FOR CONTRACT NO. 02-2E5104
PROJECT ID: 0200000216

INFORMATION HANDOUT

PLAC - PLAC ENVIRONMENTAL COMMITMENTS RECORD (ECR)

WATER QUALITY

PLAC - CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD CLEAN WATER ACT 401 TECHNICALLY CONDITIONED WATER QUALITY CERTIFICATION CENTRAL VALLEY REGION

WDID # 5A45CR00409

PERMITS

PLAC - STATE OF CALIFORNIA
DEPARTMENT OF FISH AND GAME
STREAMBED ALTERATION AGREEMENT

NOTIFICATION NO. 1600-2011-0239-R1

PLAC - UNITED STATES ARMY CORPS OF ENGINEERS (404 NWP)

IDENTIFICATION NO.: SPK-2011-00937

MATERIALS INFORMATION

FOUNDATION REPORT

GEOTECHNICAL DESIGN REPORT

AS-BUILT PLANS FOR EXISTING CONCRETE ARCH CULVERTS

ROUTE: 02-SHA-299-4.3/5.5

REVISED PER ADDENDUM NO. 1 DATED JULY 20, 2012

PLAC - PLAC ENVIRONMENTAL COMMITMENTS RECORD (ECR)

PLAC ENVIRONMENTAL COMMITMENTS RECORD (ECR)

Definitions:
Agency: A board, agency, or other entity that issues a PLAC
Activity: An event that triggers a permit requirement to keep records

Submittals:
Submit to the Engineer PLAC required:
1. Communications. The Engineer will contact the agencies.
2. Records to be maintained, within 5 working days after the activity.
3. Submittals 5 days before the agencies require them. The Engineer will review and submit to the agencies.

Central Valley Regional Water Quality Control Board Clean Water Act 401 Technically Conditioned Water Quality Certification WDID#5A45CR00409

Task	Staff Responsible to Perform the Task	Section
Conditions 4	Contractor	Additional Technically Conditioned Certification Conditions
Condition 10	Contractor	Additional Technically Conditioned Certification Conditions
Conditions 12 through 18	Contractor	Additional Technically Conditioned Certification Conditions

California Department of Fish and Game Streambed Alteration Agreement Notification No: 1600-2011-0239-R1

Task	Staff Responsible to Perform the Task	Section
Measures 2.1 through 2.6	Contractor	Avoidance and Minimization Measures
Measure 2.12	Contractor	Avoidance and Minimization Measures
Measures 2.21 through 2.26	Contractor	Avoidance and Minimization Measures

Department of the Army Nation Wide Permit (404 NWP) with Special Conditions, identification number SPK-2011-00937

Task	Staff Responsible to Perform the Task	Section
Condition 3	Contractor	Special Conditions
Condition 9	Contractor	Special Conditions
Condition 10	Contractor	Special Conditions

PLAC - CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD CLEAN WATER ACT 401 TECHNICALLY CONDITIONED WATER QUALITY CERTIFICATION

WDID#5A45CR00409

California Regional Water Quality Control Board
Central Valley Region
Karl E. Longley, ScD, P.E.,Chair

415 Knollcrest Drive, Suite 100, Redding, California 96002
(530) 224-4845 • FAX (530) 224-4857
http://www.waterboards.ca.gov/centralvalley

Matthew Rodriquez
Secretary for
Environmental Protection

Edmund G. Brown Jr.
Governor

9 March 2012

Mr. Chris Harvey
California Department of Transportation
P.O. Box 496073
Redding, CA 96049-6073

CLEAN WATER ACT §401 TECHNICALLY CONDITIONED WATER QUALITY CERTIFICATION FOR DISCHARGE OF DREDGED AND/OR FILL MATERIALS FOR THE TWIN GULCHES CURVE IMPROVEMENT PROJECT (WDID#5A45CR00409), REDDING, SHASTA COUNTY

ACTION:

1. ☐ Order for Standard Certification
2. ■ Order for Technically-conditioned Certification
3. ☐ Order for Denial of Certification

WATER QUALITY CERTIFICATION STANDARD CONDITIONS:

1. This Water Quality Certification (Certification) action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to §13330 of the California Water Code and §3867 of the California Code of Regulations.

2. This Certification action is not intended and shall not be construed to apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license unless the pertinent Certification application was filed pursuant to §3855(b) and the application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought.

3. The validity of any non-denial Certification action shall be conditioned upon total payment of the full fee required under §3833 of the California Code of Regulations, unless otherwise stated in writing by the certifying agency.

4. This Certification is valid for the duration of the described project. This Certification is no longer valid if the project (as currently described) is modified, or coverage under §404 of the Clean Water Act has expired.

ADDITIONAL TECHNICALLY CONDITIONED CERTIFICATION CONDITIONS:

In addition to the above standard conditions, Caltrans shall satisfy the following:

1. The California Department of Transportation (Caltrans) shall notify the Central Valley Regional Water Quality Control Board (Central Valley Water Board) in writing at least five working days (working days are Monday – Friday) prior to the commencement of ground disturbing activities or any in-water activities with details regarding the construction schedule, in order to allow Regional Water Board staff to be present on-site during installation and removal activities, and to answer any public inquiries that may arise regarding the project. Caltrans shall provide Regional Water Board staff access to the project site to document compliance with this order.

2. All conditions required by this Order shall be included in the Plans and Specifications prepared by Caltrans for the Contractor. In addition, Caltrans shall require compliance with all conditions included in this Order in the bid contract for this project.

3. Caltrans shall provide a copy of this Order, associated attachments, and State Water Resources Control Board (SWRCB) Order No. 2003-0017-DWQ to the contractor, all subcontractors, and all utility companies conducting the work, and require that copies remain in their possession at the work site. Caltrans shall be responsible for work conducted by its employees, contractors, subcontractors, and utility companies.

4. The Resident Engineer (or appropriately authorized agent) shall hold on-site water quality permit compliance meetings (similar to tailgate safety meetings) to discuss permit compliance, including instructions on how to avoid violations and procedures for reporting violations. The meetings shall be held at least every other week, before forecasted storm events, and when a new contractor or subcontractor arrives to begin work at the site. The contractors, subcontractors and their employees, as well as any inspectors or monitors assigned to the project, shall be present at the meetings. Caltrans shall maintain dated sign-in sheets for attendees at these meetings, and shall make them available to the Regional Water Board on request.

5. Except for activities permitted by the U.S. Army Corps under §404 of the Clean Water Act, soil, silt, or other organic materials shall not be placed where such materials could pass into surface water or surface water drainage courses.

6. Disturbance or removal of vegetation shall not exceed the minimum necessary to complete the project.

7. All areas disturbed by project activities shall be protected from washout or erosion.

8. All temporarily affected areas will be restored to pre-construction contours and conditions upon completion of construction activities.

9. Best management practices (BMPs) for erosion, sediment, turbidity and pollutant control

shall be implemented and in place at commencement of, during, and after any ground clearing activities, construction activities, or any other project activities that could result in erosion, sediment, or other pollutant discharges to waters of the State. An effective combination of erosion and sediment control BMPs shall be implemented year round, regardless of season or time of year. Caltrans shall stage erosion and sediment control materials at the work site.

10. In accordance with Caltrans District 2 Director John Bulinski's 9 May 2011 letter to Central Valley Water Board staff regarding tree removal practices on the Middle of Buckhorn Curve Improvement Project, measures shall be implemented to ensure trees are not felled across or within Class I or Class II watercourses (as defined by California Forest Practice Rules). To the fullest extent possible and with due consideration given to topography and safety factors trees shall be felled to lead in a direction away from watercourses and drainages. If a tree is felled across or within a Class I or Class II watercourse, it shall be removed immediately.

11. The applicant shall utilize wildlife-friendly 100% biodegradable erosion control products. Photodegradable synthetic products are not considered biodegradable. The applicant shall not use or allow the use of permanent erosion control products that contain synthetic (e.g., plastic or nylon, or monofilament) netting or materials. Permanent erosion control products are considered to be products left in place for two years or more or after the project is completed. The applicant shall not use or allow the use of soil stabilization products that contain synthetic materials within waters of the United States or waters of the State at any time, unless otherwise authorized by the Central Valley Water Board staff.

12. Post-Storm Photographs: Caltrans shall take photos of all areas disturbed by project activities, including all excess materials disposal areas, after rainfall events that generate visible runoff from these areas in order to demonstrate that erosion control and revegetation measures are present and have been installed appropriately and successfully. A brief report containing these photos shall be submitted within 30 days of the rainfall event that generated runoff from the disturbed areas. Once the site has demonstrated appropriate and effective erosion and sediment control, Caltrans may request a reprieve from this condition from the Central Valley Water Board.

13. Caltrans shall perform surface water sampling: 1) When performing any in-water work; 2) In the event that project activities result in any materials reaching surface waters or; 3) When any activities result in the creation of a visible plume in surface waters. The following monitoring shall be conducted immediately upstream out of the influence of the project and 300 feet downstream of the active work area. Sampling results shall be submitted to this office within two weeks of initiation of sampling and every two weeks thereafter. The sampling frequency may be modified for certain projects with written permission from the Central Valley Water Board.

Parameter	Unit	Type of Sample	Frequency of Sample
Turbidity	NTU	Grab	Every 4 hours during in water work
Settleable Material	ml/l	Grab	Same as above.
Visible construction related pollutants	Observations	Visible Inspections	Continuous throughout the construction period

14. The Central Valley Water Board adopted a *Water Quality Control Plan for the Sacramento River and San Joaquin River*, Fourth Edition, revised October 2011 (Basin Plan) that designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the plan. Turbidity and settleable matter limits are based on water quality objectives contained in the Basin Plan and required as part of this Certification.

15. Activities shall not cause turbidity increases in surface water to exceed:

    (a) where natural turbidity is less than 1 Nephelometric Turbidity Units (NTUs), controllable factors shall not cause downstream turbidity to exceed 2 NTU;
    (b) where natural turbidity is between 1 and 5 NTUs, increases shall not exceed 1 NTU;
    (c) where natural turbidity is between 5 and 50 NTUs, increases shall not exceed 20 percent;
    (d) where natural turbidity is between 50 and 100 NTUs, increases shall not exceed 10 NTUs;
    (e) where natural turbidity is greater than 100 NTUs, increases shall not exceed 10 percent.

    Except that these limits will be eased during in-water working periods to allow a turbidity increase of 15 NTU over background turbidity as measured in surface waters 300 feet downstream from the working area. In determining compliance with the above limits, appropriate averaging periods may be applied provided that beneficial uses will be fully protected. Averaging periods may only be assessed by prior permission of the Central Valley Water Board staff

16. Activities shall not cause settleable matter to exceed 0.1 ml/l in surface waters as measured in surface waters 300 feet downstream from the project.

17. Caltrans is prohibited from discharging waste to waters of the State, unless explicitly authorized by this Order. No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete, concrete washings, oil or petroleum products, or other organic or earthen material from any construction or associated activity of whatever nature, other than that authorized by this Order, shall be allowed to enter into or be placed where it may be washed by rainfall into waters of the State..

18. If at any time the above criteria for turbidity or settleable material are exceeded, or an unauthorized discharge to surface water (including wetlands, rivers or streams) occurs, the associated project activities shall cease immediately until adequate BMPs are implemented. The Central Valley Water Board shall be notified promptly and in no case more than 24 hours after the exceedance or unauthorized discharge occurs.

19. Activities shall not cause degradation of waters of the State.

20. This Certification does not allow permanent water diversion of flow from the receiving water. This Certification is invalid if any water is permanently diverted as a part of the project.

21. Caltrans shall comply with all U.S. Army Corps of Engineers requirements and conditions for the project, including, but not limited to, those requirements and special conditions described in including, but not limited to, those requirements described in Nationwide Permit #14 and Special Condition described in the U.S. Army Corps of Engineers letter to Caltrans dated 28 November 2011 (SPK-2011-00937).

22. Caltrans shall comply with all California Department of Fish and Game requirements and recommendations, including, but not limited to, those requirements and recommendations described in Streambed Alteration Agreement No. 1600-2011-0239-R.

23. Caltrans shall comply with their General NPDES Permit Order No 99-06-DWQ (NPDES No. CAS 000003) issued by the State Water Resources Control Board.

24. Caltrans shall comply with all conditions of the NPDES General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities issued by the State Water Resources Control Board.

25. In the event of any violation or threatened violation of the conditions of this Certification, the violation or threatened violation shall be subject to any remedies, penalties, process, or sanctions as provided for under state and federal law. The applicability of any state law authorizing remedies, penalties, process, or sanctions for the violation or threatened violation constitutes a limitation necessary to ensure compliance with this Certification.

    (a) If Caltrans or a duly authorized representative of the project fails or refuses to furnish technical or monitoring reports, as required under this Certification, or falsifies any information provided in the monitoring reports, the applicant is subject to civil liability, for each day of violation, and/or criminal liability.
    (b) In response to a suspected violation of any condition of this Certification, the Central Valley Water Board may require Caltrans to furnish, under penalty of perjury, any technical or monitoring reports the Central Valley Water Board deems appropriate, provided that the burden, including cost of the reports, shall be in reasonable relationship to the need for the reports and the benefits to be obtained from the reports.

(c) Caltrans shall allow the staff(s) of the Central Valley Water Board, or an authorized representative(s), upon the presentation of credentials and other documents, as may be required by law, to enter the project premises for inspection, including taking photographs and securing copies of project-related records, for the purpose of assuring compliance with this Certification and determining the ecological success of the project.

26. The Conditions in this water quality certification are based on the information in the attached "Project Information." If the information in the attached Project Information is modified or the project changes, this water quality certification is no longer valid until amended by the Central Valley Water Board.

27. Caltrans has purchased of 0.34 acres of open water credits at Stillwater Plains Mitigation Bank in Shasta County, as required by the U.S. Army Corps of Engineers for compensatory mitigation. Caltrans provided copies of the executed sales agreement and the payment receipt for the 0.34 acres of credits on 22 February 2012.

28. Caltrans shall provide a Notice of Completion (NOC) no later than 30 days after the project completion. The NOC shall demonstrate that that the project has been carried out in accordance with the project's description (and any amendments approved). The NOC shall include a map of the project location and representative pre and post construction; photographs. Each photograph shall include a descriptive title, date taken, photographic site, and photographic orientation.

REGIONAL WATER QUALITY CONTROL BOARD CONTACT PERSON:

Dannas J. Berchtold, Engineering Associate, Redding Branch Office, 415 Knollcrest Drive, Suite 100, Redding, California 96002, dberchtold@waterboards.ca.gov, (530) 224-4783

WATER QUALITY CERTIFICATION:

I hereby issue an order certifying that any discharge from Caltrans, Twin Gulches Curve Improvement Project (WDID# 5A45CR00409) will comply with the applicable provisions of §301 ("Effluent Limitations"), §302 ("Water Quality Related Effluent Limitations"), §303 ("Water Quality Standards and Implementation Plans"), §306 ("National Standards of Performance"), and §307 ("Toxic and Pretreatment Effluent Standards") of the Clean Water Act. This discharge is also regulated under State Water Resources Control Board Water Quality Order No. 2003-0017 DWQ "Statewide General Waste Discharge Requirements For Dredged Or Fill Discharges That Have Received State Water Quality Certification" which requires compliance with all conditions of this Certification. Order No. 2003-0017-DWQ is available at http://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2003/wqo/wqo2003-0017.pdf

Except insofar as may be modified by any preceding conditions, all certification actions are contingent on (a) the discharge being limited and all proposed mitigation being completed in strict compliance with Caltrans's project description and the attached Project Information

Sheet, and (b) compliance with all applicable requirements of the Water Quality Control Plan *for the Sacramento River and San Joaquin River*, Fourth Edition, revised October 2011.

(for) Pamela C. Creedon
Executive Officer

Enclosure: Project Information

DJB: wrb/jmtm

cc: Mr. Matt Kelley, U.S. Army Corp of Engineers, Redding
U.S. Fish and Wildlife Service, Sacramento
Ms. Donna Cobb, Department of Fish and Game, Region 1, Redding
Mr. Bill Jennings, CALSPA, Stockton

cc by email: Mr. Dave Smith, U.S. EPA, Region 9, San Francisco
Mr. Bill Orme, SWRCB, Certification Unit, Sacramento

U:\Clerical\Storm_water\DBerchtold\2012\401 5A45CR00409 Twin Gulches Curve Improvement Project, Caltrans.doc

PROJECT INFORMATION

Application Date: 12 September 2011

Applicant: Caltrans, Attn: Mr. Chris Harvey

Project Name: Twin Gulches Curve Improvement Project

Application Number: WDID No. 5A45CR00409

Type of Project: Safety Project - Highway Curve Realignment

Project Location: Section 31, Township 33 North, Range 7 West, MDB&M. Latitude: 40°40'12.48" and Longitude: -122°41'52.08"

County: Shasta County

Receiving Water(s) (hydrologic unit): Upper Clear Creek, and Willow Creek, which is tributary to Sacramento River. Pitt River Hydrologic Unit-French Gulch Hydrologic Area No. 524.64

Water Body Type: Riparian, Streambed, Upland Drainages

Designated Beneficial Uses: The Water Quality Control Plan *for the Sacramento River and San Joaquin River*, Fourth Edition, revised October 2011, has designated beneficial uses for surface and ground waters within the region. Beneficial uses that could be impacted by the project include: Municipal and Domestic Water Supply (MUN); Agricultural Supply (AGR); Industrial Supply (IND), Hydropower Generation (POW); Groundwater Recharge (GWR), Water Contact Recreation (REC-1); Non-Contact Water Recreation (REC-2); Warm Freshwater Habitat (WARM); Cold Freshwater Habitat (COLD); Warm Freshwater Spawning (SPWN);and Wildlife Habitat (WILD). A comprehensive and specific list of the Beneficial Uses applicable for the project area can be found at: http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/index.shtml

Project Description (purpose/goal): Twin Gulches Curve Improvement Project consists of realigning fifteen existing curves, adding an eastbound passing lane, providing eight foot paved shoulders, increasing the clear recovery zone, and improving roadway geometrics and sight distance along State Route 299 in Shasta County.

The project will require three construction seasons. Tree and vegetation removal will take place the first season; the second season includes culvert construction in Water and Trail Gulches, portions of the soil excavation (cuts and fills), and the construction of two access roads; and during the third season the remaining cuts and fills, culvert installation, road base/asphalt placement, guard rail/sign installation, and pavement striping will occur.

Sixteen watercourses will be impacted within the project limits: Two perennial streams (Water Gulch and Trail Gulch, both tributaries to Willow Creek, a tributary of Whiskeytown Reservoir), three ephemeral/intermittent drainages, and eleven upland storm water drainages. New culverts will be constructed at the five perennial, intermittent, and ephemeral drainages. The storm water drainage facilities will be either left in place, modified, or removed.

Approximately 550,000 cubic yards of soil excavation is required. Earthwork will be balanced within the project limits, avoiding the need for an off-site disposal area. Equipment will be staged and materials will be stored in upland areas within the project limits. Two access roads (one adjacent to Water Gulch, the other adjacent to Trail Gulch) will be constructed and left in place to provide access for adjacent property owners. Gabion lined benches will be constructed on fill slopes to prevent erosion.

Temporary clear water diversions are required at the two perennial streams. The new culverts will be placed within the existing channel alignment and will convey storm water runoff to rock and gabion lined ditches.

Some sections of the existing highway will left in place to maintain access to adjacent properties, in other areas the pavement will be removed and the area will be used as turnouts or graded to contour and planted with native vegetation. On-site re-vegetation includes erosion control, upland planting, and riparian planting.

Dedicated small animal dry crossings will be constructed within the fill slopes at both Water Gulch and Trail Gulch. Amphibian shelves will be placed in the new culverts constructed within Water Gulch and Trail Gulch.

Implementation of the project will result in the disturbance of approximately 18.9 acres of soil and a net increase in impervious area of 0.87 acres. Both short-term and long-term storm water Best Management Practices (BMPs) are required. Short-term BMPs are aimed at reducing erosion and sediment transport, and include linear barriers and disturbed soil cover; Long-term BMPs include project design features (gabion lined ditches, benches on fill and some cut slopes, wide paved shoulders for collecting sediment, and check dams) and permanent vegetative soil stabilization.

Preliminary Water Quality Concerns: Construction activities may impact surface waters with increased turbidity and settleable matter.

Proposed Mitigation to Address Concerns: Caltrans will implement Best Management Practices (BMPs) to control sedimentation and erosion. All temporary affected areas will be restored to pre-construction contours and conditions upon completion of construction activities. Caltrans will conduct turbidity and settleable matter testing during in-water work, stopping work if Basin Plan criteria are exceeded or are observed.

Fill/Excavation Area: Project implementation will permanently impact 0.196 acres of riparian, 0.014 acres of un-vegetated streambed and 0.0029 acres of upland drainages and temporarily impact 0.0124 acres of riparian and 0.0015 acres of un-vegetated streambed.

Dredge Volume: Not Applicable

Possible Listed Species: Not Applicable

U.S. Army Corps File Number: SPK-2011-00937

U.S. Army Corps of Engineers Permit Number: Nationwide Permit # 14

California Department of Fish and Game Lake and Streambed Alteration Agreement: Caltrans applied for a Streambed Alteration Agreement on 8 September 2011 (Lake & Streambed Alteration Agreement Number: 1600- 2011-0239-R1).

Status of CEQA Compliance: Caltrans signed a Notice of Determination 8 February 2011 approving a Negative Declaration stating the project will have a less than significant effect on the environment.

Compensatory Mitigation: Caltrans has purchased of 0.34 acres of open water credits at Stillwater Plains Mitigation Bank in Shasta County for the permanent and temporary loss of riparian streambed and un-vegetated streambed resulting from this project.

Application Fee Provided: On 12 September 2011 a certification application fee of $1,328 was submitted as required by 23 CCR §3833b(3)(A) and by 23 CCR §2200(e). A remaining certification fee of $8,828 was received on 2 December 2011 as required by 23 CCR §3833b(2)(A) and by 23 CCR §2200(e).

PLAC - CALIFORNIA DEPARTMENT OF FISH AND GAME STREAMBED ALTERATION AGREEMENT

NOTIFICATION NO.: 1600-2011-0239-R1

CALIFORNIA DEPARTMENT OF FISH AND GAME
NORTHERN REGION
601 LOCUST STREET
REDDING, CA 96001

STREAMBED ALTERATION AGREEMENT
NOTIFICATION NO. 1600-2011-0239-R1
Water and Trail Gulches

CALIFORNIA DEPARTMENT OF TRANSPORTATION
TWIN GULCHES CURVE IMPROVEMENT PROJECT

This Streambed Alteration Agreement (Agreement) is entered into between the California Department of Fish and Game (DFG) and the California Department of Transportation (Permittee) as represented by Mr. Chris Harvey.

RECITALS

WHEREAS, pursuant to Fish and Game Code (FGC) section 1602, Permittee notified DFG on September 13, 2011 that Permittee intends to complete the project (Project) described herein.

WHEREAS, pursuant to FGC section 1603, DFG has determined that the Project could substantially adversely affect existing fish or wildlife resources and has included measures in the Agreement necessary to protect those resources.

WHEREAS, Permittee has reviewed the Agreement and accepts its terms and conditions, including the measures to protect fish and wildlife resources.

NOW THEREFORE, Permittee agrees to complete the Project in accordance with the Agreement.

PROJECT LOCATION

The Project is located at Water and Trail Gulches and three unnamed tributaries to Willow Creek, between Post Miles (PM) 4.3 and 5.5 on State Route (SR) 299 in the County of Shasta, State of California; Latitude 40.668977° North, Longitude 122.698121° West.

PROJECT DESCRIPTION

The Project is limited to the removal and relocation of existing culverts at Water and Trail Gulches as well as three unnamed ephemeral tributaries to Willow Creek. The work is necessary to accommodate the realignment of SR 299 between PM 4.3 and 5.5, approximately 20 mile west of Redding. The Project proposes to increase safety by

realigning 15 existing curves, providing eight-foot shoulders, improving roadway geometrics, increasing sight distance, and increasing the recovery zone for errant vehicles. Work is proposed over three construction seasons, with tree removal taking place during the first season, construction of new culverts, access roads, and portions of the cuts and fills taking place during the second season, and the remaining earthwork, drainage installation, roadway and guardrail construction, paving and striping to occur during the third season. A complete Project description is found in Exhibit A *Twin Gulches Curve Improvement, Initial Study with Negative Declaration (SCH #2010112052) Shasta County, California. California Department of Transportation. February 1, 2011.*

Specific work authorized by this Agreement includes:

- Removal of up to 0.75 acre of riparian vegetation
- Removal and relocation of existing culverts
- Construction of clear water diversion systems at Water and Trail Gulches
- Construction of separate small mammal crossings at Water and Trail Gulches
- Construction of shelves within the Water and Trail Gulch culverts to facilitate movement of amphibians, and
- Planting riparian vegetation at suitable locations on-site, and planting or purchasing riparian mitigation credits off-site.

PROJECT IMPACTS

Existing fish or wildlife resources the Project could substantially adversely affect include: ringtail (*Bassariscus astutus*), Pacific fisher (*Martes pennanti pacifica*), and foothill yellow-legged frog (*Rana boylii*), as well as Neotropical migrant birds, aquatic invertebrates and other riparian dependent species.

The adverse effects the Project could have on the fish or wildlife resources identified above include: permanent loss of 0.75 acre of riparian habitat, direct avian mortality through removal of nests with eggs or young, increased road kill mortality associated with higher vehicle speeds on the new alignment, as well as temporary impacts to downstream benthic invertebrate communities through erosion and sediment deposition.

MEASURES TO PROTECT FISH AND WILDLIFE RESOURCES

1. Administrative Measures

Permittee shall meet each administrative requirement described below.

1.1 Documentation at Project Site. Permittee shall make the Agreement, any extensions and amendments to the Agreement, and all related notification materials and California Environmental Quality Act (CEQA) documents, readily

available at the Project site at all times and shall be presented to DFG personnel, or personnel from another state, federal, or local agency upon request.

1.2 Providing Agreement to Persons at Project Site. Permittee shall provide copies of the Agreement and any extensions and amendments to the Agreement to all persons who will be working on the Project at the Project site on behalf of Permittee, including but not limited to contractors, subcontractors, inspectors, and monitors.

1.3 Notification of Conflicting Provisions. Permittee shall notify DFG if Permittee determines or learns that a provision in the Agreement might conflict with a provision imposed on the Project by another local, state, or federal agency. In that event, DFG shall contact Permittee to resolve any conflict.

1.4 Project Site Entry. Permittee agrees that DFG personnel may enter the Project site at any time to verify compliance with the Agreement.

2. Avoidance and Minimization Measures

To avoid or minimize adverse impacts to fish and wildlife resources identified above, Permittee shall implement each measure listed below.

PROJECT TIMING

2.1 All work within the stream channel or on the stream banks shall be confined to the period commencing May 1 and ending October 15, provided the stream is dry or at low flow. If weather conditions permit and the stream flows are low, the Permittee may perform work within the stream channel or on the banks after October 15, provided a written request is made to DFG at least five (5) days before the proposed work period variance. Written approval from DFG for the proposed work period variance must be received by the Permittee prior to the start or the continuation of work after October 15.

2.2 If work is performed within the stream channel or on the banks after October 15, the Permittee shall do all of the following:

a. Stage erosion and sediment control materials at the work site.

b. Monitor the seventy-two (72) hour forecast from the National Weather Service.

c. When the 72-hour forecast indicates a probability of precipitation of 60% or greater, or at the onset of any precipitation, ground disturbing activities shall cease and erosion control measures shall be implemented to stabilize exposed soils and prevent the mobilization of sediment into the stream channel or adjacent wetland or riparian areas.

2.3 Notwithstanding Measure 2.1 above, removal of the above-ground portions of existing trees and shrubs shall occur after August 31 and before March 15 to avoid impacts to nesting birds. If vegetation must be removed during the nesting season (March 15 to August 31) nest surveys shall be conducted prior to vegetation clearing.

HABITAT AND SPECIES PROTECTION

2.4 Prior to initiating ground-disturbing Project activities, Permittee shall clearly delineate the limits of the work area. Permittee shall restrict all Project activities to the designated work area and shall maintain all fencing, stakes and flags until the completion of Project activities.

2.5 Disturbance or removal of riparian vegetation shall not exceed the minimum necessary to complete operations. Where feasible, hand tools (chain saws, etc.) shall be used to trim woody riparian vegetation to the extent necessary to gain access to work sites. Whenever possible, root systems shall be left intact to facilitate more rapid recovery following temporary construction impacts.

2.6 Except as provided in this Agreement, the removal of riparian vegetation from the streambed or stream banks is prohibited without prior written approval from DFG. Existing riparian vegetation adjacent to the work areas shall be protected as Environmentally Sensitive Areas (ESAs) and shall be off limits to construction equipment and personnel.

2.7 ESA fencing shall be installed prior to the initiation of ground disturbing activities. The placement of ESA fencing shall be inspected and approved by DFG prior to the initiation of work. Permittee shall provide written notification for inspection a minimum of 5 working days prior to beginning work. If DFG is unable to conduct a site inspection during this period, the inspection may be conducted by the Environmental Construction Liaison and the results forwarded to DFG for approval.

2.8 ESA Fencing shall consist of temporary orange construction fence or other highly visible material that clearly delineates the limits of the work area. Environmentally Sensitive Areas shall be clearly shown on the Project plans and drawings. The Permittee shall ensure that the contractor, subcontractors, and all personnel working on the Project are instructed on the purpose of the ESA fencing and understand the limits of the work area.

2.9 Dedicated small mammal crossing structures shall be constructed at Water and Trail gulches as approved by DFG.

2.10 Permittee shall establish a vegetated corridor from Water and Trail gulches to the upstream and downstream ends of the small mammal crossing structures.

2.11 An amphibian shelf shall be constructed within the new water conveyance culverts at Water and Trail gulches.

2.12 Permittee shall implement the *Twin Gulches Curve Improvement Project Revegetation Plan* dated April 2011 (Exhibit B) as approved by DFG.

CONSTRUCTION DEWATERING AND INSTREAM STRUCTURES

2.13 All work within the stream channel or on the banks shall be performed when the stream is dry or at low flow. If water is present during construction, all work shall be performed in isolation from surface or subsurface flow.

2.14 Where water is present, a temporary clear water diversion shall be constructed to isolate the work area from flow. Temporary diversions may be constructed using berms of clean washed gravel, sand bags, K-rail, plastic sheeting, or a combination of these materials upstream from the work area. Flows will then be diverted into a temporary culvert, pipe, or conduit and released downstream from the work area.

2.15 The clear water diversion shall be adequately sized to accommodate the full range of flows that may occur during the diversion period without overtopping into the work area.

2.16 Dewatering shall be done in a manner that prevents the discharge of material that could be deleterious to fish, plant life, or bird life into any river, stream or lake and maintains adequate flows to downstream reaches during all times natural flow would have supported aquatic life. Such flows shall be of sufficient quality and quantity to support aquatic life above and below the diversion. Normal flows shall be restored to the affected stream immediately upon completion of work at that location.

2.17 Dewatering activities shall be conducted in such a manner so as to minimize downstream sedimentation and turbidity, and to minimize channel disturbance to allow flows to clear.

2.18 Any turbid water pumped from the work area shall be used for construction purposes (compaction, dust abatement, etc.) or properly disposed of in an upland area where it will not drain to surface waters or wetlands.

2.19 Water that has been in contact with uncured concrete shall be contained in a concrete washout facility, Baker tank, or other impervious container and shall not be discharged to surface or ground waters.

2.20 Temporary culverts, gravel berms or other structures and materials not designed to withstand high flows shall be removed from the channel prior to October 15.

EROSION AND SEDIMENT CONTROL

2.21 The Project shall at all time feature adequate erosion and sediment control devices to prevent the degradation of water quality.

2.22 Soils exposed by Project operations shall be treated to prevent sediment runoff and transport. Erosion control measures shall include the proper installation and maintenance of approved Best Management Practices (BMPs) and may include applications of seed, certified weed-free straw, compost, fiber, commercial fertilizer, stabilizing emulsion and mulch, or combinations thereof.

2.23 Soils adjacent to the stream channel that are exposed by Project operations shall be adequately stabilized when rainfall is reasonably expected during construction, and immediately upon completion of construction, to prevent the mobilization of such sediment into the stream channel or adjacent riparian areas. National Weather Service forecasts shall be monitored by the Permittee to determine the chance of precipitation.

2.24 Erosion control measures shall be monitored and maintained during and after each storm event. Modifications, repairs, and improvements to erosion control measures shall be made following each storm event to prevent sediment from entering surface waters.

2.25 All equipment used during construction of this Project shall be cleaned (i.e. free of dirt and debris that may harbor noxious weed seeds and plant parts) prior to its arrival on site and before leaving the Project area.

2.26 RSP and energy dissipation materials shall consist of clean rock, competent for the application, sized and properly installed to resist washout. RSP slopes shall be supported with competent boulders keyed into a footing trench with a depth sufficient to properly seat the footing course boulders and prevent instability (typically at least 1/3 diameter of footing course boulders). Excavation spoils shall not be side-cast into the channel nor is any manipulation of the substrate of the channel authorized except as herein expressly provided.

2.27 Following construction, all disturbed upland areas shall be stabilized and reseeded with a native seed mix consisting of common yarrow (*Achillea millefolium*), California brome (*Bromus carinatus*), blue wild-rye (*Elymus glaucus*), California poppy (*Eschscholzia californica*), Idaho fescue (*Festuca idahoensis*), Spanish clover (*Lotus purshianus*), dwarf lupine (*Lupinus nanus*), pine bluegrass (*Poa secunda*), and three weeks fescue (*Vulpia microstachys*).

PETROLEUM, CHEMICAL AND OTHER POLLUTANTS

2.28 All construction related materials and equipment shall be stored in designated staging areas located outside of the floodplain unless approved in writing by DFG.

2.29 Refueling and vehicle maintenance shall be performed at least 100 feet from streams or other water bodies unless approved in writing by DFG.

2.30 No equipment or machinery shall be operated within any flowing stream.

2.31 Any equipment or vehicles driven and/or operated within or adjacent to the stream channel shall be checked and maintained daily to prevent leaks of materials that, if introduced to water, could be deleterious to aquatic life, wildlife, or riparian habitat.

2.32 All activities performed in or near a stream shall have absorbent materials designated for spill containment and clean up activities on-site for use in an accidental spill. In the event of a discharge, the Permittee shall immediately notify the California Emergency Management Agency at 1-800-852-7550 and shall immediately initiate the clean up activities. DFG shall be notified by the Permittee and consulted regarding clean-up procedures.

2.33 No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete or washings thereof, asphalt, paint or other coating material, oil or petroleum products or other organic or earthen material from any construction, or associated activity of whatever nature shall be allowed to enter into, or placed where it may be washed by rainfall or runoff into, waters of the State. When operations are completed, any excess materials or debris shall be removed from the work area. No rubbish shall be deposited within 150 feet of the high water mark of any stream or lake.

3. Compensatory Measures

To compensate for adverse impacts to fish and wildlife resources identified above that cannot be avoided or minimized, Permittee shall implement each measure listed below.

3.1 Riparian revegetation. Permittee shall compensate for the permanent loss of 0.75 acre of Valley-Foothill Riparian Habitat through planting 1.01 acres of riparian vegetation at suitable locations on-site and by planting 1.5 acres at a suitable off-site location. If no suitable off-site locations can be found, Permittee may purchase 1.5 acres of riparian credit at a DFG approved mitigation bank.

3.2 Plant establishment. Permittee shall maintain and provide supplemental watering to planted vegetation during a two year plant establishment period following installation.

3.3 Monitoring. Permittee shall monitor the survival and vigor of riparian plantings for a minimum of five years following installation and shall replace any plants that have died during this period. The mitigation shall be determined successful if a minimum of 80% of the plantings have survived at the end of five years.

4. Reporting Measures

Permittee shall meet each reporting requirement described below.

4.1 Monitoring reports. Permittee shall provide an annual monitoring report to DFG no later than January 31 of each year during the monitoring period. The annual report shall describe survival and growth of the riparian plantings during the previous year's growing season as well as any remedial measures undertaken to improve performance. The first report shall be submitted after the plantings have experienced an entire growing season. A final report shall be submitted following the fifth complete growing season and shall document whether success criteria have been met.

CONTACT INFORMATION

Any communication that Permittee or DFG submits to the other shall be in writing and any communication or documentation shall be delivered to the address below by U.S. mail, fax, or email, or to such other address as Permittee or DFG specifies by written notice to the other.

To Permittee:

Mr. Chris Harvey
Department of Transportation
Post Office Box 496073
Redding, CA 96049-6073
Fax: (530) 225-3019
Email: chris.harvey@dot.ca.gov

To DFG:

Department of Fish and Game
Northern Region
601 Locust Street
Redding, CA 96001
Attn: Lake and Streambed Alteration Program – Craig Martz
Notification #1600-2011-0239-R1
Fax: (530) 225-2267
Email: cmartz@dfg.ca.gov

LIABILITY

Permittee shall be solely liable for any violations of the Agreement, whether committed by Permittee or any person acting on behalf of Permittee, including its officers,

employees, representatives, agents or contractors and subcontractors, to complete the Project or any activity related to it that the Agreement authorizes.

This Agreement does not constitute DFG's endorsement of, or require Permittee to proceed with the Project. The decision to proceed with the Project is Permittee's alone.

SUSPENSION AND REVOCATION

DFG may suspend or revoke in its entirety the Agreement if it determines that Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, is not in compliance with the Agreement.

Before DFG suspends or revokes the Agreement, it shall provide Permittee written notice by certified or registered mail that it intends to suspend or revoke. The notice shall state the reason(s) for the proposed suspension or revocation, provide Permittee an opportunity to correct any deficiency before DFG suspends or revokes the Agreement, and include instructions to Permittee, if necessary, including but not limited to a directive to immediately cease the specific activity or activities that caused DFG to issue the notice.

ENFORCEMENT

Nothing in the Agreement precludes DFG from pursuing an enforcement action against Permittee instead of, or in addition to, suspending or revoking the Agreement.

Nothing in the Agreement limits or otherwise affects DFG's enforcement authority or that of its enforcement personnel.

OTHER LEGAL OBLIGATIONS

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from obtaining any other permits or authorizations that might be required under other federal, state, or local laws or regulations before beginning the Project or an activity related to it.

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from complying with other applicable statutes in the FGC including, but not limited to, FGC sections 2050 et seq. (threatened and endangered species), 3503 (bird nests and eggs), 3503.5 (birds of prey), 5650 (water pollution), 5652 (refuse disposal into water), 5901 (fish passage), 5937 (sufficient water for fish), and 5948 (obstruction of stream).

Nothing in the Agreement authorizes Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, to trespass.

AMENDMENT

DFG may amend the Agreement at any time during its term if DFG determines the amendment is necessary to protect an existing fish or wildlife resource.

Permittee may amend the Agreement at any time during its term, provided the amendment is mutually agreed to in writing by DFG and Permittee. To request an amendment, Permittee shall submit to DFG a completed DFG "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the corresponding amendment fee identified in DFG's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

TRANSFER AND ASSIGNMENT

This Agreement may not be transferred or assigned to another entity, and any purported transfer or assignment of the Agreement to another entity shall not be valid or effective, unless the transfer or assignment is requested by Permittee in writing, as specified below, and thereafter DFG approves the transfer or assignment in writing.

The transfer or assignment of the Agreement to another entity shall constitute a minor amendment, and therefore to request a transfer or assignment, Permittee shall submit to DFG a completed DFG "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the minor amendment fee identified in DFG's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

EXTENSIONS

In accordance with FGC section 1605(b), Permittee may request one extension of the Agreement, provided the request is made prior to the expiration of the Agreement's term. To request an extension, Permittee shall submit to DFG a completed DFG "Request to Extend Lake or Streambed Alteration" form and include with the completed form payment of the extension fee identified in DFG's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5). DFG shall process the extension request in accordance with FGC 1605(b) through (e).

If Permittee fails to submit a request to extend the Agreement prior to its expiration, Permittee must submit a new notification and notification fee before beginning or continuing the Project the Agreement covers (Fish & G. Code, § 1605, subd. (f)). .

EFFECTIVE DATE

The Agreement becomes effective on the date of DFG's signature, which shall be: 1) after Permittee's signature; 2) after DFG complies with all applicable requirements under the California Environmental Quality Act (CEQA); and 3) after payment of the applicable FGC section 711.4 filing fee listed at http://www.dfg.ca.gov/habcon/ceqa/ceqa_changes.html.

TERM

This Agreement shall expire on December 31, 2015, unless it is terminated or extended before then. All provisions in the Agreement shall remain in force throughout its term. Permittee shall remain responsible for implementing any provisions specified herein to protect fish and wildlife resources after the Agreement expires or is terminated, as FGC section 1605(a)(2) requires.

EXHIBITS

The documents listed below are included as exhibits to the Agreement and incorporated herein by reference.

A. Exhibit A. *Twin Gulches Curve Improvement, Initial Study with Negative Declaration (SCH #2010112052) Shasta County, California. California Department of Transportation. February 1, 2011.*
B. Exhibit B. *Twin Gulches Curve Improvement Project Revegetation Plan. California Department of Transportation. April 2011.*

AUTHORITY

If the person signing the Agreement (signatory) is doing so as a representative of Permittee, the signatory hereby acknowledges that he or she is doing so on Permittee's behalf and represents and warrants that he or she has the authority to legally bind Permittee to the provisions herein.

AUTHORIZATION

This Agreement authorizes only the Project described herein. If Permittee begins or completes a project different from the project the Agreement authorizes, Permittee may be subject to civil or criminal prosecution for failing to notify DFG in accordance with FGC section 1602.

CONCURRENCE

The undersigned accepts and agrees to comply with all provisions contained herein.

FOR DEPARTMENT OF TRANSPORTATION

Chris Harvey 2/22/12

Chris Harvey
Project Manager

Date

FOR DEPARTMENT OF FISH AND GAME

3/5/12

Curt Babcock
Habitat Conservation Program Manager

Date

Prepared by: Craig Martz
Staff Environmental Scientist

PLAC - UNITED STATES ARMY CORPS OF ENGINEERS (404 NWP)

IDENTIFICATION NO.: SPK-2011-00937

DEPARTMENT OF THE ARMY
U.S. ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO CA 95814-2922

REPLY TO
ATTENTION OF

November 28, 2011

Regulatory Division (SPK-2011-00937)

State of California
Department of Transportation
Mr. Chris Harvey
P.O. Box 496073
Redding, California 96049-6073

Dear Mr. Harvey:

We are responding to your September 7, 2011 request for a preliminary jurisdictional determination (JD), in accordance with our Regulatory Guidance Letter (RGL) 08-02, and a Department of the Army permit for the State Route (SR) 299 Twin Gulches Curve Improvement Project. We received your request on September 12, 2011. On September 23, 2011, we determined your Pre-construction Notification (PCN) was complete; however, during a subsequent review and comparison of the delineation and impact maps, we found a discrepancy. On October 24, 2011, we requested additional information in order to process your request. On November 17, 2011, as requested, we received additional information to complete your PCN. We reviewed the additional information and determined your PCN was complete on November 21, 2011.

This approximately 75-acre project involves activities, including the discharge of dredged or fill material into Water Gulch, Trail Gulch, and intermittent/ephemeral drainages, to construct a newly aligned SR 299 highway. The project is located on State Route 299 between PM 4.3 to 5.5, near Willow Creek, Section 31, Township 33 North, Range 7 West, Mount Diablo Meridian, Latitude 40.66849761109°, Longitude -122.697415334784°, Shasta County, California.

Based on the information you provided, the proposed activity, resulting in the permanent loss of approximately 0.21 acres and temporary impact to 0.014 acres of waters of the United States, is authorized by Nationwide Permit Number (NWP) 14. You are authorized to place approximately 0.227-acres of fill material below the OHWM of Water Gulch, Trail Gulch, and other intermittent/ephemeral drainages as indicated on the draft *Project Plans for Construction on State Highway in Shasta County about 17.3 Miles West of Redding from 4.3 to 5.5 Miles East of the Trinity County Line*, prepared by Caltrans, dated March 22, 2011 and enclosed in your Pre-construction Notification Package dated September 7, 2011.

However, until Section 401 Water Quality Certification for the activity has been issued or waived, our authorization is denied without prejudice. Once you have provided us evidence of water quality certification, the activity is authorized and the work may proceed subject to the conditions of certification and the NWP.

Furthermore, we concur with the amount and location of water bodies on the site as depicted on the *Wetlands and Other Waters Delineation Map*, enclosed in the *Twin Gulches Curve Improvement Project, Wetland and Other Waters Delineation Report*, prepared by Caltrans and dated February, 2011. The approximately 1.83 acres of perennial streams, and intermittent/ephemeral drainages present within the survey area are potential waters of the United States regulated under Section 404 of the Clean Water Act. A copy of our RGL 08-02 Preliminary Jurisdictional Determination Form for this site is enclosed. Please sign and return a copy of the completed form to this office.

We understand the State of California, Department of Transportation (Caltrans) is the National Environmental Policy Act (NEPA) lead Federal agency for this project, and as such, will ensure the authorized work complies with the National Environmental Policy Act, the Endangered Species Act, the National Historical Preservation Act and any other applicable federal laws.

Your work must comply with the general terms and conditions listed on the enclosed NWP information sheets and the following special conditions:

Special Conditions

1. This permit is contingent upon the permittee obtaining water quality certification under Section 401 of the Clean Water Act. Evidence of a water quality certification must be submitted to the Corps, prior to commencing work in waters of the United States. All terms and conditions of the Section 401 water quality certification are expressly incorporated as conditions of this permit.

2. To mitigate for the loss of 0.21 acre and temporary impacts to 0.014 acre of water of the United States, you shall purchase 0.34 credits of open water habitat at a Corps approved mitigation bank. The selected mitigation bank shall include the area of the permitted project within its service area. Evidence of this purchase shall be provided to this office prior to initiation of construction activities within waters of the U.S.

3. You shall remove temporary fill material placed in waters of the United States in their entirety and the affected areas returned to pre-construction elevations, contours and conditions within 30 days of completion of authorized work. A horizontal marker (e.g. fabric, certified weed free straw, etc.) shall be used to delineate the existing ground elevation of the waters temporarily filled during construction.

4. You shall notify this office of the start and completion dates for each phase of the authorized work within 30 calendar days prior to initiation of construction activities within waters of the U.S. and 30 calendar days following completion of construction activities. Along with this notification, you shall submit a copy of the project construction/work schedule or similar report.

5. Within 30 days prior to initiation of construction activities within waters of the United States, you shall submit to this office pre-construction photographs of the proposed permanent

and temporary discharge areas in waters of the U.S., landscape view photographs of major project features, which have been taken no more than 1 year prior to initiation of construction activities. Within 30 days following construction activities, you shall submit post-construction photographs of the same locations, showing the placement and/or removal of fill, landscape view photographs of all major project features. The camera positions and view angles of pre and post-construction photographs shall be identical and identified on a map, aerial photo, or project drawing. Construction locations shall include all major project features and waters of the United States.

6. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. Caltrans acting as the lead Federal agency for this project may consult as appropriate to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register, pursuant to 36 CFR Part 800, as amended August 5, 2004.

7. You are responsible for all work authorized herein and ensuring that all contractors and workers are made aware and adhere to the terms and conditions of this permit authorization. You shall ensure that a copy of the permit authorization and associated drawings are available for quick reference at the project site until all construction activities are completed.

8. You shall ensure project disposal, staging, and borrow (DSB) sites located inside and outside the project boundary are delineated for waters of the U.S. and approved by the Corps prior to commencing work authorized herein. You shall submit to this office a site plan, including site limits and access roads, a final grading plan, and a storm water management plan or water pollution control plan. Documentation shall demonstrate usage of the site complies with all local, state and federal environmental and permitted use regulations.

9. You shall clearly mark and identify the limits of project disturbance in the field with highly visible markers such as construction fencing or silt barriers prior to commencement of construction activities within waters of the United States. Such identification shall be properly maintained until construction is completed and the soils have been stabilized. Equipment, materials, or any other substances or activity that impact waters of the United States outside of the Corps permit area (as shown on the permit drawings) is prohibited.

10. Between construction seasons all equipment, materials and any other substances, with the exception of ESA fencing and silt barriers, shall be removed from waters of the U.S. and all disturbed areas shall be stabilized to prevent erosion and sedimentation.

11. Within 60 days following completion of the authorized work or at the expiration of the construction window of this permit, whichever occurs first, you shall submit as-built drawings and a description of the work conducted on the project site to this office for review. The drawings shall be signed and sealed by a registered professional engineer and include the following:

a. The Corps SPK permit identification number.

b. A plan view drawing of the location of the authorized work footprint (as shown on the permit drawings) with an overlay of the work as constructed in the same scale as the attached permit drawings. The drawing should show all earth disturbances, structures, and the boundaries of any avoidance areas.

c. Ground photographs of the completed work. The cameral positions and view-angles of the ground photographs shall be identified on a map, aerial photograph, or project drawing.

d. A description and list of all deviations between the work as authorized by this permit and the work as constructed. Clearly indicate on the as-built drawings the location of any deviations that have been listed.

12. You and your authorized contractor shall allow representatives from this office to inspect the authorized activity and all ESA/avoidance areas at any time deemed necessary to ensure that work is being or has been accomplished in accordance with the terms and conditions of this permit verification.

13. If any of the above conditions are violated or unauthorized activities occur, you shall stop work immediately and notify this office. You shall provide us with a detailed description of the unauthorized activity(s), photo documentation, and any measures taken to remedy the violation.

14. You shall notify this office of any proposed modifications to the project, including revisions to any of the work plans or documents cited in this authorization, for review and approval prior to construction work associated with the proposed modification(s).

15. Within 30 days after completion of the authorized work, you must sign the enclosed *Compliance Certification* form and return it to this office, along with the items required in Special Condition 4.

This verification is valid until March 18, 2012, when the existing Nationwide Permits are scheduled to be modified, reissued, or revoked. It is incumbent upon you to remain informed of changes to the NWPs. We will issue a public notice when the NWPs are reissued. Furthermore, if you commence or are under contract to commence this activity before the date that the relevant NWP is modified or revoked, you will have twelve (12) months from the date of the modification or revocation of the NWP to complete the activity under the present terms and conditions of this nationwide permit. Failure to comply with the General Conditions of this Nationwide Permit, or the project-specific Special Conditions of this authorization, may result in the suspension or revocation of your authorization.

We appreciate your feedback. At your earliest convenience, please tell us how we are doing by completing the customer survey on our website under *Customer Service Survey.*

Please refer to identification number SPK-2011-00937 in any correspondence concerning this project. If you have any questions, please contact Ms. Leah M. Fisher at our California South Branch at 650 Capitol Mall, Suite 5-200, Sacramento, California 95814-4708, email *Leah.M.Fisher@usace.army.mil*, or telephone 916-557-6639. For more information regarding our program, please visit our website at *www.spk.usace.army.mil/regulatory.html*.

Sincerely,

ORIGINAL SIGNED

Paul M. Maniccia
Chief, California South Branch

Enclosures:

Copies Furnished without enclosures:

Mr. Paul Jones, U.S. Environmental Protection Agency, Region IX, Wetlands Regulatory Office (WTR-8), 75 Hawthorne Street, San Francisco, California, 94105-3901

Mr. Scott Zaitz, Storm Water and Water Quality Certification Unit, Central Valley Regional Water Quality Control Board, 11020 Sun Center Drive #200, Rancho Cordova, California 95670-6114

Ms. Sharon Stacey, California Department of Transportation, North Region/District 2, 1031 Butte Street, MS 30, P.O. Box 496073, Redding, California 96049-6073

FOUNDATION REPORT AND ADDENDUM

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: **MR. GARY BLAKESLEY**
Chief
Office of Bridge Design North
Division of Engineering Services
Design Branch 5

Attn: Mr. Manode Kodsuntie

Date: April 27, 2011

File: 02-SHA-299-PM 4.3/5.5
0200000216
EA 02-2E5101
Twin Gulches Curve
Improvement Project
Water Gulch Culvert (R4.10)
Trail Gulch Culvert (R4.25)

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Foundation Report for Twin Gulches Curve Improvement Safety Project

Scope of Work

Per your request, we are providing a Foundation Report (FR) for the 2 proposed culverts on Trail Gulch and Water Gulch as part of the Twin Gulches Curve Improvement Safety Project on State Highway 299 from PM 4.3 to PM 5.5 in Shasta County, California. These culverts are identified by postmile as R4.10 (Water Gulch) and R4.25 (Trail Gulch). The culvert proposed for Water Gulch is a 6.0-foot diameter structural plate corrugated steel pipe with a length of 535.45 feet (ft). The existing Water Gulch arch culvert is significantly shorter and located about 600 ft further up the creek beneath a section of existing roadway that is to be abandoned as a result of this project. This abandonment will result in the removal of the existing culvert and the daylighting of the creek in that location. A 9.0 foot diameter structural plate corrugated steel pipe with a length of 448.0 ft is proposed for Trail Gulch. The proposed Trail Gulch Culvert (R4.25) will replace the existing culvert in approximately its same location, while providing considerable extensions on both ends to accommodate the much larger fill proposed for construction above it.

This report defines the geotechnical conditions as evaluated from field observations and field and laboratory test data. It provides recommendations and specifications for project design and construction.

For geotechnical information pertaining to other non-structural portions of this project, a separate Geotechnical Design Report (GDR) is published for this project that accompanies this FR.

Project Description

The Twin Gulches Curve Improvement Safety Project involves the straightening and widening of slightly over 1 mile of roadway. This is accomplished by a combination of large cuts and the

construction of a large curving embankment that will eliminate the two existing tight 20 mph curves located at the western end of the project that traverse Water Gulch and Trail Gulch. This large fill requires new culverts for the waters of Trail Gulch and Water Gulch, culverts which are the subject of this FR.

The proposed Water Gulch culvert (R4.10) will be buried beneath up to 124.6 ft of fill above its top. The proposed Trail Gulch culvert (R4.25) will be buried beneath up to 90.3 ft of fill above its top. The proposed Water and Trail Gulch culverts do not exactly follow the existing thalwegs.

The elevation of the inlet invert flow surface for the proposed Water Gulch culvert is 1817.4 ft above mean sea level, while the outlet invert surface is 1779.90 ft. The elevation of the inlet invert flow surface for the proposed Trail Gulch culvert is 1789.0 ft above mean sea level, while the outlet invert surface is 1766.0 ft, according to the same plans. Design plans also show that the proposed Water Gulch culvert has a design slope of -7.00%, while the proposed Trail Gulch culvert has a slope of -5.00%.

Inlet and outlet wingwalls for both culverts will be based on the Standard Plan Type 2 retaining wall. The maximum design height of the Trail Gulch wingwalls will be 10 feet with a toe pressure demand of 3.9 ksf. The maximum design height of the Water Gulch wingwalls will be 8 feet with a toe pressure demand of 3.2 ksf. The walls will be approximately 20 ft in length and flare out from the headwall down to around 4 ft at the wingwall ends.

Field Investigation and Testing Program

Seismic refraction was the primary subsurface investigation method utilized for this report. A seismic line running roughly east-west was shot parallel to, and within 30 feet north of, Water Gulch Creek. The center of the line was approximately located 150 ft west of the proposed outlet. Two additional seismic lines were shot roughly north-northwest to south-southeast, one north and one south of the existing Trail Gulch arch culvert. The south line was located about 20 feet west of and parallel to Trail Gulch, while the northern line ran parallel to the existing creek, crossing it several times due to its sinuous morphology in this location.

Data acquired from additional seismic lines shot between the two gulches and east of Trail Gulch as part of the investigation for the sizeable roadcuts involved with this project were also employed in making comparisons between rock quality and seismic velocities, since these additional lines were shot above existing roadcut exposures.

No deep borings were performed for the field investigation. The decision not to drill was based on a combination of factors, including the cost-to benefit analysis, and the time delay that would have resulted from the environmental permitting process. The primary factor in the decision not to drill was the fact that surface geologic mapping clearly indicated that the bedrock of the entire area was composed of slightly metamorphosed Bragdon formation and that seismic refraction results indicated very high quality rock.

Shallow excavations were performed by hand using a digging bar and shovel in both creek beds

to determine the general nature of the material lying atop bedrock.

Soil samples were collected in both creeks and tested for corrosion. Rock samples of Bragdon phyllite of varying quality (degree of fracturing and or foliation) were collected from the vicinity of the creeks and directly from nearby outcrops for point load tests and unconfined compression tests.

Laboratory Testing Program

Corrosion testing first involves pH and resistivity measurements, which are then followed by Chlorite and Sulfate measurements if the pH should fall below 5.5 and the resistivity measurements fall below 1000 ohm-cm. In all cases for this project no chlorite or sulfate testing was required.

Rock samples of Bragdon phyllite of varying quality (degree of fracturing and/or foliation) were collected from the vicinity of the creeks and directly from nearby outcrops for point load testing and unconfined compression testing.

Site Geology and Subsurface Conditions

The bedrock in the area of both creeks and the nearby hillsides is composed entirely of rocks of the Bragdon Formation that have been metamorphosed to a phyllite due to contact with the neighboring Shasta Bally Batholith during its emplacement. The rock quality varies throughout the project site in degree of fracturing, foliation, and strength, but beneath the locations of the proposed culverts the rock is considered to be of exceptionally high quality and strength based on measured seismic velocities between 12,000 to 16,000 feet per second. Together with observations of phyllite in surface outcrops and nearby roadcuts and the significantly lower seismic velocities obtained above these cuts, the very high velocities demonstrated by the rock beneath the creeks indicate that the phyllite beneath the creek beds is fairly massive and contains relatively few fractures. Fractures can be assumed to be closed, based on the high seismic velocities.

Surficial creek bed deposits composed primarily of boulders, cobbles, gravel, and sand exist atop the phyllite bedrock in the vicinity of the proposed pipe culverts. These deposits appear to vary between 3 and 11 ft in thickness above the bedrock and below the bottom of the proposed pipe culverts. Outside the existing creek thalwegs, the surficial deposits contain boulders, cobbles, gravel, and sand like the creek bed deposits, but differ from them by containing more silt and organics.

Bedrock lies at a depth of about 10 to 14 feet below the existing Trail Gulch creek bed surface and about 2 to 7 feet below the existing Water Gulch creek bed surface.

Though a small fault dipping about 55˚ to the east is present roughly half way between the two culverts, there is no evidence that shear zones or micro faults are present in the location of the culverts, nor does the existing fault align itself in any way that would be detrimental to the founding of either culvert.

Scour Evaluation

The existing arch culverts provide substantial empirical information regarding scour, having been in place for about 90 years. The inlet for the existing Water Gulch culvert has a concrete apron between the wing walls. This apron is flush with the top of the flow surface, and is situated above (higher in elevation) the bottom of the footings for the wing walls. This apron demonstrates little to no scouring. The inlet for the existing Trail Gulch culvert has no apparent concrete apron between the wing walls. Up to 1 foot of scour has occurred locally against the invert and one of the wing walls. As-builts for both of these inlets indicate that the inlet headwalls extend 3 feet below the invert flow surface.

Outlets for both existing culverts demonstrate evidence of minor scour having occurred, with small drops in the flow surface existing at the outlet lip of the culvert invert. As-builts indicate that the outlet headwalls extend about 4 ft (Trail Gulch Culvert) and 5 ft (Water Gulch Culvert) below the surface, so this minimal scour has had no impact whatsoever upon the culvert foundation.

Corrosion Evaluation

The existing box culverts demonstrate some abrasion damage, with up to 3.5 inches of concrete having been removed locally as determined by the degree of rebar exposure, which, according to as-builts, was placed 2 inches below the upper surface of the original concrete. The exposed rebar appears to be in fairly good condition, which indicates that corrosion has been minimal.

These observations are corroborated by lab results, which indicate that the environment upstream and in the vicinity of the proposed culverts is non-corrosive. Material from this environment has a resistivity ranging from 5006 ohm-cm to 18200 ohm-cm. The pH ranges from 6.4 to 7.6. Table 1 presents corrosion test results performed specifically for the proposed R4.10 and R4.25 culverts, as well as tests performed for the existing and neighboring culverts.

Table 1. Corrosion Test Results

SAMPLE #	LOCATION	pH	RESISTIVITY (Ohm-Cm)
Samples Collected Specifically for the Twin Gulches Project			
C710498	Downstream of existing Trail Gulch culvert, pm 4.6	7.24	18200
C710499	Downstream of existing Trail Gulch culvert, pm 4.6	6.7	14188
D74141	Center of proposed Water Gulch Culvert (station 190+00)	7.6	11000
Samples Collected Previously by Materials Lab for Other Projects			
MatLab1	Trail Gulch CulvertPM4.4	7.2	5927
MatLab3	Culvert East of Trail Gulch(PM4.99)	6.4	7988

Seismic Recommendations

AASHTO LRFD code 12.6.1 states that earthquake loads should be considered only where buried structures cross active faults. As stated in the earlier section on site geology and subsurface conditions there is no evidence that either proposed culvert crosses a fault structure, active or inactive. Therefore seismic design ('extreme event' as per AASHTO LRFD) is not required of the Office of Structures Design for these culverts. Consequently, no seismic recommendations shall be provided herein.

Foundation Recommendations

The ultimate bearing capacity of the bedrock beneath both culverts is estimated at 2080 psi (300 ksf) by an empirical correlation to the uniaxial compressive strength obtained from testing and Hoek-Brown Strength criterion to account for fractures and foliation. The allowable bearing capacity, based on a resistance factor of 0.45 at the strength limit state is 936 psi (134 ksf). This value exceeds the bearing capacity requirements specified by Structures Design of 34.4 ksf.

The allowable bearing capacity of the cohesionless soil overlying the bedrock is 40 ksf directly below the culvert proposed for Water Gulch where the proposed fill height will attain a maximum height of 124.6 ft above the top of the culvert. This meets the bearing capacity requirements specified by Structures Design of 34.4 ksf for the proposed Water Gulch culvert. The allowable bearing capacity of the cohesionless soil overlying the bedrock is 28 ksf directly below the culvert proposed for Trail Gulch where the proposed fill height will attain a maximum height of 90 ft above the top of the culvert. This value exceeds the bearing pressure requirements specified by the Office of Structures Design of 24.6 ksf for the proposed Trail Gulch culvert. The confining pressure provided by the fill overburden is integral to achieving these capacities.

Because of the compressible nature of both the surficial deposits and creek bed deposits, our office recommends excavating 4 ft of material beneath both of the proposed culvert pipes and replacing it with structural backfill compacted at 95% relative compaction. The excavation and backfill limits, shown in Appendix 1, are 27 ft wide for the 9-foot Trail Gulch SPCSP and 18 ft for the 6-foot Water Gulch SPCSP. Due to variation in the depth of the bedrock surface, excavation beneath the Water Gulch SPCSP may encounter bedrock shallower than 4 ft in a few locations. If the rise in bedrock is sharp or abrupt it shall be removed and/or made more gradual. If the rise in bedrock is gradual, no bedrock treatment shall be necessary and a lesser thickness of structural backfill than the above-prescribed 4-foot thickness may be applied there. The same approach to bedrock variation should be applied to the area beneath the proposed Trail Gulch SPCSP, although it is considered very unlikely that such a situation will arise, as seismic refraction results indicate that the bedrock is generally deeper beneath the proposed Trail gulch SPCSP than beneath the Water Gulch SPCSP. Both the Trail Gulch and Water Gulch culverts shall be placed in 4 inches of bedding material as indicated on the schematic in Appendix 1. This bedding material shall be relatively loose structural backfill material (compaction between 80 to 85%) that contains no gravel larger than 2 inches. A minimum of 2 ft of structural backfill shall be placed atop the SPCSP before placement and compaction of embankment material.

Inlet and outlet headwalls and wing wall footings should be founded 4 ft below the elevation of the culvert invert. This locates the bottom of the Trail Gulch inlet wingwall and headwall footings at an elevation of 1785.0 ft above mean sea level and the outlet wingwall and headwall footings at an elevation of 1762.0 ft above mean sea level. The Water Gulch inlet wingwall and headwall footings should be located at an elevation of 1813.4 ft above mean sea level, while the outlet wingwall and headwall footings should be located at an elevation of 1775.9 ft above mean sea level. These footings should all be placed atop 2 ft of structural backfill. If bedrock should be encountered during excavation before a full 2 ft of structural backfill can be placed, a lesser thickness of backfill may be applied. If, in the very unlikely case that bedrock is encountered before the above-prescribed 4-foot footing depth is achieved, the footings should be keyed 4 inches directly into the bedrock.

Structural backfill shall meet standard specifications (section 19-3.06). Well-graded sand and angular gravel is preferred. As stated in the standard specifications, the outer 2-foot areas adjacent to SPCSP inlets and outlets, the areas beneath wingwalls and aprons, and the areas in front, beneath, and behind headwalls shall be backfilled with impervious structural backfill.

The estimated settlement beneath the Water Gulch SPCSP is 1.2 inches beneath the center of the fill (where the fill is 126 ft thick above the top of the proposed pipe) and 0.3 inches beneath the ends of the culvert pipe. The estimated settlement beneath the Trail Gulch culvert is 1.1 inches beneath the center of the fill (where the fill is 90 ft thick above the top of the proposed pipe) and 0.3 inches beneath the ends of the culvert. This settlement will occur during the course of embankment construction. This settlement was calculated based on elastic theory for the bedrock and the Hough Method for the overlying creek bed deposits. These values are considered average estimates primarily due to the variation in thickness of the overlying creek bed deposits and the imprecision in presumptively assigning material properties for these deposits. The settlement of both the Water Gulch and Trail Gulch inlet and outlet headwalls is estimated to be 0.3 inches, all of which should occur during construction. The settlement of both the Water Gulch and Trail Gulch wingwalls is also estimated to be 0.3 inches, all of which should occur during construction.

Fill Earthwork

The material to be used for fill construction will be obtained from cuts within the project and will consist primarily of phyllite rock metamorphosed from the Bragdon Formation. Though similar in rock type with the bedrock below the culvert foundation, the large majority of the rock cut in this project that will be used for fill construction is of lesser quality, with more fractures and some weathering. Approximately 10 to 15% of this fill material will consist of soil derived from the phyllite.

Construction Considerations

Mechanized rollers should not be used close to the SPCSP. Hand-held power equipment should be used within 3 ft of the structure.

Attention should be given to assure that proper structural backfill compaction is performed at the

haunches (the area beneath the sides of the pipe). Hand tampers should be used to assure material is well placed and compacted.

Structural backfill should be placed and compacted on both sides of the pipe so that the backfill pressures are uniform and balanced. To ensure that backfill is compacted consistently and thoroughly bordering the SPCSP, compacting equipment, including hand-held operations, should be run parallel to the pipe length until the backfill has reached at least 0.75 the height of the pipe. Backfilling should be performed in a manner that is symmetric with respect to the pipe to minimize the potential for distorting the pipe shape. Structural backfill might be placed atop the pipe as lifts are built up on the sides of the pipe to prevent the upward peaking of the pipe and to maintain the pipe shape. Thorough monitoring of pipe shape is essential during the period of placement and compaction of structural backfill.

Should openings be observed in the pipe where the plates are joined that might allow some stripping of fine granular material from the structural backfill material into the pipe through such openings, then RSP fabric should be placed over the openings prior to backfill placement.

Should geotechnical problems be encountered during construction, the Office of Geotechnical Design North (OGDN) should be contacted.

If you have any questions or comments, please call me at (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., R.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North

ec: Al Trujillo
Chris Harvey (Project Manager)
Douglas Brittsan
Roy Bibbens-OGDN File
Mark Willian (Geotech Corporate)
R.E. Pending File (Mike Feakes- Project Engineer)
District 2 O.E. (Deena Matagulay)
Byron Berger, D02 Materials Lab

Attachments

Appendix 1. Excavation and Backfill Schematic

LEGEND

Excavated Material

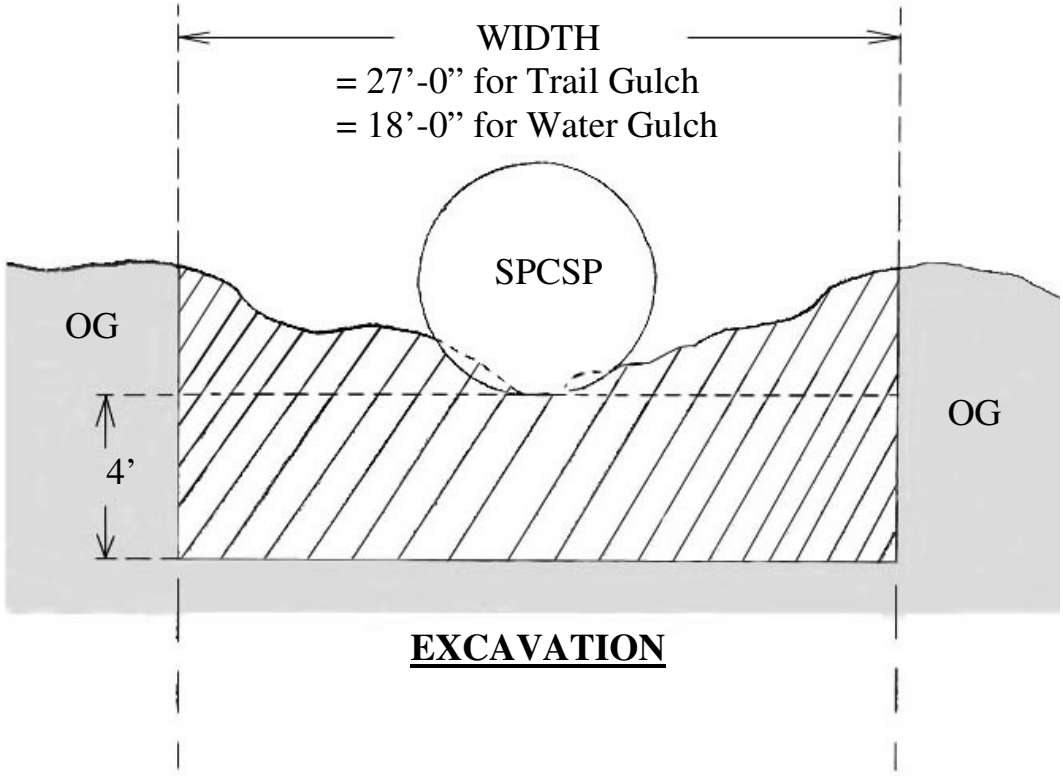
Embankment Fill

Structural Backfill @ 95% Compaction

OG

Original Ground

SPCSP Bedding Material 4" Thick



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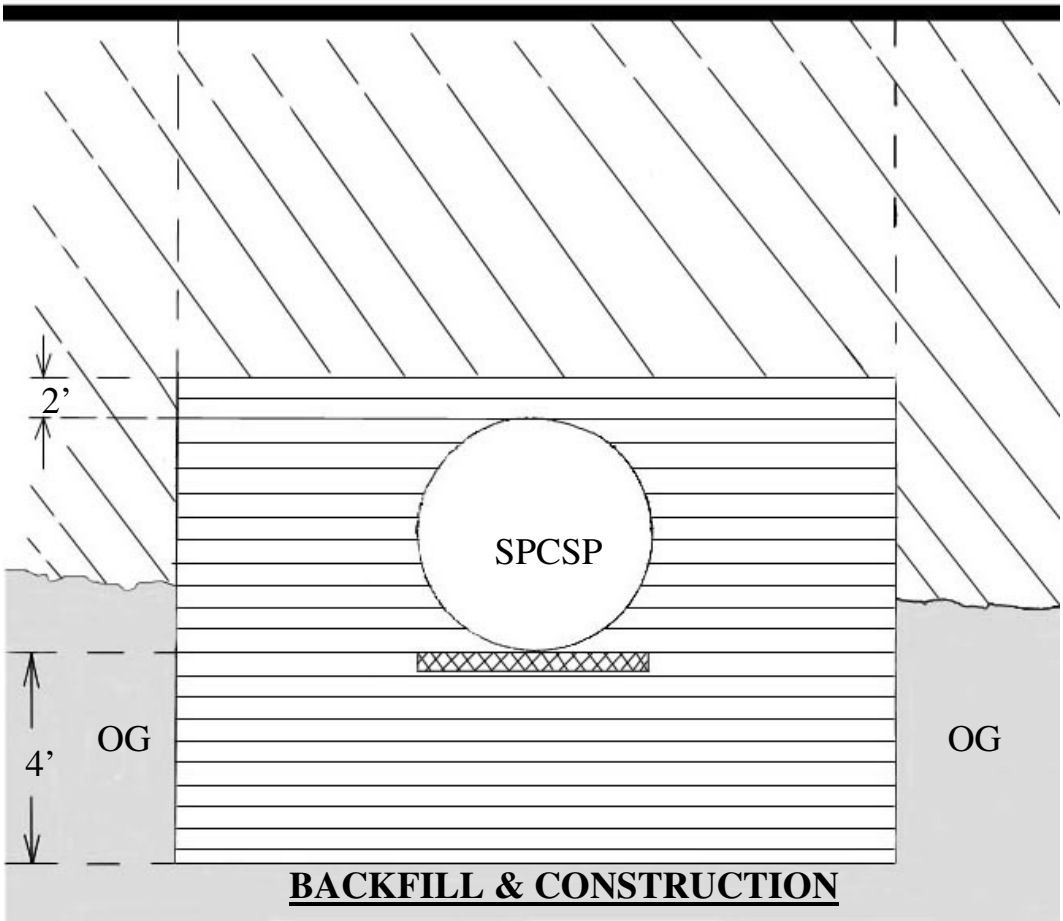


BACKFILL & CONSTRUCTION

CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design-North

EA: 02-2E5101

Date: April 2011

EXCAVATION & BACKFILL SCHEMATIC

02-SHA-299; PM 4.3/5.5
GEOTECHNICAL FOUNDATION REPORT

Appendix 1

State of California
Department of Transportation

Business, Transportation and Housing Agency

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: **MR. GARY BLAKESLEY**
Chief Design Branch 5
Office of Bridge Design North
Division of Engineering Services

Attn: Mr. Manode Kodsuntie

Date: June 28, 2011

File: 02-SHA-299-PM 4.3/5.5
0200000216
02-2E5101
Twin Gulches Curve
Improvement Project
Water Gulch Culvert (R4.10)
Trail Gulch Culvert (R4.25)

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Addendum to Foundation Report for Twin Gulches Curve Improvement Safety Project

This addendum to the initial (April 27, 2011) Twin Gulches Foundation Report (FR) provides modified foundation recommendations for the 2 proposed culverts on Trail Gulch and Water Gulch as part of the Twin Gulches Curve Improvement Safety Project on State Highway 299 from PM 4.3 to PM 5.5 in Shasta County, California. These culverts are identified by postmile as R4.10 (Water Gulch) and R4.25 (Trail Gulch). As stated in the initial FR, the culvert proposed for Water Gulch is a 6.0-foot diameter structural plate corrugated steel pipe (SPCSP), while a 9.0 foot diameter SPCSP is proposed for Trail Gulch. Since the initial FR was published, the Office of Design has extended the length of both culverts to allow for a wider fill that might someday accommodate a truck passing lane, but this extension has not created a need for any significant change in foundation recommendations, except for a slight adjustment to the elevations in the vicinity of the inlets.

The changes in recommendations that warranted this addendum relate to the breadth and depth of the excavation and structural backfill beneath and surrounding the proposed SPCSP. Recommendations provided in the initial FR were considered too costly for the project by the Project Development Team (PDT). The PDT requested OGDN to modify the initial recommendations regarding the depth and breadth of excavation and structural backfill.

Recommendations provided in the initial FR regarding the breadth of structural backfill relative to the pipe diameter (three times the pipe diameter) were based on recommendations given in the Handbook of Steel Drainage and Highway Construction, which is published by the Corrugated Steel Pipe Institute. The amended recommendations provided herein call for structural backfill to extend 2 ft to the sides of the pipe as shown in the drawing in Appendix 1.

The initial recommendations also called for 4 ft of structural backfill beneath the bottom of the pipe. This 4-foot section was intended to remove any potential risks created by differential

settlement in the founding soil caused by undulations and variations in the topography of the bedrock below the soil. Based on conversations with some SPCSP manufacturers and guidelines in the Handbook of Steel Drainage and Highway Construction, OGDN believes that settlement that creates up to a 0.5% deflection per unit length is considered acceptable. Based on this, our Office has reduced the 4-foot section of structural backfill to a 2-foot thick section. This is depicted in the drawing in Appendix 1.

Inlet and outlet headwalls and wing wall footings should still be founded 4 ft below the elevation of the culvert invert as discussed in the original FR.

We recommend that our Office be contacted to visit the construction site when the foundation excavation has been completed, and before backfill has been placed, to allow an assessment of the founding conditions and to identify any unforeseen deleterious conditions.

If you have any questions or comments, please call me at (530) 225-3516.

J. SCOTT LEWIS, P.G., C.E.G., R.G.P.
Associate Engineering Geologist
Office of Geotechnical Design - North

ec: Al Trujillo
Chris Harvey (Project Manager)
Douglas Brittsan
Roy Bibbens-OGDN File
Mark Willian (Geotech Corporate)
R.E. Pending File (Mike Feakes- Project Engineer)
District 2 O.E. (Deena Matagulay)

Attachments

Appendix 1. Modified Excavation and Backfill Schematic

LEGEND

Excavated Material

Embankment Fill

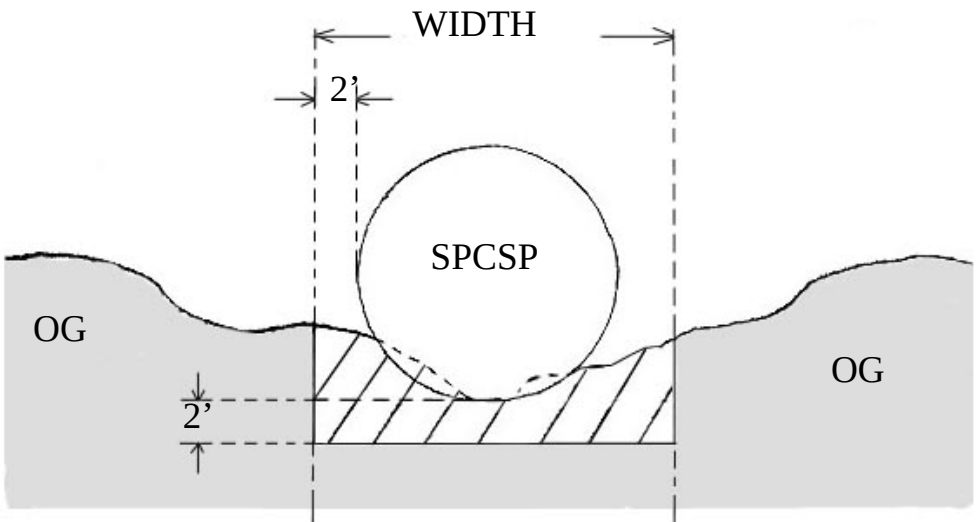
Structural Backfill @ 95% Compaction

OG

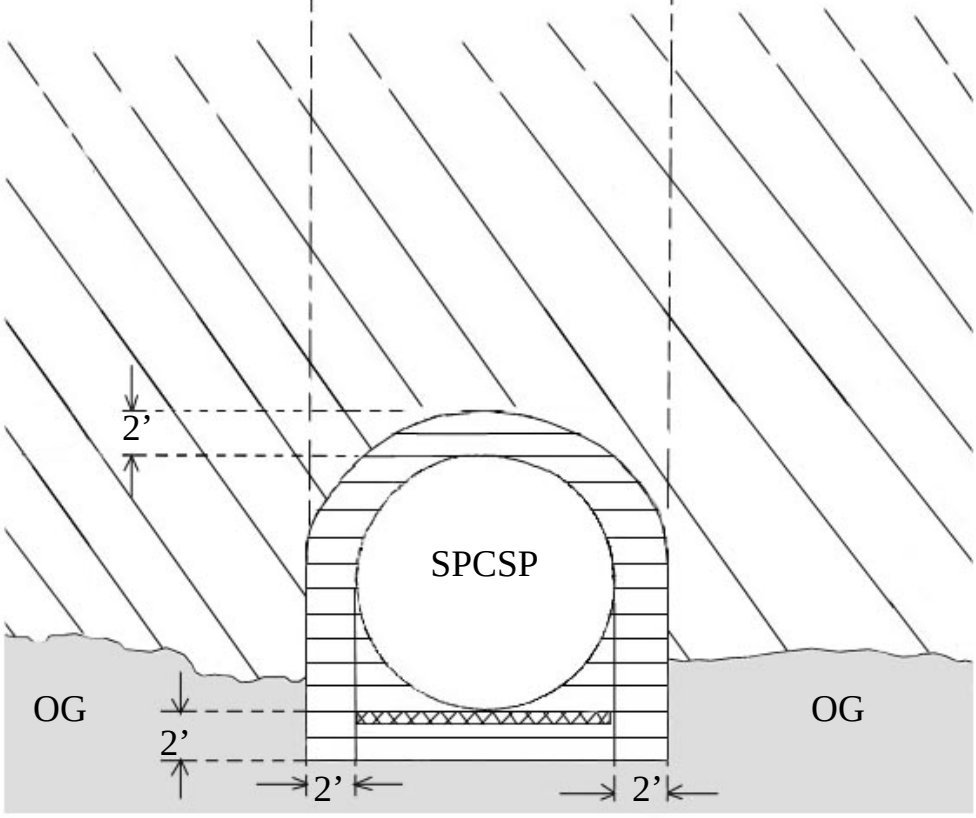
Original Ground

SPCSP Bedding Material 4” Thick

WIDTH
13’-0” for Trail Gulch
10’-0” for Water Gulch



EXCAVATION



BACKFILL & CONSTRUCTION

CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design-North

EA: 02-2E5101

Date: June 2011

EXCAVATION & BACKFILL SCHEMATIC

02-SHA-299; PM 4.3/5.5
ADDENDUM to GEOTECHNICAL FOUNDATION REPORT

Appendix 1

GEOTECHNICAL DESIGN REPORT

GEOTECHNICAL DESIGN REPORT

Twin Gulches Roadway Realignment Safety Project

State Highway 299

PREPARED FOR DISTRICT 02
SAFETY DESIGN TEAM
DESIGN R-6

By:

J. Scott Lewis
Certified Engineering Geologist-2257
Registered Geophysicist-1032

DIVISION of ENGINEERING SERVICES-GEOTECHNICAL SERVICES
OFFICE of GEOTECHNICAL DESIGN-NORTH
October 13, 2011

State of California
Department of Transportation

Business, Transportation and Housing Agency

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: **MR. AL TRUJILLO**
District 2 Safety Team Senior Engineer

Attn: Mr. Mike Feakes
Transportation Engineer

Date: October 13, 2011

File: 02-SHA-299-PM 4.3/5.5
0200000216
EA 02-2E5101
Twin Gulches Curve
Improvement Safety
Project

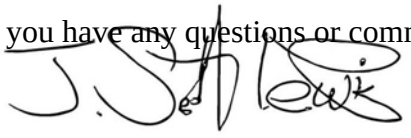
From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Geotechnical Design Report for Twin Gulches Curve Improvement Safety Project

Per your request, we are providing a Geotechnical Design Report for the Twin Gulches Curve Improvement Safety Project on State Highway 299 from PM 4.3 to PM 5.5 in Shasta County, California. This report defines the geotechnical conditions as evaluated from field and laboratory test data and used in the development of the geotechnical design. It provides recommendations and specifications for project design and construction.

Specific geotechnical aspects of this project that are addressed in this report include cut slopes, fill embankments, and rockfall mitigation. This project involves two structures which are addressed in a separate Foundation Report (FR) (April 27, 2011) and FR Addendum (June 28, 2011).

If you have any questions or comments, please call me at (530) 225-3516.



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Deena Matagulay (District 2 O.E.)

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1. Introduction

This Geotechnical Design Report (GDR) is for the Twin Gulches Curve Improvement Safety Project on State Highway 299 from PM 4.3 to PM 5.5 in Shasta County, California.

Specific geotechnical aspects of this project that are addressed in this report include cut slopes, fill embankments, and rockfall mitigation. For geotechnical information pertaining to the structural portions of this project please refer to a separate Foundation Report (FR) published (April 27, 2011) for this project.

Plate 1 presents a vicinity map showing the location of the project. Plate 2 presents an aerial view of the project site showing the locations of the proposed cut slopes, fills, and structural plate steel corrugated pipe (SPCSP) culverts.

2. Proposed Improvements and Existing Facilities

At the time of our investigation Highway 299 in the project area consisted of a 2-lane roadway with a single large pullout and 3 small pullouts, little to no shoulders, no passing lane, and two very tight 20 mile-per-hour (MPH) turns. Existing cut slope ratios vary from 0.35:1 to 1:1 (H:V), with the large majority varying between 0.45:1 and 0.75:1. Existing cut slopes have a maximum height of about 55 feet (ft), with most typically varying between 15 and 35 ft. Fill slopes on the existing embankments stand at approximately 1.35:1 and have a maximum height of about 40 ft.

The proposed improvements involve the straightening and widening of slightly over 1 mile of roadway. The proposed improvements significantly alter the route of the roadway location in the western portion of the project by replacing the two separate 20 MPH turns with two connected turns of larger radii that have a larger minimum design speed of 35 MPH. The 20 MPH turns will be abandoned and bypassed with the construction of two proposed fills- an entirely new fill over Water Gulch (maximum fill height of about 126 ft) and an enlarged and slightly shifted fill over and atop the existing fill above Trail Gulch (maximum fill height of 92 ft). Single structural plate corrugated steel pipe culverts are proposed to carry water flow through the base of these fills (Foundation Report, April 27, 2011; Foundation Report Addendum, June 28, 2011). The middle and eastern portions of the project involve a relocation of the roadway to the north, into the nearby slope, at a higher elevation that is gradually brought down to create a reasonable grade before conforming with the existing roadway at the eastern terminus of the project. This northerly relocation of the roadway involves substantial cut slopes in slightly metamorphosed sedimentary rock with heights up to 150 ft, slope ratios of 1:1, 0.75:1, and 0.5:1, and no benches. A smaller fill is also proposed to fill in a portion of the existing pullout between stations 210+00 and 213+50. These proposed fills and cuts are also intended to create space for wider shoulders (paved and unpaved), which generally increases rockfall catchment, and a passing lane.

3. Pertinent Reports and Investigations

This report includes a review of Caltrans, state, federal, and private publications. As-Builts and Plans for the existing culverts in Trail and Water Gulches were reviewed for information pertinent to this report.

Caltrans work and research done since the 1960's in an effort to improve the entire Buckhorn Grade was perused. This includes previous work done by Prysock (1968, 1979), SHN (2002), and James (1990-1996), and a collection of unpublished files in the District 2 Materials Lab. Such work has generally fallen under the umbrella of similar names such as the Buckhorn Grade Realignment Project, the Buckhorn Grade Improvement Project (02-270310), and others.

Geologic literature reviewed include the *Geologic Map of California, Redding Sheet* (Strand, 1962), the *Fault Activity Map of California and Adjacent Areas* (Jennings, 1994), *Geology of the French Gulch Quadrangle Shasta and Trinity Counties California* (Albers, 1964), *Geology of Northern California* (Bailey, 1966), *Tectonic Accretion of the Klamath Mountains* (Irwin, 1981), and the French Gulch Quadrangle, California, 15-Minute Series (Topographic) (United States Geologic Survey, 1944).

Soil information was obtained from the Natural Resources Conservation Service (NRCS) Web Soil Survey Website (http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx) and the Soil Survey of Shasta County Area, California (1974).

4. Physical Setting

The physical setting of the project and the surrounding area was reviewed to provide information that might aid the Offices of Design, Environmental, and Construction on climate, topography, drainage, and man-made and natural features. The project is located on the eastern side of Buckhorn Summit on State Highway 299 at an elevation ranging from about 1695 feet (ft) to 2035 ft (top of upper cut) above mean sea level.

The following is a discussion of the above review:

4.1. Climate

Climate information was obtained from the Western Regional Climate Data Center (http://www.wrcc.dri.edu/) weather station located at Whiskeytown Reservoir for the period of record from 1960 to 2009. The Whiskeytown Reservoir Station is located about 7 miles east of the project area at about 1295 feet above sea level, which is about 600 feet lower than the average elevation of the project area. The average annual precipitation at the Whiskeytown Reservoir Weather Station is about 62 inches, with over 95% in the form of rain (as opposed to minor snow). The majority of this precipitation falls between October and March. The average annual maximum and minimum air temperatures at the Whiskeytown Reservoir Weather Station are 73.0 °F and 48.7 °F, respectively. The average monthly extremes are 36.1°F in January and 95.8°F in July.

4.2. Topography and Drainage

The existing and future proposed roadway traverses a south-facing slope north of Willow Creek through most of its steady 300-plus foot climb from the eastern to western ends of the project. In the western end of the project, where the two existing tight 20 mph turns traverse Trail Gulch and Water Gulch, the existing roadway remains on the north side of Willow Creek, but travels sinuously as it negotiates the gulches and traverses slopes facing multiple directions. The proposed roadway will also remain north of Willow Creek in the western end of the project, but will traverse in a smoothly arcuate non-sinuous pattern atop the two proposed fills. Both above and below the road the slopes are moderately steep throughout the entire length of the project.

The primary drainage in the project area is Willow Creek, which flows from its origin a short distance to the west-southwest into Whiskeytown Lake a few miles to the east. The south-facing slope traversed by the roadway is punctuated by periodic ephemeral drainages that end in Willow Creek south of the roadway. At the western end of the project Trail Gulch, a perennial creek, flows from the north-northwest beneath the road and into Willow Creek. Water Gulch, also a perennial creek, flows from the west under the roadway and into Willow Creek.

4.3. Man-made and Natural Features of Engineering and Construction Significance

Man-made features that may potentially have an impact on the project, or be impacted by the project, include drainage inlets and culverts, access to a private road on the west side of Trail Gulch dirt road at about station 196+50, access to the mine road about 400 ft to the south-southeast that crosses Willow Creek, and access to a dirt road up Water Gulch that will be regarded and connected to the highway when the existing Water Gulch loop is abandoned.

The water quality of Whiskeytown Lake, the centerpiece for the National Park Service's Whiskeytown National Recreation Area, may be adversely affected if sediment laden runoff is allowed to escape the construction area and flow down into Willow Creek.

4.4. Regional Geology and Seismicity

The project lies within the Eastern Klamath Belt in the southeastern portion of the Klamath Mountains Geologic Province (Irwin, 1966). Within the project region the Eastern Klamath Belt is composed of the Ordovician (about 440 to 500 million years ago) Trinity Ultramafic Sheet beneath Devonian (about 345 to 400 million years ago) to Middle Jurassic (about 165 to 190 million years ago) metavolcanic, sedimentary and metasedimentary rocks, which collectively dip together to the east as a result of tectonic accretion (Irwin, 1981). The late Jurassic (about 135 million years ago) Shasta Bally Batholith, the largest granitic pluton (a large rising body of magma that cools and crystallizes below the surface) in the Eastern Klamath Belt, is found along the western edge of the eastern Klamath Belt and less than a mile west of the project. It is composed primarily of quartz diorite to

granodiorite. Structural and mineralogical evidence indicate that the pluton was forcibly intruded into the older metavolcanic, sedimentary, and metasedimentary rocks of the Eastern Klamath Belt, including the metasedimentary rocks in the project area. The Devonian Copley Greenstone, which unconformably overlies the Trinity Ultramafic sheet, is composed of keratophyre, spilite, and meta-andesite with a few localized lenses of tuff and shale. The Balaklala Rhyolite intertongues with, and unconformably overlies, the Copley Greenstone, and is composed of porphyritic and non-porphyritic quartz keratophyre with some minor tuff, tuffaceous shale, and breccia. The Balaklala is unconformably overlain by the Bragdon Formation, which is composed of conglomerate and sandstone interbedded with siltstone and shale, as well as subordinate tuff and mudstone. Some elongate portions of the Bragdon Formation parallel to, and in close proximity to, the northeastern edge of the Shasta Bally Batholith have been metamorphosed into phyllite, while other pieces of the Bragdon, together with some portions of the Copley and Balaklala Formations, have been metamorphosed into gneiss and amphibolite, in response to the intrusion of the batholith.

Faults are present in the rocks north and east of the Shasta Bally Batholith (Albers, 1964), an area that includes the project area. These consist of the irregular low-angle faults of the Spring Creek Thrust system and high-angle normal faults, which includes the Hoadley fault that lies about 0.7 miles west of the project. These faults are not considered active.

The nearest active faults are the Keswick Fault (east-northeast of the project area), the Battle Creek Fault (southeast of project area), and the Bartlett Springs Fault system (southwest of project area). The Keswick Fault, a fairly recent discovery (USBR, 2004), is located at depth on the subducting oceanic plate that dips into the earth beneath the project area and the area to the east of the project.

The project area is located in an area less seismically active than many other parts of California. Still, active faults to the west are capable of producing earthquakes with maximum moment magnitudes (MMax) up to 7.9 (Merriam, 2009).

4.5 Soil Survey Mapping

Four series of soils, as classified by the USDA Soil Conservation Service (SCS; Klaseen & Ellison, 1974), comprising four different soil types are mapped in the Project area: (CsF) Colluvial Land composed of 25 to 90 percent gravel and stones, (MbG2) Maymen Very Stony Loam with 30 to 80 percent slopes (3.3:1 to 1.25:1), (MeG) Millsholm Gravelly Loam with 50 to 70 percent slopes (2:1 to 1.43:1), and (NdG) Neuns Very Stony Loam with 50 to 80 percent slopes (2:1 to 1.25:1). The portion of the SCS soil map that covers the project area is shown in Plate 3.

MeG soils cover the majority of the material proposed for excavation in the project area, extending from the east side of Trail Gulch to beyond the eastern terminus of the project. Permeability is considered moderate, runoff rapid, and the erosion hazard high in these soils. The SCS labels these soils as being good for road fill, with medium strength, and having low to medium compressibility, low to medium susceptibility to piping, low

permeability after compaction, and good to fair compaction characteristics. The SCS classifies these soils according to the Unified Soil Classification system as being composed of clayey sand (SC) over shallow bedrock. Liquid limits range from 25 to 35, and plasticity indexes range from 10 to 20. These soils are considered low in shrink-swell potential and corrosivity to steel.

CsF soils cover the second greatest area of material proposed for excavation in the project area, extending from the west side of Trail Gulch through the western cuts to the beginning of the proposed Water Gulch Fill. The SCS provides no engineering properties for these heterogeneous soil deposits, as they are considered too variable.

MbG2 soils cover a small amount of the material proposed for excavation in the project area, located in the top of a short stretch of cuts near the eastern terminus of the project. The SCS labels these soils as being good for road fill, with medium strength, and having low to medium compressibility, medium susceptibility to piping, medium to low permeability after compaction, and good to fair compaction characteristics. The SCS classifies these soils according to the Unified Soil Classification system as being composed of silty sand (SM) or clayey sand (SC) over shallow bedrock. Liquid limits range from 20 to 30, and plasticity indexes range from 5 to 15. These soils are considered low in shrink-swell potential and corrosivity to steel.

The two fills proposed for the project are to be founded on material mapped as MeG and NdG. The SCS labels the NdG soils as being good (in this area) for road fill, with medium strength, and having medium compressibility, low to medium susceptibility to piping, low permeability after compaction, and good to fair compaction characteristics. The SCS classifies these soils according to the Unified Soil Classification system as being composed of clayey sand (SC) over shallow bedrock. Liquid limits range from 20 to 35, and plasticity indexes range from 10 to 20. These soils are considered low in shrink-swell potential and low to medium in corrosivity to steel.

4.6 Naturally Occurring Asbestos (NOA)

Geologic units or formations mapped (Albers, 1964) in the project area are the Bragdon Formation, the Balaklala Rhyolite, and the Copley Greenstone, none of which are typically known to harbor naturally occurring asbestos (NOA) deposits. According to the map contained within the report referenced by the State of California Air Resources Board (California Dept of Conservation, 2000), the project site is not mapped as an area likely to contain NOA. No native serpentine exists within the project area. No non-native serpentine (dumped or imported as fill material) was observed at the site.

5. Exploration

5.1 Drilling and Sampling

Based on resource constraints the Project Development Team (PDT) made the decision to utilize only existing borings for this project. Integral to this decision was the assessment by

the Office of Geotechnical Design North (OGDN) that even though this decision entailed a risk, it was considered to be a fairly low one due to the considerable exposures present on existing cut slopes and the capability to extrapolate the geotechnical information present in these exposures deeper into the slopes by the employment of multiple seismic refraction lines (see section 5.3 below on geophysical studies).

Three borings completed by SHN consultants (2002) within the project limits as part of the subsurface investigation for the broader Buckhorn Grade Improvement Project, a project that has been intermittently ongoing for several decades, provided some useful subsurface information, though these borings were not drilled in the most suitable locations for this particular project. Earlier Caltrans work by Prysock (1968, 1979) involved drilling and sampling in some material near the project boundaries that is similar to that within the project area.

Soils and rocks were sampled during field surveys performed specifically for this project (both the roadway and the foundation (culverts) portions) using a small shovel and pick ax, and evaluated with field methods. Some of these samples were also evaluated in the laboratory (see section 6 on geotechnical testing below).

5.2. Geologic Mapping

A portion of a geologic map produced by Albers (1974) that includes the project area and neighboring terrain is shown in Plate 4.

Analysis of aerial photos of the project area and nearby surroundings was performed prior to, during, and after field work.

Geologic reconnaissance was conducted along the road, and on the slopes above and below the highway within the project area, as well as some geologically representative locations west and east of the project area. Data was collected regarding rock type, quality, structure, and weathering. Following the procurement of results from the geophysical investigation (discussed below), follow-up geological mapping was performed to provide geological verification to the seismic results and to determine slope ratio recommendations on a station-by-station basis.

5.3. Geophysical Studies

Nine seismic refraction lines were shot for the Twin Gulches Project, three specifically for the culvert foundation investigations in Twin and Water Gulches, and six specifically for the investigation of the cut slopes. Because the bedrock is generally of the same type (but varying quality) throughout most of the project, seismic information obtained for the culverts foundation report (FR) was also of some use for the roadcut designs, and vice-versa. Existing roadcuts exposed rock conditions that were used to assist in evaluating refraction results obtained from the lines shot above these existing roadcuts. The locations of all 9 lines are shown on Plate 5. Cross-sectional depth sections for these lines are shown in Appendix B.

6. Geotechnical Testing

A few soil samples were collected and tested in the lab specifically for this project by OGDN. These tests include gradation analyses, Atterberg limits determinations, corrosion tests (pH, resistivity), φ angle (shear box testing), and cohesion (C) (shear box testing). These results are included in Table 1.

Table 1. Compilation of Laboratory Test Results.

Compilation of Laboratory Test Results				
LOCATION	Test	PI	Date	Result
Station 196+00	Direct Shear	OGDN	2011	φ = 38.1˚; C= 536 psf
Station 196+00	PI & Gradation	OGDN	2011	PI = 9; 100% pass @ 19.0 mm; 96% pass @ 4.75 mm; 62% pass @ 0.075mm; Sandy Silt (ML)
Trail Gulch	PH & Resistivity	OGDN	2011	R=4436 ohms; pH = 6.19
B02-7@5' PM 4.4	Gradation, PI, and Triaxial UU	SHN	2002	Sandy Silt (ML); PI =4; ϕ = 34˚ & C= 537 psf
B02-7@10' PM 4.4	Gradation, PI, and Triaxial UU	SHN	2002	Sandy Silt (ML); PI =6; ϕ = 15˚ & C=1124 psf
B02-8@10'; PM 4.85	Gradation, PI	SHN	2002	Sandy Silt (ML); PI =3
B02-8@15'; PM 4.85	Gradation, PI, and Triaxial UU	SHN	2002	Sandy Silt (ML); PI =5; ϕ = 19˚ & C=786 psf
B02-8@20'; PM 4.85	Gradation, PI, and Triaxial UU	SHN	2002	Silty Sand (SM); PI =0; ϕ = 32˚ & C=1602 psf
BS-1; west of Trail Gulch	Gradation, PI, and Large Diameter Triaxial	Prysock	1979	Silty Clay(ML-CL); PI =11; ϕ = 15˚, 16˚, 20˚, & 22˚; C= 7000, 4000, 6500, & 8000 psf

No geotechnical testing was performed on the rocks specifically for this GDR, though some rock strength testing was performed on rocks within the project area for the FR produced for the culverts beneath the project's two major fills, testing which did provide geological information for the GDR because of a similarity in rock types.

A few soil samples collected previously as part of the larger Buckhorn Grade project had been analyzed for gradation, Atterberg Limits, corrosivity (resistance, pH, and chlorite/sulfate values), φ angle, and cohesion (C) by SHN (2002). Their test results are given in Appendix C and summarily included in Table 1. Results from laboratory tests performed by Prysock (1979) on nearby material similar to soil within the project area are also included in Table 1.

7. Geotechnical Conditions

7.1 Site Geology

7.1.1 Lithology

With the exception of a fairly small sliver of quartz keratophyre from the Balaklala Rhyolite, bedrock in the project area consists exclusively of phyllitic shale, sandstone, conglomerate, and tuff from the Bragdon Formation that have undergone varying degrees of mild to moderate contact metamorphism resulting from their relatively close proximity to the hot rising Shasta Bally Batholith. These rocks were mapped by Albers (1964) as phyllite metamorphosed from the Bragdon Formation and are labeled **Mbp** on Albers' geologic map, a portion of which is shown in Plate 4.

Though the surface bedrock exposures have been mapped as exclusively Bragdon by both Albers (1964) and OGDN, borings drilled by SHN (2002) for OGDN appear to indicate that some hornblende quartz diorite (presumably of the nearby Shasta Bally Batholith) can be found about 40 ft below the level of the existing road at about station 203+00 (boring B02-9 in Appendix D), and greenstone (presumably Copley Greenstone) has been logged about 75 ft below the existing roadway pullout at the western terminus of the project at about station 187+00 (boring B02-7 in Appendix D). Given the thrust fault nature of the contacts between the geological units and the relatively near proximity to both the Shasta Bally Batholith and Copley Greenstone, it is plausible that small thrust slices of both the Shasta Bally Batholith granitics and the Copley Greenstone lie at fairly shallow depths, even though Albers has depicted (in the cross-section accompanying his geological map) the Bragdon formation as being on the order of at least a thousand ft thick in this area.

Bragdon rocks lying immediately below the varying soil overburden are typically moderately to highly fractured and moderately to highly weathered, with compressional seismic velocities (p wave) generally varying from about 1900 to 3200 feet per second (fps). Deeper Bragdon rocks (or possibly, underlying Copley Greenstone – or even quartz diorite) possess compressional seismic velocities between 4600 and 16,800 fps, likely indicative of rocks with significantly less fracturing and little to no weathering.

7.1.2 Structure

Within the project area, bedding in the phyllitic Bragdon rocks varies from about 1" to massive beds over 5 ft thick. Bragdon bedding generally dips between about 45˚ and 60˚ at an azimuth varying between about 10˚ and 40˚ east of north.

Schistosity or foliation, when present or discernible, varies in dip from about 40˚ to 55˚ at azimuths between about 0˚ and 20˚ east of north.

Albers (1964) mapped some moderately large anticlinal-synclinal folds to the north of the project area, as well as a few minor anticlinal-synclinal folds immediately to the east of the project area. Though he did not map any folds within the project area itself, the mapping effort by OGDN did reveal some minor anticlinal-synclinal folds within the project area that border a local shear zone in the Bragdon and are likely drag folds created by the movement. Fairly similar in orientation to those mapped by Albers, the plunge of these minor folds dips about 20˚ at an azimuth of about 50˚ west of north. These folds are exposed in the existing cut slope located approximately between stations 212+25 and 215+00.

7.1.3 Native Slope Stability

Natural slopes within the project area are considered stable in their current morphology based on field observations. Slope ratios average about 1.9:1, with the steepest being about 1.5:1.

7.2 Soils

Field reconnaissance and field evaluation of soils in the project area by OGDN, laboratory tests performed by previous investigators, and a few laboratory tests performed specifically for this project by OGDN, have all produced soil descriptions based on engineering properties that were strongly linked to the geological sources. This resulted in soil and boundary descriptions that differ only slightly than those of the Soil Conservation Service (section 4.5).

The soils in the proposed cuts are generally composed of sandy silts with gravel (ML) and slightly lesser amounts of silty sands with gravel (SM). These soils generally have very low shrink-swell potential, a PI ranging from 0-9, and low corrosivity to steel. The φ angle of these soils is estimated to vary between 15˚ and 35˚, based on a test conducted specifically for this project, previous laboratory tests (Prysock, 1979; SHN, 2002) conducted on soils in or near the project area, and surface hand-sample evaluations across the project area that were visually compared with tested soils.

The soils found in the floodplains of Water and Trail Gulch Creeks, where the two primary project fills are to be constructed, are also generally composed of sandy silts with gravel (ML) and slightly lesser amounts of silty sands with gravel (SM). These soils have very low shrink-swell potential, low corrosivity to steel, and very low to no PI.

7.3 Surface Water and Groundwater

Two creeks, Water Gulch Creek and Trail Gulch Creek, flow through the project area into Willow Creek, which borders the southern edge of the project. Groundwater flow in the local environs of these three creeks (within the project area) is likely predominantly

conducted within the soil overlying the bedrock, while a lesser amount flows through the less transmissive fractures within the upper reaches of the bedrock.

Groundwater flow through the slopes above the existing highway that are proposed for cutting likely flows through fractures in the upper reaches of the bedrock, with some percolating deeper into lower parts of the bedrock where fracturing may also be prevalent. Rainwater that hits these slopes probably does not form any type of long-standing groundwater table in the soil column. Some of the water travelling in the rocks underlying the slopes feeds into the three creeks mentioned above, while other water likely travels deeper into a more regional aquifer through localized fracture conduits.

No problematic seeps were observed in any of the areas proposed for cutting. Groundwater is fairly unlikely to create problems for the proposed cuts, either during construction or afterwards, although it is possible that the lower reaches of the proposed cuts might possibly produce water where more permeable fractured rock contacts harder unfractured rock. Should these seeps occur it is still very unlikely that they would present a flow volume that could create geotechnical problems or instability.

7.4 Erosion

Erosion in the existing rock cuts is insignificant. Erosion potential in the soils above the proposed cuts is moderately high if the soils are left unprotected by vegetation, and even more especially when positioned in the paths of sheet flow or concentrated surface water. Present soils within the project area appear to be sufficiently protected by grasses and vegetation and are, therefore, fairly protected against erosion.

7.5 Project Site Seismicity

Based on Caltrans Seismic Design Criteria, Appendix B (2006) soil conditions within the project area are classified as soil profile types B and C. Calculations performed on the Caltrans ARS (Acceleration Response Spectra) online tool, using these soil profile types, yield a probabilistic PBA (peak bedrock acceleration) of 0.211 g and a probabilistic PGA (peak ground acceleration) of 0.250 g for the project area. The primary contributing fault determined by the ARS tool is the Keswick Fault, with the secondary contributing fault being the San Andreas Fault System towards the coast. The Keswick Fault, a reverse fault believed to be a part of the subducting oceanic plate descending into the mantle, has a maximum moment magnitude (MMax) of 6.0. It is located about 6 miles northeast of the project at a minimum depth of 3 miles and dips approximately 65˚ to the southeast. The San Andreas Fault System, a right-lateral strike-slip fault system with a maximum moment magnitude (MMax) of 7.9, is located about 85 miles to the west-southwest of the project.

8. Geotechnical Analysis and Design

8.1. Cuts and Excavations

8.1.1 Cut Slopes

Present cut slopes have slope ratios generally around 0.75:1, with a few locations being slightly steeper. A majority of these cuts are over 70 years old, with some having been constructed over 80 years ago, according to as-built drawings and other DRS records. The present condition and appearance of the cut slopes are thought to be fairly similar to the original cut faces, with the exception of some small localized planar failures (rock) and sloughs that likely occurred fairly soon after their construction, as well as the long-term raveling of localized periodic rockfall. All of this suggests that the slopes are globally stable in their existing slope ratio.

The existing and proposed cut faces dip in directions significantly opposite that of the dip of the geologic structure and bedding, so daylighting of the structure or stratigraphy is not considered a potential threat to existing or proposed cut slope stability.

Examination of the Bragdon rocks in and near the project area, together with seismic refraction results, indicates that the rock quality is sufficient in many places, particularly at depth, to stably support cut slope ratios steeper than 0.75:1. Therefore, in an effort to reduce excavation quantities while maximizing rockfall catchment widths, cut slopes utilizing two or three slope ratios have been analyzed for stability and rockfall design. The top portions of the cuts have slope ratios of 1:1, which, based on field observations, is flat enough to prevent failure of the soil and weaker overburden. At some depth (determined perpendicular to the native topographic surface) this slope ratio changes to 0.75:1 when the rock is deemed competent enough. In a majority of the proposed cuts the rock quality and strength improves sufficiently with depth that an additional steepening to a 0.5:1 cut slope ratio may be implemented. A generic cross-section drawing of such a cut slope is shown in Plate 6, which also demonstrates how the transition depths are measured. Table 5 in section 10.1 provides recommendations for slope ratios and the depths at which they begin for all cut slopes based on station intervals.

Overwintering of Cut Slopes

Discussions with the PDT from the onset of this project have assumed that this project would entail two seasons of construction. Because of this schedule at least a portion of the slope cuts will overwinter through at least one interim wet season. This should expose any possible stability or rockfall problems while the construction work is still under contract, which will allow OGDN and the Office of Construction to remedy and/or mitigate any such problems before construction is completed, as well as to anticipate such problems on slopes still to be cut during the second construction season. Because the potential risk of stability problems is considered to be low, and because rockfall problems also pose relatively little risk to the project due to the rockfall catchment widths recommended (section 8.1.4) by OGDN and implemented by Design, this overwintering, while beneficial, is not mandatory.

8.1.2 Rippability

Rippability assessments were made based on seismic velocity (P waves), rock type, and rock fracture and joint characteristics. As discussed earlier in section 5.3 nine seismic lines were shot for this project (see Plate 5 for locations of seismic lines; see Appendix B for seismic depth sections). Velocities and depths determined from the seismic results were extrapolated into nearby areas not surveyed seismically. Seismic velocity correlations are based on two different scales, each with differing rippability assessments depending upon ripping equipment and rock type. Caltrans has its own non-rock-type specific internal correlation scale between seismic velocity and rippability based on a Caterpillar D9 Series bulldozer with a single-toothed ripper:

Velocity (ft/s)	**(Caltrans)**	**Rippability**
< 3445		Easily Ripped
3446 – 4921		Moderately Difficult
4922 – 6562		Difficult
> 6563		Non-Rippable

A rock-type specific seismic velocity scale based on a larger bulldozer (Caterpillar D10 with a single or multi-shank no. 10 ripper) taken from a handbook published by Caterpillar (1982) is also presented here to provide the contractor with a wider range of rippability information. The handbook lists multiple rock types, including shale, sandstone, conglomerate, and schist (the closest rock to phyllite), which are basically the primary rock constituents in the proposed cuts. Of these four rock types, schist has the lowest seismic velocities at the demarcation between rippable and marginally rippable, as well as between marginally rippable and non-rippable, which makes it the most conservative choice for rippability description for this project. The Caterpillar D10 ripper table gives the following rippability descriptions and seismic velocity correlations for schist:

Velocity (ft/s)	**(Caterpillar (Schist))**	**Rippability**
≤ 8,000		Rippable
8,000 – 10,000		Marginally Rippable
> 10,000		Non-Rippable

Table 2 below lists seismic velocities and rippabilities by station intervals for both Caltrans and Caterpillar standards. This table shows that all rock proposed for excavation in this project is considered rippable based on the Caterpillar standard, while the more conservative Caltrans standard describes the rock as a mix of easily ripped, moderately difficult to rip, difficult to rip, and non-rippable. OGDN estimates that, based on the Caltrans standard, 70% of the proposed excavation volume is easily ripped, 15% is moderately difficult to difficult to rip, and the remaining 15% is non-rippable. Depths listed in this table to which rippability descriptions extend are determined perpendicular to the native topographic surface as shown in Plate 7.

Table 2. Rippability Description by Station Interval. Rippability descriptions are given for both the Caltrans Scale (D9 dozer with single-tooth ripper) and Caterpillar Scale (D10 Dozer with no. 10 ripper). See section 8.1.2 for more details regarding these scales and their correlation with seismic velocity. Depths are measured perpendicular to original ground surface.

STATION INTERVAL		CALTRANS SCALE	CATERPILLAR SCALE
Begin	End		
181+00	188+00	Easily ripped down to 25' to 40'; moderately difficult to rip deeper	Rippable
188+00	192+25	No Excavation (fill)	N/A
192+25	195+00	Easily Ripped	Rippable
195+00	199+75	No Excavation (fill)	N/A
199+75	200+25	Easily Ripped	Rippable
200+25	208+00	Easily ripped down to 20' to 35' depth; non-rippable deeper	Rippable
208+00	212+00	Easily ripped down to 18' to 40' depth; difficult to rip deeper	Rippable
212+00	215+25	Easily ripped down to 20' to 30' depth; non-rippable deeper	Rippable
215+25	225+50	Easily ripped down to 15' to 28' depth; moderately difficult to rip deeper	Rippable
225+50	226+50	Easily ripped down to 5' to 8' depth; moderately difficult to rip down to about 16'; non-rippable deeper	Rippable

8.1.3 Grading factor

Grading factors were estimated by station based on the geological examination of rock outcrops (involving rock type, quality, and structural orientation), the seismic refraction results, the preliminary cross-sections provided by the Office of Design, and previous construction experience with similar materials in the on earlier Buckhorn projects.

Table 3. Grading Factors

GRADING FACTORS BY STATION INTERVAL		
Station Begin	Station End	Grading Factor
181+00	187+75	0.96
192+25	195+00	0.95
199+75	215+75	1.02
217+00	225+25	0.99

Generally, overburden soil material is expected to shrink when compacted (yielding a grading factor less than 1.0), with the estimated degree of shrinkage based on experience (both that of OGDN and some local resident engineers (RE)), estimated amount of rocks in the soil, and seismic velocities of the material. Rock volume is typically expected to either stay constant (a grading factor of 1.0) or swell (grading factor greater than 1.0), depending on the rock type, rock quality, and seismic velocity of the rock. Outcrops and seismic results were used in conjunction with the cross-sections to determine the relative amounts of soils and rocks at a particular station, and then the grading factors for each were combined proportionately for each station interval. The estimated factors are presented above in Table 3 by station interval.

8.1.4 Rockfall

Rockfall presently occurs from localized parts of the existing cut slopes. Almost all existing catchment ditches slope away from the roadway at 4:1 and are typically 2 to 4 ft in width. These catchment ditches are inadequate to contain rock run-out from reaching the travelled way, according to maintenance personnel who typically clear rocks from the roadway during and following storms, as well as during times of seasonal diurnal freeze-thaw.

The proposed cuts for this project are significantly higher than the existing ones in most locations, which means that 1) there will be a greater amount of slope surface area from which rockfall can originate, 2) the fall heights (and therefore the inertias and kinetic energies) will be substantially greater, and 3) the resultant impact and run-out distances (from the base of the cut slope) of the rocks and the catchment widths required to sufficiently contain these rocks will be substantially greater.

Rockfall mitigation analysis and design was performed based on field observations of present catchments and performance, field observations and data on present geological conditions, catchment tables created from over 10,000 rockfall simulations by Pierson, et al (2001), and modeling simulations utilizing the Colorado Rockfall Simulation Program software (CRSP; Jones, et al, 2000). Pierson's catchment tables are based on single slope ratio cut slopes and, as such, do not allow direct analysis of the effect of double and triple slope ratio cut slopes upon rockfall impact and rock run-out distances. CRSP analysis was used primarily to determine scaling factors that, together with engineering and geologic judgement, could be applied to Pierson's tables.

Catchment has been defined previously in this report as the unpaved shoulder laying flat or sloping away from the pavement. That definition is expanded here to include the paved shoulder space outside of the edge of traveled way (ETW) for the purpose of analysis. Unpaved catchment functions far better than paved catchment for stopping and retaining falling and rolling rocks, but all shoulder space (paved and unpaved) was considered during modeling runs in CRSP (the properties of the catchment surface can be varied in the software and pavement can be modeled). On average, 8-foot paved shoulders were found to equal 2 feet of soft shoulders for absorbing rock run-out. Paved shoulders contributed no benefit if located in the impact zone (the area where the falling rock first strikes the

ground); in fact, paved shoulders dramatically increased rock run-out distances if located within the impact zone. Consequently, the minimum recommendation for catchment widths required that 90% of rockfall impacts occur within the unpaved soft shoulder.

Minimum catchment width recommendations are given by station interval in the third column of Table 5. Analysis indicates that catchments with these widths should capture 90+% of projected impacts and about 50% of rock run-out. The fourth column in Table 5 provides catchment widths that are 6 ft wider than those in column 3. These widths increased the rock run-out capture percentage to between 75 % and 90 %, depending upon the particular station interval and slope ratios recommended.

The 6 foot addition to the widths in column 4 was based on discussions with Design and the PDT's desire to add 6 ft of additional width to the unpaved shoulder that could potentially be used for part of a possible future truck climbinging lane (to be combined with 4 ft of the paved shoulder) should the District decide at some point in the future that it has become warranted. Discussions between Design and OGDN resulted in a decision to implement the wider catchment widths, with the perspective that if and when District Management should decide to install the truck climbing lane there will have been at least a few years of rockfall observations from the proposed cut slopes and wider catchments upon which OGDN can base new rockfall mitigation recommendations for any such future passing lane. Rockfall mitigation measures, if needed (empirical observations may differ from the projected analyses provided in this report), could then be in the form of localized drapery systems rather than additional catchment width, which would eliminate the need for slope excavation during the future passing lane addition.

8.1.5 Post-Construction Sloughing and Erosion-Potential and Control

The majority of the proposed cut slopes are not expected to present any significant erosion problems due to the predominantly rocky nature expected of the new faces. The tops of some of these cuts, however, may expose surfaces composed predominantly of soil that may be moderately to highly erosive in places. Based on the significant resistance to erosion provided by the grass cover on the top surfaces of existing cut slopes, any such potential erosion could likely be mitigated by applying a hydroseed mulch or other similar erosion prevention product to the tops of the proposed cut slopes.

8.2 Embankments

A 1.5:1 slope ratio was chosen for the two large embankment fills, and the smaller fill at the pullout area between station 211+00 and 213+00, based on multiple factors and parameters, including properties of the material to be used in the proposed fills, height of the fills, constraints limiting the spatial footprint of the fills, empirical experience with existing fills, costs, and risks. Because of the substantial magnitude of the two large fills, any flattening of their slope ratios would substantially increase right-of-way needs, earthwork volumes and costs, and environmental costs. Experience indicated that building the fills at a steeper slope ratio than 1.5:1 to further reduce the footprint would likely require significant slope reinforcement and substantial additional erosion protection, and,

therefore, was not considered economically feasible in respect to the relatively small reduction in footprint gained.

The material properties (φ, C, γ) of the rock and soil to be used in constructing the fills are discussed in section 8.2.1 below on embankment material. These parameters were utilized in the stability analyses, which are discussed below in the section (8.2.2) on stability analysis.

8.2.1 Embankment Material

The fills are to be built from material excavated from the cut slopes, which consists predominantly of rock and, to a lesser amount, of soil overburden that sits atop this rock. The material properties of these excavated materials, as they pertain to fill construction, are discussed here.

Excavation of the rock is highly likely to produce predominantly subangular to angular, blocky to slightly elongate or slightly tabular shapes, based on field observations of the intact rock on the slopes, rock shed from the slopes found in the catchment ditches, and general experience with rock cuts on the Buckhorn Grade. The expected shapes of the excavated rock indicate that it will possess a fairly high φ (angle of internal friction) angle, likely approaching 45˚ (1:1). Observations of other rocky fills constructed on the Buckhorn Grade with fairly similar material indicates that this material is very stable at 1.5:1 (33.7˚). For the purpose of stability analysis, the rock was assigned φ angles from 37˚ to 40˚, which are considered to be highly conservative to slightly conservative. Being in essence a 'cohesionless soil', the rock was assigned a C (cohesion) of 0. The rock was assumed to have an average γ (unit weight) of 140 pounds per cubic ft (pcf), based on rock type and empirical charts.

Soils overlying the bedrock have φ angles ranging from as low as 15˚ to as high as 38˚. Soil samples from within the project boundaries were tested for shear strength by OGDN (direct shear box test), SHN (direct shear box test; 2002), and Prysock (Large diameter Triaxial; 1979). The OGDN test on a sandy silt (ML) sample from the vicinity of station 196+00 and a depth of about 10 ft yielded a φ angle of 38˚ and a C of 536 pounds per square foot (psf). SHN's samples (mostly sandy silts (ML) with one silty sand (SM)) yielded φ angles of 15˚, 34˚, 19˚, and 32˚, with corresponding C values of 1124, 537, 786, and 1602 psf, respectively. Prysock's silty clay-clayey silt (ML-CL) samples yielded φ angles of 15˚, 16˚, 20˚ and 22˚, with corresponding C values of 4000, 6500, 8000 and 7000 psf, respectively. Soils were assigned a lump γ value of 115 pcf.

The relative percentage of rock versus soil that exists in the proposed cuts is estimated to be about 90% rock and 10% soil.

8.2.2 Embankment Stability Analysis

Slope stability analysis was performed based on the C, φ, and γ values discussed in section 8.2.1 to evaluate the stability of a 1.5:1 fill constructed from 1) the overburden soil, 2) the

bedrock, 3) and the bedrock and soil mix. Limit equilibrium methods available in Slope/W (2004) that utilize both force and moment equations together were employed in the analyses. A Factor of Safety (FOS) of 1.3 was considered the minimum acceptable.

Table 4 presents a synopsis of the primary stability analyses performed. These runs primarily involve variations in φ and C for each of the three fill types (soil, rock, rock-soil). Numerous additional runs were performed tangential to the runs listed in this table in order to test sensitivity and the effects of altering γ and conditions such as the groundwater table, since these were estimated or assumed. Factors of Safety (FOS) for primary modelling runs are given for each of the runs. The column titled "Failure Surface" refers to the depth (perpendicular to the fill surface) of the critical failure surface (the surface with the lowest FOS for that run). Deep surfaces rotate at least 15 ft perpendicular into the fill surface and usually comprise the entire fill surface (extending from the top of the fill to the bottom). Shallow failure surfaces are relatively surficial, penetrating no more than 4 ft into the fill surface. Such shallow surfaces arose only when cohesion was non-existent; such shallow failures do not represent significant global instability so much as surficial sloughing potential. The last column in this table provides comments regarding the conservativism or riskiness of the φ and C parameters – this refers to the likelihood of the parameter strengths being met by the materials available. A 'highly conservative' description indicates that the material will easily meet the specified value; a 'very risky' description indicates that there is a considerable possibility that the material will not meet the specified value, a value that is then considered unlikely to occur.

All fill models in Table 4 contained high ground water tables, with the phreatic surface approximately 8 feet from the fill surface near its top and at the fill surface near the bottom of the embankment. Stability runs employing lower ground water conditions were found to be slightly more stable, so these were not considered in an effort to provide more conservative analyses. This is considered necessary to account for those occasional years when precipitation is excessive and drawn out.

Fills constructed entirely of soil (Table 4, runs 1-5) were first analyzed utilizing considerably conservative parameters (likely to be met or exceeded in reality): a φ of 20˚, a C of 500 psf, and a γ of 115 pcf for the total soil mass. This produced a minimum FOS of 0.87. Decreasing the conservatism of the model parameters to a φ of 22˚, a C of 700 psf, and a γ of 115 pcf produced a minimum FOS of 1.0. Further decreasing the conservatism of the model parameters to a φ of 25˚, a C of 1000 psf, and a γ of 115 pcf produced a minimum FOS of 1.2. A minimum FOS of 1.3 was not obtained until φ and C were set at either 25˚ and 1500 psf, or 28˚ and 1000 psf, values which are completely lacking in conservatism. All of the above stability models depend significantly upon substantial amounts of cohesion, a dependence which carries long-term stability risks due to the potential for cohesive forces to decrease under certain conditions (Bullock, et. Al., 1988) and allow creep under certain wet conditions, creep that can eventually lead to failure. Engineering judgment therefore precludes the dependence on large amounts of cohesion for long-term stability. Because of the significant risk inherent in the model that produced a FOS of 1.3, because of the mildly conservative φ and C values of 22˚ and 700 psf failure to produce the minimum required FOS of 1.3, and because of the over-dependence upon

cohesion in these models, fills constructed entirely from the soils available within the project are not considered stable.

Fills constructed entirely of rock (Table 4, runs 6-9) were analyzed for stability utilizing a γ of 140 pcf, a C value of 0, and φ values ranging from 37˚ to 40˚. Variation of the γ value within a reasonably plausible range indicated only a small effect upon the resultant FOS's, with higher γ values producing FOS's with equal or only slightly higher values. The 140 pcf value, which lies in the lesser end of the plausible range of values for this rock, was chosen for subsequent modeling runs in order to be slightly conservative. The first three 'rock only' runs shown in Table 4 with φ values ranging from 37˚ to 39˚ produced FOS values slightly below 1.3 for shallow critical surfaces. The subsequent application of a false veneer of cohesive material to the fill surface acted to force the critical surface deeper (which would be more representative of actual global stability rather than surficial sloughing) and the FOS higher to 1.3 (not shown in Table 4) for these φ values. A φ value of 40˚ resulted in a deep critical failure surface without the utilization of a false cohesive veneer, and produced a FOS of 1.32 (run 9). Because the φ values ranging from 37˚ to 40˚ are considered to be very conservative to slightly conservative, these stability analyses indicate that fills composed entirely of rock would be globally stable.

Fills constructed of a rock-soil mixture approximating the ratio of 90% rock and 10% soil estimated to exist within the total proposed excavation material were analyzed for stability. A γ of 137.5 pcf was estimated for the mixture as a whole by proportioning the relative combinations of the γ values for each component (140 pcf for rock and 115 pcf for soil). This value was rounded down to 135 pcf for the sake of conservatism, since test runs indicated that the FOS generally increased slightly with increasing γ.

Estimation of the φ angle for the rock-soil mixture was not done by simple proportioning, because the nature of this parameter prevents it from acting in such a straightforward fashion. The fairly large φ angle of the rock (40˚) is obtained through rock-to-rock contact combined with the subangular to angular shape of the rocks, which together cause the individual pieces to lock or restrain one another from sliding or moving relative to each other. If the rock-to-rock contact is eliminated or reduced substantially by the addition of a substantial proportion of soil, the φ angle would be significantly reduced. In contrast, if the addition of soil was relatively small as it is in this case, the φ angle of the rock-soil mixture will likely be controlled predominantly by the initial φ angle of the rock. In such a case, the lower φ angle of the soil probably contributes less to the overall φ angle of the mixture than its relative proportion would suggest. This would indicate that a 10% contribution to the φ angle of the mixture by the φ angle of the soil (25˚) would result in a conservative overall φ angle for the mixture. Thus a φ angle of 38.5˚ was estimated to be a fairly conservative φ angle for the rock-soil mixture.

Estimation of the cohesion (C) for the rock-soil mixture was also not done by simple proportioning. C is basically the shear strength in a soil not produced by interparticle friction. Some cohesion (true cohesion) is caused by electrostatic forces (ionic) within the clays and cementing by certain molecules, while other cohesion (apparent cohesion) is caused by negative capillary pressure (lost by wetting) and certain pore pressure responses.

Table 4. Stability Analysis Modelling Runs. Parameters (ϕ, C, & γ) and Factors of Safety (FOS) for primary modelling runs are given for the three types of fills modelled: soil only, rock only, and rock-soil mixture. The column titled "Failure Surface" refers to the depth of the critical failure surface. Deep surfaces rotate at least 15 ft perpendicular into the fill surface and usually comprise all of the fill surface. Shallow Failure surfaces are relatively surficial, penetrating no more than 5 ft into the fill surface. Comments regarding the conservativism or riskiness of the ϕ and C parameters refer to the likelihood of the strengths being met by the materials available. A 'highly conservative' description indicates that the material will easily meet the specified value; a 'very risky' description indicates that there is a considerable possibility that the material will not meet the specified value.

Run #	Fill Type	φ?	C (psf)	γ (pcf)	FOS	Failure Surface	Comments on φ and C Parameters
1	Soil Only	20	500	115	0.87	Deep	φ & C highly conservative
2	Soil Only	22	700	115	1	Deep	φ & C moderately conservative
3	Soil Only	25	1000	115	1.2	Deep	φ & C no conservatism
4	Soil Only	25	1500	115	1.3	Deep	φ slightly risky/ C moderately risky
5	Soil Only	28	1000	115	1.3	Deep	φ very risky/ C no conservatism
6	Rock Only	37	0	140	1.19	Shallow	φ very conservative/ C accurate
7	Rock Only	38	0	140	1.24	Shallow	φ very conservative/ C accurate
8	Rock Only	39	0	140	1.28	Shallow	φ slightly conservative/ C accurate
9	Rock Only	40	0	140	1.32	Deep	φ slightly conservative/ C accurate
10	Rock-Soil	36	150	135	1.27	Deep	φ highly conservative/ C moderately conservative
11	Rock-Soil	36	200	135	1.29	Deep	φ highly conservative/ C slightly conservative
12	Rock-Soil	37	100	135	1.29	Deep	φ highly conservative/ C moderately conservative
13	Rock-Soil	37	150	135	1.31	Deep	φ highly conservative/ C moderately conservative
14	Rock-Soil	38	100	135	1.33	Deep	φ very conservative/ C moderately conservative
15	Rock-Soil	38	150	135	1.34	Deep	φ very conservative/ C moderately conservative
16	Rock-Soil	39	100	135	1.38	Deep	φ very conservative/ C moderately conservative
17	Rock-Soil	39	150	135	1.39	Deep	φ very conservative/ C moderately conservative
18	Rock-Soil	40	500	135	1.61	Deep	φ slightly conservative/ C no conservatism
19	Rock-Soil	40	500	155	1.62	Deep	φ slightly conservative/ C no conservatism
20	Rock-Soil	40	150	135	1.43	Deep	φ slightly conservative/ C moderately conservative

These cohesive forces act mostly on similar particles within the soil, but some of these forces may also act on other particles or molecules, like those present on the surface of rocks. The cohesion of a fill composed of a rock-soil mixture that is predominantly soil will still retain a significant portion of its cohesion, albeit some of it apparent, since the soil will bind cohesively to some degree to the rock surfaces. The rocks themselves will hold together internally (in essence, be internally cohesive like cementation). The net result will likely be a rock-soil mixture that acts as if its cohesion was only moderately less than if the mass were composed entirely of the soil. As the relative percent of rock increases this cohesive behavior should remain fairly uniform until a significant amount of rock surfaces come into contact without cohesive soil between them. At that point cohesion in the mixture as a whole probably diminishes more, though likely not to the relative percent

indicated by the volume percent the soil contributes to the mixture. Based on this reasoning, it is probably conservative to estimate for modeling purposes the C in the 90/10 rock-soil mixture at 10% to 15% of the cohesion of the soil by itself. Therefore a C of 100 psf to 150 psf for the rock-soil mix was considered moderately conservative for the purposes of stability analysis.

Stability analysis involving varying parameter values for the rock-soil mixture are presented in runs 10 thru 20 in Table 4. Of these runs only 3 (runs 10, 11, and 12) failed to meet the minimum FOS of 1.3, falling short only by a few hundredths while employing considerately conservative parameter values. The remaining runs all met minimum FOS requirements, with FOS values ranging from 1.3 to 1.62. All but two of these runs employed at least some degree of conservatism in the parameters. Runs 18 and 19, which produced FOS values of 1.61 and 1.62, respectively, involved a non-conservative C value of 500 psf.

Based on the discussion above regarding the stability analyses of the rock-soil mixture, fills composed of such material are considered to be stable. This conclusion involves the caveat that no large homogeneous volumes of soil devoid of rock will be placed in the fills by construction personnel, unless located away from the fill surface and near the center of the fill.

8.2.3 Embankments - Founding and Settlement

The two main fills are situated to span moderately narrow small valleys that have steep side slopes that act to restrain any movement at the ends of these fills.

The central portions of these fills will be founded primarily above Bragdon rocks that are covered by about 5 to 12 ft of overburden soil composed of silty sands (SM) with gravel, cobbles and boulders. The bedrock is believed to be relatively unweathered and highly competent to bear the weight of the proposed fills. Specific foundation conditions beneath the steel plate corrugated steel pipe culverts proposed to carry water flow through the base of these fills, as well as recommendations regarding these foundations, are provided in the Foundation Report (April 27, 2011) and the Foundation Report Addendum (June 28, 2011).

Field investigatory work revealed no indications of gaseous waters (such as sulphuric) in the creek valleys or nearby tributaries that would indicate any need for special considerations during the construction of the embankments and culverts.

Foundation settlement beneath the fills is expected to be no more than 1.2 inches beneath the Trail Gulch fill and 1.1 inches beneath the center of the Water Gulch fill, with all of this occurring during embankment construction. Post-construction settlement activity within the compacted fills is expected to be low due to the rocky nature of the material and the standard 90% relative compaction requirement recommended (section 10.3) for these fills, with no more than 1.5 inches occurring at the center of either fill. This settlement was estimated based on elastic theory, the Hough Method, and empirical measurements of post-

construction fill settlement occurring on a nearby fill that was recently constructed (2009) with nearly identical rock and soil.

8.2.6 Embankments-Erosion

The proposed fills, if unprotected, will be mildly susceptible to localized erosion where pockets of soil may be left exposed on the fill surface rather than the predominant rocky material that the bulk of both fills are to be constructed from.

8.2.7 Embankments - Drainage

With the exception of Trail Gulch and Water Gulch, no groundwater seeps or channelized surface water was observed within the footprints of the proposed fills. Consequently, no subsurface drainage, other than the two SPCSP culverts, is considered necessary.

9. Construction Considerations

9.1 Construction Advisories

Trees larger than 6" at chest height that are situated within 5 feet outside of the excavation lines should be cut. Smaller vegetation may remain in place in this area outside of the cut zone. Stumps from the trees cut within this 5-foot zone should be left in place at a height of 10 inches to 24 inches above the surrounding ground.

Cuts excavated during the first season of construction should be allowed to weather the following rainy/wet season without cover or protection. Appropriate and necessary BMP and storm water protection measures should be in place below them and proper BMP methods should be followed to prevent sediment discharge violations. This exposure of the unprotected cuts to the weathering season is intended to instigate sloughing that would likely occur during the first few post-cutting wet seasons regardless of protection, and expose any localized planar weaknesses, failures, or rockfall issues in the rock cut slopes. Following the wet season, cut slopes shall be evaluated by OGDN and the Office of Construction to determine which slopes might require trimming, additional cutting, and or scaling during the next construction season. In addition, trees located near the top hinge points of some cut slopes may be deemed problematic after undergoing the interim wet season, and shall be designated for cutting during the next construction season. Problematic trees include those that appear likely to fall soon, and those that are close enough to a newly developed edge (from wet season sloughing) that they could act as levers under the force of winds to cause the top of slope to fail.

Cut slopes are likely to shed some rock during construction, so appropriate caution below these cuts should be exercised. Due to the naturally steep slopes, the significantly high cuts, and the additional distance upslope of the proposed cuts above the existing highway distance that could add rolling speed to the rocks), rolling rock and rockfall created during cut slope construction will pose a threat to the existing travelled way if precautions are not taken to mitigate the threat.

9.2 Construction Considerations that Influence Design

Due to the likelihood of mostly mild localized sloughing, erosion, and rockfall from the newly cut slopes during their first wet season following cutting, work should be staged, if possible, so that the cuts most likely to be problematic are given priority in the order that cutting is to occur. Cuts between stations 192+50 and 196+00, followed by the cuts at the east end of the project, should receive higher priority. Such staging will allow the winter observation of any developing problems so that specific recommendations can be made for mitigation and repair work to be performed during the following construction season. Such staging will also help to synchronize the greatest proportion of post-cutting wet season problems that might arise from these slopes with the on-site presence of a contractor still under contract so that winter cleanup may proceed swiftly and efficiently without traffic and pavement directly below the problematic cut slope(s). Staging priorities based on such cut slope priorities, however, should not override staging priorities based on the logistical necessities involved with the construction of the two fills.

9.3 Construction Monitoring

Cut slopes should be monitored visually while they are being cut, primarily for loose rock or sections of rock. Such monitoring will also serve to detect problems early, should they arise, so that changes, if necessary, to the cut slope design may be implemented as early in the construction process as possible. Visual monitoring basically entails observing the slope above a cut and looking for cracks and fissures that are precursory to tension cracks that would indicate imminent slope failure or sloughing. Visual observation of the cut face for cracks and notable shifts of material should also be performed.

Periodic visual monitoring of the cut slopes and the areas in front of them through the wet season is considered necessary to make sure that BMP installations are functioning as intended. This monitoring is also important so that cut slope evolution can be observed and understood in order to better plan for any possible trimming or additional cutting that may be required.

9.4 Differing or Problematic Site Conditions

Should differing site conditions arise during construction please contact Mr. Lewis of ODGN.

10. Recommendations and Specifications

10.1. Cut Slopes

- Prior to cutting slopes, it is recommended that trees larger than 6" at chest height that are situated within 5 feet outside of the excavation lines be cut. Stumps from trees cut within this 5-foot zone shall be left at a height of 10 inches to 24 inches above surrounding ground.

- Triple slope-ratio cut slopes of 1:1 (top of cuts), 0.75:1 (below the 1:1 cuts), and 0.5:1 (at the base of the cut below the 0.75:1 cuts) are recommended for most cut slopes when the excavation extends sufficiently into the native slopes. When the excavation shallows, the steeper 0.5:1 cut slope ratio is no longer recommended at the bottom of the cut. When the excavation shallows even further, the 0.75:1 cut slope ratio also not recommended, leaving 1:1 as the recommended cut slope ratio. Recommended slope ratios as a function of excavation depth are given by station interval in Table 5 below.

- Benches are not recommended for cut slopes.

- It is recommended that as many cut slopes as possible be allowed to overwinter unprotected during the interim wet season between construction seasons, preferably those between station 193+50 and 196+00.

- Temporary BMP's are recommended at the bottom of all cut slopes during the interim construction wet season (some sort of sediment catch basin).

- It is recommended to apply hydroseed mulch or a similar erosion prevention product to the tops of the cut slopes at the end of the final construction season.

- Unpaved shoulders varying from 16 to 28 ft in width with a 6:1 back slope are recommended at the base of all cut slopes for rockfall catchment. Catchment widths are given by station interval in Table 5. Column 3 contains catchment widths designed for 90% capture of rockfall impacts and about 50% of rockfall run-out. Column 4 contains catchment widths designed for greater than 95% capture of rockfall impacts and about 75% to 90% of rockfall run-out. Widths in Column 3 are 6 ft wider than those in Column 2, with 6 ft representing the amount set aside by Design for a possible future truck climbing lane.

Table 5. Catchment Widths and Cut Slope Ratios by Station. The first column of catchment widths is based on 90% containment of impacts and 40-50% of rollouts. The second column adds the 6' that Design and Management want allocated for a possible future additional passing lane (see text). These larger catchments provide containment for 95% of impacts and 75% - 90% of rollouts. Slope ratio 1 (S1) is the cut slope ratio beginning at the top of cut. Slope ratio 2 (S2) begins at the depth (determined perpendicular to ground surface) given in S1/S2 column. S3 begins similarly at the depth given in the S2/S3 column. Plate 6 provides a generic cross-section drawing to visually explain these parameters.

STATION INTERVAL		CATCHMENT WIDTH	CATCHMENT WIDTH (with additional 6')	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
Begin	End	(ft)	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
192+25	192+50	10	16	1.0:1.0	0.75:1	no	20	no
192+75	194+00	12	18	1.0:1.0	0.75:1	no	20	no
194+25	194+50	10	16	1.0:1.0	0.75:1	no	20	no
194+75	195+00	6	12	1.0:1.0	no	no	no	no
195+25	199+50	Fill Only - No Cutting						
199+75	199+75	10	16	0.75:1	no	no	no	no
200+00	200+25	12	18	1.0:1.0	0.75:1	no	12	no
200+50	202+00	16	22	1.0:1.0	0.75:1	0.5:1	12	35
202+25	202+25	14	20	1.0:1.0	0.75:1	0.5:1	10	35
202+50	202+50	14	20	1.0:1.0	0.75:1	0.5:1	8	35
202+75	202+75	14	20	1.0:1.0	0.75:1	no	6	no
203+00	203+00	14	20	1.0:1.0	0.75:1	0.5:1	6	35
203+25	203+25	14	20	1.0:1.0	0.75:1	0.5:1	6	33
203+50	203+75	16	22	1.0:1.0	0.75:1	0.5:1	6	33
204+00	204+00	18	24	1.0:1.0	0.75:1	0.5:1	6	33
204+25	204+25	18	24	1.0:1.0	0.75:1	0.5:1	12	30
204+50	205+00	20	26	1.0:1.0	0.75:1	0.5:1	14	30
205+25	205+25	20	26	1.0:1.0	0.75:1	0.5:1	12	30
205+50	205+50	20	26	1.0:1.0	0.75:1	0.5:1	10	30
205+75	205+75	20	26	1.0:1.0	0.75:1	0.5:1	8	30
206+00	206+25	20	26	1.0:1.0	0.75:1	0.5:1	8	35
206+50	206+75	21	27	1.0:1.0	0.75:1	0.5:1	8	35
207+00	207+00	20	26	1.0:1.0	0.75:1	0.5:1	8	35
207+25	207+50	18	24	1.0:1.0	0.75:1	0.5:1	8	35
207+75	208+50	16	22	1.0:1.0	0.75:1	0.5:1	8	35
208+75	208+75	16	22	1.0:1.0	0.75:1	0.5:1	8	33
209+00	209+75	16	22	1.0:1.0	0.75:1	0.5:1	6	30
210+00	210+00	14	20	no	0.75:1	0.5:1	no	25
210+25	210+25	14	20	no	0.75:1	0.5:1	no	20
210+50	210+50	12	18	no	0.75:1	0.5:1	no	15
210+75	210+75	12	18	no	0.75:1	0.5:1	no	10
211+00	211+00	10	16	no	0.75:1	0.5:1	no	5

STATION INTERVAL		CATCHMENT WIDTH	CATCHMENT WIDTH (with additional 6')	SLOPE RATIO 1	SLOPE RATIO 2	SLOPE RATIO 3	Depth to Slope Break (ft)	
Begin	End	(ft)	(ft)	(S1)	(S2)	(S3)	(S1/S2)	(S2/S3)
211+25	211+50	Fill Only - No Cutting						
211+75	212+25	10	16	no	0.75:1	no	no	no
212+50	212+50	12	18	1.0:1.0	0.75:1	0.5:1	6	25
212+75	212+75	14	20	1.0:1.0	0.75:1	0.5:1	6	25
213+00	213+00	14	20	1.0:1.0	0.75:1	0.5:1	6	30
213+25	213+75	16	22	1.0:1.0	0.75:1	0.5:1	6	30
214+00	214+75	14	20	1.0:1.0	0.75:1	0.5:1	6	30
215+00	215+25	12	18	1.0:1.0	0.75:1	0.5:1	6	30
215+50	215+50	10	16	1.0:1.0	0.75:1	no	4	no
215+75	215+75	10	16	no	0.75:1	no	no	no
216+00	216+75	Fill Only - No Cutting						
217+00	217+00	10	16	no	0.75:1	no	no	no
217+25	217+25	10	16	1.0:1.0	0.75:1	no	2	no
217+50	217+50	10	16	1.0:1.0	0.75:1	no	4	no
217+75	215+75	12	18	1.0:1.0	0.75:1	0.5:1	6	30
218+00	218+00	12	18	1.0:1.0	0.75:1	0.5:1	8	30
218+25	218+50	14	20	1.0:1.0	0.75:1	0.5:1	8	30
218+75	219+25	16	22	1.0:1.0	0.75:1	0.5:1	8	30
219+50	219+50	14	20	1.0:1.0	0.75:1	0.5:1	8	30
219+75	220+00	12	18	1.0:1.0	0.75:1	0.5:1	8	30
220+25	220+25	10	16	1.0:1.0	0.75:1	no	6	no
220+50	220+50	10	16	1.0:1.0	0.75:1	no	4	no
220+75	220+75	10	16	1.0:1.0	0.75:1	no	6	no
221+00	221+00	12	18	1.0:1.0	0.75:1	0.5:1	8	30
221+25	221+50	14	20	1.0:1.0	0.75:1	0.5:1	8	30
221+75	222+25	16	22	1.0:1.0	0.75:1	0.5:1	8	30
222+50	223+50	18	24	1.0:1.0	0.75:1	0.5:1	8	30
223+75	223+75	16	22	1.0:1.0	0.75:1	0.5:1	8	30
224+00	224+00	14	20	1.0:1.0	0.75:1	0.5:1	8	30
224+25	224+25	14	20	1.0:1.0	0.75:1	0.5:1	6	25
224+50	224+50	12	18	1.0:1.0	0.75:1	0.5:1	6	25
224+75	224+75	10	16	1.0:1.0	0.75:1	0.5:1	4	25
225+00	225+00	10	16	1.0:1.0	0.75:1	no	2	no
225+25	225+25	10	16	no	0.75:1	no	no	no
225+50	225+50	Fill Only - No Cutting						
225+75	225+75	10	16	1.0:1.0	0.75:1	no	4	no
226+00	226+25	10	16	1.0:1.0	0.75:1	0.5:1	6	12
226+50	226+50	10	16	no	0.75:1	0.5:1	no	12

10.2 Embankments

- It is recommended that the 2 large embankment fills and the smaller fill (between stations 211+00 and 213+00) proposed for this project be constructed at a slope ratio of 1.5:1.
- Gabion-lined ditches for collecting surface water and transporting it safely (by minimizing erosion) off the fill surface are recommended for the faces of the fill slopes. These ditches should be underlain by impermeable geomembrane to prevent water from seeping into the fill beneath these ditches. Our office recommends that these ditches be located no greater than 40 vertical feet apart and that they drain into similarly gabion-lined collection ditches that can transport the water completely off the fill and into the natural drainages and creeks.
- It is recommended that the exposed surfaces of the embankment fills be sprayed with some type of hydroseed mulch or other form of erosion control at a minimum at the completion of the fill and before entering any overwintering or rainy period.

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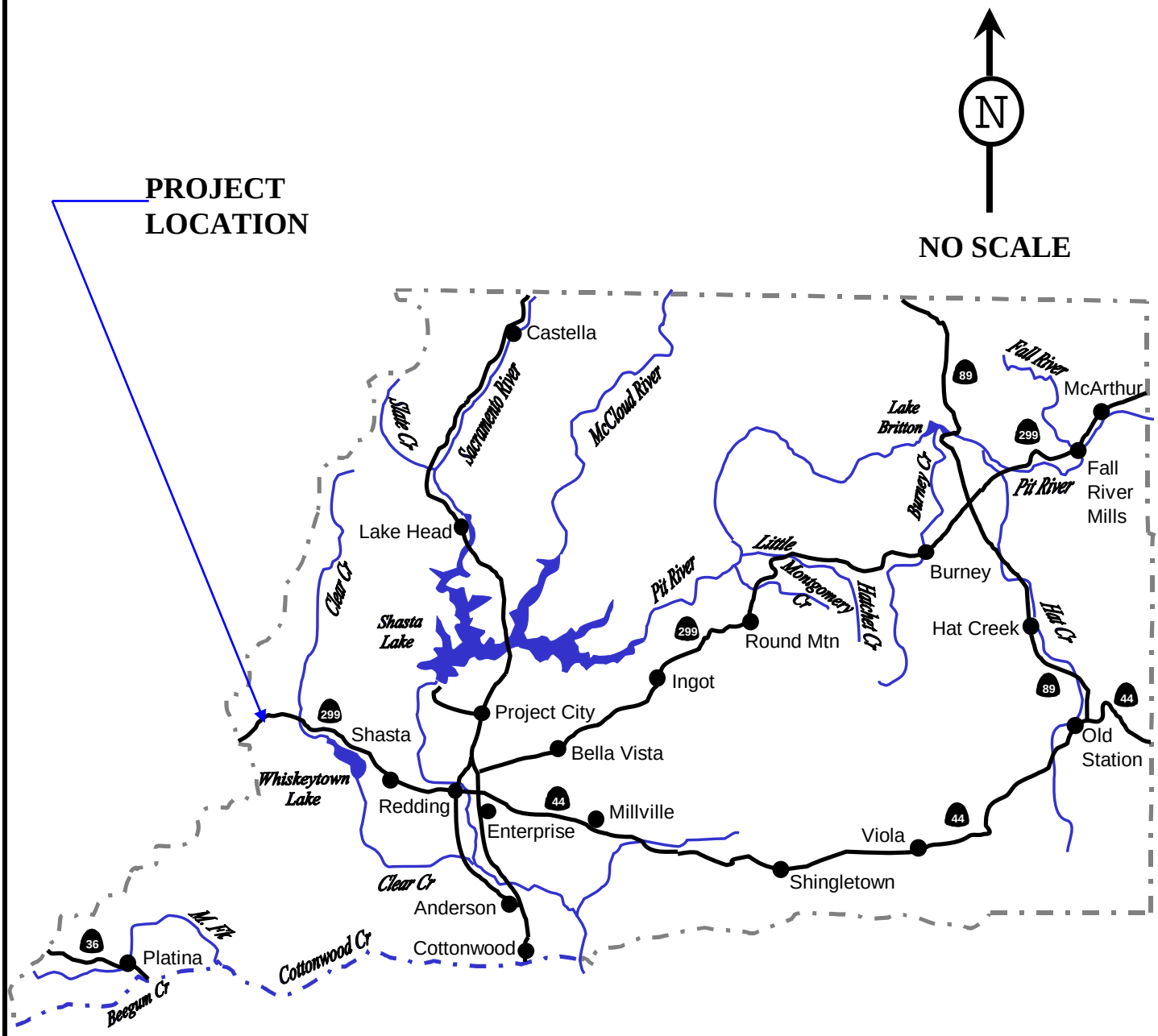
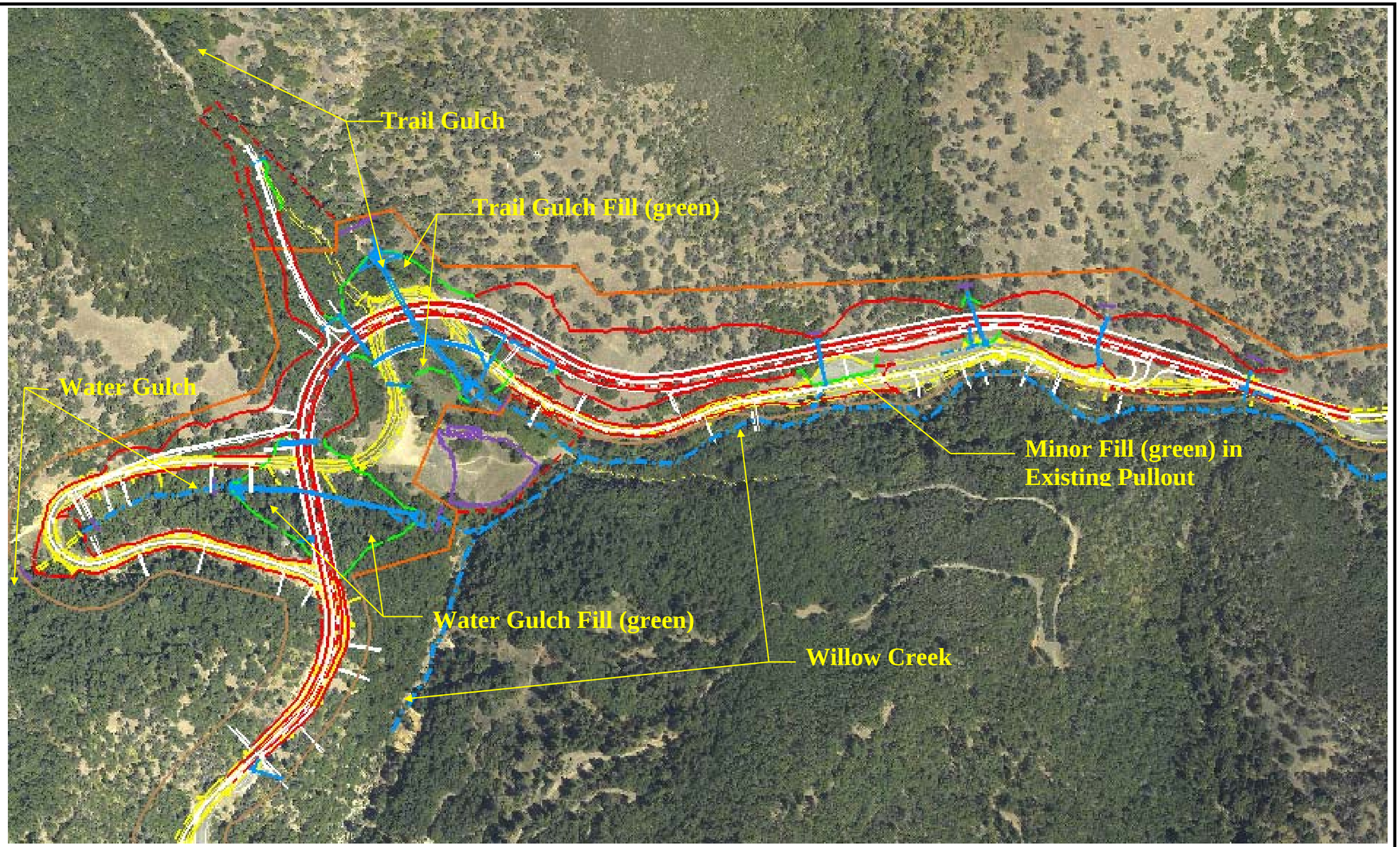
APPENDIX A

Plates 1 - 7



CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E5101 Date: October 2011	**VICINITY MAP**
	02-SHA-299 PM 4.3/5.5 GEOTECHNICAL DESIGN REPORT	Plate No. 1



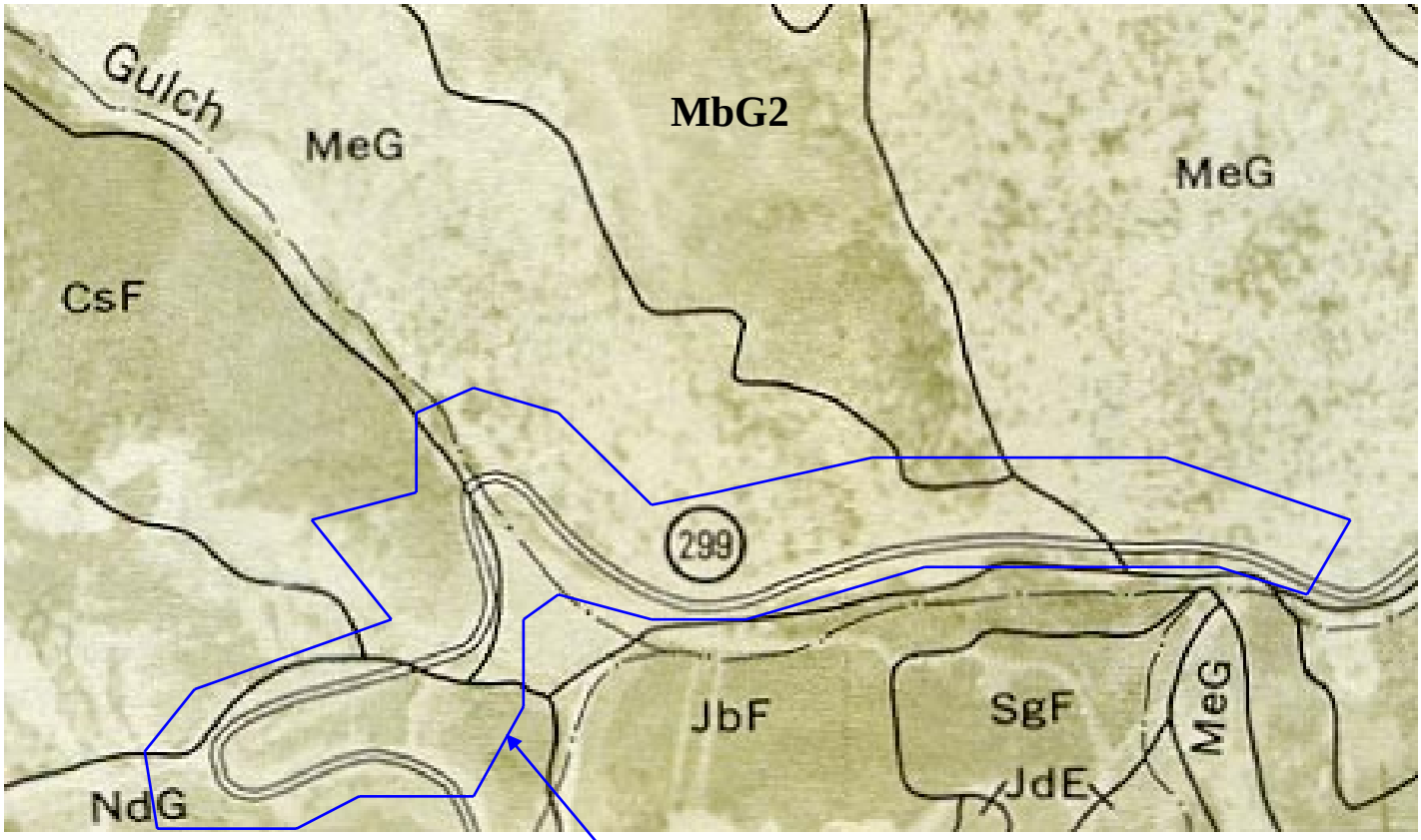
Caltrans	CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E5101 Date: October 2011	**AERIAL VIEW OF PROJECT AREA**
		02-SHA-299 PM 4.3/5.5 **GEOTECHNICAL DESIGN REPORT**	Plate No. 2

Soil Types

CsF Colluvial Land. Heterogenous deposits of soil, 25 – 90% gravel & stones.
MbG2 Maymen Very Stony Loam 30-80% Slopes.
MeG Millsholm Gravelly Loam 50-70% slopes. Slightly acidic gravelly loam over shallow sedimentary or metasedimentary bedrock at ~ 16".
NdG Neuns Very Stony Loam 50-80% Slopes.

N

NO SCALE



Soil Map of Project Area. Soil Map taken from the Soil Survey of Shasta County Area, California, August 1974, by USDA Soil Conservation Service and Forest Service. The soil units within the project area (approximately delimited by blue line), in order from greatest coverage to least coverage are the Millsholm Gravelly Loam 30 to 70% slopes (MeG), Colluvial Land (CsF), the Maymen Very Stony Loam 30 to 80 % Slopes (MbG2), and the Neuns Very Stony Loam (NdG). These soil classifications and descriptions are agriculturally based, not engineering based, and do not follow naming and description protocol of the Caltrans Boring and Logging Manual.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E5101 Date: October 2011	**SOIL MAP of PROJECT AREA**
	02-SHA-299 PM 4.3/5.5 GEOTECHNICAL DESIGN REPORT	Plate No. 3

EXPLANATION
Geologic Units

Quaternary-Recent

Qal — Recent sand and gravel in stream beds

Jurassic - Cretaceous

gn — Gneiss and amphibolite derived from Copley, Balaklala and Bragdon Formations.

Mississippian-Carboniferous

Mbp — **Bragdon Formation.**
Mbp Phyllite created by contact metamorphism of Bragdon Formation with Shasta Bally Batholith

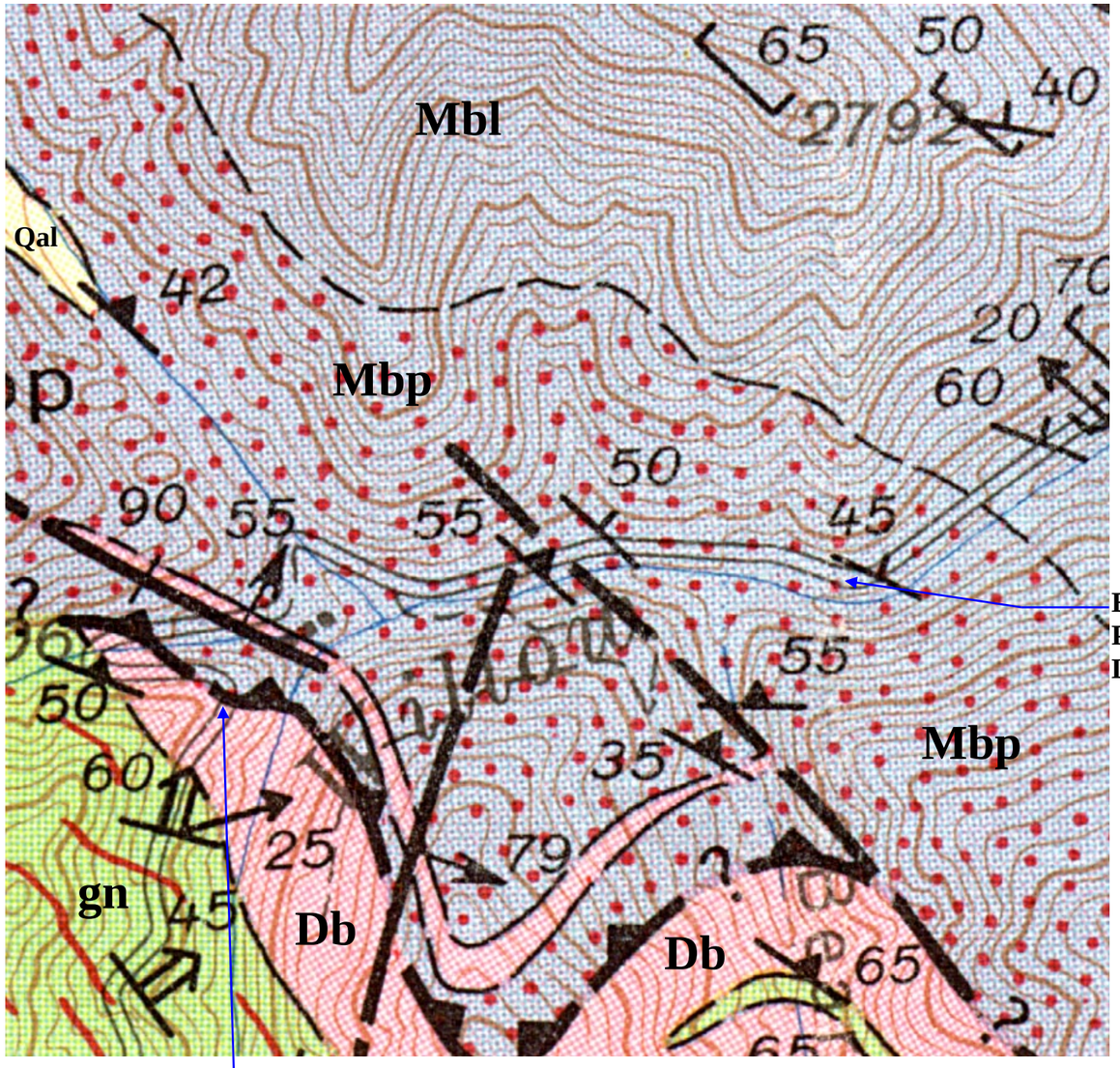
Mbl — **Mbl** Mostly shale, mudstone, & siltstone with subordinate tuff & conglomerate

Devonian

Db — **Balaklala Rhyolite.**
Non-porphyritic quartz keratophyre and quartz keratophyre containing quartz phenocrysts

N

From *Geologic Map and Section of the French Gulch Quadrangle, Shasta and Trinity Counties, California* in *Geology of the French Gulch Quadrangle, Shasta and Trinity Counties, California* by J.P. Albers, 1964.



EXPLANATION
Structural Features

Contact, showing dip
Long dashed where approximately located; short dashed where indefinite; dotted where concealed

Fault, showing dip
Dashed where approximately located; queried where probable; dotted where concealed. U, upthrown side; D, downthrown side

Vertical fault

Spring Creek thrust
Mainly between Bragdon formation and underlying rocks, but in places between Copley greenstone and tuff of the Balaklala rhyolite. Sawteeth on upper plate. Queried where doubtful; dotted where concealed

Plunge of fold axis

Inclined / Vertical
Attitude of beds

Strike and dip of beds and plunge of lineation

Inclined / Vertical
Attitude of schistosity

Strike and dip of schistosity and plunge of lineation

Inclined / Vertical
Attitude of compositional layering in gneiss

Strike and dip of compositional layering in gneiss, and plunge of lineation

Inclined / Vertical
Attitude of primary flow banding in granitic rocks as shown by alined crystals or inclusions

Strike and dip of sheeting

Inclined / Vertical
Attitude of cleavage

Inclined / Vertical
Attitude of joints

Caltrans

CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design-North

EA: 02-2E5101

Date: October 2011

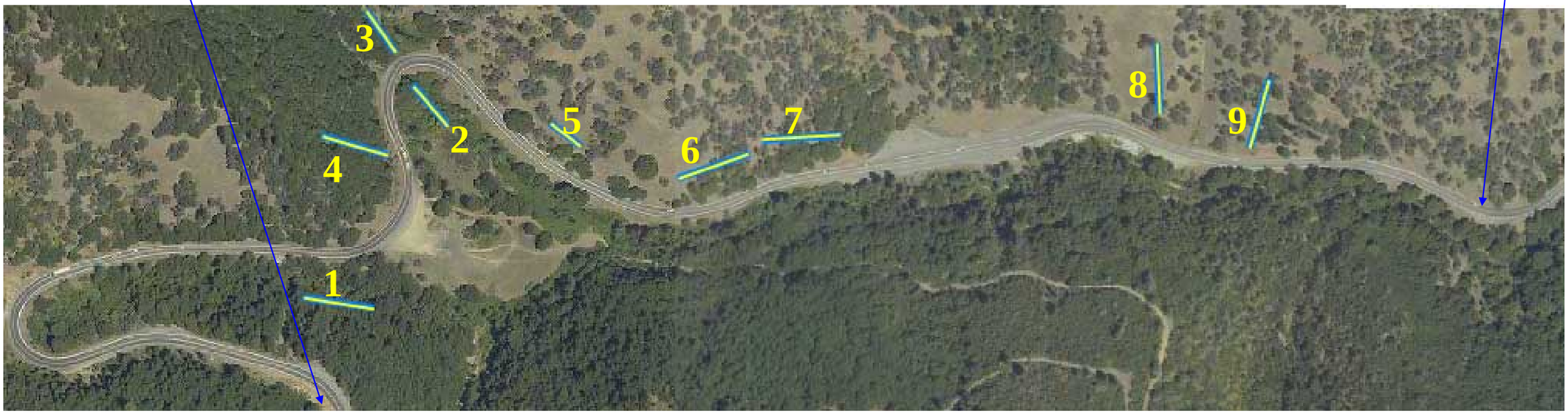
GEOLOGIC MAP

02-SHA-299 PM 4.3/5.5
GEOTECHNICAL DESIGN REPORT

Plate No. 4

Western End
of Project

Eastern End
of Project



Aerial Photo of Project Area with Location of Seismic Refraction Lines. Approximate line locations are indicated by yellow-on-blue lines. Lines 1, 2, and 3 were performed for the Project Foundation Report (FR) to assess the underlying conditions beneath the two proposed culverts, which will be buried beneath the two fills spanning Water Gulch and Trail Gulch. Lines 4 through 9 are located in the locations of proposed cuts.

N

CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design-
North

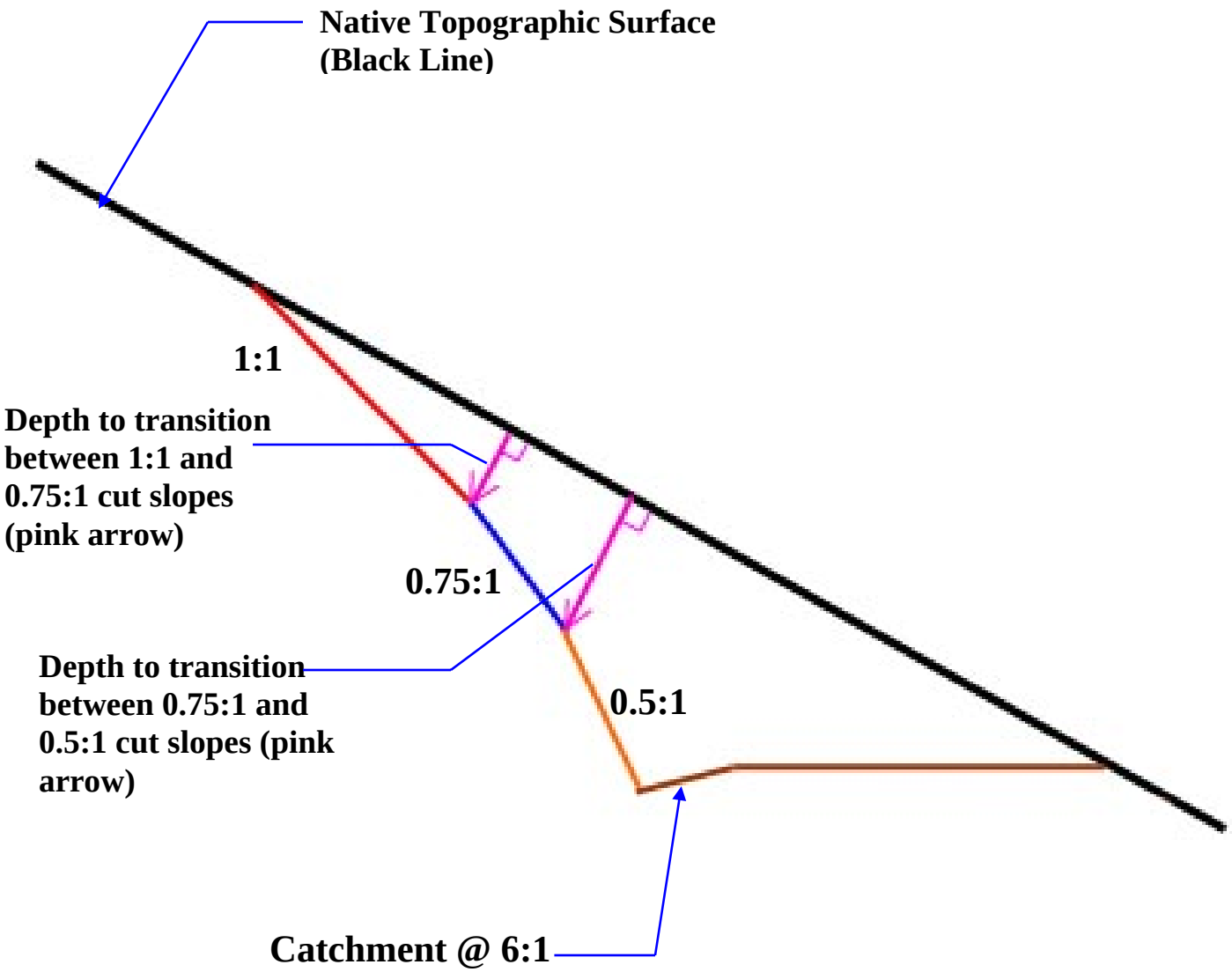
EA: 02-2E5101

Date: October 2011

AERIAL PHOTO OF PROJECT AREA SHOWING LOCATION OF SEISMIC REFRACTION LINES

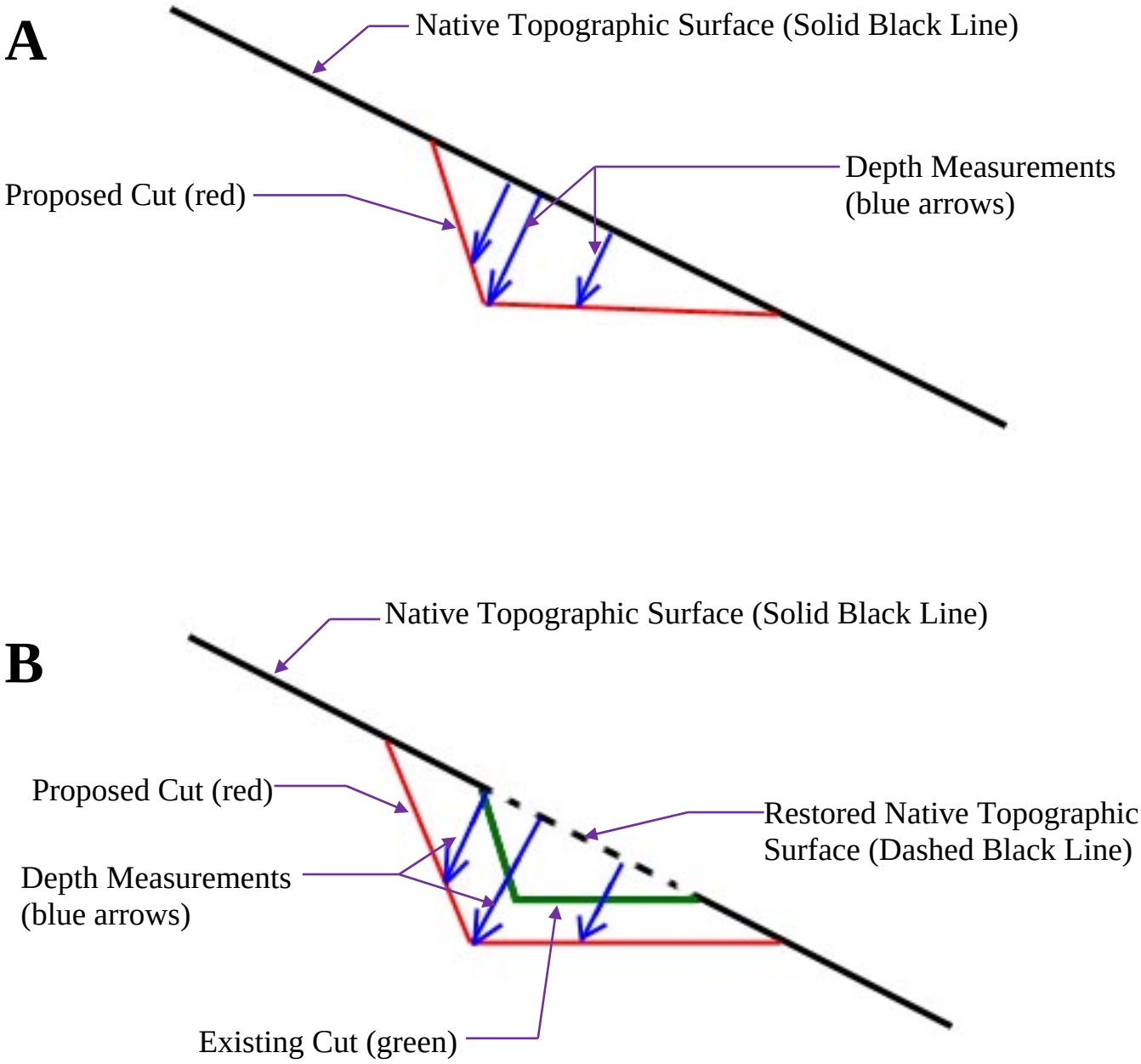
02-SHA-299 PM 4.3/5.5
GEOTECHNICAL DESIGN REPORT

Plate
No.5



Cross-Sectional Drawing Showing a Triple Slope Ratio Cut Slope. The top part of the cut has a slope ratio of 1:1 (red), the middle portion of the cut has a 0.75:1 slope ratio (blue), and the bottom of the cut has a 0.5:1 slope ratio (orange). The catchment has a backslope of 6:1. The depth given in the text (Table 5) at which a transition between slope ratios occurs is determined perpendicular to the native topographic surface, as is shown by the pink arrows. This is based on the fact that increased weathering and rock quality generally increase with depth parallel to the native topographic surface in the project area. This has been demonstrated in seismic refraction profiles and field observations of existing cut slopes.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E5101 Date: October 2011	**TRIPLE SLOPE RATIO CUT SLOPE**
	02-SHA-299 PM 4.3/5.5 GEOTECHNICAL DESIGN REPORT	Plate No. 6



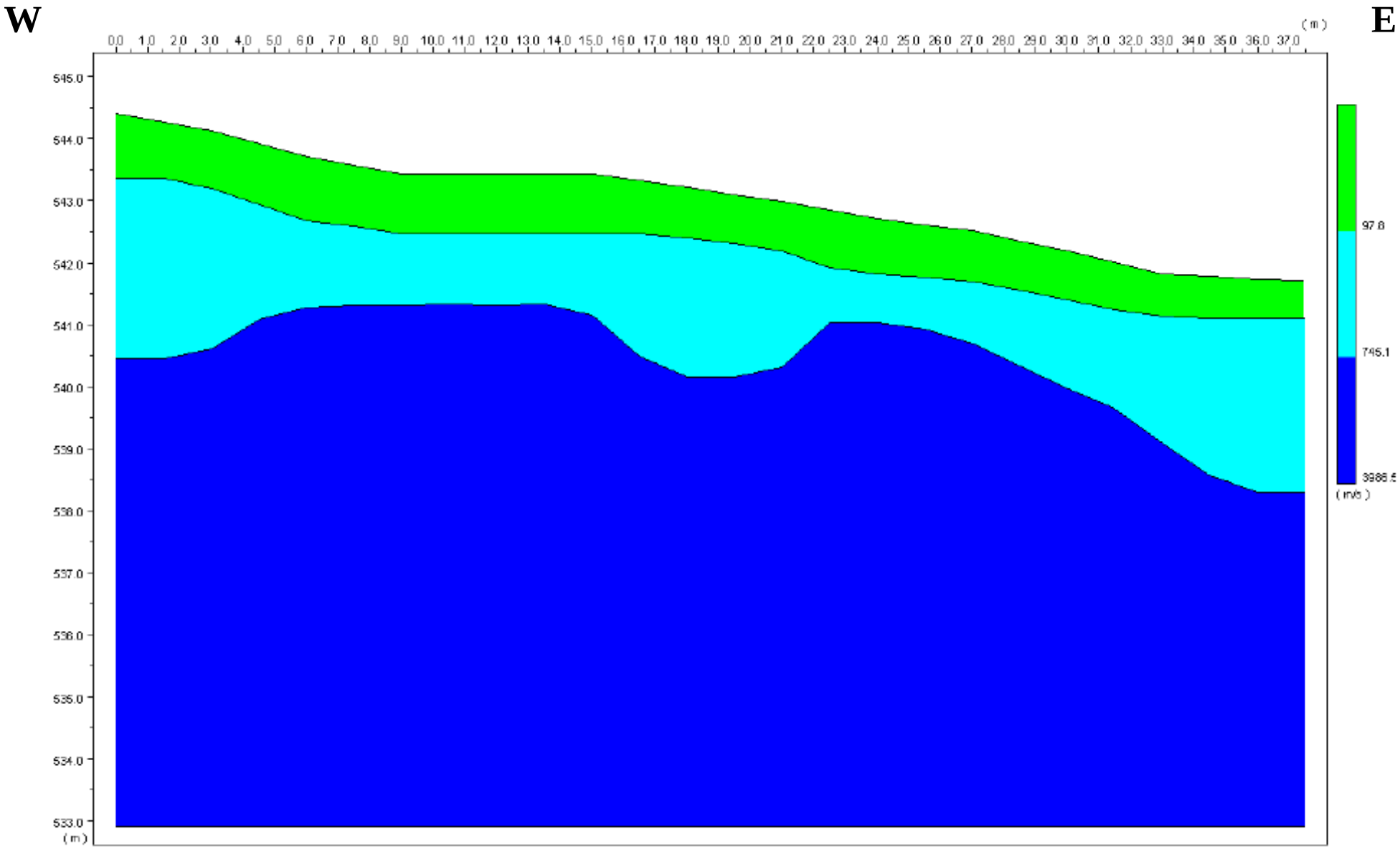
Determining Depth Regarding Rippability Descriptions. Depths cited in the text regarding rippability are determined perpendicular to the original ground surface (solid heavy black line), based on the fact that weathering generally parallels (or sub-parallels) the native topographic surface within the project area. **(A)** Depth (blue arrows) is determined relative to, and perpendicular to, the native topographic surface. The proposed cut is shown in red. **(B)** Depth (blue arrows) is still determined relative to, and perpendicular to, the native topographic surface. In this case, where a 60-year-old cut already exists (green lines), the depths are taken from a line (bold black dashed line) interpolated across the existing cut that best restores the original native topographic surface.

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-2E5101 Date: October 2011	**DEPTH MEASUREMENT for RIPPABILITY**
	02-SHA-299 PM 4.3/5.5 GEOTECHNICAL DESIGN REPORT	Plate No. 7

APPENDIX B

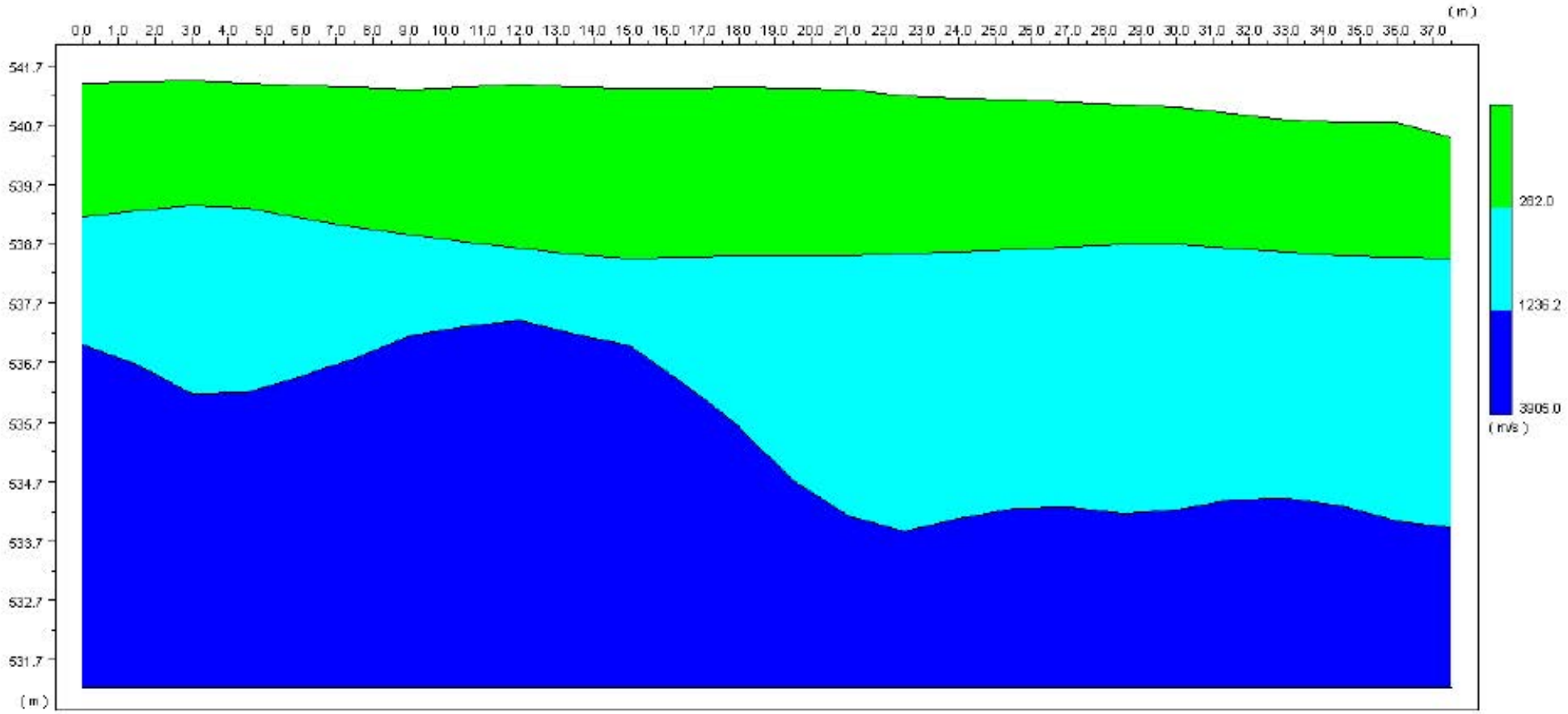
SEISMIC REFRACTION DEPTH SECTIONS

LINE 1



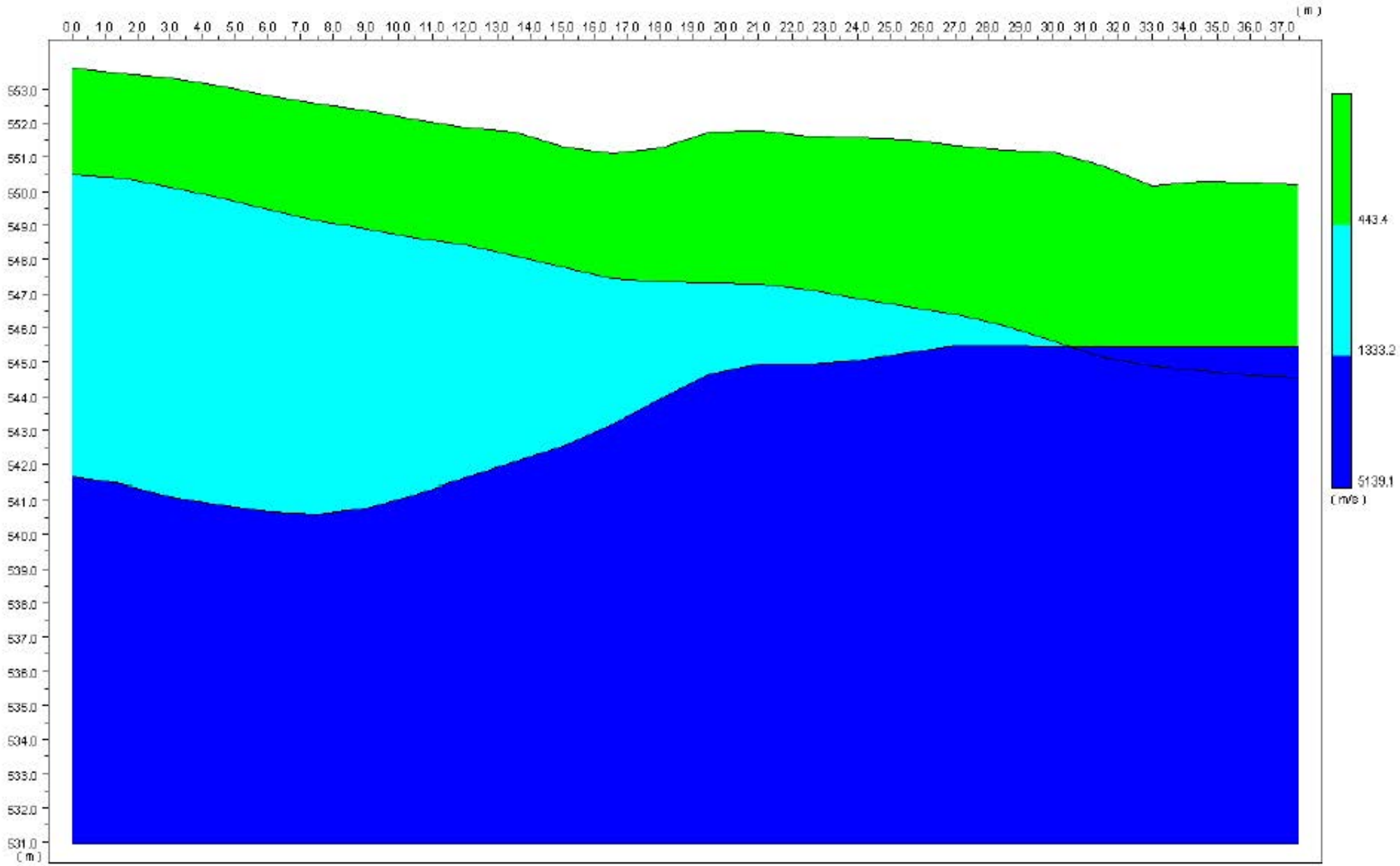
LINE 2

N **S**


(m)
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 36.0 37.0
541.7
540.7
539.7
538.7
537.7
536.7
535.7
534.7
533.7
532.7
531.7
(m)
282.0
1236.2
3905.0
(m/s)

LINE 3

N **S**


(m)
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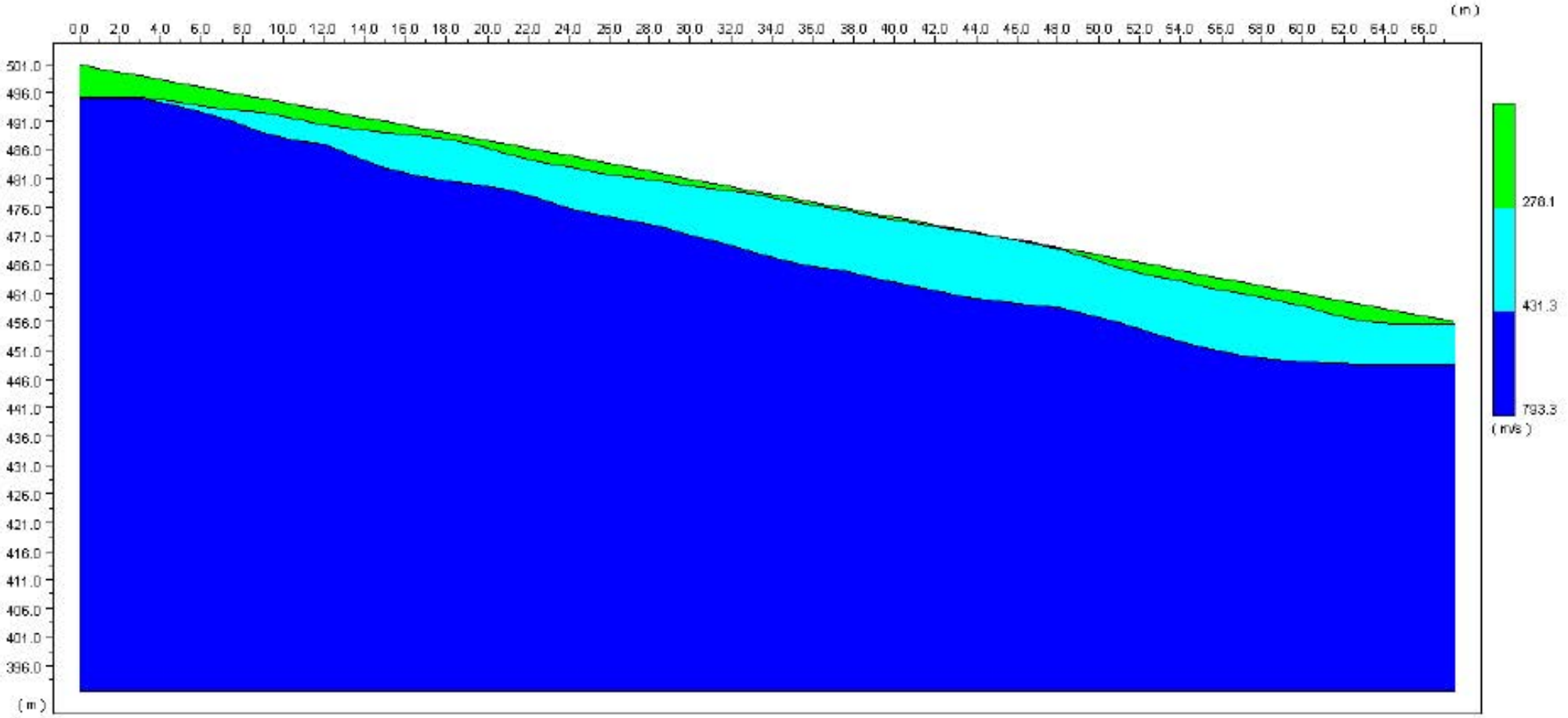
553.0
552.0
551.0
550.0
549.0
548.0
547.0
546.0
545.0
544.0
543.0
542.0
541.0
540.0
539.0
538.0
537.0
536.0
535.0
534.0
533.0
532.0
531.0
(m)
443.4
1333.2
5139.1
(m/s)

LINE 4

W **E**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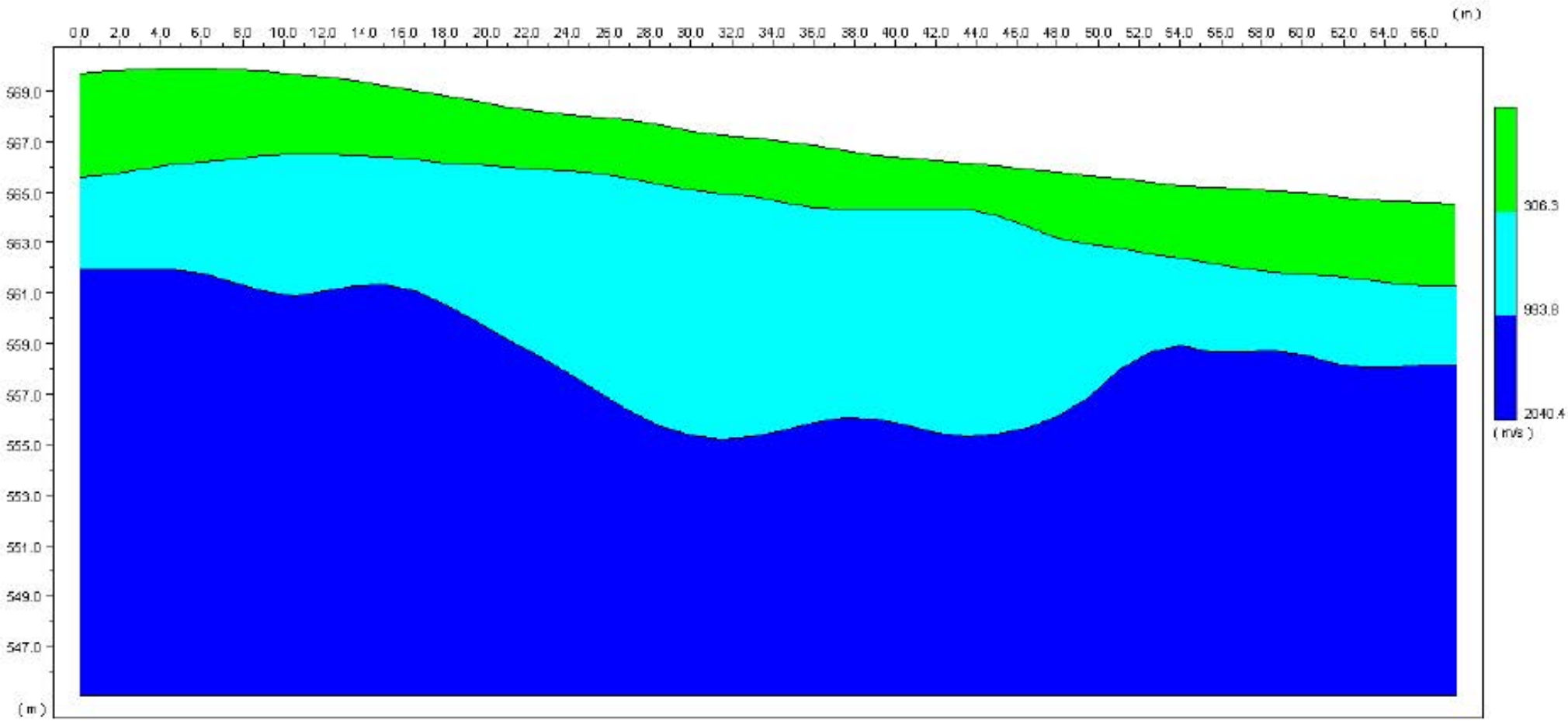
501.0
496.0
491.0
486.0
481.0
476.0
471.0
466.0
461.0
456.0
451.0
446.0
441.0
436.0
431.0
426.0
421.0
416.0
411.0
406.0
401.0
396.0
(m)
278.1
431.3
793.3
(m/s)

LINE 5

W **E**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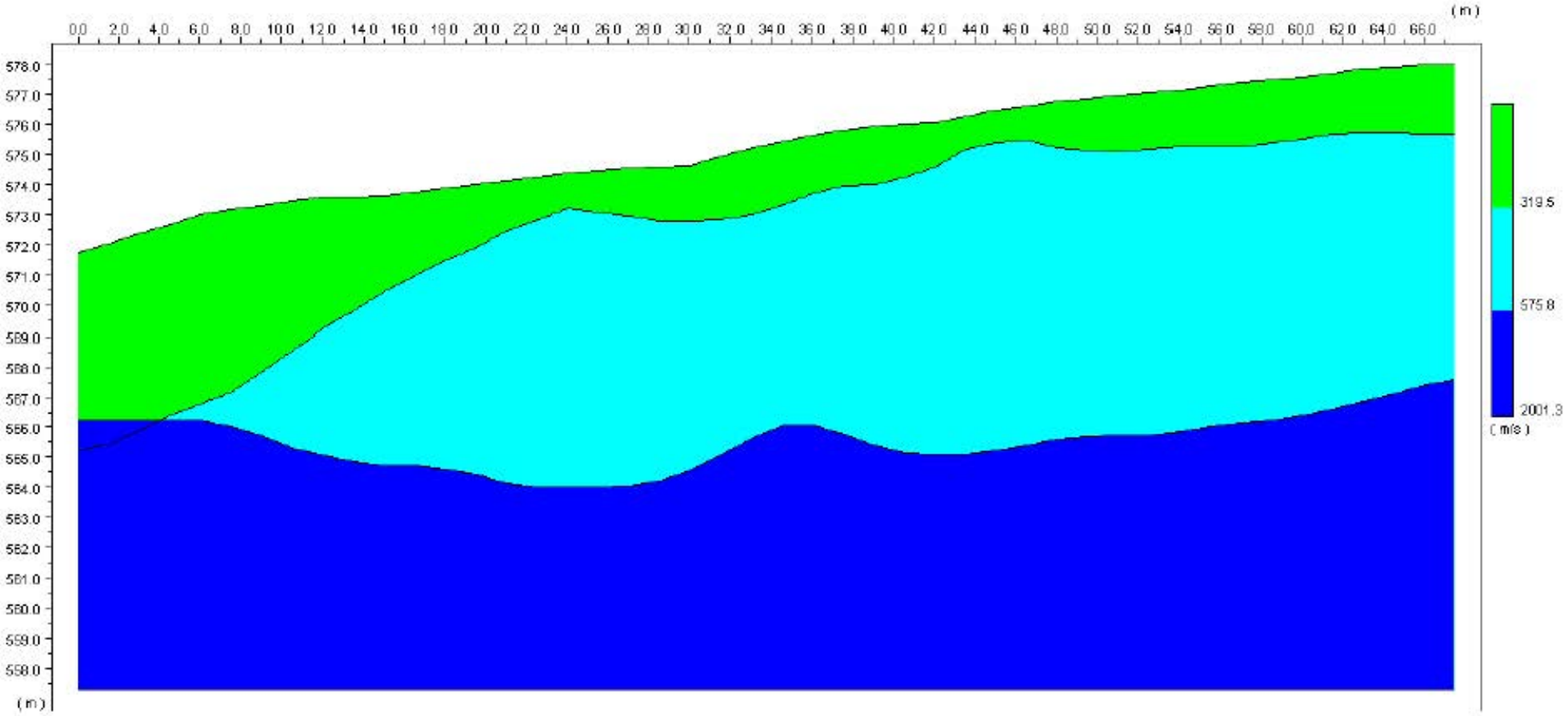
569.0
567.0
565.0
563.0
561.0
559.0
557.0
555.0
553.0
551.0
549.0
547.0
(m)
306.3
983.8
2040.4
(m/s)

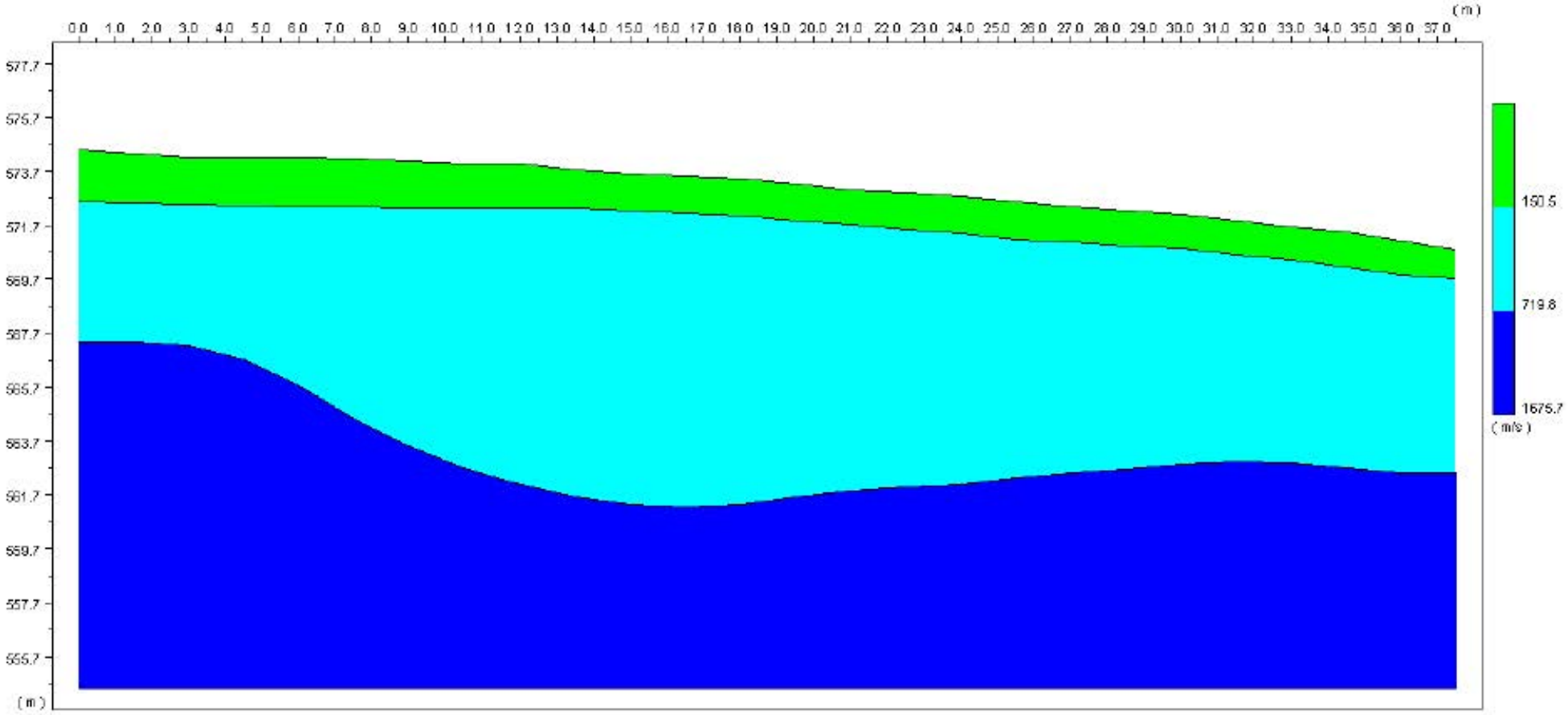
LINE 6

W **E**


(m)
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0 22.0 24.0 26.0 28.0 30.0 32.0 34.0 36.0 38.0 40.0 42.0 44.0 46.0 48.0 50.0 52.0 54.0 56.0 58.0 60.0 62.0 64.0 66.0
578.0
577.0
576.0
575.0
574.0
573.0
572.0
571.0
570.0
569.0
568.0
567.0
566.0
565.0
564.0
563.0
562.0
561.0
560.0
559.0
558.0
(m)
319.5
575.8
2001.3
(m/s)

LINE 7

W **E**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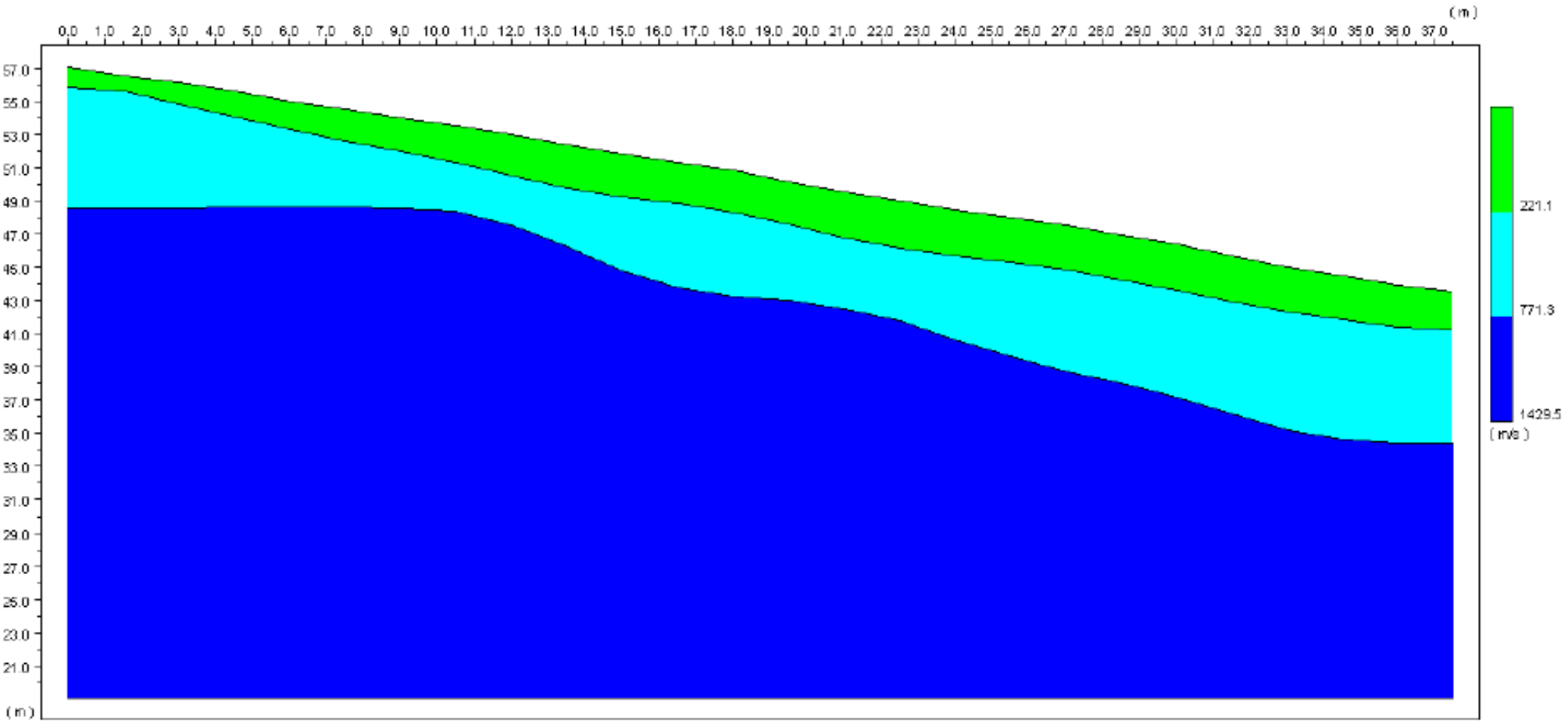
577.7
575.7
573.7
571.7
569.7
567.7
565.7
563.7
561.7
559.7
557.7
555.7
(m)
150.5
719.8
1675.7
(m/s)

LINE 8

W **E**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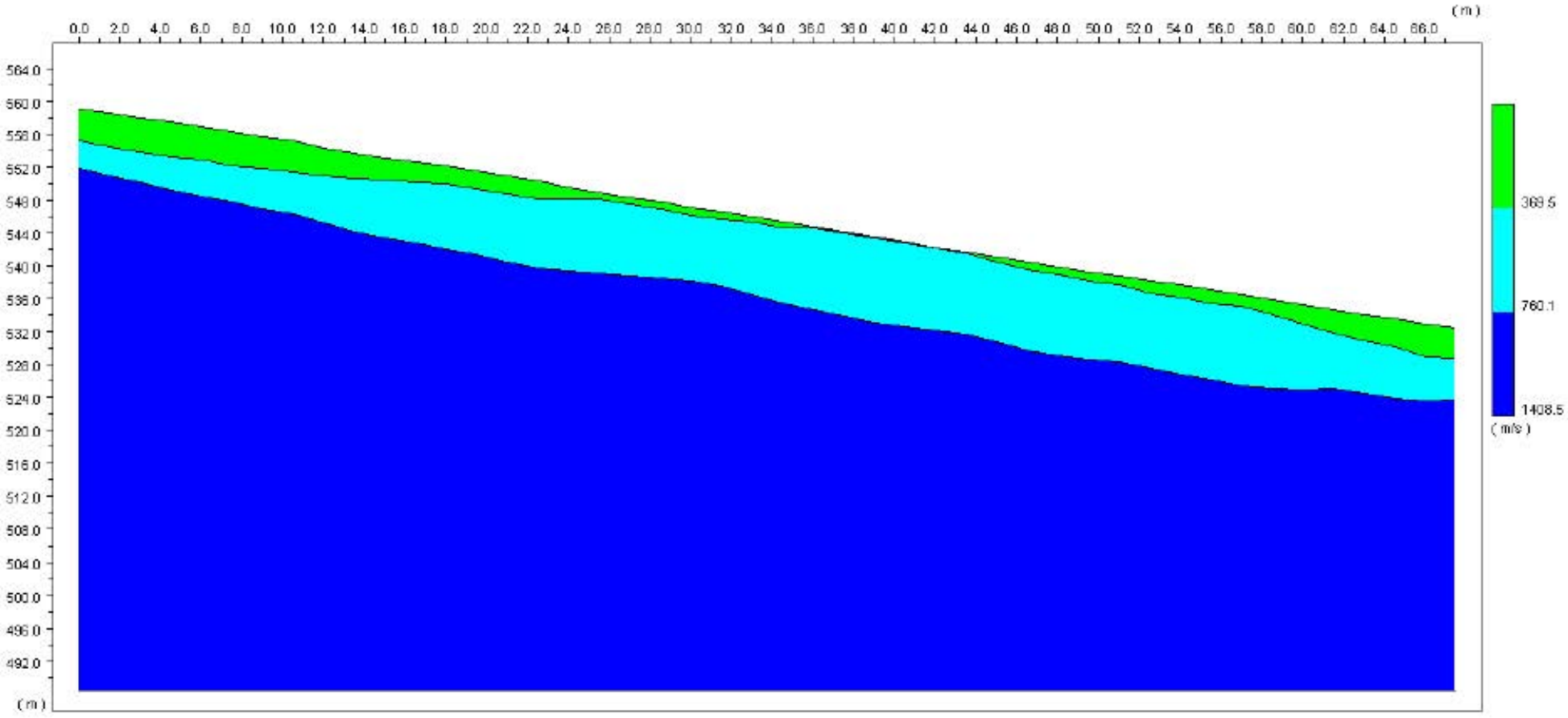
57.0
55.0
53.0
51.0
49.0
47.0
45.0
43.0
41.0
39.0
37.0
35.0
33.0
31.0
29.0
27.0
25.0
23.0
21.0
(m)
221.1
771.3
1429.5
(m/s)

LINE 9

W **E**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564.0
560.0
556.0
552.0
548.0
544.0
540.0
536.0
532.0
528.0
524.0
520.0
516.0
512.0
508.0
504.0
500.0
496.0
492.0
(m)
369.5
760.1
1408.5
(m/s)

APPENDIX C

Laboratory Tests

1. OGDN pH & Resistivity
2. OGDN Direct Shear
3. OGDN PI and Gradation
4. SHN Tests (Gradation, Atterberg (PI), Direct Shear, Consolidation, Corrosion)

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C 824238

- [x] PRELIMINARY TESTS
- [ ] PROCESS TESTS
- [ ] ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS

- [ ] DIST. LAB
- [ ] TRANS. LAB
- [ ] SPECIAL TESTS

SAMPLE SENT TO:

- [ ] HDQTRS. LAB
- [ ] BRANCH LAB
- [x] DIST. LAB

FIELD NO. TG511

DIST. LAB NO.

LOT NO. D74561

SHIPMENT NO.

P.O. OR REQ. NO.

AUTHORIZATION NO. 02-3E410

SAMPLE OF SOIL

FOR USE IN EMBANKMENTS

SAMPLE FROM HILLSIDE

DEPTH 0-6"

LOCATION OF SOURCE ON SIDE OF ROAD

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS)	AND IS ONE OF A GROUP OF	SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.)
1		

OWNER OR MANUFACTURER

TOTAL QUANTITY AVAILABLE	TEST RESULTS DESIRED [ ] NORMAL [ ] PRIORITY	DATE NEEDED

REMARKS CORROSION (pH and Resistivity)

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 8-26-11

BY SCOTT LEWIS TITLE ENGINEERING GEO

DIST, CO, RTE, PM 02-SHA-299 60

LIMITS

CONT. NO. CALL SCOTT AJ

FED. NO.

RES. ENGR. OR SUPT. 3516 With Pics/Info

ADDRESS

CONTRACTOR

MAIL TO SAME DESTINATION AS SAMPLE

...g Form - California Test 643

Corrosion Test No. D74561 EA: 02-3E410K

Tested By: Terry Inhc Date: 9-7-11

Total Water Added (milliliters)	Soil Sample Resistance (Ohms)
15	13000
25	6400
30	4100
35	3900
40	4000

Minimum Soil Resistance, R_{min-T}

R_{min-T} = 3900 (Ohms)

Resistance of Water, R_T

R_T = _____ (Ohms)

Sample Temperature, T

T= 21.0 °C

Minimum Resistance of soil sample corrected to 15.5° C, $R_{min-15.5}$

$R_{min-15.5} = \frac{R_{min-T}(24.5+T)}{40}$ (3900, 21.0)

$R_{min-15.5}$ = 4436 (Ohms)

Minimum Soil Resistivity, $\rho_{min-15.5}$

$\rho_{min-15.5} = R_{min-15.5}$ x (Soil Box Constant)*

$\rho_{min-15.5}$ = _____ (Ohm-cm)

Resistance of water sample corrected to 15.5° C, $R_{15.5}$

$R_{15.5} = \frac{R_T(24.5+T)}{40}$

$R_{15.5}$ = _____ (Ohms)

Resistivity of Water Sample, $\rho_{15.5}$

$\rho_{15.5} = R_{15.5}$ x (Soil Box Constant)*

$\rho_{15.5}$ = _____ (Ohm-cm)

pH Value

Soil	Water
pH= 6.19	pH= _____

*Where: Soil Box Constant for Small Box=1 cm and for Large Box=6.76 cm

California Test 643
June 2007

DIVISION OF
ENGINEERING SERVICES
OFFICE OF GEOTECHNICAL SUPPORT
GEOTECHNICAL LABORATORY
5900 Folsom Boulevard
Sacramento, CA 95819

Date: 8/31/2011

To: Scott Lewis / GDN

From: Lilibeth C. Purta / (916) 227-5239

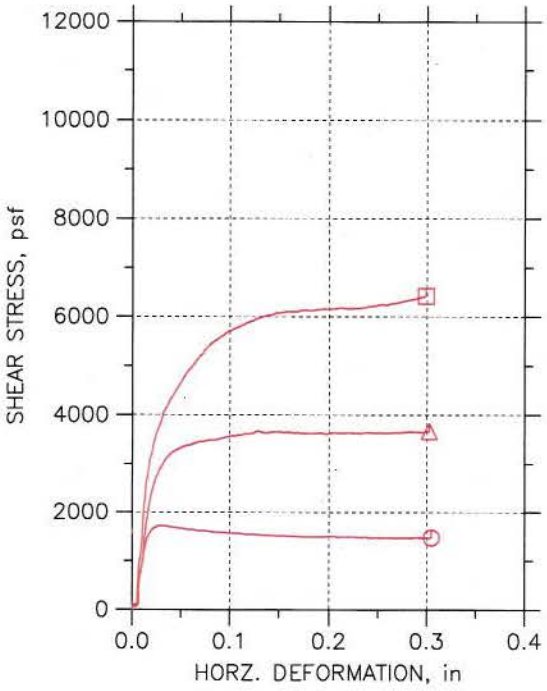
RE: Laboratory Test Report -- EA: 02-2E5101
GL 11-066

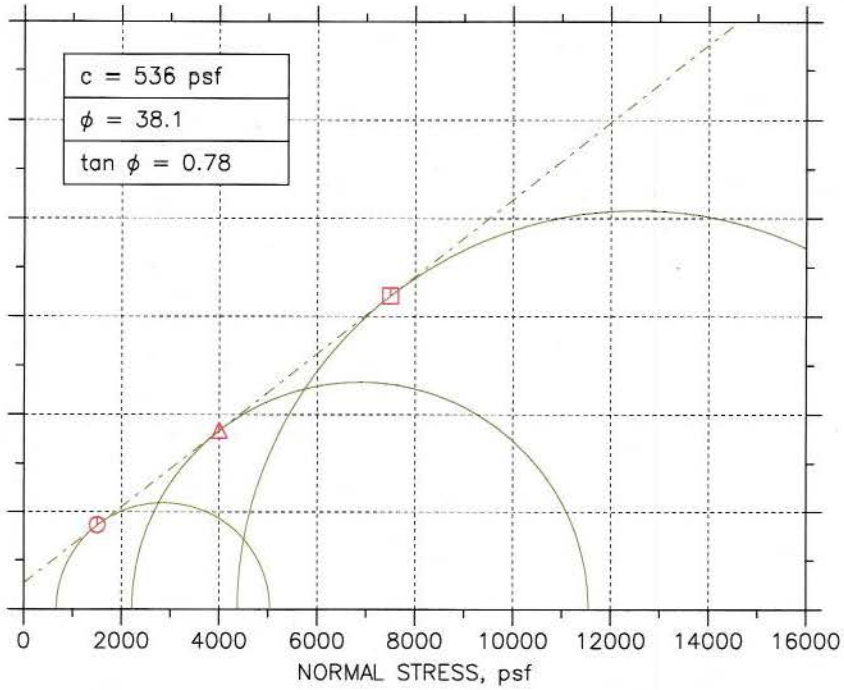
Final test results.

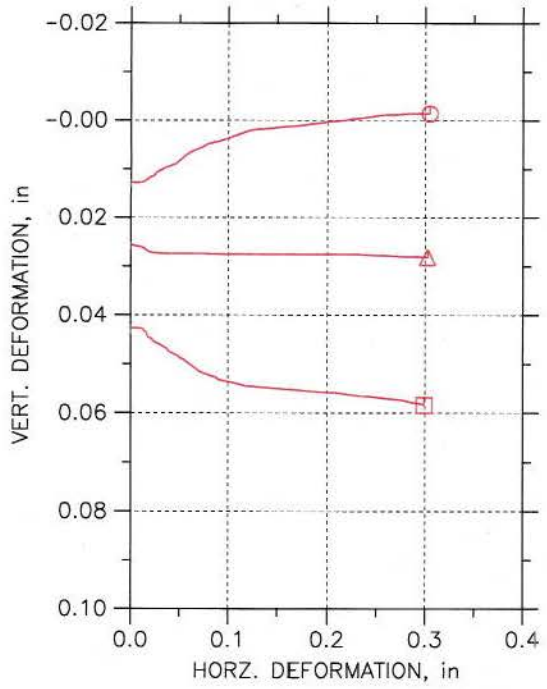
Note: All remaining test specimens will be disposed of in 30 calendar days from the release date of the final test results.

AASHTO R18

DIRECT SHEAR TEST REPORT







Symbol		⊙	△	⊡	
Test No.		DS11051A	DS11051B	DS11051C	
Sample No.		TGS196_1	TGS196_1	TGS196_1	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.944	1.944	1.944	
	Area, in^2	2.9681	2.9681	2.9681	
	Height, in	1	1	1	
	Water Content, %	12.77	12.34	12.34	
	Dry Density, pcf	102.55	102.94	102.94	
	Saturation, %	52.08	50.83	50.83	
	Void Ratio	0.67405	0.66779	0.66779	
Consol. Height, in		0.98734	0.97492	0.95787	
Consol. Void Ratio		0.65286	0.62597	0.59753	
Final	Water Content, %	22.03	20.82	20.70	
	Dry Density, pcf	102.41	105.92	109.32	
	Saturation, %	89.56	92.24	99.79	
	Void Ratio	0.67634	0.62079	0.57041	
Normal Stress, psf		1503.7	3998.9	7497.5	
Max. Shear Stress, psf		1718.3	3670.5	6421.1	
Ult. Shear Stress, psf		1468.7	3667.9	6419.8	
Time to Failure, min		6.6804	26.698	59.625	
Disp. Rate, in/min		0.005	0.005	0.005	
Implied Specific Gravity		2.75	2.75	2.75	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: TwinGulchesCurveImproveme
Location: 02-SHA-299-4.3/5.5
Project No.: 02-2E5101
Boring No.:
Sample Type: REMOLD
Description: Brown, Silty Clay. Remolded to 90% RC
Remarks: ASTM D 3080.

8/31/11

Wed, 31-AUG-2011 09:25:25

DIRECT SHEAR
JOB : 02-2E5101
SAMPLE : TGS196_1
Test Specimen A

DIRECT SHEAR
JOB : 02-2E5101
SAMPLE : TGS196_1
Test Specimen B

DIRECT SHEAR
JOB : 02-2E5101
SAMPLE : TGS196_1
Test Specimen C

Division of Engineering Services
Geotechnical Laboratory

Compaction Curve

CTM 216

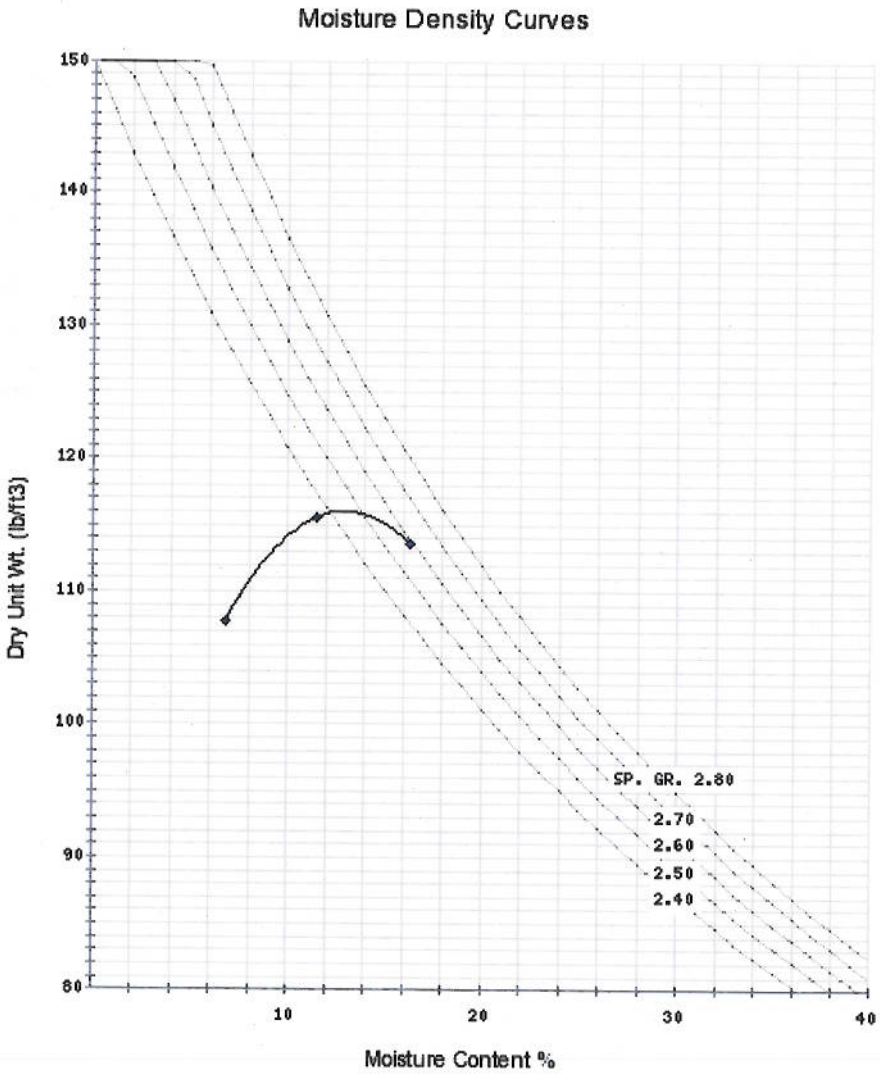
Dist-EA: 02-2E5101
Dist-Co-Rte-PM: SHA-299-4.3/5.5
Sample ID: TGS196_1
GI Tracking No.: 11-066

Maximum Dry Density: 116.0 pcf
Optimum Moisture: 13.0 %
Moisture (as Received:) 4.0 %
Approved: August 23, 2011

Trial No.	Moisture Adjustment	Tamper Reading	Wet + Tare Weight (g)	Dry + Tare Weight (g)	Tare (g)	Moisture Content (%)	Dry Unit Weight (pcf)
1	100	11.25	3013	2874	814	6.7	107.7
2	200	10.50	3042	2805	742	11.5	115.6
3	300	10.70	3148	2810	744	16.4	113.6
4							
5							
6							

Soil Description : BROWN SILTY CLAY

Remarks:



STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

REPORT OF TESTS ON SOILS, BASES & SUBBASES

TL-0361 (REV. 1/2004)

TEST NO.	DATE RECEIVED	APPROVED BY	
D74562	8-29-11	TRM	☐ DIS. MAT'LS. ENGR. ☐ TRANS. LAB
	CALC. BY: DMR TRM	DATE REPORTED: 9/12/11	☐ RESIDENT ENGINEER ☒ Scott Lewis

GRADING ANALYSIS

SIEVE	AS RECEIVED	RET. CR.	ADJ. OR COMB. GRADE	AS USED	☐ SPECIF. LIMITS ☐ SOUGHT
75 mm					
63 mm					
50 mm					
37.5mm					
25.0 mm	100				
19.0 mm	100				
12.5 mm	99				
9.5 mm	97				
4.75 mm	96				
2.36 mm	91				
1.18 mm	82				
600 µm	74				
300 µm	69				
150 µm	65				
75 µm	62				
5 µm					
1 µm					

REMARKS:

REPORT OF TESTS ON

Soil Embankment

IF CONTRACT, USE CONTRACT ITEM

SOURCE	CHARGE	EXPENDITURE AUTHORIZATION
		3E410

SPECIAL DESIGNATION (USE WHEN APPLICABLE)	ACTIVITY OR OBJECT	SUBJOB

TEST SPECIMEN	A	B	C	D	E
BATCH MASS					
DATE TESTED					
COMPACTOR FOOT PRESSURE kPA					
INITIAL MOISTURE %					
SOAK WATER mL					
WATER ADDED-mL (TOTAL)					
WATER ADDED %					
MOISTURE AT COMPACTION %					
WET. WT. OF BRIQUETTE -gms					
HEIGHT OF BRIQUETTE -mm					
DRY DENSITY OF BRIQ.-kg/m³					
STABILOMETER P_H AT 8900 N-kPa					
DISPLACEMENT					
R-VALUE BY STABILOMETER					
EXUDATION PRES. MPa					
THICK, BY STAB. mm					
EXPANSION DIAL READING-mm					
THICK, BY EXP. PRESS. mm					

TRM **TEST RESULTS** SPEC.

LL. 41 P.L. 32 P.I. 9

CV

SP. GR. ☐ BULK (OVEN DRY) ☐ BULK (SSD) ☐ APPARENT

			FINE	COARSE
SURFACE	S.E.	AS REC'D.	AS REC'D		
BASE		CRUSHED	CRUSHED		
SUBBASE		COMBINED	**REL. COMPACTION DATA**		
	LART GRADE	100 REV.		IN PLACE	OPTIMUM
GRAVEL EQUIVALENT FACTOR		500 REV.	DENSITY		
TRAFFIC INDEX	DUR.	D_f	MOISTURE		
R VALUE EXUDATION PRESSURE		D_c	% REL. COMP.		
R VALUE EXPANSION PRESSURE	% CRUSHED PARTICLES		SPEC.		
R VALUE AT EQUILIBRIUM SPEC.	% MOISTURE BY O.D.				

INDICATED MINIMUM THICKNESS OF COVER FOR ABOVE CONDITIONS - m

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

SAMPLE IDENTIFICATION CARD

TL-0101 (REV. 10/97)

CARD NUMBER C 824237

☒ PRELIMINARY TESTS
☐ PROCESS TESTS
☐ ACCEPTANCE TESTS

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE SENT TO:
☐ HDQTRS. LAB
☐ BRANCH LAB
☒ DIST. LAB

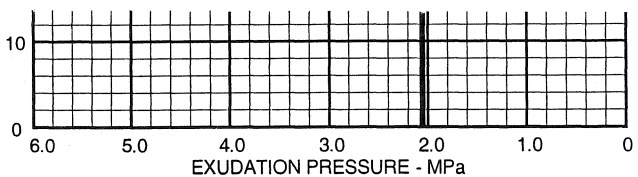
FIELD NO. TG S10
DIST. LAB NO. D74562
LOT NO.
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO. 02-3E410

SAMPLE OF SOIL
FOR USE IN EMBANKMENT
SAMPLE FROM HILLSIDE
DEPTH 0-8"
LOCATION OF SOURCE ON SITE

THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1
AND IS ONE OF A GROUP OF 1
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.)
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☑ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS GRADATION & ATTERBERG LIMITS

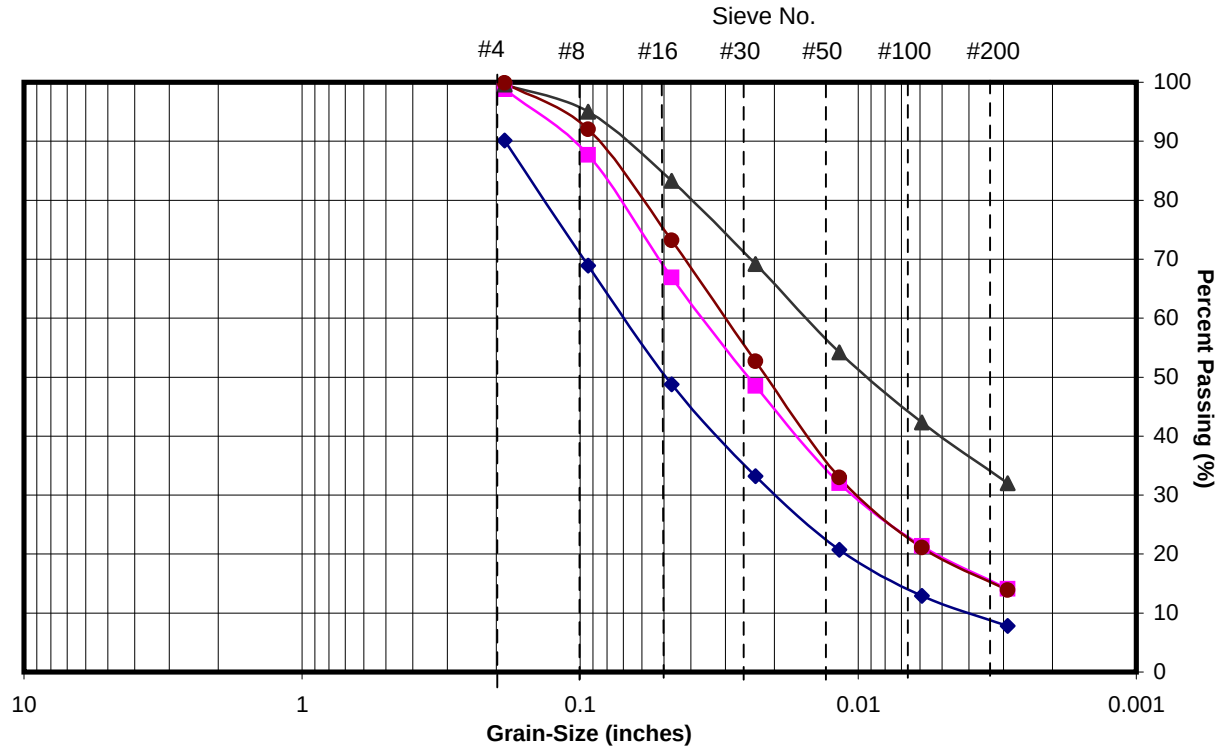
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 9-26-11
BY SCOTT LEWIS TITLE ENGINEERING GEO
DIST, CO, RTE, PM 02-SIA-299-4.5
LIMITS CALL SCOTT AT
CONT. NO. 3516 WITH QUESTIONS
FED. NO.
RES. ENGR. OR SUPT.
ADDRESS
CONTRACTOR

MAIL TO SAME DESTINATION AS SAMPLE



Project:	Buckhorn Grade	**Project No.:**	502001.02
Location of Project:	Shasta Co., CA	**Tested By:**	SHN
Client:	Caltrans	**Date of Testing:**	09/17/2002

GRAIN-SIZE DISTRIBUTION



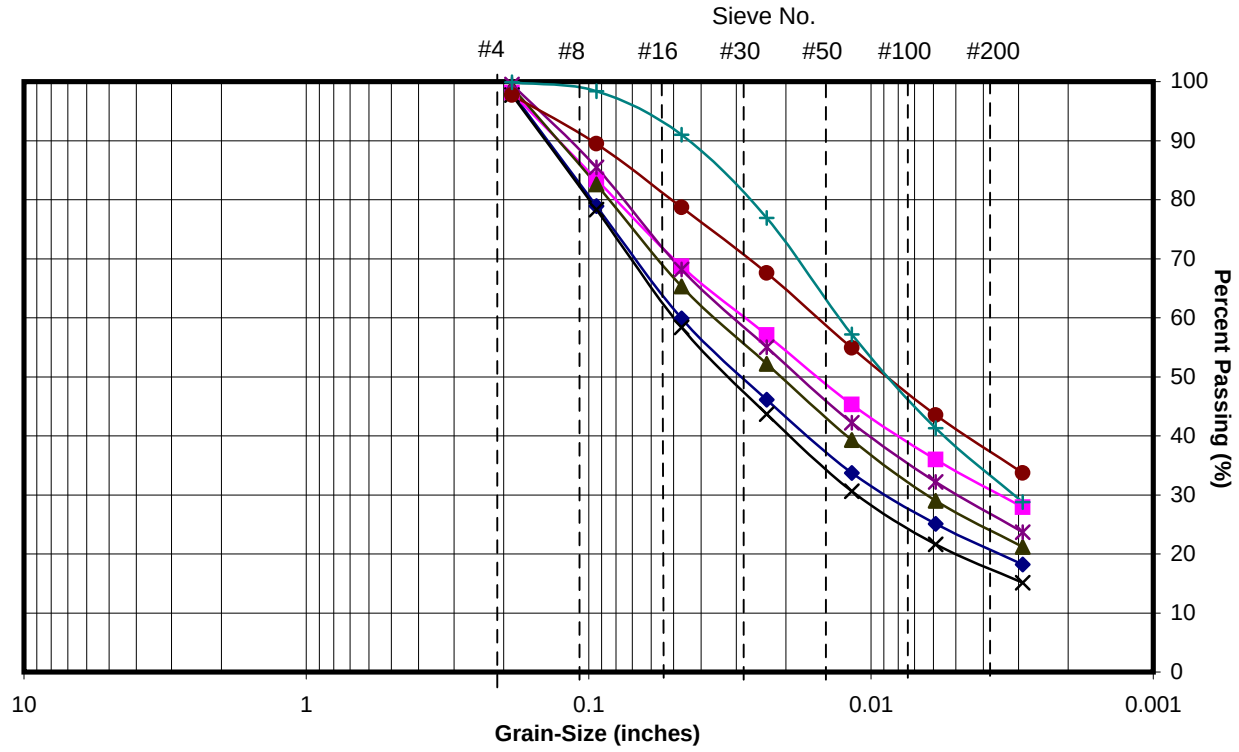
Drill Hole No.	B02-1	B02-1	B02-1	B02-1			
Sample	2	3	4	5			
Depth (ft)	10	15	20	25			
Sieve (inches)	**Percent Passing (%)**						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	90.1	98.8	99.6	99.9			
0.0929	68.9	87.7	95	92			
0.0465	48.8	66.9	83.3	73.2			
0.0236	33.2	48.5	69.2	52.7			
0.0118	20.7	32	54.2	33			
0.00591	12.9	21.4	42.3	21.1			
0.00295	7.8	14.1	32	13.9			

Borehole B02-1
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.021
Tested By: SHN
Date of Testing: 09/17/2002

GRAIN-SIZE DISTRIBUTION



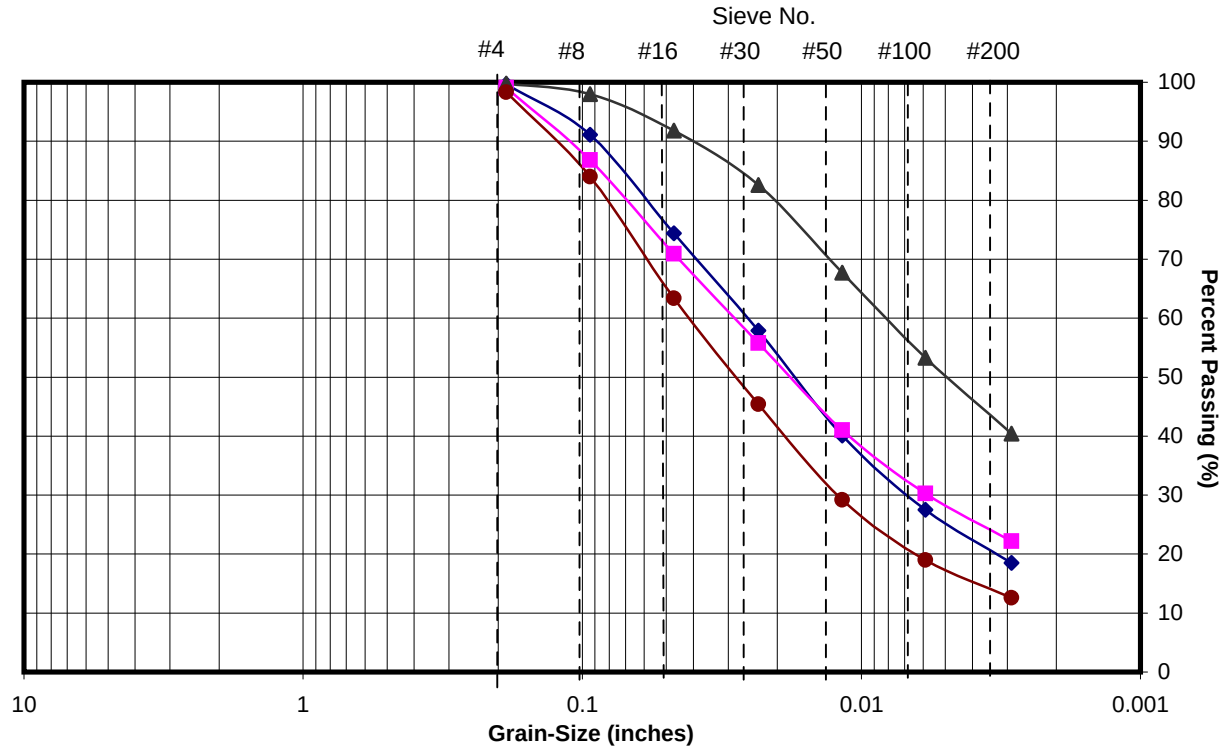
Drill Hole No.	B02-2	B02-2	B02-2	B02-2	B02-2	B02-2	B02-2
Sample	2	3	4	5	6	7	9
Depth (ft)	10	15	20	25	30	35	45
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	98.1	98.1	99	97.7	99.5	97.7	99.9
0.0929	78.9	83.4	82.6	78.3	85.5	89.5	98.4
0.0465	59.9	68.7	65.3	58.4	68.2	78.7	91
0.0236	46.1	57.1	52.2	43.7	55	67.6	76.9
0.0118	33.7	45.3	39.3	30.6	42.2	54.9	57.2
0.00591	25.1	36	29	21.6	32.2	43.5	41.3
0.00295	18.2	27.9	21.2	15.1	23.7	33.7	28.8

Borehole B02-2
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

GRAIN-SIZE DISTRIBUTION

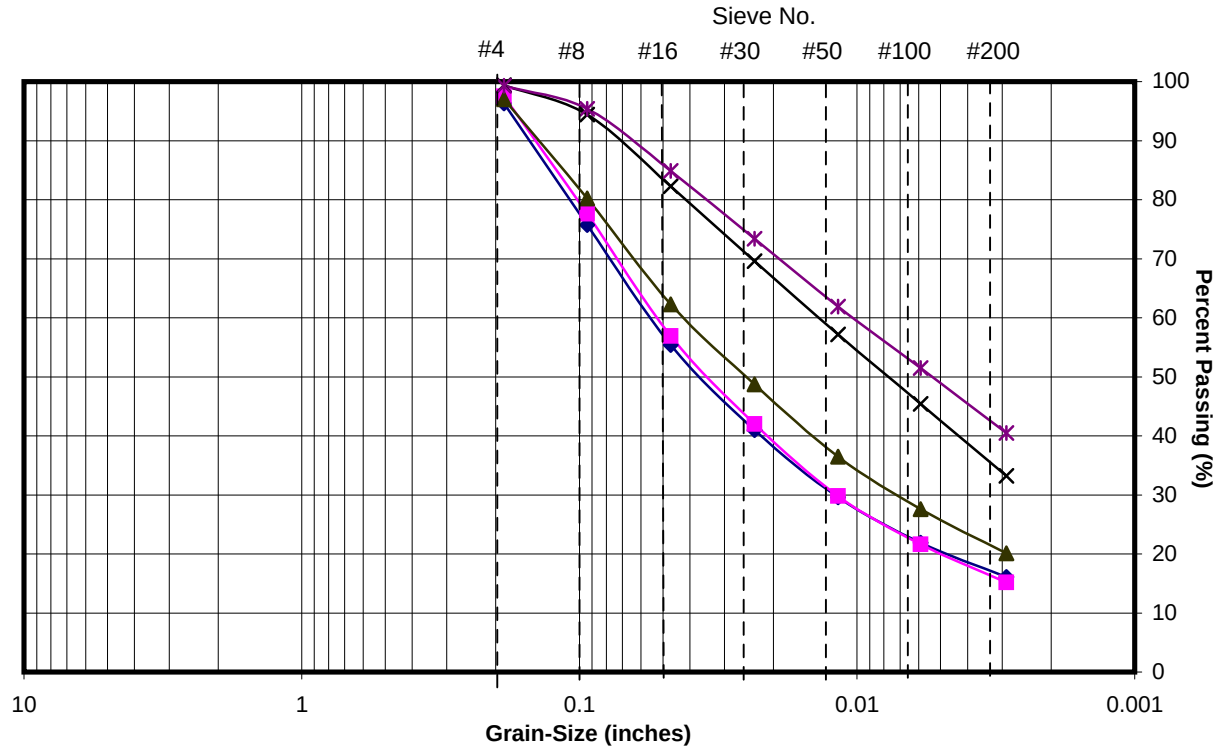


Drill Hole No.	B02-3	B02-3	B02-3	B02-3			
Sample	1	2	3	4			
Depth (ft)	5	10	15	20			
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	99.7	99.1	99.8	98.3			
0.0929	91.1	86.8	98	84			
0.0465	74.4	70.9	91.8	63.4			
0.0236	57.9	55.8	82.6	45.4			
0.0118	40.1	41	67.7	29.2			
0.0059	27.5	30.3	53.3	19			
0.0029	18.5	22.2	40.4	12.6			

Borehole B02-3
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.02
Location of Project:	Shasta Co., CA	**Tested By:**	SHN
Client:	Caltrans	**Date of Testing:**	09/17/2002

GRAIN-SIZE DISTRIBUTION

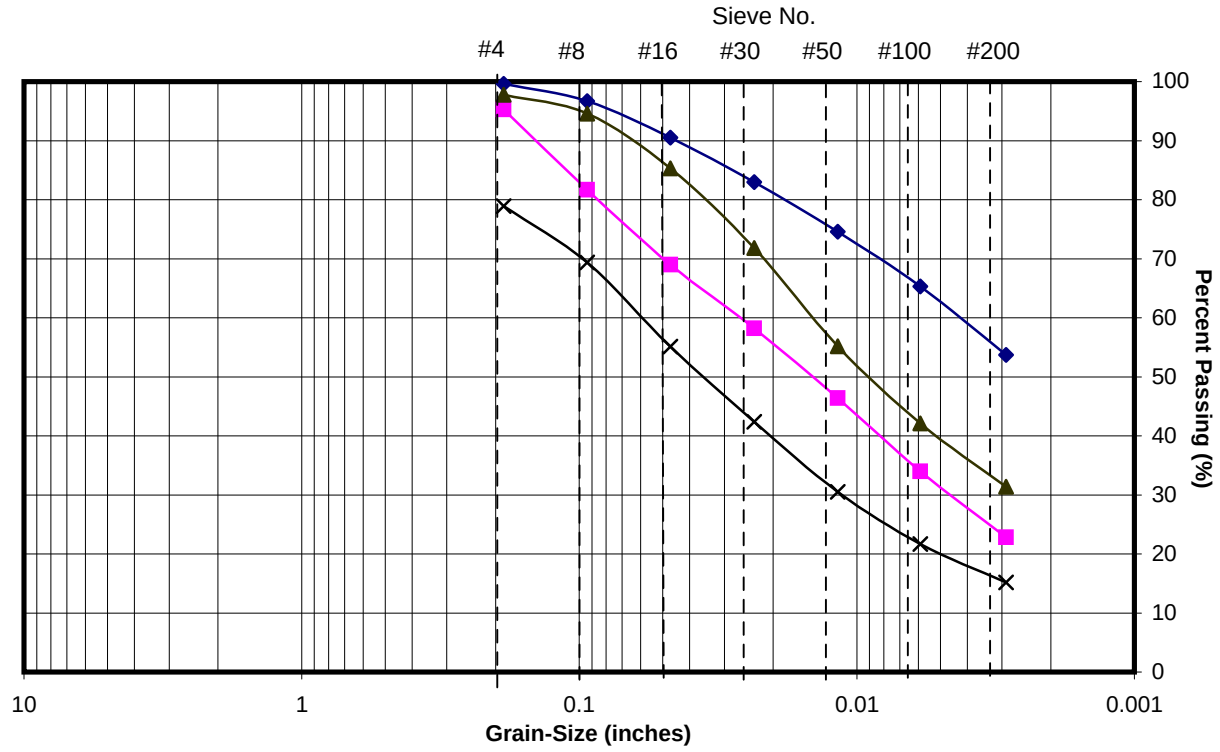


Drill Hole No.	B02-5	B02-5	B02-5	B02-5	B02-5		
Sample	1	2	3	4	5		
Depth (ft)	5	10	15	20	25		
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	96.3	97.5	97	99.4	99.3		
0.0929	75.7	77.6	80.2	94.4	95.4		
0.0465	55.4	56.9	62.3	82.3	84.9		
0.0236	41	42	48.7	69.6	73.4		
0.0118	29.6	29.8	36.5	57.2	61.9		
0.00591	21.9	21.6	27.6	45.4	51.5		
0.00295	16.1	15.2	20.1	33.2	40.5		

Borehole B02-5
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.02
Location of Project:	Shasta Co., CA	**Tested By:**	SHN
Client:	Caltrans	**Date of Testing:**	09/17/2002

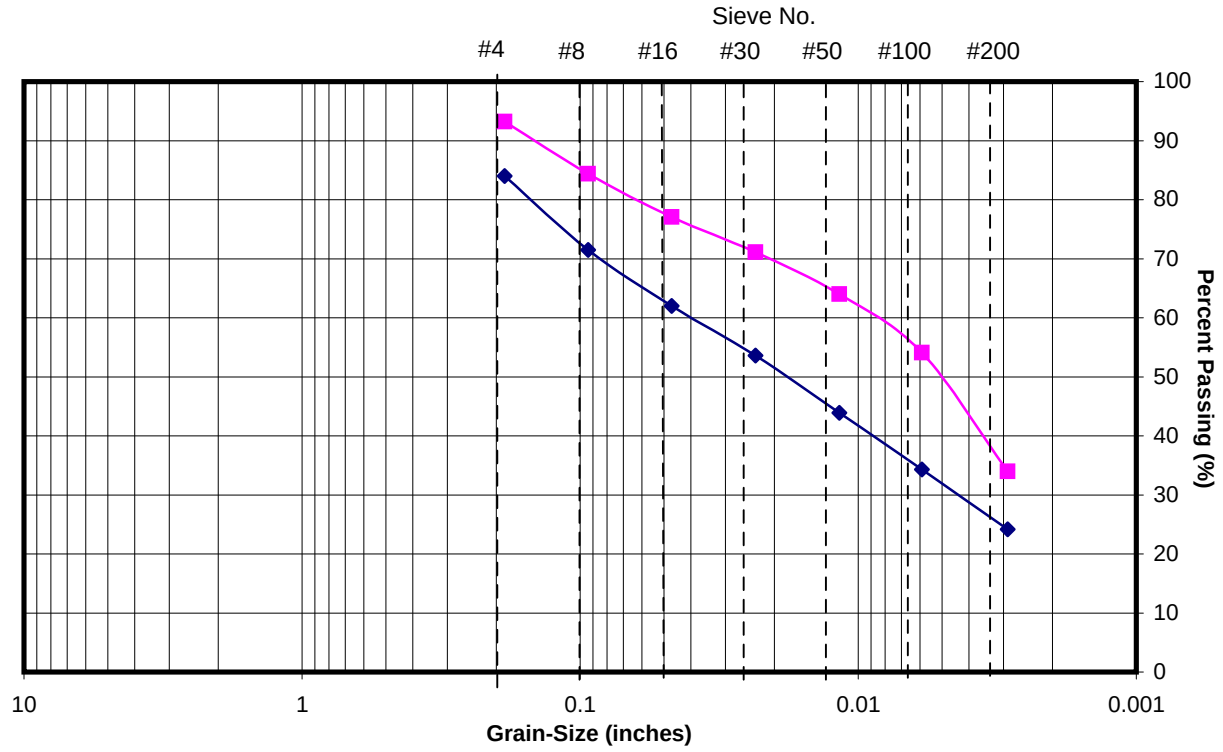
GRAIN-SIZE DISTRIBUTION



Drill Hole No.	B02-5	B02-5	B02-5	B02-5			
Sample	6	7	8	9			
Depth (ft)	30	35	40	45			
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	99.6	95.3	97.8	78.9			
0.0929	96.7	81.7	94.6	69.4			
0.0465	90.5	69	85.3	55.1			
0.0236	83	58.2	71.8	42.4			
0.0118	74.6	46.4	55.2	30.5			
0.00591	65.3	34	42.1	21.7			
0.00295	53.7	22.8	31.4	15.2			

Project:	Buckhorn Grade	**Project No.:**	502001.02
Location of Project:	Shasta Co., CA	**Tested By:**	SHN
Client:	Caltrans	**Date of Testing:**	09/17/2002

GRAIN-SIZE DISTRIBUTION



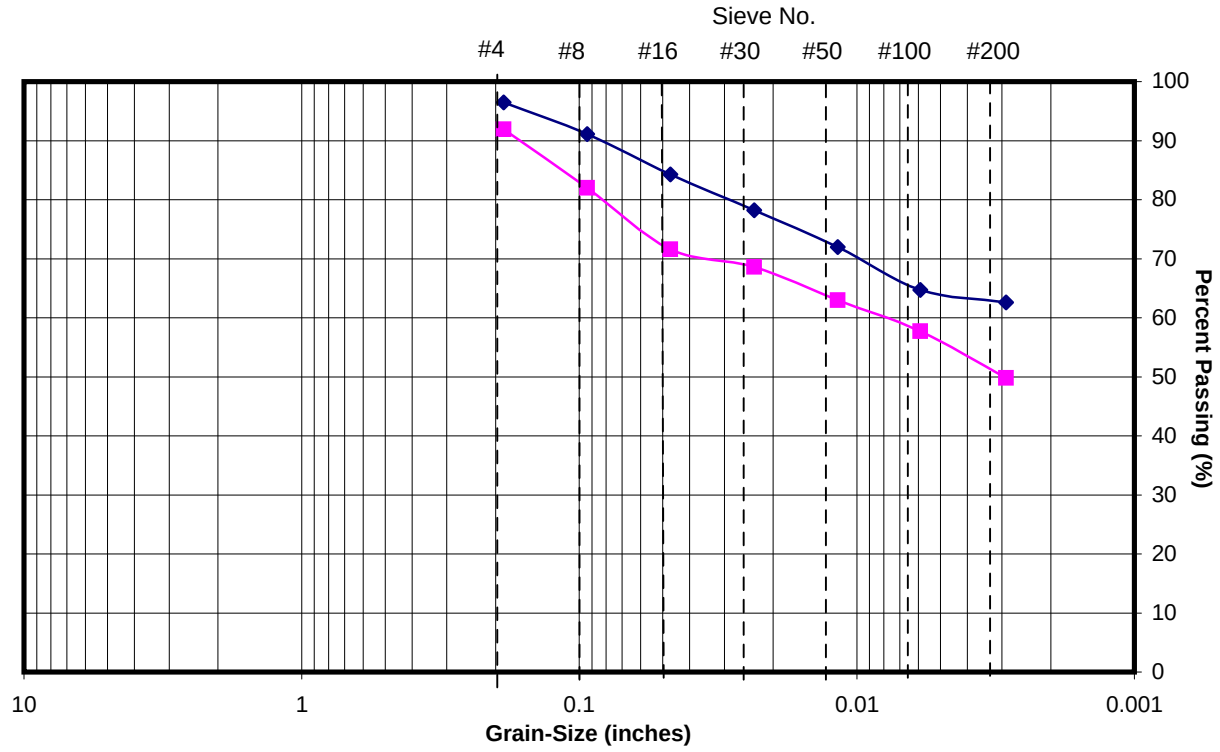
Drill Hole No.	B02-6	B02-6					
Sample	1	2					
Depth (ft)	5	10					
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	84	93.2					
0.0929	71.5	84.4					
0.0465	62	77.1					
0.0236	53.6	71.1					
0.0118	43.9	64					
0.00591	34.3	54.1					
0.00295	24.2	34					

Borehole B02-6
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

GRAIN-SIZE DISTRIBUTION



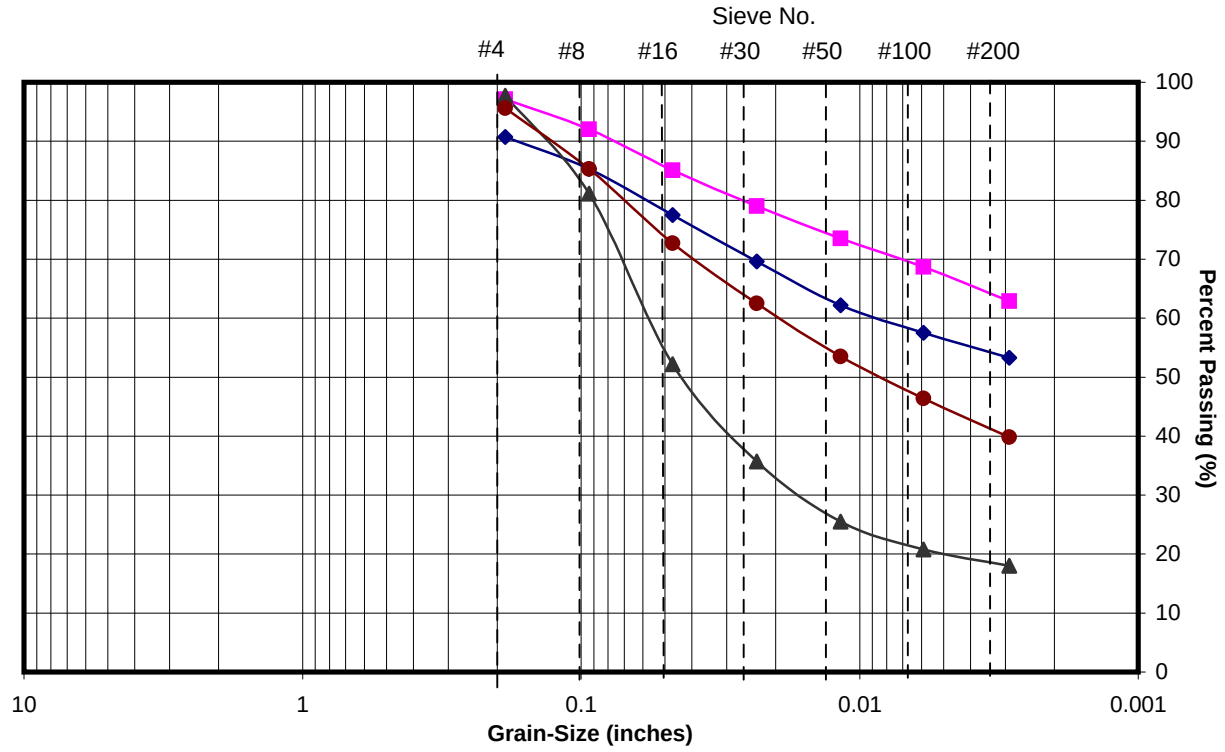
Drill Hole No.	B02-7	B02-7					
Sample	1	2					
Depth (ft)	5	10					
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	96.5	91.9					
0.0929	91.1	82					
0.0465	84.3	71.6					
0.0236	78.2	68.6					
0.0118	72	63					
0.00591	64.7	57.7					
0.00295	62.6	49.8					

Borehole B02-7
Buckhorn Grade

Project: Buckhorn Grade
Location of Project: Shasta Co., CA
Client: Caltrans

Project No.: 502001.02
Tested By: SHN
Date of Testing: 09/17/2002

GRAIN-SIZE DISTRIBUTION



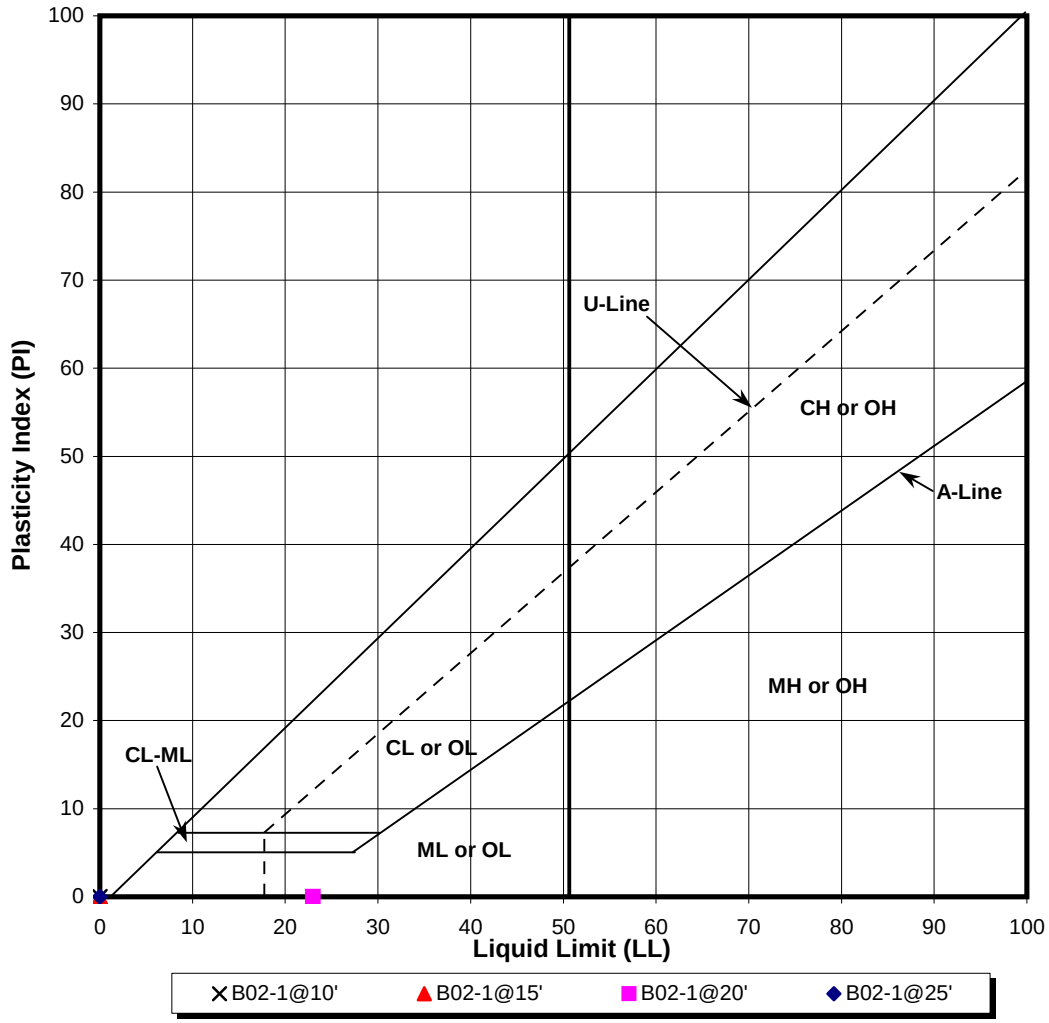
Drill Hole No.	B02-8	B02-8	B02-8	B02-8			
Sample	2	3	4	5			
Depth (ft)	10	15	20	25			
Sieve (inches)	Percent Passing (%)						
3							
2							
1							
0.75							
0.5							
0.375							
0.187	90.7	97.1	97.7	95.6			
0.0929	85.3	92	81.1	85.3			
0.0465	77.5	85.1	52.2	72.7			
0.0236	69.6	79	35.7	62.5			
0.0118	62.2	73.5	25.5	53.5			
0.0059	57.5	68.7	20.8	46.4			
0.0029	53.3	62.9	18	39.8			

Borehole B02-8
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-1	10.0	2	Silty SAND (SM)	0	0	0
B02-1	15.0	3	SAND with silt (SW-SM)	0	0	0
B02-1	20.0	4	Silty SAND (SM)	23	23	0
B02-1	25.0	5	Silty SAND (SM)	0	0	0

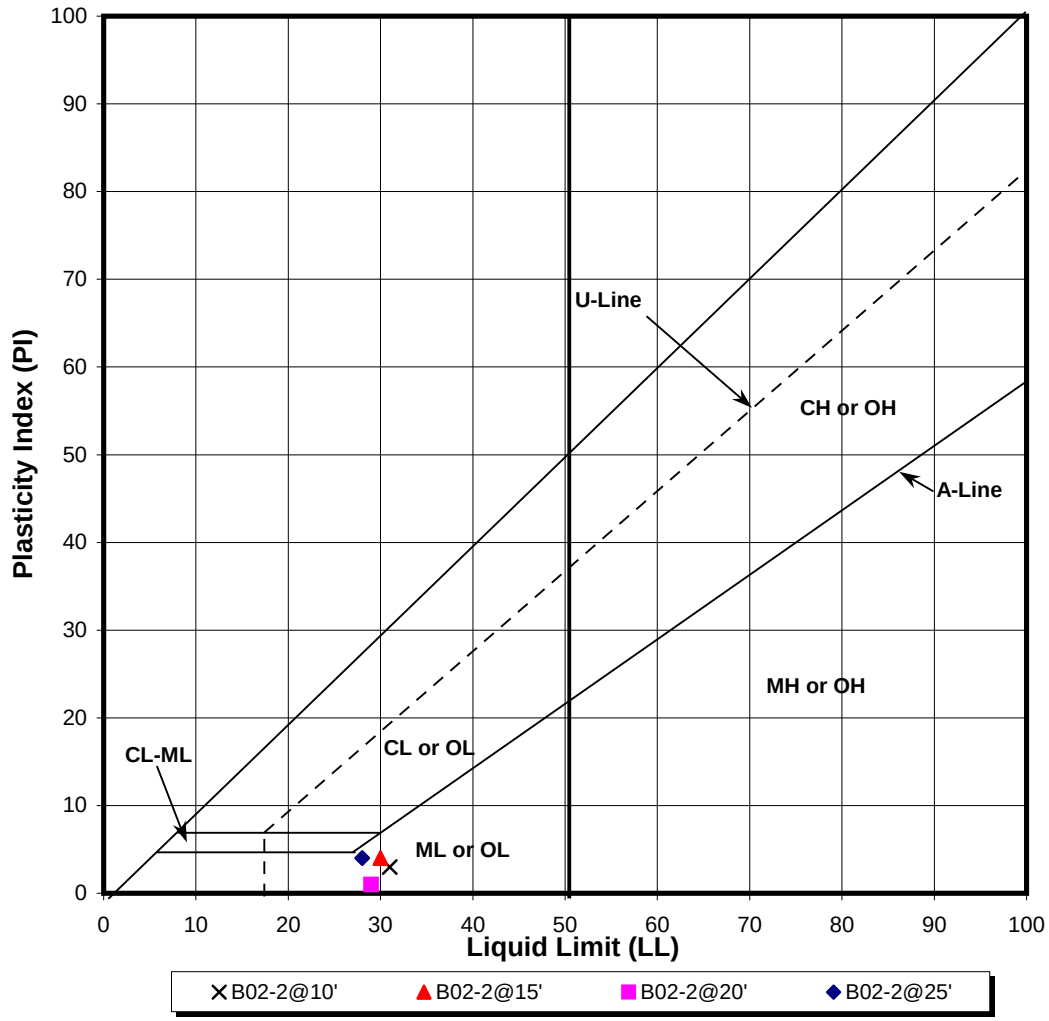
ASTM D4318 & D2487

Borehole B02-1
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-2	10.0	2	Silty SAND (SM)	31	28	3
B02-2	15.0	3	Silty SAND (SM)	30	26	4
B02-2	20.0	4	Silty SAND (SM)	29	28	1
B02-2	25.0	5	Silty SAND (SM)	28	24	4

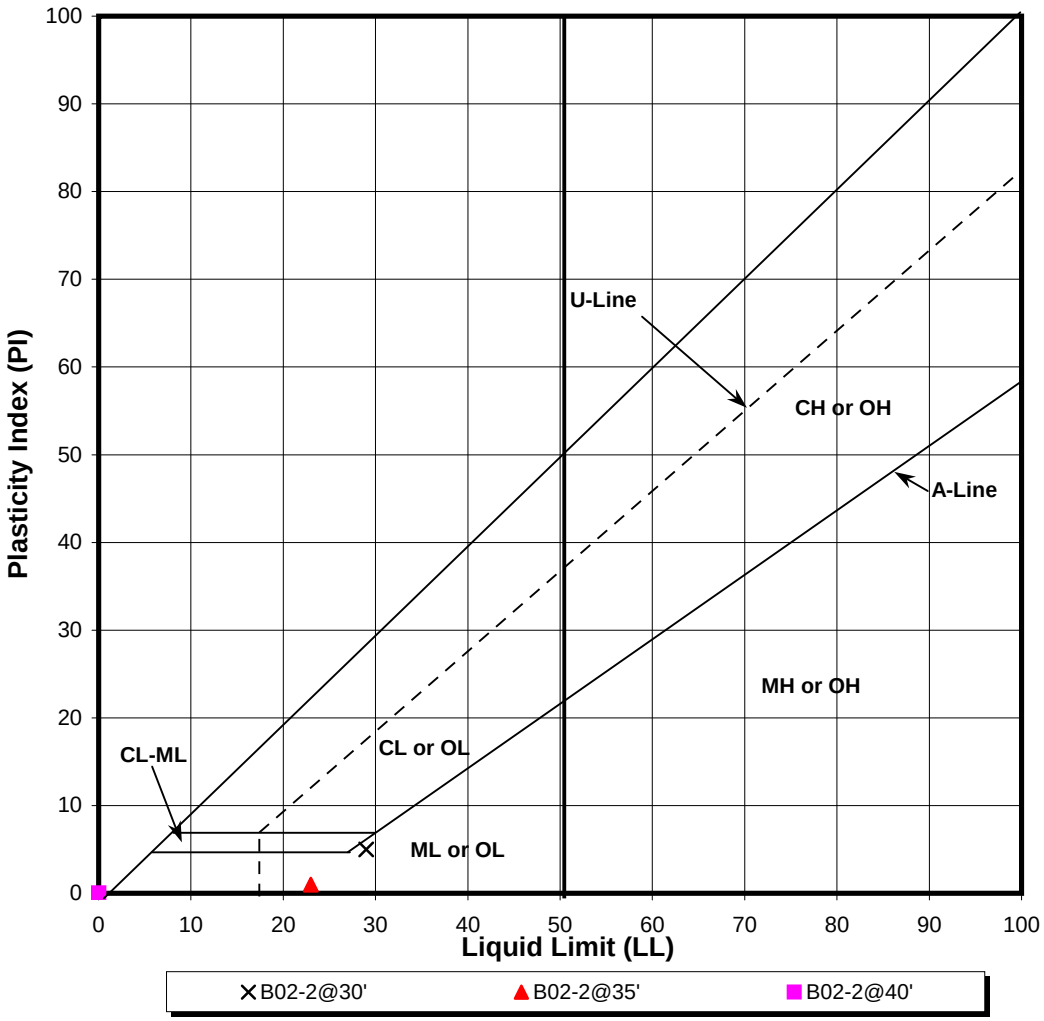
ASTM D4318 & D2487

Borehole B02-2
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



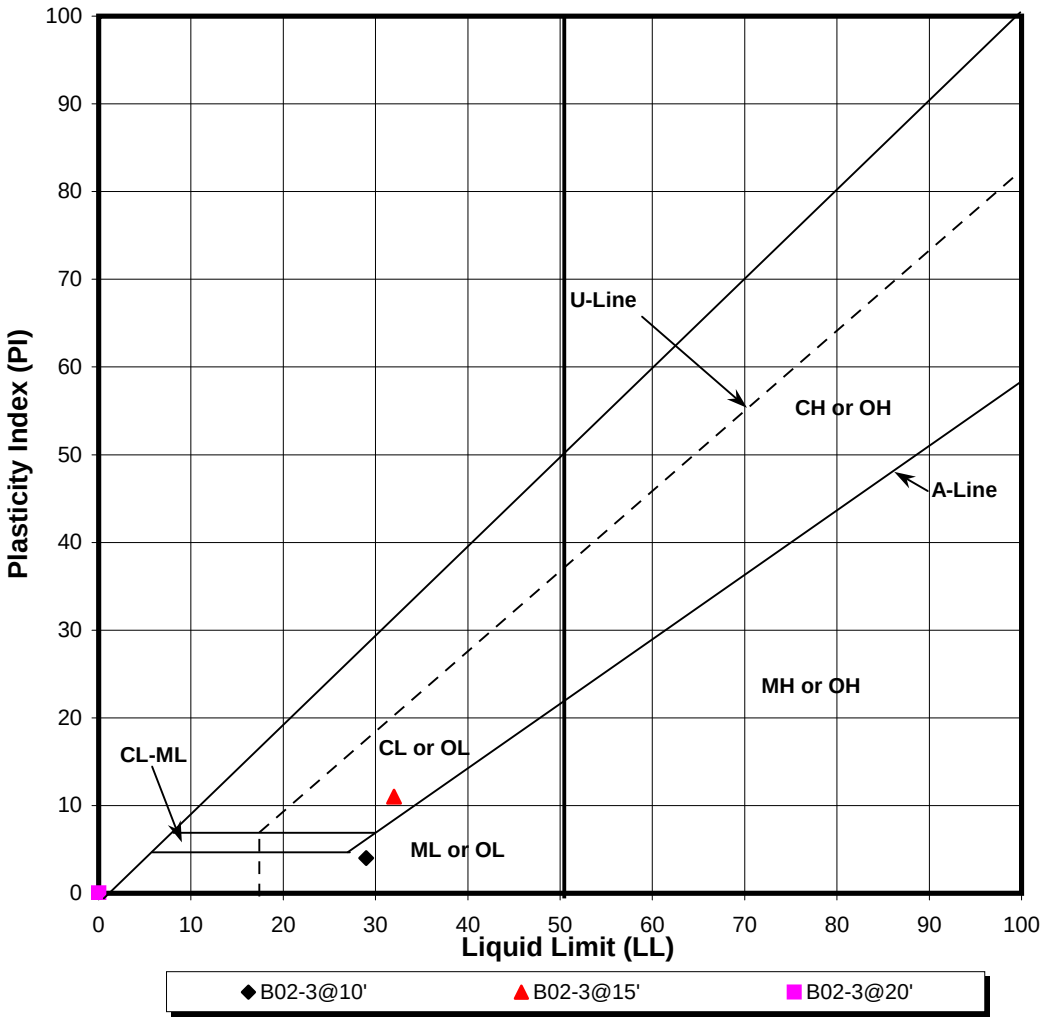
LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-2	30.0	6	Silty SAND (SM)	29	24	5
B02-2	35.0	7	Silty SAND (SM)	23	22	1
B02-2	40.0	8	Silty SAND (SM)	0	0	0

ASTM D4318 & D2487

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-3	10.0	2	Silty SAND (SM)	29	25	4
B02-3	15.0	3	Clayey SAND (SC)	32	21	11
B02-3	20.0	4	Silty SAND (SM)	0	0	0

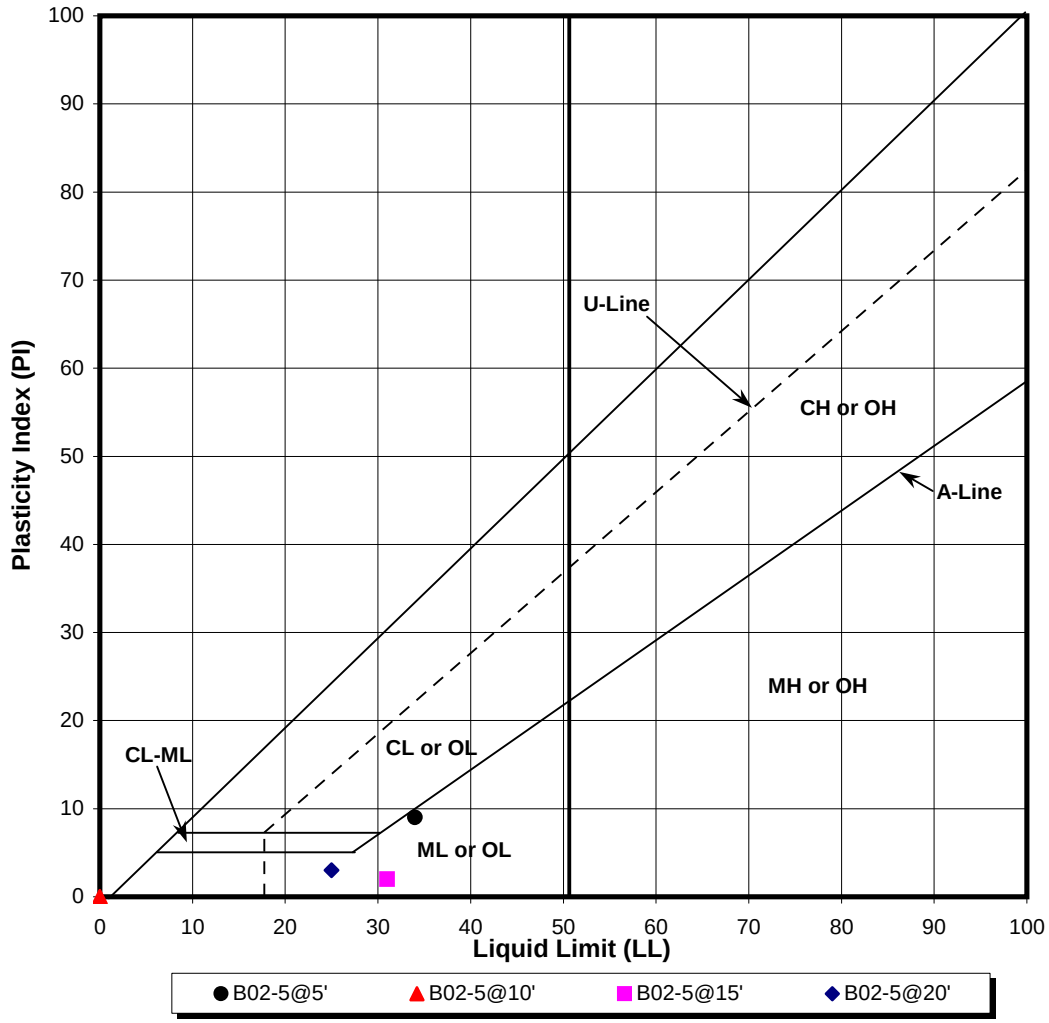
ASTM D4318 & D2487

Borehole B02-3
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-5	5.0	1	Silty SAND (SM)	34	25	9
B02-5	10.0	2	Silty SAND (SM)	0	0	0
B02-5	15.0	3	Silty SAND (SM)	31	29	2
B02-5	20.0	4	Silty SAND (SM)	25	22	3

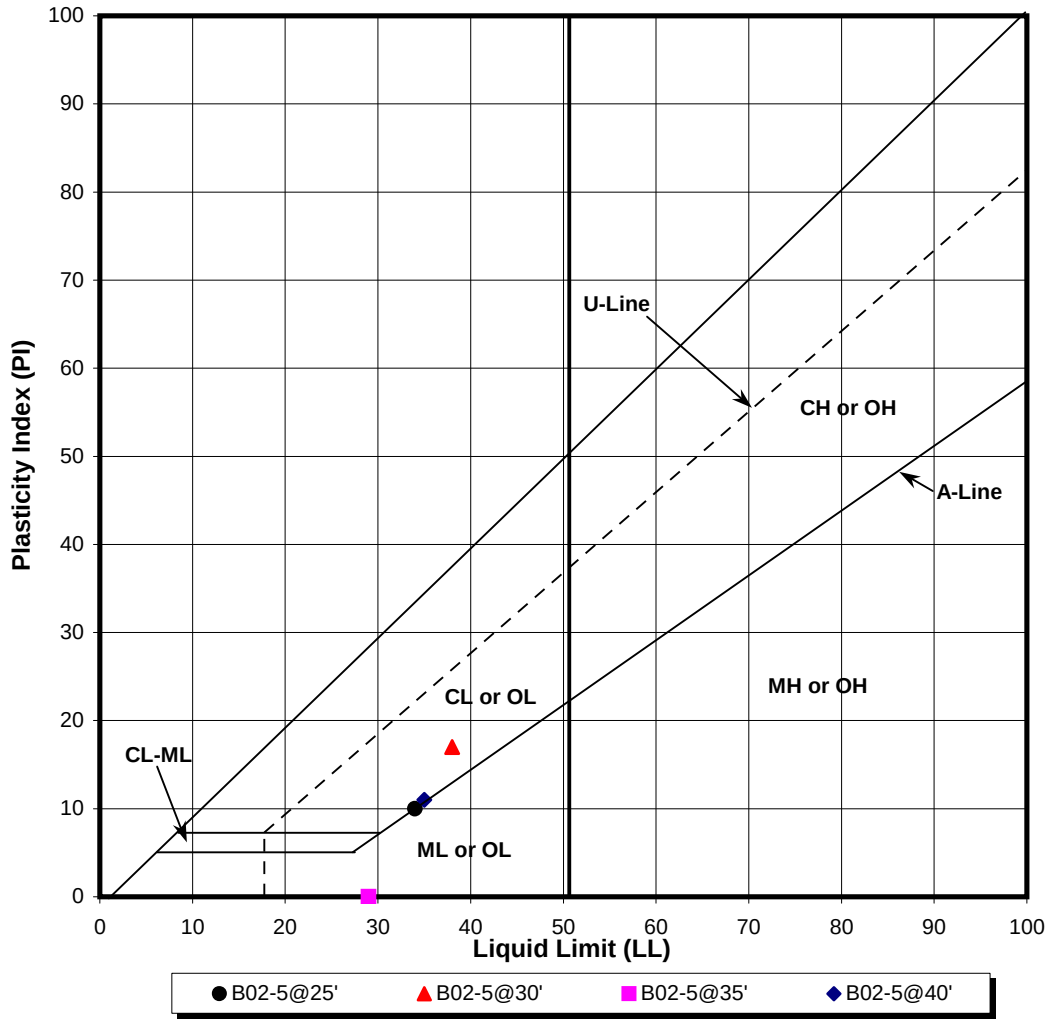
ASTM D4318 & D2487

Borehole B02-5
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/17/2002

ATTERBERG LIMITS



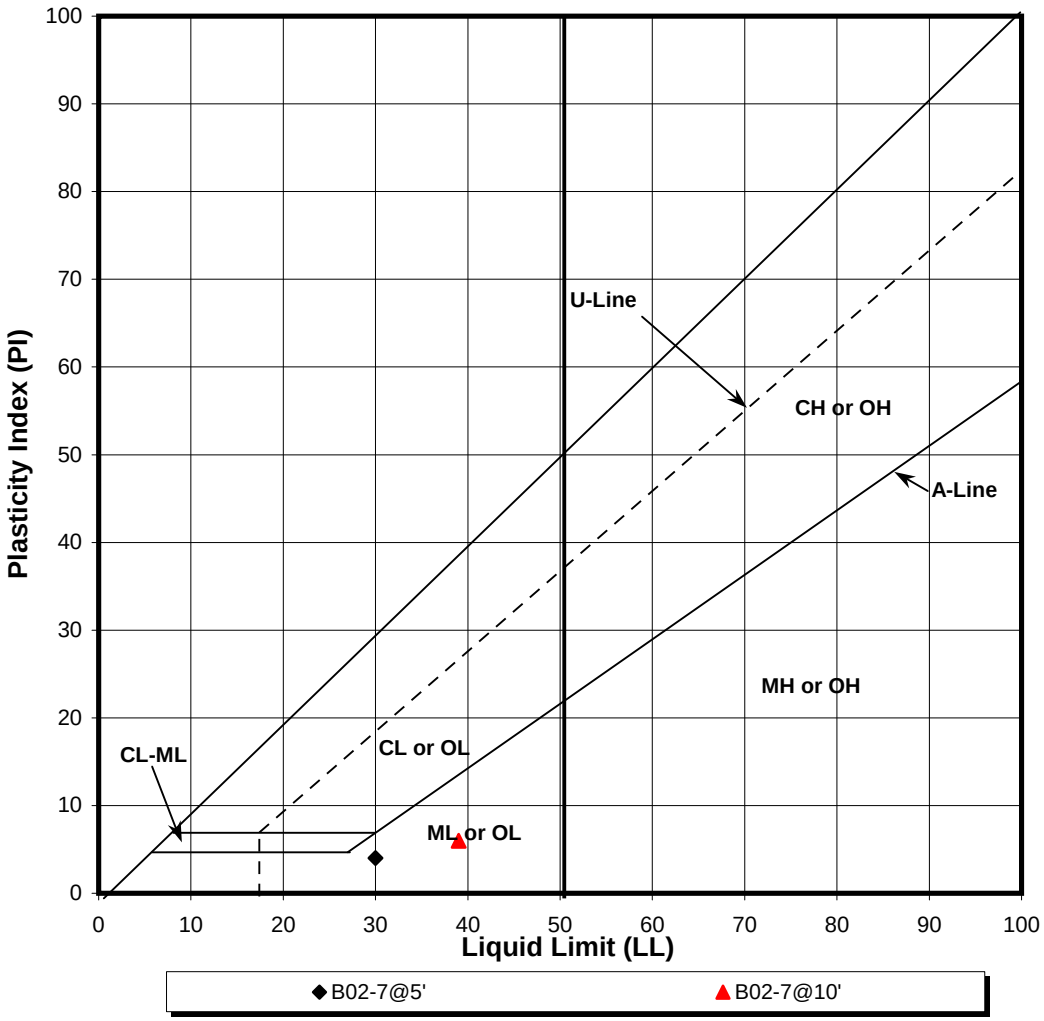
LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-5	25.0	5	Silty SAND (SM)	34	24	10
B02-5	30.0	6	Sandy SILT (ML)	38	21	17
B02-5	35.0	7	Silty SAND (SM)	29	29	0
B02-5	40.0	8	Clayey SAND (SC)	35	24	11

ASTM D4318 & D2487

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-7	5.0	1	Sandy SILT (ML)	30	26	4
B02-7	10.0	2	Sandy SILT (ML)	39	33	6

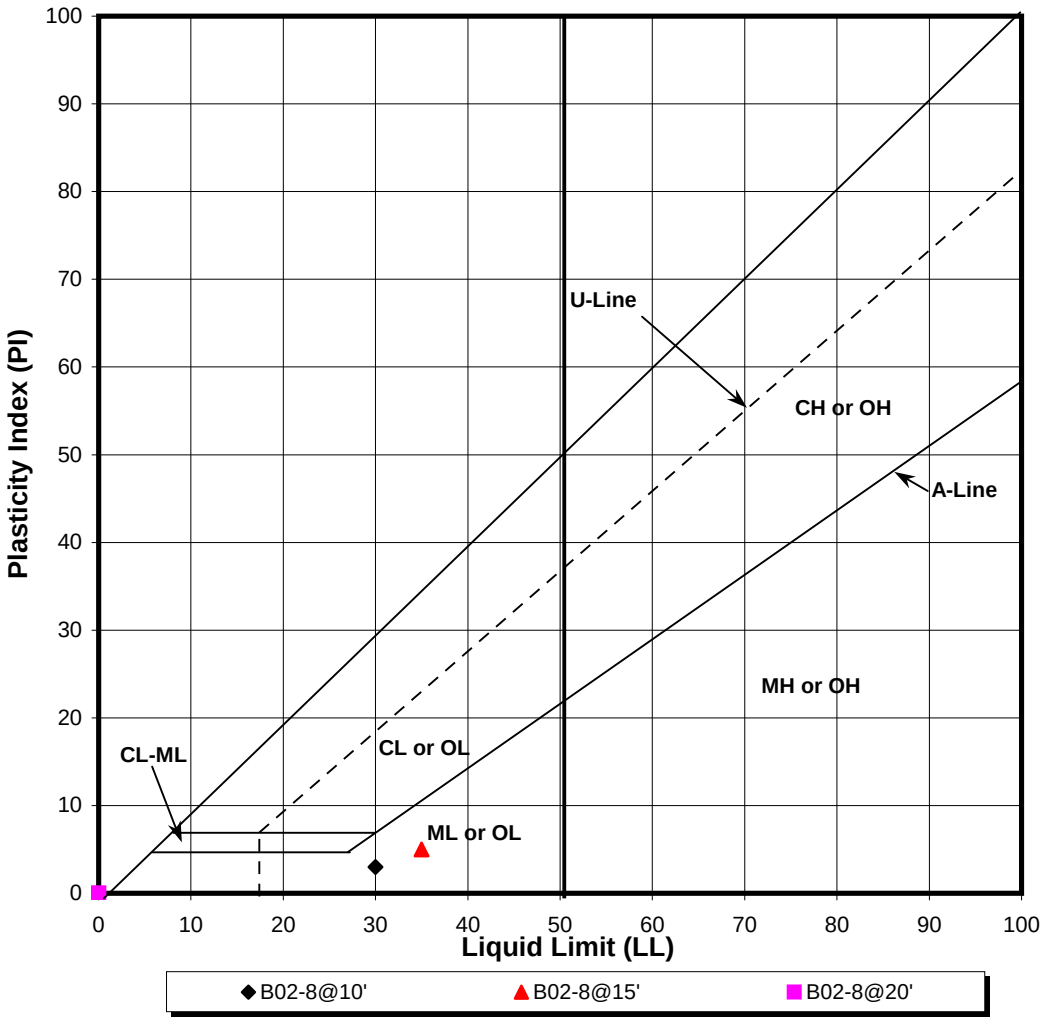
ASTM D4318 & D2487

Borehole B02-7
Buckhorn Grade

Project: Buckhorn Grade
Client: Caltrans

Project No.: 502001.021
Date of Testing: 09/20/2002

ATTERBERG LIMITS



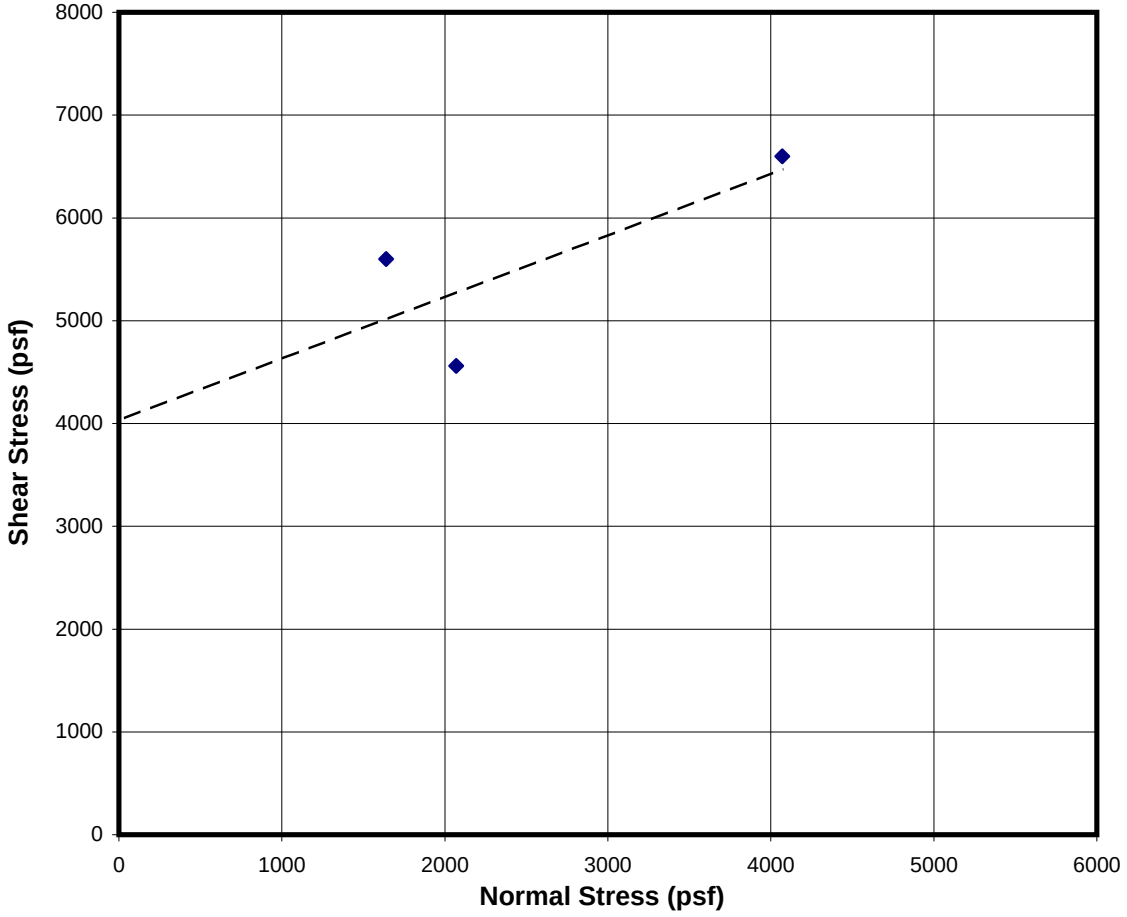
LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
Location	Depth, ft	Sample No.		Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)
B02-8	10.0	2	Sandy SILT (ML)	30	27	3
B02-8	15.0	3	Sandy SILT (ML)	35	30	5
B02-8	20.0	4	Silty SAND (SM)	0	0	0

ASTM D4318 & D2487

Borehole B02-8
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-1@10'

DIRECT SHEAR DATA



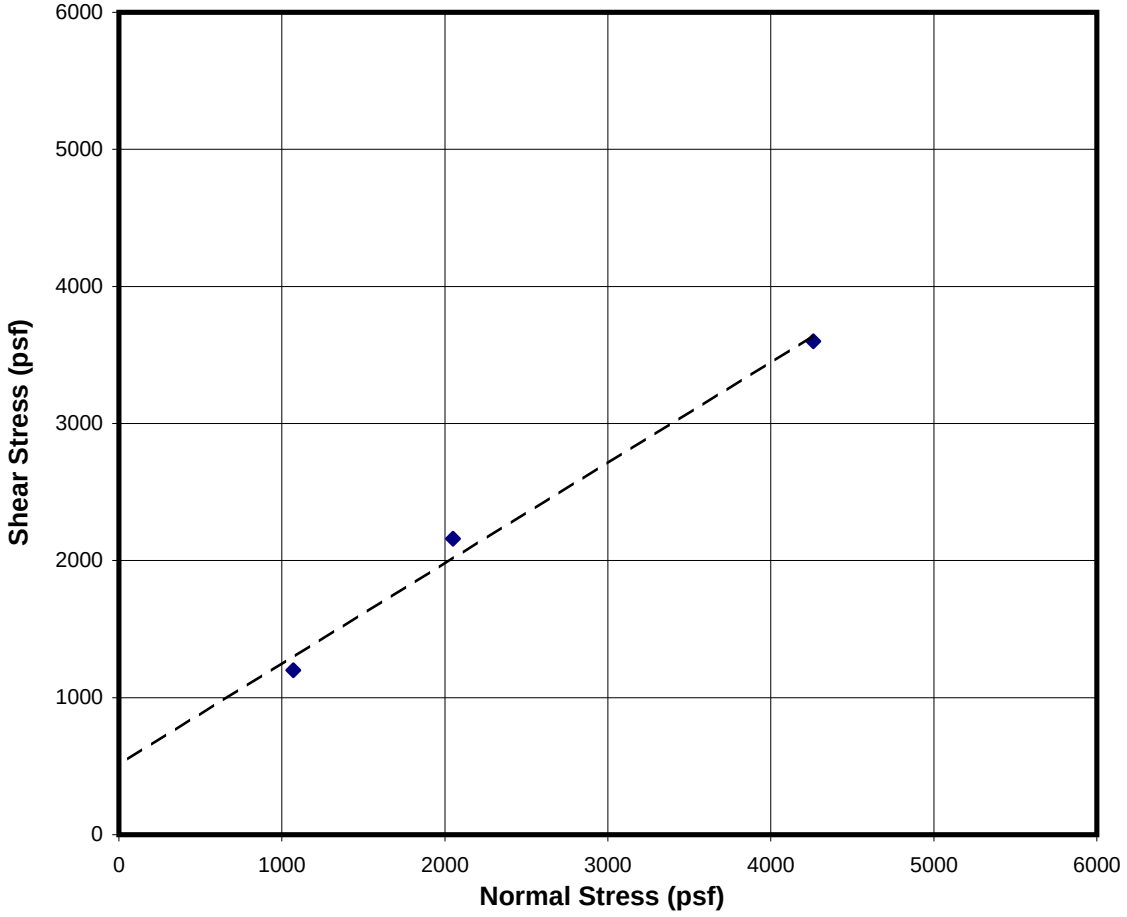
B02-1@10'			
Angle of Internal Friction:	31	degrees	Test Type
Cohesion :	4028	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1640	5600	9	112.3	15.3	112.9
2	2070	4560	7	114.9	8.7	115.3
3	4070	6600	7.9	107.5	9	111.2

Sample B02-1@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/13/2002
		Sample No.:	B02-1@20'

DIRECT SHEAR DATA



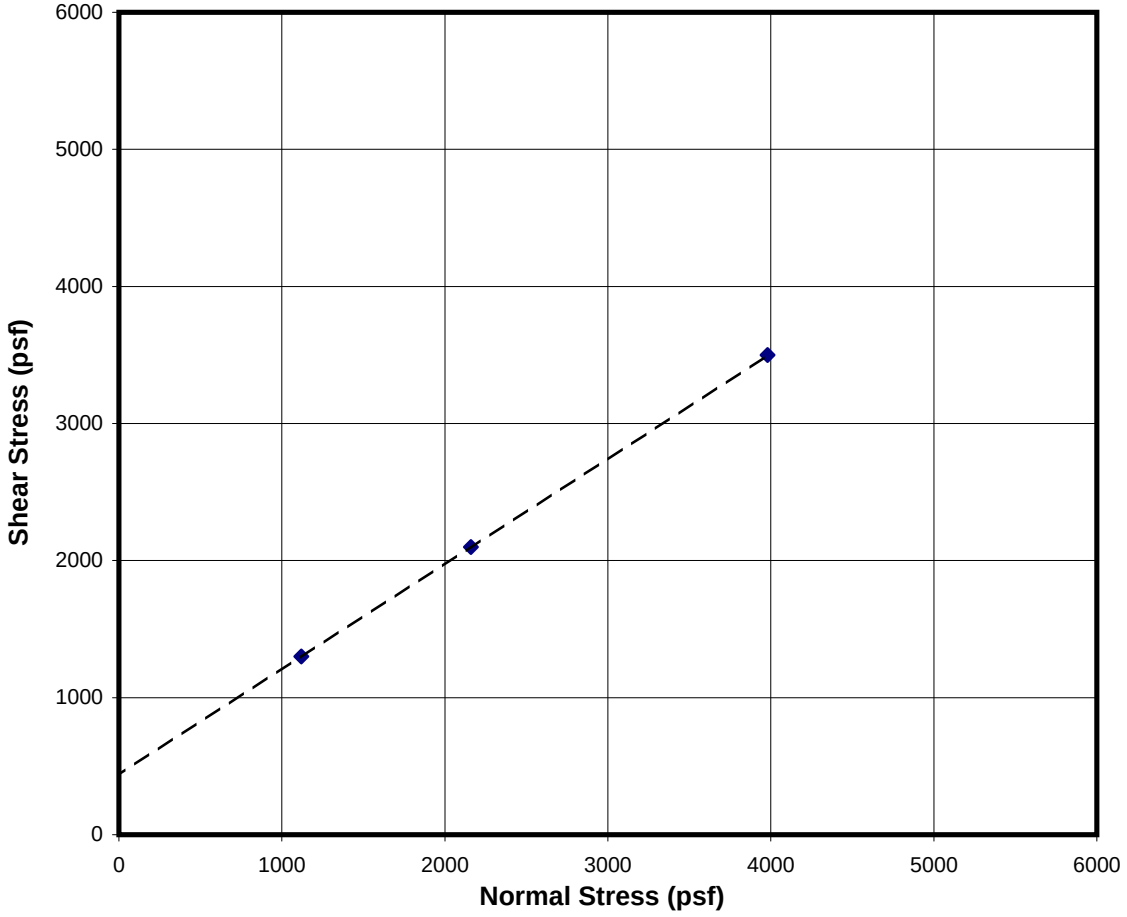
B02-1@20'			
Angle of Internal Friction:	36	degrees	Test Type
Cohesion :	511	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1070	1200	16.7	105	16.4	106.7
2	2050	2160	15.1	107.6	16.9	110.2
3	4260	3600	15.4	108.5	16.7	111.6

Sample B02-1@20ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/18/2002
		Sample No.:	B02-2@20'

DIRECT SHEAR DATA



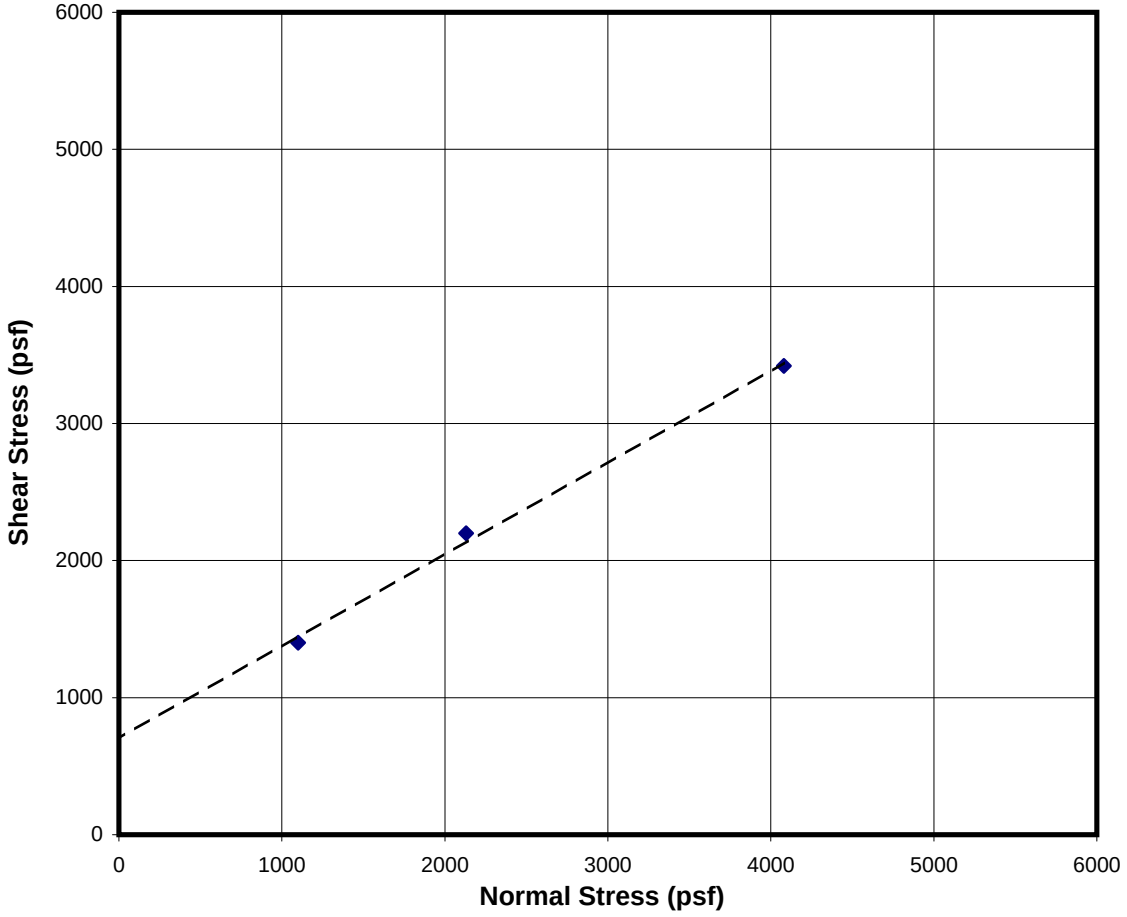
B02-2@20'			
Angle of Internal Friction:	38	degrees	Type
Cohesion :	438	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1120	1300	9.9	116.9	12.1	118.3
2	2160	2100	10.7	112.8	12.4	115.7
3	3980	3500	9.8	115.6	11.8	118.8

Sample B02-2@20ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-2@30'

DIRECT SHEAR DATA



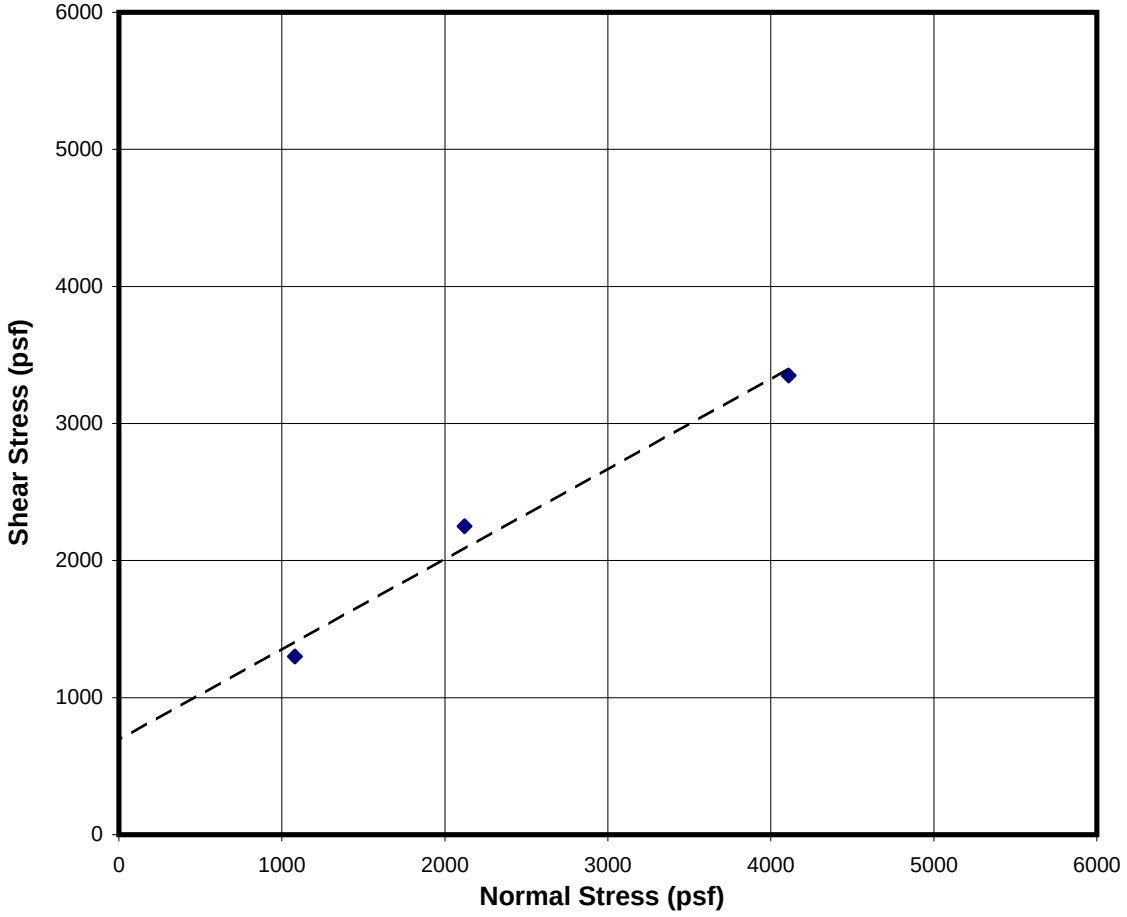
B02-2@30'			
Angle of Internal Friction:	34	degrees	Type
Cohesion :	705	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1100	1400	12.2	112.3	16.4	114.2
2	2130	2200	12.4	116.2	14.1	118.7
3	4080	3420	11.9	117.3	13.9	120.5

Sample B02-2@30ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/14/2002
		Sample No.:	B02-2@40'

DIRECT SHEAR DATA



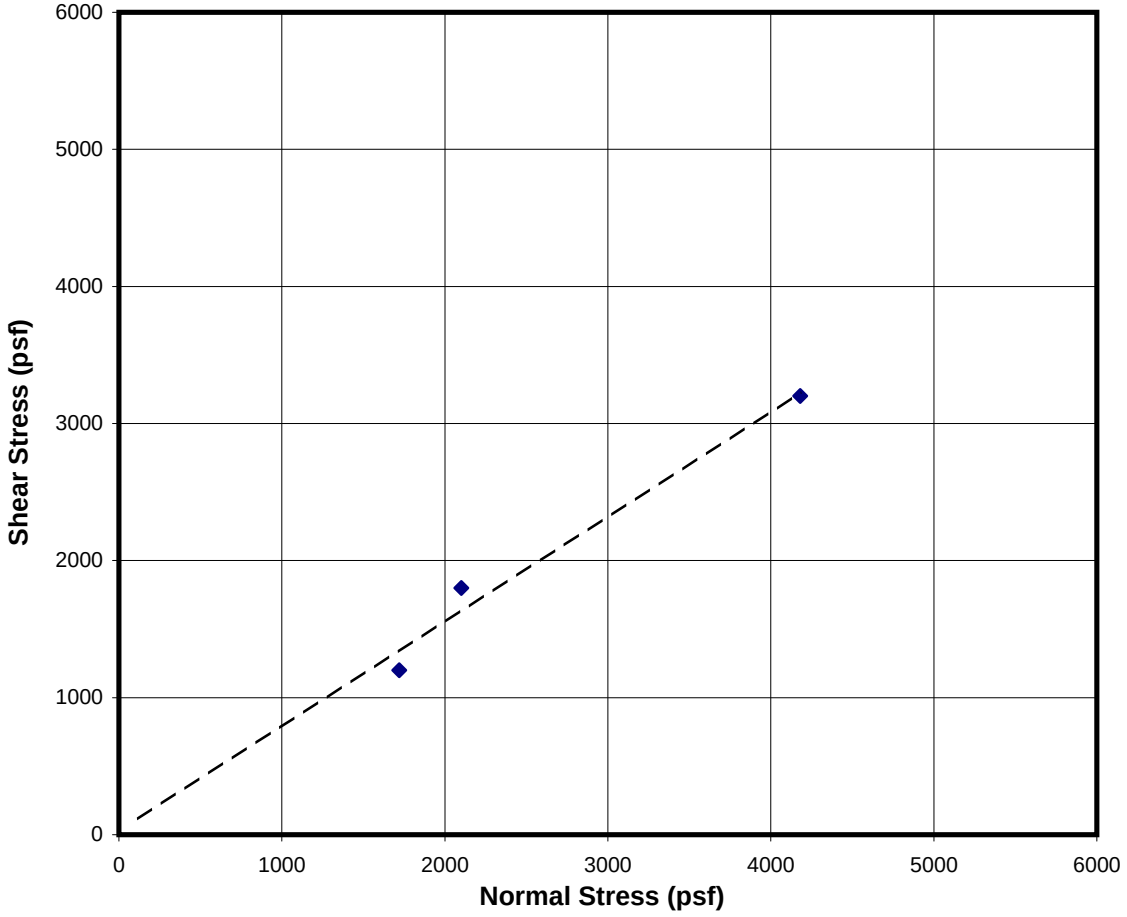
B02-2@40'			
Angle of Internal Friction:	33	degrees	Type
Cohesion :	692	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1080	1300	16.6	109.7	17.8	113.0
2	2120	2250	16.5	109.5	18.3	112.1
3	4110	3350	16.5	103.3	19.8	108.7

Sample B02-2@40ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/17/2002
		Sample No.:	B02-3@10'

DIRECT SHEAR DATA



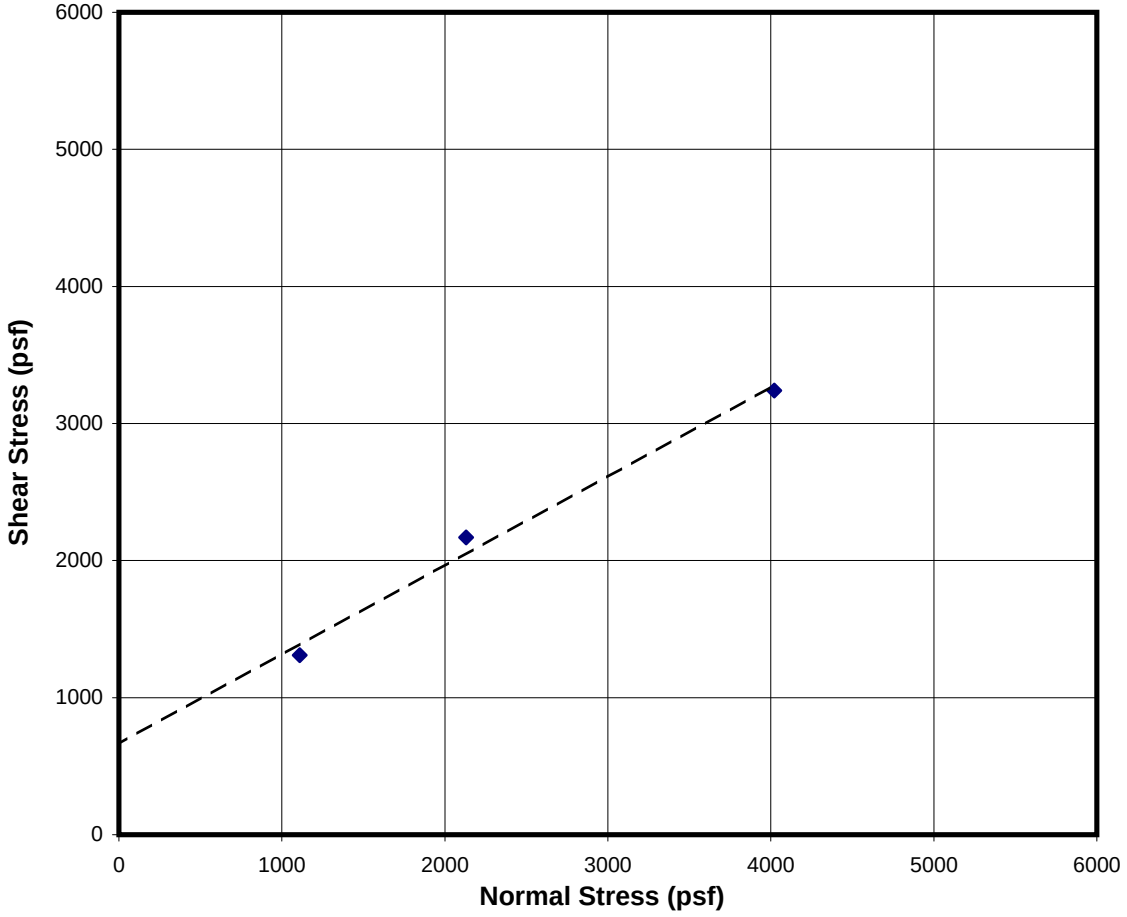
B02-3@10'			
Angle of Internal Friction:	37	degrees	Type
Cohesion :	24	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1720	1200	3.5	124.4	10.7	125.7
2	2100	1800	4.2	117.3	9.9	119.8
3	4180	3200	3.9	119.5	7.2	124.3

Sample B02-3@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/16/2002
		Sample No.:	B02-3@15'

DIRECT SHEAR DATA



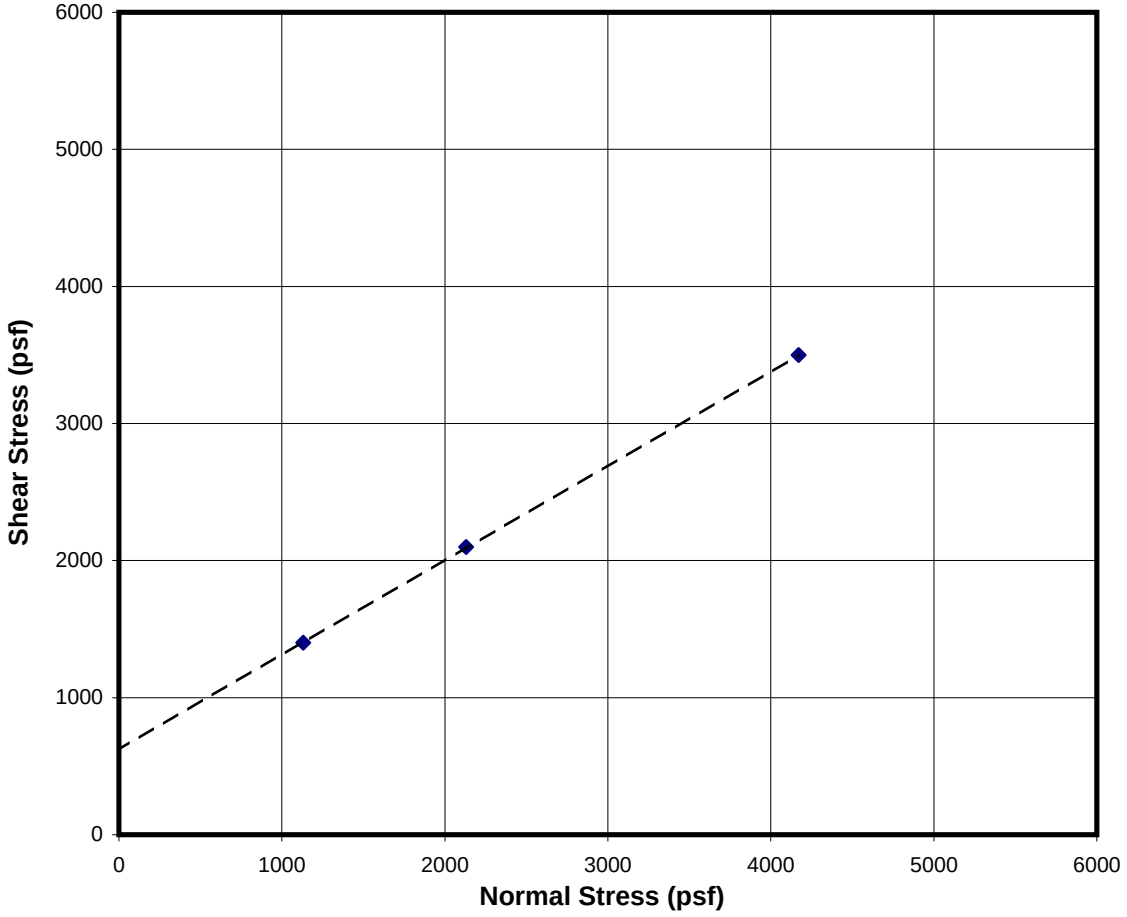
B02-3@15'			
Angle of Internal Friction:	33	degrees	Type
Cohesion :	665	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1110	1310	9.7	112.5	17.4	113.7
2	2130	2170	10.1	116.2	11.0	118.2
3	4020	3240	7.6	119.9	13.9	123.1

Sample B02-3@15ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/18/2002
		Sample No.:	B02-5@35'

DIRECT SHEAR DATA



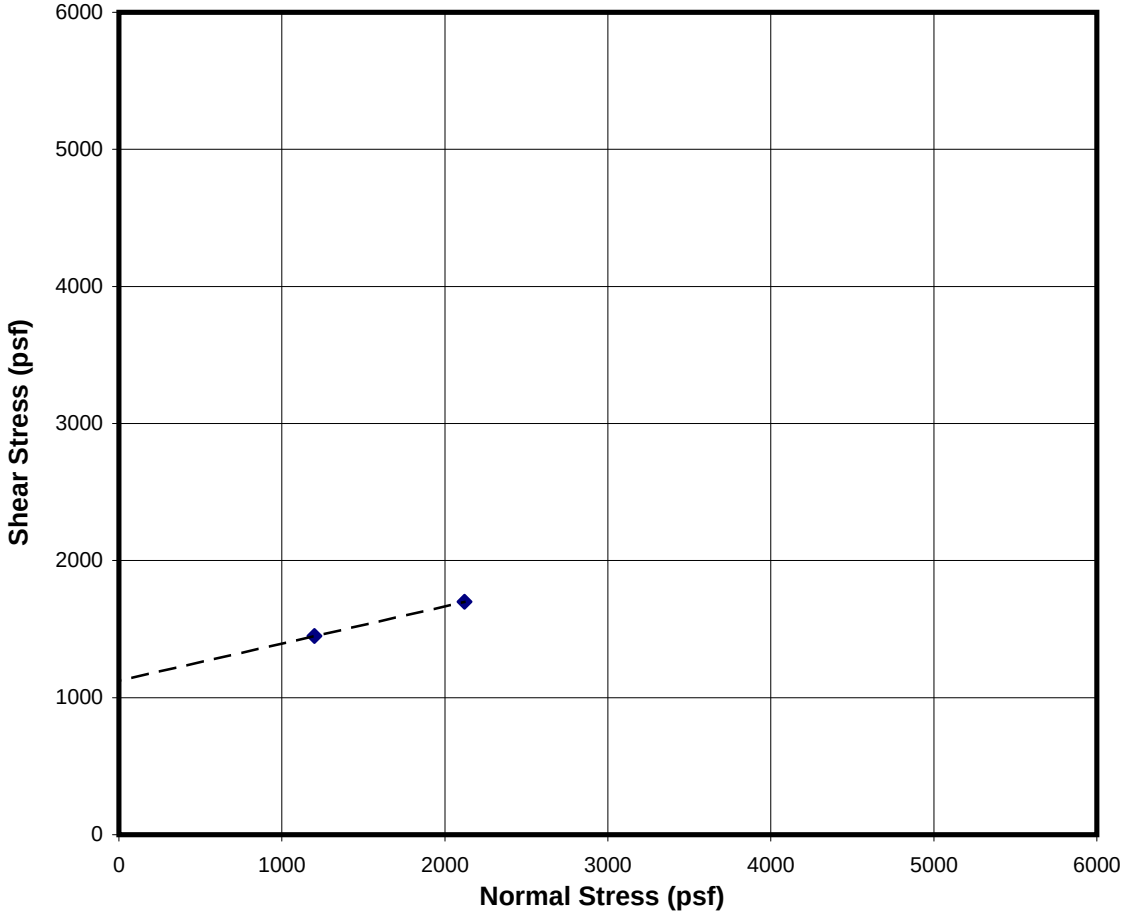
B02-5@35'			
Angle of Internal Friction:	35	degrees	Type
Cohesion :	624	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1130	1400	9.3	114.9	10.8	116.4
2	2130	2100	9.5	117.5	9.6	120.5
3	4170	3500	9.6	117.3	13.2	120.8

Sample B02-5@35ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/13/2002
		Sample No.:	B02-7@10'

DIRECT SHEAR DATA



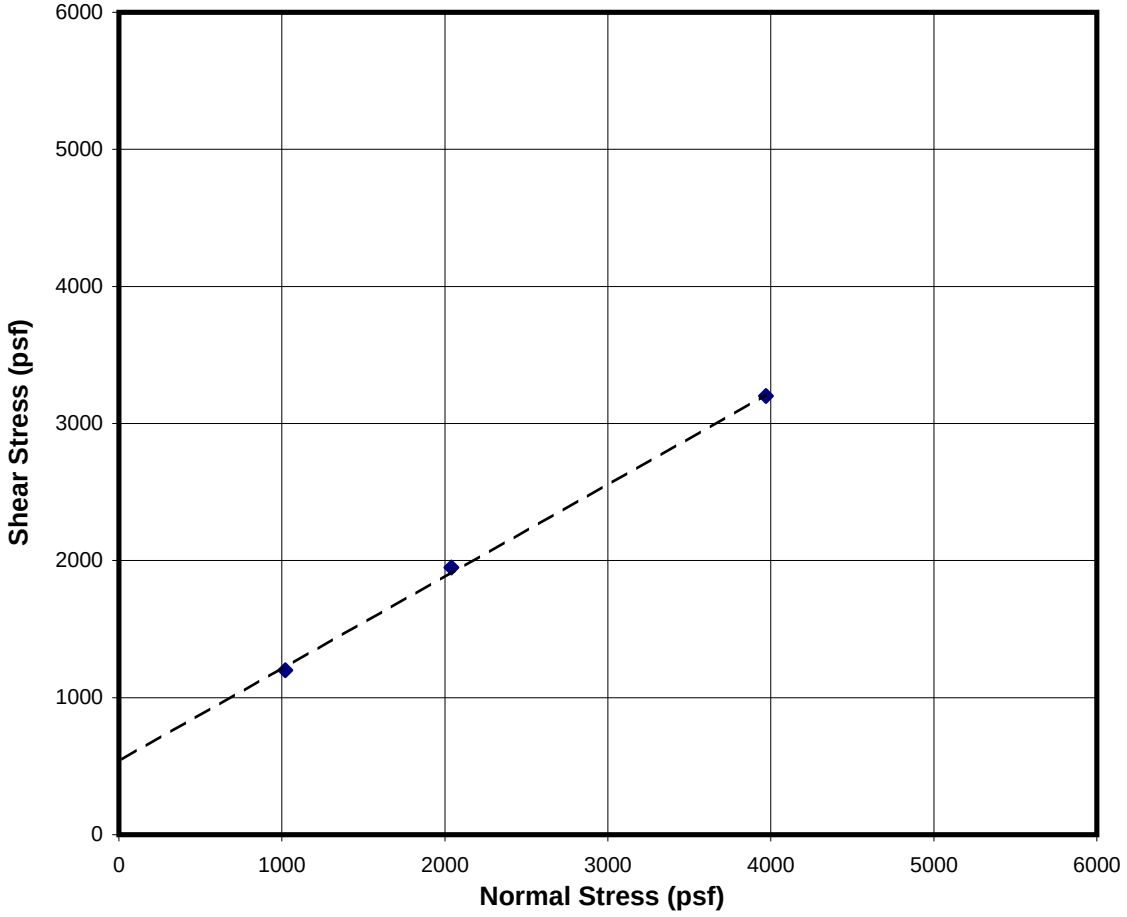
B02-7@10'			
Angle of Internal Friction:	15	degrees	Type
Cohesion :	1124	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1200	1450	15.0	107.5	18.1	108.4
2	2120	1700	13.5	107.3	18.7	109.0

Sample B02-7@10ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-7@5'

DIRECT SHEAR DATA



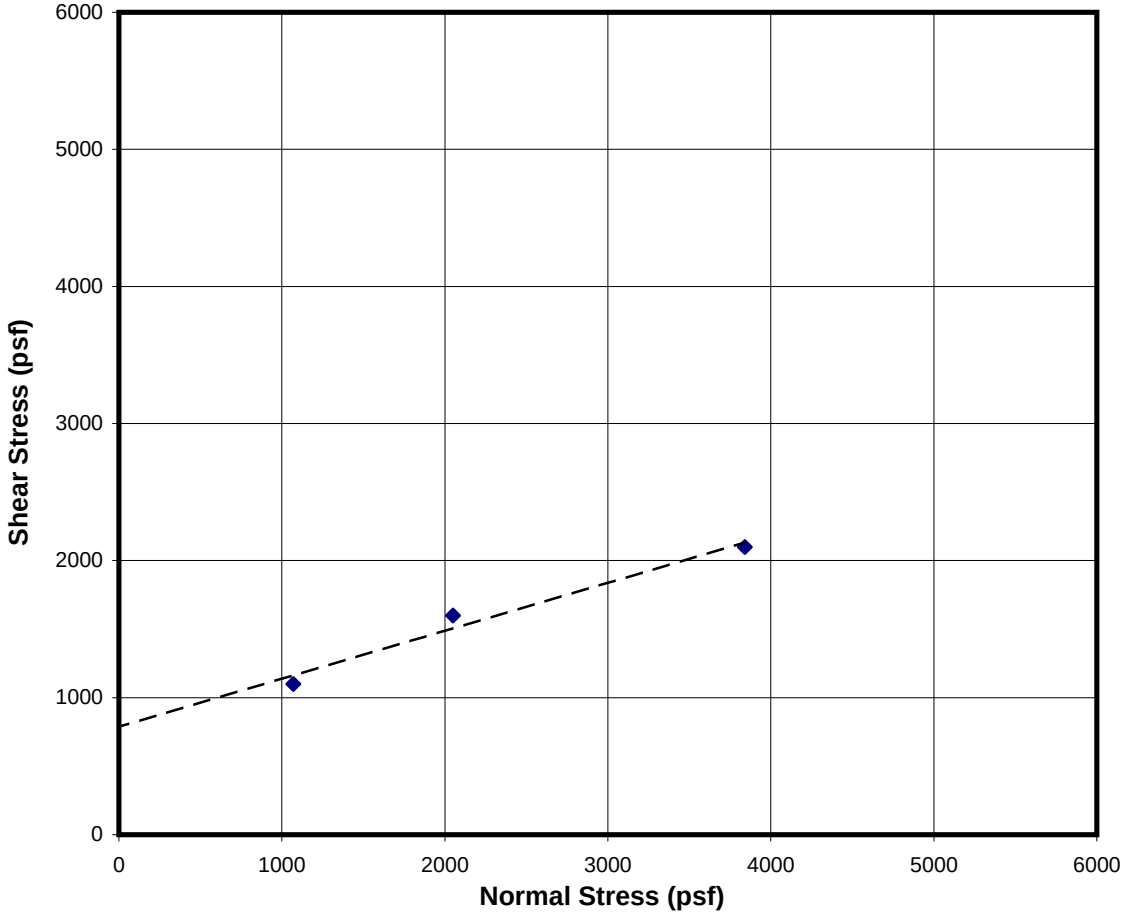
B02-7@5'			
Angle of Internal Friction:	34	degrees	Type
Cohesion :	537	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1020	1200	9.4	104.0	12.5	105.3
2	2040	1950	9.1	106.9	11.1	109.5
3	3970	3200	9.8	101.4	11.7	107.1

Sample B02-7@5ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/19/2002
		Sample No.:	B02-8@15'

DIRECT SHEAR DATA



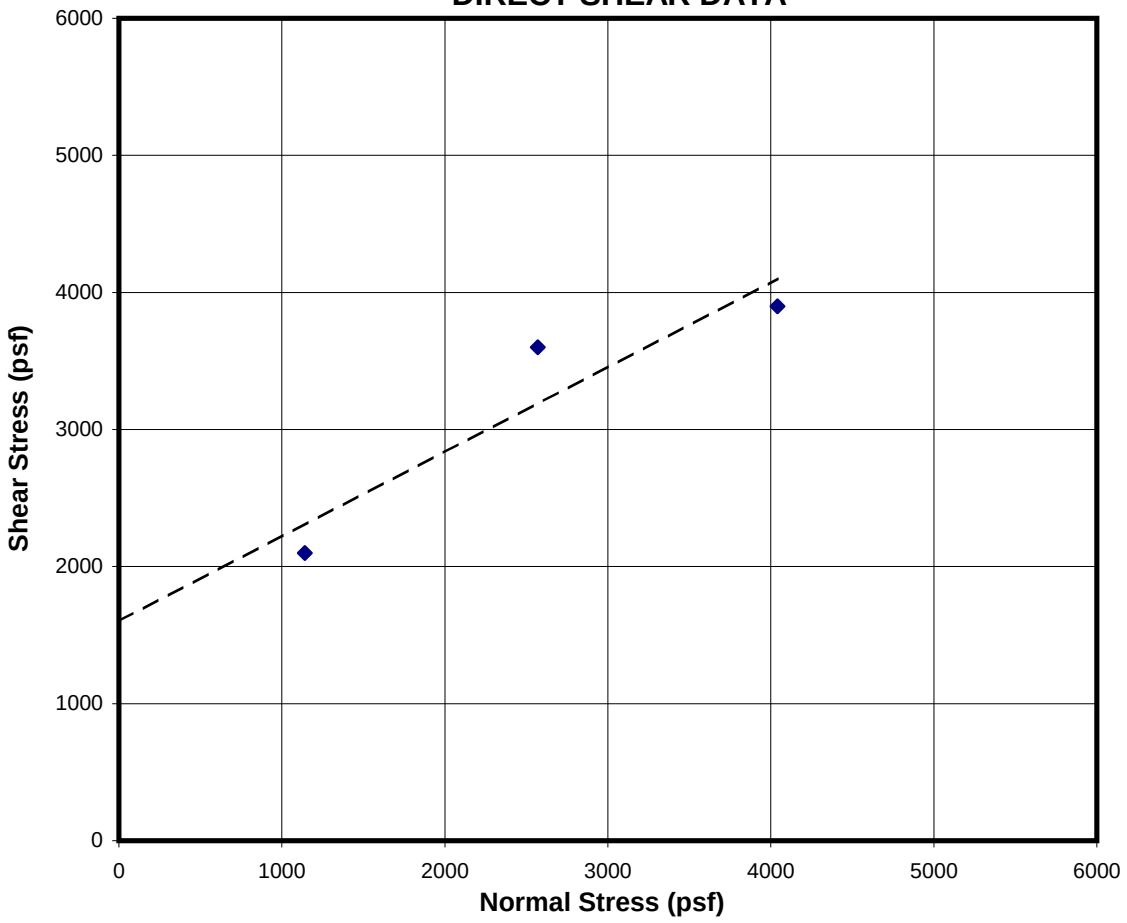
B02-8@15'			
Angle of Internal Friction:	19	degrees	Type
Cohesion :	786	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1070	1100	17.2	107.4	20.6	108.3
2	2050	1600	14.7	109.5	19.3	111.4
3	3840	2100	15.6	106.7	20.0	110.2

Sample B02-8@15ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/14/2002
		Sample No.:	B02-8@20'

DIRECT SHEAR DATA



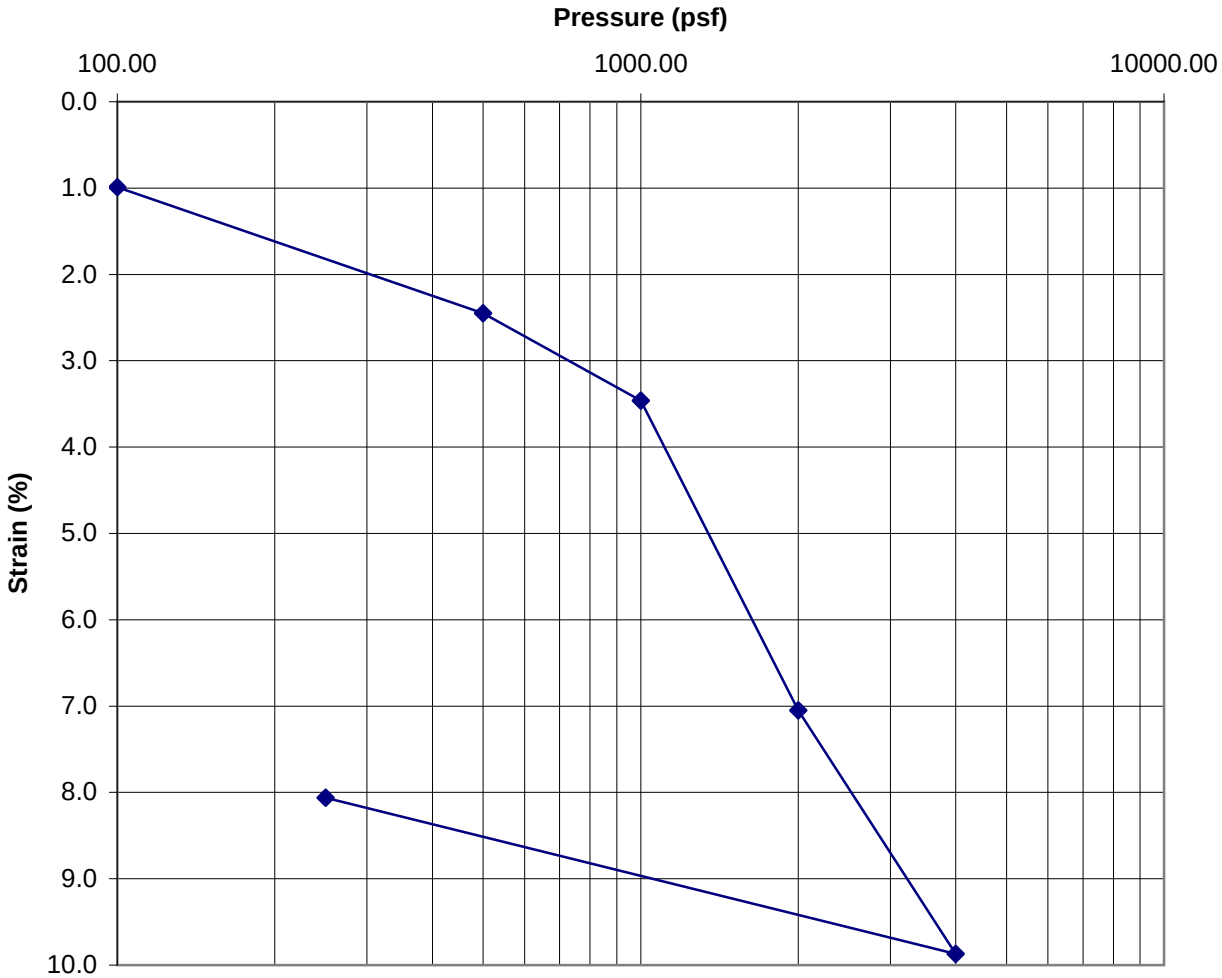
B02-8@20'			
Angle of Internal Friction:	32	degrees	Type
Cohesion :	1602	psf	Post Peak

Point No.	Normal Stress (psf)	Shear Stress (psf)	Initial		Final	
			Water Content (%)	Dry Density (pcf)	Water Content (%)	Dry Density (pcf)
1	1140	2100	10.9	116.9	13.1	118.1
2	2570	3600	9.8	121.7	12.2	123.4
3	4040	3900	8.4	118.8	11.9	122.2

Sample B02-8@20ft.
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/26/2002
Exploration No.:	B02-7	**Sample No.:**	1
Sample Depth (ft):	5.0		

CONSOLIDATION TEST RESULTS

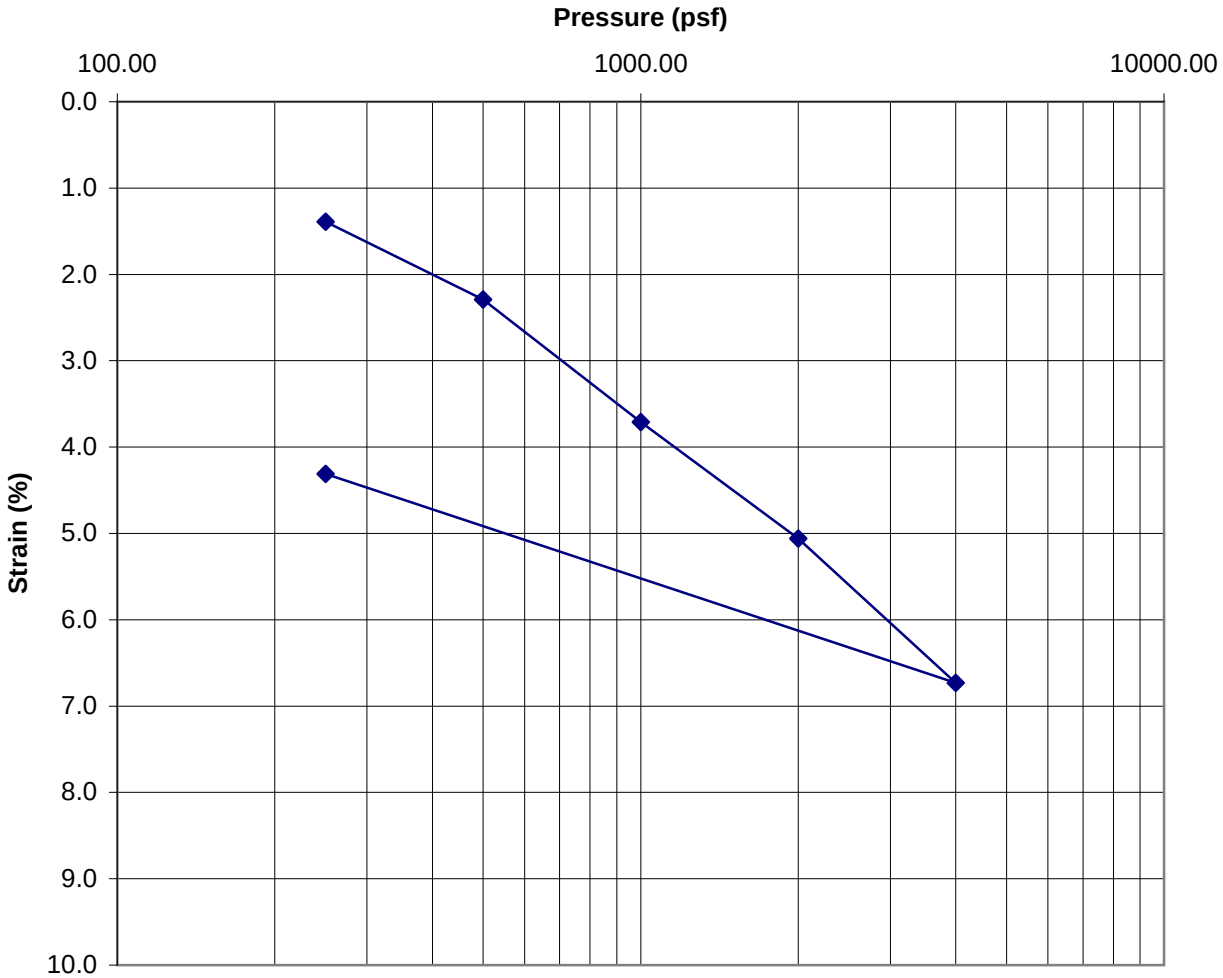


Material Description:	Sandy SILT (ML)
Specimen Type:	Cal. Mod. 2.5"
Initial Water Content (%):	14.3
Initial Dry Density (pcf):	104.1

Sample B02-7@5ft.
Consolidation Test Results
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/17/2002
Exploration No.:	B02-7	**Sample No.:**	2
Sample Depth (ft):	10.0		

CONSOLIDATION TEST RESULTS

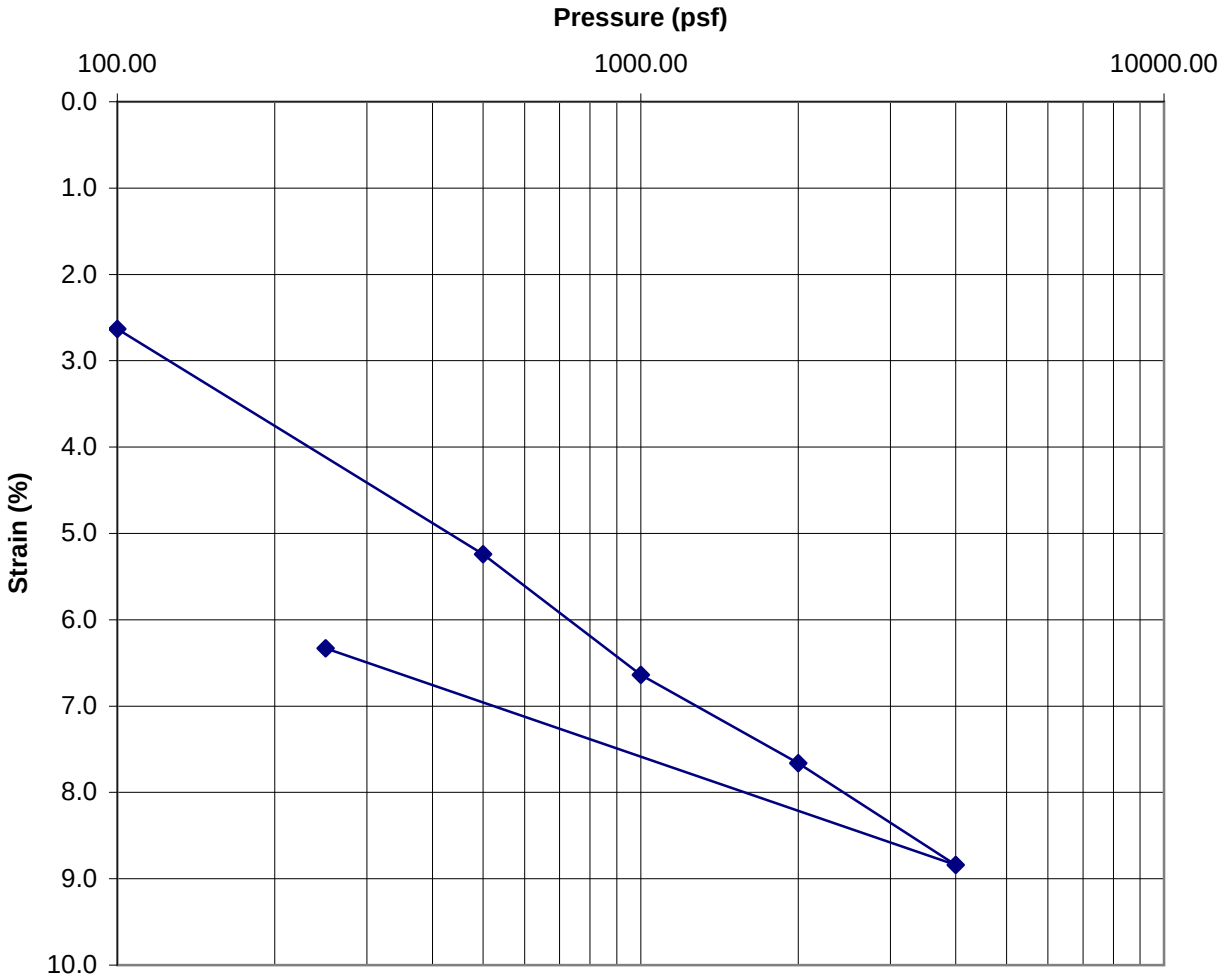


Material Description:	Sandy SILT (ML)
Specimen Type:	Cal. Mod. 2.5"
Initial Water Content (%):	18.0
Initial Dry Density (pcf):	99.3

Sample B02-7@10ft.
Consolidation Test Results
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/26/2002
Exploration No.:	B02-8	**Sample No.:**	3
Sample Depth (ft):	15.0		

CONSOLIDATION TEST RESULTS

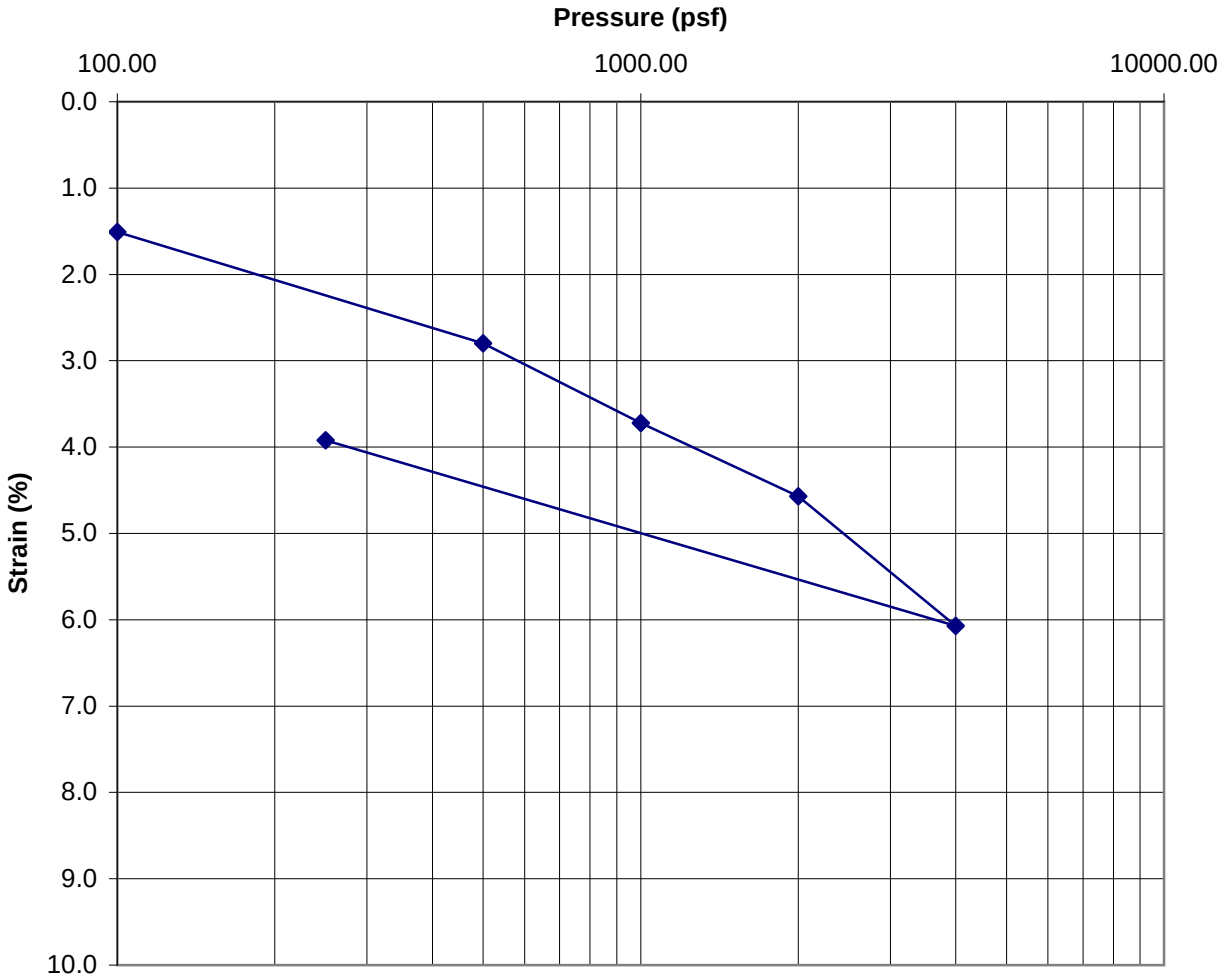


Material Description:	Sandy SILT (ML)
Specimen Type:	Cal. Mod. 2.5"
Initial Water Content (%):	19.3
Initial Dry Density (pcf):	104.4

Sample B02-8@15ft.
Consolidation Test Results
Buckhorn Grade

Project:	Buckhorn Grade	**Project No.:**	502001.021
Location of Project:	Shasta Co., California	**Tested By:**	SHN
Client:	CALTRANS	**Test Date:**	09/18/2002
Exploration No.:	B02-8	**Sample No.:**	4
Sample Depth (ft):	20.0		

CONSOLIDATION TEST RESULTS



Material Description:	Silty SAND (SM)
Specimen Type:	Cal. Mod. 2.5"
Initial Water Content (%):	11.9
Initial Dry Density (pcf):	110.5

Sample B02-8@20ft.
Consolidation Test Results
Buckhorn Grade

EXCELCHEM
ENVIRONMENTAL LABS

500 Giuseppe Court, Suite 3
Roseville, CA 95678
Phone#: (916) 773-3664 Fax#: (916) 773-4784

ANALYSIS REPORT

Attention: Jim Banchin
SHN
480 Hemsted Drive
Redding, CA 96002
Project: Buckhorn Grade / 502021-021

Date Sampled: 07/25/02-08/21/02
Date Received: 09/17/02

Method: EPA 9045C(s) Date Analyzed: 09/18/02

Client Sample I.D.	B02-1@20'	B02-2@40'	B02-8@20'	B02-4@10'
LAB. NO.	S0902408	S0902409	S0902410	S0902411
ANALYTE	Results	Results	Results	Results
pH	5.7	5.2	5.8	6.0

Client Sample I.D.	B02-3@15'	B02-5@15'	B02-6@10'	B02-7@10'
LAB. NO.	S0902412	S0902413	S0902414	S0902415
ANALYTE	Results	Results	Results	Results
pH	6.4	6.1	6.5	5.6

Method: EPA 120.1 Date Analyzed: 09/18/02

Client Sample I.D.	B02-1@20'	B02-2@40'	B02-8@20'	B02-4@10'
LAB. NO.	S0902406	S0902409	S0902410	S0902411
ANALYTE	Results	Results	Results	Results
Resistivity	0.0051	0.0052	0.020	0.0031

Client Sample I.D.	B02-3@15'	B02-5@15'	B02-6@10'	B02-7@10'
LAB. NO.	S0902412	S0902413	S0902414	S0902415
ANALYTE	Results	Results	Results	Results
Resistivity	0.0081	0.0056	0.014	0.00061

Soil samples reported in micro-ohms/cm

Laboratory Representative

09/24/02
Date Reported

EXCELCHEM
ENVIRONMENTAL LABS

500 Giuseppe Court, Suite 3
Roseville, CA 95678
Phone#: (916) 773-3664 Fax#: (916) 773-4784

ANALYSIS REPORT

Attention: Jim Blanchin
SHN
480 Hemsted Drive
Redding, CA 96002
Project: Buckhorn Grade
Method: EPA 300.0

Date Sampled: 07/25/02-08/21/02
Date Received: 09/17/02
Choride Analyzed: 09/24/02
Sulfate Analyzed: 09/19/02

Client Sample I.D.	B02-1@20'		B02-2@40'		B02-8@20'		B02-4@10'	
LAB. NO.	S0902408		S0902409		S0902410		S0902411	
ANALYTE	R/L	Results	R/L	Results	R/L	Results	R/L	Results
Chloride	4.0	14	4.0	18	4.0	6.8	4.0	39
Sulfate	2.0	8.0	2.0	13	2.0	19	2.0	19

Client Sample I.D.	B02-3@15'		B02-5@15'		B02-6@10'		B02-7@10'	
LAB. NO.	S0902412		S0902413		S0902414		S0902415	
ANALYTE	R/L	Results	R/L	Results	R/L	Results	R/L	Results
Chloride	2.5	ND	4.0	4.8	2.5	ND	2.5	120
Sulfate	2.0	4.0	2.0	18	2.0	36	2.0	ND

QA/QC %RECOVERY		
	LCS	LCSD
Sulfate	110	100

QA/QC Analyzed: 09/19/02

QA/QC %RECOVERY				
	LCS	LCSD	MS	MSD
Chloride	111	101	81	76

QA/QC Analyzed: 09/19/02

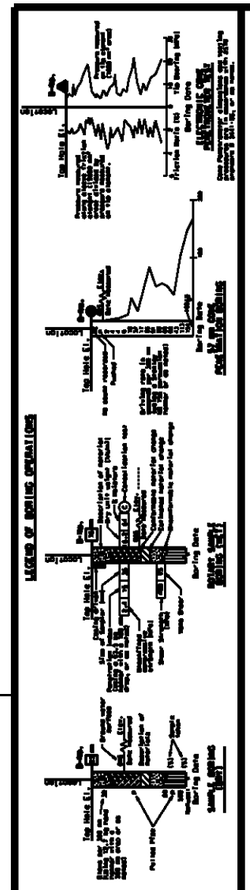
ND = Not detected. Compound(s) may be present at concentrations below the reporting limit.
R/L = Reporting Limit
Water samples reported in mg/L

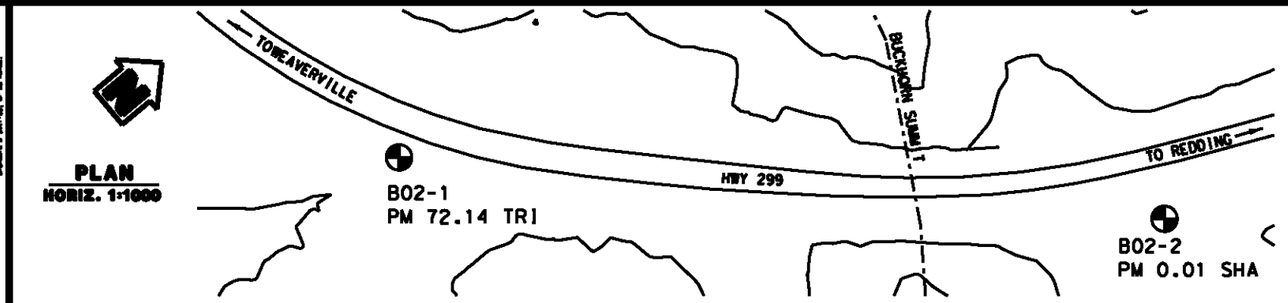
Laboratory Representative

09/24/02
Date Reported

APPENDIX D

LOTBs by SHN (2002)

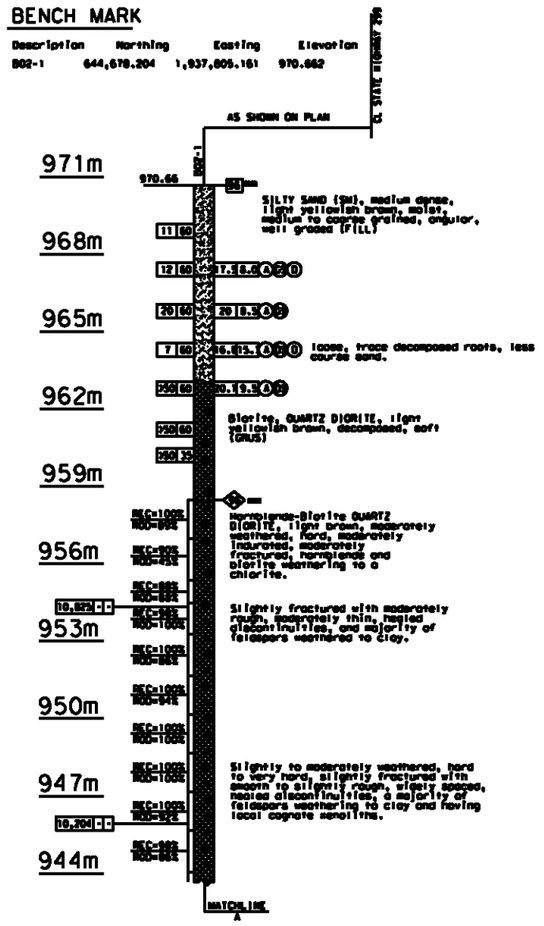


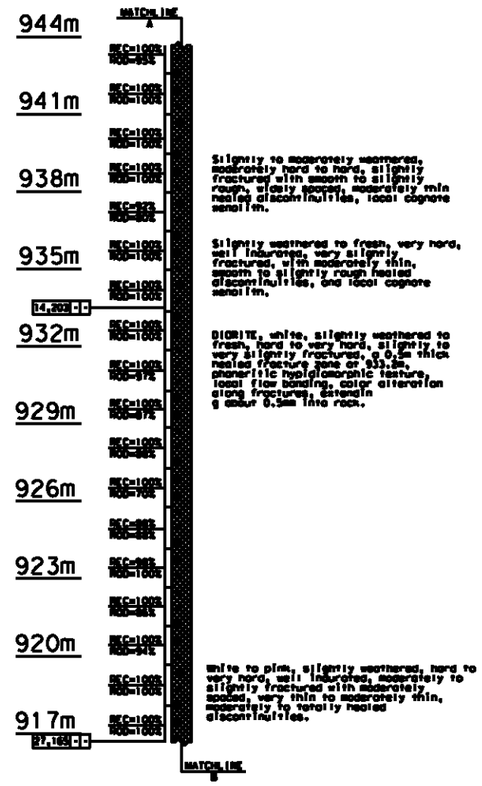


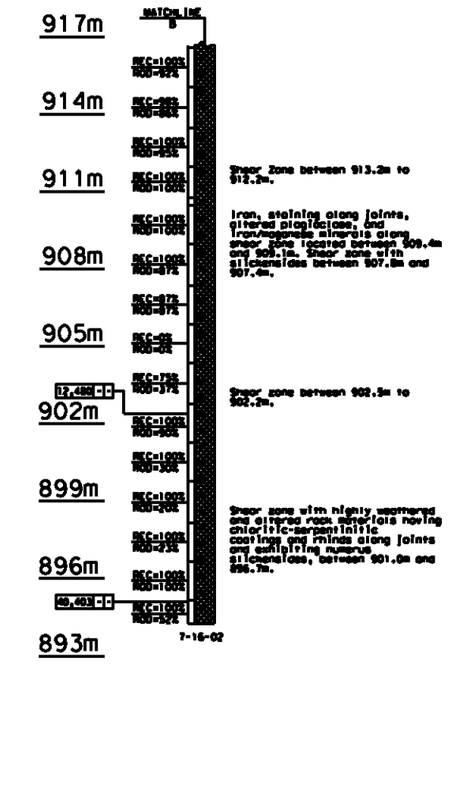
PLAN
HORIZ. 1:1000

BENCH MARK

Description	Northing	Easting	Elevation
B02-1	644,678.204	1,937,805.161	970.662







PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST — 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 6-30-03 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

CONSULTING ENGINEERS & GEOLOGISTS, INC.
488 Hemsted Drive (530)221-5474
Redding, CA 96002FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	BUCKHORN GRADE
	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY	PROJECT ENGINEER	LOG OF TEST BORINGS
SIGN OFF DATE			DATE: SEE BORINGS		

CU
EA 02-270310

REVISION DATES (PRELIMINARY STAGE ONLY) — 9-26-02 — SHEET 1 OF 1

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USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-1.dgn 10/4/2011 9:28:25 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

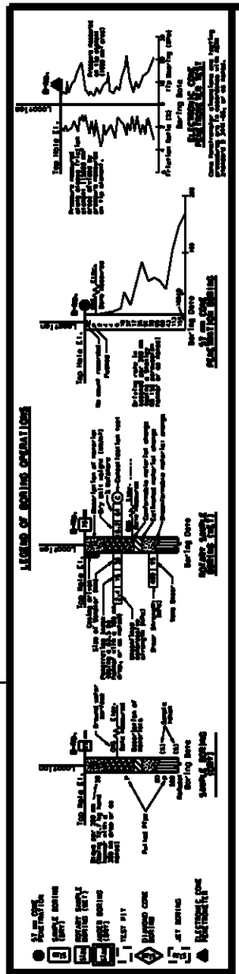
CERTIFIED ENGINEER GEOLOGIST 9/26/02

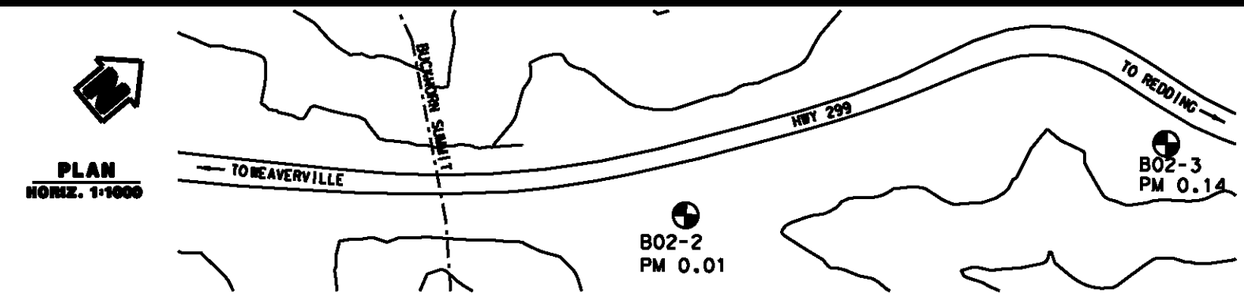
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

CONSULTING ENGINEERS & GEOLOGISTS, INC.
468 Hemsted Drive (530)221-3424
Redding, CA 96002 Fax (530)221-0135

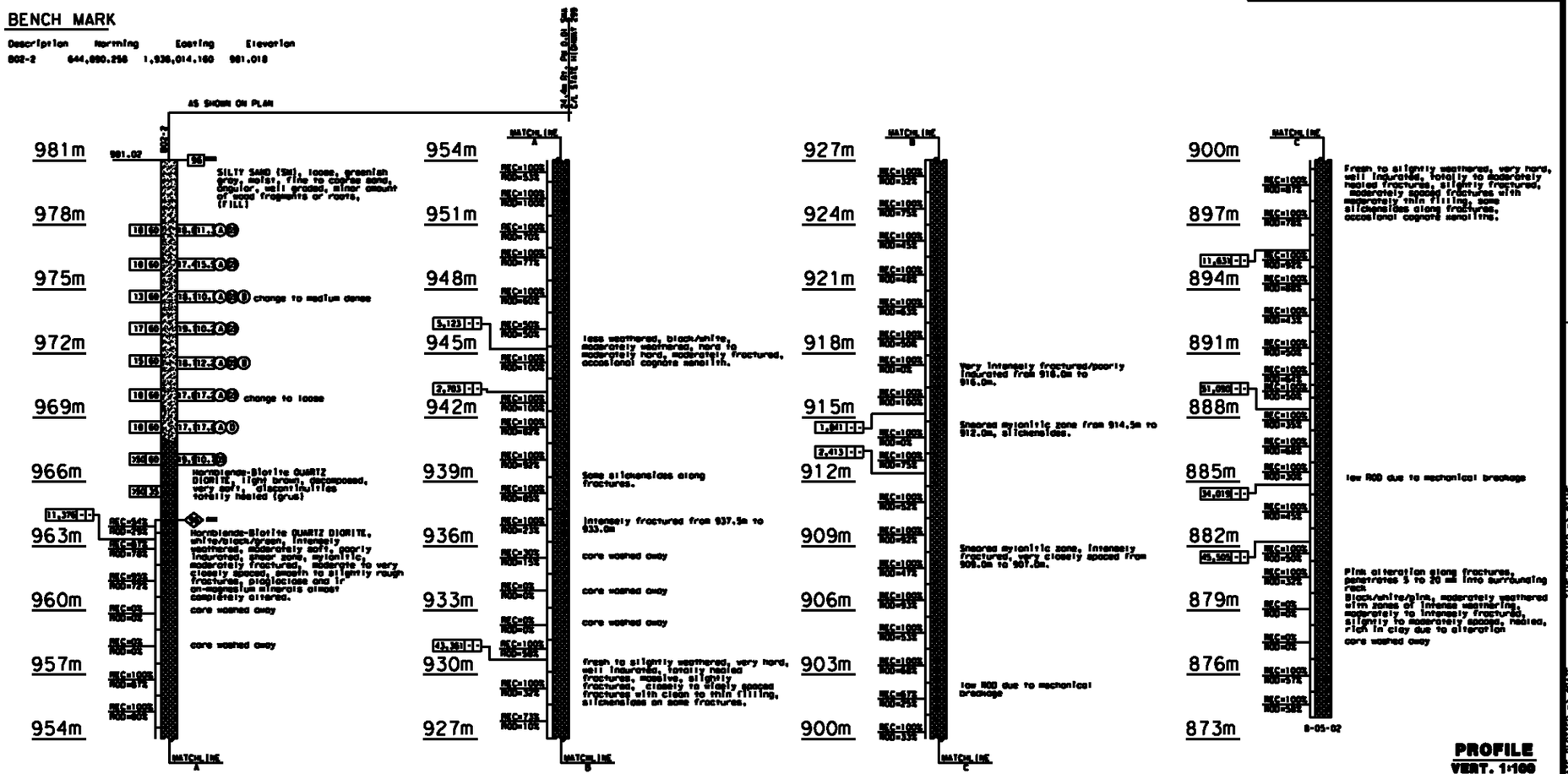
JOB No. 502001.021 LOCATION: BUCKHORN GRADE





BENCH MARK

Description	Northing	Easting	Elevation
B02-2	644,690.256	1,936,014.160	981.018



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	BRIDGE NO.
DATE OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS	PROJECT ENGINEER	KILOMETER POST

BUCKHORN GRADE
LOG OF TEST BORINGS

CU
EA 02-270310

REVISION DATES WHEN NECESSARY	STATE ONLY								SHEET	OF
9-26-02									1	1

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) REV 2/1/00

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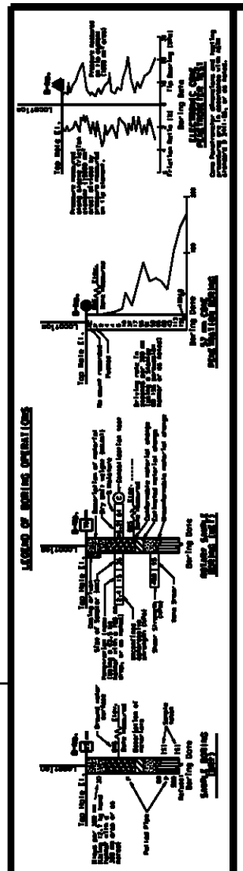
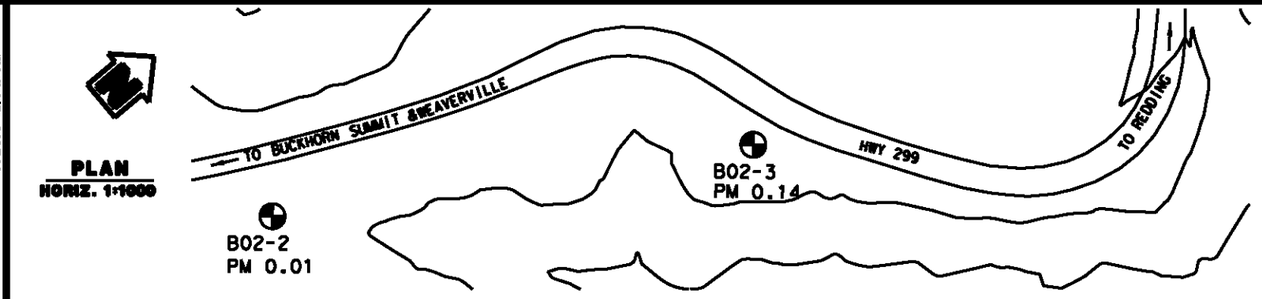
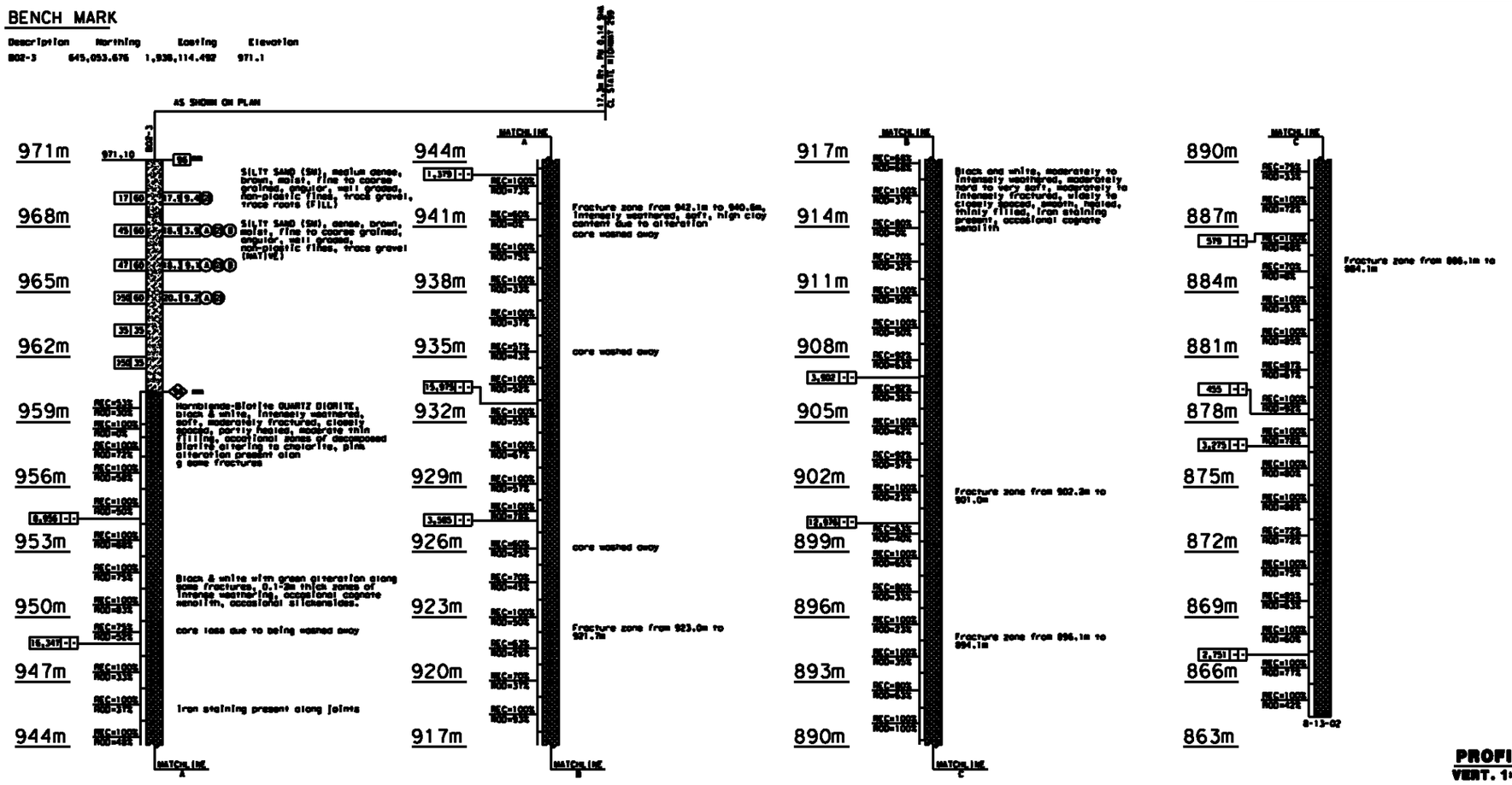




PLAN
HORIZ. 1:1000

BENCH MARK

Description	Northing	Easting	Elevation
B02-3	645,093.676	1,936,114.492	971.1



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST — 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1241 — Exp. 6-30-03 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

CONSULTING ENGINEERS & GEOLOGISTS, INC.
488 Hemsted Drive (530)221-5424
Redding, CA 96002FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

LEGEND OF EARTH MATERIALS

CONSISTENCY CLASSIFICATION FOR SOILS

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply essential details.

DESIGN OVERSIGHT

DRAWN BY M. JURING
CHECKED BY J. BIANCHIN

D. LINDSAY
FIELD INVESTIGATION BY
DATE: SEE BORINGS

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

CU
EA 02-270310

BUCKHORN GRADE
LOG OF TEST BORINGS

REVISION DATES (PRELIMINARY STAGE ONLY) — 9-26-02

SHEET 1 OF 1

FILE => GREQUEST

DGN: LOTB-02-3.dgn 10/4/2011 9:39:59 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

PLANS APPROVAL DATE

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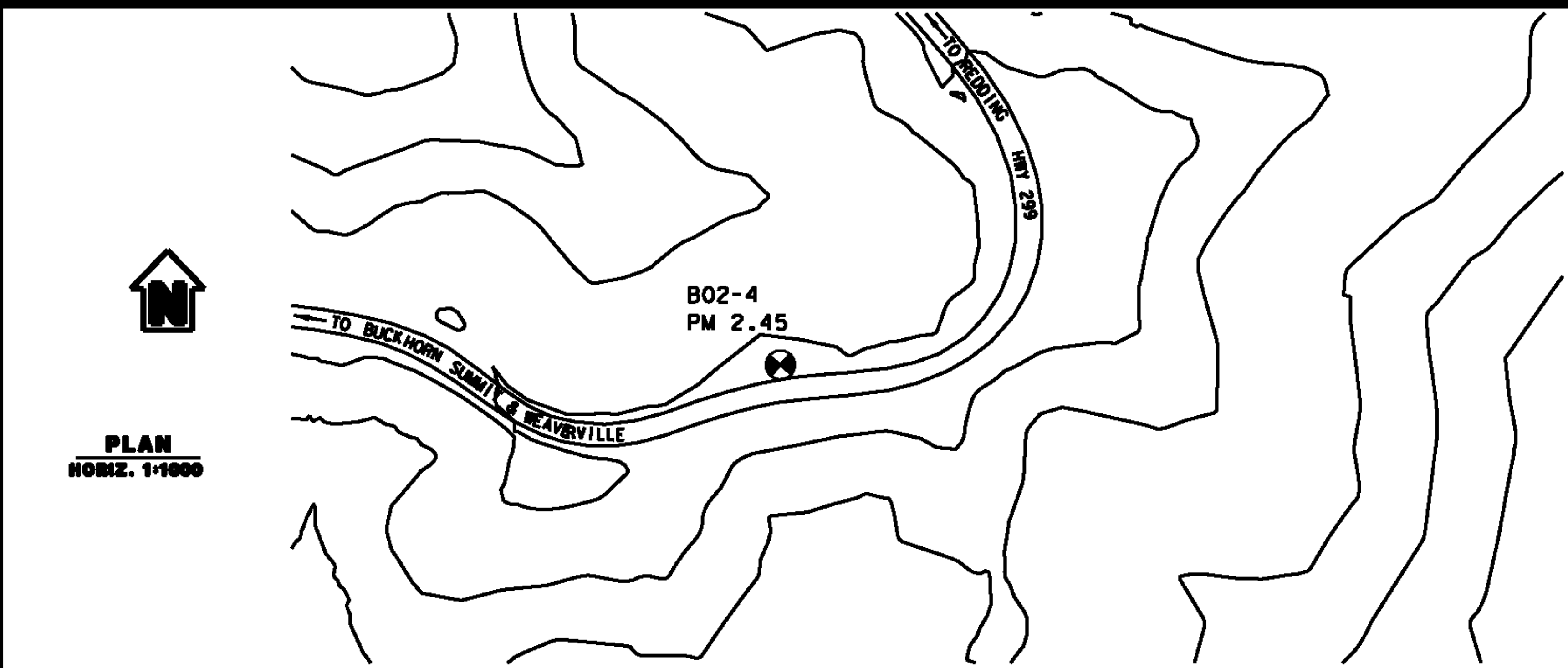
CONSULTING ENGINEERS & GEOLOGISTS, INC.

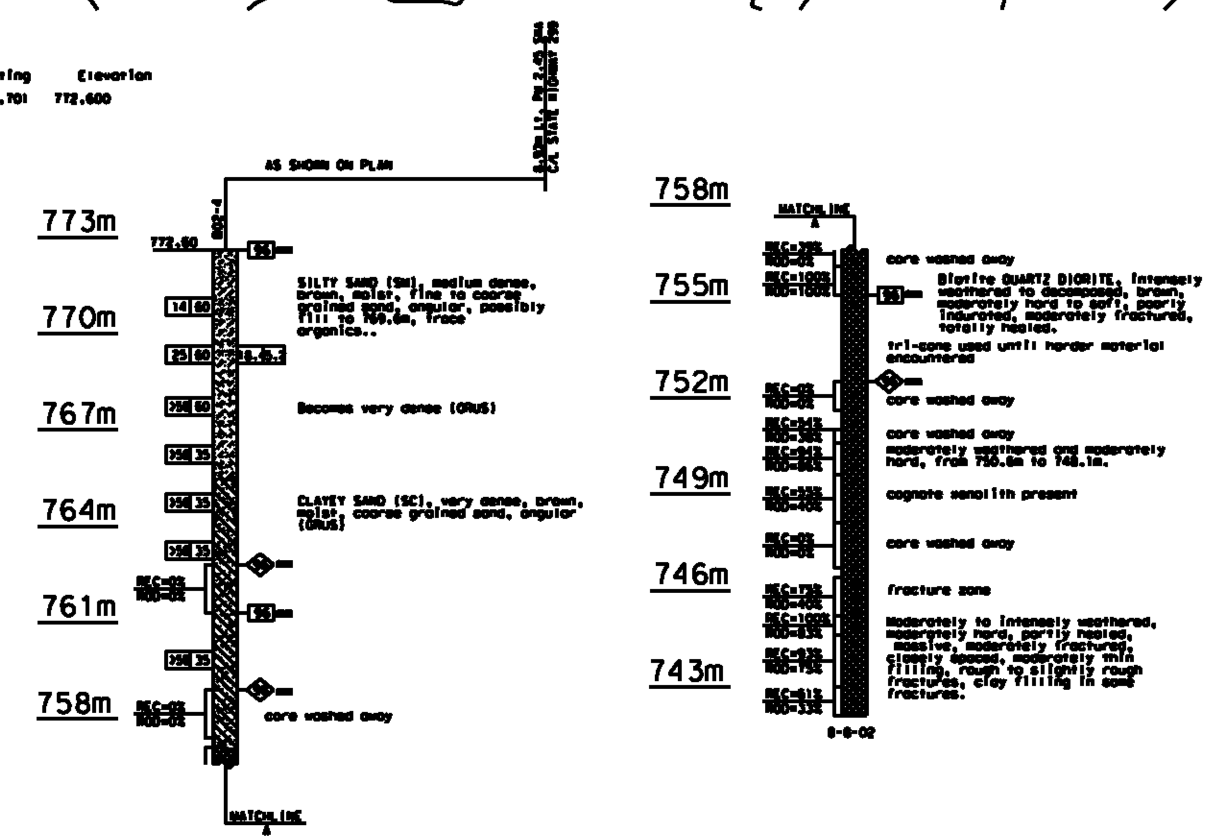
JOB No. 502001.021 LOCATION: BUCKHORN GRADE



PLAN
HORIZ. 1:1000

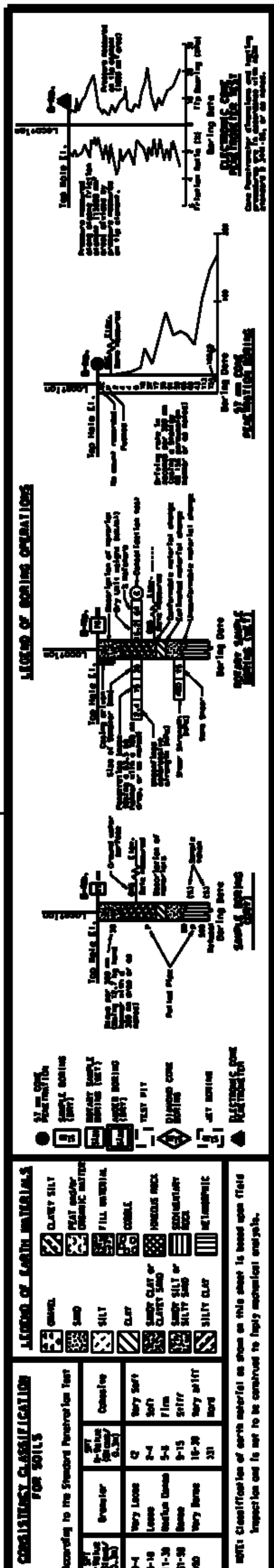
BENCH MARK

Description	Northing	Easting	Elevation
B02-4	646,356.950	1,940,150.701	772.600



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN



DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS	PROJECT ENGINEER

BUCKHORN GRADE

LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 3/1/00)

CU
EA 02-270310

9-26-02

FILE => $REQUEST

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST — 9/26/02

REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1645 — Exp. 6-30-03 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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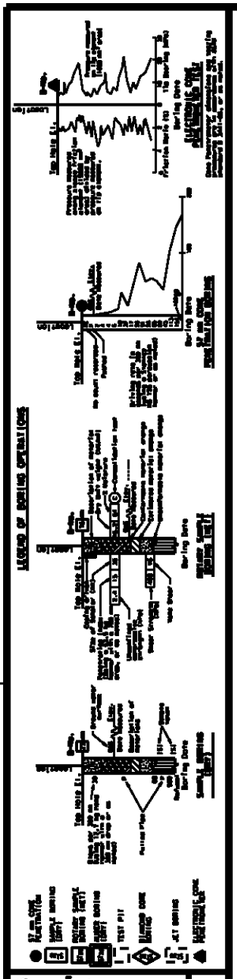
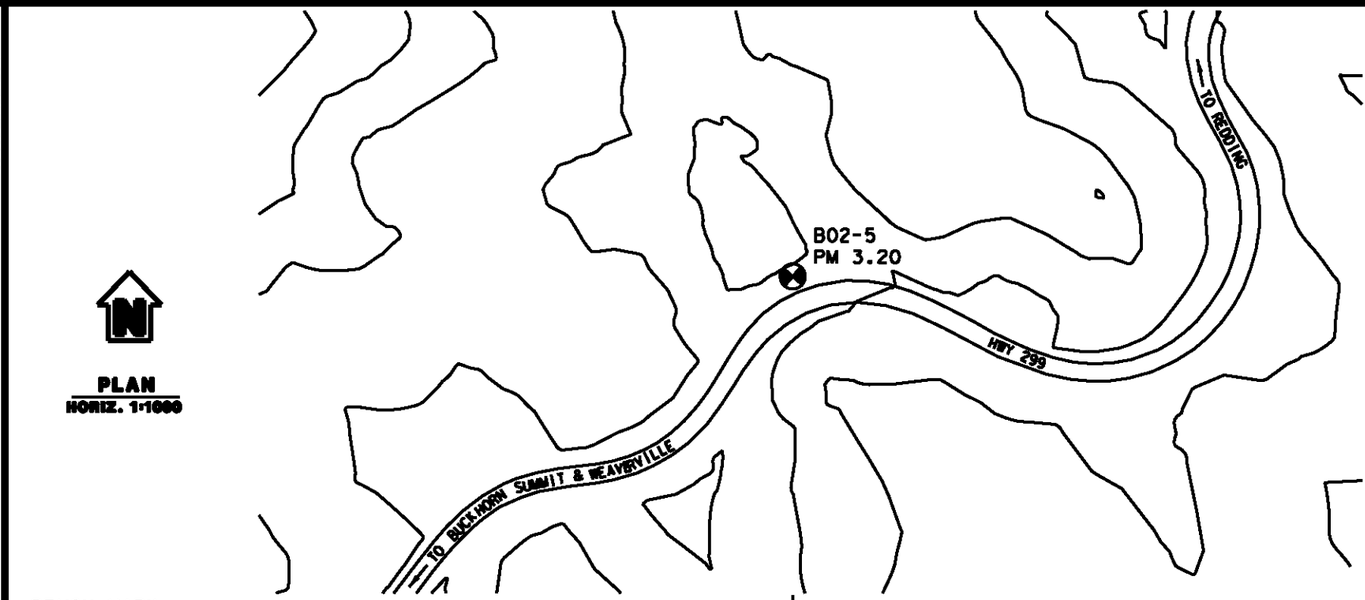
CONSULTING ENGINEERS & GEOLOGISTS, INC.
400 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0935

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

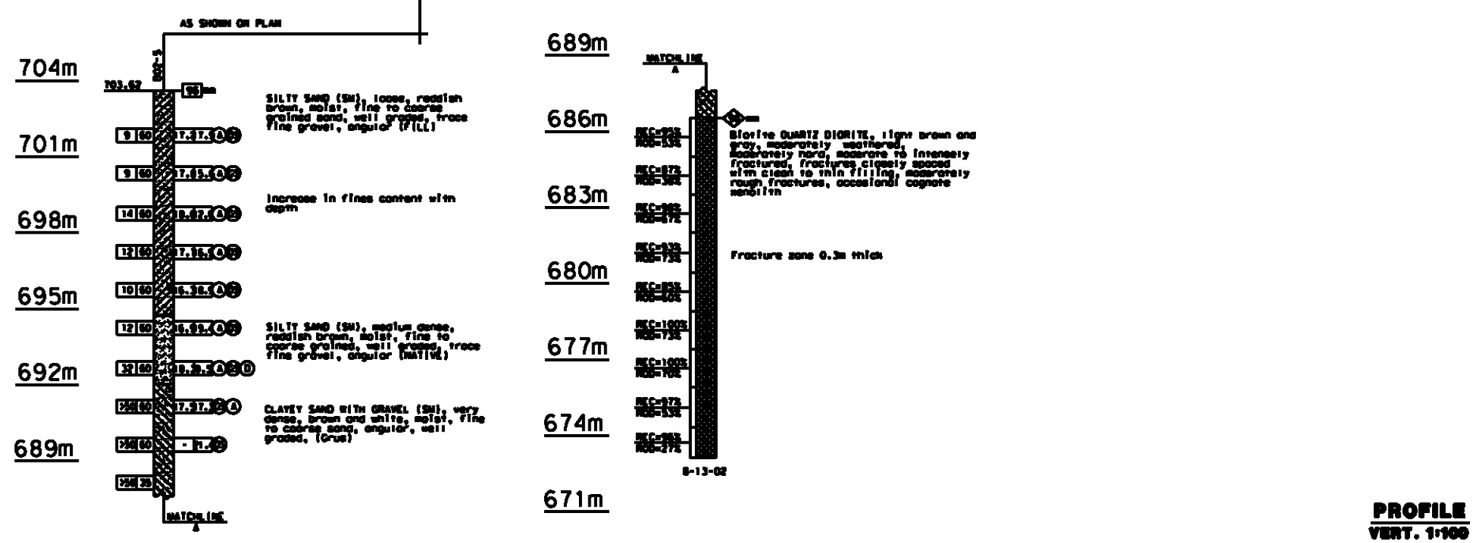
Metric





BENCH MARK

Description	Northing	Easting	Elevation
B02-5	647,069.223	1,940,536.737	703.617



PROFILE
VERT. 1=100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS		

CU 02-270310
EA 02-270310

BUCKHORN GRADE
LOG OF TEST BORINGS

REVISION DATES (PRELIMINARY STAGE ONLY): 9-26-02
SHEET 1 OF 1

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 3/1/00)

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DGN: $DGNNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

LOTB-02-5.dgn 10/4/2011 9:44:01 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

PLANS APPROVAL DATE

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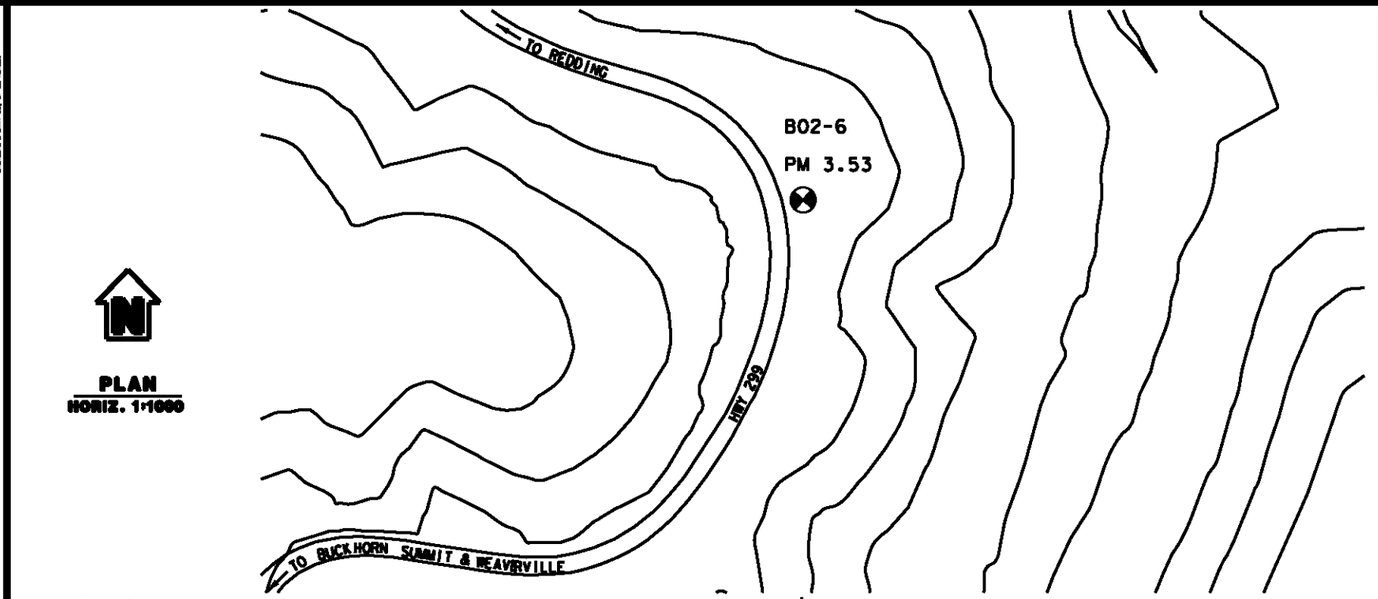
REGISTERED GEOLOGIST — JAMES L. HANSEN — No. EG No. 1641 — Exp. 6-30-03 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

CONSULTING ENGINEERS & GEOLOGISTS, INC.
488 Hemsted Drive (530)221-5424
Redding, CA 96002Fax (530)221-0135

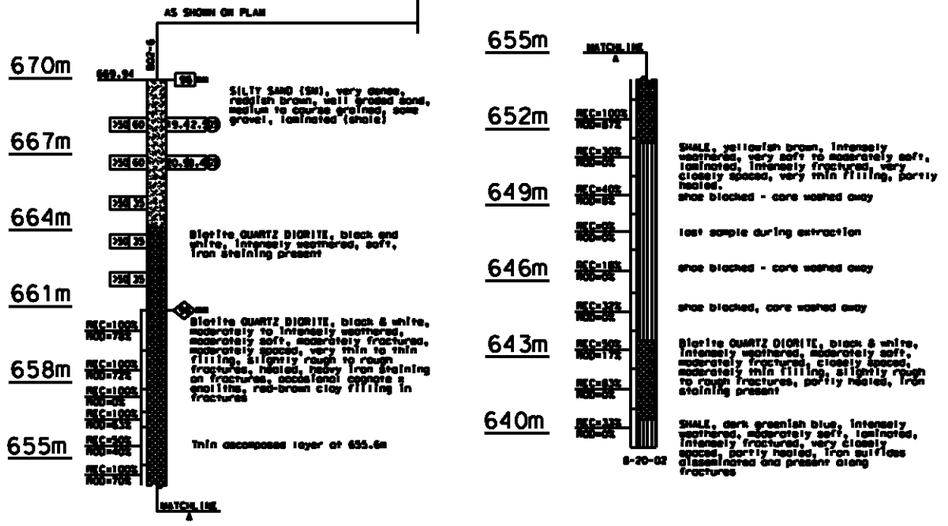
JOB No. 502001.021 LOCATION: BUCKHORN GRADE



PLAN
HORIZ. 1:1000

BENCH MARK

Description	Northing	Easting	Elevation
B02-6	647,336.070	1,940,917.039	669.939



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

LEGEND OF DRILLING OPERATIONS

LEGEND OF EARTH MATERIALS

DESIGNATION CLASSIFICATION FOR SOILS (According to the Standard Penetration Test)

Cohesive		Granular	
Very Soft	0-1	Very Loose	0-4
Soft	2-4	Loose	5-10
Firm	5-8	Medium Dense	11-30
Stiff	9-15	Dense	31-50
Very Stiff	16-30	Very Dense	50
Hard	30		

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply subsurface conditions.

DESIGN OVERSIGHT

Date OFF DATE

DRAWN BY	M. JURING
CHECKED BY	J. BIANCHIN

D. LINDSAY
FIELD INVESTIGATION BY
DATE: SEE BORINGS

PREPARED FOR THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT ENGINEER

CU
EA 02-270310

BRIDGE NO.

BUCKHORN GRADE
LOG OF TEST BORINGS

REVISION DATES (PRELIMINARY STAGE ONLY)														SHEET #	OF
9-26-02														1	1

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 3/1/00)

FILE => GREQUEST

DATE PLOTTED => 9/26/02 TIME PLOTTED => 07:56

USERNAME => JUSER

LOTB-02-6.dgn 10/4/2011 9:46:21 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

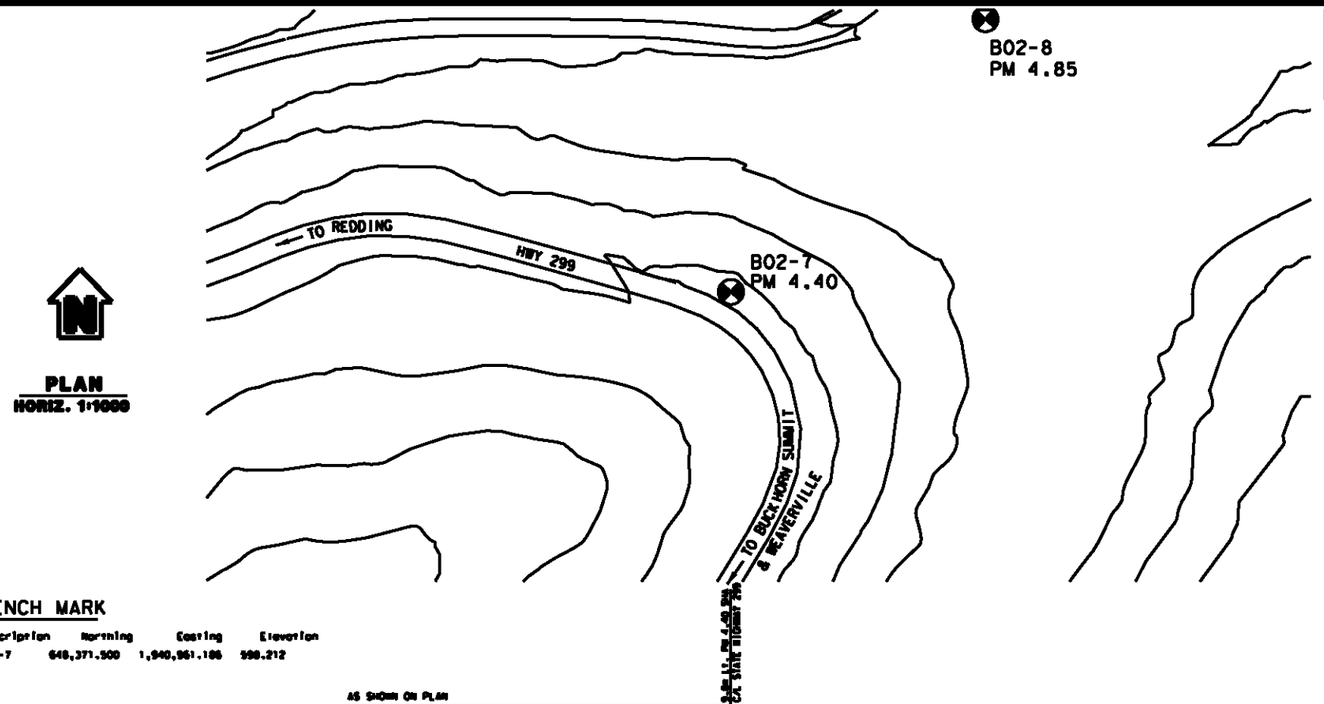
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED GEOLOGIST JAMES A. MANCINI No. EG No. 1644 Exp. 6-2005 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA

CONSULTING ENGINEERS & GEOLOGISTS, INC. 400 Hemsted Drive (530)221-5424 Redding, CA 96002Fax (530)221-0135

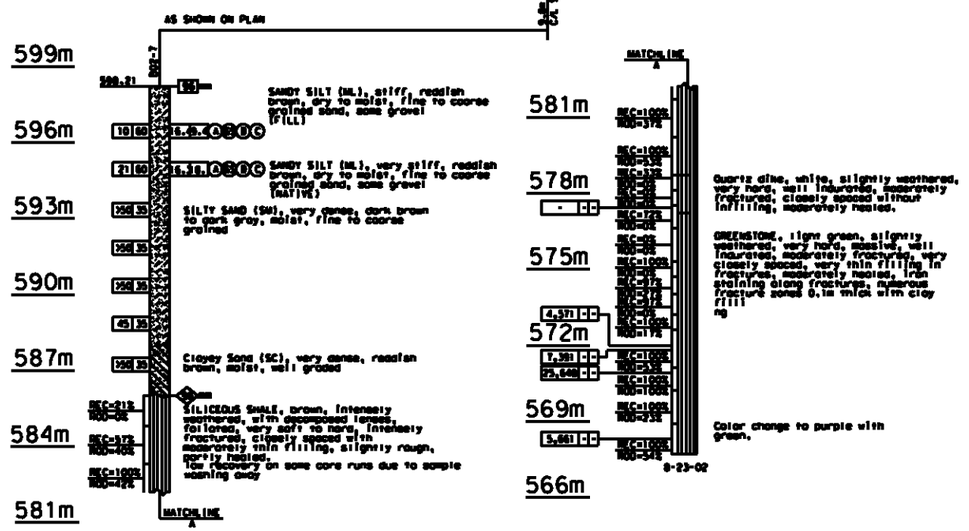
JOB No. 502001.021 LOCATION: BUCKHORN GRADE



PLAN
HORIZ. 1:1000

BENCH MARK

Description	Northing	Easting	Elevation
B02-7	648,371.900	1,940,961.186	598.212



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

LEGEND OF BORING OPERATIONS

LEGEND OF EARTH MATERIALS

CONSISTENCY CLASSIFICATION FOR SOILS

Note: Classification of earth material as shown on this sheet is based upon Field Inspection and is not to be construed to imply material analysis.

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY FIELD INVESTIGATION BY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER	BRIDGE NO.	BUCKHORN GRADE
Date: SEE DATE	CHECKED BY	J. BIANCHIN	DATE: SEE BORINGS			ELEMENTED PEA	LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 8/1/00)

ORIGINAL SCALE IN MILLIMETERS FOR MICROFILM 0 10 20 30 40 50 60 70 80 90 100

CU EA 02-270310 FILE => WREQUEST

REVISION DATES PRELIMINARY STAGE ONLY 9-26-02

DISTRICT | COUNTY | ROUTE | SHEET | OF

1 | 1

USERNAME => JOSEH DATE PLOTTED => 9/26/02 TIME PLOTTED => 07:16

LOTB-02-7.dgn 10/4/2011 9:47:59 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST 9/26/02

PLANS APPROVAL DATE

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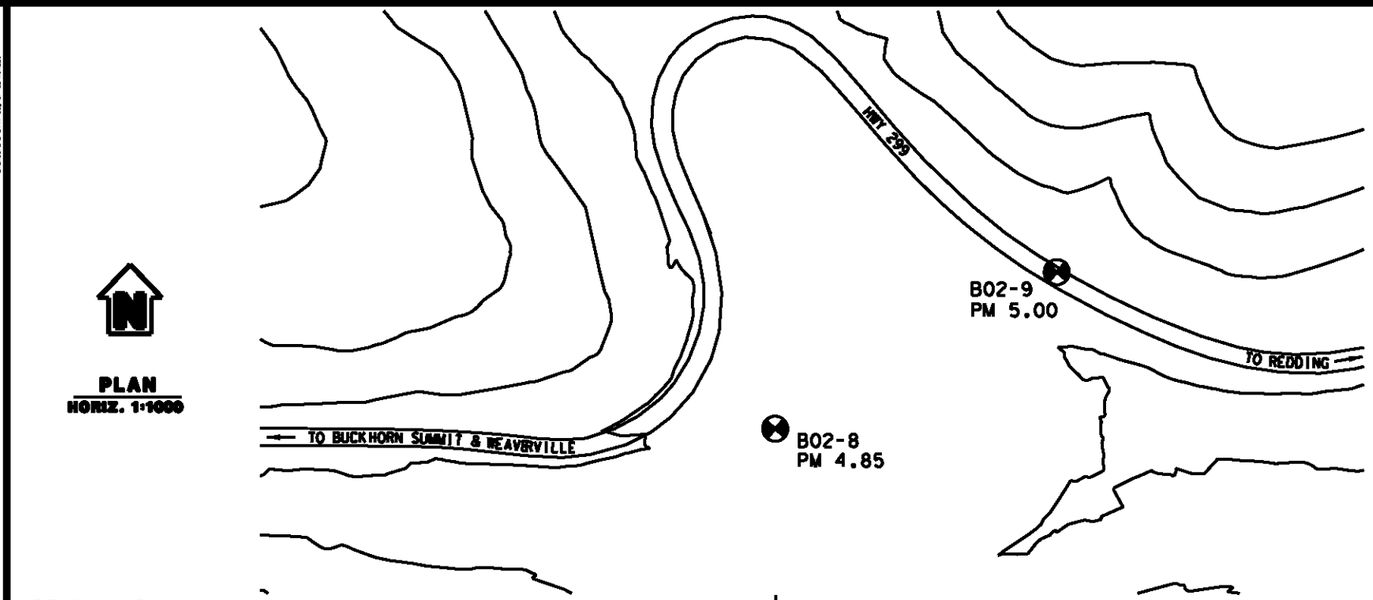
REGISTERED GEOLOGIST — JAMES A. BIANCHIN — No. EG No. 1644 — Exp. 12-31-02 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

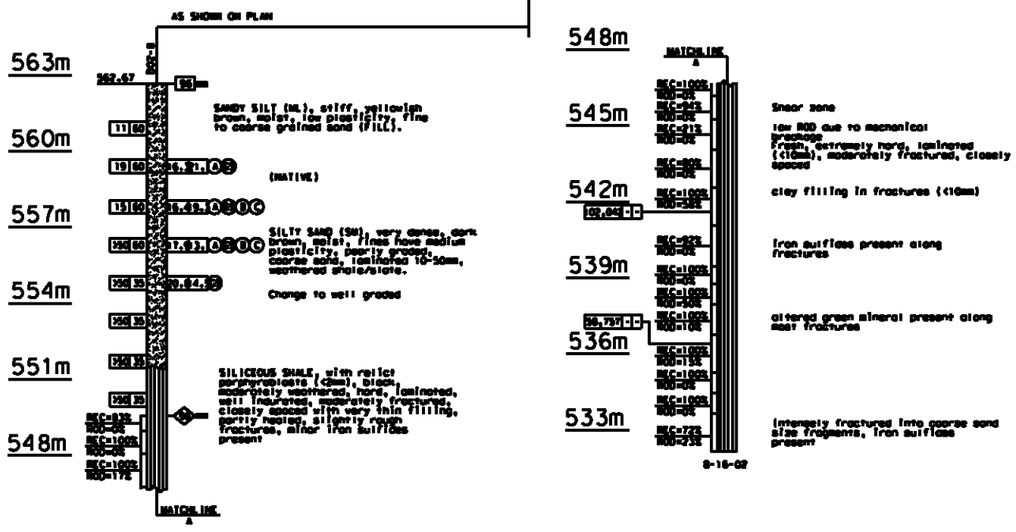
CONSULTING ENGINEERS & GEOLOGISTS, INC.
408 Hemsted Drive (530)221-5424
Redding, CA 96002FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE



BENCH MARK

Description	Northing	Easting	Elevation
B02-8	648,479.123	1,941,061.623	562.667



PROFILE
VERT. 1:100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

LEGEND OF EARTH MATERIALS
CLAYEY SILT, PEAT and/or ORGANIC MATERIAL, FILL MATERIAL, GRAVEL, SAND, SILT, CLAY, SANDY CLAY or CLAYEY SAND, SANDY SILT or SILTY SAND, SILTY CLAY, IGNEOUS ROCK, SEDIMENTARY ROCK, METAMORPHIC

CONSISTENCY CLASSIFICATION FOR SOILS
According to the Standard Penetration Test

SPT Blows/0.3m	Cohesive	Very Soft, Soft, Firm, Stiff, Very stiff, Hard
SPT Blows/0.3m	Cohesionless	V, 2-4, 5-8, 9-15, 16-30, 31-
Granular	Very Loose, Loose, Medium Dense, Dense, Very Dense	
SPT Blows/0.3m	Cohesionless	0-4, 5-10, 11-30, 31-50, 50

NOTE: Classification of earth materials as shown on this sheet is based upon visual inspection and is not to be construed to imply material analysis.

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER
Date OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS		

BRIDGE NO.
STRUCTURE NO.

BUCKHORN GRADE
LOG OF TEST BORINGS

CU EA 02-270310

REVISION DATES

DATE												SHEET	OF
9-26-02												1	1

GEOTECHNICAL LOG OF TEST BORINGS SHEET METRIC REV 5/1/01

DESIGNATED SCALE IS FOR 11" X 17" PLOTS

DESIGNATED SCALE IS FOR HALF SIZE PLOTS

0 10 20 30 40 50 60 70 80 90 100

DGN: => $USERNAME
USER: => $USER
DATE PLOTTED: => $DATE
TIME PLOTTED: => $TIME
FILE => $REQUEST

LOTB-02-8.dgn 10/4/2011 9:49:46 AM

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO	TOTAL SHEETS
02	SHASTA	299	116.48	1	1

CERTIFIED ENGINEER GEOLOGIST — 9/26/02

REGISTERED GEOLOGIST — JAMES L. BIANCHIN — No. EG No. 1648 — Exp. 6-30-05 — CERTIFIED ENGINEERING GEOLOGIST — STATE OF CALIFORNIA

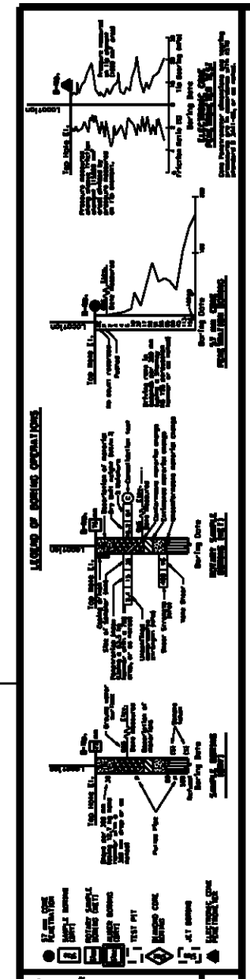
PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

CONSULTING ENGINEERS & GEOLOGISTS, INC.
488 Hemsted Drive (530)221-5424
Redding, CA 96002 FAX (530)221-0135

JOB No. 502001.021 LOCATION: BUCKHORN GRADE

Metric

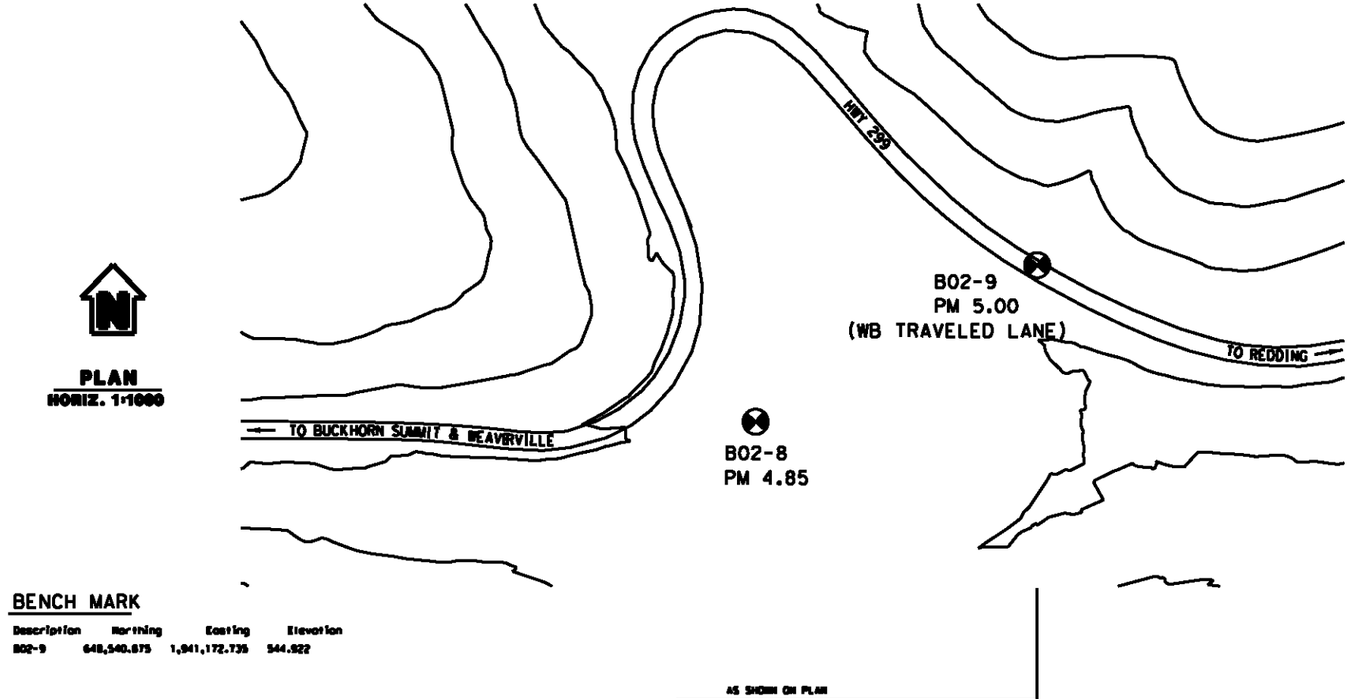


LEGEND OF BORING SYMBOLS

LEGEND OF EARTH MATERIALS

CLASSIFICATION FOR SOILS

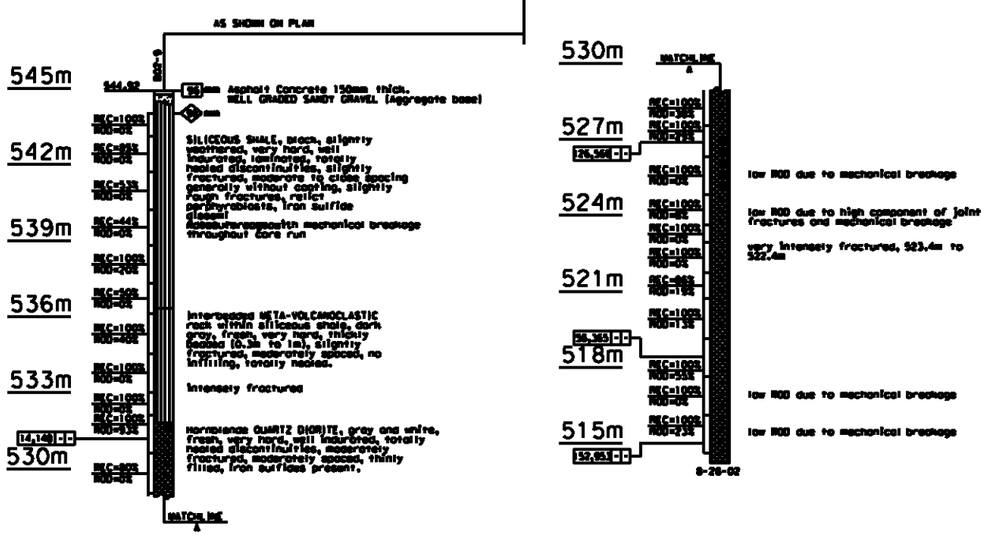
NOTE: Classification of earth materials as shown on this sheet is based upon Field Inspection and is not to be construed to imply Laboratory analysis.



PLAN
HORIZ. 1=1000

BENCH MARK

Description	Northing	Easting	Elevation
B02-9	648,540.875	1,941,172.735	544.922



PROFILE
VERT. 1=100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	M. JURING	D. LINDSAY	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	J. BIANCHIN	FIELD INVESTIGATION BY: DATE: SEE BORINGS		

BRIDGE NO.
ALTERNATIVE NO.

BUCKHORN GRADE
LOG OF TEST BORINGS

GEOTECHNICAL LOG OF TEST BORINGS SHEET METRIC REV 2/1/00

PLOTTED TO SCALE IN MILLIMETERS: 0 10 20 30 40 50 60 70 80 90 100

CU EA 02-270310
FILE => SREQUEST

REVISION DATES (PRELIMINARY STAGE ONLY)
ENGINEER'S REVISION DATES → 9-26-02

SHEET 1 OF 1

DESIGNED => USER DATE PLOTTED => %DATE TIME PLOTTED => %TIME

LOTB-02-9.dgn 10/4/2011 9:51:11 AM

AS-BUILT PLANS FOR EXISTING CONCRETE ARCH CULVERTS

DIV	COUNTY	ROUTE	SEC	SHEET No.	TOTAL SHEETS
II	SHA	20	A	12	20

Dist Eng., Dist II

Approved June 23, 1930.

Engineer, Surveys and Plans.

State Highway Engineer.

T.33N.R.7W.M.D.B.&M.
T.32N.R.7W.M.D.B.&M.

Township Lines

Approx. Boundary Line

Sec 31

Sec 6

Approx. Boundary Line

Jim Crow Mining Claim

U.S.A.
All of Sec.6 Except Mining Claims

All Mining Claims belong to The Atascadero Copper Co.

Atascadero Copper Co.

Present Irrigation Ditch

Proposed Irrigation Ditch

Sta 842+00 to 842+88 Construct Rubble Masonry Wall With Parapet
M=47.49CY E&B=.47CY. P=.88Ln ft

Sta 844+82 Construct 10'x17.65' Arch Culv(Spl)
C=37.67CY R=21.88° E&B=6.07CY

Sta 847+96 Place 18"x74'C.M.P. 1Std H.W.Lt
C=.66CY R=28° E&B=11.6CY

Sta 850+00 Place 18"x98'C.M.P. 1Std H.W.Lt
C=.56CY R=28° E&B=10.4CY

Sta 852+60 Construct 12'x11.0.16' Conc.Culv.(Spl)
C=35.06CY R=7.79° E&B=31.6CY
Az. 82°

Sta 854+00 Place 18"x94'C.M.P. 1D.I.Lt
C=1.00CY R=5.15° E&B=13.7CY

Sta 856+22 Place 18"x32'C.M.P. 1D.I.Lt
C=.10.2CY R=5.13° E&B=1.76CY

Sta 858+30 Place 18"x36'C.M.P. 1D.I.Lt
C=.36CY R=5.16° E&B=3.2CY

Sta 836+00 Place 18"x48'C.M.P. 1D.I.Lt
C=.65CY R=5.11° E&B=3.26CY

EQUATION

EQUATION

EQUATION

Sta 4+00 of Construction

Present Ditch

Approx. Boundary Line

Water Ditch

Elev 1890.09
North 22° West
60' Lt. Sta 845+00

Profile Grades Finished Grade
20' Roadbed
Cut Slopes 1/2:1
Fill Slopes 1:1

Cut Slopes 3/4:1

C.S. 1:1

C.S. 1:1

Fill Slopes 1:1

Cor Found

1960
1940
1920
1900
1880
1860
1850

'M' Line

'M' Line

'M' Line

'M' Line

Concrete Rip Rap 20'x3.0' Rock Debris Retainer

Placed 180 mil/hr at junction

Placed 20'x3.' River H

1467	195	997	1309	139	1037	2167	2256	1409	4143	3918		13	2912	610	220	211	125	590	418		377	576	426	146	3084	1852							
	17	50		74	572			9		273	13685	5087		193	278	619	1258	55	5		586	20	384	4		6							
4	5	6	7	8	9	840	1	2	3	4	5	6	7	8	9	850	1	2	3		4	5	6	7	8	9							

SHA. 297

DIV.	COUNTY	ROUTE	SEC.	SHEET NO.	TOTAL SHEETS
II	Sha.	[redacted]		1	1

Acting Bridge Engineer.

Approved February 27, 1924

State Highway Engineer.

STA. 844+79 II-SHA. 20-A
STEEL LIST FOR ARCH CULVERT

BARREL

No.	Size	Mark	Length		No.	Size	Mark	Length	
48	½"	a_1	24'-4"	Bend in place	56	½"	f_1	31'-5"	
43	½"	a_2	24'-9"	" " "	16	½"	f_2	33'-5"	Extend 2'-0" into wings Bend in place.
181	⅞"	b_1	15'-2"		80	⅝"	f_3	32'-1"	
					16	⅝"	f_4	34'-1"	Extend 2'-0" into wings Bend in place.

WING "A"

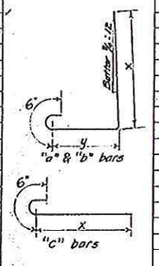
No.	Size	Mark	Length	x	y	
2	½"	a_7	10'-1"	7'-11"	1'-8"	
2	½"	a_8	11'-3"	8'-11"	1'-10"	
2	½"	a_9	12'-5"	9'-11"	2'-0"	
2	½"	a_{10}	13'-7"	10'-11"	2'-2"	
2	½"	a_{11}	14'-8"	11'-11"	2'-3"	
2	½"	c_7	3'-9"	3'-3"		
2	½"	c_8	4'-1"	3'-7"		
2	½"	c_9	4'-6"	4'-0"		
2	½"	c_{10}	4'-10"	4'-4"		
2	½"	c_{11}	5'-3"	4'-9"		
2	½"	c_{12}	5'-7"	5'-1"		
2	½"	d	11'-10"	Extend 2" Bend in place.		into Barrel
1	½"	a_4	8'-10"			
7	½"	a_5	10'-10"	Extend 2" into Barrel & Cutoff. Bend in place.		into Barrel
1	½"	a_6	9'-0"			
1	½"	a_7	5'-0"			

WING "B"

Same as for Wing "A"

WING "C"

19	½"	a_{11}	15'-10"	12'-11"	2'-5"	
18	½"	b_{12}	8'-9"	5'-10"	2'-5"	
19	½"	c_{12}	5'-7"	5'-1"		
1	½"	c_8	17'-10"			
11	½"	a_9	19'-10"	Extend 2" Bend in place.		into Barrel



WING "D"

No.	Size	Mark	Length	x	y	
2	½"	a_8	11'-3"	8'-11"	1'-10"	
2	½"	a_9	12'-5"	9'-11"	2'-0"	
2	½"	a_{10}	13'-7"	10'-11"	2'-2"	
2	½"	a_{11}	14'-8"	11'-11"	2'-3"	
2	½"	a_{12}	15'-10"	12'-11"	2'-5"	
2	½"	c_8	4'-1"	3'-7"		
2	½"	c_9	4'-6"	4'-0"		
2	½"	c_{10}	4'-10"	4'-4"		
2	½"	c_{11}	5'-3"	4'-9"		
2	½"	c_{12}	5'-7"	5'-1"		
2	½"	d	11'-10"	Extend 2" into Barrel & Bend in place.		
1	½"	a_4	8'-10"			
8	½"	a_5	10'-10"	Extend 2" into Barrel & Cutoff. Bend to place.		
1	½"	a_{10}	7'-0"			

TWO HEAD WALLS

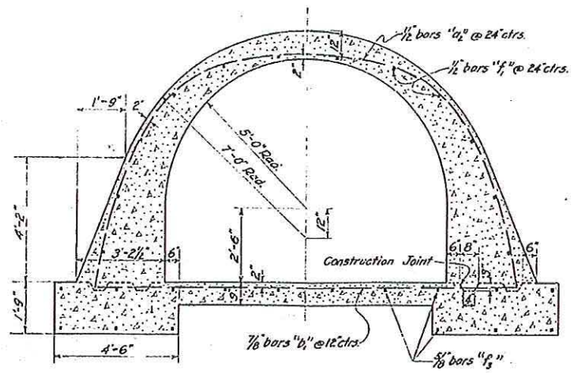
No.	Size	Mark	Length
8	⅝"	a_3	12'-4"
6	½"	a_4	2'-4"
4	½"	a_5	3'-2"
4	½"	a_6	4'-9"
4	½"	a_{11}	7'-0"

CUTOFF Inlet

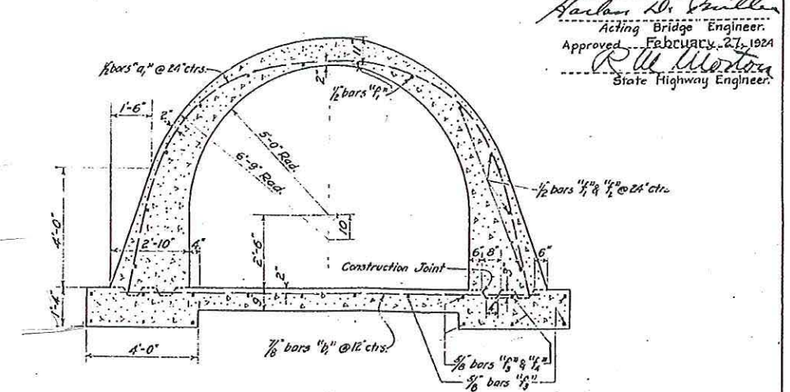
16	½"	g_1	3'-2"	Stickers
2	½"	g_2	12'-0"	Extend 2" into Wings Bend to place.

Outlet

16	½"	g_1	4'-2"	Stickers
2	½"	g_2	12'-0"	Extend 2" into Wings Bend to place.

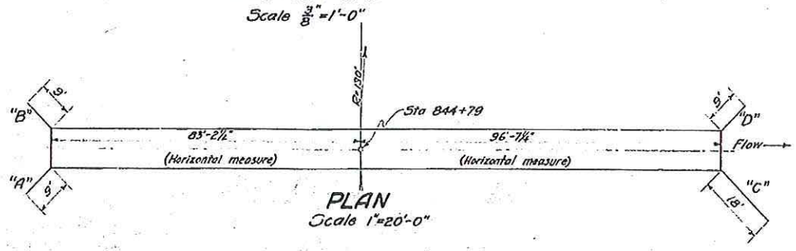


SECTION A-A
Scale ⅜"=1'-0"

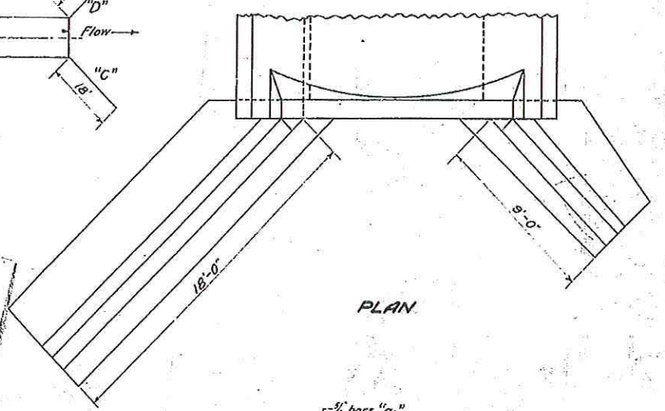


SECTION B-B
Scale ⅜"=1'-0"

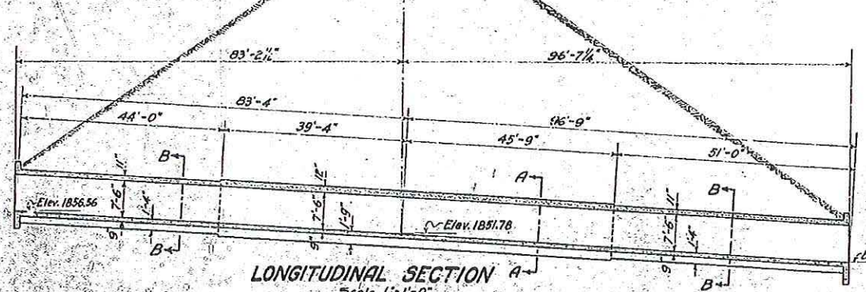
Note: "f₁" and "f₂" bars extend into wings and replace "f" and "f₃" bars.



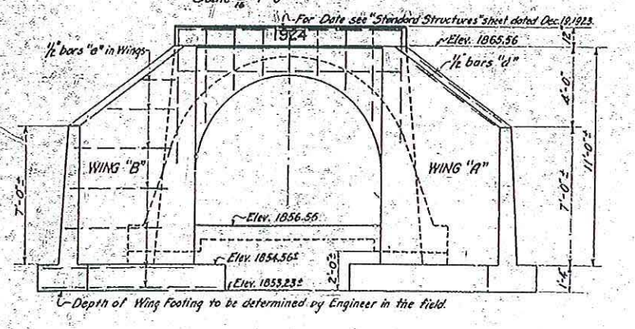
PLAN
Scale 1"=20'-0"



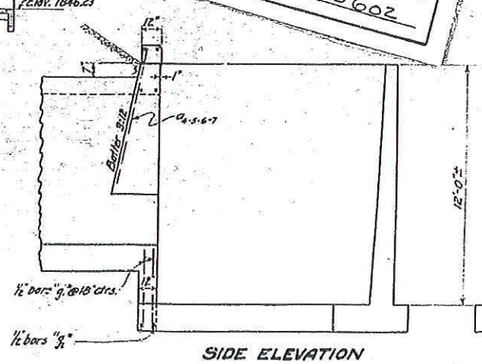
PLAN



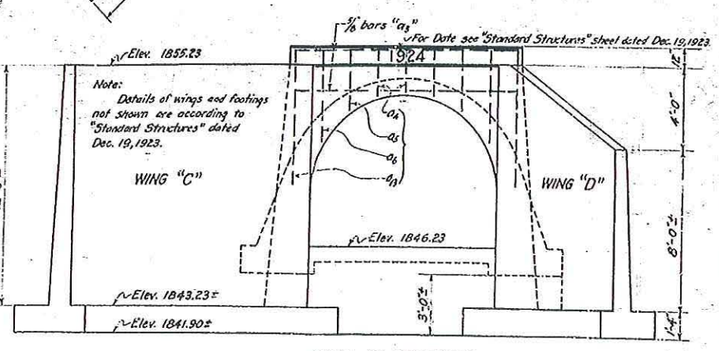
LONGITUDINAL SECTION A
Scale 1/16"=1'-0"



INLET ELEVATION
Scale ¼"=1'-0"



SIDE ELEVATION



OUTLET
Scale ¼"=1'-0"

END ELEVATION

AS BUILT PLANS
Contract No.
Date Completed
Document No. 2000602

General Notes:
All concrete to be Class A (1-2-4 mix).
All reinforcing steel to be square deformed bars
All bars to be embeded at least 2 diameters.
All exposed edges to be chamfered ½inch.
All splices in reinforcing steel to be lapped 40 diams.

Drawn by M.P.K.
Traced by C.N.O.
Checked by H.D.S
J.G.

STATE OF CALIFORNIA
CALIFORNIA HIGHWAY COMMISSION
SPECIAL ARCH CULVERT
STA. 844+79 II-SHA. 20-A
SCALES AS SHOWN

ARCH CULVERT STEEL LIST

BARREL

No.	Size	Mark	Length	Remarks
24	½"	a_1	30'-1½"	Bend in place.
32	½"	a_2	30'-7"	" " "
80	½"	f_1	28'-9"	Spacers.
16	½"	f_2	30'-3"	" Extend 2' into Wings Bend in place.
52	⅝"	f_3	29'-1"	"
16	⅝"	f_4	31'-1"	" " " " " "
111	⅝"	b_1	17'-2"	

WING A

No.	Size	Mark	Length	x	y
3	½"	a_9	11'-3"	8'-11"	1'-10"
3	½"	a_{10}	12'-5"	9'-11"	2'-0"
4	½"	a_{11}	14'-8"	11'-11"	2'-3"
2	½"	a_{12}	15'-10"	12'-11"	2'-5"
2	½"	a_{13}	17'-1"	14'-3"	2'-7"
2	½"	b_{11}	8'-9"	5'-10"	2'-5"
2	½"	b_{12}	9'-10"	6'-8"	2'-8"
3	½"	c_8	4'-1"	3'-7"	
3	½"	c_{10}	4'-10"	4'-4"	
3	½"	c_{11}	5'-3"	4'-9"	
3	½"	c_{12}	5'-7"	5'-1"	
4	½"	c_{13}	6'-0"	5'-6"	
2	½"	d_4	16'-0"	Wing top.	
1	½"	e_3	12'-10"	Footing.	
2	½"	e_{13}	16'-3"	"	
6	½"	e_{14}	14'-10"	"	
1	½"	e_{15}	10'-10"	"	
1	½"	e_{19}	8'-0"	"	

WING B

No.	Size	Mark	Length	x	y
2	½"	a_7	10'-1½"	7'-11"	1'-8"
4	½"	a_8	11'-3"	8'-11"	1'-10"
3	½"	a_{14}	13'-7"	10'-11"	2'-2"
2	½"	a_{15}	15'-10"	12'-11"	2'-5"
2	½"	a_{16}	17'-1"	14'-3"	2'-7"
2	½"	b_{11}	8'-9"	5'-10"	2'-5"
2	½"	b_{12}	9'-10"	6'-8"	2'-8"
2	½"	c_7	3'-9"	3'-3"	
8	½"	c_8	4'-1"	3'-7"	
3	½"	c_{10}	4'-10"	4'-4"	
2	½"	c_{11}	5'-7"	5'-1"	
4	½"	c_{13}	6'-0"	5'-6"	
2	½"	d_3	15'-3"		
1	½"	e_8	11'-10"	Footing	
2	½"	e_{10}	14'-8"	"	
5	½"	e_9	13'-10"	"	Wing
1	½"	e_{12}	12'-6"	Wing.	
1	½"	e_{18}	8'-1"	"	
1	½"	e_{17}	5'-0"	"	

WING D

No.	Size	Mark	Length	x	y
6	½"	a_9	11'-3"	8'-11"	1'-10"
4	½"	a_{10}	13'-7"	10'-11"	2'-2"
6	½"	a_{11}	15'-10"	12'-11"	2'-5"
2	½"	a_{11}	18'-1"	14'-11"	2'-8"
1	½"	b_{12}	8'-9"	5'-10"	2'-5"
2	½"	b_{13}	9'-10"	6'-8"	2'-8"
3	½"	c_8	4'-1"	3'-7"	
3	½"	c_{10}	4'-10"	4'-4"	
9	½"	c_{11}	5'-7"	5'-1"	
4	½"	c_{13}	6'-0"	5'-6"	
2	½"	d_3	16'-4"		
1	½"	e_{13}	12'-10"	Footing	
2	½"	e_{16}	16'-3"	"	
6	½"	e_{18}	14'-10"	Wing + footing	
1	½"	e_{19}	10'-10"	"	
1	½"	e_{14}	9'-0"	"	

WING C

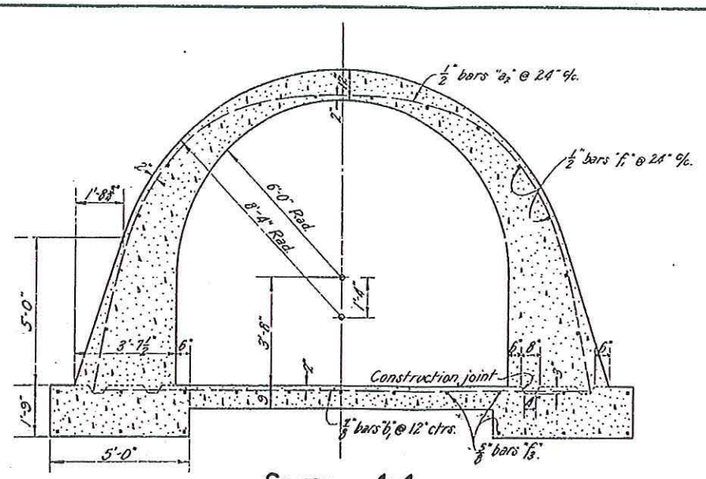
No.	Size	Mark	Length	x	y
2	½"	a_7	10'-1"	7'-11"	1'-8"
3	½"	a_8	11'-3"	8'-11"	1'-10"
3	½"	a_{14}	13'-7"	10'-11"	2'-2"
3	½"	a_{15}	15'-10"	12'-11"	2'-5"
2	½"	a_{16}	18'-1"	14'-11"	2'-8"
3	½"	b_{12}	8'-9"	5'-10"	2'-5"
2	½"	b_{13}	9'-10"	6'-8"	2'-8"
2	½"	c_7	3'-9"	3'-3"	
8	½"	c_8	4'-1"	3'-7"	
3	½"	c_{10}	4'-10"	4'-4"	
3	½"	c_{12}	5'-7"	5'-1"	
4	½"	c_{13}	6'-4"	5'-10"	
1	½"	d_6	16'-0"		
1	½"	e_8	11'-10"	Footing	
2	½"	e_{10}	14'-8"	"	
5	½"	e_9	13'-10"	"	Wing
1	½"	e_{11}	12'-6"	"	
1	½"	e_{12}	9'-3"	"	
1	½"	e_{13}	6'-2"	"	

TWO HEADWALLS

8	½"	a_5	13'-11"		
6	½"	a_6	2'-6"		
3	½"	a_5	3'-0"		
4	½"	a_6	3'-10"		
1	½"	a_5	5'-4"		
1	½"	a_6	7'-0"		

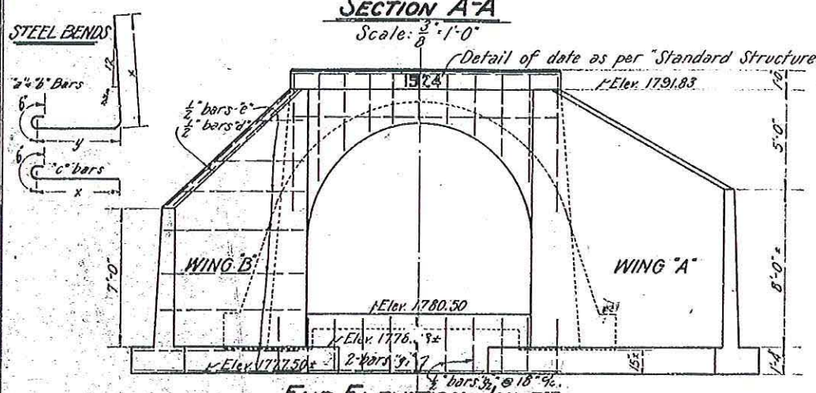
CUT-OFF WALLS

4	½"	g_1	16'-0"		
22	½"	g_2	2'-11"		
22	½"	g_3	3'-11"		



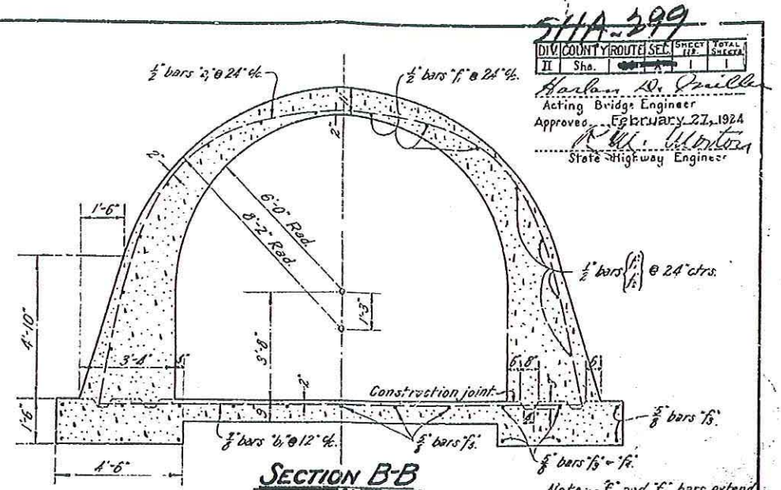
SECTION A-A

Scale: ⅜" = 1'-0"



END ELEVATION - INLET

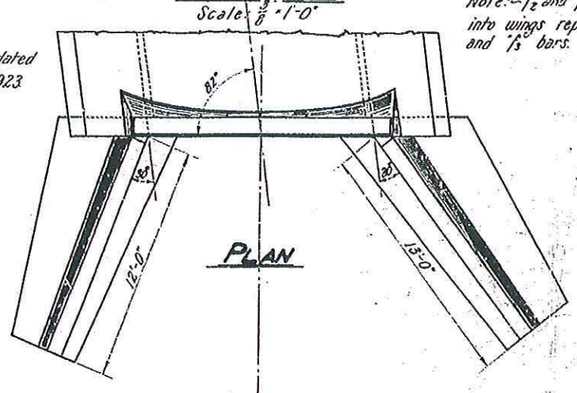
Scale: ¼" = 1'-0"



Note:- f_2 and f_4 bars extend into wings replacing f_1 and f_3 bars.

SECTION B-B

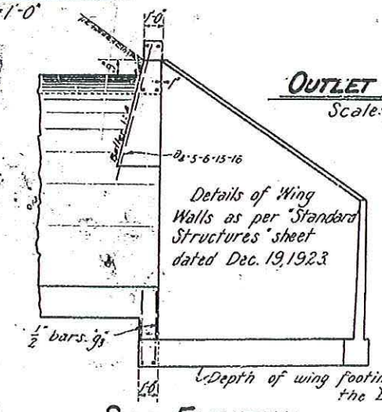
Scale: ⅜" = 1'-0"



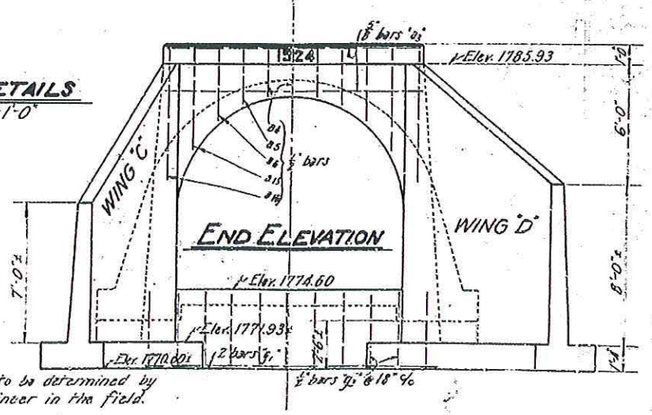
PLAN

OUTLET DETAILS

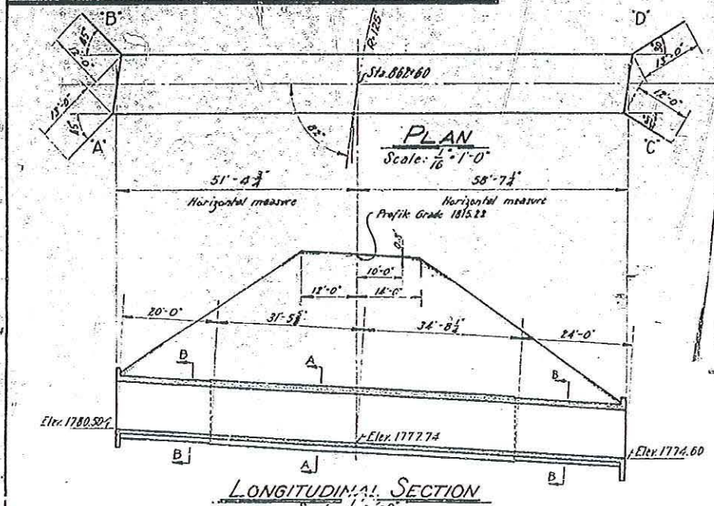
Scale: ½" = 1'-0"



SIDE ELEVATION



END ELEVATION



LONGITUDINAL SECTION

Scale: 1/16" = 1'-0"

AS BUILT PLANS
Contract No.
Date Completed
Document No. 2000661

Drawn by H.P.W.
Traced by A.J.M. 2-21-24
Checked by H.D.S 2-21-24
J.G. 2-28-24

GENERAL NOTES:-

All concrete to be class 'A' (1-2-4 mix).
All reinforcing steel to be square deformed bars.
All bars embedded at least two diameters.
All exposed edges to be chamfered one inch.
Lap bars forty diameters at splices.

STATE OF CALIFORNIA
CALIFORNIA HIGHWAY COMMISSION

SPECIAL ARCH CULVERT

STA. 862+60 II SHA. 20-A
SCALES AS SHOWN

SHA-299

DIV.	COUNTY	ROUTE	SEC.	SHEET NO.	TOTAL SHEETS
II	Sha.		A	1	1

Harlan D. Smith
Acting Bridge Engineer
Approved February 27, 1924
[illegible]
State Highway Engineer