegetated scars recognized by steep, even-faceted slope and light-bulb shape; includes scarp and slide deposits; solid where active, dashed where dormant.

DEBRIS FLOW/TORRENT TRACK: long stretches of bare, generally unstable stream channel banks scoured and eroded by the extremely rapid movement of water-laden debris; commonly triggered by debris sliding in the upper part of the drainage during high intensity storms; scoured debris may be deposited downslope as a tangled mass of organic material in a matrix of rock and soil; debris may be reactivated or washed away during subsequent events; solid where active, dashed where dormant.

DEBRIS SLIDE SLOPE: geomorphic feature characterized by steep (generally greater than 65 percent), usually well vegetated slopes that have been sculpted by numerous debris slide events; vegetated soils and colluvium above shallow soil/bedrock interface may be disrupted by active debris slides or bedrock exposed by former debris sliding; slopes near angle of repose may be relatively stable except where weak bedding planes and extensive bedrock joints and fractures parallel slope.

ACTIVE SLIDE: too small to delineate at this scale.

DISRUPTED GROUND: irregular ground surface caused by complex landsliding processes resulting in features that are indistinguishable or too small to delineate individually at this scale; also may include areas affected by downslope creep, expansive soils, and/or gully erosion; boundaries usually are indistinct.

af ARTIFICIAL FILL: earthfill dams.

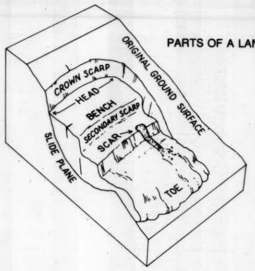
Qsc STREAM/RIVER CHANNEL DEPOSITS (Holocene): sand and gravel in active stream channel along major streams and rivers; characteristically unvegetated.

Qf ALLUVIAL FAN DEPOSITS (Holocene): alluvial sand and gravel deposited in characteristic fan-cone shape at the mouths of eroding stream canyons.

Qac ALLUVIUM COLLUVIUM (Holocene-Pleistocene): unconsolidated alluvium and/or colluvial slope deposits adjacent to mountains, fine-grained sand and silt with minor amounts of gravel.

Qrt RIVER TERRACE DEPOSITS (Holocene-Pleistocene): dominantly sand and gravel with minor amounts of silt and clay deposited during higher stands of major streams and rivers.

QTa ALLUVIUM OF ANDERSON VALLEY (Pleistocene-Pliocene?): compact but unconsolidated alluvial deposits in Anderson Valley ranging from cobble conglomerate to fine sand and silt; coarser facies more common along edges of deposit near contact with more consolidated bedrock.




TKfs COASTAL BELT FRANCISCAN (Tertiary-Cretaceous): well consolidated clastic sedimentary rocks; mainly sandstone and shale with minor amounts of limestone and conglomerate; NW trending streams tend to lie in more sheared shale; may contain rocks of the Central Belt Franciscan (Cretaceous-Jurassic).

TKfv COASTAL BELT FRANCISCAN (Tertiary-Cretaceous): volcanic rocks; greenstone and metamorphosed tuffaceous sandstone.

sp SERPENTINITE

LITHOLOGIC CONTACT: dashed where approximately located, queried where inferred.

FAULT: dashed where approximately located, dotted where projected or inferred, queried where uncertain.

35 STRIKE AND DIP OF BEDDING

STRIKE OF VERTICAL BEDDING

LINEAMENT: linear feature of unknown origin observed on aerial photographs.

ANTICLINAL AXIS: axis of fold away from which beds dip.

QUARRY OR BORROW PIT

x ROCK OUTCROP: too small to delineate at this scale.

SPRING

MARSH

## REFERENCES

California Department of Forestry, 1981, Cal Aero Photos: Photos CDF-ALL-UK; Flight 7/9/81; Frames 19-1 to 19-9, 21-1 to 21-8, 23-1 to 23-8, and 25-1 to 25-8; black and white, scale 1:24,000.

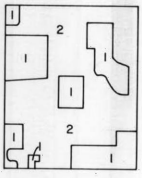
California Division of Mines and Geology, 1976-1984, Geologic review of Timber Harvesting Plans: Unpublished field studies conducted for the California Department of Forestry.

Irwin, W. P., 1960, Geologic reconnaissance of the northern Coast Ranges and Klamath Mountains, California, with a summary of mineral resources: California Division of Mines, Bulletin 179, 80 p., map scale 1:500,000.

## SOURCES OF GEOLOGIC DATA

Geologic data were compiled from aerial photo interpretation, field reconnaissance, and the modification of unpublished geologic data from references listed above. The author was assisted in office studies by Charles Smith.

1. Mapping from aerial photo interpretation, previously existing geologic data, and reconnaissance level field work.
2. Mapping from aerial photo interpretation and previously existing geologic data; field access not available.




RATES OF LANDSLIDE MOVEMENT*

| | |
|---|---|
| 10 ft/sec or more | = extremely rapid |
| 1 ft/min-10 ft/sec | = very rapid |
| 5 ft/day-1 ft/min | = rapid |
| 5 ft/mo-5 ft/day | = moderate |
| 5 ft/yr-5 ft/mo | = slow |
| 1 ft/5yr-5 ft/yr | = very slow |
| 1 ft/5yr or less | = extremely slow |

*Modified from: Varnes, D.J., 1978, Slope movement types and processes, *in* Landslides: Analysis and Control, Transportation Research Board, National Academy of Sciences, Washington, D.C., Special Report 176, Figure 2.1.

ACTIVITY OF LANDSLIDES

Active or probably active - presently moving or recently moved. Distinct topographic slide features present, i.e., sharp barren scarps, cracks, jackstrawed trees. Major revegetation has not occurred.

Dormant - little evidence of recent movement. Slide features modified by weathering and erosion. Vegetation generally well established. Some mass movements may have developed under climatic conditions different from today. Causes of failure may remain and movement could be renewed.

SEE FIGURE 4A FOR MAP

NORTH

**Map Source:**
*Manson, M.W., 1984, Geology and Geomorphic Features Related to Landsliding, Boonville SW (Philo) 7.5' Quadrangle, OFR 84-43, California Division of Mines and Geology, Scale 1:24000*

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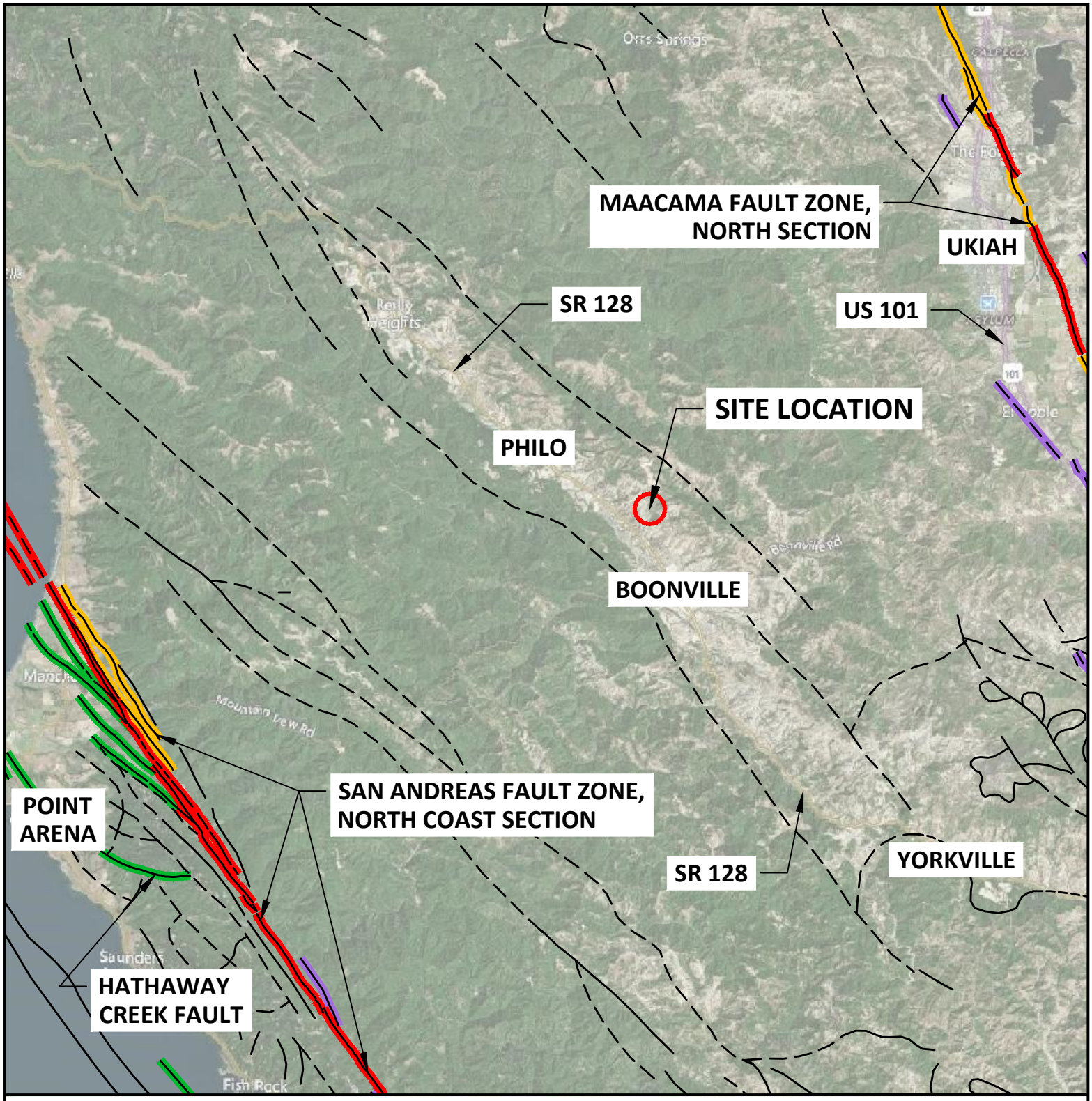
GEOTECHNICAL INVESTIGATION
PEACHLAND ROAD (CR 128)
FAILURE AT MP 0.95

MENDOCINO COUNTY, CA

**Figure 4B**
Landslide and Geologic Map Legend

Proj. No: 16-337.6
Scale: N/A
Date: 09/22/2017

Path: \\psf\Home\Box\Projects\16-337.X Mendocino 2016 Quadrennial Support Project\16-337.6 Peachland Road (CR 128) at MP 0.95\CAD\16-337.6-Peachland Road at MP 0.95.dwg Plot Date: Sep 19, 2017 at 12:29pm




## LEGEND

| CGS Faults (Last Activity Age) | CGS Faults (Last Activity Age) | Fault Location |
|---|---|---|
| <200 years (Historic) | <1.6 million years (Quaternary) | Certain |
| <11,700 years (Holocene) | >1.6 million years (Pre-Quaternary) | Approx. or Inferred |
| <700,000 years (Late Quaternary) | | Concealed |

NORTH

**Map Sources:**
*1. Base map via AutoCAD Civil 3D geolocation tool*
*2. Fault data via CGS Fault Activity Map of California 2010 GIS data*

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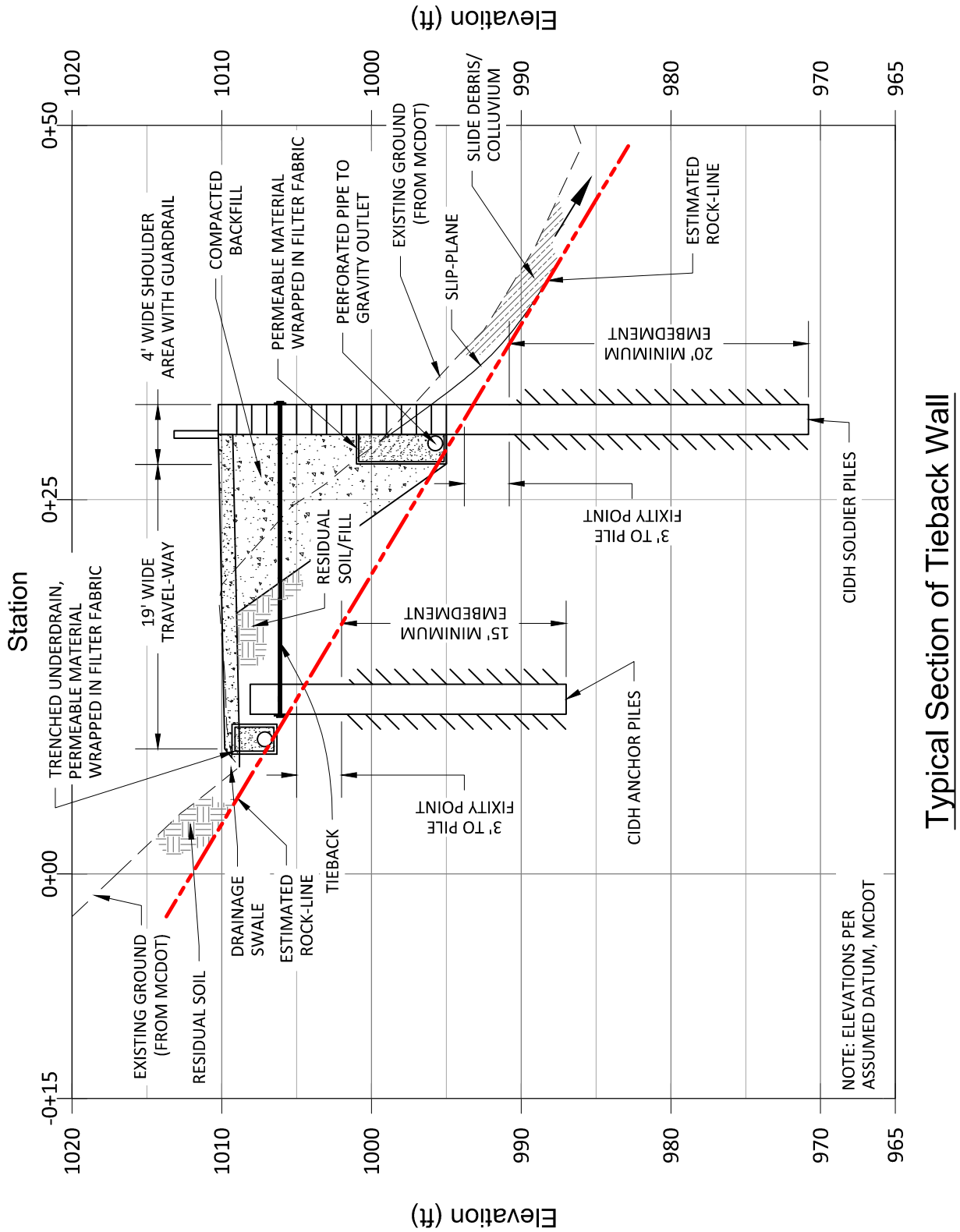
MENDOCINO COUNTY, CA

**Figure 5**
Fault Activity Map

Proj. No: 16-337.6
Scale: 1" = 20,000'
Date: 09/22/2017




NORTH

**Data Source:**
*Existing ground surface area provided by MCDOT via electronic transfer on 09/07/2017*

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FAILURE AT MP 0.95

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**Figure 6**
Typical Section of Tieback Wall

Proj. No: 16-337.6
Scale: 1" = 10'
Date: 09/22/2017

Path: \\psf\Home\Box\Projects\16-337.X Mendocino 2016 Quadrennial Support Project\16-337.6 Peachland Road (CR 128) at MP 0.95\CAD\16-337.6-Peachland Road at MP 0.95.dwg Plot Date: Oct 06, 2017 at 7:49pm

# APPENDIX A

**BORING LOG LEGEND**
**BORING LOGS**

## GROUP SYMBOLS AND NAMES

| Graphic / Symbol | Group Names |
|---|---|
| GW | Well-graded GRAVEL<br>Well-graded GRAVEL with SAND |
| GP | Poorly graded GRAVEL<br>Poorly graded GRAVEL with SAND |
| GW-GM | Well-graded GRAVEL with SILT<br>Well-graded GRAVEL with SILT and SAND |
| GW-GC | Well-graded GRAVEL with CLAY (or SILTY CLAY)<br>Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND) |
| GP-GM | Poorly graded GRAVEL with SILT<br>Poorly graded GRAVEL with SILT and SAND |
| GP-GC | Poorly graded GRAVEL with CLAY (or SILTY CLAY)<br>Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND) |
| GM | SILTY GRAVEL<br>SILTY GRAVEL with SAND |
| GC | CLAYEY GRAVEL<br>CLAYEY GRAVEL with SAND |
| GC-GM | SILTY, CLAYEY GRAVEL<br>SILTY, CLAYEY GRAVEL with SAND |
| SW | Well-graded SAND<br>Well-graded SAND with GRAVEL |
| SP | Poorly graded SAND<br>Poorly graded SAND with GRAVEL |
| SW-SM | Well-graded SAND with SILT<br>Well-graded SAND with SILT and GRAVEL |
| SW-SC | Well-graded SAND with CLAY (or SILTY CLAY)<br>Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) |
| SP-SM | Poorly graded SAND with SILT<br>Poorly graded SAND with SILT and GRAVEL |
| SP-SC | Poorly graded SAND with CLAY (or SILTY CLAY)<br>Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL) |
| SM | SILTY SAND<br>SILTY SAND with GRAVEL |
| SC | CLAYEY SAND<br>CLAYEY SAND with GRAVEL |
| SC-SM | SILTY, CLAYEY SAND<br>SILTY, CLAYEY SAND with GRAVEL |
| PT | PEAT |
| | COBBLES<br>COBBLES and BOULDERS<br>BOULDERS |

| Graphic / Symbol | Group Names |
|---|---|
| CL | Lean CLAY<br>Lean CLAY with SAND<br>Lean CLAY with GRAVEL<br>SANDY lean CLAY<br>SANDY lean CLAY with GRAVEL<br>GRAVELLY lean CLAY<br>GRAVELLY lean CLAY with SAND |
| CL-ML | SILTY CLAY<br>SILTY CLAY with SAND<br>SILTY CLAY with GRAVEL<br>SANDY SILTY CLAY<br>SANDY SILTY CLAY with GRAVEL<br>GRAVELLY SILTY CLAY<br>GRAVELLY SILTY CLAY with SAND |
| ML | SILT<br>SILT with SAND<br>SILT with GRAVEL<br>SANDY SILT<br>SANDY SILT with GRAVEL<br>GRAVELLY SILT<br>GRAVELLY SILT with SAND |
| OL | ORGANIC lean CLAY<br>ORGANIC lean CLAY with SAND<br>ORGANIC lean CLAY with GRAVEL<br>SANDY ORGANIC lean CLAY<br>SANDY ORGANIC lean CLAY with GRAVEL<br>GRAVELLY ORGANIC lean CLAY<br>GRAVELLY ORGANIC lean CLAY with SAND |
| OL | ORGANIC SILT<br>ORGANIC SILT with SAND<br>ORGANIC SILT with GRAVEL<br>SANDY ORGANIC SILT<br>SANDY ORGANIC SILT with GRAVEL<br>GRAVELLY ORGANIC SILT<br>GRAVELLY ORGANIC SILT with SAND |
| CH | Fat CLAY<br>Fat CLAY with SAND<br>Fat CLAY with GRAVEL<br>SANDY fat CLAY<br>SANDY fat CLAY with GRAVEL<br>GRAVELLY fat CLAY<br>GRAVELLY fat CLAY with SAND |
| MH | Elastic SILT<br>Elastic SILT with SAND<br>Elastic SILT with GRAVEL<br>SANDY elastic SILT<br>SANDY elastic SILT with GRAVEL<br>GRAVELLY elastic SILT<br>GRAVELLY elastic SILT with SAND |
| OH | ORGANIC fat CLAY<br>ORGANIC fat CLAY with SAND<br>ORGANIC fat CLAY with GRAVEL<br>SANDY ORGANIC fat CLAY<br>SANDY ORGANIC fat CLAY with GRAVEL<br>GRAVELLY ORGANIC fat CLAY<br>GRAVELLY ORGANIC fat CLAY with SAND |
| OH | ORGANIC elastic SILT<br>ORGANIC elastic SILT with SAND<br>ORGANIC elastic SILT with GRAVEL<br>SANDY elastic ELASTIC SILT<br>SANDY ORGANIC elastic SILT with GRAVEL<br>GRAVELLY ORGANIC elastic SILT<br>GRAVELLY ORGANIC elastic SILT with SAND |
| OL/OH | ORGANIC SOIL<br>ORGANIC SOIL with SAND<br>ORGANIC SOIL with GRAVEL<br>SANDY ORGANIC SOIL<br>SANDY ORGANIC SOIL with GRAVEL<br>GRAVELLY ORGANIC SOIL<br>GRAVELLY ORGANIC SOIL with SAND |

## FIELD AND LABORATORY TESTS

| | |
|---|---|
| **C** | Consolidation (ASTM D 2435) |
| **CL** | Collapse Potential (ASTM D 4546) |
| **CP** | Compaction Curve (CTM 216) |
| **CR** | Corrosion, Sulfates, Chlorides (CTM 643, CTM 417, CTM 422) |
| **CU** | Consolidated Undrained Triaxial (ASTM D 4767) |
| **DR** | Drained Residual Shear Strength (ASTM D 6467) |
| **DS** | Direct Shear (ASTM D 3080) |
| **EI** | Expansion Index (ASTM D 4829) |
| **M** | Moisture Content (ASTM D 2216) |
| **OC** | Organic Content (ASTM D 2974) |
| **P** | Permeability (CTM 220) |
| **PA** | Particle Size Analysis (ASTM D 422) |
| **PI** | Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89, AASHTO T 90) |
| **PL** | Point Load Index (ASTM D 5731) |
| **PM** | Pressure Meter |
| **R** | R-Value (CTM 301) |
| **SE** | Sand Equivalent (CTM 217) |
| **SG** | Specific Gravity (AASHTO T 100) |
| **SW** | Swell Potential (ASTM D 4546) |
| **UC** | Unconfined Compression - Soil (ASTM D 2166)<br>Unconfined Compression - Rock (ASTM D 7012-C) |
| **UU** | Unconsolidated Undrained Triaxial (ASTM D 2850) |
| **UW** | Unit Weight (ASTM D 7263) |

## SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler (ID 2.5 in.)
- Modified California Sampler (ID 2.0 in.)
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

## DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

## WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (short-term)
- Static Water Level Reading (long-term)

**REFERENCE:** Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010) with Errata Sheet (2015).

| CONSISTENCY OF COHESIVE SOILS | | | | |
|---|---|---|---|---|
| **Descriptor** | **Unconfined Compressive Strength (tsf)** | **Pocket Penetrometer (tsf)** | **Torvane (tsf)** | **Field Approximation** |
| Very Soft | < 0.25 | < 0.25 | < 0.12 | Easily penetrated several inches by fist |
| Soft | 0.25 - 0.50 | 0.25 - 0.50 | 0.12 - 0.25 | Easily penetrated several inches by thumb |
| Medium Stiff | 0.50 - 1.0 | 0.50 - 1.0 | 0.25 - 0.50 | Can be penetrated several inches by thumb with moderate effort |
| Stiff | 1.0 - 2.0 | 1.0 - 2.0 | 0.50 - 1.0 | Readily indented by thumb but penetrated only with great effort |
| Very Stiff | 2.0 - 4.0 | 2.0 - 4.0 | 1.0 - 2.0 | Readily indented by thumbnail |
| Hard | > 4.0 | > 4.0 | > 2.0 | Indented by thumbnail with difficulty |

| APPARENT DENSITY OF COHESIONLESS SOILS | |
|---|---|
| **Descriptor** | **SPT $N_{60}$ (blows / 12 inches)** |
| Very Loose | 0 - 5 |
| Loose | 5 - 10 |
| Medium Dense | 10 - 30 |
| Dense | 30 - 50 |
| Very Dense | > 50 |

| MOISTURE | |
|---|---|
| **Descriptor** | **Criteria** |
| Dry | No discernable moisture |
| Moist | Moisture present, but no free water |
| Wet | Visible free water |

| PERCENT OR PROPORTION OF SOILS | |
|---|---|
| **Descriptor** | **Criteria** |
| Trace | Particles are present but estimated to be less than 5% |
| Few | 5 to 10% |
| Little | 15 to 25% |
| Some | 30 to 45% |
| Mostly | 50 to 100% |

| SOIL PARTICLE SIZE | | |
|---|---|---|
| **Descriptor** | | **Size** |
| Boulder | | > 12 inches |
| Cobble | | 3 to 12 inches |
| Gravel | Coarse | 3/4 inch to 3 inches |
| | Fine | No. 4 Sieve to 3/4 inch |
| Sand | Coarse | No. 10 Sieve to No. 4 Sieve |
| | Medium | No. 40 Sieve to No. 10 Sieve |
| | Fine | No. 200 Sieve to No. 40 Sieve |
| Silt and Clay | | Passing No. 200 Sieve |

| PLASTICITY OF FINE-GRAINED SOILS | |
|---|---|
| **Descriptor** | **Criteria** |
| Nonplastic | A 1/8-inch thread cannot be rolled at any water content. |
| Low | The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit. |
| Medium | The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit. |
| High | It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit. |

| CEMENTATION | |
|---|---|
| **Descriptor** | **Criteria** |
| Weak | Crumbles or breaks with handling or little finger pressure. |
| Moderate | Crumbles or breaks with considerable finger pressure. |
| Strong | Will not crumble or break with finger pressure. |

**REFERENCE:** Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).

## ROCK GRAPHIC SYMBOLS

IGNEOUS ROCK

SEDIMENTARY ROCK

METAMORPHIC ROCK

## BEDDING SPACING

| Descriptor | Thickness or Spacing |
|---|---|
| Massive | > 10 ft |
| Very thickly bedded | 3 ft - 10 ft |
| Thickly bedded | 1 ft - 3 ft |
| Moderately bedded | 4 in - 1 ft |
| Thinly bedded | 1 in - 4 in |
| Very thinly bedded | 1/4 in - 1 in |
| Laminated | < 1/4 in |

## WEATHERING DESCRIPTORS FOR INTACT ROCK

| | Diagnostic Features | | | | | |
|---|---|---|---|---|---|---|
| | Chemical Weathering-Discoloration-Oxidation | | Mechanical Weathering and Grain Boundary Conditions | Texture and Solutioning | | |
| Descriptor | Body of Rock | Fracture Surfaces | | Texture | Solutioning | General Characteristics |
| Fresh | No discoloration, not oxidized | No discoloration or oxidation | No separation, intact (tight) | No change | No solutioning | Hammer rings when crystalline rocks are struck. |
| Slightly Weathered | Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull | Minor to complete discoloration or oxidation of most surfaces | No visible separation, intact (tight) | Preserved | Minor leaching of some soluble minerals may be noted | Hammer rings when crystalline rocks are struck. Body of rock not weakened. |
| Moderately Weathered | Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty"; feldspar crystals are "cloudy" | All fracture surfaces are discolored or oxidized | Partial separation of boundaries visible | Generally preserved | Soluble minerals may be mostly leached | Hammer does not ring when rock is struck. Body of rock is slightly weakened. |
| Intensely Weathered | Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in situ disaggregation (refer to grain boundary conditions) | All fracture surfaces are discolored or oxidized; surfaces are friable | Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated | Altered by chemical disintegration such as via hydration or argillation | Leaching of soluble minerals may be complete | Dull sound when struck with hammer; usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures or veinlets. Rock is significantly weakened. |
| Decomposed | Discolored of oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay | | Complete separation of grain boundaries (disaggregated) | Resembles a soil; partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete | | Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes". |

**Note**: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

## PERCENT CORE RECOVERY (REC)

$$\frac{\Sigma \text{ Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100$$

## ROCK QUALITY DESIGNATION (RQD)

$$\frac{\Sigma \text{ Length of intact core pieces > 4 in.}}{\text{Total length of core run (in.)}} \times 100$$

**Note:** RQD* indicates soundness criteria not met

## ROCK HARDNESS

| Descriptor | Criteria |
|---|---|
| Extremely Hard | Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows |
| Very hard | Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows |
| Hard | Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen |
| Moderately Hard | Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows |
| Moderately Soft | Specimen can be grooved 1/16 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure |
| Soft | Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure |
| Very Soft | Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light manual pressure. |

## FRACTURE DENSITY

| Descriptor | Criteria |
|---|---|
| Unfractured | No fractures |
| Very Slightly Fractured | Core lengths greater than 3 ft. |
| Slightly Fractured | Core lengths mostly from 1 ft. to 3 ft. |
| Moderately Fractured | Core lengths mostly from 4 in. to 1 ft. |
| Intensely Fractured | Core lengths mostly from 1 in. to 4 in. |
| Very Intensely Fractured | Mostly chips and fragments. |

**REFERENCE:** Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).

# LOG OF BORING B1

PROJECT NO: 16-337.6
PROJECT: Peachland Road at MP 0.95
LOCATION: Peachland Road, Boonville
CITY/COUNTY: Mendocino
CLIENT: MCDOT
LOGGED BY: JJW
DEPTH OF BORING: 35 ( ft)

BEGIN DATE: 8/23/17
COMPLETION DATE: 8/23/17
SURFACE ELEVATION: 1000.12 ( ft)*
SURFACE CONDITION: Gravel
WATER DEPTH: Not Encountered ( ft)
READING TAKEN: 8/23/17
HAMMER EFFICIENCY: 75 ( %)

DRILLING CONTRACTOR: Geo-Ex Subsurface Exploration
DRILLING METHOD: Solid-Stem Auger and Rotary Wash
DRILL RIG: CME 45 (Track)
HAMMER TYPE: Automatic, 140 lbs, 30" drop
SAMPLER TYPE & SIZE: Bulk, CAL (ID 2.4"), and SPT (1.4")
BOREHOLE DIAMETER: 4"
BACKFILL METHOD: Type I/II Cement Grout

| FIELD | | | | | | | | | | LABORATORY | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEVATION (ft) | DEPTH ( ft) | SAMPLE | SAMPLE NO | BLOWS PER 6 IN. | BLOWS PER FOOT | POCKET PEN. (TSF) | GRAPHIC LOG | DESCRIPTION | RECOVERY(%) | RQD (%) | PLASTIC LIMIT | LIQUID LIMIT | MOISTURE (%) | D. DENSITY (PCF) | % PASSING 200 SIEVE | DRILL METHOD / CASING DEPTH | REMARKS |
| | 1 | | | | | | | SILTY GRAVEL (GM); light brown; dry; about 20 to 30% coarse SAND; about 15% nonplastic to low plasticity fines [FILL]. | | | | | | | | | |
| 998 | 2 | | | | | | | SANDY lean CLAY with GRAVEL (CL); brown; dry; about 15 to 20% coarse to fine GRAVEL; about 20 to 25% coarse to medium SAND; medium plasticity fines [FILL]. | | | | | | | | | |
| | 3 | | 0 | | | | | | | | | | | | | | |
| 996 | 4 | | | | | | | SEDIMENTARY ROCK (SANDSTONE), light brown, very intensely weathered, very intensely fractured. | | | | | | | | | |
| | 5 | | 1 | 17 27 30 | 57 | | | | 44 | | | | | | | | |
| 994 | 6 | | | | | +4.5 | | | | | | | 2.5 | 113.1 | | | |
| | 7 | | | | | | | | | | | | | | | | |
| 992 | 8 | | | | | | | | | | | | | | | | Slight drill chatter |
| | 9 | | | | | | | | | | | | | | | | |
| 990 | 10 | | 2 | 12 18 24 | 42 | | | | 83 | | | | | | | | |
| | 11 | | | | | +4.5 | | | | | | | 3.3 | 137.8 | | | Unconfined Comp. Test UC = 1757 psf |
| 988 | 12 | | | | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | | | | |
| 986 | 14 | | | | | | | | | | | | | | | | |
| | 15 | | 3 | 16 17 50/3" | 67/9 | | | | 80 | | | | | | | | |
| 984 | 16 | | | | | +4.5 | | | | | | | 4.4 | 139 | | | |
| | 17 | | | | | | | | | | | | | | | | Very hard drilling, screeching |
| 982 | 18 | | | | | | | | | | | | | | | | Auger refusal, switch to rotary |
| | 19 | | | | | | | | | | | | | | | | |
| 980 | 20 | | 4 | 50/1" | REF | | | | 0 | | | | | | | | |
| | 21 | | | | | | | | | | | | | | | | |
| 978 | 22 | | | | | | | | | | | | | | | | |

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Geotechnical Engineering, Design and Construction Services

Crawford & Associates, Inc.
1100 Corporate Way, Suite 230
Sacramento, CA 95831
(916) 455-4225

PROJECT NUMBER: 16-337.6
PROJECT: Peachland Road at MP 0.95
BORING: B1
ENTRY BY: RRH
CHECKED BY: RDS

| ELEVATION (ft) | DEPTH ( ft) | SAMPLE | SAMPLE NO | BLOWS PER 6 IN. | BLOWS PER FOOT | POCKET PEN. (TSF) | GRAPHIC LOG | DESCRIPTION | RECOVERY(%) | RQD (%) | PLASTIC LIMIT | LIQUID LIMIT | MOISTURE (%) | D. DENSITY (PCF) | % PASSING 200 SIEVE | DRILL METHOD | CASING DEPTH | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | SEDIMENTARY ROCK (Sandstone) *(continued)*. | | | | | | | | | | |
| 976 | 24 | | | | | | | SEDIMENTARY ROCK (SANDSTONE), gray, decomposed, very soft, [matrix of Clayey SAND (SC)]. | | | | | | | | | | Hard drilling stops |
| | 25 | X | 5 | 2<br>3<br>5 | 8 | | | | 28 | | | | | | | | | |
| 974 | 26 | X | | | | | | | | | | | | | | | | Unconfined Comp. Test<br>UC = 274 psf |
| | 27 | | | | | | | | | | | | | | | | | |
| 972 | 28 | | | | | | | | | | | | | | | | | |
| | 29 | | | | | | | SEDIMENTARY ROCK (SANDSTONE), dark brown/gray/light brown, very intensely weathered, very intensely fractured. | | | | | | | | | | Hard drilling resumes at 29', loss of cirulation between 24' and 29' |
| 970 | 30 | X | 6 | 50/2" | REF | | | | 50 | | | | | | | | | |
| | 31 | | | | | | | | | | | | | | | | | |
| 968 | 32 | | | | | | | | | | | | | | | | | |
| | 33 | | | | | | | | | | | | | | | | | No circulation between 33'-35' (very hard/slow drilling from 29'-35', circulation loss likely from 24'-29' zone) |
| 966 | 34 | | | | | | | | | | | | | | | | | |
| | 35 | | | | | | | Bottom of borehole at 35.0 ft bgs | | | | | | | | | | |
| 964 | 36 | | | | | | | Backfilled with cement grout, field inspection by MCDEH | | | | | | | | | | |
| | 37 | | | | | | | *Elevation Reference: CP 1, Elev. 1000.0 per MCDOT Project Datum | | | | | | | | | | |
| 962 | 38 | | | | | | | | | | | | | | | | | |
| | 39 | | | | | | | | | | | | | | | | | |
| 960 | 40 | | | | | | | | | | | | | | | | | |
| | 41 | | | | | | | | | | | | | | | | | |
| 958 | 42 | | | | | | | | | | | | | | | | | |
| | 43 | | | | | | | | | | | | | | | | | |
| 956 | 44 | | | | | | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | | | | | | |
| 954 | 46 | | | | | | | | | | | | | | | | | |
| | 47 | | | | | | | | | | | | | | | | | |
| 952 | 48 | | | | | | | | | | | | | | | | | |
| | 49 | | | | | | | | | | | | | | | | | |
| 950 | 50 | | | | | | | | | | | | | | | | | |

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(916) 455-4225

PROJECT NUMBER: 16-337.6
PROJECT: Peachland Road at MP 0.95
BORING: B1
ENTRY BY: RRH
CHECKED BY: RDS SHEET 2 of 2

# LOG OF BORING B2

PROJECT NO: 16-337.6
PROJECT: Peachland Road at MP 0.95
LOCATION: Peachland Road, Boonville
CITY/COUNTY: Mendocino
CLIENT: MCDOT
LOGGED BY: JJW
DEPTH OF BORING: 49.5 ( ft)

BEGIN DATE: 8/23/17
COMPLETION DATE: 8/24/17
SURFACE ELEVATION: 1017.06 ( ft)*
SURFACE CONDITION: Gravel
WATER DEPTH: Not Encountered ( ft)
READING TAKEN: 8/23/17
HAMMER EFFICIENCY: 75 ( %)

DRILLING CONTRACTOR: Geo-Ex Subsurface Exploration
DRILLING METHOD: Solid-Stem Auger and Rotary Wash
DRILL RIG: CME 45 (Track)
HAMMER TYPE: Automatic, 140 lbs, 30" drop
SAMPLER TYPE & SIZE: CAL (ID 2.4") and SPT (ID 1.4")
BOREHOLE DIAMETER: 4"
BACKFILL METHOD: Type I/II Cement Grout

| FIELD | | | | | | | | | | | LABORATORY | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ELEVATION (ft) | DEPTH ( ft) | SAMPLE | SAMPLE NO | BLOWS PER 6 IN. | BLOWS PER FOOT | POCKET PEN. (TSF) | GRAPHIC LOG | DESCRIPTION | RECOVERY(%) | RQD (%) | PLASTIC LIMIT | LIQUID LIMIT | MOISTURE (%) | D. DENSITY (PCF) | % PASSING 200 SIEVE | DRILL METHOD | CASING DEPTH | REMARKS |
| | 1 | | | | | | | CLAYEY SAND with GRAVEL (SC); light brown; dry; about 15 to 20% fine GRAVEL; about 20% low to medium plasticity fines; weak cementation; Trace vegetation/rootlets to 1'. | | | | | | | | | | |
| 1015 | 2 | | | | | | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | | | | | | |
| 1013 | 4 | | | | | | | | | | | | | | | | | |
| | 5 | | 1 | 10 10 10 | 20 | | | | 50 | | 21 | 39 | 6.2 | 86.6 | | | | |
| 1011 | 6 | | | | | | | Possibly sedimentary rock (decomposed). | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | | | | |
| 1009 | 8 | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | |
| 1007 | 10 | | 2 | 8 8 8 | 16 | | | | 67 | | | | | | | | | |
| | 11 | | | | | +4.5 | | SEDIMENTARY ROCK (SANDSTONE), brown to dark brown, very intensely weathered, very intensely fractured. | | | | | | | | | | Chemical Analysis<br>pH = 6.65<br>Min. Res. = 3750 ohm-cm<br>Chloride = 2.0 ppm<br>Sulfate-S = 5.9 ppm |
| 1005 | 12 | | | | | | | | | | | | | | | | | |
| | 13 | | | | | | | | | | | | | | | | | |
| 1003 | 14 | | | | | | | | | | | | | | | | | |
| | 15 | | 3 | 6 9 12 | 21 | | | Decomposed to very intensely weathered. | 89 | | | | 10 | 120.6 | | | | |
| 1001 | 16 | | | | | +4.5 | | | | | | | | | | | | |
| | 17 | | | | | | | | | | | | | | | | | |
| 999 | 18 | | | | | | | | | | | | | | | | | |
| | 19 | | | | | | | | | | | | | | | | | |
| 997 | 20 | | 4 | 10 15 15 | 30 | | | Light gray. | 83 | | | | 7.8 | 123.9 | | | | Switch to rotary |
| | 21 | | | | | +4.5 | | | | | | | | | | | | |
| 995 | 22 | | | | | | | | | | | | | | | | | |
| | 23 | | 5 | 12 50/3" | 50/3 | | | SEDIMENTARY ROCK (SANDSTONE), light gray, intensely weathered, intensely fractured. | 100 | | | | 6.5 | 151.6 | | | | 23' to 28' smooth, but very hard<br>Unconfined Comp. Test<br>UC = 2275 psf |
| 993 | 24 | | | | | | | | | | | | | | | | | |

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PROJECT NUMBER: 16-337.6
PROJECT: Peachland Road at MP 0.95
BORING: B2
ENTRY BY: RRH
CHECKED BY: RDS

| ELEVATION (ft) | DEPTH ( ft) | SAMPLE | SAMPLE NO | BLOWS PER 6 IN. | BLOWS PER FOOT | POCKET PEN. (TSF) | GRAPHIC LOG | DESCRIPTION | RECOVERY(%) | RQD (%) | PLASTIC LIMIT | LIQUID LIMIT | MOISTURE (%) | D. DENSITY (PCF) | % PASSING 200 SIEVE | DRILL METHOD | CASING DEPTH | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | SEDIMENTARY ROCK (Sandstone) *(continued)*. | | | | | | | | | | |
| 991 | 26 | | | | | | | | | | | | | | | | | |
| | 27 | | | | | | | | | | | | | | | | | |
| 989 | 28 | | 6 | 50/4" | REF | | | | 0 | | | | | | | | | No circulation |
| | 29 | | | | | | | | | | | | | | | | | 29' to 35' consistently dense/smooth |
| 987 | 30 | | | | | | | | | | | | | | | | | |
| | 31 | | | | | | | | | | | | | | | | | |
| 985 | 32 | | | | | | | | | | | | | | | | | |
| | 33 | | | | | | | | | | | | | | | | | |
| 983 | 34 | | | | | | | | | | | | | | | | | |
| | 35 | | 7 | 50/4" | REF | | | Very intensely to intensely fractured, decomposed to intensely weathered. | 50 | | | | | | | | | |
| 981 | 36 | | | | | | | | | | | | | | | | | |
| | 37 | | | | | | | | | | | | | | | | | |
| 979 | 38 | | | | | | | | | | | | | | | | | |
| | 39 | | | | | | | | | | | | | | | | | |
| 977 | 40 | | | | | | | | | | | | | | | | | Harder drilling |
| | 41 | | | | | | | | | | | | | | | | | |
| 975 | 42 | | | | | | | | | | | | | | | | | Dark gray, slick material coming up in cuttings (shale?) |
| | 43 | | | | | | | | | | | | | | | | | |
| 973 | 44 | | | | | | | | | | | | | | | | | |
| | 45 | | | | | | | | | | | | | | | | | |
| 971 | 46 | | | | | | | | | | | | | | | | | |
| | 47 | | | | | | | | | | | | | | | | | |
| 969 | 48 | | 8 | 36 | 92 | | | Decomposed to very intensely weathered. | 100 | | | | | | | | | |
| | 49 | | | 46 46 | | | | | | | | | | | | | | |
| 967 | 50 | | | | | | | Bottom of borehole at 49.5 ft bgs | | | | | | | | | | |
| | 51 | | | | | | | Backfilled with cement grout, field inspection by MCDEH | | | | | | | | | | |
| 965 | 52 | | | | | | | *Elevation Reference: CP 1, Elev. 1000.0 per MCDOT Project Datum | | | | | | | | | | |
| | 53 | | | | | | | | | | | | | | | | | |
| 963 | 54 | | | | | | | | | | | | | | | | | |
| | 55 | | | | | | | | | | | | | | | | | |

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PROJECT NUMBER: 16-337.6
PROJECT: Peachland Road at MP 0.95
BORING: B2
ENTRY BY: RRH
CHECKED BY: RDS

# APPENDIX B

## LABORATORY AND FIELD TEST RESULTS SUMMARY

Job: **Peachland Road Road (CR 128) Slide at MP 0.95**
Job No: **16-337.6**
Date: **10/6/17**

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## Laboratory/Field Test Summary

| | | | | | | Moisture/Density | | | Classification | | | | | | | Strength | | Chemical Analysis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Atterberg Limits | | | | | | | | | | | | |
| | Boring I.D. | Sample I.D. | Sample Depth (ft) | USCS Class. | Blow Counts $N_{60}$ (bpf) | Dry Density (pcf) | Moist. Content (%) | Wet Density (pcf) | Liquid Limit | Plastic Limit | Plasticity Index | Gravel (%) | Sand (%) | Fines (%) | Organic Content (%) | Pocket Pent. (tsf) | Uncon. Comp. (psf) | pH | Min. Resist. (ohm-cm) | Chloride (ppm) | Sulfate-S (ppm) |
| Soldier Pile Wall | B1 | Bulk | 3.0 | CL | N/A | | | | | | | | | | | | | | | | |
| | B1 | 1 | 5.5 | D. Rock | 46 | 113.1 | 2.5 | 115.9 | | | | | | | | +4.5 | | | | | |
| | B1 | 2 | 10.5 | D. Rock | 53 | 137.8 | 3.3 | 142.3 | | | | | | | | +4.5 | 1,757 | | | | |
| | B1 | 3 | 15.5 | D. Rock | 67/9" | 139.0 | 4.4 | 145.1 | | | | | | | | +4.5 | | | | | |
| | B1 | 4 | 20.0 | D. Rock | REF | | | | | | | | | | | | | | | | |
| | B1 | 5 | 25.5 | D. Rock | 10 | | | | | | | | | | | | 274 | | | | |
| | B1 | 6 | 30.0 | D. Rock | REF | | | | | | | | | | | | | | | | |
| | B2 | 1 | 5.5 | SC | 16 | 86.6 | 6.2 | 92.0 | 39 | 21 | 18 | 20 | 49 | 31 | | | | | | | |
| | B2 | 2 | 10.5 | SC | 20 | | | | | | | | | | | +4.5 | | 6.65 | 3,750 | 2.0 | 5.9 |
| | B2 | 3 | 15.5 | D. Rock | 26 | 120.6 | 10.0 | 132.7 | | | | | | | | +4.5 | | | | | |
| | B2 | 4 | 20.5 | D. Rock | 38 | 123.9 | 7.8 | 133.6 | | | | | | | | +4.5 | | | | | |
| | B2 | 5 | 23.0 | D. Rock | 50/3" | 151.6 | 6.5 | 161.5 | | | | | | | | | 2,275 | | | | |
| | B2 | 6 | 28.0 | D. Rock | REF | | | | | | | | | | | | | | | | |
| | B2 | 7 | 35.0 | D. Rock | REF | | | | | | | | | | | | | | | | |
| | B2 | 8 | 48.5 | D. Rock | 115 | | | | | | | | | | | | | | | | |

**Note:** Highlighted values were disturbed, granular, or contained significant amount of intact fractured rock.

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Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road at MP 0.95
CAInc File No: 16-337.6
Date: 9/18/2017
Technician: MEA/ETT

## MOISTURE-DENSITY TESTS - D2216

| | 1 | 2 | 3 | | 5 |
|---|---|---|---|---|---|
| Sample No. | B1-1 | B1-2 | B1-3 | | B2-1 |
| USCS Symbol | D. Rock | D. Rock | D. Rock | | GM |
| Depth (ft.) | 5.5 | 10.5 | 15.5 | | 5.5 |
| Sample Length (in.) | 5.143 | 3.414 | 6.002 | | 3.612 |
| Diameter (in.) | 2.400 | 1.428 | 1.417 | | 2.376 |
| Sample Volume ($ft^3$) | 0.01346 | 0.00316 | 0.00548 | | 0.00927 |
| Total Mass Soil+Tube (g) | 962.2 | 204.3 | 483.0 | | 663.1 |
| Mass of Tube (g) | 253.9 | 0.0 | 122.6 | | 276.4 |
| Tare No. | A8 | A8 | H16 | | R5 |
| Tare (g) | 20.9 | 21.0 | 20.58 | | 126.2 |
| Wet Soil + Tare (g) | 91.9 | 94.0 | 70.3 | | 326.6 |
| Dry Soil + Tare (g) | 90.2 | 91.7 | 68.2 | | 314.9 |
| Dry Soil (g) | 69.3 | 70.8 | 47.6 | | 188.7 |
| Water (g) | 1.8 | 2.3 | 2.1 | | 11.7 |
| **Moisture (%)** | **2.5** | **3.3** | **4.4** | | **6.2** |
| **Dry Density (pcf)** | **113.1** | **137.8** | **139.0** | | **86.6** |

Notes:

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road at MP 0.95
CAInc File No: 16-337.6
Date: 9/18/2017
Technician: MEA/ETT

## MOISTURE-DENSITY TESTS - D2216

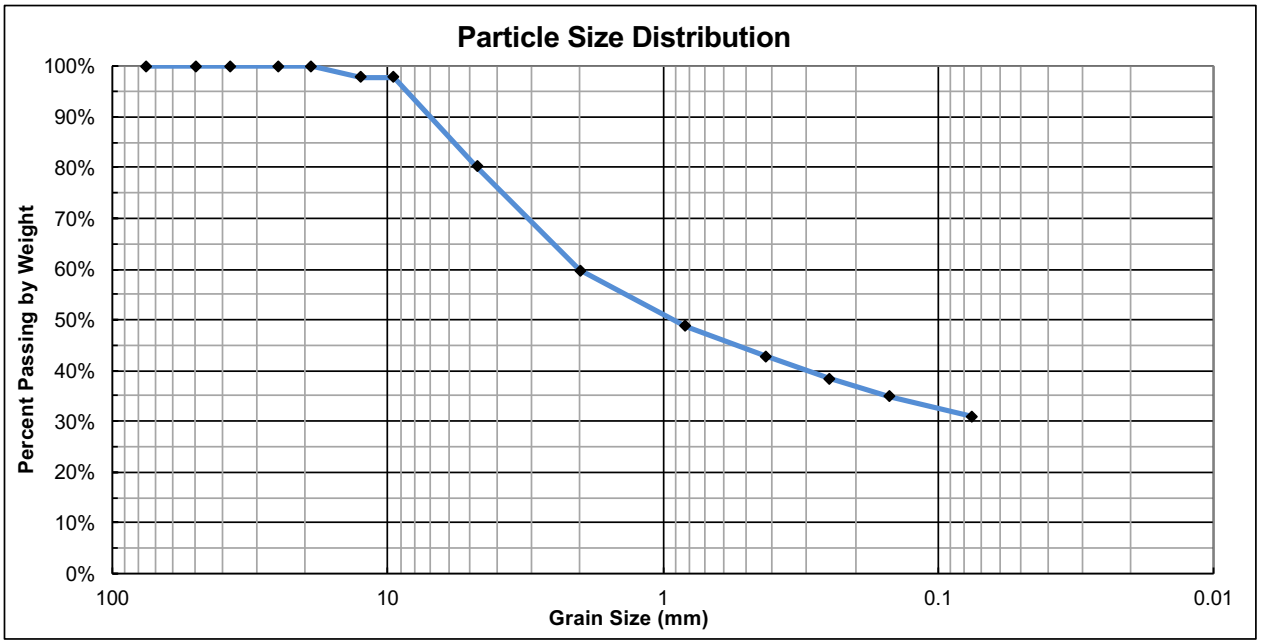
| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Sample No. | B2-3 | B2-4 | B2-5 | | |
| USCS Symbol | D. Rock | D. Rock | D. Rock | | |
| Depth (ft.) | 15.5 | 20.5 | 23 | | |
| Sample Length (in.) | 3.128 | 5.865 | 3.341 | | |
| Diameter (in.) | 1.365 | 1.414 | 1.373 | | |
| Sample Volume ($ft^3$) | 0.00265 | 0.00533 | 0.00286 | | |
| Total Mass Soil+Tube (g) | 281.9 | 447.2 | 209.6 | | |
| Mass of Tube (g) | 122.5 | 124.1 | 0.0 | | |
| Tare No. | G12 | B2 | H7 | | |
| Tare (g) | 13.7 | 20.8 | 20.3 | | |
| Wet Soil + Tare (g) | 63.8 | 72.4 | 59.2 | | |
| Dry Soil + Tare (g) | 59.3 | 68.7 | 56.9 | | |
| Dry Soil (g) | 45.6 | 47.9 | 36.6 | | |
| Water (g) | 4.6 | 3.8 | 2.4 | | |
| **Moisture (%)** | **10.0** | **7.8** | **6.5** | | |
| **Dry Density (pcf)** | **120.6** | **123.9** | **151.6** | | |

Notes:

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road at MP 0.95
CAInc File No: 16-337.6
Date: 9/22/17
Technician: ETT
Sample ID: B2-1
Depth: 5.5'
USCS Classification: Clayey Sand with Gravel

**ASTM 6913 - Method A**




| % Cobble | % Gravel | | % Sand | | | % Fines |
|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt/Clay |
| | 0 | 20 | 20 | 17 | 12 | |
| **0** | **20** | | **49** | | | **31** |

| | | Sieve # | Opening mm | Cummulative Mass Retained (g) | % Passing % |
|---|---|---|---|---|---|
| Cobbles | | **3"** | 75 | 0.0 | 100% |
| Gravel | Coarse | **2"** | 50 | 0.0 | 100% |
| | | **1-1/2"** | 37.5 | 0.0 | 100% |
| | | **1"** | 25.0 | 0.0 | 100% |
| | | **3/4"** | 19.0 | 0.0 | 100% |
| | Fine | **1/2"** | 12.5 | 4.2 | 98% |
| | | **3/8"** | 9.50 | 4.2 | 98% |
| | | **#4** | 4.75 | 37.3 | 80% |
| Sand | Coarse | **#10** | 2.00 | 76.0 | 60% |
| | Medium | **#20** | 0.825 | 96.6 | 49% |
| | | **#40** | 0.425 | 107.8 | 43% |
| | Fine | **#60** | 0.250 | 116.2 | 38% |
| | | **#100** | 0.150 | 122.7 | 35% |
| | | **#200** | 0.075 | 130.3 | 31% |

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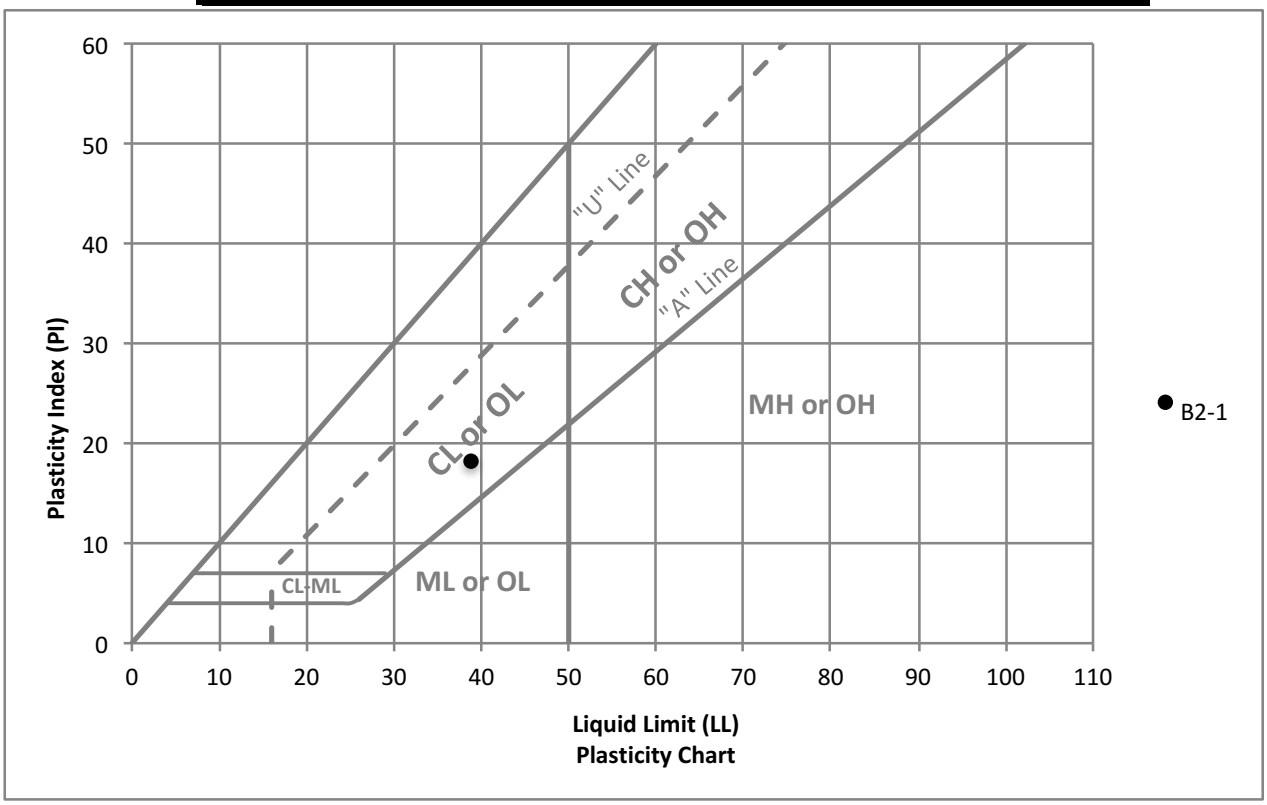
Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road at MP 0.95
CAInc File No: 16-334.6
Date: 9/22/17
Technician: CAP

## Plastic Index - ASTM D4318

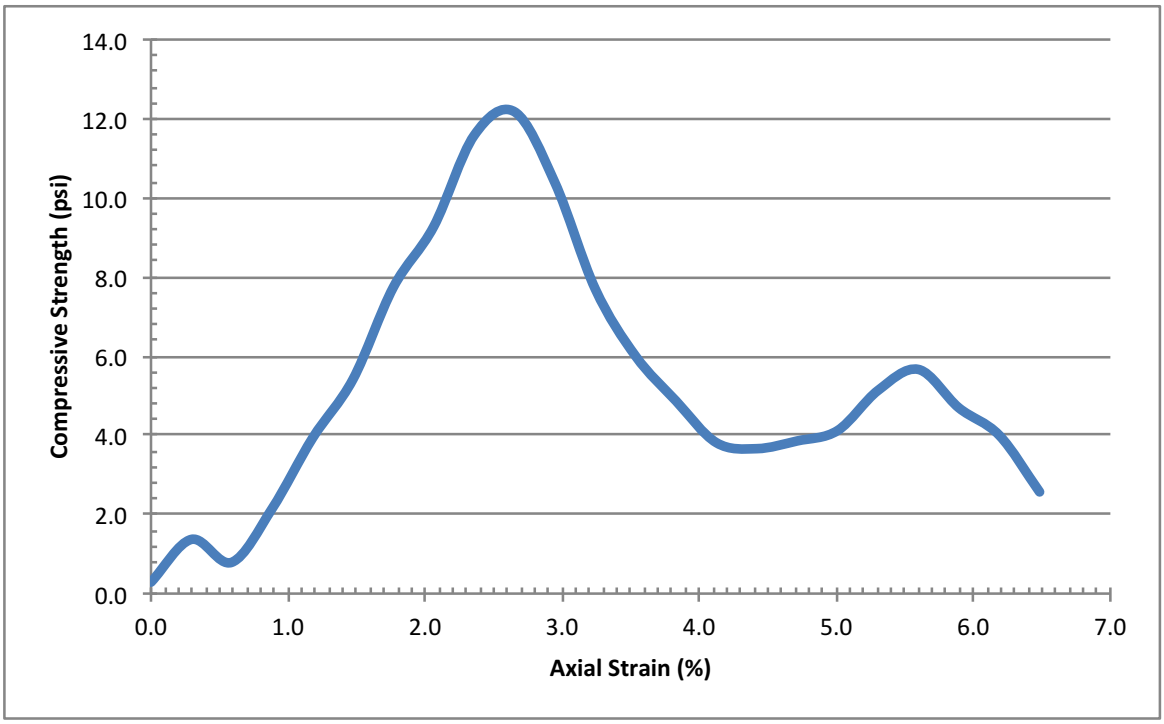
| Sample ID | Depth (ft) | Liquid Limit | Plastic Limit | PI |
|---|---|---|---|---|
| B2-1 | 5.5 | 39 | 21 | 18 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |



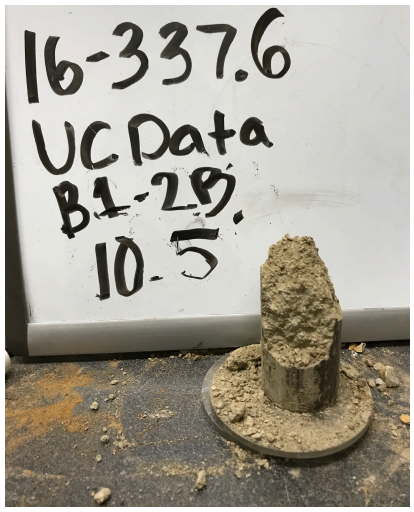
Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road st MP 0.95
CAInc File No: 16-337.6
Date: 9/25/17
Technician: HFW
Sample ID: B1-2B Depth (ft): 10.5
USCS Classification: D. Rock

## UNCONFINED COMPRESSION TEST - D2166




| | |
|---|---|
| **Dry Density (pcf)** | **137.9** |
| **Water Content (%)** | **3.3** |
| **Unconfined Compressive Strength (psi)** | **12.2** |
| **Unconfined Compressive Strength (psf)** | **1757** |
| **Shear Strength (psf)** | **878.4** |
| Average Height (in) | 3.414 |
| Average Diameter (in) | 1.428 |
| Rate of strain (%) | 1.0 |
| Strain at Failure (%) | 2.7 |

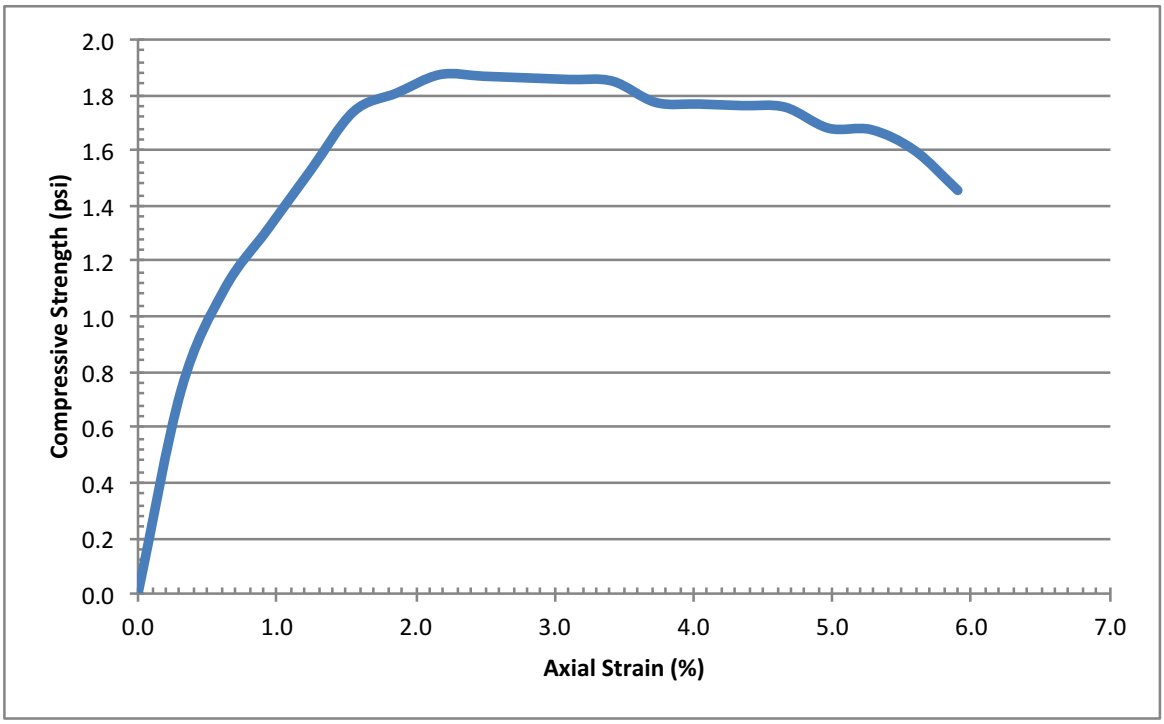



Notes:

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

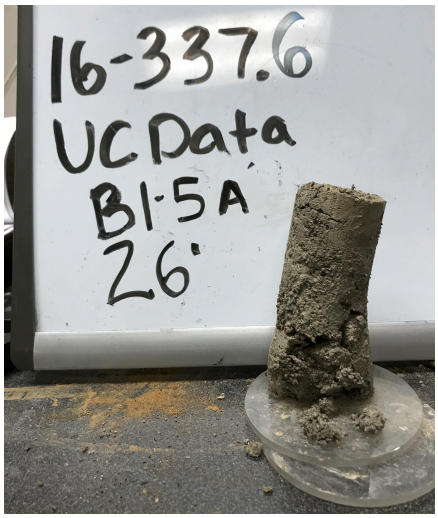
Project Name: Peachland Road st MP 0.95
CAInc File No: 16-337.6
Date: 9/25/17
Technician: HFW
Sample ID: B1-5 Depth (ft): 26.0
USCS Classification: D. Rock

## UNCONFINED COMPRESSION TEST - D2166




| | |
|---|---|
| **Dry Density (pcf)** | **162.0** |
| **Water Content (%)** | **8.7** |
| **Unconfined Compressive Strength (psi)** | **1.9** |
| **Unconfined Compressive Strength (psf)** | **274** |
| **Shear Strength (psf)** | **136.8** |
| Average Height (in) | 3.239 |
| Average Diameter (in) | 1.414 |
| Rate of strain (%) | 1.0 |
| Strain at Failure (%) | 2.2 |

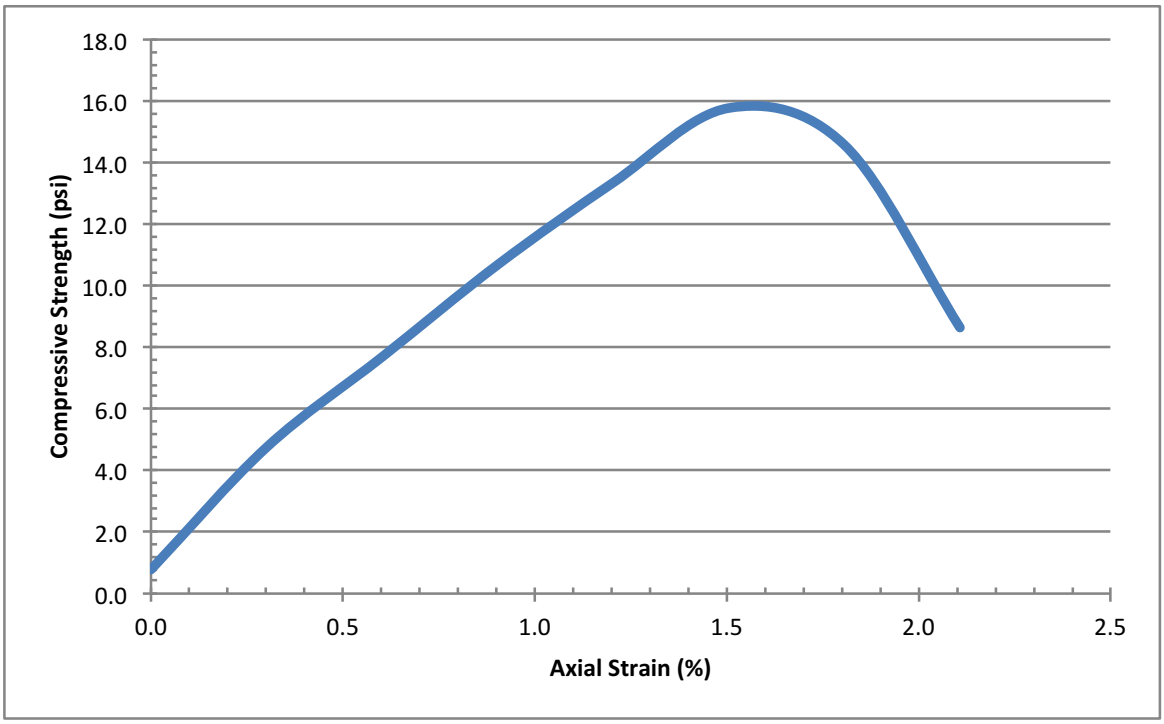
Notes:



Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services

Project Name: Peachland Road st MP 0.95
CAInc File No: 16-337.6
Date: 9/25/17
Technician: HFW
Sample ID: B2-5 Depth (ft): 23.3
USCS Classification: D. Rock

## UNCONFINED COMPRESSION TEST - D2166




| | |
|---|---|
| **Dry Density (pcf)** | **151.5** |
| **Water Content (%)** | **6.5** |
| **Unconfined Compressive Strength (psi)** | **15.8** |
| **Unconfined Compressive Strength (psf)** | **2275** |
| **Shear Strength (psf)** | **1137.6** |
| Average Height (in) | 3.341 |
| Average Diameter (in) | 1.373 |
| Rate of strain (%) | 1.0 |
| Strain at Failure (%) | 1.5 |

Notes:

# Sunland Analytical
**11419 Sunrise Gold Cir.#10**
**Rancho Cordova, CA 95742**
**(916) 852-8557**


Date Reported 10/04/17
Date Submitted 09/27/17

To: Hailey Wagenman
Crawford and Associates Inc.
4020 Rocklin Rd, Ste 1
Rocklin, CA, 95677

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following:
Location : 16-337.6-MP 0.95 Site ID: B2-1A@6FT
Thank you for your business.

* For future reference to this analysis please use SUN # 75318 - 157216

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EVALUATION FOR SOIL CORROSION

| | | | |
|---|---|---|---|
| Soil pH | 6.65 | | |
| Minimum Resistivity | 3.75 | ohm-cm (x1000) | |
| Chloride | 2.0 ppm | 0.0002 | % |
| Sulfate-S | 5.9 ppm | 0.0006 | % |

METHODS:
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422