State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

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To: MR. JEFF WOODY
Branch Chief, Special Designs
Office of Structure Design

Date: September 10, 2007

Attention: Joel Magana

File: 04-SCL-101 & 580 PM Var.
04-SM-101 & 880 PM Var.
04-4A5321
Install VDS

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Subject: Foundation Report for VDS Poles

I. PROJECT DESCRIPTION

This project proposes to install approximately 173 wireless Vehicle Detector Sensors (VDS), stations at various locations. The proposed VDS are located along Route 101 in Santa Clara and San Mateo Counties and Route 880 in Santa Clara County. The VDS stations consist of sensors, antennas, access point, photo-voltaic cells installed on a poles with CIDH foundations. The poles are 35 to 40 feet high and the foundations consist of 2 feet in diameter CIDH piles. The post mile (PM) designation of the VDS sites are listed in the attached Foundation Recommendation Table.

II. SCOPE OF WORK

Work performed in the following scope of work for this investigation: 1) Site reconnaissance of each proposed VDS site location to determine the site conditions, 2) review of published geotechnical/geologic literature and published maps to determine the site geologic conditions, 3) Review of As-built Log of Test Borings (LOTB) sheet of nearby bridges/structures (obtained from BIRIS) to determine the likely soil conditions at the site.

Please note that no subsurface investigation was conducted for this project because of the large number of VDS sites and tight project schedule.

III. SUBSURFACE CONDITIONS

The site subsurface conditions were characterized based on the As-built LOTBs, published geology maps, our observations during site reconnaissance, and our engineering judgment. For simplicity, we categorized the subsurface soils in this project into four types. The soil types along with engineering parameters assumed are listed below:

- Loose granular soil; internal friction angle (ϕ) of 28 degrees, unit weight (γ) of 120 pcf and cohesion (c) of zero psf
- Dense granular soil; internal friction angle (ϕ) of 34 degrees, unit weight (γ) of 120 pcf and cohesion (c) of zero psf
- Soft cohesive soil; cohesion (c) of 500 psf, unit weight (γ) of 120 pcf, and internal friction angle (ϕ) of zero degrees
- Stiff cohesive soil; cohesion (c) of 1500 psf, unit weight (γ) of 120 pcf, and internal friction angle (ϕ) of zero degrees

It is our opinion that these categories adequately cover the anticipated soils condition likely to be encountered in this project. The attached Foundation Recommendation Table list the soil conditions at each VDS site based on the categories listed above.

IV SITE CONDITION

The foundation design of a VDS pole can be affected by the site topography especially sloping ground condition. Therefore, we characterized the ground conditions during our reconnaissance as follows:

- Sloping ground with a slope inclination steeper than 2H: 1V.
- Sloping ground with slope inclination between 4H: 1V and 2H: 1V
- Level ground. Ground is considered level, if the slope inclination is flatter than 4H: 1V.

V. FOUNDATION ANALYSIS AND RECOMMENDATIONS

Based on foundation loading provided by the Office of Structures Design (OSD), we analyzed a 2 feet diameter CIDH pile foundation for different subsurface soil and ground surface conditions, mentioned in Sections III and IV, using computer program LPILE (Version 5.0) with the maximum proposed deflection of 0.75" (free-head condition). The results of these analyses are presented in the attached "Technical Memorandum." This "Technical Memorandum" was sent to OSD on August 28, 2007.

Based on the results of the analyses and our assessment of the subsurface soil conditions, we estimated the minimum CIDH pile foundation depth for each VDS location. The minimum CIDH pile foundation depths are listed in the attached Foundation Recommendation Table.

VI. CONSTRUCTION CONSIDERATIONS

Difficult drilling conditions due to the presence of groundwater, caving soil, and hard rock may be encountered. The attached Foundation Recommendation Table lists locations where such problems may arise.

The following construction considerations should be included in the design and construction specifications for the proposed CIDH pile foundation in this project.

- During drilling operation for the proposed CIDH piles in granular material and due to the presence of groundwater, some caving of the drilled holes is possible. Thus, use of casing may be required.

- Groundwater may be encountered in some locations. Installation of CIDH may require drilling and placing concrete in wet conditions if de-watering is not desirable. For displacement of groundwater, the contractor may choose to use a closed system using a concrete pump or a tremie tube to place concrete at the bottom of the hole for CIDH piles. A positive head should be maintained at all times to reduce potential for concrete segregation.

- Installation of the CIDH piles should be performed in accordance with Section 49-4 of the May 2006 Standard Specifications.

* * * * *

Should you have any questions, please call Eduardo Ortega at (510) 286-4821 or Samuel Awad at (510) 622-5443.

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Attachments:

1. Foundation Recommendation Table
2. Technical Memorandum

c: TPokrywka, WNyaz, HNikoui, E☺rtega, SAwad, TLy, Daily File, Route File,Translab File

Eduardo ☺rtega/Samuel Awad/mm/4A5311.doc

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ATTACHMENTS

Technical Memorandum (2 pages)

Foundation Recommendation Table (6 pages)

TECHNICAL MEMORANDUM

(EA 0A5311, EA 0A5321, EA 0A5331, EA 0A5341, EA 0A5351)

Based on the loading condition of Table 1 and Electrical Systems (Vehicle Detection System Pole) detail plan sheet (dated July 17, 2007) provided to us, we analyzed a 2 ft. diameter CIDH pile foundation for different subsurface soil and ground surface conditions using computer program LPILE (version 5.0) with the maximum proposed deflection of 0.75".

Table 1: Revised Loading Condition

Axial load (lb)	Shear (lb)	Moment (lb-ft)
1,048	1,447	28,045

Load Case 2 (DL +100/20 WL)

We also performed a manual check using Broms method. The results of the LPILE analysis are reported because of the accuracy of the method and the ability to simulate sloping ground condition.

The results of the analyses are summarized in Tables 2 and 3 below. In our analyses, we neglected the passive resistance form the top 1-diameter (2 feet) of the CIDH Pile.

Table 2: CIDH Pile Analysis for Pole Foundation of Vehicle Detection System - Cohesionless Soils

Internal Friction Angle, (degree)	Unit Weight, (pcf)	Ground Surface Condition	Pile Length, (ft)	Deflection, (in)	Maximum Moment, (lb-in)	Maximum Shear, (lb)
28	120	Level	10	0.74	388,208	-7,886
28	120	Slope 2H to 1V	12	0.60	398,830	-7,306
34	120	Level	9	0.28	387,527	-10,783
34	120	Slope 2H to 1V	10	0.41	394,262	-10,070

Table 3: CIDH Pile Analysis for Pole Foundation of Vehicle Detection System - Cohesive Soil

Undrained Shear Strength, (psf)	Unit Weight, (pcf)	Ground Surface Condition	Pile Length, (ft)	Deflection, (in)	Maximum Moment, (lb-in)	Maximum Shear, (lb)
500	120	Level	12	0.76	381,578	-6,446
500	120	Slope 2H to 1V	14	0.56	388,293	-5,864
1500	120	Level	8	0.25	374,261	-10,025
1500	120	Slope 2H to 1V	8	0.40	375,384	-10,545

Standard foundation details can be developed using the results of the analysis. The structural engineer must ensure that pile can resist the maximum bending moments and shear forces. We suggest that a separate Table is included in the detail plan sheet which lists various pile depths based on the soil and ground conditions.

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SCL	101	0.10	NB			x		x			9		18	
SCL	101	0.18	SB	x			x				12		31'	Caving
SCL	101	0.55	NB			x				x	8		31'	
SCL	101	0.60	SB	x			x				12		31'	Caving
SCL	101	1.10	SB		x			x			10		16'	
SCL	101	1.19	NB	x				x			10		20'	
SCL	101	1.60	NB			x				x	8		18	
SCL	101	1.60	SB			x		x			9		31'	
SCL	101	2.00	NB	x				x			10		18	
SCL	101	2.10	SB	x						x	8	x	31'	
SCL	101	2.50	NB			x				x	8	x	18	
SCL	101	2.54	SB			x		x			9		18'	
SCL	101	2.90	NB			x				x	8	x	31'	
SCL	101	2.90	SB		x			x			10		Near Onramp	
SCL	101	3.50	NB			x				x	8		31'	
SCL	101	3.50	SB			x		x			9		31'	
SCL	101	4.00	NB			x				x	8		31'	
SCL	101	4.00	SB			x		x			9		31'	
SCL	101	4.50	NB			x		x			9		31'	
SCL	101	4.52	SB			x		x			9		15.4'	
SCL	101	4.80	SB		x			x			10		31'	
SCL	101	4.82	NB			x				x	8		31'	
SCL	101	5.50	NB			x		x			9		31'	
SCL	101	5.50	SB	x			x				12		31'	Caving
SCL	101	6.02	NB			x				x	8		31'	
SCL	101	7.00	NB			x				x	8		31'	
SCL	101	7.20	SB		x			x			10		31'	
SCL	101	7.50	NB	x						x	8		31'	
SCL	101	7.64	SB		x			x			10		31'	
SCL	101	7.80	NB	x						x	8		31'	
SCL	101	8.20	NB	x						x	8		31'	
SCL	101	8.20	SB		x			x			10		31'	

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SCL	101	8.70	NB	x			x				12		31'	Caving
SCL	101	8.75	SB	x				x			10		31'	
SCL	101	9.12	SB	x				x			10	x	25'	
SCL	101	9.20	NB	x						x	8		31'	
SCL	101	9.62	NB			x				x	8		25.9'	
SCL	101	9.70	SB	x			x				12		31'	Caving
SCL	101	10.10	NB			x				x	8		31'	
SCL	101	10.10	SB	x			x				12		31'	Caving
SCL	101	10.40	NB			x				x	8		31'	
SCL	101	10.60	SB	x			x				12		31'	Caving
SCL	101	10.80	NB	x						x	8	x	20.7'	
SCL	101	11.00	SB	x			x				12		31'	Caving
SCL	101	11.50	SB	x				x			10		31'	
SCL	101	11.60	NB	x						x	8		23'	
SCL	101	11.90	SB	x				x			10		31'	
SCL	101	11.94	NB	x						x	8		31'	
SCL	101	12.30	NB			x				x	8		31'	
SCL	101	12.30	SB			x		x			9		31'	
SCL	101	12.60	SB			x		x			9		31'	
SCL	101	12.65	NB	x						x	8		31'	
SCL	101	13.10	NB			x				x	8	x	31'	
SCL	101	13.10	SB	x				x			10		31'	
SCL	101	13.55	SB	x						x	8		31'	
SCL	101	13.60	NB			x				x	8	x	31'	
SCL	101	13.95	SB	x						x	8		31'	
SCL	101	14.10	NB			x				x	8	x	31'	
SCL	101	14.50	NB			x				x	8	x	31'	
SCL	101	14.50	SB	x						x	8		31'	
SCL	101	14.93	SB			x		x			9		31'	
SCL	101	14.95	NB			x				x	8	x	31'	
SCL	101	15.20	NB			x				x	8	x	31'	
SCL	101	15.49	SB			x		x			9		31'	
SCL	101	15.70	NB			x				x	8	x	31'	

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SCL	101	15.90	SB			x		x			9		31'	
SCL	101	16.40	SB			x		x			9		31'	
SCL	101	17.20	NB			x				x	8	x	31'	
SCL	101	17.20	SB			x		x			9		31'	
SCL	101	18.30	NB		x			x			10		31'	
SCL	101	18.30	SB			x		x			9		31'	
SCL	101	18.75	NB		x			x			10		22.6	
SCL	101	18.80	SB	x			x				12		31'	Caving
SCL	101	19.23	NB	x				x			10		18.4'	
SCL	101	19.30	SB	x			x				12			Caving
SCL	101	19.80	NB			x		x			9		31'	
SCL	101	19.80	SB			x				x	8		31'	
SCL	101	20.30	NB		x			x			10		19'	
SCL	101	20.30	SB	x			x				12			Caving
SCL	101	20.70	SB		x			x			10		31'	
SCL	101	20.90	NB		x			x			10		13.5'	
SCL	101	21.80	SB	x				x			10		25'	
SCL	101	21.93	NB		x			x			10		25'	
SCL	101	22.75	SB	x				x			10		31'	
SCL	101	22.84	NB			x		x			9		23'	
SCL	101	23.90	NB		x			x			10		19'	
SCL	101	23.90	SB			x				x	8		31'	
SCL	101	24.92	NB		x			x			10		31'	
SCL	101	25.00	SB			x		x			9		20'	
SCL	101	25.40	NB		x			x			10		31'	
SCL	101	25.40	SB			x		x			9		31'	
SCL	101	25.90	NB			x				x	8	x	31'	
SCL	101	25.90	SB	x			x				12		31'	Caving
SCL	101	26.45	NB			x		x			9	x	23.3	
SCL	101	26.40	SB	x			x				12		31'	Caving
SCL	101	27.30	SB			x		x			9			
SCL	101	27.60	NB			x				x	8		31'	
SCL	101	27.60	SB	x				x			10		29.5'	

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SCL	101	28.12	NB			x				x	8		19.5	
SCL	101	28.24	NB			x				x	8		19'	
SCL	101	29.00	SB	x				x			10		31'	
SCL	101	29.30	NB			x				x	8		20'	
SCL	101	29.60	NB		x					x	8		31'	
SCL	101	30.66	NB		x			x			10		22'	
SCL	101	31.00	NB			x		x			9		31'	
SCL	101	31.40	NB	x				x			10		24'	
SCL	101	32.10	NB	x						x	8		16.4	
SCL	101	32.20	SB	x				x			10		31'	
SCL	101	32.60	SB	x						x	8		31'	
SCL	101	32.70	NB	x						x	8		19'	
SCL	101	33.33	SB			x		x			9		22.3	
SCL	101	33.46	NB	x						x	8		17.7'	
SCL	101	34.00	NB			x				x	8		31'	
SCL	101	34.00	SB	x			x				12		31'	Caving
SCL	101	34.60	SB			x		x			9		31'	
SCL	101	36.60	NB	x						x	8		15.7'	
SCL	101	36.60	SB		x			x			10		9.5'	
SCL	101	37.10	NB			x		x			9		13.1'	
SCL	101	37.10	SB			x				x	8		31'	
SCL	101	38.73	SB			x		x			9		15.8	
SCL	101	38.77	NB	x				x			10		31'	
SCL	101	41.10	NB			x		x			9		17.4	
SCL	101	43.30	SB			x		x			9		31'	
SCL	101	43.37	NB	x				x			10		16.7'	
SCL	101	44.37	SB			x		x			9		12.5'	
SCL	101	44.40	NB			x		x			9		17.4'	
SCL	101	44.87	NB			x		x			9		31'	
SCL	101	45.10	SB			x		x			9		13.8'	
SCL	101	45.30	NB			x		x			9		19'	
SCL	101	46.10	NB			x		x			9		31'	
SCL	101	47.30	NB	x				x			10		18	

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SCL	101	47.32	SB			x		x			9		16.7'	
SCL	101	49.50	SB			x		x			9		25'	
SCL	101	49.60	NB			x		x			9		16'	
SCL	101	50.40	NB			x				x	8		31'	
SCL	101	50.40	SB			x		x			9		31'	
SCL	101	50.70	SB			x		x			9	x	11.5'	
SCL	101	51.00	NB			x		x			9		12'	
SCL	101	51.40	SB			x		x			9		11'	
SCL	101	51.90	NB	x			x				12		9'	Caving
SCL	101	52.40	NB			x		x			9		31'	
SCL	101	52.40	SB			x		x			9		21'	
SCL	880	0.25	NB	x						x	8		31'	
SCL	880	1.00	NB			x				x	8		12'	
SCL	880	3.10	NB	x						x	8		15.5'	
SCL	880	3.10	SB			x		x			9		13'	
SCL	880	4.80	NB			x				x	8		31'	
SCL	880	4.80	SB			x		x			9		31'	
SCL	880	5.50	SB	x			x				12		15'	Caving
SCL	880	5.70	NB	x						x	8		31'	
SCL	880	6.00	NB	x				x			10		25'	
SCL	880	6.05	SB			x				x	8		15'	
SCL	880	6.50	NB	x			x				12		31'	Caving
SCL	880	7.00	NB			x	x				10		14'	Caving
SCL	880	7.00	SB	x				x			10		16'	
SCL	880	7.95	SB			x		x			9		24.5'	
SCL	880	8.00	NB	x			x				12		15'	Caving
SCL	880	9.20	NB	x			x				12		15'	Caving
SCL	880	9.30	SB	x				x			10	x	19'	
SCL	880	9.80	NB			x		x			9	x	16	
SCL	880	9.80	SB	x					x		14	x	15'	Caving
SM	101	9.60	SB			x		x			9		31'	
SM	101	10.40	NB	x				x			10		19'	
SM	101	10.40	SB	x				x			10		17'	

VDS Foundation Recommendation Table

LOCATION				Topography			Geotechnical Conditions				Min CIDH	Notes		Comments
				Slop Ground		Level Ground	Granular		Cohesive		Found. Depth	Ground	Distance	
CO	RTE	PM	Direction	Fill	Cut		Loose	Dense	Soft	Stiff	(ft)	Water	ETW	
SM	101	12.10	NB			x		x			9		11.5'	
SM	101	12.10	SB			x		x			9		31'	
SM	101	12.60	NB	x				x			10		23'	
SM	101	12.60	SB			x		x			9		10'	
SM	101	13.00	NB			x		x			9		31'	
SM	101	13.30	NB			x		x			9		25	
SM	101	22.70	NB			x		x			9		31'	
SM	101	23.10	SB	x			x				12		14.4'	Caving
SM	101	23.20	NB			x		x			9		31'	