Memorandum

Flex your power!
Be energy efficient!

To: **MR. COLIN DORAN**
Project Engineer
Design IV, Branch I

Date: July 9, 2008

File: 10-TUO-49
KP 37.2/37.8 (PM 23.1/23.5)
10-0J1501
Curve Improvement

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – MS 5

Subject: Geotechnical Design Report

Introduction

Per your request, a Geotechnical Design Report (GDR) is provided for a curve improvement project on Highway 49. This project is located, along the highway, south of Tuttletown in Tuolumne County from KP 37.2 to 37.8 (PM 23.1/23.5). See Plate No. 1, Vicinity Map.

This project is proposed to improve the sight distance condition on the T-intersection of Highway 49 and Poppy Hills Road. The project is proposed to modify both the vertical and horizontal alignments. Cuts into the native rock are anticipated. This project primarily presents the rippability evaluation generated from the seismic refraction survey.

This report includes a review of published data, recent site visits, and a seismic refraction investigation performed for rippability evaluation. No subsurface exploration or related laboratory analyses were performed.

Pertinent Reports and Investigations

In preparing this report, we have reviewed the following documents:

1. Preliminary Geotechnical Report, dated Feb 24, 2003.
2. Route 49 Curve Improvements (seismic refraction investigation, rippability

evaluation), dated June 27, 2008.

3. Western Regional Climate Center for 1992-2007
4. "California Seismic Hazard Map", prepared by Caltrans, dated 1996
5. "Geologic map of the San Francisco-San Jose quadrangle", California, 1991

Existing Facilities and Proposed Improvements

The proposed project extends from KP 37.1, and follows Highway 49 north, to KP 37.8 Road. Along the stretch of the roadway, Highway 49 consists of a 2-lane undivided roadway paved with asphalt concrete aligned in a general north/south direction. The roadway is built on rolling hills terrain. The existing cut slopes are approximately 1:0.5 (V:H) or flatter and fill slopes of 1:2 (V:H) or flatter. There are driveways that are directly connected to residential areas along this section of roadway. Utility lines parallel the roadway on the east side.

This project is proposed to improve the sight distance at the T-intersection of Route 49 and Poppy Hills Drive. The existing crest vertical curve at the intersection is followed by a sag vertical curve. This causes a sight distance problem for vehicles turning left from the southbound of Route 49 into Poppy Hills Drive. The project is also proposed to include vertical and horizontal curves correction in order to fix the non-standard features within the project limits.

Physical Setting

The physical setting of the project site and the surrounding area was reviewed to provide climate, topography and drainage, man-made and natural features, geology and seismicity characteristics to aid in project design and construction. The following is a discussion of our review:

Climate

According to the Western Regional Climate Center for 1992-2007, the average annual precipitation at the New Melones Dam HQ Station is about 807 mm (31.76 in). The majority of this precipitation falls between November and May. The average annual air

temperature is approximately 16.9° C (62.5° F) with the highest average daily maximum of 35.8° C (96.5° F) in July and the lowest average daily minimum of 3.4 C (38.1° F) in December and January.

Topography & Drainage

The site is located on the western side of the Sierra Nevada Mountain Range. The terrain is hilly with an elevation of 503 meters on the south end (KP 37.2) of the project and an elevation of 495 meters on the north end (PM37.8) of the project. Most of the localized drainage is generally trending to the west.

Man-made and Natural Features of Engineering and Construction Significance

Man-made features that will be considered during design include overhead power and telephone lines as well as underground utility lines, existing driveways for residential buildings, and the existing side slopes. Natural features that will be considered during design are the existing soil and rock types.

Regional Geology and Seismicity

The project area is located within the Sierra Nevada geomorphic province of California. This province is a northwest trending mountain range 400 miles in length and 40 to 100 miles in width. It is bounded on the west by the Great Valley province, on the north by the Cascade Range, and on the east by the Basin Ranges province.

The Geologic Map of California, San Francisco-San Jose Sheet, 1991, By CDMG, was used to determine the geologic formations in the project location. A section from these maps showing the project location is attached as Plate No. 2. The project location is mapped as being in an area of Jurassic Metasedimentary Rocks (Jms) formed during the Jurassic Period of the Mesozoic Era, between 144 million to 208 million years ago. See Plate No. 2, Geology Map.

Department's California Seismic Hazard Map, 1996 was reviewed for the regional seismicity. The map indicates that the controlling fault is the Forest Hill-Melones Fault (FHM), which is located approximately 3.0 km west of the project location. The fault is expected to be capable of producing a Maximum Credible Earthquake (MCE) of

magnitude 6.5. The MCE from this source is expected to produce peak bedrock acceleration on the order of 0.6g at the project location where "g" represents the acceleration due to gravity. See Plate No. 3, Seismic Hazard Map.

Existing Roadway Condition

Jurassic metasedimentary rock, phyllite, was observed within the existing cut slopes. The phyllite is moderately weathered, moderately bedded, moderately hard and yellowish brownish gray in color.

The project starts just after Fraguero Road (Station 10+40) and ends about 420 m after Mormon Road at Station 16+40. The following is a brief description of the conditions encountered along this stretch of Highway 49. Station limits and measurements should be considered approximations. Directions (north, south, east, and west) are stated in accordance to the direction of travel along the roadway.

The project starts at Station 10+40 (KP 37.2). From Station 10+40 to Station 11+80, cut slopes are present on the east side of the roadway. The slopes ratios are 1:0.5 (V:H) or flatter and are up to 3 m in height. The west side appears to be on fill slopes of 1:1.5 (V:H) or flatter and heights of up to 6 m. Both sides of the road are covered with grass, weeds and a few trees. Overhead power lines are present on the east side of the highway.

From Station 11+80 to Station 12+90 (Poppy Hills Road), cut slope are present on the east side of roadway with slopes of 1:1.5 (V:H) or flatter and 1 m in height. The west side appears to be on original grade with cut starting at the end of this section. Both sides of the roadway are covered with grass, weeds, and trees. Overhead power lines are along the east side of the road.

From Station 12+90 (Poppy Hills Road) to Station 14+80, cut slope is present on the east of roadway with slopes of 1:0.5 (V:H) or flatter and 1.5 m in height. West side of roadway appears to be at original grade except from Station 12+90 to Station 13+20 where cut slopes of 1:0.5 (V:H) and heights of up to 1.5 m are present on the west side of roadway. Both sides of the roadway are covered with grass, weeds, and trees. Overhead power lines are along the east side of the road. There are existing driveways that are directly connected to residential areas along this section.

From Station 14+80 to Station 16+40 (North end of project), both sides of the roadway are constructed on original grade. Both sides of the roadway are covered with grass, weeds, and trees. Overhead power lines are along the east side of the road. There are existing driveways that are directly connected to residential areas along this section.

Groundwater

No groundwater or seepage was observed during site visits. Groundwater levels are expected to be deep and would not affect the planned construction activities.

Due to the presence of the phyllite, it is noted that the infiltration rates would be low and may not exceed the minimum infiltration rate of 12.7 mm/hr required in the State Storm Water Quality Practice Guidelines Appendix D to the Statewide Storm Water Management Plan, dated June 2001.

Geotechnical Recommendations

General

Based on observations during site visits, a literature review, and the seismic refraction survey results, it is our opinion that the proposed improvements may be constructed.

As the existing cut and fill slopes are generally behaving well, additional cuts may be constructed at 1:1.5 (V:H) or flatter and fills at 1:2 (V:H) or flatter as planned. According a stereographic analysis and field observations, cuts slopes can be constructed up to 1:1 (V:H). All fills should be keyed and benched according to Section 19 of the Standard Specifications. Settlement resulting from the placement of fills is expected to be minimal and to occur during construction.

The project foundations are mostly bedrock in nature and should be considered minimal erodible. However, it is recommended that Landscape Architecture be consulted regarding erosion control measures and storm water runoff management.

According to the *Report and General Soil Map Western Tuolumne County California*, the soils at the project location are in Group 1, which is listed as AK-AB/BE. A portion of the map is attached and can be found on Plate No.4, Soil Map. The Group 1 soils are listed as "Areas dominated by shallow to moderately deep rocky soil underlain with metamorphic or ultrabasic rock". The depth to bedrock varies from 0.3 to 0.8 meters below the ground surface.

Blasting

Due to the neighboring residences, controlled blasting is recommended to perform cuts of slopes. A Non-Standard Special Provision (NSSP) required for controlled blasting will be sent separately. A copy of the seismic refraction investigation, rippability evaluation (memo subject: Route 49 Curve Improvement) is included as an attachment to this report. The report describes the fieldwork that was conducted and results of the rippability analysis. The amount of required blasting for the cut sections is estimated based on the seismic refraction results along with field observations. Table 1 below shows an estimate for the quantity of blasting required for specific sections. Excavation equipment and techniques will greatly influence the amount of blasting required.

TABLE 1: Estimated Blasting Quantities (Percentages are in volume)

Station 10+40 to 11+80	50 % of cut section (some surface layers may be rippable)
Station 11+80 to 12+90	5% of cut section (mostly fill, some shallow cuts)
Station 12+90 to 14+80	25% of cut section (mostly fill, some shallow cuts)
Station 14+80 to 16+40	50% of cut section

Construction Considerations

The contractor should anticipate difficult ripping rocks that are not on the surface. Use of a hydraulic hammer mounted on an excavator may be needed. Blasting is expected to be necessary for most cut sections. There are many residences in the area and some local roads that connect to the highway, traffic will most likely have to be held up during blasting.

Existing power lines located on the east side of roadway may need to be relocated prior to excavation.

Project Information

Standard Special Provision S5-280, "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is an excerpt from SSP S5-280 disclosing information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to the addressee(s) of this report via electronic mail.

Data and information attached with the project plans are:

A. None

Data and Information included in the Information Handout provided to the bidders and Contractors are:

A. Geotechnical Design Report for EA 10-0J1501, dated July 9, 2008.

Data and Information available for inspection at the District Office:

A. None

Data and Information available for inspection at the Transportation Laboratory are:

A. None

The recommendations contained in this report are based on specific project information. If any conceptual changes are made during final design, the Office of Geotechnical Design-North should review those changes to determine if the recommendations herein are still applicable.

If you have any questions or comments, please call Carolyn Zhen at (916) 227-1055 or John Huang at (916) 227-1037.

CAROLYN ZHEN
Transportation Engineer, Civil
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Branch E

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Transportation Engineer, Chef
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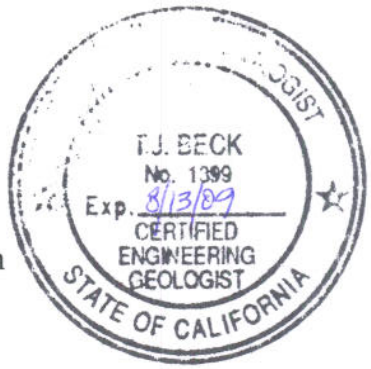
TIMOTHY J. BECK, C.E.G #1399
Senior Engineering Geologist
Office of Geotechnical Design-North
Special Studies



Attachments
- Plate 1 – Vicinity Map
-Plate 2 – Geology Map
-Plate 3 – Seismic Hazard Map
-Plate 4 – Soil Map
-Route 49 Curve Improvements (seismic refraction investigation, rippability evaluation)

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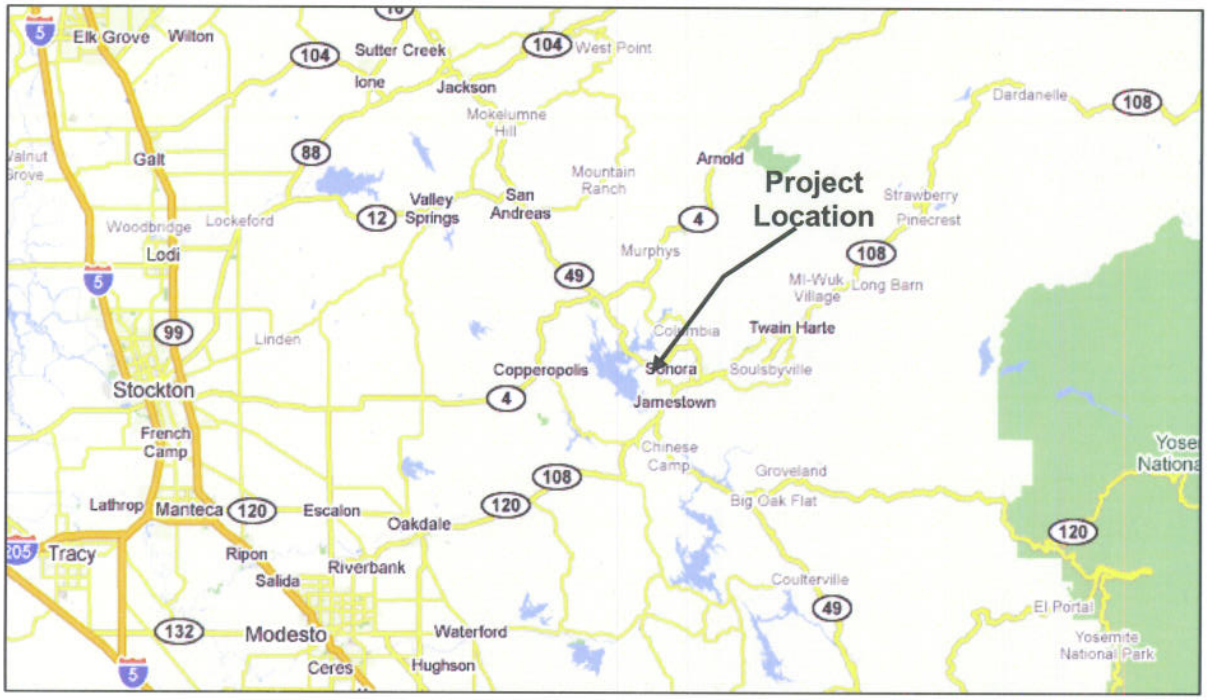
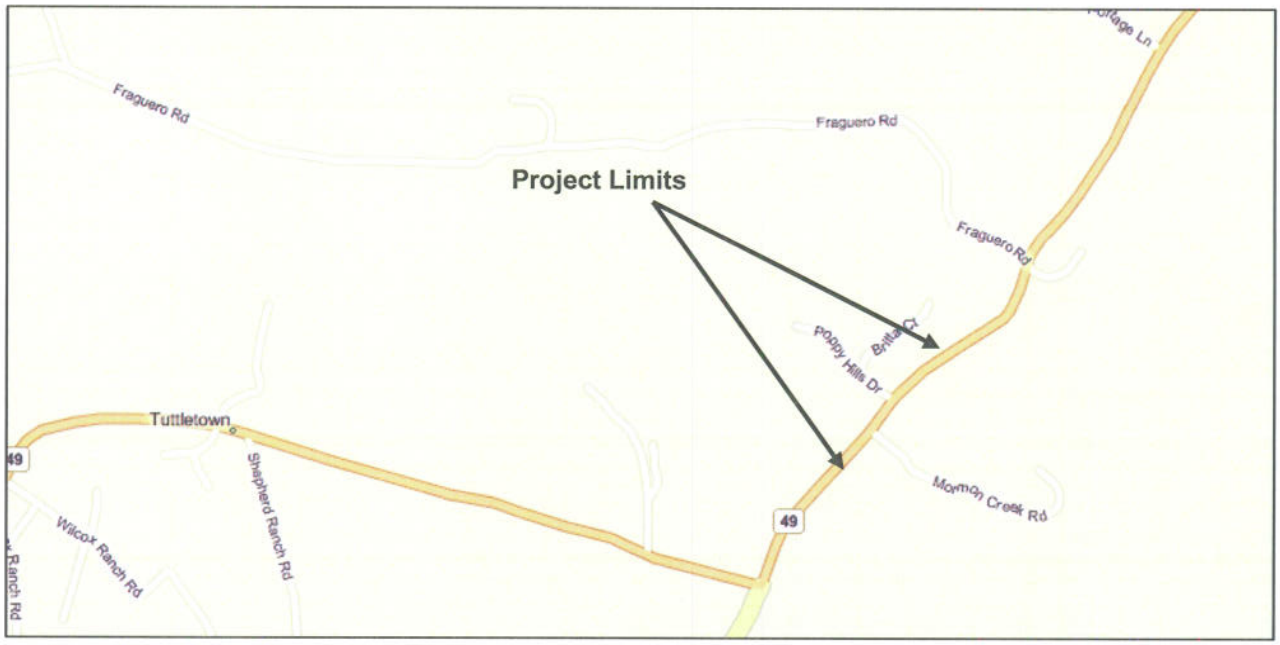
GDN File

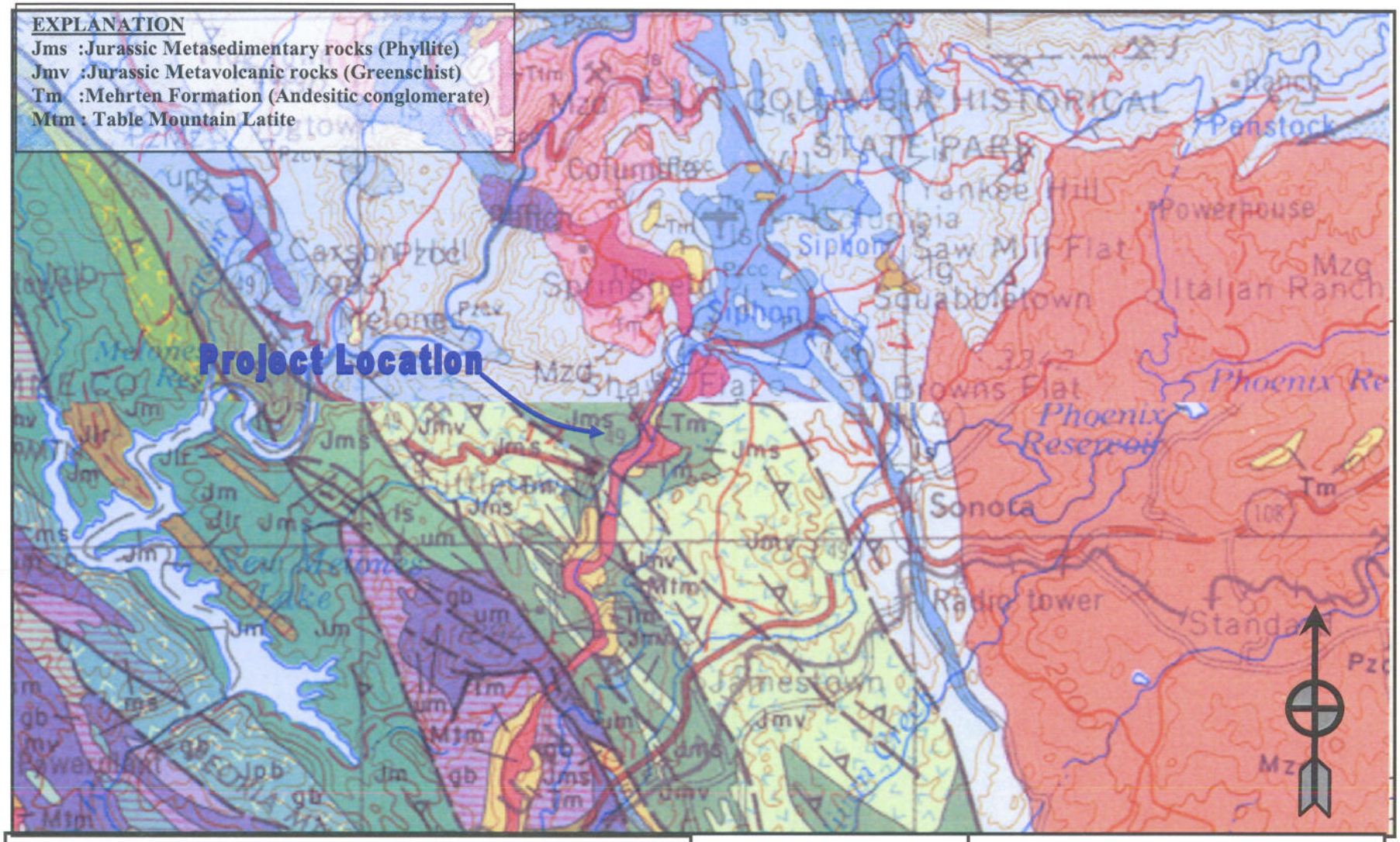




No scale

N

CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design - North	EA: 10-0J1501 Date: July 2008	**VICINITY MAP**
	10-TUO-49-KP 37.2/37.8 GEOTECHNICAL DESIGN REPORT	Plate No. 1



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

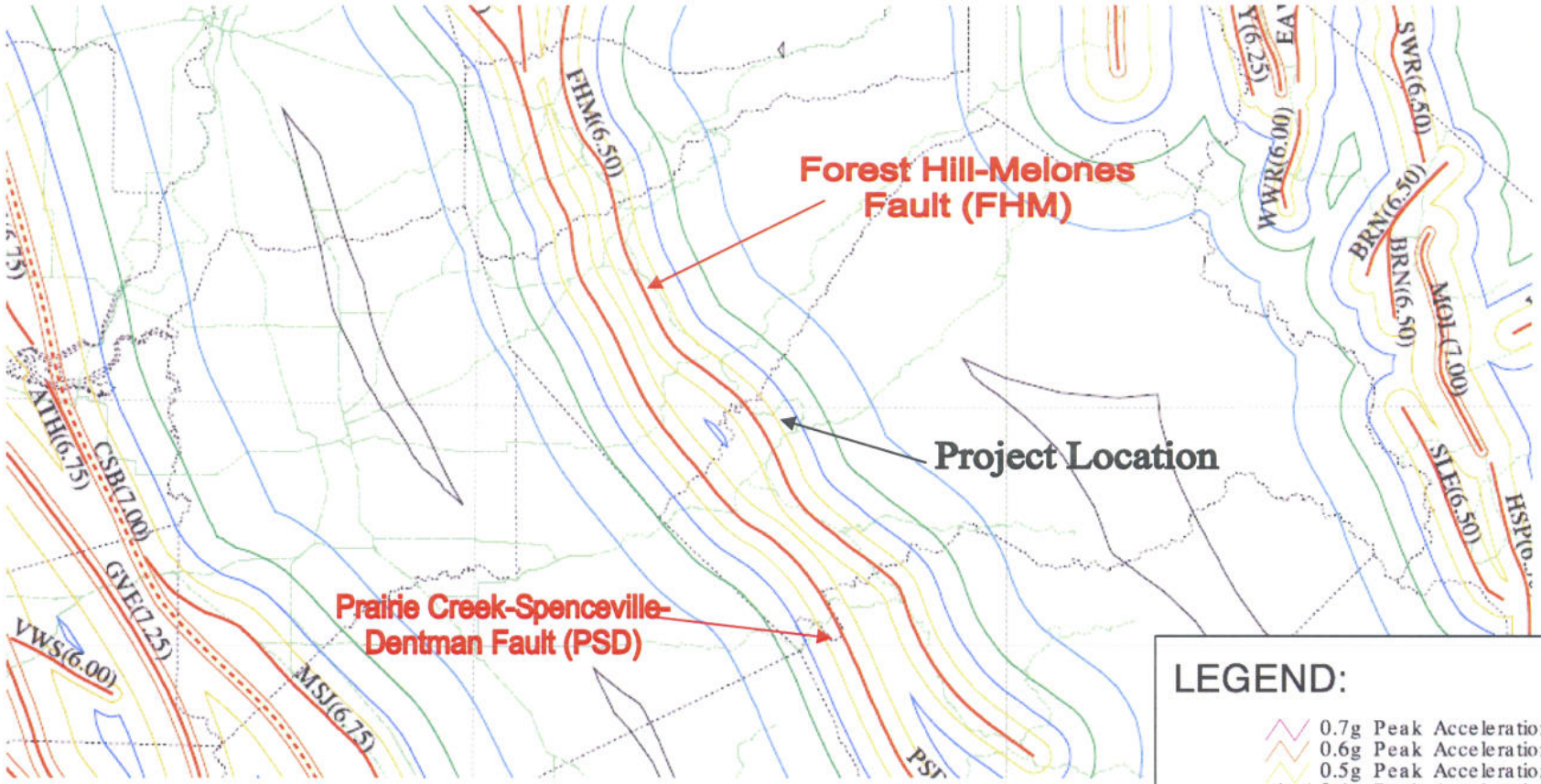
EA: 10-0J1501

Date: July 2008

GEOLOGIC MAP

10-TUO-49-KP 37.2/ 37.8
GEOTECHNICAL DESIGN REPORT

Figure No. 2



California Seismic Hazard Map, 1996, by Lalliana Mualchin

LEGEND:

- 0.7g Peak Acceleration Contour
- 0.6g Peak Acceleration Contour
- 0.5g Peak Acceleration Contour
- 0.4g Peak Acceleration Contour
- 0.3g Peak Acceleration Contour
- 0.2g Peak Acceleration Contour
- 0.1g Peak Acceleration Contour
- Special Seismic Source (SSS)
- Faults with Fault Codes (MCE)
- State Highways
- County Boundary
- Latitude & Longitude

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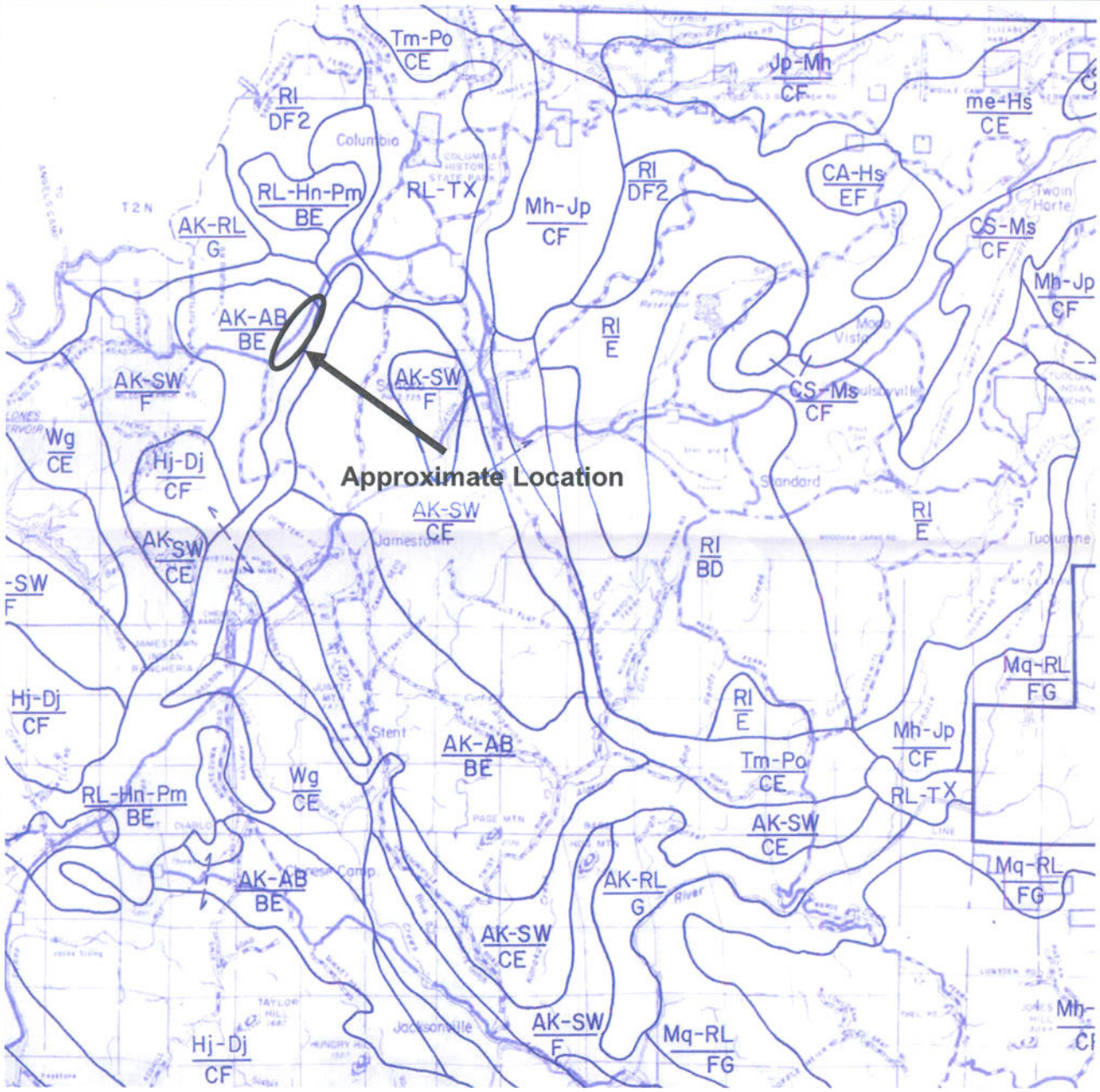
EA: 10-0J1501

July 2008

SEISMIC HAZARD MAP

10-TUO-49-KP 37.2/37.8
GEOTECHNICAL DESIGN REPORT

Plate No. 3



AK - AB / BE — Group 1 Soil. Areas dominated by shallow to moderately deep rocky soil underlain with metamorphic or ultrabasic rock.

Base Map: General Soil Map Western Portion Tuolumne County California, dated March 1967.

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Geotechnical Services
Office of Geotechnical Design - North

EA: 10-0J1501

Date: July 2008

SOIL MAP

10-TUO-49 KP 37.2/37.8 (PM 23.1/23.5)
GEOTECHNICAL DESIGN REPORT

Plate No.4

Memorandum

Flex your power!
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To: **Qiang Huang**
Senior M&R Engineer
Geotechnical Design North
Division of Engineering Services

Date: June 27, 2008

File: 10-TUO-49-23.28
10-0J1501

Attention: Carolyn Zhen

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES-MS#5

Subject: Route 49 Curve Improvements

Introduction

This memo documents the results of a refraction seismic survey to assist in the design of curve improvements for Highway 49 near Tuttletown in Tuolumne County. The main objective is measuring the rippability of the materials comprising the existing embankments where construction is planned.

Results and Discussion

Figure 1 shows the approximate locations of the seismic lines. Figures 2-5 are the processed models of the four seismic lines. All models are interpreted using a three layer case. Table 1 summarizes the results of the investigation.

Seismic Line 1 (figure 2) and Line 2 (figure 3) were laid out where rock was exposed in the existing cut. Ripping should be expected to be moderately difficult from the surface (see Figure 2) and become non-rippable as shallow as approximately 3 meters from existing ground surface.

Seismic line 3 (figure 4) is along a vertical curve on Highway 49 just north of Poppy Hills Road. Similar conditions exist at this site as Line 1. Based on seismic data, low-velocity surficial material pinches out across the profile and the road is constructed directly on higher-velocity material along the southern half of the line. That material will be difficult to rip, and any material exposed below that (beginning at approximately 4 meters below surface) will require blasting or other means of mechanical reduction for excavation.

Ripping ability is based on unpublished Caltrans data for a Caterpillar D9 series bulldozer with a single-tooth ripper. These values are as follows:

Velocity (m/s)	Rippability
<1050	Easily Ripped
1050-1500	Moderately Difficult
1050-2000	Difficult Ripping
>2000	Not Rippable

Different excavation equipment may experience different results. Penetrating efficacy of the ripping tooth is often more important in predicting ripping success than seismic velocity alone. Undetected blocks or lenses of high-velocity material may also be present within rippable zones, requiring blasting or other means of mechanical breakage for excavation. Elevations in this report are derived from temporary benchmarks provided by Caltrans surveys.

Line	Layer	Average Thickness (m.)	Average Velocity (m/s)	Inferred Material	Rippability
1	2	4.0	1176-1344	Weathered Metamorphics	DR
1	3	N/A	3900	Metamorphics	NR
2	2	4.8	1575-1806	Weathered Metamorphics	DR
2	3	N/A	3100	Metamorphics	NR
3	2	3	1281-1512	Weathered Metamorphics	MD/DR
3	3	N/A	3400	Metamorphics	N/R

[1] ER = Easily Ripped, MD = Moderately Difficult, DR = Difficult Ripping, NR = Not Rippable, NA = Not Applicable.

Table 1. Results of the refraction survey at Highway 49 in Tuolumne County

Data Acquisition and Processing

Seismic refraction data were recorded using an EG&G Smartseis 24channel seismograph with 14 MHz geophones. The profiles varied in length. Refraction data from each shot were stored in the seismograph's memory. Both profile geometry and refraction data were backed-up to paper and floppy disk upon completion of the survey.

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

discontinuous velocities might result from variation in the degree of alteration in the form of physical and chemical weathering and should be considered in the interpretation of the data.

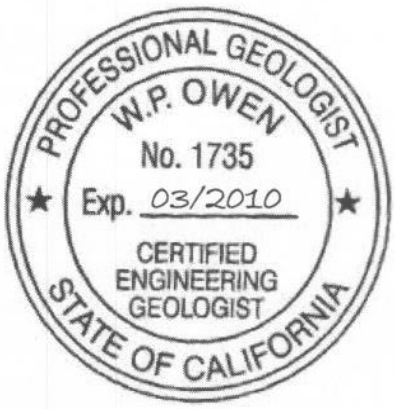
Thank you for the opportunity to work on this project. If you have any questions or need additional assistance, please contact me at (916) 227-1307 or Mr. Bill Owen at (916) 227-0227.

Report by:

Dennison Leeds
Engineering Geologist
Geophysics and Geology Branch

Reviewed By:

William Owen, CEG 1735
Chief, Geophysics and Geology Branch



Project File.

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Figure 1. Photo showing the approximate locations of the seismic lines.

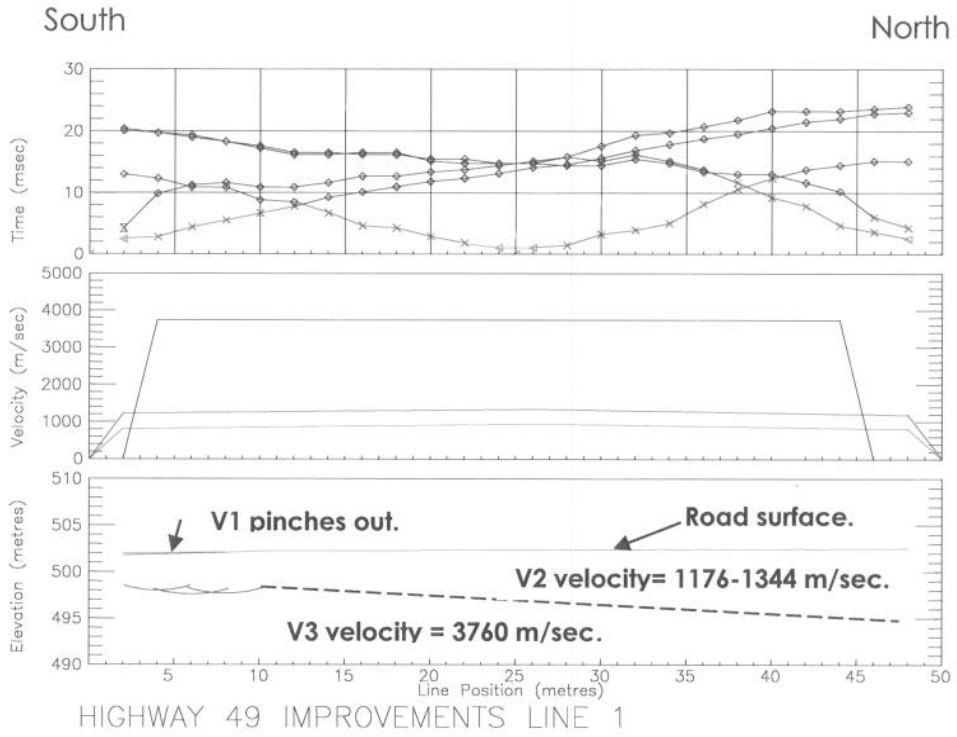

Figure 2. Travel-time curve, velocity model and depth section for Line 1. Layer 1 pinches out meaning the AC sits directly on V2 material. V1 appears to have been removed during original construction. V2 may contain zones requiring light blasting or special equipment for removal. V3 is not rippable. If construction remains above elevation 498.5+/- blasting should not be required, but special equipment may be needed.

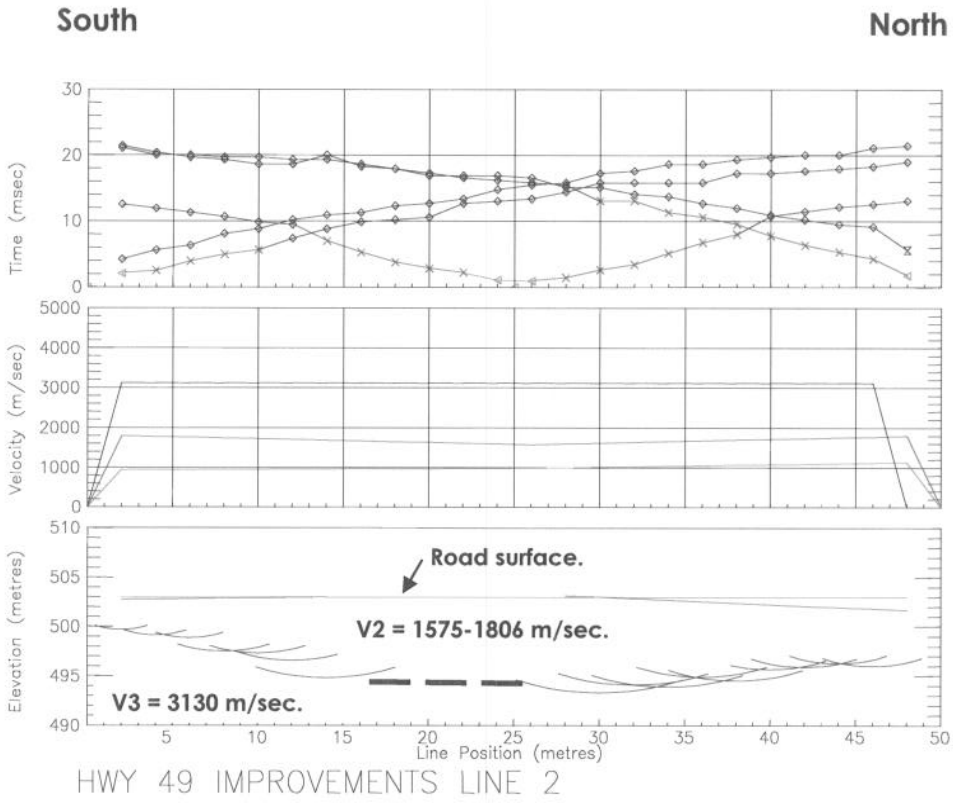

Figure 3. Travel-time curve, velocity model and depth section for Line 2. V1 pinches out, meaning the AC& structural section (if any exists) sits directly on V2 material. This may be due to V1 material being removed during original construction. V2 will be difficult to rip and may require special equipment for removal. V3 is not rippable. Construction above elevation 500 meters should not require blasting but may need special equipment for some hard zones.

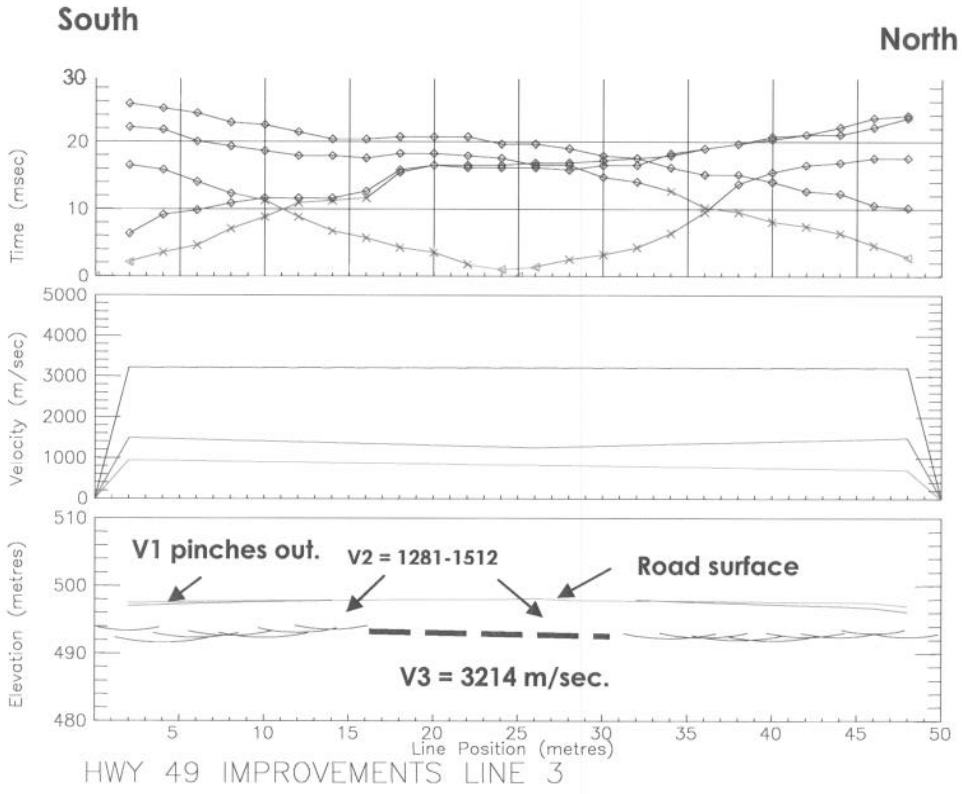

Figure 4. Travel-time curve, velocity model and depth section for Line 3. V1 pinches out most likely due to original construction. AC & structural section (if any exists) sits directly on V2 material and may require special equipment or light blasting depending on depth of designed cut. Any construction below elevation 494 meters is not rippable and zones within V2 may require light blasting or special means of removal.