Appendix M

Preliminary Geotechnical Report, SR 32 Widening – Project Study Report

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Attention: Matt Brogan

Subject: **Preliminary Geotechnical Report** 1P2/304/30
SR 32 Widening – Project Study Report
Chico, California

This preliminary geotechnical report is provided for your use in project planning and preliminary engineering. We expect that design study including field exploration and soils testing will be performed after project planning and environmental documentation are completed.

Project Description

The project being considered consists of widening about 2-miles of SR 32 from 2-lanes to 4-lanes. The project begins near the end of existing 4-lane roadway a short distance east of SR 99 and ends about 1000-ft east of Yosemite Drive, about 4500-ft east of Bruce Road. The approximate extent of the project is shown on attached "Vicinity Map."

Widening is expected to be on the north side of existing roadway from beginning of project to Bruce Road and on both sides east of Bruce Road. Widened roadway grade is expected to match existing, mostly in fills 1-5±ft above original ground surface with some local cuts less than 5±ft high.

Existing SR 32 bridge on Dead Horse Slough Diversion Channel (Bridge No. 12-0135) and a concrete box culvert on South Fork Dead Horse Slough located just east of Bruce Road are expected to require modification and widening as part of this project. No other roadway structures have been identified at this time; such structures might include sound barriers, retaining walls and/or sign or signal supports.

Study

Geotechnical study has included office review of published topographic and geologic mapping, review of Caltrans "as-built" plans and "Log of Test Boring" drawing for existing SR 32 bridge (12-135) at Dead Horse Slough Diversion Channel and a brief site reconnaissance. Additionally, we have reviewed the Caltrans "Log of Test Borings" drawings for Highway 99 overcrossing bridges at SR 32 and Taber file "Log of Test Borings" drawings for several bridge foundation investigations in the immediate vicinity. The locations of existing SR 32 structures and of referenced foundation studies relative to project limits are shown on attached "LOTB Reference Map."

Geologic Setting

The project is located on the eastern side of the Great Valley geomorphic province of California. The west end is located about 7-miles from the Sacramento River and the east end in the margin of the Sierra Nevada foothills.

The USGS "Chico" 7½' topographic map (see attached "Vicinity Map") shows the natural ground in the area as gently to moderately rolling and as draining to the southwest along Big Chico Creek, Dead Horse Slough and Little Chico Creek. Dead Horse Slough Diversion Channel connects Dead Horse Slough to Little Chico Creek and crosses SR 32 from north to south just east of Forest Avenue.

Natural ground along the project alignment is shown at about elev. 225± at the west end of the project, rising gently to elev. 250± near Bruce Road (5500±ft east) and then rising somewhat more steeply to about elev. 375± at the end of the project about 4500±ft east of Bruce Road. In undeveloped areas, the ground supports a moderate grass and star thistle cover; developed areas are commonly landscaped with heavier vegetation and extensive tree cover.

Geologic mapping shows three surface units in the project area, Pleistocene age alluvium of the Modesto and Red Bluff formations mostly west of Bruce Road and Tuscan formation rock of Pliocene age east of Bruce Road (see attached "Geologic Map"). Although they are distinct stratigraphic formations, the Red Bluff formation in this vicinity is reportedly of limited thickness (less than 6±ft) and it is reasonable for the purpose of this report to consider the Modesto and Red Bluff formations as a single engineering unit with a generalized description as gravel, sand, silt and clay derived from the Tuscan formation.

The Red Bluff formation is in unconformable contact (i.e. a surface of erosion and subsequent deposition) with the (older) Tuscan formation. The Tuscan formation is described as predominately lahar ("volcanic mudflow") deposits composed of angular to sub-rounded volcanic fragments, as much as 10-ft in diameter, in a matrix of gray-tan volcanic mudstone. Maximum thickness of this formation is reported as about 500-ft.

No faults or other geologic hazards such as landslides, springs or significant depth/areas of Recent alluvium are indicated on published mapping. State (DWR) groundwater (well) database suggests that general "water table" is present at 100+ft below existing ground surface for most of the project alignment.

Reference Test Boring Data

We have reviewed reference "Log of Test Borings" drawings made for bridge structures at ten different sites from Highway 99 to just east of Bruce Road. The approximate location of these sites are shown on attached "LOTB Reference Map" and individual sites are identified in attached "Selected References."

These borings indicate the presence of three earth material units considered significant to proposed project: surface materials that include topsoil, recent alluvium, channel bedload and artificial fill; older alluvium comprised of Modesto and Red Bluff Formations; and rock of the Tuscan Formation. Older alluvium of the Modesto and Red

Bluff Formations underlies the surface soils for most of the site between Highway 99 and Bruce Road, with Tuscan Formation present at shallow depth at and east of Bruce Road.

The test boring logs indicate a fairly persistent 5-15±ft depth of mostly loose silt/sand alluvium and topsoil. Such materials are as deep as 25±ft at some locations and essentially absent at others – likely thinner east of Bruce Road. These soils are considered relatively weak and potentially compressible, suitable for support of only light fill and structure loads. Where exposed to surface flow, they are expected to be erodible and susceptible to scour in channels.

The older alluvial materials typically consist of dense silty sandy gravel and cobbles interlayered with stiff to hard silt and clay with sand. The dense gravel/cobble layers vary widely in thickness, from as little as 5±ft at the Dead Horse Slough Diversion Channel bridges to more than 20±ft at the Dead Horse Slough bridge at El Monte Avenue. These materials are considered capable of developing support for heavy, concentrated foundation loads. Although somewhat resistant to erosion, they should be considered potentially susceptible to erosion and scour where exposed to concentrated flow.

The volcanic mudflow ("lahar") rock of the Tuscan Formation was encountered at depths of 5±ft to 20±ft in borings made for existing culvert and bridge just north and northeast of SR32 intersection with Bruce Road. These materials are considered hard, mostly scour and erosion resistant and capable of supporting very heavy, concentrated foundation loads. Such materials should be presumed present at shallow depth from Bruce Road to end of project east of Yosemite Drive.

Although regional groundwater is believed to be present at/below 100±ft depth, test borings made for various bridge structures between 1956 and 1996 have persistently found free groundwater at depths of 10-15±ft. Such encounters appear to represent a separate, shallow groundwater phase "perched" on top of relatively impermeable silt/clay layers or rock. The level of the shallow groundwater phase is expected to vary seasonally and, particularly at locations near channels, to follow channel water surface.

Site Observations

There are relatively few exposures of underlying earth materials along the alignment. At the SR 32 bridge over Dead Horse Slough Diversion, there is light rock slope protection facing on the banks. The channel bottom is mostly sand and gravel with local exposure of silt/clay in a 1±ft deep scour hole at one of the pile bents.

Earthwork for a development project southeast of the intersection of SR 32 and El Monte has exposed material consisting of gravel and cobbles in a silty matrix. Similar materials, but intact and with broken cobble faces are exposed in a minor road cut made for SR 32 as it approaches Bruce Road from the west.

At the concrete box culvert located about 100±ft east of Bruce Road, channel bottom materials consist of gravel and cobbles. There is evidence of some minor

erosion of the fill bank above the southwest wingwall of the culvert; this erosion appears more consist with the effects of temporary backwater on this (upstream) end of the culvert rather than concentrated surface runoff.

East of Bruce Road, there are scattered boulders on the natural ground and a spoil pile of boulders in the developed area along the north side of the road.

As-Built Plans

The existing SR 32 Bridge over Dead Horse Slough Diversion Channel (Bridge No. 12-0135) is shown on Division of Highways (Caltrans) plans dated February 1957 with "as-built" notations dated November 1957 (attached as Appendix A). The existing bridge is a four-span flat-slab structure supported on diaphragm abutments and multi-column bents; substructure is skewed about 45˚ to match channel alignment.

The bridge is supported on driven pile foundations – step-tapered shells with 8-inch tip and 15.75-inch butt diameter – with 32 ton design loads. Concrete cast in the steel shells includes longitudinal reinforcement down to 12±ft below ground line. These piles penetrated to highly variable lengths of between 12±ft and 45±ft below adjacent ground surface. The shorter piles apparently encountered effective "refusal" in dense gravel/cobble layers.

No indications of structure distress were noted and the bridge appears to be in good condition. Although a minor scour hole was noted in field review, the steel shells were not seen to be exposed; cut-off of steel shell for pile bent column extensions is shown on the plans as 1-ft below ground surface.

The reinforced concrete box culvert located just east of Bruce Road is not on the Caltrans bridge log and as-built plans have not been provided. It appears reasonable to expect that structure details for reinforced concrete box culvert and wingwalls are similar to those in Caltrans "Standard Plans." Based on topography and reference documents for the Bruce Road culvert located downstream, this channel has been re-aligned to avoid the Bruce Road intersection.

Site Seismic Conditions

The site is located approximately 20 km (12±miles) west of the Big Bend fault; the style of this fault is listed as undetermined (per Caltrans "California Seismic Hazard Map 1996" and accompanying technical report). A "peak bedrock acceleration" of 0.16 g can be assigned, associated with a controlling event of 6.25 magnitude on this fault. Based on available boring data, the site can be assigned a soils profile Type-D (per Table B.1, Caltrans "Seismic Design Criteria" (SDC) version 1.3).

Current Caltrans structure design practice requires consideration of increases in SDC response curves due to fault type and fault proximity. The 0.2 g response curve is expected to adequately envelope increase in peak bedrock acceleration that would conservatively be associated with unknown fault style; "near-field" conditions do not apply to this project.

Based on the above information, structure design is recommended to be based on the following SDC parameters:

- Soil Type D;
- Magnitude 6.5±0.25;
- peak bedrock acceleration of 0.2 g; and
- ARS curve from SDC Figure B.7.

Liquefaction is a secondary effect associated with seismic loading. The risk of liquefaction at this site is expected to be generally low due to the relatively dense consistency of underlying soils, limited depth of recent alluvium and (typical) absence of ground water within the depth of recent alluvium. However potentially susceptible soils may be present locally, particularly in and along stream channels.

Should there be important structural and/or economic considerations associated with more closely defining the above values or other site-seismicity characteristics, further study would be required.

Conclusions-Discussion

The proposed project alignment appears to be grossly stable and no over-riding geologic or soils related defects are identified from available data. Adequate foundation support for low embankments is expected to be available in near-surface soils and adequate bridge and culvert foundation support available in underlying older alluvium and/or rock. Geotechnical conditions that will require consideration in project planning, design and construction are expected to include the presence of weak near-surface soils at some locations, the presence of relatively shallow groundwater and the presence of resistant rock.

Since it does not appear that any major cuts are planned, roadway excavation is expected to be accomplished with typical earth moving equipment. Where Tuscan Formation rock is present – most likely at/east of Bruce Road – excavation is expected to be difficult and excavations that penetrate more than a few feet into rock to require heavy ripping. The need for blasting cannot be precluded, particularly for small or confined excavations (e.g. trenches).

Based on existing site topography, it appears that much of existing roadway embankment was constructed using borrow from within the remaining width of state right-of-way (i.e. from local borrow adjacent to existing road). On this basis, it appears likely that much of new roadway embankment will require that fill be imported from off-site. The proposed borrow has not been identified and the quality of imported fill is expected to substantially control design of new pavement structural sections. Although groundwater is present at relatively shallow depth along significant parts of the alignment, subdrainage (in addition to raised embankment and good surface drainage) is not expected to be a general requirement.

The foundations of the existing Dead Horse Slough Diversion bridge appear to be adequately stable and secure. New foundations are expected to consist of typical Caltrans Class 45 and Class 70 driven piles. The presence of a relatively thin, but

variable dense gravel/cobble layer at 10±ft below the channel suggests that pre-drilling will be required to assure adequate pile penetration for lateral stability in accordance with current bridge design practice. The use of H-piling is a reasonable alternative to standard displacement piling, particularly at abutments. Other foundation types, such as large diameter cast-in-drilled-hole piling or spread footings appear technically feasible and can be considered if desired.

We expect that construction of the box culvert extension will require excavation below the base of culvert slab to remove soft/loose channel materials and also to remove any hard rock projections with 1±ft of bottom of slab. Structure backfill to plan grade should then provide adequately firm and uniform culvert slab support. Cutoffs and wingwalls per Caltrans “Standard Plans” appear likely to be suitable.

Foundation support for minor roadway structures appears to be generally available by means of spread footing foundations. Where loose soils are present, it may be necessary to provide a prism of structure backfill below footings to achieve adequate support. The use of cast-in-drilled-hole piling is expected to be problematic at many locations due to the presence of cobbles, groundwater and/or rock. Nonetheless, drilled pile foundations may be a suitable choice for, say, sound walls or sign structures at some locations.

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Attachments: “Selected References”
“Vicinity Map”
“LOTB Reference Map”
“Geologic Map”

Appendix “As-Built” Plans Bridge No. 12-135

Distribution: Client (6)

Selected References

1. Harwood, D. S., Helley, E. J. and Doukas, M. P., 1981, "Geologic Map of the Chico Monocline and Northeastern Part of the Sacramento Valley, California", U.S. Geological Survey, Miscellaneous Investigations Series Map I-1238, Scale 1:62,500.
2. Mualchin, Lalliana, 1996a, "A Technical Report To Accompany The Caltrans California Seismic Hazard Map 1996 (Based On Maximum Credible Earthquakes)," California Department of Transportation.
3. Mualchin, Lalliana, 1996b, "California Seismic Hazard Map - Detail 18," California Department of Transportation, Map Scale 1" = 3.75 Kilometers.
4. Saucedo, G.J. and Wagner, D. L., 1992, "Geologic Map Of The Chico Quadrangle," California Division of Mines and Geology, Map 7A, scale 1:250,000.
5. State of California Department of Water Resources Water Data Library: http://wdl.water.ca.gov; accessed 10-29-05
6. U.S. Geological Survey, "Chico Quadrangle 7.5-Minute Series (topographic)", dated 1948, photo-revised 1978, scale 1:24,000.
7. U.S. Geological Survey, "Richardson Springs Quadrangle 7.5-Minute Series (topographic)", dated 1951, photo-revised 1968, scale 1:24,000.

8. Caltrans Log of Test Borings Sheets

Bridge Name	Bridge Number	Year of Exploration
Route 99/32 Separation (South)	12-0149L/R	1960
Route 99/32 Separation (North)	12-0150L/R	1960
SR 32 at Dead Horse Slough Diversion	12-0135	1956
Humboldt Road at Dead Horse Slough Diversion	12C-0114	1956

9. Taber Consultants Log of Test Boring Sheets

Project Name	File Number	Year of Exploration
Humboldt Rd. Bike Path/Little Chico Creek	1P2/388/153	1991
Humboldt Rd./Dead Horse Slough Diversion -- Widen	1P2/391/18-1	1991
El Monte Ave. at Dead Horse Slough	376/33-1	1976
Little Chico Creek Pedestrian Bridge	1P1/396/19	1996
Notre Dame Blvd. Extension at Little Chico Cr.	1P2/391/18-2	1991
Bruce Road at Little Chico Creek	1P2/395/67	1996
Bruce Road at Dead Horse Slough	370/120F-4 & 1P2/303/15	1971
Yosemite Drive at Dead Horse Slough (spillway)	370/120F-8	1972