State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

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To: MR. TOM OSTROM
Supervising Bridge Engineer
Office of Earthquake Engineering

Date: August 1, 2013

Attention: Mark Yashinsky

File: 01-MEN-101 PM 28.58
59-93034-N
EFIS# 0000001016-N
Pomo Lane UC 10-0105L

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Subject: Preliminary Evaluation of Fault Rupture Potential for Pomo Lane Undercrossing - Bridge 10-0105L on Highway 101, Mendocino County

SUMMARY

Caltrans bridge 10-0105L, the Pomo Lane Undercrossing left bridge (MEN-101-28.58; Figure 1), in Ukiah, Mendocino County, is crossed by the active Maacama fault. The mapped trace of the Maacama fault lies immediately southwest of the bridge, and material consistent with fault gouge was encountered during foundation excavation for the bridge. No further geologic studies are recommended at this time.

The probabilistic potential offset within the bridge footprint is 8.2 feet (2.5 meters). Vertical displacement of approximately 10% of the horizontal value, or up to 0.82 feet (0.25 meters), should be assumed to occur with the horizontal displacements.

INTRODUCTION

This evaluation was prepared as part of a statewide evaluation of fault rupture potential at Caltrans bridges. Caltrans policies regarding fault rupture at bridges are described in Memo to Designers 20-10. Caltrans requires a fault rupture evaluation if a bridge is located within an Alquist-Priolo Earthquake Fault Zone or within 1,000 feet of an un-zoned fault 15,000 years or younger in age.

The Pomo Lane Undercrossing bridges were built in 1962. They are continuous 3-span cast-in-place reinforced concrete T-girder bridges on reinforced concrete 3-column bents and reinforced concrete diaphragm abutments. The abutments are founded on driven precast concrete piles and the bents are on reinforced concrete spread footings.

This evaluation consisted of literature, air photo, and LiDAR review, a site visit, and deterministic and probabilistic calculations of expected offset.

LITERATURE, AIR PHOTO, LiDAR, AND FIELD REVIEW

The left bridge lies immediately northeast of an active strand of the Maacama fault mapped by the USGS (2010), on the Alquist-Priolo EFZ map (Figure 2), and by Upp (1982). The Fault Evaluation Report (FER-111) prepared by the California Department of Mines and Geology in 1981 placed the fault at this same location with air photo interpretation (CDMG, 1981).

Caltrans Logs of Test Borings

During the excavation of the spread footings on Bent 3, material was encountered that is consistent with fault gouge (very stiff dense blue clay streaked with brown sandy clay). This material was also recorded in the Logs of Test Borings. In addition, Logs of Test Borings logged in May 1958 show groundwater within a few feet of the ground surface. Faults can act as groundwater barriers. The presence of possible fault gouge and high groundwater is consistent with subsurface conditions in a fault zone.

Hart and Bryant, 2001 (USGS Fault and Fold Database)

The northern Maacama fault, north section extends from Mark West Creek in Sonoma County to Laytonville in Mendocino County. It has been interpreted as a right-stepping extension of the Rogers Creek fault. The fault has a slip rate of 11-14 mm/year. Fault creep near Ukiah and Willits measures approximately 5-7 mm/year.

Creep

Sanford Ranch Road lies approximately 5 miles southeast of the site. Fault creep of 4.2 mm/year on average has been recorded there for two decades (McFarland et al, 2009). This creeping segment of the fault does not appear to extend to the Pomo Undercrossing (McFarland, personal communication) but fault creep has also been recorded on fault segments north of the Pomo Lane Undercrossing in Willits.

Paleoseismic Studies

Sickler and others (2005) excavated a trench approximately 1.25 miles southeast of the Pomo Lane Undercrossing. They found a laterally offset terrace riser and were able to constrain the date of the most recent surface rupture on this segment of the fault. The fault segment that they

trenched is mapped as historic, and it terminates a few hundred meters southeast of the Pomo Lane Undercrossing.

Alquist-Priolo Studies

Alquist-Priolo study 2254 (Applied Earth Sciences, 1987) was conducted immediately west of the Pomo Lane Undercrossing in 1987. The boundaries of the site lay west of the mapped trace of the fault nearest the Undercrossing, and east of a second mapped trace shown on Figures 2 and 3. No faults were found on the property. The mapped trace of the fault nearest the Pomo Lane UC was not trenched.

Historical Air Photos

Air photos from 1955 confirm the mapped location (Figure 2) of the fault near the Pomo Undercrossing. There is a northwest-trending scarp and a northwest-trending elongated sag pond or depression where blackberry brambles lie today just southwest of the bridge. This was also described by the CDMG (1981), and Upp (1982). The area was extensively graded in the late 1950's and early 1960's when Highway 101 was built. The area was already cultivated in 1955 and many places where fault features might have occurred had been plowed.

LiDAR Images

LiDAR images from the USGS (2010; Figure 3) show that the area immediately around the Pomo Undercrossing has been extensively graded and cultivated. No fault-related features in the bridge footprint are apparent on the LiDAR images.

Site Visit

Martha Merriam (Caltrans Office of Geotechnical Support) and I visited the site in June 2013. There is no obvious fault trace or evidence of creep in the bridge footprint. We observed blackberry bushes southwest of the left bridge, approximately at the mapped location of the fault.

Literature Review and Site Visits - Conclusions

The mapped fault trace passes through a blackberry patch immediately southwest of the bridges. This is likely the correct location of the fault, as confirmed with air photos from 1955. Subsurface conditions indicate that the fault zone extends through the bridge footprint.

CALCULATIONS OF EXPECTED OFFSET

To quantify potential fault offset, I used a spreadsheet developed by the Division of Research and Innovation in collaboration with Geotechnical Services, based upon methods presented in Petersen, et al. (2011), and Abrahamson (2008). Both a deterministic fault displacement analysis and a probabilistic fault displacement analysis were performed. The input parameters included maximum magnitude, slip rate, mapping and base map errors, and average block model moment reduction (aseismicity factor).

Mmax

The $\mathbf{M}_{max}$ of 7.4 is cited in the Caltrans fault database[1], which references Dawson and Weldon (2012). This is consistent with values of Mw 7.0 to 7.6 calculated by Sickler, et al. (2005).

Slip Rate

In this report we use the slip rate from Dawson and Weldon (2012) of 9 mm/year, also cited by Hart and Bryant (2001). This is consistent with a rate calculated by Sickler, et al. (2005) of 8.7-13.4 mm/year.

Average Block Model Moment Reduction (Aseismicity Factor)

On a creeping fault, average slip on the fault as a whole should be reduced by the ratio of creep to total slip. We apply an average block model moment reduction (aseismicity factor) of 0.25, presented in the UCERF 3 (Weldon, et al., 2012). This has the effect of reducing the predicted offset to account for the reduction in moment created by ongoing slip on a portion of the fault plane.

Empirical Slip Measurements

Numerous paleoseismic trenches in the area failed to define a slip measurement for the most recent event on the Maacama fault. Empirical slip measurement is complicated by creep on the fault. In this analysis, no empirical slip measurements were used.

Site-to-Source Distance

We used the closest measured distance from the southwest corner of the left bridge to the fault mapped in the USGS maps in Google Earth and confirmed with CGS EFZ maps on paper (USGS, 2010; State of California, 1974). Although the USGS (2010) mapped fault locations can be inaccurate to hundreds of feet in some places, the map shows the fault cutting through a

[1] CT fault database: http://dap3.dot.ca.gov/shake_stable/v2/technical.php

blackberry bramble southwest of the bridges, a likely location for the fault that was confirmed on 1955 air photos and in the field.

Type of Slip

The Maacama fault is a right-lateral strike-slip fault.

Calculated Potential Offset at the Bridge

Fault Offset within the Bridge Footprint

The probabilistic value (2.6 m) of offset within the bridge footprint is shown on Figure 4. The deterministic value was 1.5 m. There are no published empirical slip estimates for prehistoric earthquakes on the Maacama fault, so the probabilistic calculation yielded higher offsets, probably because of higher uncertainties.

Vertical Displacement

Vertical displacements of approximately 10% of the horizontal offset should be assumed to occur temporally with horizontal displacements in the bridge footprint. This corresponds to approximately 10.25 inches for the probabilistic case.

Table 1 - Results of Offset Calculations

Scenario	M_{max}[2]	Slip Rate[3]	Site-to-source distance	Deterministic offset	Probabilistic offset, 975 yr return
Mapped trace – 100%	7.4	9 mm/year	11 m	1.5 m	2.5 m

RECOMMENDATIONS

The potential fault offset for the left bridge is 2.5 meters. No further geologic work is recommended at this time. If you have any questions, please contact Anna Sojourner at (510) 622-8839.

c: TPokrywka, CRisden, Daily File
ASojourner/mm
Attachments: Figures 1 - 4

[2] CT fault database: http://dap3.dot.ca.gov/shake_stable/v2/technical.php
[3] Dawson and Weldon (2012)

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0 0.5
Approximate
Scale, Miles

Figure 1 **Pomo UC Location Map**

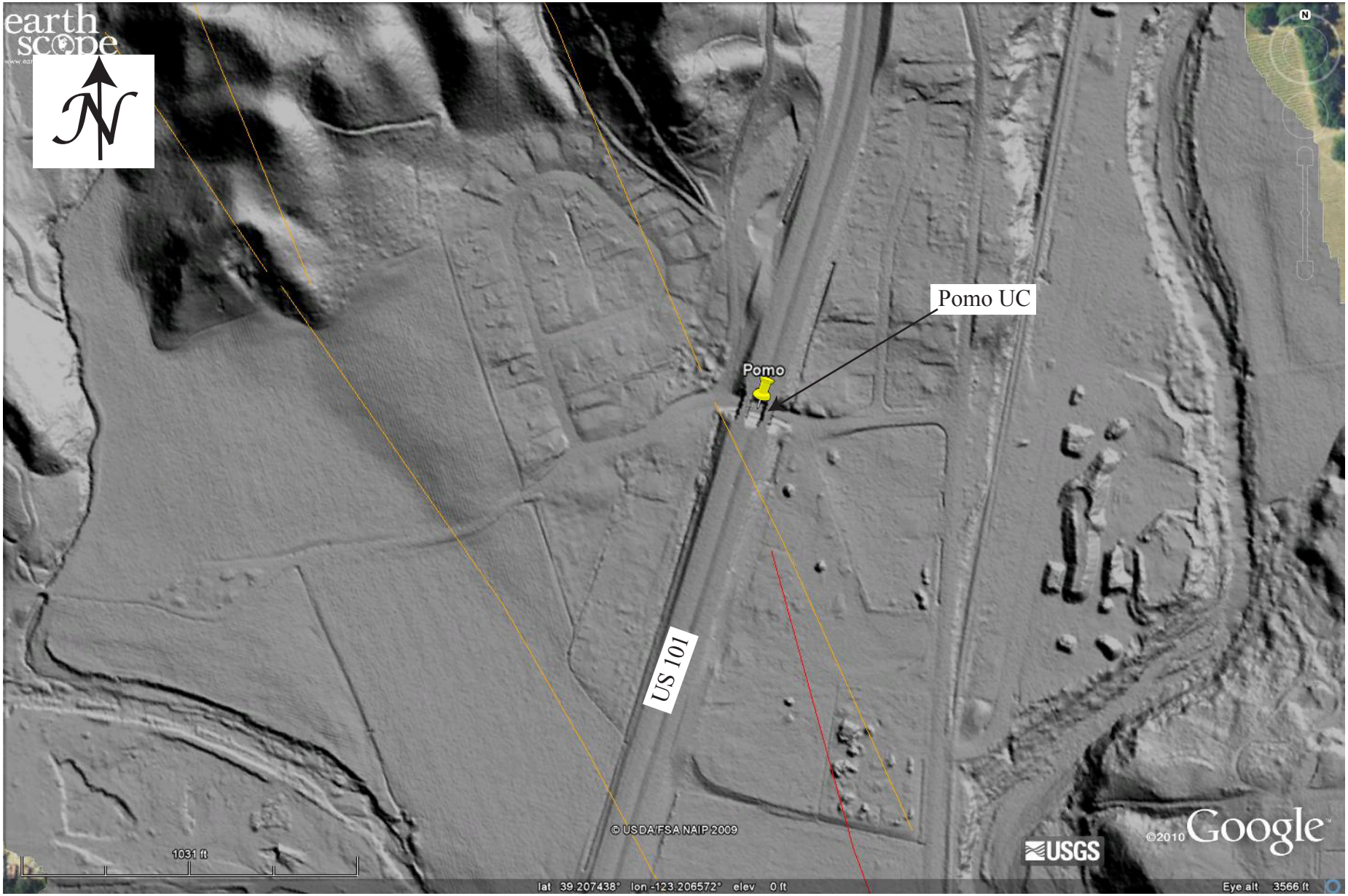
04-MEN-101 PM 28.58

EFIS 0000001016-N August 2013

SCALE 1:24,000

Source: State of California, 1974, State of California Special Studies Zones, Ukiah Quadrangle, Official Map

Figure 2	**Pomo UC EFZ Map**
04-MEN-101	PM 28.58
EFIS 0000001016-N	August 2013



0 1000

Approximate Scale, feet

Figure 3	**Pomo UC LiDAR Image**
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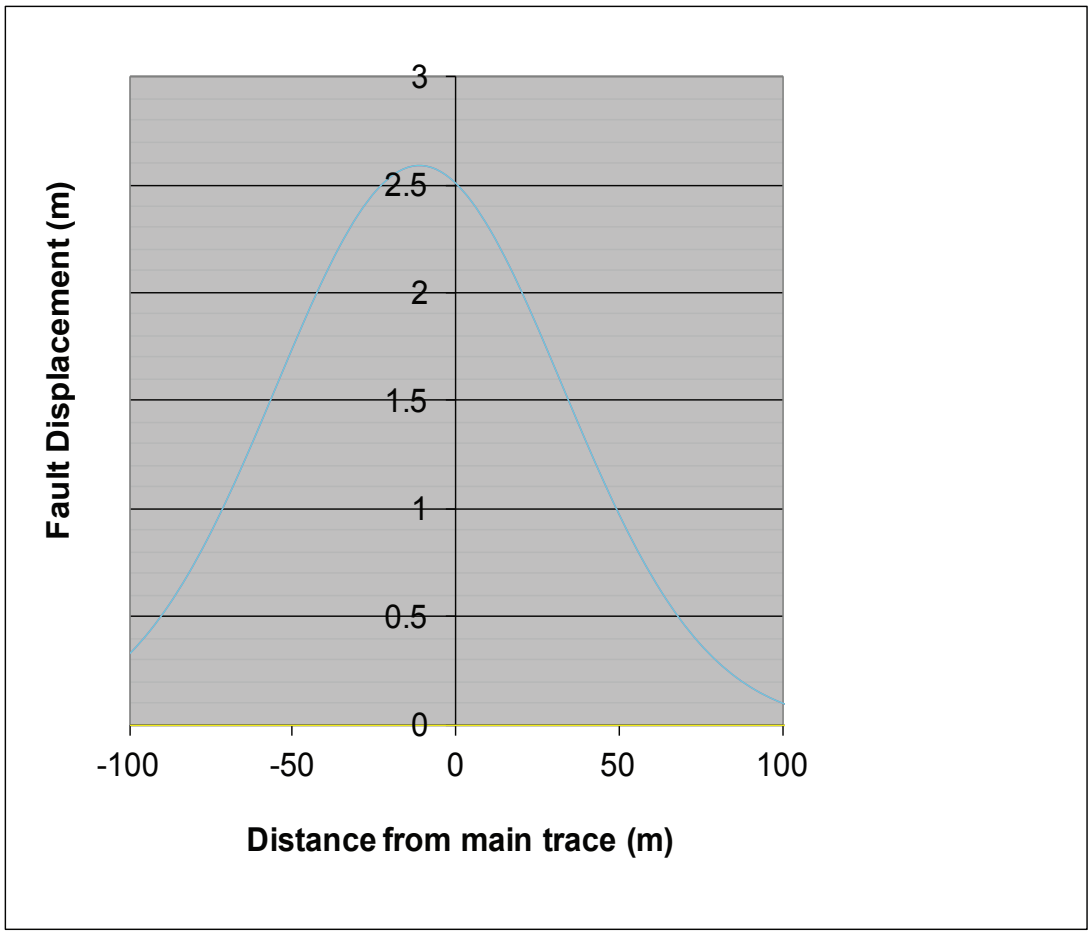

Graph showing probabilistic offset on the Maacama fault within the left bridge footprint. Offset at the bridge (distance = 0) could be up to 2.5 meters.

	Figure 4	**Probabilistic Offset - Left Bridge**
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