State of California
DEPARTMENT OF TRANSPORTATION

California State Transportation Agency

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To: MR. DAVID SOON, CHIEF
Bridge Design Branch 10
Office of Bridge Design North

Date: December 21, 2018

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Retaining Wall No. 1

Attn: Ms. Tracy Sanderson

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design South

Subject: **PRELIMINARY FOUNDATION REPORT (PFR) FOR RETAINING WALL NO. 1**

Scope of Work

Per the request from Office of Bridge Design North (OBDN), Branch 10 dated November 26, 2018, this Preliminary Foundation Report (PFR) has been prepared for the proposed retaining wall No. 1. The purpose of this report is to summarize the investigations performed and to provide preliminary foundation recommendations for the subject wall. The recommendations presented in this report are based on the general plan and layout plan, provided by OBDN on November 26, a recent 2018 subsurface investigation consisting of a boring and a CPT (Cone Penetrometer Testing) at the EB (end of bridge) of San Jose Creek Bridge, and 1963 As-built LOTB for San Jose Creek Bridge (see As-built Data section of this report).

Project Description

The existing 4-lane bridge spans the San Jose Creek, carrying State Route 217 traffic to and from University of California Santa Barbara in the City of Goleta, Santa Barbara County. Reactive aggregates in all structure concrete elements has caused the deterioration of the bridge which resulted in peer review recommendation of bridge replacement. To accommodate this bridge replacement and a nearby bike path, a retaining wall with a length of 252.94' is necessary at the end of at the EB (end of bridge) of the proposed bridge. Since the peak ground acceleration (PGA) is greater than the design PGA of 0.6 for standard plan walls, Type 1 (Case 1) special design retaining wall has been proposed. To Accommodate the special design, 2' has been added to the Design H by OBDN.

All elevations referenced within this report are based on the North American Vertical Datum of 1988 (NAVD 88), unless otherwise noted. To convert an elevation at this site from National Geodetic Vertical Datum of 1929 (NGVD 29) to NAVD 88, add 2.05 feet to the NGVD 29 elevations.

Information for the proposed retaining wall is summarized in Table 1 below.

Table 1. Retaining Wall Data

Structure Type	Stations	Approximate Length	Wall Height	BOF Elevation Range
Type 1 (Case 1) (mod)	Sta. 1+00.00 to Sta. 3+52.94	252.94'	6' - 10'	12.1'- 14.5'

Field Investigation and Field Testing Program

No retaining wall specific subsurface investigation was conducted for RW No. 1. Because of the proximity to the EB (end of bridge) of San Jose Creek Bridge, Boring RC-18-001 and CPT-18-002 developed for the proposed San Jose Creek Bridge were utilized for the geotechnical design of this wall.

Summary of Boring RC-18-001 and CPT-18-002 data is presented in Table 2. Drilling was performed by Caltrans Drilling Services and CPT was performed by Gregg Drilling Services. The boring was drilled using rotary core (self-cased wireline) method. Soils were logged and classified in accordance with the 2010 Caltrans Soil and Rock Logging, Classification and Presentation Manual. Soil samples were obtained at 5-foot intervals from Standard Penetration Test (SPT) split spoon sampler with 1.4-inch inner diameter. Blow counts (SPT N-values) were performed with a 140 lbs. safety hammer dropped 30 inches, with a 78% hammer efficiency.

Table 2. Subsurface Investigation Summary

Boring No.	Completion Date	Drill Rig Type	Hammer Type	Hammer Efficiency (%)	Approx. Ground Surface Elevation (ft)	Boring Depth (ft)	Bottom of Boring Elevation (ft)
RC-18-001	8/16/2018	Acker Drill Rig	Automatic	78	14	150	-136.4
CPT-18-002	8/1/2018	N/A	N/A	N/A	15	120	-105.0

Laboratory Testing Program

Selected representative soil samples were tested in FUGRO laboratories to obtain or derive relevant physical and engineering soil properties. All laboratory tests were performed in general accordance with California Test Methods (CTM) or American Society for Testing and Materials (ASTM) Standards. Field and laboratory testing intervals will be shown on the LOTB sheets. The summarized laboratory tests data are presented in Table 3.

Table 3. Summary of Laboratory Tests

Testing Type	ASTM/CTM Designation
Particle Size Analysis	ASTM D422
Atterberg Limit	CTM 204
Unconfined Compression Test	ASTM D2166
Triaxial Test - Consolidated Undrained	ASTM D4767
Consolidation Test	ASTM D2435
Corrosion	CTM 417, 422, 643

Site Geology and Subsurface Conditions

The project site is located within Geologic Province of Western Transverse Ranges, along the coastal low lands of Santa Barbara Plain at southern foothills of Santa Ynez Mountains. The subsurface materials consist of unconsolidated flood plain deposits of silt, clay, sand and gravel, underlain by thin bedded hard, brittle upper siliceous shale unit of Monterey Formation. USGS maps indicate that outcrops of the Monterey Formation on the north and south side of the site have southerly dipping beds, generally at 40^{o} to 45^{o}. The As-built borings indicate about 5-10 feet of loose sand; 20-30 feet of medium dense and very dense sand underlain by interbeds of medium dense sand and very stiff to hard silt and clayey silt to the maximum boring depth of 65 feet (elevation -58 ft.).

Per Boring RC-18-001 and CPT-18-002, the subsurface consists of alluvium to elevation -71' (NAVD 88). The material encountered is as follows. From elevation +10' to approximate elevation +4', very stiff clay; from elevation +4' to approximate elevation -1', loose silty sand; from elevation -1' to approximate elevation -6', medium dense silty sand; from elevation -6' to approximate elevation -25', very dense silty sand; from elevation -25' to approximate elevation -35', stiff to very stiff silt with sand; from elevation -35' to approximate elevation -41', very dense silty sand; from elevation -41' to approximate elevation -51', stiff lean clay with sand; from elevation -51' to approximate elevation -61', interbedded layers of loose silty gravel, very stiff lean clay and loose to medium dense sand; from elevation -61' to approximate elevation -71', very stiff to hard lean clay; from elevation -71' to approximate elevation -111', stiff to very stiff elastic silt/decomposed mudstone; from elevation -111' to approximate elevation -136', very slightly to moderately fractured mudstone.

Groundwater was encountered in all borings during the 1959 subsurface investigation. The highest measured groundwater level is +3.2 feet (per NGVD 1929 Datum), or +5.2 (per NAVD 1988 Datum) Groundwater was encountered at elevation +0.65 feet and +2.5 feet in RC-18-001 and in CPT-18-002 which is close to the surface elevation of the water flowing in the creek. It should be noted that

groundwater levels can fluctuate with the change of season and other factors including sea level rise. The design ground water table was considered as +5.2 feet.

Scour Evaluation

There is no risk of scour for the proposed retaining wall.

Corrosion Evaluation

Nine soil samples taken from Boring No. RC-18-001 were tested by Caltrans laboratory for corrosion testing. A summary of corrosion test results is presented in Table 5.

Table 5. Corrosion Test Results

Boring No.	Sample Depth (ft)	pH	Minimum Resistivity (Ohm-Cm)	Sulfate Content (PPM)	Chloride Content (PPM)
RC-18-001	6.5 - 10	8.14	989	445	82
	11.5 - 15	7.78	455	852	550
	36.5 - 40	7.63	130	1600	4100
	46.5 – 50	8.22	130	790	4600
	51.5 - 55	8.03	122	1000	3400
	61.5 - 65	7.31	154	780	4700
	71.5 - 75	7.16	195	900	3950
	91.5 - 95	5.22	629	3500	87
	116.5 - 120	6.78	465	4600	96

Note: The Caltrans Corrosion Guidelines states that if the minimum resistivity is greater than 1100 Ohm-Cm the sample is considered to be non-corrosive and testing to determine sulfate and chloride is not performed. Caltrans currently considers a site 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 1500 ppm, or the pH is 5.5 or less.

Based on the results of corrosion tests, the site is considered corrosive to foundation elements.

Preliminary Site Seismicity and Analysis

The proposed retaining wall site is not within an Alquist-Priolo Earthquake Fault Zone as established by the California Geological Survey. The project site may be subject to strong ground motions from nearby earthquake sources during the design life of the proposed retaining wall. Table 4 below presents the nearby faults identified by Caltrans ARS Online (v. 2.3.09).

Table 4. Active Faults and Design Ground Motion Parameters

Fault Name	Fault ID	Type	Dip (deg)	Dip Direction	M_{max}	R_{RUP} (miles)	R_{JB} (miles)	R_X (miles)	PGA
Red Mountain	292	R	56	N	7.4	2.48	0	2.99	0.60
More Ranch Fault	278	R	80	S	6.8	0.11	0	0.11	0.52
Pitas Point (Lower West)	302	R	13	N	6.8	3.21	0	10.21	0.57

Notes: R_X = Horizontal distance to the fault trace
R_{JB} = Shortest horizontal distance to the surface projection of the rupture area
R_{RUP} = Closest distance to the fault rupture plane
R = Reverse

Based on the recent (2018) field investigation and the Standard Penetration Test correlations, the average shear wave velocity for the upper 100 feet (VS30) of soil is estimated to be 755 ft/sec (230 m/sec).

The Design Spectrum was determined using the Caltrans ARS Online (v. 2.3.09) web tool. The Design Spectrum is the upper envelope of deterministic and probabilistic response spectrums. For this site, the Design Spectrum is controlled by the probabilistic approach. The probabilistic ARS curve corresponds to a ground motion return period of 975 year (5% probability to be exceeded in 50 years).

Using the USGS Interactive Deaggregation Tool, the controlling probabilistic fault scenario for this site was determined to have a design magnitude of M = 7.3 and site-to-fault distance of approximately 5.67 km (3.52 miles).

The peak ground acceleration (PGA) is 0.69g and 0.73g when using Caltrans ARS Online (v. 2.3.09) web tool and USGS Interactive Deaggregation tool respectively. The design PGA is considered as 0.73g.

Due to the presence of shallow groundwater and loose to medium dense sandy soil, liquefaction potential exists.

As-built Data

There is no existing retaining wall at the proposed retaining wall location. And therefore, As-built plan is not applicable. 1963 As-built LOTB for San Jose Creek Bridge was referenced in determining the subsurface soil condition.

Preliminary Recommendations

Since the project site has liquefiable soil layers and there is a potential for lateral spreading, following deep foundations were considered for the proposed retaining wall.

- Driven Precast Concrete Piles: Using precast concrete piles is recommended.

- Driven Steel Piles: steel piles are feasible, but if selected, would need to be mitigated to account for the corrosive environment by adding a sacrificial steel thickness to the steel piles (please refer to the latest Caltrans Corrosion Guidelines and consult Caltrans Corrosion and Structural Concrete Field Investigation Branch (CSCFI) in Office of Structural Materials. Also, if steel piles are selected, they would require a closed ended tip to create a displacement pile.

- Driven H-Piles: H-piles piles are feasible, but not recommended due to the possibility of piles cutting through the soils and running longer that the other alternatives.

- CIDH Piles: 24" diameter CIDH piles are feasible, but not recommended. Due to high ground water. If used, wet method needs to be considered. As caving is anticipated within drilled holes (due to presence of granular material up to approximate elevation -56'), the contractor should devise a method such as using temporary casing.

Spread Footing: The proposed retaining wall no. 1 cannot be supported on spread footings due to the presence of liquefiable soil layers at the project site and the potential for lateral spreading.

Additional Field Work and Laboratory Testing

Field work and laboratory testing performed for the nearby San Jose Creek Bridge Replacement project was used to prepare this PFR. Additional field work including one or two borings and laboratory testing are necessary to prepare the Foundation Report which is due by February 1, 2020 per the request from Office of Bridge Design North (OBDN), Branch 10 dated November 26, 2018, for PFR and FR.

If you have any questions or comments, please call Deepa Wathugala at (213) 620-2134 or Chris Harris at (213) 620-2147.

Prepared by: Date: 12/21/18

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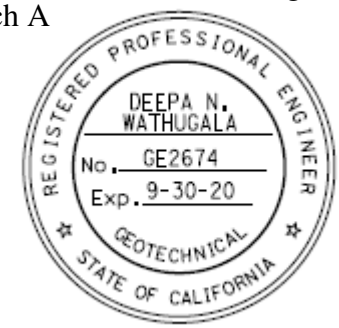

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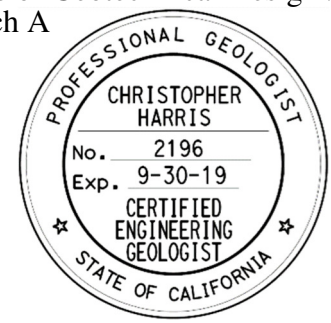

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