DRAFT

FOUNDATION REPORT

Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

Prepared by:

Crawford & Associates, Inc.

5701 Lonetree Boulevard, Suite 110

Rocklin, CA 94588

May 2015

Prepared for:

Lassen County Department of Public Works

707 Nevada Street, Suite 4

Susanville, CA 96130

May 11, 2015
CAInc File No. 14-184.3

Mr. Dave Ernaga, P.E.
Associate Engineer
Lassen County Department of Public Works
707 Nevada Street, Suite 4
Susanville, CA 96130

Subject: **DRAFT FOUNDATION REPORT**
Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

Dear Mr. Ernaga,

Attached is our Draft Foundation Report for the Long Valley Creek Overflow Bridge (Bridge No. 7C-12) on Hackstaff Road. Crawford & Associates, Inc. (CAInc) completed this report in accordance with our agreement. This report contains the results of our subsurface exploration, conclusions and recommendations for design of new bridge foundations. We will submit the Final Foundation Report after receiving comments from the design team on this draft report.

Please call if you have questions or require additional information.

Sincerely,

Crawford & Associates, Inc.,

Adam Killinger, PE
Project Manager

Benjamin D. Crawford, PE, GE
Principal Geotechnical Engineer

CC: Bob Morrison

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1 INTRODUCTION

1.1 Purpose

Crawford & Associates, Inc. (CAInc) prepared this Draft Foundation Report for the Long Valley Creek Overflow Bridge Replacement (Bridge No. 7C-12) project located along Hackstaff Road in Lassen County, California. This report presents the results of our subsurface exploration and testing, and provides our conclusions and recommendations for design of new structure foundations. We will submit a Final Foundation Report addressing comments received from this draft.

1.2 Scope of Services

To prepare this report, CAInc:

- Reviewed preliminary bridge design plans and loads provided by Morrison Structures, Inc..
- Visited the site with Mr. Dave Ernaga on November 4, 2014.
- Reviewed geologic and seismic maps pertaining to the site.
- Reviewed previous borings logs by Converse Consultants dated December 6, 2005.
- Drilled, logged, and sampled two test borings at the bridge abutments to a maximum depth 74 feet below ground surface (bgs).
- Drilled, logged and sampled two test borings along the approach roadway sections to depth 3 feet bgs.
- Performed laboratory testing on soil samples recovered from the borings.
- Performed engineering analyses for structure foundations and roadway approaches.

2 PROJECT DESCRIPTION

2.1 Project Location

The project is located on Hackstaff Road, approximately one-half mile southeast of the town of Doyle. Site coordinates are approximately latitude 40.025290 and longitude -120.098359. Figure 1 shows the project location.

2.2 Site Description

The existing bridge is a 3-span, 62-foot long, 22-foot wide, timber structure on timber pile abutments and bents. The existing bridge deck is at approximate elev. 4182 ft and the channel bottom is about elev. 4163 ft (about 16 ft below the deck level). Long Valley Creek is a natural channel that flows north at this location. At the time of our investigation (December 2014), creek flow depth was approximately 3.5-5.5 feet and bridge approaches appeared to have recently undergone pavement improvement.

2.3 Proposed Project

The new bridge will be located approximately 100 feet north (downstream) from the existing bridge and is expected to be an 85 ft long single span bridge with 30 degree skew. Discussions with Morrison Structures, Inc. (Structural Designer) indicated the bridge will be precast I-girders with cast-in-place decks bearing on Class 140 H-piles. Pile caps will be constructed at elevation 4156.4 feet The new roadway for the realignment will be designed by the county.

3 SITE GEOLOGY

The site is located along the edge of the Long Valley River and east of the Port of Sage Mountains. Published geologic mapping[1] shows the site underlain by Quaternary lake deposits and Quaternary Alluvium. The hills to the east and west are mapped as Permian metavolcanic rocks and Teritary volcanics. We show the site geology on Figure 2.

Web soil survey[2] shows the surface soils to be mostly Bobert sandy loam along Long Valley Creek Overflow and Mottsville gravelly loamy and coarse sand to the east and west of the channel.

4 SUBSURFACE CONDITIONS

4.1 Exploration

CAInc retained Geo-Ex Subsurface Exploration (Geo-Ex) to drill four test borings on Dec 6-8, 2014 to a maximum depth of 74 feet (elevation 4108 feet). Per Lassen County request, we located our test borings about 100 feet south of the proposed bridge alignment at the existing bridge to avoid right-of-entry issues. Geo-Ex used a truck-mounted CME 55 drill rig equipped with an automatic hammer and auger/rotary wash capabilities. CAInc 's project engineer, Mr. Shawn Leyva, logged the test borings consistent with the Unified Soil Classification System (USCS) and the Caltrans 2010 Logging Manual. CAInc retained samples from the test borings and made ground water observations during drilling operations. The test borings were backfilled with native soil.

4.2 Soil Profile

Abutment 1 (West Abutment)

The soil conditions at this abutment are characterized in three units. The uppermost unit, from ground surface to depth 31 ft (elevation 4151 ft), is primarily soft to medium stiff, sandy lean clay and loose to medium dense, silty sand, clayey sand, and sandy silt. These materials extend approximately 15 ft below the channel bottom.

The middle unit extends to depth 43 ft (elev. 4139 ft). These soils are mostly stiff to very stiff, silty clay and lean clay and medium dense to very dense clayey sand with lenses of silty sand.

The lowermost unit extends through the maximum depth explored, 74.5 ft, (elevation 4107.5 ft) and is comprised of dense to very dense, clayey sand and silty sand with thin layers of very stiff lean clay and sandy lean clay.

Abutment 2 (East Abutment)

The soil conditions at this abutment are characterized in four units. The first unit, from ground surface to depth of 14.5 ft (elev. 4166.5 ft), is primarily very stiff sandy silt and silty clay with sand. These materials extend to approximately 0.5 ft above channel bottom.

[1] Lydon, P.A., Geologic Atlas of California Map, Westwood Sheet, California Geological Survey, 1:250,000, 1960.
[2] United States Department of Agriculture, Natural Resource Conservation Service: websoilsurvey.sc.egov.usda.gov

The second unit extends below the first unit to depth 29 ft (elevation 4152 ft). Soils at these depths/elevations generally consist of medium dense poorly graded sand with silt and silty sand.

The third unit extends from the second to a depth of 44 ft (elev. 4137 ft). These soils are comprised of mostly stiff silty clayey sand, silt with sand and dense sandy lean clay.

The fourth and lower most unit extends beneath the maximum depth explored 60.5 ft, to elevation 4120.5 ft) and is comprised of alternating dense to very dense, silty sand/ poorly graded sand with very stiff silt with sand/ silty clayey with sand.

Details of the soils logs are shown on the Log of Test Borings drawing in Appendix A. The soil profiles we encountered appear to have more cohesive soils than the 2005 profiles presented by Converse Consultants.

4.3 Groundwater

During our December 4, 2014 field investigation, we encountered groundwater in boring B-2 at 11.5 feet bgs (elevation 4170.5 ft); approximately 3.5 ft above channel bottom. Our measured groundwater level matches closely with the levels measured by Converse Consultants (10 and 12 feet bgs) and the in-channel water level. Groundwater was not measured in boring B-4 due to rotary wash drilling method. In general, we expect the alluvial soils below groundwater levels to be saturated and yield significant water volume to open excavations.

5 LABORATORY TESTING

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

- Moisture Content - Dry Density (ASTM D2216 / D2937)
- Particle Size Analysis (ASTM D422)
- Atterberg Limits (ASTM D4318)
- Triaxial U-U Shear Strength (ASTM D2850)
- Sulfate/Chloride Content (CTM 417/422)
- pH/Minimum Resistivity (CTM 643)
- R-value (CTM 301)

We present the laboratory test results in Appendix B.

6 SCOUR CONSIDERATIONS

We understand hydraulic analysis is still pending on this project, but it is unlikely scour will impact abutment foundation performance since pile caps will be constructed below existing channel elevation and the banks will be armored with rock slope protection (RSP). If it is determined that scour will impact foundation performance (i.e., design scour elevation is below the pile cap), our firm should be consulted so that we may revise our calculations.

7 CORROSION EVALUATION

Table 1 summarizes the results of soil corrosivity tests on a sample obtained from the borings for this study.

Table 1: Soil Corrosion Test Summary

Boring/Sample Number	Depth (ft)	Elevation (ft)	Minimum Resistivity (Ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
B4/1	5.0-7.0	4238	1290	7.45	14.8	11.3

According to Caltrans corrosion guidelines a site is considered to be corrosive to foundation elements if one or more of the following conditions exist: Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 2000 ppm, minimal resistivity of 1000 ohm-cm or less, or the pH is 5.5 or less. Per Caltrans corrosion guidelines, the site is not corrosive to structural elements.

These tests are only an indicator of soil corrosivity. The designer should consult with a corrosion engineer if these values are considered significant.

8 SEISMIC DATA

8.1 Ground Motion Study

CAInc used the Caltrans ARS Online (web-based) to calculate both deterministic and probabilistic acceleration response spectra for the site based on criteria provided in Appendix B of Caltrans' Seismic Design Criteria.

The deterministic spectrum is determined as the average of median response spectra calculated using ground motion prediction equations developed under the "Next Generation Attenuation" (NGA) project. These equations are applied to all faults considered active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater.

Based on Caltrans ARS Online (V2.3.06), and the 2012 Fault Database, the nearest deterministic seismic source is the Honey Lake 2011 CFM.

Table 2: Fault Data

Fault Parameters	Honey Lake 2011 CFM
Fault Identification Number (FID)	50
Maximum Moment Magnitude (M_{max})	6.9
Site-to-Fault (R_{RUP}) Distance (km/mi)	0.775/0.482
Style of Faulting	Strike Slip
Fault Dip (degrees)	90
Dip Direction	Vertical

Based on our test boring data and correlations outlined in the Caltrans "Geotechnical Services Design Manual," we assign the site an average small strain shear wave velocity (V_S30) equal to 275 meters per second (Site Class D) for the upper 100 ft of the soil profile. Since the site is located less than 15.5 miles from the causative fault, we applied an adjustment factor for near-fault effects consistent with Caltrans procedures.

We used the above information to develop deterministic response spectra for the site and compared that to the Caltrans minimum deterministic response spectrum. Using the Caltrans ARS Online tool, we then compared the deterministic results with the probabilistic response spectrum based on data from the 2008 United States Geological Survey (USGS) National Seismic Hazard Map for a 5% in 50 year probability of exceedance (975 year return period).

We recommend a design spectrum based on both the combined Caltrans minimum deterministic and the USGS 5% in 50 years hazard (2008) probabilistic response spectra across the period spectrum from 0 to 5 seconds. We assign the site a Maximum Moment Magnitude (M_{max}) of 6.9 with a Peak Ground Acceleration (PGA) of 0.48g. We present limited data points for site spectra in Table 3 and additional data points and the graphed site spectra on Figure 3.

Table 3: Caltrans ARS Online Envelope Spectrum Data

Period	SA	Period	SA	Period	SA
0.01	0.539	0.5	1.052	3	0.293
0.05	0.773	0.6	0.997	4	0.204
0.1	0.902	0.7	0.957	5	0.154
0.15	1.032	0.85	0.895		
0.2	1.134	1	0.852		
0.25	1.138	1.2	0.745		
0.3	1.141	1.5	0.621		
0.4	1.090	2	0.468		

8.2 Fault Rupture

The site does not lie within an Alquist–Priolo Earthquake Fault Zone and no known active faults are mapped within or through the project area. The closest fault considered in the ground motion analysis is the Honey Lake 2011 CFM system (Caltrans Fault Identification No. 50) located approximately 0.5 miles Northeast of the site. We show nearby faults on Figure 4.

Based on this mapping we consider the potential for fault rupture at the site to be low.

9 LIQUEFACTION POTENTIAL

Liquefaction can occur when saturated, loose to medium dense, granular soils (generally within 50 ft of the surface), or specifically defined cohesive soils, are subjected to ground shaking. Based on the soil and ground water conditions encountered during our exploration and current industry accepted liquefaction evaluation methods, the potential for liquefaction at foundation depths is not likely to occur. The pile cap cut off elevation will be placed 25 feet below proposed finish grade which is below potential liquefiable soils.

10 FOUNDATION RECOMMENDATIONS

Structure support can be achieved by either steel pipe piles or steel H-piles. Both options can be readily transported and spliced in the field. Based on discussions with Morrison Structures, Inc. and the County, Class 140 H-piles are the preferred pile type and are recommended below.

10.1 Foundation Data and Loading

To evaluate H-pile foundations, CAInc used the following information provided by Lassen County and Morrison Structures, Inc.:

- Load & Resistance Factor Design (LRFD) Method.
- Class 140 H-Piles (HP 10 X 57) for the abutments.
- 196 kip Strength Limit State compression load per pile (maximum).
- No tension demand.
- Pile cut-off at elevation 4156.4 ft at Abutments 1 and 2.
- Pile layouts for abutment 1 and 2 as shown on the September 17, 2014 Morrison Structures, Inc. plot
- Permissible settlement of 0.5-inch at Strength Limit State.

Morrison Structures, Inc. provided the foundation design and load information shown in Tables 4 and 5 below.

Table 4: Foundation Design Data Sheet

Support No.	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft)		Permissible Settlement under Service Load (in)*	Number of Piles per Support
				B	L		
Abut 1	HP 10x57	4166.0	4156.4	42.8	13.0	0.5	17
Abut 2	HP 10x57	4164.0	4156.4	42.8	13.0	0.5	17

Table 5: Foundation Factored Design Loads

Support No.	Service-I Limit State (kips)		Strength/Construction Limit State (Controlling Group, kips)				Extreme Event Limit State (Controlling Group, kips)			
	Total Load Per Support	Permanent Loads Per Support	Compression		Tension		Compression		Tension	
			Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile	Per Support	Max. Per Pile
Abut 1	999	821	1407	196	0	0	821	91	0	0
Abut 2	999	821	1407	196	0	0	821	91	0	0

10.2 Engineering Parameters

Tables 6 and 7 show the general soil parameters used in our analyses for Abutment 1 (west) and Abutment 2 (east). We base these parameters on our material observations, laboratory testing and empirical values.

Table 6: Abutment 1 Soil Parameter Profile

Elevation	Soil Type	Unit Weight (lbs/ft3)	Friction Angle (degrees)	Cohesion Top/Bottom (psf)	Modulus, K (lbs/in3)	E50 Top/Bottom
4182' to 4174'	Sand	110	29	---	20	---
4174' to 4150'	Soft Clay	110/45	---	500/1250	---	0.02/0.007
4150' to 4146'	Sand	57.6	33	---	30	---
4146' to 4139'	Stiff Clay	70	---	1500/1500	---	0.006
4139' to 4136'	Sand	64.1	37	---	35	---
4136' to 4122'	Sand	72	39	---	40	---
4122' to 4108'	Sand	67	38	---	42	---

Table 7: Abutment 2 Soil Parameter Profile

Elevation	Soil Type	Unit Weight Top/Bottom (lbs/ft3)	Friction Angle (degrees)	Cohesion Top/Bottom (psf)	Modulus, K (lbs/in3)	E50
4181' to 4167'	Clay	110	---	1824/1824	---	0.008
4167' to 4152'	Sand	55	33	---	30	---
4152' to 4137'	Clay	57.6	---	1750/1250	---	0.0085
4137' to 4132'	Sand	59.6	34	---	35	---
4132' to 4127'	Clay	59.2	---	2500	---	0.005
4127' to 4120.5'	Sand	60.5/62	36	---	40/45	---

10.3 Foundation Recommendations and Pile Data Table

CAInc evaluated abutment foundations using current Caltrans Bridge Design Specifications for foundations using Load & Resistance Factor Design method. Table 8 presents our pile data table. We present our engineering analysis in the following sections.

Table 8: Pile Data Table

Support No.	Pile Type	Nominal Resistance (kips)		Design Tip Elevations (ft.)[1]	Specified Tip Elevation (ft.)	Nominal Driving Resistance (kips)
		Compression	Tension			
Abut 1	Class 140 HP 10 X 57	196	0	(a) 4119 (b) 4131	(a) 4119	196
Abut 2	Class 140 HP 10 X 57	196	0	(a) 4126 (b) 4135	(a) 4126	196

[1]Design tip elevations for Abutments are controlled by (a) Compression, (b) Lateral Load.

10.4 Pile Analyses

10.4.1 Compressive Resistance

CAInc determined compressive resistance for Class 140 steel H-piles using A-Pile computer program developed by Ensoft, Inc. We used applied a strength limit reduction factor of 0.7 to the soil profile. We then calculated the pile length needed to support the factored compression requirement of 196 Kips. We include static pile results in Appendix C.

10.4.2 Settlement

We calculated settlement of piles driven at or below the specified tip elevations to be within the permissible ½ inch specified by Morrison Structures, Inc.. We do not anticipate significant long-term settlement (creep) at this site.

10.4.3 Lateral Load Analysis

We used LPILE Plus Version 2013.7.07 software to evaluate lateral pile capacity. As specified by Morrison Structures, Inc., CAInc determined the allowable lateral pile design loads that would produce approximately 1 1/8-inch and 5/8-inch pile head deflection at Abutments 1 and 2, respectively, along with ¼-inch pile head deflections for both abutments. Our analysis assumes a pinned (free-head) condition.

We used a p-multiplier of 0.52 in the longitudinal direction with a minimum spacing of 3.0 times the pile diameter (center-to-center spacing), and a p-multiplier of 1.0 in the transverse direction with a minimum spacing of 11.0 times the pile diameter.

For our analysis, we applied a minimum axial compression of 140 kips to the top of the pile. We show our lateral pile analysis results for the strong and weak axes directions in Tables 9 and 10, respectively. LPile output graphs are presented in Appendix D.

Table 9: Lateral Pile Capacity
(H-Pile Strong Axis)

Support	Top-of-Pile Deflection (inches)	Lateral Resistance (kips)
Abutment 1	0.25	23
	1.125	48
Abutment 2	0.25	29
	0.625	59

Table 10: Lateral Pile Capacity
(H-Pile Weak Axis)

Support	Top-of-Pile Deflection (inches)	Lateral Resistance (kips)
Abutment 1	0.25	10
	1.125	24
Abutment 2	0.25	13
	0.625	27

11 LATERAL EARTH PRESSURES

We assume that approach fill material will meet the requirements of Caltrans standard for Structure Backfill. To determine equivalent fluid weights (EFWs), we used Caltrans specified structural backfill with a soil unit weight of approximately 125 pcf, a minimum angle of internal friction equal to 34 degrees, and an assumed drained condition behind the walls. Table 11 shows the recommended EFWs for design of abutment walls and wing walls.

Table 11: Equivalent Fluid Weights

Condition	Static EFW (pcf)	Seismic EFW (pcf)
Active	36	42
At-Rest	56	66
Passive	221	205

We estimate the EFWs for seismic loading using the Mononabe-Okabe equation for active and passive lateral coefficients Ka and Kp. We estimate the at-rest coefficient, Ko, for the seismic condition using an increase ratio similar to the active condition. We use a horizontal acceleration of 0.24g (approximately 50% of the peak site acceleration of 0.48g) in the Mononabe-Okabe equation.

Apply the resultant of the seismic active and at-rest pressures at a depth 0.5H from the base of the wall, where H equals the wall height. For surcharge loads, apply an additional uniform lateral load behind the wall equivalent to 0.30 times the surcharge pressure. Use a coefficient of friction of 0.48 to resist sliding for concrete placed on compacted fill.

As noted in the Caltrans Seismic Design Criteria (SDC), the maximum passive pressure is 5.0 ksf, which must be used with the proportionality factor presented in Section 7.8.1 of the SDC. Assuming that backfill at the abutments meets Caltrans criteria for structure backfill, SDC Section 7.8 criteria for initial abutment soil stiffness (20 kips/inch/ft) should be applicable.

12 APPROACH ROADWAY SUBGRADE AND PRELIMINARY PAVEMENT SECTIONS

We completed two R-value tests (CTM 301) on bulk samples from each existing bridge approach consisting of silty sand/sandy silt. Test results indicate R-values of 32 and 49 by stabilometer. We emphasize that soil R-Values beneath proposed bridge approach pavements may vary from our test results. Assuming similar conditions to those we tested, a minimum R-value of 32, and Chapter 600 of the Caltrans Highway Design Manual (CHDM), 5th Edition, we recommend the pavement sections in Table 12 for design of the approach roadway pavement.

Table 12: Preliminary Pavement Sections

Traffic Index	Material Type/Depth Required	
	Hot Mix Asphalt (HMA) (ft)	Aggregate Base (ft)
11.0	0.55	1.30
10.0	0.50	1.20
9.0	0.45	1.05
8.0	0.40	0.85
7.0	0.30	0.80

Appropriate traffic indices (TI's) should be determined by the Design Engineer.

13 CONSTRUCTION CONSIDERATIONS

13.1 Earthwork

Perform earthwork and grading operations in accordant with Section 19 of Caltrans Standard Specifications.

13.2 H-Piles

H-piles can sometimes "walk" out of plane along their weak axis during difficult driving conditions. The contractor should take care not to overdrive the piles. Verify pile capacity during final driving using energy equations in accordance with Caltrans Standard Specification 49-1.08 (Modified Gates Formula). Although H-piles are not considered "displacement" piles, they will densify adjacent soil structure during driving. Drive piles within the interior footprint of the pile configuration first to reduce the potential for pile refusal during installation of subsequent piles.

Piles shall conform to Section 49-1 of the Caltrans Standard Specifications. Jetting or vibratory hammers should not be used to obtain the specified pile penetration.

The contractor shall provide a Pile Driving System Submittal in accordance with Caltrans Bridge Reference Specification 49-208 (49HAMR) to verify the pile driving system is adequate.

13.3 Shoring

The contractor is responsible for design and construction of excavation sloping and shoring in accordance with CalOSHA Standards, and to protect existing structures, utilities and other facilities during construction.

13.4 Excavation Dewatering

Excavations extending below the creek water level will require dewatering and/or diking/diversion methods to construct abutment foundations and pile caps in the "dry". Dewatering will likely require a well point system.

14 RISK MANAGEMENT

Our experience and that of our profession clearly indicates that the risks of costly design, construction, and maintenance problems can be significantly lowered by retaining the geotechnical engineer of record to provide additional services. For this project, CAInc should be retained to:

- Review and provide written comments on the (civil, structural) plans and specifications prior to construction.
- Monitor construction to check and document our report assumptions. At a minimum, CAInc should observe pile installation.
- Update this report if design changes occur, 2 years lapse between this report and construction, or site conditions change.

If CAInc is not retained to perform the above applicable services, we are not responsible for any other parties' interpretation of our report, and subsequent addendums, letters, and discussions.

15 LIMITATIONS

CAInc performed these services in accordance with generally accepted geotechnical engineering principles and practices currently used in this area. This report is based on the current site and project conditions and should be used only for the design and construction of the Long Valley Creek Bridge Replacement on Hackstaff Road over Long Valley Creek Overflow (Bridge 7C-12) project. We agreed with the County to perform our soil explorations within the current road bridge alignment 100 feet south of the new bridge alignment. We assume soil and ground water conditions in our borings are representative of the subsurface conditions within the construction area; however, subsurface conditions can vary. We provide R-Value testing results and associated pavement sections only as an indicator of how much support local soils may provide pavements and how thick those pavements may be. Pavement design is beyond the scope of our commissioned work. Additional testing and pavement design should be performed by others.

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

The interface shown between soil materials on the logs is approximate. The transition between materials may be abrupt or gradual. We base our recommendations on the final logs, which represent our interpretation of the field logs and general knowledge of the site and geological conditions.

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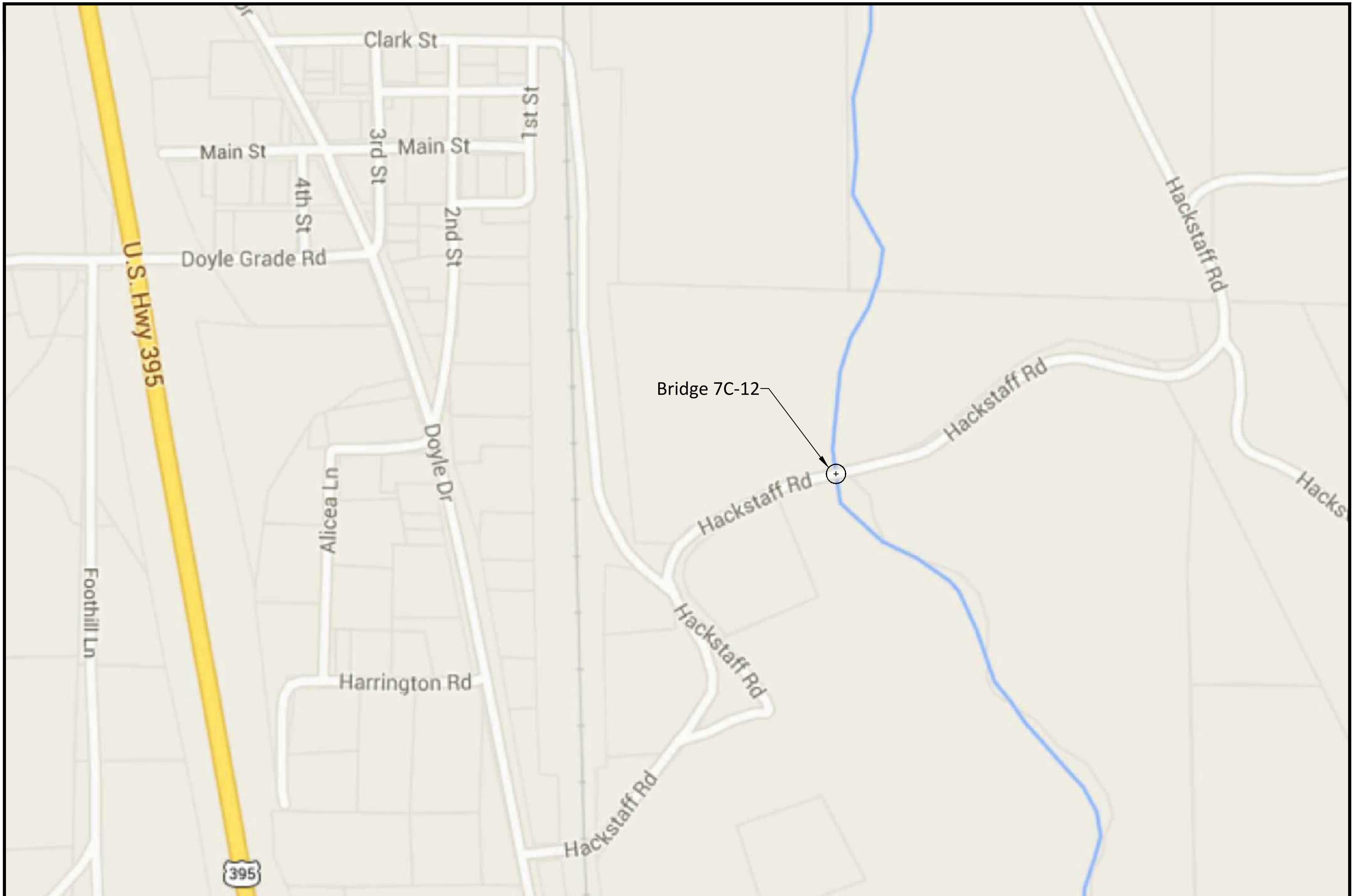
Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

Figures



Project Mgr.	AJK	5/11/15
Project Eng.	SL	5/11/15
Designer		
Checked By		
Drawn By	SJC	5/11/15
	By	Date

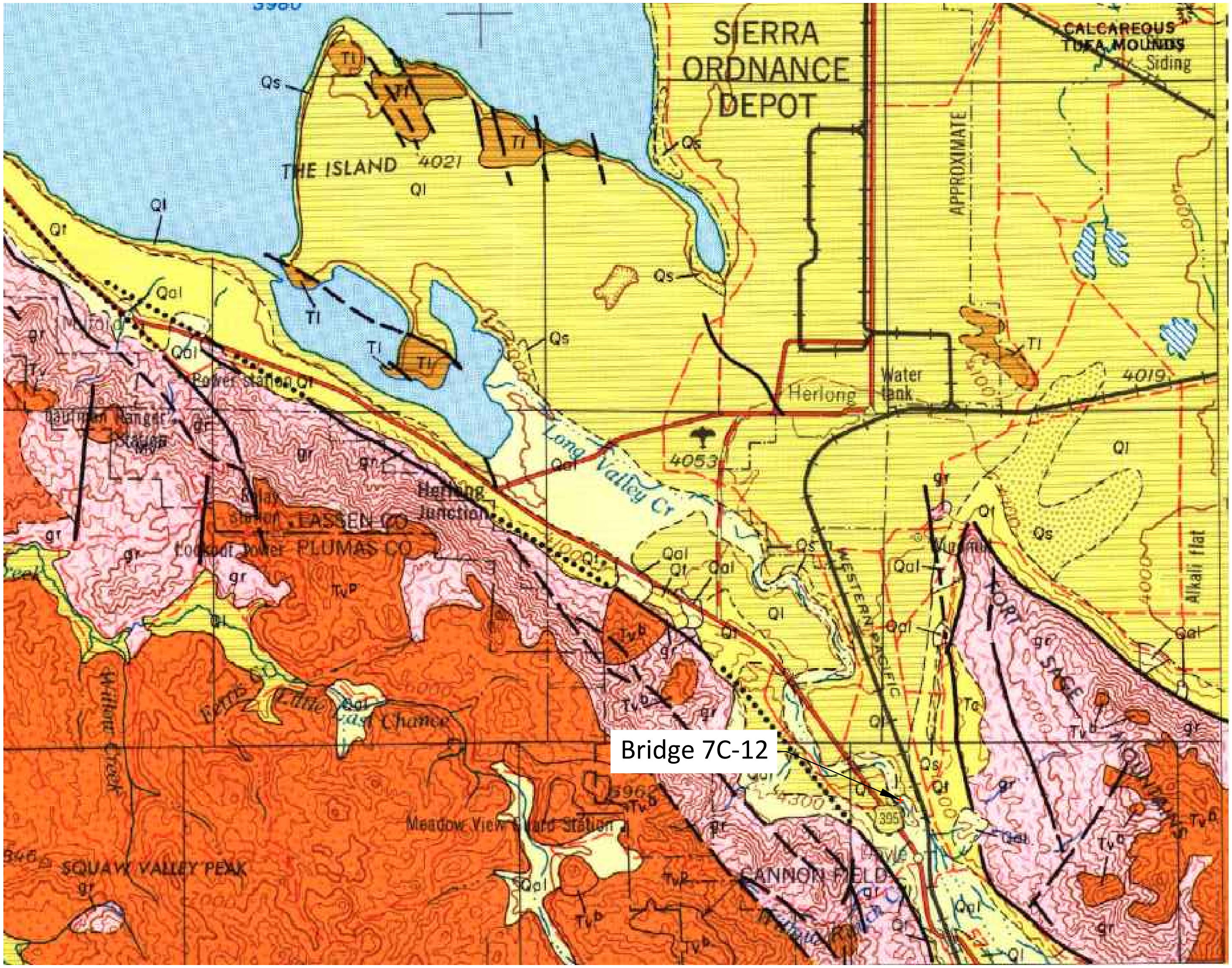
Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services
4030 S. Land Park Drive, Suite C
Sacramento, CA 95822

Long Valley Creek Overflow Bridge on Hackstaff Road

Lassen County, CA

Figure 1
Vicinity Map

Project No.	14-184.4
Scale	NTS
Date	3/12/15



LEGEND

Qal	Alluvium	Qt	Quaternary nonmarine terrace deposits	Ql	Quaternary lake deposits

Project Mgr.	AJK	5/11/15
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Geotechnical Engineering, Design and Construction Services
4030 S. Land Park Drive, Suite C
Sacramento, CA 95822

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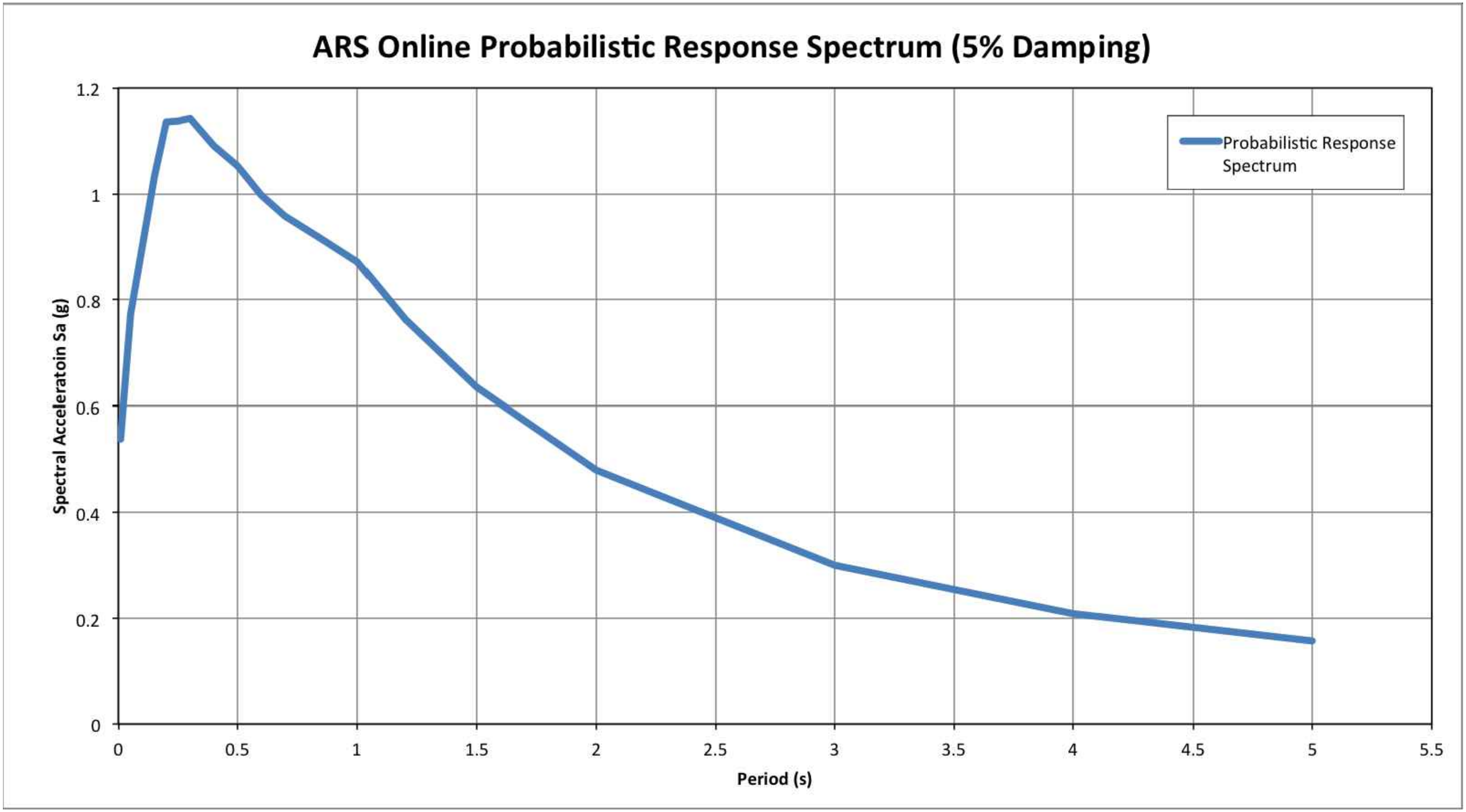
Lassen County, CA

Figure 2
Geologic Map

Project No.	14-184.4
Scale	NTS
Date	3/12/15



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4030 S. Land Park Drive, Suite C
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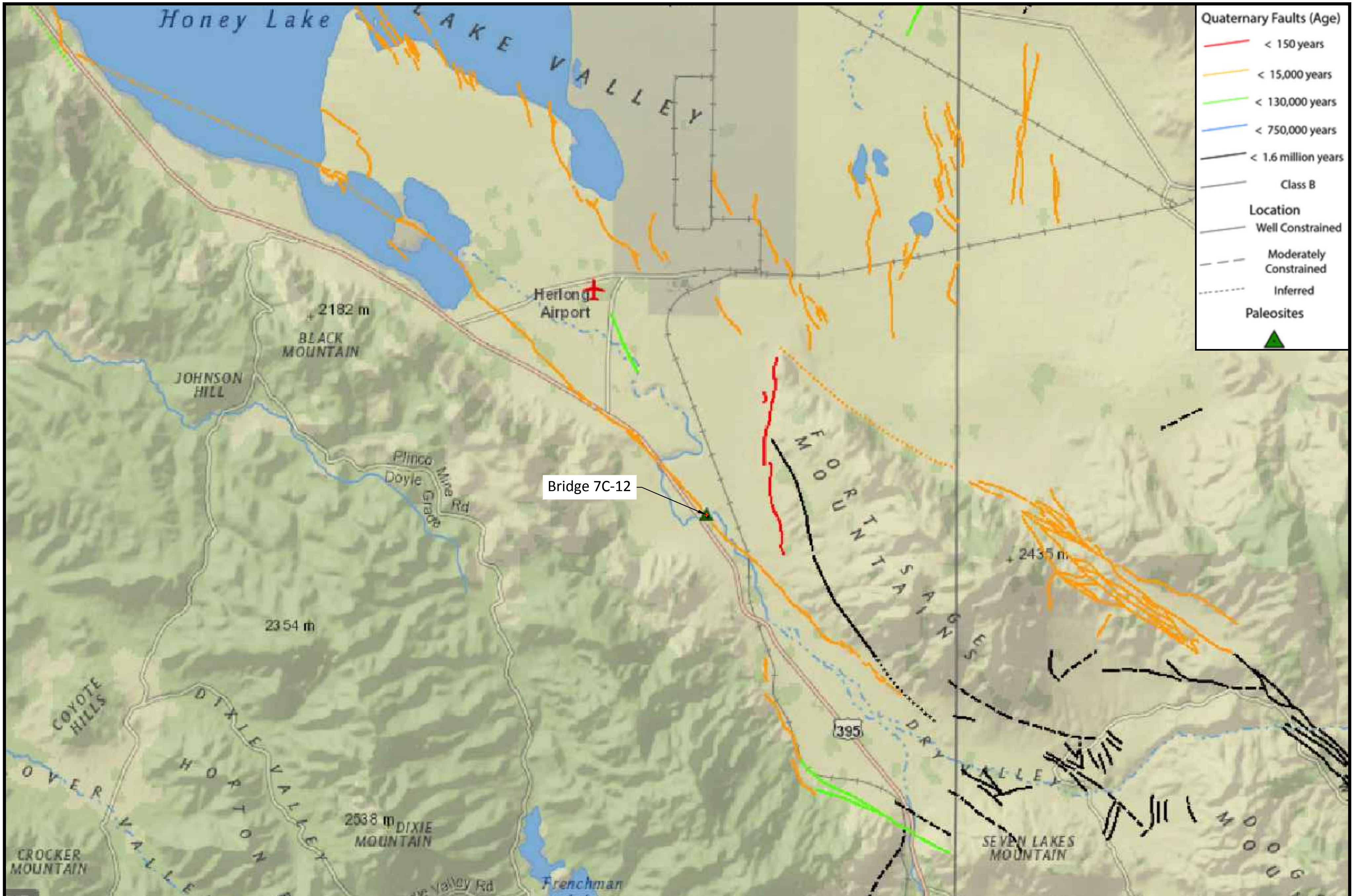
Long Valley Creek Overflow Bridge on Hackstaff Road

Lassen County, CA

Figure 3
Design ARS Curve

Project No.	14-184.4
Scale	NTS
Date	3/12/15



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Geotechnical Engineering, Design and Construction Services
4030 S. Land Park Drive, Suite C
Sacramento, CA 95822

Long Valley Creek Overflow Bridge on Hackstaff Road

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Figure 4
Fault Map

Project No.	14-184.4
Scale	NTS
Date	3/12/15

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Long Valley Creek Overflow Bridge on Hackstaff Road
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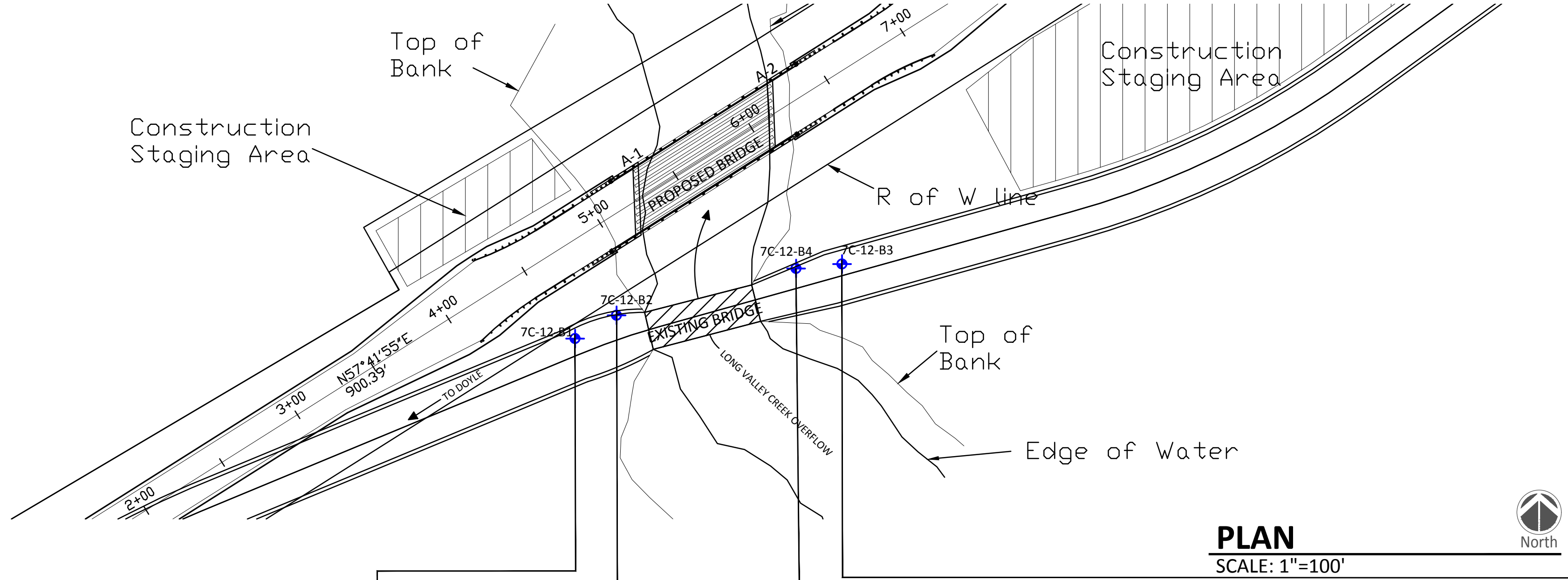
Lassen County, California

Appendix A
Log of Test Borings



NOTES:
1. Field classification of soils was in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010). See Log of Test Borings No. 2, "Soil Legend".
2. Standard Penetration tests were performed using in accordance with ASTM D 1586-99 using a hammer operated with an automated drop system. Drill rods were 1 5/8-inch diameter "A"-rods; sampler was driven with brass liners.
3. "2.4 inch sampler": ID=2.4 inch, OD=2.9 inch. "2.0 inch sampler": ID=2.0 inch, OD=2.5 inch. Both driven in same manner as SPT ("1.4 inch") sampler.
4. If laboratory tests are not shown as being performed, the soil descriptions presented in the LOTB are based solely on the visual practices described in this Manual.
5. The length of each sampled interval is shown graphically on the boring log. Whole number blow counts ("N") represent the "standard penetration resistance" interval in accordance with the Caltrans Soil & Logging, Classification, and Presentation Manual (June 2010). Where less than 0.5 feet of penetration is achieved, the blow count shown is for that fraction of the "standard penetration resistance" interval actually penetrated.
6. Consistency of soils shown in ( ) where estimated.
7. Ground water surface (GWS) elevations in the borings indicated on the Log of Test Boring Sheets reflect the fluid level in the borings on the specified date.
8. Ground water surface elevations are subject to seasonal fluctuations and may occur at higher or lower elevations depending on the conditions at any particular time.
9. The "Log of Test Borings" drawing is included with plans in accordance with Section 2-1.03 of Caltrans "Standard Specifications".
10. Groundwater was encountered in boring 7C-12-B4, but elevation was not measured.
11. Test borings were drilled with offset (top of boring may not match profile grade).
12. Profile grade is based on a cross section through project stationing (along proposed alignment) and was surveyed by Lassen County.
13. Surveying datum is based on NAVD 88.
14. Edge of water is based on survey by Lassen County for Hackstaff Road Preliminary Plan dated 02/2009.

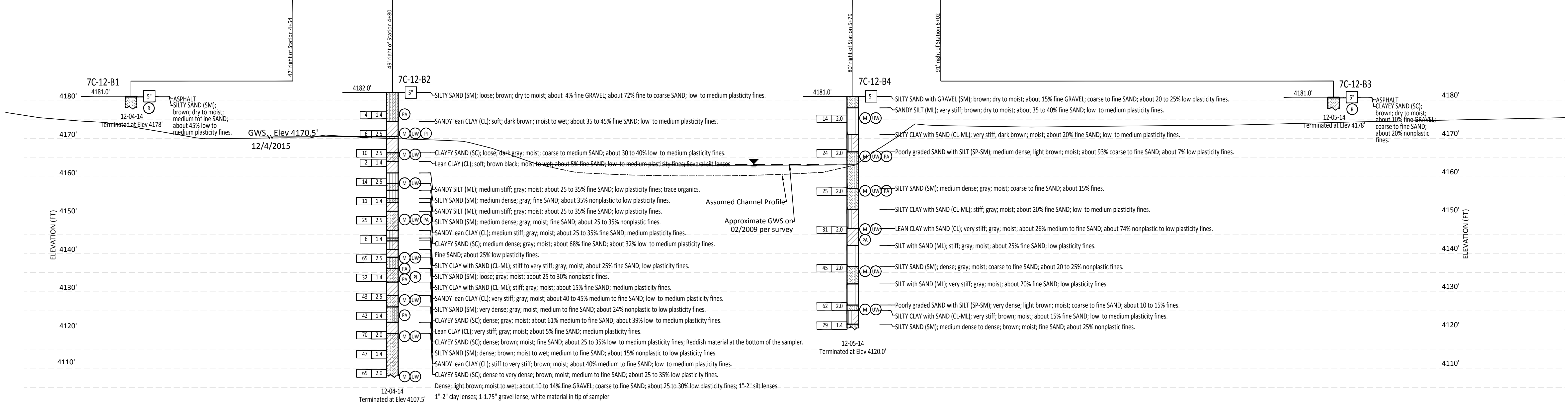
DIST	COUNTY	ROUTE	TOTAL PROJECT	SHEET NO	TOTAL SHEETS
2	LASSEN				

REGISTERED CIVIL ENGINEER DATE

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 PROFESSIONAL ENGINEER
BENJAMIN D. CRAWFORD
No. 68457
EXP. 9-30-15
CIVIL
STATE OF CALIFORNIA



PROFILE HORIZ: 1"=25' VERT: 1"=25'

ENGINEERING SERVICES		GEOTECHNICAL SERVICES
FUNCTIONAL SUPERVISOR	DRAWN BY: SJC	FIELD INVESTIGATION BY: Shawn M. Leyva
NAME: Benjamin D. Crawford	CHECKED BY: AJK	

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN
DESIGN BRANCH

BRIDGE NO.	7C-12
POST MILE	

HACKSTAFF ROAD BRIDGE 7C-12

DRAFT LOG OF TEST BORINGS

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU XXXXX
EA XXXXXX

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET OF 03

UNIFIED SOIL CLASSIFICATION (ASTM D 2487-06)

MATERIAL TYPES	CRITERIA FOR ASSIGNING SOIL GROUP NAMES			GROUP SYMBOL	SOIL GROUP NAMES
COARSE-GRAINED SOILS >50% RETAINED ON NO. 200 SIEVE	GRAVELS >50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS <5% FINES	$Cu \geq 4$ AND $1 \leq Cc \leq 3$	GW	WELL-GRADED GRAVEL
			Cu < 4 AND/OR 1 > Cc > 3	GP	POORLY-GRADED GRAVEL
		GRAVELS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	GM	SILTY GRAVEL
			FINES CLASSIFY AS CL OR CH	GC	CLAYEY GRAVEL
	SANDS <50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN SANDS <5% FINES	$Cu \geq 6$ AND $1 \leq Cc \leq 3$	SW	WELL-GRADED SAND
			Cu < 6 AND/OR 1 > Cc > 3	SP	POORLY-GRADED SAND
		SANDS WITH FINES >12% FINES	FINES CLASSIFY AS ML OR MH	SM	SILTY SAND
			FINES CLASSIFY AS CL OR CH	SC	CLAYEY SAND
FINE-GRAINED SOILS >50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT <50	INORGANIC	PI>7 AND PLOTS ON OR ABOVE "A" LINE	CL	LEAN CLAY
			PI>4 AND PLOTS BELOW "A" LINE	ML	SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)	OL	ORGANIC CLAY OR SILT
	SILTS AND CLAYS LIQUID LIMIT >50	INORGANIC	PI PLOTS ON OR ABOVE "A" LINE	CH	FAT CLAY
			PI PLOTS BELOW "A" LINE	MH	ELASTIC SILT
		ORGANIC	LL (oven dried)<0.75/LL (not dried)	OH	ORGANIC CLAY OR SILT
HIGHLY ORGANIC SOILS		PRIMARILY ORGANIC MATTER, DARK COLOR, ORGANIC ODOR		PT	PEAT

NOTE: $Cu = D_{60} / D_{10}$

$Cc = (D_{30})^2 / D_{10} \times D_{60}$

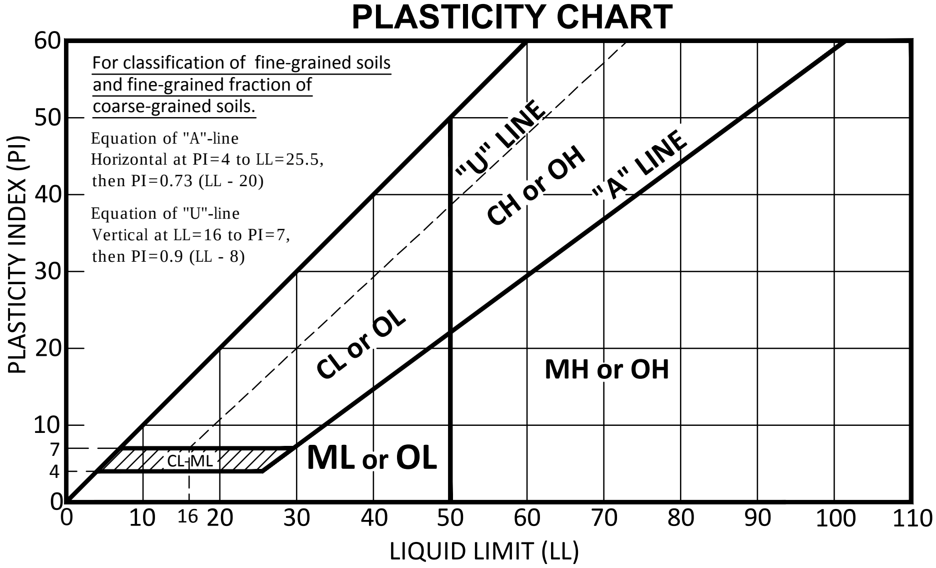
BLOW COUNT

The number of blows of a 140-lb. hammer falling 30-inches required to drive the sampler the last 12-inches of an 18-inch drive. The notation 50/4 indicates 4-inches of penetration achieved in 50 blows.

SAMPLE TYPES

- Auger or backhoe cuttings
- Shelby tube
- Standard Penetration (SPT)
- Modified California (2.0")
- Standard California (2.5")
- Rock core

PLASTICITY CHART



ADDITIONAL TESTS

C - Consolidation
CP - Compaction Curve
CR - Corrosivity Testing
CU - Consolidated Undrained Triaxial
DS - Direct Shear
EI - Expansion Index
P - Permeability
PA - Partical Size Analysis
PI - Plasticity Index
PP - Pocket Penetrometer
R - R-Value
SE - Sand Equivalent
SG - Specific Gravity
SL - Shrinkage Limit
SW - Swell Potential
TV - Pocket Torvane Shear Test
UC - Unconfined Compression
UU - Unconsolidated Undrained Triaxial

GROUND WATER LEVELS

- Later water level after drilling
- Water level at time of drilling

Crawford & Associates, Inc.
Geotechnical Engineering, Design and Construction Services
4030 S. Land Park Drive, Suite C
Sacramento, CA 95822

BORING LOG, TEST PIT LEGEND, AND SOIL DESCRIPTIONS

DRAFT FOUNDATION REPORT

Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

Appendix B
Laboratory Test Results

Laboratory Test Summary
Samples from Exploratory Borings
14-184.3 Lassen County Bridge 7C-12

Boring	Sample I.D.	Depth (ft)	Unfied Soil Classification	Dry Density	Natural Moisture Content	Plastic Limit	Liquid Limit	Plasticity Index	Gravel (%)	Sand (%)	Fines (%)	R-Value	Organic (%)	Pocket Pen (tsf)	Unconfined Compressive Strength (tsf)	Triaxial Test Results Total		Corrosivity test			
																Phi (degrees)	Cohesion (psf)	pH	Min Resistivity (ohm-cm	Chloride (ppm)	Sulfate-S (ppm)
B-1	Bulk 1	0-3	ML									49									
B-2	1	5	SM						3.5	72.2	24.3										
B-2	2	10	CL	97.1	26.7	20	32	12								0	391				
B-2	3	15.5	SC/CL	90.9	32.8																
B-2	5	23	SM	81.3	43.1																
B-2	7	32.5	SC	104.3	22						32										
B-2	9	43	SM	126.5	13.1				0	76.3	23.7										
B-2	10	47.8	SC			18	33	15			38.6										
B-2	11	53.5	SC	114.7	16.5																
B-2	12	58.5	SM								14.7										
B-2	13	63	SM	119.9	13.5																
B-2	15	73.5	SP-SM	105.9	15.8																
B-3	Bulk	0-3	SC									32									
B-4	1	5	CL	94	26.5											0	1824				
B-4	2	14	SP-SM	108.4	17.2				0.2	93.3	6.5										
B-4	3	24	SM	98.4	24						14.7										
B-4	4	34	CL	93.5	30.4				0	25.8	74.2										
B-4	5	45	SP-SM	100.8	23.7																
B-4	6	55	SP	108.5	15.3																

GEOCON CONSULTANTS

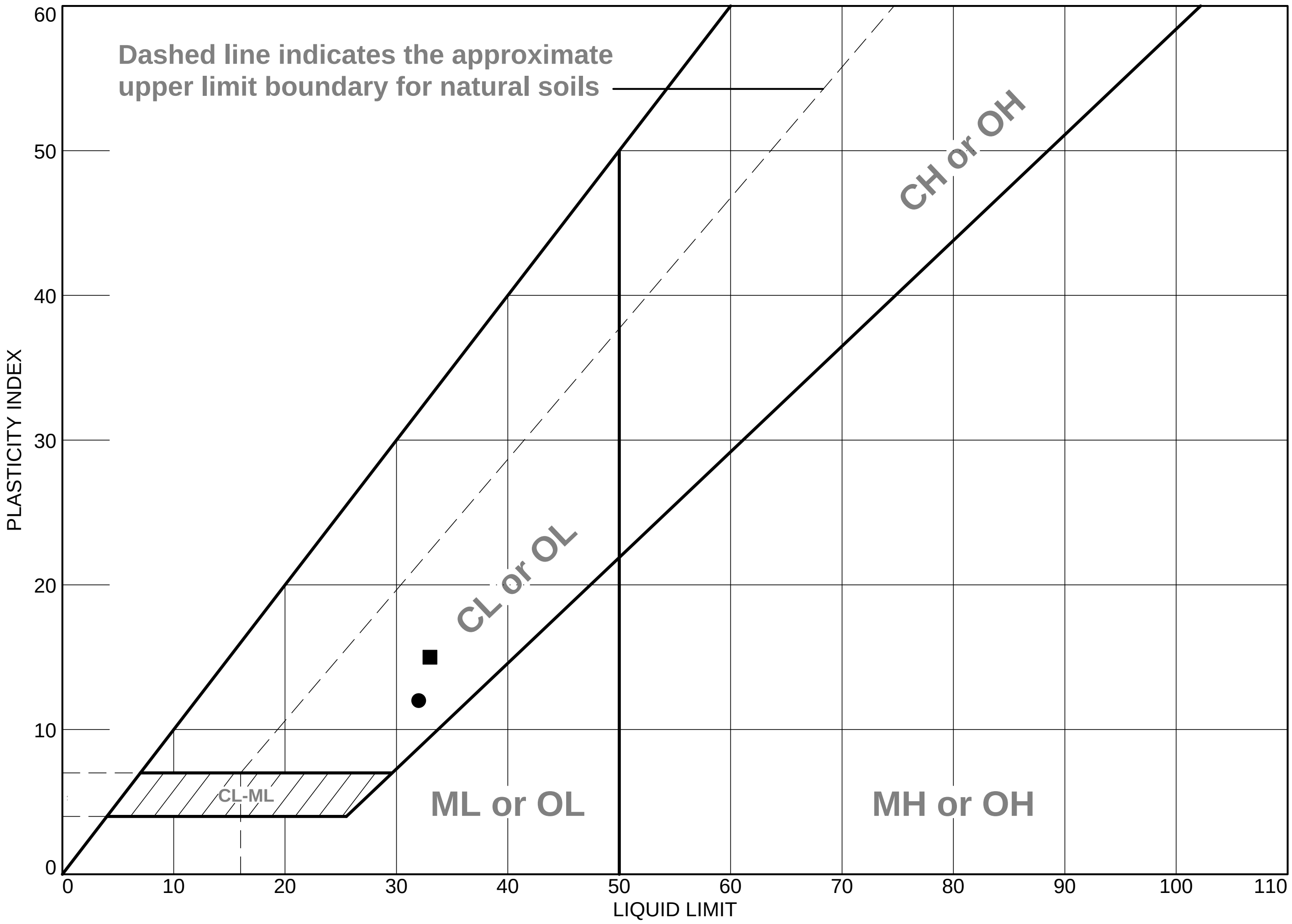
MOISTURE / DENSITY TESTS

PROJECT NAME: Crawford Lab-14-184.3 PROJECT NUMBER: S9763-05-32

DATE: 1/13/2015 TESTED BY: MR/RC LAB NUMBER: 3936 SHEET of 1

SAMPLE NO.	B2@32.5-7C-12	B2@42.5-7C-12	B4@14-7C-12	B4@24-7C-12	B4@34-7C-12		
DEPTH OF SAMPLE (ft)	33-33.5	43.5-44	15-15.5	25-25.5	35-35.5		
SAMPLE DIAMETER (in.)	2.37	2.35	1.91	1.92	1.92		
SAMPLE HEIGHT (cm)	14.61	15.29	14.25	15.22	14.11		
TARE NO.	#6	SR-1	B1	#6	F-1		
WET WT.+TARE (gm.)	1053.8	1188.9	673.7	762.4	726.8		
WET WT.+TARE (gm.) (split)	448.8	437.6	673.70	762.4	726.80		
DRY WT.+TARE (gm.)	405.20	411.20	594.90	654.8	606.9		
TARE WT. (gm.)	206.9	209.00	137.80	206.70	212.4		
WT. OF WATER (gm.)	43.6	26.4	78.8	107.6	119.9		
WT. OF DRY SOIL (gm.)	694.3	866.7	457.1	448.1	394.5		
WT. OF DRY SOIL (gm.) (split)	198.3	202.2	457.1	448.1	394.5		
WATER CONTENT (%)	22.0%	13.1%	17.2%	24.0%	30.4%		
DRY DENSITY (PCF)	104.3	126.5	108.4	98.4	93.5		

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	lean CLAY	32	20	12			
■	lean CLAY	33	18	15			

Project No. S9763-05-32 **Client:** Crawford and Associates

Project: Crawford Lab 14-184.3

● **Location:** B2 **Depth:** 11-11.5 **Sample Number:** B2@10-7C-12

■ **Location:** B2 **Depth:** 47.5-49 **Sample Number:** B2@47.5-7C-12

Remarks:

GEOCON CONSULTANTS, INC.

Figure

Tested By: ○ LC □ RC **Checked By:** MR

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PHONE 916.852.9118 – FAX 916.852.9132

GEOCON CONSULTANTS

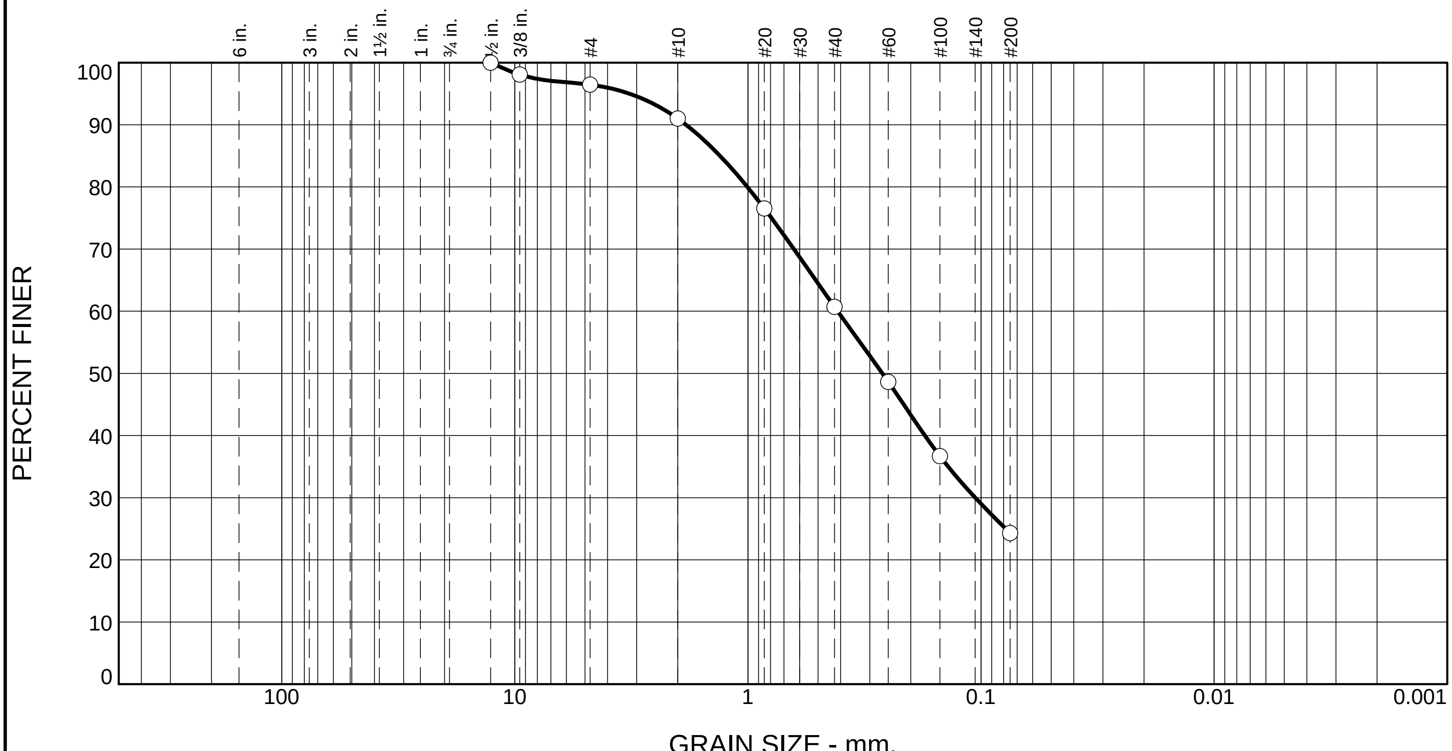
200 Wash (ASTM 1140)

PROJECT NAME: Crawford 14-184.3 PROJECT NUMBER: S9763-05-32

DATE: 1/12/2015 TESTED BY: MR/RC LAB NUMBER: 3936 SHEET 1 of 1

BORING NO.	B2@32-7C-12	B2@47.5-7C-12	B2@57.5-7C-12	B4@24-7C-12			
DEPTH OF SAMPLE (ft)	33-33.5	47.5-49	57.5-59	25-25.5			
TARE NO.	#6	K5	99	B1			
DRY WT. Before Wash + TARE (gm.)	405.2	309	473.1	673.7			
DRY WT. After Wash + TARE (gm.)	341.7	242.1	426.5	594.9			
TARE WT. (gm.)	206.9	135.9	155.9	137.8			
Percent Passing 200 (%)	32.0%	38.6%	14.7%	14.7%			
Sample Description (ASTM D2487/D2488)							

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	3.5	5.5	30.3	36.4	24.3	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.5	100.0		
.375	98.1		
#4	96.5		
#10	91.0		
#20	76.5		
#40	60.7		
#60	48.6		
#100	36.7		
#200	24.3		

* (no specification provided)

Material Description

Silty SAND

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 1.8414 D_{85}= 1.3177 D_{60}= 0.4121
D_{50}= 0.2651 D_{30}= 0.1058 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/12-15/15

Tested By: RC

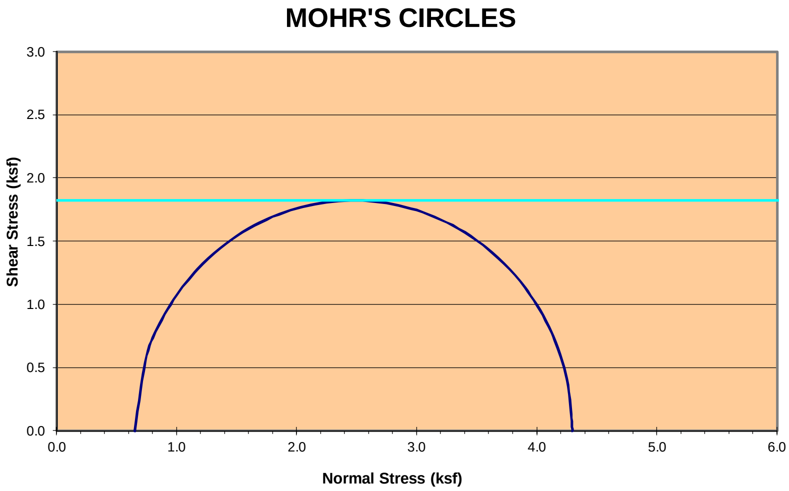
Checked By: MR

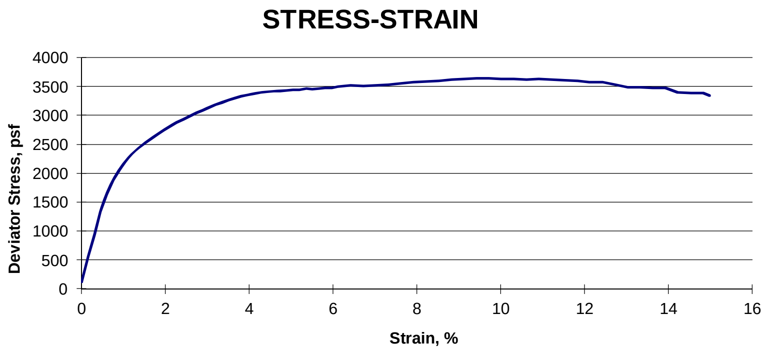
Title: Lab Manager

Location: B2
Sample Number: B1@5-7C-12 **Depth:** 5-6.5 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford Lab 14-184.3
Project No: S9763-05-32 **Figure**





Failure Photo

Sample Description	
Sample Number	B4@5-7C-12
Sample Depth (feet)	6-6.5
Material Description	Dark yellowish brown Sandy lean CLAY

Initial Conditions at Start of Test	
Height (inch)	4.00
Diameter (inch)	1.90
Moisture Content (%)	26.5
Dry Density (pcf)	94.0
Estimated Specific Gravity	2.7
Saturation (%)	90.5

Shear Test Conditions	
Strain Rate (%/min)	0.9977
Major Principle Stress at Failure (psf)	4300
Minor Principle Stress, Cell Pressure (psf)	650
Deviator Stress at Fail (psf)	3650

Test Results	
Friction Angle ϕ, (degrees)	0
Cohesion, (psf)	1824

Note: Strength attibuted to cohesion with no value of friction assigned

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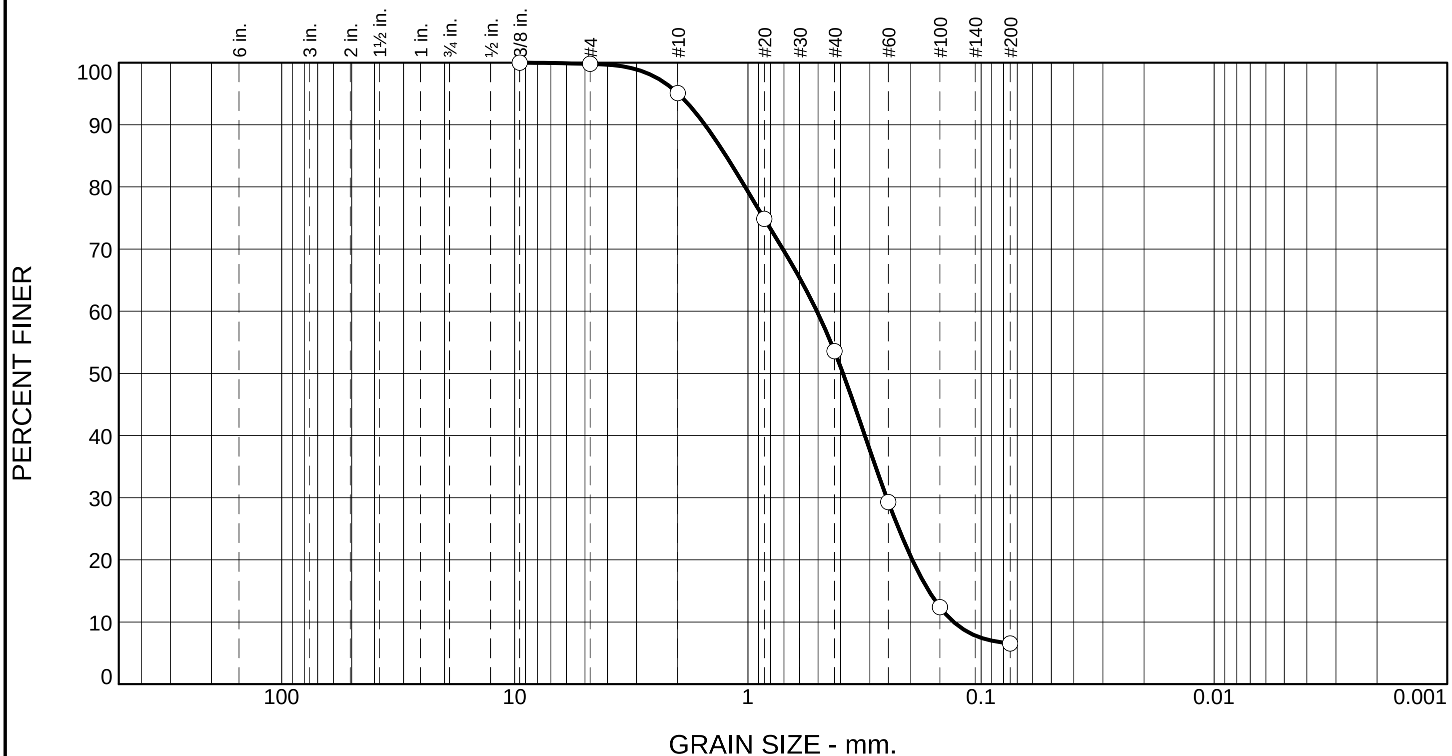
3160 Gold Valley Drive, Suite 800
Rancho Cordova, California 95742
Telephone: (916) 852-9118
Fax: (916) 852-9132

Triaxial Shear Strength - UU Test (single)

Project: Crawford 14-184.3
Location: Lassen County, CA
Number: S9763-05-32
Figure:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.2	4.7	41.5	47.1	6.5	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.375	100.0		
#4	99.8		
#10	95.1		
#20	74.9		
#40	53.6		
#60	29.3		
#100	12.4		
#200	6.5		

* (no specification provided)

Material Description

Poorly graded SAND with silt

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 1.5286 D_{85}= 1.2422 D_{60}= 0.5055
D_{50}= 0.3907 D_{30}= 0.2540 D_{15}= 0.1674
D_{10}= 0.1309 C_u= 3.86 C_c= 0.97

Remarks

Date Received: **Date Tested:** 1/14-16/15

Tested By: RC

Checked By: MR

Title: Lab Manager

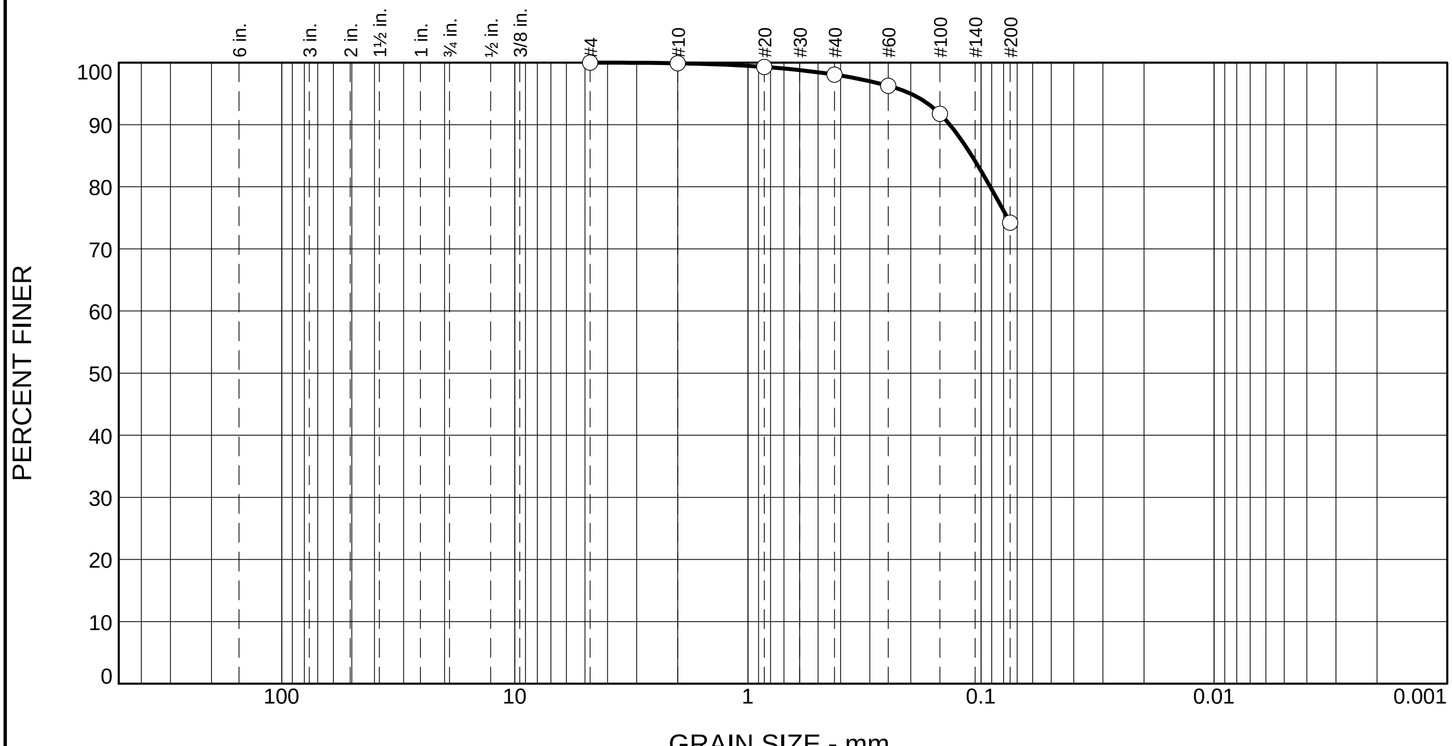
Location: B4
Sample Number: B4@14-7C-12 **Depth:** 15-15.5 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford Lab 14-184.3

Project No: S9763-05-32 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	1.8	23.9	74.2	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	99.3		
#40	98.1		
#60	96.3		
#100	91.8		
#200	74.2		

* (no specification provided)

Material Description

Sandy SILT or Sandy lean CLAY

Atterberg Limits (ASTM D 4318)

PL= **LL=** **PI=**

Classification

USCS (D 2487)= **AASHTO (M 145)=**

Coefficients

D_{90}= 0.1360 D_{85}= 0.1094 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/14-16/15

Tested By: RC

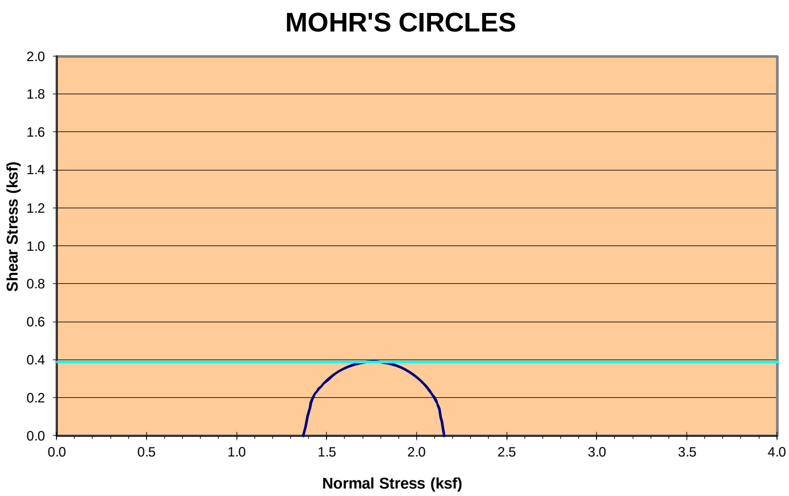
Checked By: MR

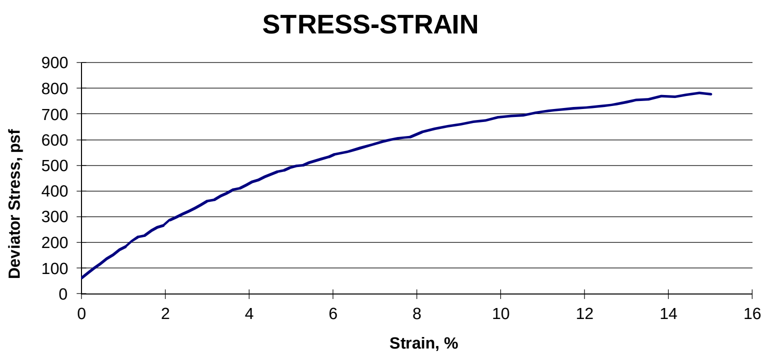
Title: Lab Manager

Location: B4
Sample Number: B4@34-7C-12 **Depth:** 35-35.5
Date Sampled:

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford Lab 14-184.3
Project No: S9763-05-32 **Figure**





Failure Photo

Sample Description	
Sample Number	B2@10-7C-12
Sample Depth (feet)	11-11.5
Material Description	Very Dark Brown Silty Clayey SAND
Initial Conditions at Start of Test	
Height (inch)	4.92
Diameter (inch)	2.38
Moisture Content (%)	26.7
Dry Density (pcf)	97.1
Estimated Specific Gravity	2.7
Saturation (%)	98.0
Shear Test Conditions	
Strain Rate (%/min)	0.2998
Major Principle Stress at Failure (psf)	2150
Minor Principle Stress, Cell Pressure (psf)	1370
Deviator Stress at Fail (psf)	780
Test Results	
Friction Angle ϕ, (degrees)	0
Cohesion, (psf)	391

Note: Strength attibuted to cohesion with no value of friction assigned

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Rancho Cordova, California 95742
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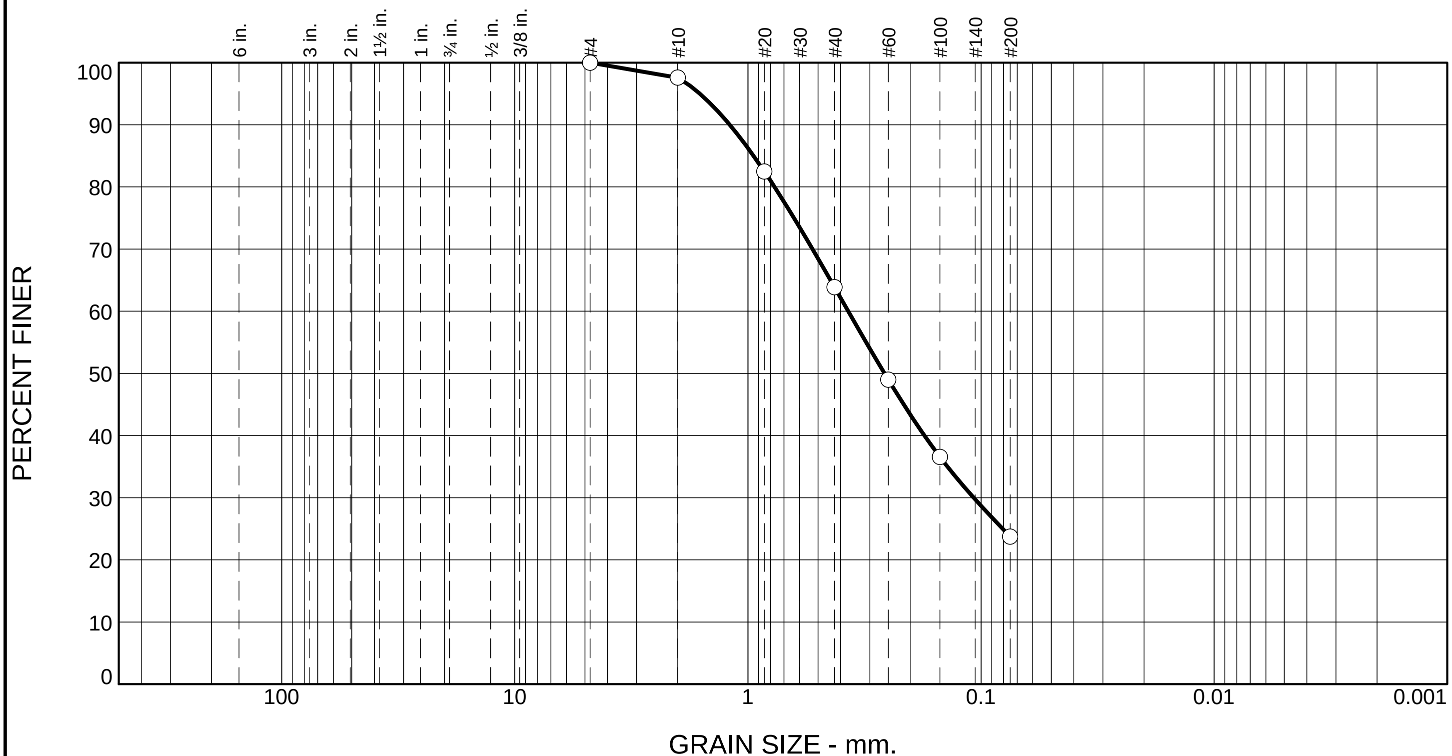
Fax: (916) 852-9132

Triaxial Shear Strength - UU Test (single)

Project: Crawford 14-184.3
Location: Lassen County, CA
Number: S9763-05-32
Figure:

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	2.4	33.7	40.2	23.7	

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	97.6		
#20	82.5		
#40	63.9		
#60	49.0		
#100	36.6		
#200	23.7		

* (no specification provided)

Material Description

Silty SAND

Atterberg Limits (ASTM D 4318)

PL= LL= PI=

Classification

USCS (D 2487)= AASHTO (M 145)=

Coefficients

D_{90}= 1.1970 D_{85}= 0.9457 D_{60}= 0.3710
D_{50}= 0.2595 D_{30}= 0.1074 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: **Date Tested:** 1/12-15/15

Tested By: RC

Checked By: MR

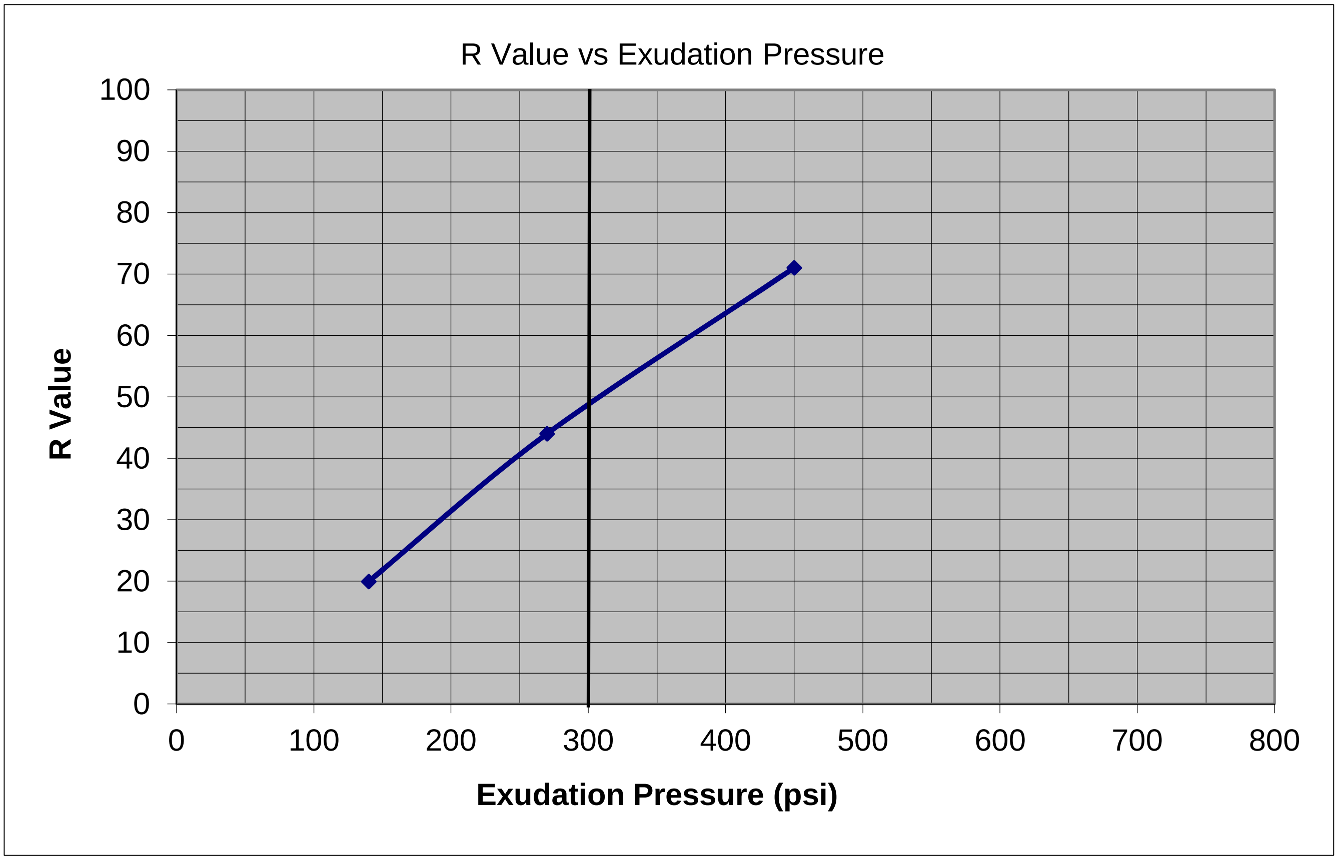
Title: Lab Manager

Location: B2
Sample Number: B2@43-7C-12 **Depth:** 43.5-44 **Date Sampled:**

GEOCON CONSULTANTS, INC.

Client: Crawford and Associates
Project: Crawford Lab 14-184.3

Project No: S9763-05-32 **Figure**



Sample ID & Description	
Boring Number	B1
Sample ID	B1@0-3 7C-12
Material Description	Grayish Brown Silty SAND with trace clay

Test Data			
Specimen	D	E	F
Exudation Pressure (psi)	140	270	450
Expansion Dial (.0001")	0	2	4
Expansion Pressure (psf)	0	9	17
Resistance 'R' Value	20	44	71
Moisture at test (%)	12	9.9	9.2
Dry density at test (pcf)	122.1	128.0	127.9
R Value at 300 psi exudation pressure	**49**		
R Value by expansion pressure (TI=5.0)	88		

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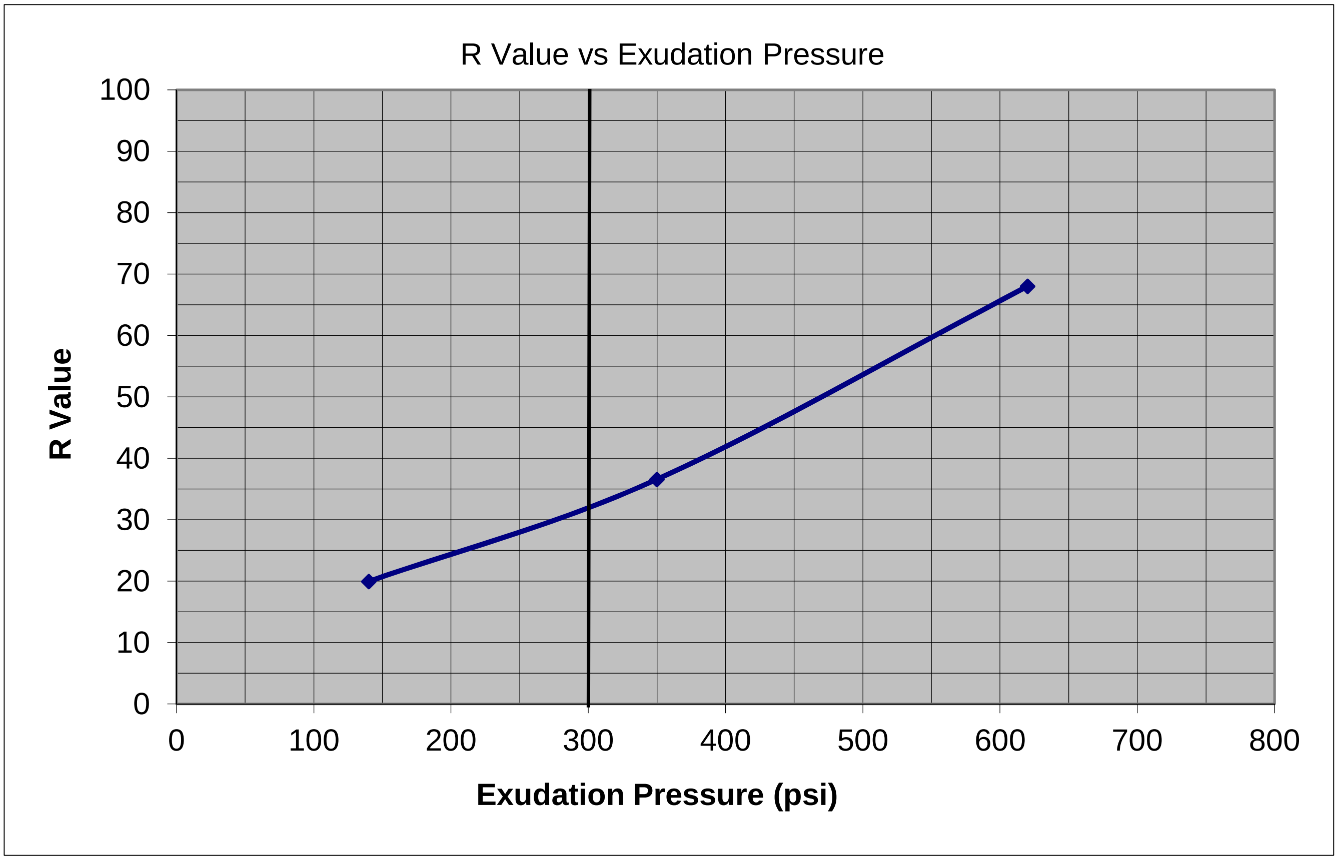
R Value By Exudation

Project: Crawford 14-184.3
Location: Lassen County, CA
Number: S9763-05-32
Figure:



Sample ID & Description			
Boring Number	B3		
Sample ID	B3@0-3 7C-12		
Material Description	Very dark brown Clayey SAND with trace gravel		

Test Data

Specimen	D	E	F
Exudation Pressure (psi)	140	350	620
Expansion Dial (.0001")	0	17	37
Expansion Pressure (psf)	0	74	160
Resistance 'R' Value	20	37	68
Moisture at test (%)	12	11.4	10.4
Dry density at test (pcf)	122.1	125.3	126.1
R Value at 300 psi exudation pressure	**32**		
R Value by expansion pressure (TI=5.0)	48		

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R Value By Exudation

Project: Crawford 14-184.3
Location: Lassen County, CA
Number: S9763-05-32
Figure:

Sunland Analytical

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

Date Reported 01/23/15
Date Submitted 01/20/15

To: Mark Repking
Geocon
3160 Gold Valley Dr. #800
Rancho Cordova, CA, 95742

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

The reported analysis was requested for the following:
Location : S9763-05-32-14-184.3 Site ID: B4@5-7C-12
Thank you for your business.

* For future reference to this analysis please use SUN # 68608 - 142543

EVALUATION FOR SOIL CORROSION

Soil pH	7.45			
Minimum Resistivity	1.29	ohm-cm (x1000)		
Chloride	14.8	ppm	0.0015	%
Sulfate-S	11.3	ppm	0.0011	%

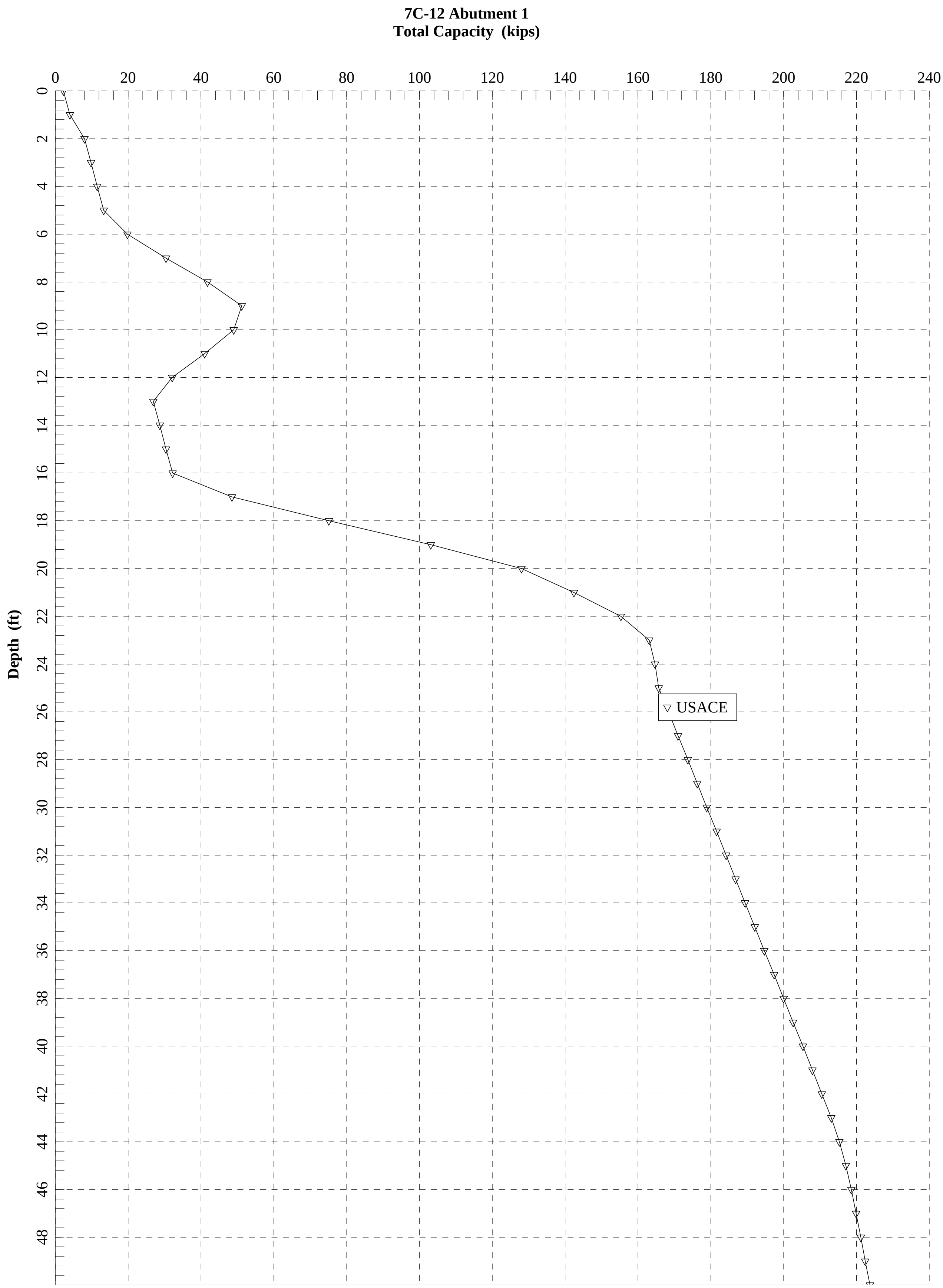
METHODS:
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

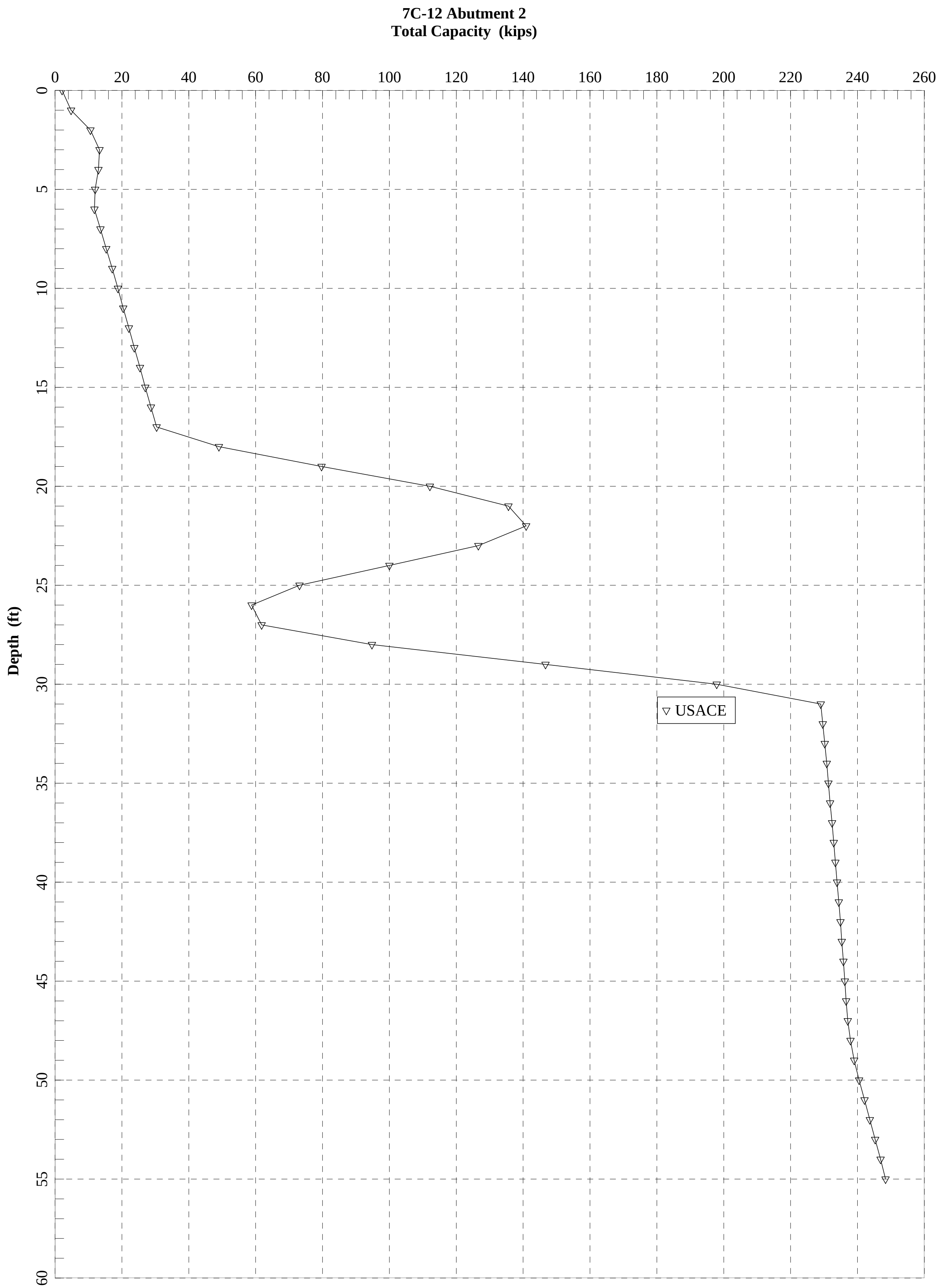
DRAFT FOUNDATION REPORT

Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

Appendix C

APile Analysis


7C-12 Abutment 1
Total Capacity (kips)
0
20
40
60
80
100
120
140
160
180
200
220
240
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48
USACE

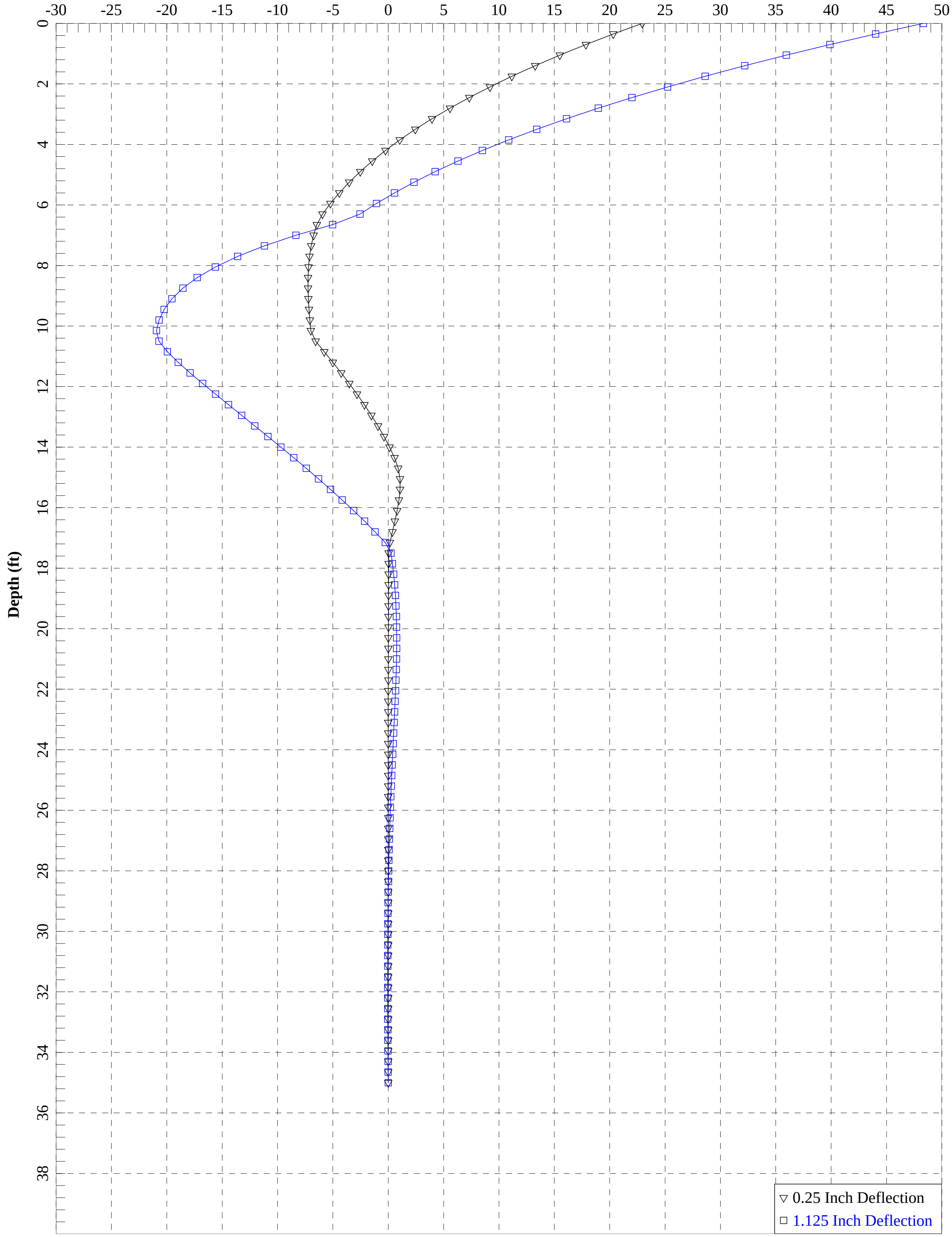

7C-12 Abutment 2
Total Capacity (kips)
0 20 40 60 80 100 120 140 160 180 200 220 240 260
Depth (ft)
0 5 10 15 20 25 30 35 40 45 50 55 60
USACE

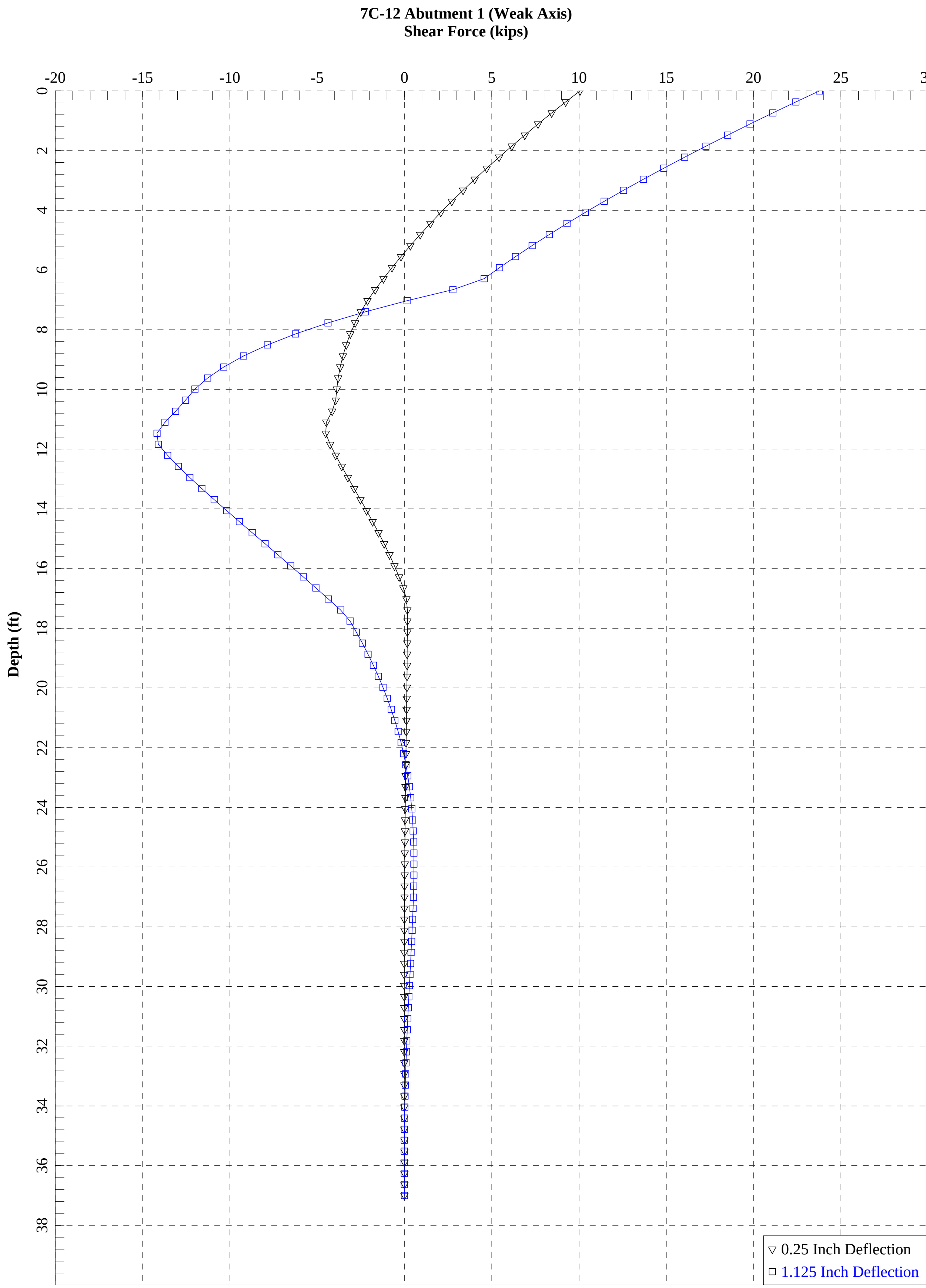
DRAFT FOUNDATION REPORT

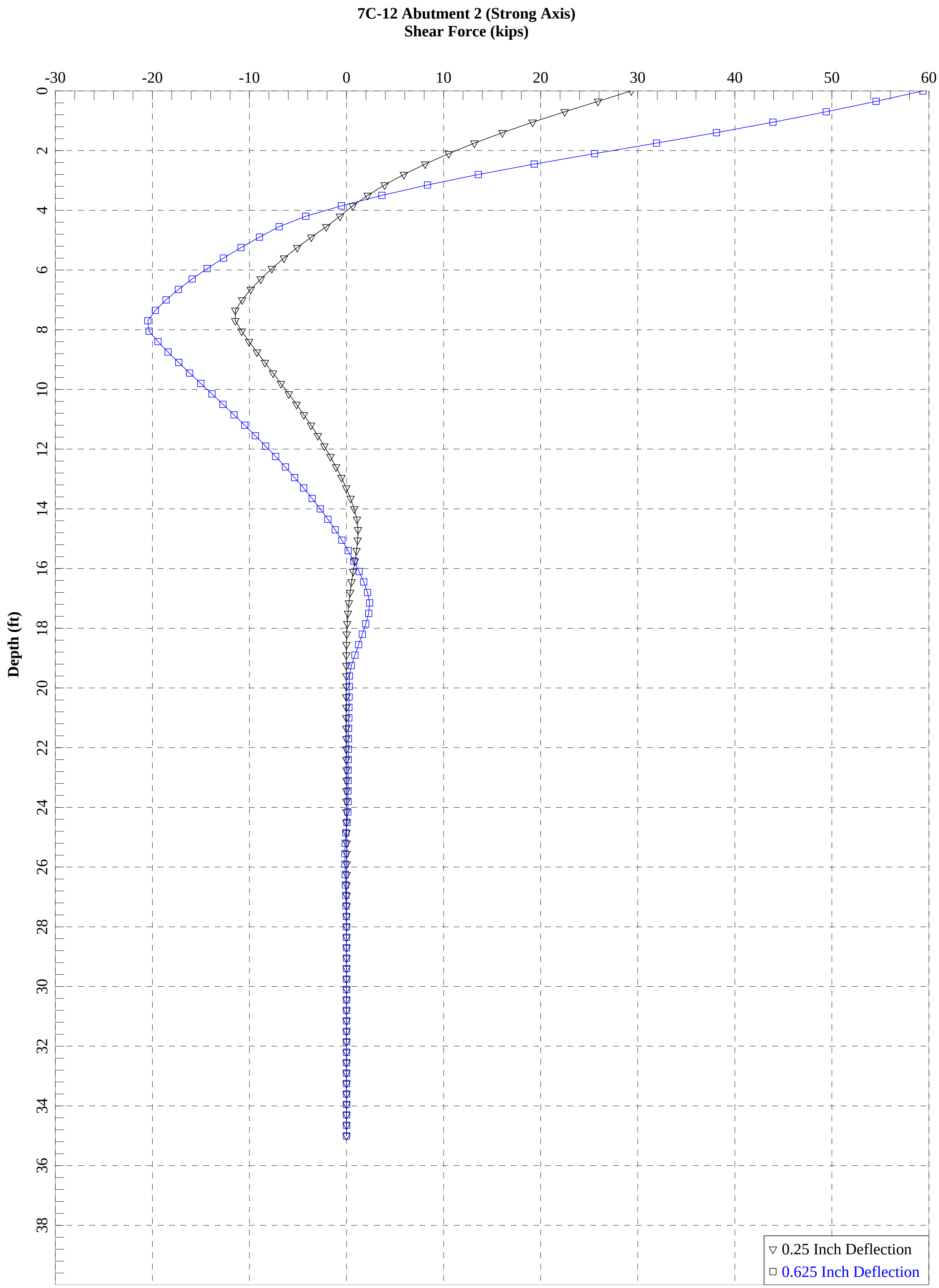
Long Valley Creek Overflow Bridge on Hackstaff Road
Bridge No. 7C-12
Lassen County, California

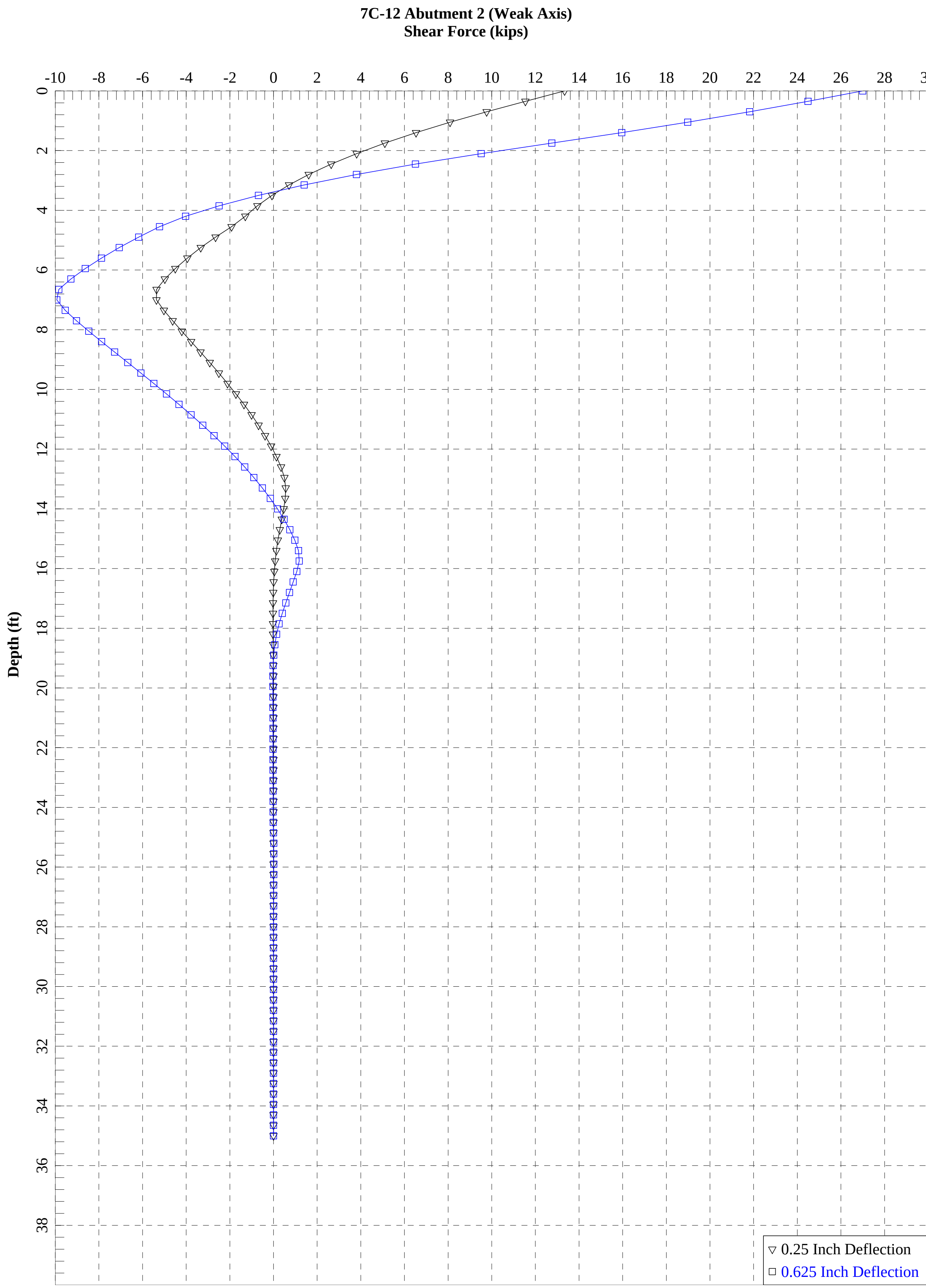
Appendix D
LPile Analysis

7C-12 Abutment 1 (Strong Axis)
Shear Force (kips)




7C-12 Abutment 1 (Weak Axis)
Shear Force (kips)
-20
-15
-10
-5
0
5
10
15
20
25
30
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
0.25 Inch Deflection
1.125 Inch Deflection


7C-12 Abutment 2 (Strong Axis)
Shear Force (kips)
-30
-20
-10
0
10
20
30
40
50
60
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
0.25 Inch Deflection
0.625 Inch Deflection


7C-12 Abutment 2 (Weak Axis)
Shear Force (kips)
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Depth (ft)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
34
36
38
0.25 Inch Deflection
0.625 Inch Deflection