FOR CONTRACT NO.: 06-325504

INFORMATION HANDOUT

MATERIALS INFORMATION

FOUNDATION REPORT FOR 19th AVENUE OVERCROSSING
(Br No 45-0104), DATED MAY 10, 2010

AMENDED FOUNDATION REPORT (FR) - 19th AVENUE OVERCROSSING
(Br No 45-0104), DATED APRIL 4, 2011

FOUNDATION REPORT (FR) FOR TYPE 1 RETAINING WALLS AT ABUTMENT 1
19th AVENUE OVERCROSSING, DATE APRIL 4, 2011

FOUNDATION REPORT (FR) FOR TYPE 1 RETAINING WALLS No 1 AT ABUTMENT 3
19th AVENUE OVERCROSSING, DATE June 1, 2010

FOUNDATION REPORT FOR 19th AVENUE MSE RETAINING WALL, DATE JUNE 1, 2010

TEMPORARY HALF GABION-FACED MSE WALL BEHIND ABUTMENT 3
19th AVENUE OVERCROSSING, DATE June 24, 2010

ADDENDUM TO TEMPORARY HALF GABION-FACED MSE WALL BEHIND ABUTMENT 3
19th AVENUE OVERCROSSING, DATE June 13, 2011

FOUNDATION REVIEW - 19th AVENUE OVERCROSSING
(Br No 45-0104), DATED APRIL 14, 2011

FOUNDATION REVIEW - 19th AVENUE OVERCROSSING MSE WALL
(Br No 45-0104), DATED APRIL 17, 2011

GEOTECHNICAL DESIGN REPORT FOR THE 19th AVENUE OVERCROSSING
(Br No 45-0104), DATED JUNE 23, 2010

SUMMARY OF GEOTECHNICAL RECOMMENDATIONS FOR 19th AVENUE
INTERCHANGE, DATED NOVEMBER 3, 2011

MATERIAL INFORMATION

UNITED STATES FISH AND WILDLIFE SERVICE (USFWS)

BIOLOGICAL OPINION #1-1-03-F-00140 AND STANDARDIZED RECOMMENDATIONS FOR PROTECTION OF THE SAN JOAQUIN KIT FOX PRIOR TO GROUND DISTURBANCE

INSTALLATION DETAILS FOR BATTERY BACKUP SYSTEM

(BBS Cabinet mounting details and wiring details)

ROUTE: 06-Kin-198-PM R8.9/Rl0.1

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: PAUL CHUNG
Chief,
Office of Bridge Design Central
Bridge Design Branch 17

Attention: Elijah Hall

Date: May 10, 2010

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
19th Ave OC
Br. No. 45-0104

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

Subject: Foundation Report (FR) for 19th Avenue Overcrossing (OC)

Scope of Work

This report presents foundation recommendations for the proposed new 19th Avenue Overcrossing (OC) located Kings County. The Office of Geotechnical Design North (OGD-N), Branch A, has completed a foundation study for the proposed new structure. The study consisted of a surface and subsurface field exploration program conducted at the proposed site in May, 2009. The subsurface investigation included drilling and sampling the foundation soils at the site. The data generated were used to characterize and evaluate the subsurface soils and determine the suitability as foundation material for the new bridge. One mud rotary soil boring was drilled for each proposed support location of the new bridge. Borings R-09-001 and R-09-003 were drilled and sampled to 120 feet for the proposed locations of Abutments 1 and 3 respectively. Boring R-09-002 was drilled to 100 feet at the proposed location of Bent 2. Fourteen additional borings were drilled at the footprints of the proposed earth retaining structures for the approach embankments and also for the proposed sound walls. The groundwater levels were measured during and after the field exploration program. The Log of Test Borings (LOTB) for this project is being developed and will be submitted to you when completed.

The recommendations presented in this report are based mainly on the data generated during this field investigation, and on a review of pertinent documents including the following:

1. Preliminary Foundation Report (PFR) for 19th Avenue OC, dated March 17, 2009.

2. Geologic Map of California, Fresno Sheet (Olaf P. Jenkins Edition, 1965).

3. Geology of California (Norris and Webb, 2nd Edition, 1990).

4. Foundation Recommendations for Route 41/198 Separation, Bridge No. 45-0060L/R, dated

June 14, 1994.

5. Foundation Recommendations for Bush Street UC, Bridge No. 45-0100 L/R, dated June 7, 1994.

Project Description

The project is located at the intersection of 19th Avenue and State Route (SR) 198 at the west end of the city of Lemoore in Kings County. The 19th Avenue OC is approximately perpendicular to the east-west SR 198 at the project location. The site is flat and is bounded on the southeast quadrant by a farm field and on the southwest by a farm field and commercial facilities. An infiltration basin occupies the northeast quadrant while a residential area occupies the northwest portion.

The project proposes to construct a semi-clover-leaf type interchange at the intersection of 19th Avenue and SR 198. This involves raising the existing roadway profile of 19th Avenue to a higher grade within the project limits, and constructing an overcrossing bridge over SR 198. The project is part of the roadway widening and improvement program along the 198 corridor. The new overcrossing structure will consist of a 2-span Cast-in-Place/Prestressed (CIP/PS) concrete box-girder bridge with a four column bent and short seat at Abutment 1. The Abutment 1 footing will be constructed within the soil fill of the south approach embankment. The north approach embankment will be comprised of an MSE wall behind Abutment 3. Abutment 3 will be a high cantilever abutment with the footing constructed below native ground surface.

Within the project limits, it is also proposed to construct an MSE wall for the entire length of the north approach embankment, sound walls, and a tangent wall adjacent to the MSE wall to protect residential dwellings from stresses induced by settlement of the loose/soft saturated foundation soil beneath the proposed embankment. Detailed information about the approach embankments, including settlement, the MSE, tangent and sound walls, will be provided in reports by OGD-N, Branch C.

The elevations used in this report are referenced to the NAVD88 Vertical Datum as provided on the project Foundation Plan dated March 19, 2009.

Summary of Site Geology and Subsurface Conditions

The project site is located within the Great Valley geomorphic province of California (Norris and Webb 2nd Edition). The Geologic Map of California, Fresno Sheet (Olaf P. Jenkins Edition 1965) indicates that the site is underlain by Recent alluvial fan deposits (Qf) that consist mainly of sand and silt of granitic provenance.

The field investigation conducted in May, 2009 for this project, explored to a maximum depth of 120 feet (approximately elevation 94 ft). The foundation material encountered consists of interbeds of granular and cohesive soils comprised of sand, silt, silty clay and clay.

The upper granular soil layers consists mostly of fine to medium grained layers of loose to medium dense micaceous sand and silty sand and generally extends to elevation 120 ft.
The upper cohesive soil layers that also generally extend to elevation 120 ft consist of soft to mostly medium stiff to very stiff clay, sandy clay, silty clay, sandy silt and silt. The granular soils below elevation 120 ft is generally dense to very dense with interbeds of very stiff to hard cohesive layers. Some cohesive layers contain yellow/brown oxides and calcite veins and veinlets. The boring data will be provided on the LOTB for this project.

Groundwater

A PVC piezometer was installed in Boring R-09-003 and groundwater measured at elevation 203 feet during the May, 2009 drilling program. This approximately corresponds to 11 feet below the existing ground surface at the proposed bridge site.

Scour Evaluation

Surface water in the vicinity of the project will be limited to local storm water run-off, which must be controlled in shallow ditches or channels and directed away from foundation elements and embankment fills. Scour will not affect the structure foundations because there is no watercourse under, or adjacent to the proposed new overcrossing.

Corrosion Evaluation

Caltrans considers a site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

Chloride concentration is 500 ppm or greater, sulfate concentration is 2000 ppm or greater, or the pH is 5.5 or less.

Table 1 below shows laboratory results for soil samples collected and analyzed during the foundation investigations conducted in May, 2009 for this project.

Table 1: Corrosion Test Summary Report-19th Ave OC

SIC Number (TL101)	Sample Location (Boring Number)	Sample Type	Sample Depth (ft)	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
C639701	R-09-003 # 1A	Soil	0-5	4900	8.86	-	-
C639702	R-09-003	Soil	10-15	2142	8.79	-	-
C639703	R-09-003	Soil	20-25	8794	9.04	-	-
C639704	R-09-003	Soil	30-36	1656	8.74	-	-
C639705	R-09-004	Soil	0-5	5770	8.04	-	-
C639706	R-09-004	Soil	10-15	4828	8.33	-	-

Based on these corrosion results, the native soil beneath the proposed new 19th Ave OC bridge site is non-corrosive to foundation elements per Caltrans standards.

Seismicity

Based on the Department of Transportation Caltrans Seismic Hazard Map of 1996, the controlling fault for the proposed project site is the Coast Ranges-Sierran Block Boundary Zone (CSB, reverse, including thrust). The CSB fault is located approximately 28 miles west of the project site and is capable of generating a Maximum Credible Earthquake moment magnitude of M_w=7.0. Based on the above referenced map, the estimated Peak Horizontal Bedrock Acceleration at this site is recommended to be 0.2g. The potential for surface rupture at the site due to fault movement is considered insignificant since there are no known faults projecting towards or passing directly through the project site.

Based on the LOTB developed from the recent field exploration performed in May, 2009 for this project, the soil profile at the site may be classified a Type D, as defined in the Department's Seismic Design Criteria (SDC, 2006, Version 1.4). The recommended design Acceleration Response Spectrum (ARS) curve shown in Figure 1 was obtained from Figure B.8 of the SDC. According to the guidelines presented in Section 6.1.2.1 of the SDC, for structures that are within 10 miles (15 km) of a fault, the ARS curve needs to be modified. Since the distance to the fault from this project location is more than 10 miles, no modification to the ARS curve is needed.

Based on subsurface information from the May 2009 field investigation for this project, analysis of the subsurface conditions at the proposed new bridge location indicates that liquefaction is considered negligible.

As-Built Foundation Data

The proposed new structure has no As-Built information. We have produced below the As-Built Foundation Data for SR 41/198 Separation (Br. No. 45-0102R), located approximately 1000 feet west of the proposed new bridge site. Bridge No. 45-0102 R was constructed in 1998 and was founded on Class 70C prestressed concrete piles as shown in Table 2 below.

Table 2: Pile Data Table for the existing SR 41/198 separation (Br. No. 45-0102R)

Location	Pile Type	Design Load (tons)	Bottom of Footing Elevation (feet)	Specified Tip Elevation (feet)
Abutment 1	Prestressed concrete piles (Class 70C)	70	218.0	133.0
Bent 2	Prestressed concrete piles (Class 70C)	70	204.0	133.0
Bent 3	Prestressed concrete piles (Class 70C)	70	202.5	133.0
Abutment 4	Prestressed concrete piles (Class 70C)	70	220.0	133.0

Foundation Recommendations

The proposed new 19th Ave OC (Br. No. 45-0104), as indicated on the 19th Avenue OC General Plan dated November 11, 2009, may be supported on Class 140 concrete piles at Abutments 1 and 3 according to the table below.

Table 3: Abutment Foundations Design Recommendations (19th Ave OC Br. No. 45-0104)

Support	Pile	Cut-off Elevation (ft)	LRFD Service-I Limit State Load (kips) per Support		LRFD Service-I Limit State Total Load (kips) per Pile (Compression)	Nominal Resistance (kips)	Design Tip Elevations (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance Required (kips)
			Total	Permanent					
Abut 1	Class 140 Alt. X	223.25	4450	3900	136	280	(a) 144 (c) 149	144	280
Abut 3	Class 140 Alt. X	209.25	6550	5900	120	240	(a)144 (c) 147	144	240

Note:

1) *Design tip elevations are controlled by: (a) Compression and (c) Settlement, respectively.*
2) *The specified tip elevation shall not be raised above the design tip elevation for settlement and lateral load.*

The proposed new 19th Ave OC (Br. No.45-0104), as indicated on the 19th Avenue OC General Plan dated April 4, 2009, may be supported on Class 200 concrete piles at Bent 2 according to the table below.

Table 4: Bent Foundations Design Recommendations (19th Ave OC Br. No. 45-0104)

Support Location	Pile Type	Cut-off Elevation (ft)	Service-I Limit State Load per Support (kips)	Total Permissible Support Settlement (inches)	Required Factored Nominal Resistance (kips)				Design Tip Elevations (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance Required (kips)
					Strength Limit		Extreme Event				
					Comp. (φ=0.7)	Tension (φ=0.7)	Comp. (φ=1)	Tension (φ=1)			
Bent 2 Interior	Class 200 Alt X	211.75	1950	0.6	180	0	130	0	(a-I) 168 (a-II) 181 (c) 144	144	320
Bent 2 Exterior	Class 200 Alt X	211.75	2600	0.6	235	0	100	0	(a-I) 140 (a-II) 186 (c) 140	140	340

Note:

1) *Design tip elevations are controlled by: (a-I) Compression (Strength Limit), (a-II) Compression (Extreme Event) (c) Settlement.*
2) *The specified tip elevation shall not be raised above the design tip elevation for settlement.*

Table 5: PILE DATA TABLE (19th Ave OC, Br. No. 45-0104)						
Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)
		Compression	Tension			
Abut. 1	Class 140 Alt. X	280	0	(a) 144 (c) 149	144	280
Bent 2 Interior	Class 200 Alt. X	260	0	(a) 168 (c) 144	144	320
Bent 2 Exterior	Class 200 Alt. X	340	0	(a) 140 (c) 140	140	340
Abut 3	Class 140 Alt. X	240	0	(a) 144 (c) 147	144	240

Notes:

1) *Design tip elevations for Abutments are controlled by: (a) Compression and (c) Settlement.*
2) *Design tip elevations for Bents are controlled by: (a) Compression and (c) Settlement.*
3) *The specified tip elevation shall not be raised above the design tip elevation for Settlement.*

General Note to Designer

1. We used a total permissible settlement of 1.5 inches at Abutment 1, 0.6 inches at Bent 2 exterior, and Bent 2 interior, and1.0 inch at Abutment 3.

Construction Considerations

1. Groundwater was encountered at this site during the geotechnical field investigation and should be considered to be an issue during all phases of construction and pile installation. Groundwater levels fluctuate seasonally and may occur at elevations different from those provided in this report during construction due to seasonal fluctuations.

2. All newly placed embankment fills shall undergo a minimum settlement period that requires monitoring. For details regarding waiting period and settlement monitoring, refer to the GDR for EA 06-325501 provided by OGD-N Branch C.

3. Piles shall be driven in pre-drilled holes through the new fill, to elevation 214 ft at Abutment 1. Pre-drilling shall be performed in accordance of Section 49-1-06 of the Standard Specifications.

4. All piles shall be installed after the Engineer has determined that settlement of the approach embankments is complete.

5. At all the support locations of the new bridge (No. 45-0104), we recommend that the piles be driven to the specified tip elevations provided in this report. However, if during driving a pile achieves 2 x the required nominal resistance below the specified tip for settlement, as determined by Section 49-1.8 "Bearing Values and Penetration," of the Standard Specifications, it shall be considered adequate and may be cut off upon the approval of the Engineer.

6. Any pile that does not achieve bearing at the recommended specified pile tip elevation should be re-struck after a minimum of one day (24 hours) setup time.

7. The Office of Geotechnical Design-North should be invited to a pre-construction meeting.

The recommendations contained in this memorandum are based on specific project information regarding structure type, location and design loads that have been provided by Structure Design. If any conceptual changes to the structure are proposed during final project design, the Office of Geotechnical Design-North should review those changes to determine if the foundation recommendations herein provided are still applicable.

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:

1. *Log of Test Boring (19 Ave OC, Br. No. 45-0104)*

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

1. *Foundation Report (19th Ave OC, Br No. 45-0104)*
2. *Geotechnical Design Reports, for EA 06-325501*

If you have any questions regarding this project, please contact Abu Barrie at (916) 227-1043, Reid Buell at (916) 227-1012, or Reza Mahallati at (916) 227-1033.

Report by:

ABUBAKARR BARRIE
Engineering Geologist
Office of Geotechnical Design-North

REID BUELL, C.E.G. NO. 1481
Senior Engineering Geologist
Office of Geotechnical Design-North

Attachment

c: Jim Heinen (E-copy)
Mark Willian (E-copy)
Struct. Cons. R.E. Pending File
DES OE, PS&E (E-copy)
Mike Webber DME (E-copy)

REZA MAHALLATI, P.E.
Office of Geotechnical Design-North
Senior Materials and Research Engineer

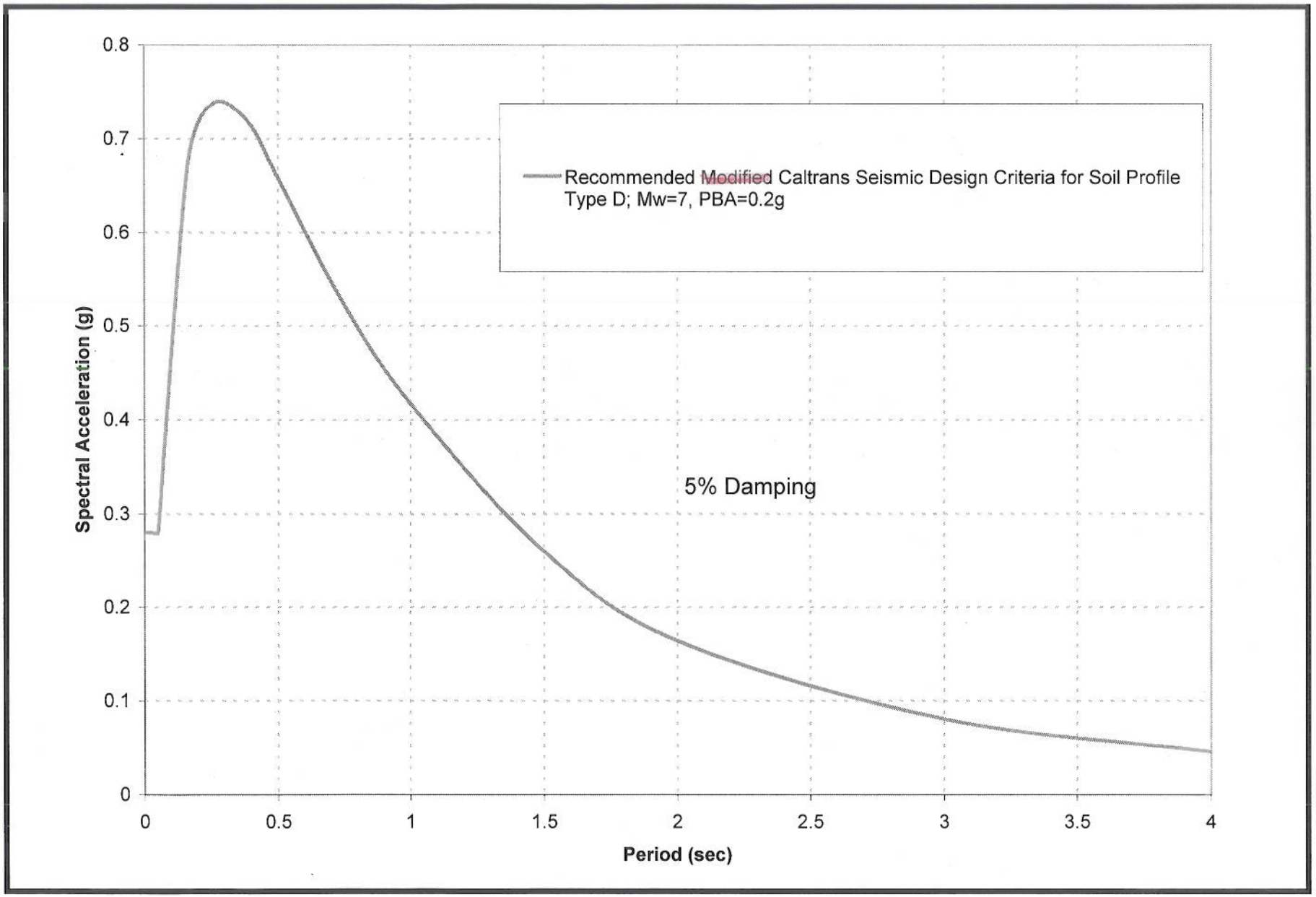


Figure 2. Acceleration Response Spectrum Recommended for Design

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: GARY JOE
Chief,
Bridge Design Branch 17
Bridge Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES 17

Date: April 4, 2011

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
19th Ave OC
Br. No. 45-0104

Attention: Rene Coria & Elijah Hall

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

Subject: Amended Foundation Report (FR)

This amendment is in response to your Foundation Report Revision Request # 2, dated March 22, 2011, for 19th Ave Overcrossing (OC) due to new changes in design. We have reviewed your request and this memo revises and amends portions of the cited FR to reflect the proposed changes in your request. The following revisions have been made to the FR for 19th Ave OC dated May 10, 2010:

1. Abutment 1 will be a high cantilever abutment and the adjacent wingwalls are Type 1 Retaining Walls. The abutment footing will be constructed below native ground surface.

2. Statement No. 3 under Construction Considerations in the above referenced FR no longer applies and shall be ignored.

3. The Pile Data Tables below have been revised to reflect the changes in your request memo dated March 23, 2011.

Table 3: Abutment Foundations Design Recommendations (19th Ave OC Br. No. 45-0104)

Support	Pile	Cut-off Elevation (ft)	LRFD Service-I Limit State Load (kips) per Support		LRFD Service-I Limit State Total Load (kips) per Pile (Compression)	Nominal Resistance (kips)	Design Tip Elevations (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance Required (kips)
			Total	Permanent					
Abut 1	Class 140 Alt. X	213.25	6275	5833	120	240	(a) 144 (c) 149	144	240
Abut 3	Class 140 Alt. X	209.25	6550	5900	120	240	(a)144 (c) 147	144	240

Notes: 1) Design tip elevations are controlled by: (a) Compression and (c) Settlement, respectively.
2) The specified tip elevation shall not be raised above the design tip elevation for settlement and lateral load.

Table 5: PILE DATA TABLE (19th Ave OC, Br. No. 45-0104)						
Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)
		Compression	Tension			
Abut. 1	Class 140 Alt. X	240	0	(a) 144 (c) 149	144	240
Bent 2 Interior	Class 200 Alt. X	260	0	(a) 168 (c) 144	144	320
Bent 2 Exterior	Class 200 Alt. X	340	0	(a) 140 (c) 140	140	340
Abut 3	Class 140 Alt. X	240	0	(a) 144 (c) 147	144	240

Notes:

1) *Design tip elevations for Abutments are controlled by: (a) Compression and (c) Settlement.*
2) *Design tip elevations for Bents are controlled by: (a) Compression and (c) Settlement.*
3) *The specified tip elevation shall not be raised above the design tip elevation for Settlement.*

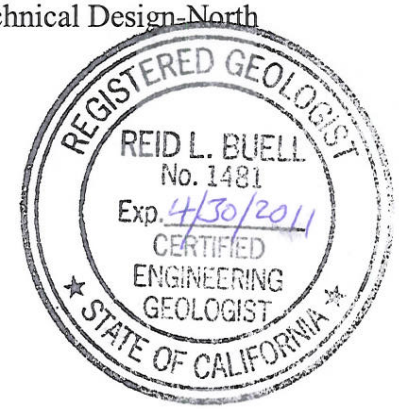
All other recommendations contained in the FR for 19th OC dated May 10, 2010, remain valid and still applicable to the current scope of the 19th Ave OC project.

If you have any questions regarding this project, please contact Abu Barrie at (916) 227-1043, Reid Buell at (916) 227-1012, or Reza Mahallati at (916) 227-1033.

Report by:

ABUBAKARR BARRIE
Engineering Geologist
Office of Geotechnical Design-North

REID BUELL, C.E.G. NO. 1481
Senior Engineering Geologist
Office of Geotechnical Design-North



Attachment

c: Jim Heinen (E-copy)
Mark Willian (E-copy)
Struct. Cons. R.E. Pending File
DES OE, PS&E (E-copy)
Mike Webber DME (E-copy)

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: GARY JOE, Chief
Bridge Design Branch 17
Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES-17

Attention: Rene Coria & Elijah Hall

Date: April 4, 2011 30, 2011

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
Ret Walls at Abutment 1
19th Ave OC
Br. No. 45-0104

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

Subject: Foundation Report (FR) for Type 1 Ret Walls at Abutment 1, 19th Avenue Overcrossing (OC)

Scope of Work

This report presents foundation recommendations for the proposed Type 1 Retaining Walls (wingwalls) to be located adjacent to Abutment 1 of the proposed 19th Avenue Overcrossing OC located in Kings County. These recommendations are based on a field investigation completed in May, 2009, by the Office of Geotechnical Design North (OGD-N) for the proposed new 19th Avenue OC (Br. No. 45-0104) and the approach embankments at the 19th Ave/State Route (SR) 198 Interchange in Lemoore. Soil data generated from Boring R-09-001 drilled for the foundation investigation for 19th Ave OC (Bridge No. 45-0104) are utilized for this report. The Log of Test Boring (LOTB) for Boring R-09-001 is included in the LOTB for 19th Ave OC, which has been completed and submitted earlier.

In preparing this report, we have made reference to the following:

1. Foundation Report (FR) for 19th Ave Overcrossing (OC) dated May 10, 2010.

2. Foundation Report (FR) for the Type 1 retaining Wall at 19th Avenue Overcrossing (OC), dated June 1, 2010.

3. Foundation Report Revision # 2, dated March 22, 2011 and other information received from the Office of Bridge Design Services (OBDS).

Project Description

This report provides foundation recommendations for Type 1 retaining walls (wingwalls) to be constructed adjacent to Abutment 1 of the proposed 19th Ave OC. A change was made to the original offramp profile grade elevations that resulted in the lowering of Abutment 1 by 10 feet. The original seat type abutment has therefore been replaced by a high cantilever abutment, and the adjacent wingwalls are replaced by Type 1 Retaining Walls.

The project is located at the intersection of 19th Avenue and SR 198 at the west end of the city of Lemoore in Kings County. The 19th Avenue OC is approximately perpendicular to the east-west SR 198 at the project location. The site is flat and is bounded on the southeast quadrant by a farm field and on the southwest by a farm field and commercial facilities. The infiltration basin located in the northeast quadrant is proposed to be relocated. The northwest portion is occupied by a residential area. The overall project proposes to construct a semi-clover-leaf type interchange at the intersection of 19th Avenue and SR 198. This will raise the existing roadway profile of 19th Avenue by a maximum of 30 feet within the project limits, and construct an overcrossing bridge over SR 198. The south approach embankment of the new OC will consist of soil fill with 2:1 (H:V) slope and no earth retaining systems. The north approach embankment behind Abutment 3 will consist of an MSE wall to minimize the footprint of the embankment on the west, and soil fill with a 2:1 slope to the east. Abutment 3 will consist of a high cantilever abutment with the footing constructed below native ground surface while the footing for Abutment 1 will be located within the soil fill of the south approach embankment.

Detailed information about the approach embankments, MSE wall, settlement and sound walls for this project, are provided in the Geotechnical Design Report (GDR) and the MSE wall FR by OGD-N, Branch C.

The elevations used in this report are referenced to the North American Vertical Datum 1988 as provided on the project Foundation Plan dated March 19, 2009.

Summary of Site Geology and Subsurface Conditions

The project site is located within the Great Valley geomorphic province of California (Norris and Webb 2nd Edition). The Geologic Map of California, Fresno Sheet (Olaf P. Jenkins Edition 1965) indicates that the site is underlain by Recent alluvial fan deposits (Qf) in the Great Valley that consist mainly of sand and silt of granitic provenance.

The field investigation conducted in May, 2009 for this project, explored to a maximum depth of 120 feet (approximately elevation 94 ft). The foundation material encountered consists of interbeds of granular and cohesive soils comprised of sand, silt, silty clay and clay. The upper granular soil layers consist mostly of fine to medium grained layers of loose to medium dense micaceous sand and silty sand and generally extend to elevation 120 ft. The upper cohesive soil layers that also generally extend to elevation 120 ft consist of soft to mostly medium stiff to very

stiff clay, sandy clay, silty clay, sandy silt and silt. The granular soils below elevation 120 ft are generally dense to very dense with interbeds of very stiff to hard cohesive layers. Some cohesive layers contain yellow/brown oxides and calcite veins and veinlets. Refer to Boring R-09-001 of the 19th Ave OC LOTBs.

Groundwater

A PVC piezometer was installed in Boring R-09-003 and groundwater was measured at elevation 203 feet during the May 2009 drilling program (approximately 11 feet below the existing ground surface).

Scour Evaluation

Surface water in the vicinity of the project will be limited to local storm water run-off, which must be controlled in shallow ditches or channels and directed away from foundation elements and embankment fills. Scour will not affect the structure foundations because there is no watercourse under, or adjacent to the proposed new overcrossing.

Corrosion Evaluation

Caltrans considers a site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

Chloride concentration is 500 ppm or greater, sulfate concentration is 2000 ppm or greater, or the pH is 5.5 or less.

Soil samples were obtained for corrosion analyses at the locations shown in Table 1 below. Table 1 shows laboratory results for soil samples collected and analyzed during the foundation investigations conducted in May 2009 for this project.

Table 1: Corrosion Test Summary Report-19th Ave OC

SIC Number (TL101)	Sample Location (Boring Number)	Sample Type	Sample Depth (ft)	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
C639701	R-09-003 # 1A	Soil	0-5	4900	8.86	-	-
C639702	R-09-003	Soil	10-15	2142	8.79	-	-
C639703	R-09-003	Soil	20-25	8794	9.04	-	-
C639704	R-09-003	Soil	30-36	1656	8.74	-	-
C639705	R-09-004	Soil	0-5	5770	8.04	-	-
C639706	R-09-004	Soil	10-15	4828	8.33	-	-

The minimum resistivity serves only as an indicator parameter for the possible presence of soluble salts and is not used to define a site as being corrosive. It is the practice of the Corrosion Technology Branch that if the minimum resistivity of the sample is greater than 1000 ohm-cm, the sample is considered to be non-corrosive and testing to determine the sulfate and chloride content is not performed.

Based on these corrosion results, the native soil beneath the proposed new 19th Ave OC bridge site is non-corrosive to foundation elements per Caltrans standards.

Summary of Project Site Seismicity

1. *Ground Motions*

The controlling fault for the proposed project site is the Coast Ranges-Sierran Block Boundary Zone (Mw= 7.0), which is located approximately 28 miles west of the project site. Based on the LOTB developed from the May, 2009 field exploration for this project, the soil profile at the site may be classified as a Type D, as defined in the Department's Seismic Design Criteria (SDC, 2006, version 1.4). A peak horizontal bedrock acceleration of 0.2g (with a peak ground acceleration of 0.28g) is anticipated at the site.

2. *Ground Rupture*

Since no known active faults project towards or pass through the project site, the potential for ground rupture during a seismic event is considered low.

3. *Liquefaction*

Based on the LOTB developed for this project, the subsurface conditions indicate that liquefaction is considered negligible at the site. For the detailed seismic account of the site, refer to the FR for 19th Ave OC (Br. No. 45-0104) dated 10 May 2010.

The Type 1 Retaining Wall (wingwall) at Abutment 1

Standard Type 1 retaining walls founded on 45 ton driven piles are proposed to be constructed as wingwalls adjacent to Abutment 1. The wall adjacent to the west side will be approximately 30 feet long (including overlap) with a maximum retained height of 16 feet. On the east side of Abutment 1, the wall will be 35 long (including overlap) with a maximum retained height of 16 feet also. The wall parameters are shown in Table 2 below.

Table 2: Type 1 Retaining Wall at Abutment 1 of 19th Ave OC (west side)

Retaining Wall Segment	Approximate Stationing (19th Line)	Wall Design Height (feet)	Wall Length (feet)	Bottom of footing Elevation (feet)	Foundation Type	Design load (kips)
1	44 ft Lt 23+14.29 to 23+25. 29	4	11	235.0	Driven concrete piles	90
2	44 ft Lt 23+24.29 to 23+33.29	8	9	232.0	Driven concrete piles	90
3	44 ft Lt 23+32.29 to 23+42.29	16	10	224.0	Driven concrete piles	90

Table 3: Type 1 Retaining Walls at Abutment 1 of 19th Ave OC (east side)

Retaining Wall segment	Approximate Stationing (19th Line)	Wall Design Height (feet)	Wall Length (feet)	Bottom of footing Elevation (feet)	Foundation Type	Design load (kips)
1	44 ft Rt 23+55.30 to 23+67.30	4	12	235.3	Driven concrete piles	90
2	44 ft Rt 23+66.30 to 23+79.30	10	13	229.5	Driven concrete piles	90
3	44 ft Rt 23+78.30 to 23+88.30	16	10	224.5	Driven concrete piles	90

Foundation Recommendations

The proposed Standard Type 1 Retaining Walls (wingwalls) to be located at Abutment 1 of 19th Ave OC (Br. No.45-0104), as indicated on the General Plan dated March 21, 2011, and as described in the Updated Foundation Report Request, dated April 2, 2011, may be supported on Class 90 concrete piles according to the Tables 4 and 5 below.

Table 4: Pile Data Table for Type 1 Retaining Wall at Abut 1, (west side) 19th Ave OC (Br. No. 45-0104)

Retaining Wall Segment	Approximate Stationing (19th Line)	Design Height (feet)	Pile Type	Bottom of Footing Elevation (ft)	Design load (kips)	Nominal Resistance (kips)	Specified Tip Elevation (ft)
1	44 ft Lt 23+14.29 to 23+25. 29	4	Class 90 Alt. X	235.0	90	180	172.0
2	44 ft Lt 23+24.29 to 23+33.29	8	Class 90 Alt. X	232.0	90	180	172.0
3	44 ft Lt 23+32.29 to 23+42.29	16	Class 90 Alt. X	224.0	90	180	172.0

Table 5: Pile Data Table for Type 1 Retaining Wall at Abut 1, (east side) 19th Ave OC (Br. No. 45-0104)

Retaining Wall Segment	Approximate Stationing (19th Line)	Design Height (feet)	Pile Type	Bottom of Footing Elevation (ft)	Design load (kips)	Nominal Resistance (kips)	Specified Tip Elevation (ft)
1	44 ft Rt 23+55.30 to 23+67.30	4	Class 90 Alt. X	235.3	90	180	172.0
2	44 ft Rt 23+66.30 to 23+79.30	10	Class 90 Alt. X	229.5	90	180	172.0
3	44 ft Rt 23+78.30 to 23+88.30	16	Class 90 Alt. X	224.5	90	180	172.0

Note: 1) Specified tip elevations are controlled by compression.

Construction Considerations

1. Groundwater was encountered at elevation 203 feet during the geotechnical field investigation and should be considered during all phases of construction and pile installation. Groundwater levels fluctuate seasonally and may occur at elevations different from those provided in this report during construction due to seasonal fluctuations.

2. The locations of all underground utilities shall be properly identified and marked before commencing excavations for construction of the footing for the proposed retaining wall.

3. The footings for the proposed Type 1 retaining walls will be located on the new fill. It is important to place the footings neat on the compacted new fill that has undergone the specified settlement period as provided in the GDR for this project.

4. Piles shall be driven in pre-drilled holes through the new fill, to elevation 214 ft at Abut 1. Pre-drilling shall be performed in accordance of Section 49-1-06 of the Standard Specifications.

3. All piles shall be installed after the Engineer has determined that settlement of the approach embankments is complete.

5. We recommend that the piles be driven to the specified tip elevations provided in this report. If a pile does not achieve bearing at the recommended specified pile tip elevation, it should be re-struck after a minimum of one day (24 hours) setup time.

7. The Office of Geotechnical Design-North should be invited to a pre-construction meeting.

The recommendations contained in this memorandum are based on specific project information regarding structure type, location and design loads that have been provided by Structure Design. If any conceptual changes to the structure are proposed during final project design, the Office of Geotechnical Design-North should review those changes to determine if the foundation recommendations herein provided are still applicable.

If you have any questions regarding this project, please contact Abu Barrie at (916) 227-1043, Reid Buell at (916) 227-1012, or Reza Mahallati at (916) 227-1033.

REGISTERED GEOLOGIST
REID L. BUELL
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Report by:

ABUBAKARR BARRIE
Engineering Geologist
Office of Geotechnical Design-North

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Mark Willian (E-copy)
Struc. Cons. R.E. Pending File
DES OE, PS&E (E-copy)
Mike Weber DME (E-copy)

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: PAUL CHUNG, Chief
Bridge Design Branch 17
Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES-17

Attention: Elijah Hall

Date: June 1, 2010

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
Ret Wall at 19th Ave OC
Br. No. 45-0104

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

Subject: Foundation Report (FR) for the Type 1 Retaining Wall at 19th Avenue Overcrossing (OC)

Scope of Work

Per your request, we present foundation recommendations for the Type 1 Retaining Wall to be located adjacent to Abutment 3 of the proposed 19th Avenue Overcrossing OC located in Kings County. A field investigation was completed in May, 2009, by the Office of Geotechnical Design North (OGD-N) for the proposed new 19th Avenue OC and the embankments of the 19th Ave/State Route (SR) 198 Interchange in Lemoore. These recommendations are based on data generated during the May 2009 field investigation, on the FR for 19th Ave OC dated May 10, 2010, and on the Foundation Report Request memo dated May 18, 2010. Soil data generated from Borings R-09-002 and R-09-003 drilled for the foundation investigation for 19th Ave OC (Bridge No. 45-0104) are utilized for this report. The Log of Test Borings (LOTB) for this report will be submitted when completed.

Project Description

The purpose of this report is to provide foundation recommendations for a Type 1 retaining wall to be constructed adjacent to the east side of Abutment 3 of the proposed 19th Ave OC parallel to SR 198. The wall will minimize the footprint and retain the fill of the eastern extension of the north approach embankment and prevent it from obstructing the SR 198 roadway.

The project is located at the intersection of 19th Avenue and SR 198 at the west end of the city of Lemoore in Kings County. The 19th Avenue OC is approximately perpendicular to the east-west SR 198 at the project location. The site is flat and is bounded on the southeast quadrant by a farm field and on the southwest by a farm field and commercial facilities. The infiltration basin located in the northeast quadrant is proposed to be relocated. The northwest portion is occupied by a residential area.

The overall project proposes to construct a semi-clover-leaf type interchange at the intersection of 19th Avenue and SR 198. This will raise the existing roadway profile of 19th Avenue by a maximum of 30 feet within the project limits, and construct an overcrossing bridge over SR 198. The south approach embankment of the new OC will consist of soil fill with 2:1 (H:V) slope and no earth retaining systems. The north approach embankment behind Abutment 3 will consist of an MSE wall to minimize the footprint of the embankment on the west, and soil fill with a 2:1 slope to the east. Abutment 3 will consist of a high cantilever abutment with the footing constructed below native ground surface while the footing for Abutment 1 will be located within the soil fill of the south approach embankment.

Detailed information about the approach embankments, MSE wall, settlement and sound walls, will be provided in the Geotechnical Design Report and the MSE wall FR by OGD-N, Branch C.

The elevations used in this report are referenced to the North American Vertical Datum 1988 as provided on the project Foundation Plan dated March 19, 2009.

Summary of Site Geology and Subsurface Conditions

The project site is located within the Great Valley geomorphic province of California (Norris and Webb 2nd Edition). The Geologic Map of California, Fresno Sheet (Olaf P. Jenkins Edition 1965) indicates that the site is underlain by Recent alluvial fan deposits (Qf) in the Great Valley that consist mainly of sand and silt of granitic provenance.

The field investigation conducted in May, 2009 for this project, explored to a maximum depth of 120 feet (approximately elevation 94 ft). The foundation material encountered consists of interbeds of granular and cohesive soils comprised of sand, silt, silty clay and clay. The upper granular soil layers consist mostly of fine to medium grained layers of loose to medium dense micaceous sand and silty sand and generally extend to elevation 120 ft. The upper cohesive soil layers that also generally extend to elevation 120 ft consist of soft to mostly medium stiff to very stiff clay, sandy clay, silty clay, sandy silt and silt. The granular soils below elevation 120 ft are generally dense to very dense with interbeds of very stiff to hard cohesive layers. Some cohesive layers contain yellow/brown oxides and calcite veins and veinlets. The boring data will be provided on the LOTB for this project.

Groundwater

A PVC piezometer was installed in Boring R-09-003 and groundwater was measured at elevation 203 feet during the May 2009 drilling program (approximately 11 feet below the existing ground surface).

Scour Evaluation

Surface water in the vicinity of the project will be limited to local storm water run-off, which must be controlled in shallow ditches or channels and directed away from foundation elements

and embankment fills. Scour will not affect the structure foundations because there is no watercourse under, or adjacent to the proposed new overcrossing.

Corrosion Evaluation

Caltrans considers a site to be corrosive to foundation elements if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

Chloride concentration is 500 ppm or greater, sulfate concentration is 2000 ppm or greater, or the pH is 5.5 or less.

Soil samples were obtained for corrosion analyses at the locations shown in Table 1 below. Table 1 shows laboratory results for soil samples collected and analyzed during the foundation investigations conducted in May 2009 for this project.

Table 1: Corrosion Test Summary Report-19th Ave OC

SIC Number (TL101)	Sample Location (Boring Number)	Sample Type	Sample Depth (ft)	Minimum Resistivity (ohm-cm)	pH	Chloride Content (ppm)	Sulfate Content (ppm)
C639701	R-09-003 # 1A	Soil	0-5	4900	8.86	-	-
C639702	R-09-003	Soil	10-15	2142	8.79	-	-
C639703	R-09-003	Soil	20-25	8794	9.04	-	-
C639704	R-09-003	Soil	30-36	1656	8.74	-	-
C639705	R-09-004	Soil	0-5	5770	8.04	-	-
C639706	R-09-004	Soil	10-15	4828	8.33	-	-

The minimum resistivity serves only as an indicator parameter for the possible presence of soluble salts and is not used to define a site as being corrosive. It is the practice of the Corrosion Technology Branch that if the minimum Resistivity of the sample is greater than 1000 ohm-cm, the sample is considered to be non-corrosive and testing to determine the sulfate and chloride content is not performed.

Based on these corrosion results, the native soil beneath the proposed new 19th Ave OC bridge site is non-corrosive to foundation elements per Caltrans standards.

Summary of Project Site Seismicity

1. *Ground Motions*

The controlling fault for the proposed project site is the Coast Ranges-Sierran Block Boundary Zone (Mw= 7.0), which is located approximately 28 miles west of the project site. A peak horizontal bedrock acceleration of 0.2g is anticipated at the site.

2. *Ground Rupture*

Since no known active faults project towards or pass through the project site, the potential for ground rupture during a seismic event is considered low.

3. *Liquefaction*

Based on the LOTB developed for this project, the subsurface conditions indicate that liquefaction is considered negligible at the site. For the detailed seismic account of the site, refer to the FR for 19th Ave OC (Br. No. 45-0104) dated 10 May 2010.

The Type 1 Retaining Wall

A Standard Type 1 retaining wall founded on piles is proposed to be constructed adjacent to, and east of, Abutment 3 of 19th Ave OC along SR 198. The wall will extend from 56.190 feet right of Station 511+30.515 to 50.94 feet right of Station 512+52.60 "WBO" Line. This wall is approximately 122 feet long and has a maximum retained height of 30 feet. The wall parameters are shown in Table 2 below.

Table 2: Type 1 Retaining Wall at Abutment 3 of 19th Ave OC

Approximate Stationing ("WBO" Line)	Design Height (feet)	Foundation Type	Design load (kips)
511+30.515 to 511+52.890	30	Driven concrete piles	90
511+52.890 to 511+72.890	26	Driven concrete piles	90
511+72.890 to 511+92.890	22	Driven concrete piles	90
511+92.890 to 512+12.890	18	Driven concrete piles	90
512+12.890 to 512+32.890	14	Driven concrete piles	90
512+32.890 to 512.42.890	6	Driven concrete piles	90
512+42.890 to 512+52.60	4	Driven concrete piles	90

Soil Parameters

Table 3 below lists the range of soil parameters selected for analysis and design of the foundation of the proposed retaining wall. The properties are based on the results of the May 2009 field investigation, including in-situ testing, laboratory analysis and geotechnical judgment.

Table 3: Soil and Range of Selected Properties for Foundation Design

Material Type	Engineering Classification	Saturated Unit Weight (pcf)	SPT Blow Counts (b/ft)	Friction Angle (Degree)	Cohesion (psf)
Sand	SP	120	14 -15	32	0
Sandy silt	ML	105-120	7- 40	29-32	0
Silt	ML	105-120	4-18	29-32	0
Clay	CL	118-120	7-32	0	750-3500

Foundation Recommendations

The proposed Standard Type 1 Retaining Wall located at Abutment 3 of 19th Ave OC (Br. No. 45-0104), as indicated on the General Plan dated February 25, 2010, may be supported on Class 90 concrete piles according to the table below.

Table 4: Pile data Table for Type 1 Retaining Wall at Abut 3, 19th Ave OC (Br. No. 45-0104)

Ret Wall Segment	Approximate Stationing (WBO Rte 198)	Design Height (feet)	Pile Type	Bottom of Footing Elevation (ft)	Design load (kips)	Nominal Resistance (kips)	Specified Tip Elevation (ft)
1	511+30.515 to 511+52.890	30	Class 90 Alt. X	208	90	180	177.0
2	511+52.890 to 511+72.890	26	Class 90 Alt. X	208.6	90	180	177.0
3	511+72.890 to 511+92.890	22	Class 90 Alt. X	209.1	90	180	178.0
4	511+92.890 to 512+12.890	18	Class 90 Alt. X	209.3	90	180	178.0
5	512+12.890 to 512+32.890	14	Class 90 Alt. X	209.3	90	180	178.0
6	512+32.890 to 512+52.60	6-4	Class 90 Alt. X	213.4	90	180	179.0

Note:

1) Specified tip elevations are controlled by compression.

Construction Considerations

1. Groundwater was encountered at elevation 203 feet during the geotechnical field investigation and should be considered during all phases of construction and pile installation. Groundwater levels fluctuate seasonally and may occur at elevations different from those provided in this report during construction due to seasonal fluctuations.

2. The locations of all underground utilities shall be properly identified and marked before commencing excavations for construction of the footing for the proposed retaining wall.

3. All piles shall be installed after the Engineer has determined that settlement of the approach embankments is complete.

5. We recommend that the piles be driven to the specified tip elevations provided in this report. If a pile does not achieve bearing at the recommended specified pile tip elevation, it should be re-struck after a minimum of one day (24 hours) setup time.

7. The Office of Geotechnical Design-North should be invited to a pre-construction meeting.

The recommendations contained in this memorandum are based on specific project information regarding structure type, location and design loads that have been provided by Structure Design. If any conceptual changes to the structure are proposed during final project design, the Office of Geotechnical Design-North should review those changes to determine if the foundation recommendations herein provided are still applicable.

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:

1. *Log of Test Boring (19 Ave OC, Br. No. 45-0104)*

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

1. *Foundation Report for Type 1 Ret. Wall at Abut 3 of 19th Ave OC (Br No. 45-0104)*
2. *Geotechnical Design Report for EA 06-325501*

If you have any questions regarding this project, please contact Abu Barrie at (916) 227-1043, Reid Buell at (916) 227-1012, or Reza Mahallati at (916) 227-1033.

Report by:

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Attachment

c: Jim Heinen (E-copy)
Mark Willian (E-copy)
Struc. Cons. R.E. Pending File
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STATE OF CALIFORNIA

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. PAUL CHUNG
Branch Chief
Office of Bridge Design - Central
Bridge Design Branch 17

Date: June 1, 2010

File: 06-KIN-198-PM 9.4/10.2
06-325501

Attention: Mr. Elijah Hall

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services – MS 5
Office of Geotechnical Design – North

Subject: Foundation Report for 19th Avenue MSE Retaining Wall

Scope of Work

This report presents foundation recommendations for the proposed Mechanically Stabilized Embankment (MSE) retaining wall at the new 19th Avenue Overcrossing near Lemoore in Kings County. The information and recommendations included in this report are based on OGDN staff's subsurface exploration conducted in June and July of 2009 for the 19th Avenue OC foundation investigation. In addition to borings for the bridge foundation investigation, additional 5-inch diameter rotary borings and CPT borings were drilled to further characterize the subsurface materials.

The recommendations presented in this report are based on the data generated during this field investigation, and on review of pertinent documents including the following:

1. Preliminary Foundation Report (PFR) for 19th Avenue OC, dated March 17, 2009.
2. Foundation Report (FR) for 19th Avenue OC, dated May 10, 2010.
3. Geologic Map of California, Fresno Sheet, 1965.
4. Geotechnical Design Report (GDR) for 19th Avenue OC, dated June 2010.
5. *Mechanically Stabilized Embankment*", Caltrans Bridge Design Aids, March 2009
6. *Mechanically Stabilized Embankment Walls*, Caltrans Bridge Standard Detail Sheets, Section 13, Details No. 5, March 2010
7. Bridge Design Specifications (BDS), Section 5 – Retaining Walls, 2004.

Project Description

The proposed improvements will convert the existing at-grade intersection at SR 198/19th Avenue to a 2-quadrant clover interchange. The overcrossing construction will raise the existing 19th Avenue roadway onto a new bridge, Br. No. 45-0104. Approach fill embankments will be constructed to a maximum height of approximately 30 feet on the south end of the bridge, with a 31.5-foot high mechanically stabilized earth or embankment (MSE) wall on the north side, adjacent to the residential area. The proposed MSE wall is approximately 880 feet in length and tapers from the maximum height of 31.5 feet at Station 9+65.88 to a minimum height of

approximately two feet at Station 18+45.44. The approach embankment will be approximately 80 feet wide at the top by 880 feet long for the north approach to the bridge.

OGDN staff understands the system to be used for the MSE wall may incorporate welded wire mat soil reinforcement with 5-foot by 5-foot precast concrete panel facing or use an equivalent design. A two-stage construction process would allow the embankment to settle for the recommended waiting period prior completion of the wall and surface structures. The surface structures will include a concrete traffic barrier with a 6-foot tall sound wall founded on eccentrically loaded pile foundations as depicted on Caltrans Bridge Standard Detail Sheets, Section 13, "Mechanically Stabilized Embankment Walls", Details No. 5, dated March 2010.

Field Exploration

As noted above, the 2009 subsurface exploration for the bridge foundation consisted of mud rotary sample borings that were advanced using a self-casing wire-line drilling method to a maximum depth of 121.5 ft below ground surface or approximate elevation 92 ft. Equipment used for the subsurface investigation consisted of CS 2000 and Acker drill rigs, both equipped with automatic hammers. Sampling was achieved by utilizing continuous Standard Penetration Tests (SPT) for the first 10 feet and at 5-foot intervals thereafter. Shelby tubes and brass tube samples were collected at various depths based on the investigator's criteria. Selected soil samples were either bagged or cased in brass tubes and Shelby tubes for subsequent laboratory testing.

Test borings information, including exploration numbers, stations, offsets, top of borehole elevations, and bottoms of borehole elevations are summarized in the following table. For more details, please refer to the LOTBs.

Table 1: Summary of the Geotechnical Exploration

Boring Number	Station (ft)	Offset (ft)	Top of Borehole Elevation (ft)	Bottom of Borehole Elevation (ft)
R-09-001	23+97.5	111'Rt. CL	214	±92
R-09-002	25+63.7	25' Rt. CL	217	±115
R-09-003	26+80.6	46' Lt. CL	214	±92
R-09-004	28+22.5	34' Lt. CL	214	±172
R-09-007	22+82.5	35' Rt. CL.	214	±147
R-09-008	30+24	42' Lt. CL	213	±162
R-09-010	32+90	47' Lt. CL.	213	±162
CPT 1	22+66	27' Rt. CL.	214	164
CPT 6	31+84	160' Rt. CL	216	166
CPT 7	35+85	63' Lt. CL	213	163

Laboratory Testing

The subsurface investigation for the proposed retention basins and fills for the on and off ramps consisted of 7 borings of variable depths. Soil samples from the proposed retention basins were submitted to the Translab soils laboratory for the following soil tests:

- Moisture Content (ASTM D 2216-05)
- Unit Weight (ASTM D 4767-04)
- Particle-Size Analysis (ASTM D 422-63)
- Liquid Limit, Plastic Limit and Plasticity Index (AASHTO T 89-02 & 90-00)
- Consolidation Remolded (ASTM D 2435-04)
- Direct Shear Remolded (ASTM D 3080-04)
- Relative Compaction (CTM 216)
- R-Value (CTM 301, AASHTO T 190-02)

The referenced tests were used to assist in classifying the soil encountered during the subsurface investigation. Results of these soil laboratory analyses are provided in the Geotechnical Design Report.

Site Geology and Subsurface Conditions

The subsurface characterization of the site is based on the information obtained from borings performed for the Geotechnical Design Report (GDR) and the Foundation Reports for the new bridge. As described in the GDR, OGDN's subsurface investigation indicates the project area is underlain by interbedded granular and cohesive soils comprised of sand, silt, silty clay and clay. The granular soil consists mostly of loose to medium dense, fine to medium grained layers of micaceous sand and silty sand. The cohesive fraction consists of soft to mostly medium stiff to very stiff clay, sandy clay, silty clay, sandy silt, and silt with a few hard layers. Some cohesive layers contain yellow/brown oxides and calcite veins and veinlets. The granular soil encountered below elevation 120 feet is generally dense to very dense. Please refer to Log of Test Borings for more detailed descriptions.

Groundwater

Perched groundwater was encountered during our subsurface investigation at relatively uniform depths. Water level measurements taken in May and June 2009 ranged from about 10 to 11 feet below the ground surface. Subsequent measurements of the perched water level, taken in February 2010 from four wells within the project area, were slightly higher and ranged from about 9.6 to 10 feet below ground surface.

Seismic Data and Evaluation

Based on the LOTB developed from the recent field exploration performed in May, 2009 for this project, the soil profile at the site may be classified a Type D, as defined in the Department's Seismic Design Criteria (SDC, 2006, Version 1.4). The recommended design Acceleration

Response Spectrum (ARS) curve was obtained from Figure B.8 of the SDC. The distance from the project site to the Coast Ranges- Sierran Block fault zone is greater than 10 miles and there are no known faults projecting towards or passing directly through the project site. According to the guidelines presented in section 6.1.2.1 of the SDC, for structures that are within 10 miles (15 km) of a fault, the ARS curve needs to be modified. Since the distance to the fault from this project location is more than 10 miles, no modification to the ARS curve is needed. The recommended estimate for Peak Horizontal Bedrock Acceleration at this site is 0.2g.

Liquefaction Evaluation

Liquefaction is a phenomenon in which saturated cohesionless soils are subjected to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stress associated with earthquake shaking. Submerged cohesionless sands and silts of low relative density are the type of soils that are susceptible to liquefaction. Clays are generally not susceptible to liquefaction.

The analysis of the subsurface conditions at the proposed new bridge location indicates that liquefaction potential at this site is considered negligible.

Corrosion Evaluation

Several composite soil samples were collected from Borings R-09-001, R-09-006, R-09-007, R-09-009 and R-09-010 during the 2009 subsurface investigation. The Office of Testing and Technology Services, Corrosive Technology Branch tested the samples for corrosive potential. The Corrosion Technology Branch considers a site to be corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site: chloride concentration of 550 ppm or greater, sulfate concentration of 2000 ppm or greater, or if pH is 5.5 or less.

Minimum resistivity serves only as an indicator parameter for the possible presence of soluble salts and is not included to define a corrosive site. It is the practice of the Corrosion Technology Branch that if the minimum resistivity of a sample is greater than 1000 ohm-cm, the sample is considered to be non-corrosive and testing to determine sulfate and chloride content is not performed. The results of our laboratory tests determined that the composite soil samples collected during our geotechnical investigation are non-corrosive. However, the maximum corrosion requirements when using soil reinforcement may vary from this standard. Please see the GDR (Section 10.3 Maximum Corrosion Requirements) for more information on this issue.

Corrosion test results from the Caltrans Corrosion Technology Branch are shown in the following table:

Table 2: Corrosion Test Summary: Composite Samples 19th Avenue OC

SIC Corrosion Number	Boring Number	Sample Depth (ft)	pH	Minimum Resistivity (ohm-cm)	Sulfate Content (PPM)*	Chloride Content (PPM)*
C644089	R-09-001	12.0-15.0	9.26	1171	110	32
C644090	R-09-001	51.5-55	9.00	408	1500	99
C644091	R-09-006	0.0-5.0	8.08	5676	---	---
C644092	R-09-006	61.5-70.0	9.51	558	---	---
C749321	R-09-007	0.0-1.5	8.80	2761	---	---
C749322	R-09-009	0.0-1.5	8.14	627	389	384
C703564	R-09-010	2.5-4.0	7.91	837	30	1758

Foundation Recommendations

Calculations for the external stability of the MSE walls were performed assuming that the walls and the select reinforced backfill will act as an integral unit. The minimum depth of wall embedment below finished grade is 2.0 ft or 0.1 H, whichever is greater. The loading condition selected in the design charts for these walls reflects a level ground surface in front and behind the wall. A traffic surcharge corresponding to 240 psf and barrier/soundwall load of 1,700 lbs/ft is assumed. Stability analyses were conducted as per the procedures described in FHWA manuals titled "Earth Retaining Structures, FHWA NHI-99-025" and "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines, FHWA-SA-96-071." Global slope stability for the MSE wall was evaluated by running slope stability analyses using the SlopeW program (version 7.02) from Geo-Slope International, Ltd. The calculated factors of safety for sliding and overturning for static conditions, bearing capacity, and global stability for static and a seismic pseudo-static (K_h=0.2) conditions are presented in Table 3. The wall manufacturer and/or structural designer will need to address the internal stability of the proposed MSE walls.

External Stability

Table 3 presents the calculated factors of safety and the external stability requirements for the proposed MSE wall.

Table 3: Summary of External Stability Analysis of the MSE Wall

Wall Height, H (ft)	Base Width, B (ft)	Bearing Material	Factor of Safety						
			Sliding Conditions		Overturning Conditions		Bearing Capacity	Global Stability	
			Static	Seismic	Static	Seismic		Static	Seismic
31.5	0.90H	Structure Backfill[1]	4.0	---	8.4	---	6.3	1.6	1.2
10 ft or less[2]	0.80H	Structure Backfill [1]	3.6	---	3.4	---	4.6	2.8	1.9
Minimum Factor of Safety Required			≥1.5	---	≥2.0	---	≥2.0	≥1.5	≥1.1

Notes:
1) MSE wall footing (leveling pad) is to be placed on compacted Structure Backfill to reduce differential settlement (See Construction Considerations).
2) The minimum reinforcement length (L) or base width (B) should be the greater of 0.80H and 8.0 ft for H equal to or less than 10 feet.

External stability analyses results in the above table are summarized for the maximum height of 31.5 feet and for wall height of 10 feet. From these analyses, static global stability controls the reinforcement length design. A minimum wall reinforcement length, L (or base width, B) of 0.90H should be used in the design, where H is over 10 feet. For H equal to 10 feet or less, L (or base width, B) of 0.80H should be used. Minimum reinforcement lengths (L) are referenced to Caltrans MSE design charts for 34-degrees friction angle backfill (Caltrans, Bridge Design Aids, Section 3-8 dated April 2002). Reinforcement lengths for the MSE wall vary along the length of the wall and can be taken as a function of the wall design height (H) that includes the depth of embedment below the finished grade. See attached global stability graphical output with assumed soil parameters.

Settlement of MSE Wall

Settlement of the MSE wall is anticipated due to soft foundation conditions. A waiting period and settlement monitoring is recommended when the wall construction is approximately 5 feet from maximum height. For settlement estimates, details of waiting periods and monitoring refer to the Geotechnical Design Report (GDR) for EA 06-325501.

Construction Considerations

1) Site preparation should be performed in accordance with Sections 16 and 19 of the State of California, Standard Specifications (July 2002 or latest version) and Special Provisions.

2) Earthwork should be performed in accordance with Section 19 of the Sate of California, Standard Specifications (July 2002 or latest version) and Special Provisions.

3) All fill materials used to construct the MSE walls and related fills should be in accordance with the Department of Transportation, Standard Specifications (July 2006 or latest version) and Special Provisions.

4) The native soil below the MSE leveling pad should be sub-excavated to a minimum depth of 5 feet below the bottom of the leveling pad and replaced with Structure Backfill material compacted to 95% RC as per section 19-5.03 of Standard Specifications. The base width of this excavation should be a minimum of 8 feet horizontally. The purpose of this is to reduce differential settlement and increased panel connection stress from the weight of the concrete panels, barrier and soundwall (see BDS Section 5.9.2.3).

5) If unsuitable soils are encountered at the bottom of the excavation, the unsuitable soils shall be removed and replaced with structure backfill and compacted to 95% RC.

6) Surface (survey) monument(s) should be placed and monitored for settlement when MSE height is within 5 feet of finished height. Specific recommendations for settlement estimates, monitoring and settlement criteria (primary settlement) are addressed in the Geotechnical Design Report. The approach slab, concrete barrier, and barrier slab along the top of the wall should not be cast until the primary settlement has ceased.

7) If an approved alternative MSE wall is chosen, preference should be given to systems that are able to be constructed in 2 stages. That is, to build a synthetically reinforced embankment with a wrapped face, waiting 120 days or until upon the Engineer's approval, and then constructing the face panels.

Any questions regarding the above recommendations should be directed to the attention of Doug Brittsan at (916) 227-1079, or Jim Morris at (530) 265-9867.

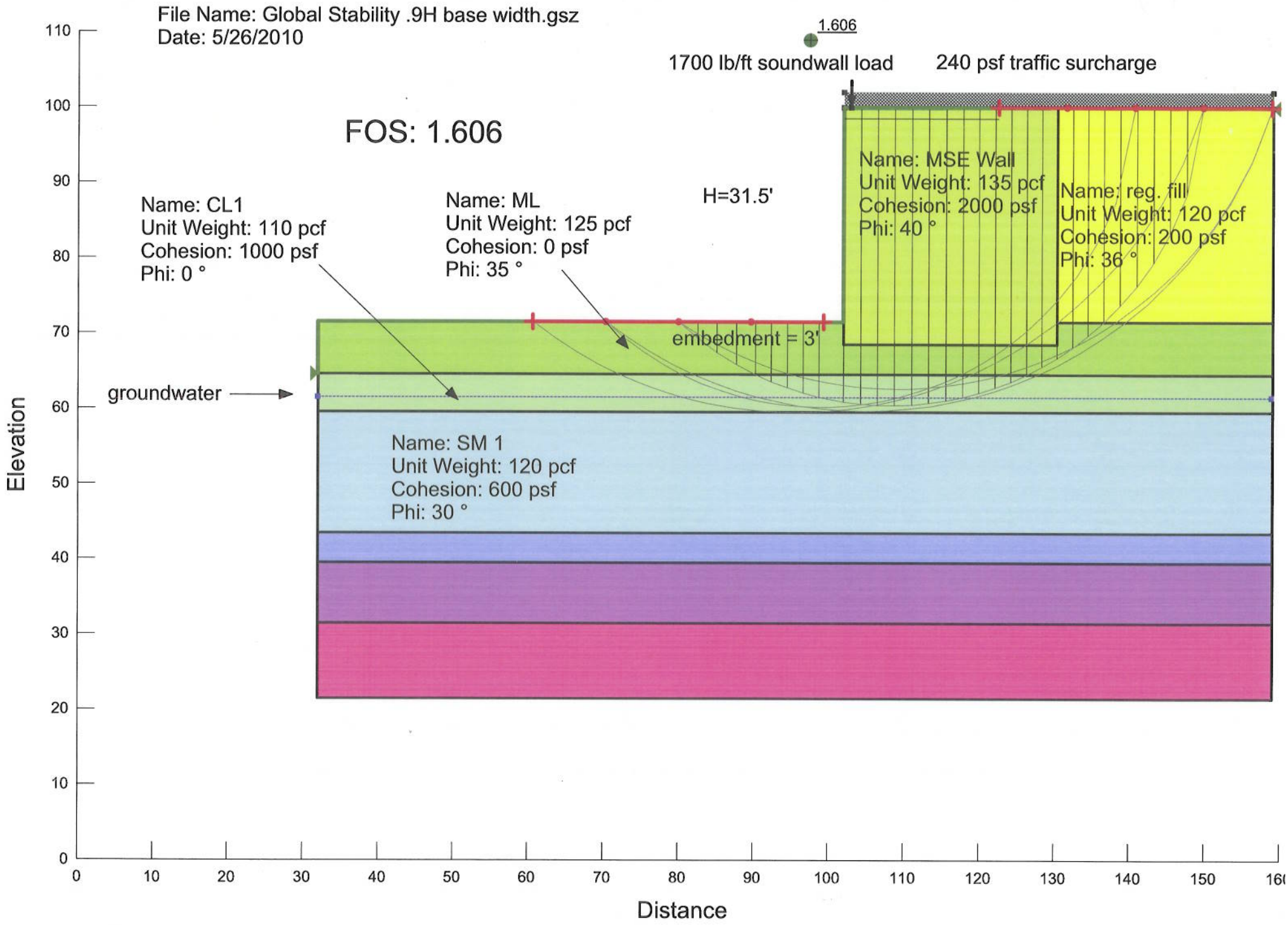
Prepared by: Date: 6/1/10

Douglas S. Brittsan

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS E. BRITTSAN
No. GE2459
Exp. 9/30/10
GEOTECHNICAL
STATE OF CALIFORNIA

DOUGLAS BRITTSAN, P.E., G.E.
Senior Transportation Engineer
Office of Geotechnical Design – North

c: Jim Heinen – PM (e-copy)
Str. Constr. R.E. Pending File
GS Corporate
DES OE, PS&E (e-copy)
DBrittsan
JPeterson, D03-DME (e-copy


File Name: Global Stability .9H base width.gsz
Date: 5/26/2010
1.606
1700 lb/ft soundwall load
240 psf traffic surcharge
FOS: 1.606
Name: MSE Wall
Unit Weight: 135 pcf
Cohesion: 2000 psf
Phi: 40 °
Name: reg. fill
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 36 °
H=31.5'
Name: CL1
Unit Weight: 110 pcf
Cohesion: 1000 psf
Phi: 0 °
Name: ML
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 35 °
embedment = 3'
groundwater
Name: SM 1
Unit Weight: 120 pcf
Cohesion: 600 psf
Phi: 30 °
Elevation
Distance
0
10
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120
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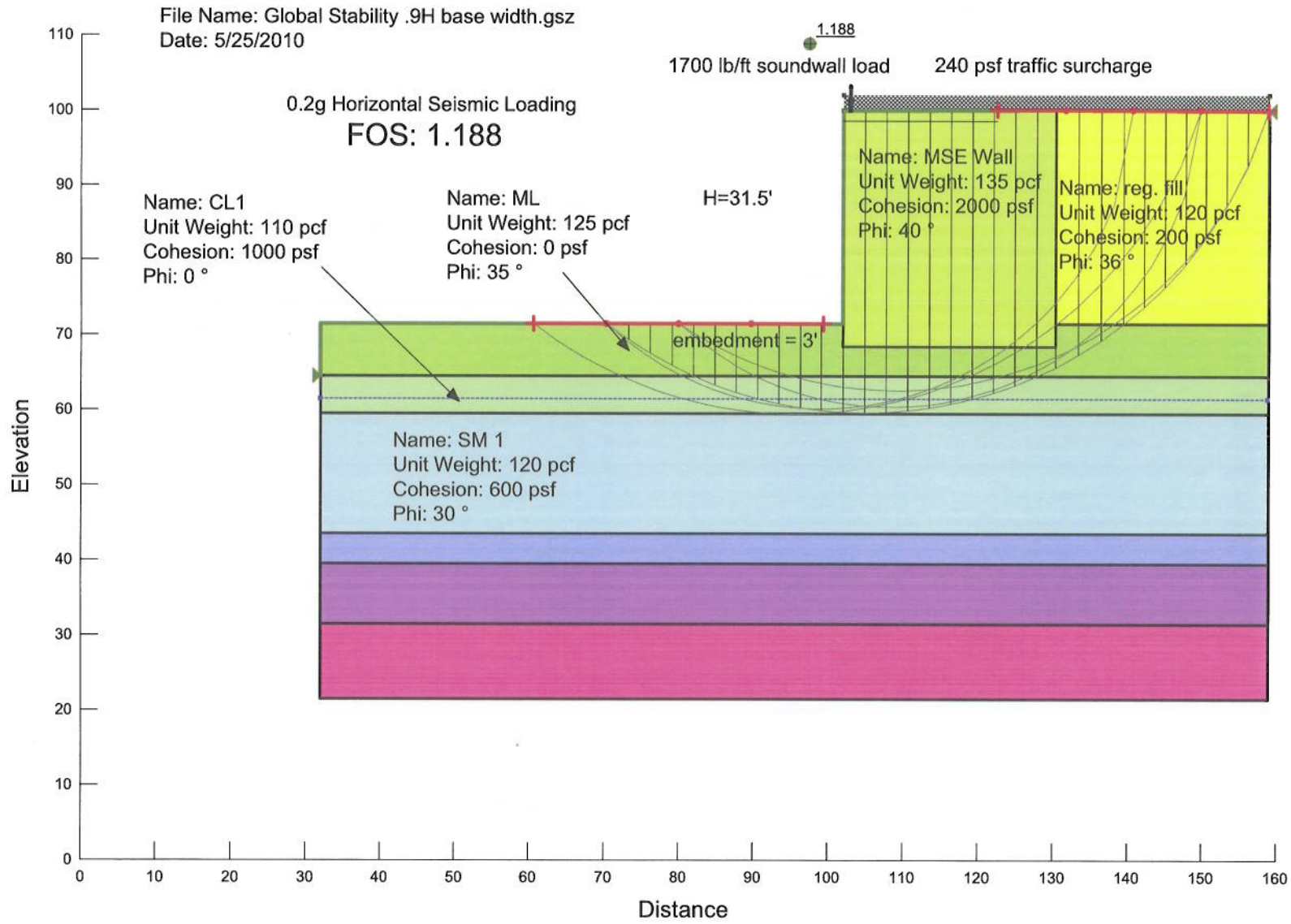
140
150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Date: 5/25/2010
1.188
1700 lb/ft soundwall load
240 psf traffic surcharge
0.2g Horizontal Seismic Loading
FOS: 1.188
Name: MSE Wall
Unit Weight: 135 pcf
Cohesion: 2000 psf
Phi: 40 °
Name: reg. fill
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 36 °
Name: CL1
Unit Weight: 110 pcf
Cohesion: 1000 psf
Phi: 0 °
Name: ML
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 35 °
H=31.5'
embedment = 3'
Name: SM 1
Unit Weight: 120 pcf
Cohesion: 600 psf
Phi: 30 °
Elevation
Distance
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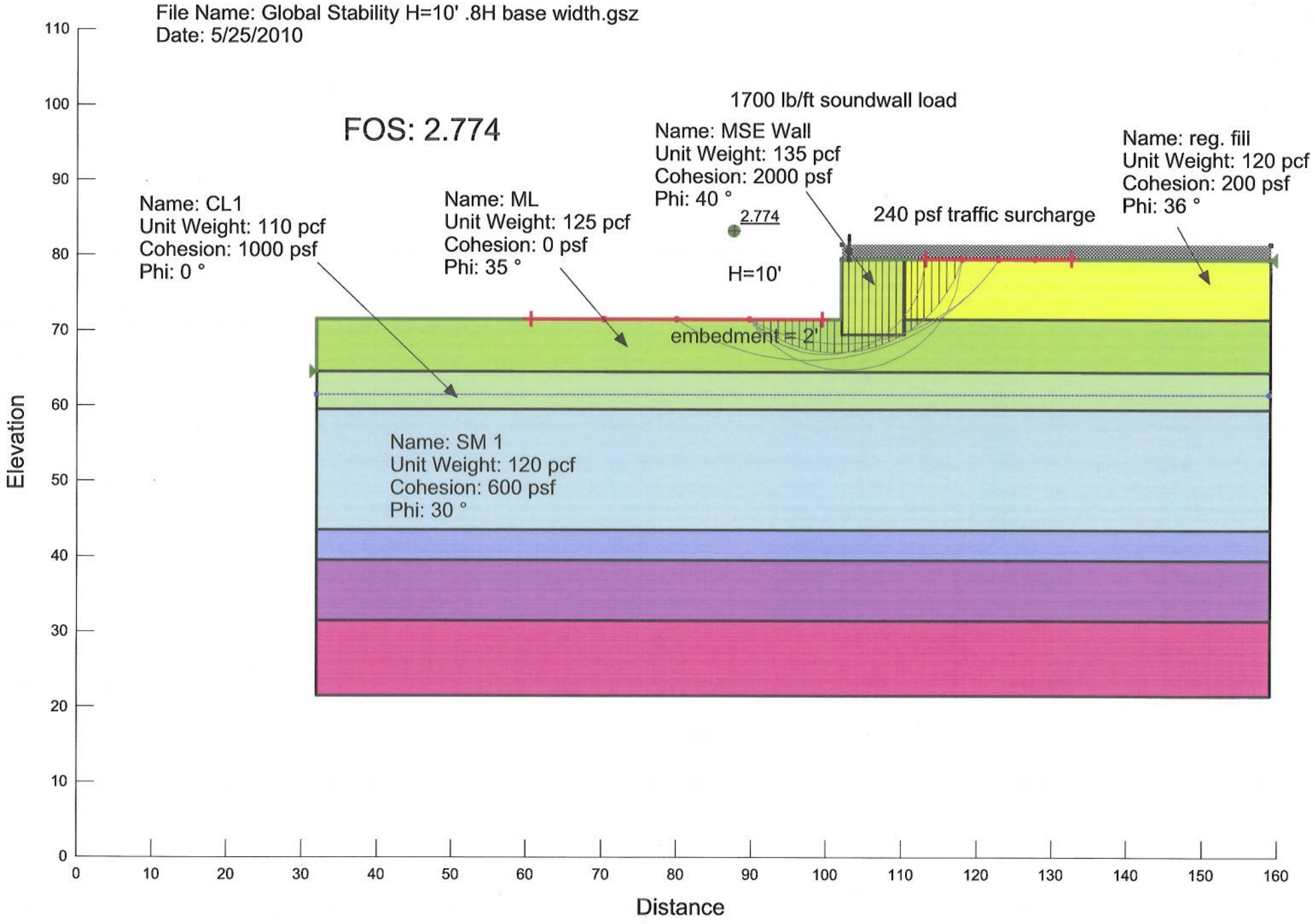
File Name: Global Stability H=10' .8H base width.gsz
Date: 5/25/2010
FOS: 2.774
1700 lb/ft soundwall load
Name: MSE Wall
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Phi: 40 °
Name: reg. fill
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 36 °
Name: CL1
Unit Weight: 110 pcf
Cohesion: 1000 psf
Phi: 0 °
Name: ML
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 35 °
2.774
240 psf traffic surcharge
H=10'
embedment = 2'
Name: SM 1
Unit Weight: 120 pcf
Cohesion: 600 psf
Phi: 30 °
Elevation
Distance
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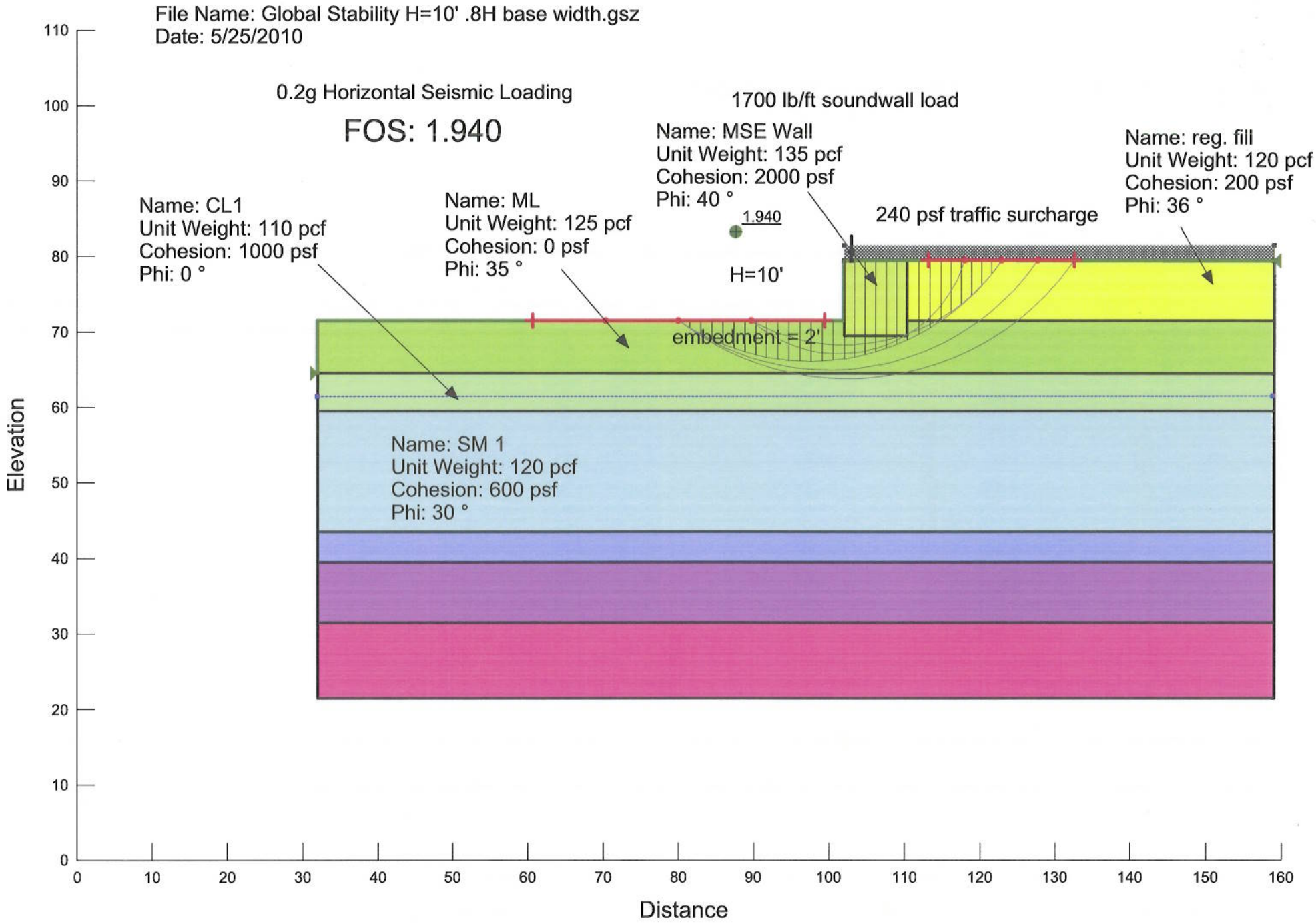
File Name: Global Stability H=10' .8H base width.gsz
Date: 5/25/2010
0.2g Horizontal Seismic Loading
FOS: 1.940
1700 lb/ft soundwall load
Name: MSE Wall
Unit Weight: 135 pcf
Cohesion: 2000 psf
Phi: 40 °
Name: reg. fill
Unit Weight: 120 pcf
Cohesion: 200 psf
Phi: 36 °
Name: CL1
Unit Weight: 110 pcf
Cohesion: 1000 psf
Phi: 0 °
Name: ML
Unit Weight: 125 pcf
Cohesion: 0 psf
Phi: 35 °
1.940
240 psf traffic surcharge
H=10'
embedment = 2'
Name: SM 1
Unit Weight: 120 pcf
Cohesion: 600 psf
Phi: 30 °
Elevation
Distance
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State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: PAUL CHUNG, Chief
Bridge Design Branch 17
Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES-17

Attention: Elijah Hall

Date: June 24, 2010

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
Half Gabion Wall
19th Ave OC
Br. No. 45-0104

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

Subject: Temporary Half Gabion-faced MSE Wall behind Abut 3, 19th Avenue Overcrossing (OC)

Scope of Work

This report provides recommendations for the construction of a temporary half gabion-faced reinforced soil wall (or a Hilfiker welded wire wall) as an end-wall to the south face of the proposed permanent MSE wall behind the Abutment 3 footing location of the proposed 19th Ave OC located in Kings County. The Office of Geotechnical Design North (OGD-N) has provided foundation recommendations (FR) under this EA for the proposed 19th Ave OC, the MSE retaining wall for the north embankment and for a Type 1 Retaining Wall at Abutment 3. A Geotechnical Design Report (GDR) is also being completed for the embankments to be constructed for the new 19th Ave/State Route (SR) 198 interchange project. This report provides complementary recommendations to those provided in the reports mentioned above.

Project Description

The weight of the embankment fill will cause settlement of the foundation soils. A total settlement of 12 to 14 inches has been estimated for the north approach embankment (see GDR for this project dated June 23, 2010). The foundations reports have recommended commencing construction of pile foundations only after settlement. The GDR recommends 120 day waiting period after the placement of the fill and the retaining structures.

An MSE wall is proposed to be constructed at the west side of north approach embankment to limit the footprint of the proposed 30 feet high embankment fill. The wall is required to retain the fill and minimize the footprint of the embankment for the existing residential dwellings located on the west side. The eastern extension of the embankment north of abutment 3 will slope at a ratio of to 2 Horizontal to 1 Vertical (2H:1V). The section of the embankment near

Abutment 3 will slope at a ratio of 4 horizontal to 1 vertical (4H:1V).
A full description of the permanent MSE wall is provided in the FR for MSE Retaining Wall dated June 1, 2010.

This report recommends the construction of a temporary half gabion wall (or the Hilfiker welded wire retaining wall) at the south face of the permanent MSE wall to allow for the subsequent construction of Abutment 3 after the specified settlement period. The half gabion wall may remain in place after construction of the abutment. Meanwhile, a fabric reinforced shoring backfill will also be added over the footprints of the abutment and the Type 1 retaining wall. This shoring will protect the temporary wall and provide surcharge over the footing areas of the abutment and retaining wall during settlement of the foundation soil. A detailed description of the temporary shoring backfill is provided in the GDR for this project (see Figures 1 & 2).

The half gabion (or welded wire wall)

The Half Gabion Return Wall (or the Hilfiker Welded Wire Wall) is a flexible soil reinforced earth retaining system comprised of welded wire mesh mats and compacted soil. The wall is usually configured and specified according to the need of the project.

1. *Location and configuration of the Half Gabion Wall*

The half gabion wall (or Hilfiker welded wire wall) for this project is to be constructed as an end-wall to the Standard MSE Retaining Wall proposed for the west side of the north embankment of the 19th Ave/SR 198 Interchange project. This wall is a temporary extension of the southern portion of the permanent wall to the footprint of the Abutment 3 foundation footing.
The width (eastern extension) equals the length of the welded wire mat soil reinforcements for the permanent MSE wall plus 1 foot (approximately 22 feet). The soil reinforcing wire mats of the half gabion wall shall be no less than 70% of the wall height at Abutment 3 (approximately 21 feet).

2. *Specifications of the half gabion wall*

a) The half gabion wall can be designed to have the same configuration as the permanent MSE wall.

b) The specified soil fill parameters and the soil reinforcement welded wire mesh mats for the permanent MSE wall shall also apply to the temporary wall.

c) The half gabion cages shall be constructed from steel wire fabric conforming to ASTM A-185 (ASHTO M 55), except that testing will be required on all wire mat configurations. The selected welded wire fabric mats need not be galvanized because the half gabion wall is temporary structure intended to last for approximately three years.

d) The half gabion cages shall consist of 9 gage non-galvanized welded wire fabric. Individual cages shall be 18 inches high by 18 inches wide and made with a mesh size of 3 x 3 inches.

e) The contractor has the option to acquire the cages and all other materials for use in the half gabion cages from Hilfiker Retaining walls in Eureka, California, C.E. Shepeard Co in Houston Texas, Maccaferri Inc. in West Sacramento, California, or equal.

f) Shipment of half gabion cages to the project site shall be accompanied by a Certificate of Compliance conforming to the provisions in the Section 6-1.07, "Certificate of Compliance" of the Caltrans Standard Specifications.

g) In assembling the gabion half cages (gabion-to-gabion joints), the gabion half cages shall be set in place. The constructed individual cages are then overlapped by approximately 4 inches and joined successively together to the next gabion half cage with 13.5-gage tie wire or 9-gage standard spiral binder before placing the geogrid fabric, and filling with rock and structure backfill.

h) The half gabion cages shall be joined along the front and bottoms of the adjacent gabion half cages.

Construction Considerations

1) Site preparation, excavation and all foundation issues shall be in accordance with those specified under "Construction Considerations" in the Foundation Report for 19th Ave MSE Wall, dated June 1, 2010.

2. The wire mesh reinforcement mats shall be place in similar manner as for the permanent MSE wall except the mats for successive lifts or sequences in the half gabion wall are offset at regular intervals (see Figure 3). place @ 2' 6"

3. The select soil fill and its placement shall follow the recommendations provided in the FR for permanent MSE Wall.

4. A geotextile filter fabric shall be used on the inside face to prevent the loss of backfill material inside the half gabion wall.

5. We recommend that the eastern face of the half gabion wall be fabric reinforced or wrapped for stability during construction of the footings for Abutment and the Type 1 retaining wall (see Figure 4 & 5)

6. There shall be a 2-to-3 feet wide gap between the half gabion wall and temporary shoring unit. The said gap shall be filled with granular material during the waiting period.

7. During construction of the abutment, adequate space is required behind the half gabion wall to allow for the construction of the abutment footing.

8. The construction of the Abutment 3 and Type 1 retaining wall after the waiting period will involve the removal of the temporary shoring backfill over the foundation footprints. The south face of the embankment fill will need to be appropriately sloped to maintain stability. The space behind the completed Abutment and the Type 1 retaining wall shall then be backfilled with the specified backfill material for the embankment.

9. Pile installation for all the structures shall only commence after the recommended waiting period for settlement or as recommended by the Engineer.

10. The Office of Geotechnical Design-North shall be invited to a pre-construction meeting.

The recommendations contained in this memorandum are based on specific project information regarding structure type, location and design loads that have been provided by Structure Design. If any conceptual changes to the structure are proposed during final project design, the Office of Geotechnical Design-North should review those changes to determine if the foundation recommendations herein provided are still applicable.

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:

1. *Log of Test Boring (LOTBs) 19th Ave OC (Br. No. 45-0104)*

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

1. *Foundation Report for 19th Avenue MSE Retaining Wall dated June 1, 2010*
2. *Foundation Report for 19th Ave OC dated May 10, 2010*
3. *Foundation Report for Type 1 Ret. Wall at Abut 3 of 19th Ave OC (Br No. 45-0104) dated June 1, 2010*
4. *Geotechnical Design Report for EA 06-325501dated June 23, 2010*

If you have any questions regarding this project, please contact Abu Barrie at (916) 227-1043, or Luis Paredes-Mejia at (916) 227-1047, or Douglas Brittsan at (916) 227-10 79.

Report by:

ABUBAKARR BARRIE
Engineering Geologist
Office of Geotechnical Design-North

Reviewed by

LUIS PAREDES-MEJIA, PG, CEG # 2329
Engineering Geologist
Office of Geotechnical Design-North

Attachments

c: Jim Heinen (E-copy)
Mark Willian (E-copy)
Struc. Cons. R.E. Pending File
DES OE, PS&E (E-copy)
Mike Weber DME (E-copy)

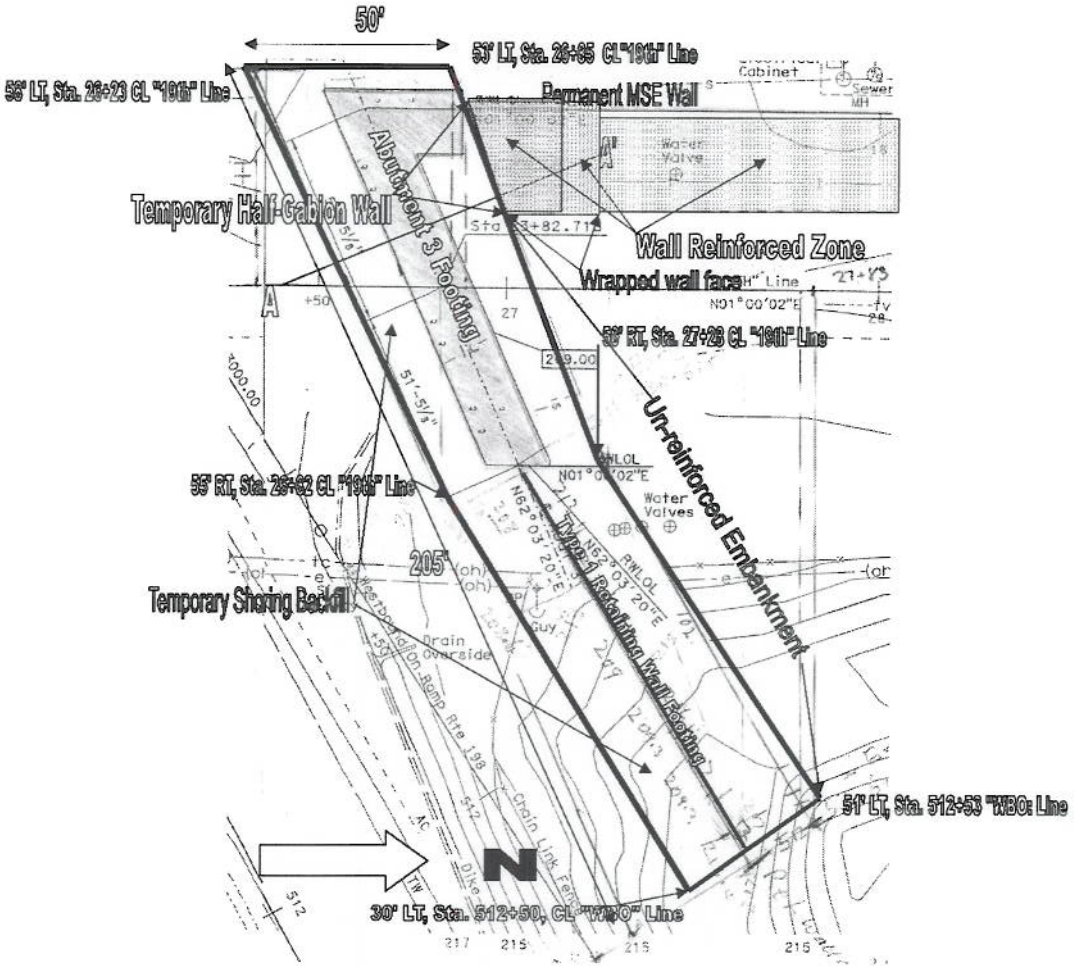

Figure 1: Locations of the half gabion wall and the temporary shoring backfill

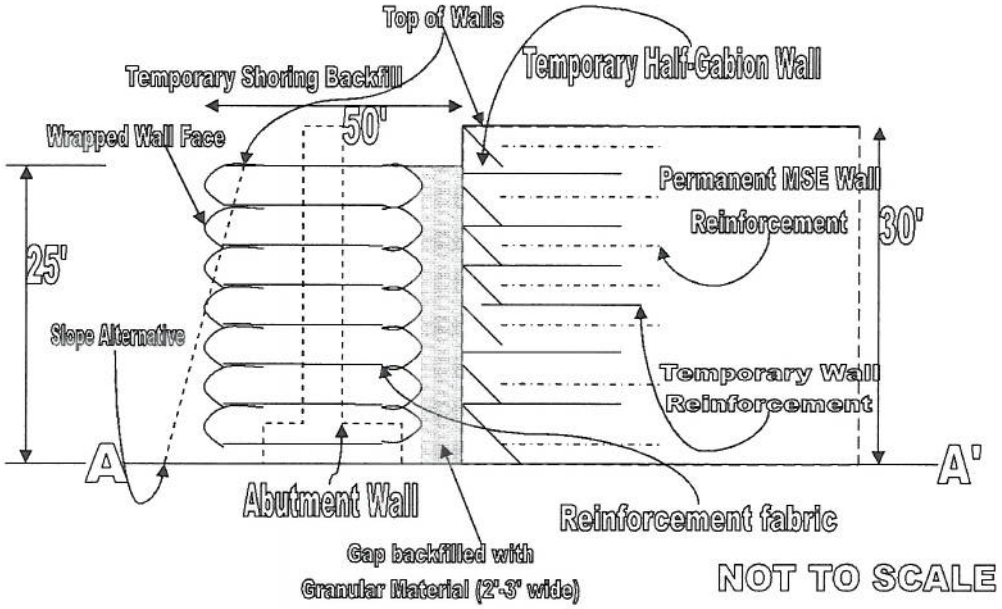

Figure 2: A cross section across the temporary shoring backfill and the half gabion wall

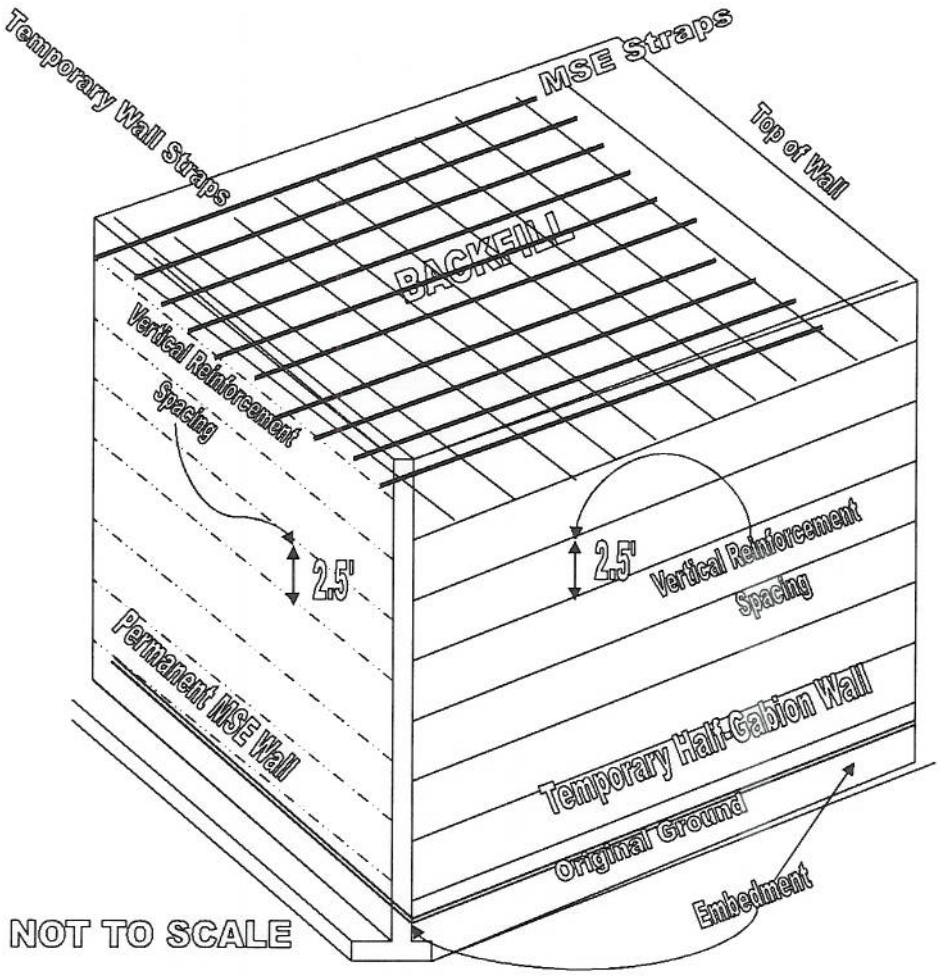

Figure 3: Schematic configuration of the wire mesh reinforcements for the MSE and half gabion walls

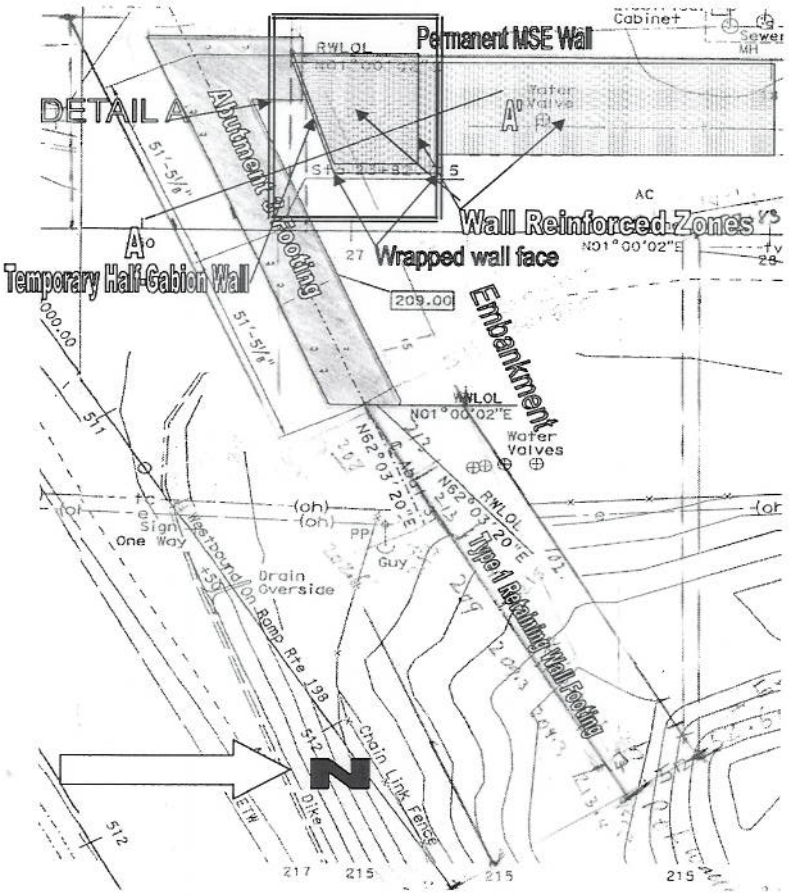

Figure 4 (a): Location of half gabion wall showing the east face

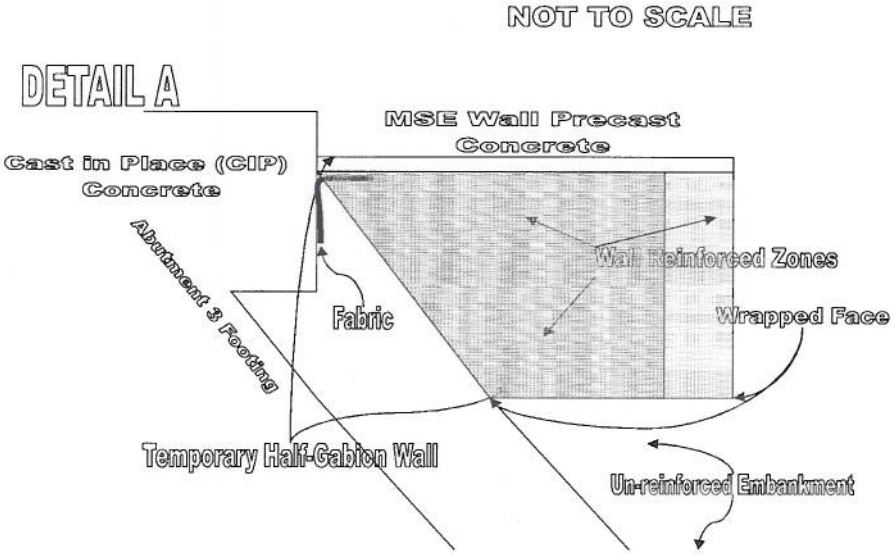

Figure 4 (b): Details of half gabion and MSE walls showing limits of the east face.

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: PAUL CHUNG, Chief
Bridge Design Branch 17
Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES-17

Date: June 13, 2011

File: 06-KIN-198-PM 9.4/10.2
06-325501
0600000367
Half Gabion Wall
19th Ave OC
Br. No. 45-0104

Attention: Rene Coria

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

Subject: **Addendum to Temporary Half Gabion-faced MSE Wall behind Abut 3, 19th Avenue Overcrossing (OC)**

Our Office is providing additional information and clarification to the report dated June 24, 2010, entitled "Temoporary Half Gabion-faced MSE Wall behind Abut 3, 19th Avenue Overcrossing.".

This Office recommends a 120 day waiting period after the placement of the fill for the temporary shoring structure and the MSE wall and half gabion wall. The temporary shoring structure shall be removed after the waiting period, but the half gabion wall will not.

The geosynthetic reinforcement used with the Gabion Half Cage wall shall have a LTDS of 2600 pounds/foot. In addition, on top of the geosynthetic, the contractor shall place a filter fabric as described in the standard specifications 88-1.03 to contain fill material within the basket.

Please find attached, the modified "Gabion Half Cage" non Standard Special Provision. Specific changes include changing the basket fill material from rock to the same material that is used in the MSE wall. Also, there needs to be at least 6" separation between the metal MSE reinforcement strips and the geosynthetic. The last change is that the Gabion geosynthetic reinforcement is placed perpendicular to the Gabion wall face. However, with the skew that we have, this would leave the west most baskets without enough

reinforcement. So we have added a line that the 3 west most baskets have additional geosynthetic placed parallel to the MSE wall face.

In addition, at this time, we are getting the concurrence letter for approval for the use of this nSSP.

If you have any questions, please call Luis Paredes-Mejia at (916) 227-1047.

Report by:

PROFESSIONAL GEOLOGIST
LUIS MARIO PAREDES-MEJIA
No. 2339
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

LUIS PAREDES-MEJIA
Engineering Geologist
Office of Geotechnical Design - North

Reviewed by:

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS E. BRITTSAN
No. GE2459
Exp. 9/30/12
GEOTECHNICAL
STATE OF CALIFORNIA

DOUGLAS BRITTSAN, P.E., G.E.
Senior Transportation Engineer
Office of Geotechnical Design - North

Attachment: Gabion Half Cage nSSP

c: Jim Heinen
Mark Willian
Structure Construction RE Pending File
DES Office Engineer
Mike Weber DME

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: **Structure Design**
1. Design
2. R.E. Pending File
3. Specifications & Estimates
4. File

Geotechnical Services
1. GD - North ; South ; West
2 GS File Room

Date: 4/14/11

19th Ave. OC
Structure Name

06 - Kin - 198 - 9.4/10.2
District County Route ~~km~~ Post
mi

District Project Development
District Project Engineer

06-325501 48-104
E.A. Number Structure Number

Foundation Report By: A. Barrie
Dated: 5/10/10 ; 4/4/11 ; 6/1/10 ;

Reviewed By: R. Corsini (SD) R. Prime (GS)

General Plan Dated: 4/13/11

Foundation Plan Dated: 4/13/11

☒ No changes. ☐ The following changes are necessary.

FOUNDATION CHECKLIST

Pile Types and Design Loads
Pile Lengths
Predrilling
Pile Load Test
Substitution of H Piles For Concrete Piles ☐ Yes ☒ No

Footing Elevations, Design Loads, and Locations
Seismic Data
Location of Adjacent Structures and Utilities
Stability of Cuts or Fills
Fill Time Delay

Effect of Fills on Abutments and Bents
Fill Surcharge
Approach Paving Slabs
Scour
Ground Water
Tremie Seals/Type D Excavation

Structure Design

17
Bridge Design Branch No.

Geotechnical Services

Rev. 06/02

FOUNDATION REVIEW

DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

To: **Structure Design**
1. Design
2. R.E. Pending File
3. Specifications & Estimates
4. File

Geotechnical Services
1. GD - North ; South ; West
2 GS File Room

Date: 4/14/11

19TH Ave OC MSE WALL
Structure Name

04-Kin-198-9.4/10.2
District County Route ~~km~~ Post M.

District Project Development
District Project Engineer

04-325501 45E104
E.A. Number Structure Number

Foundation Report By: D. Brittsan Dated: 6/1/10

Reviewed By: R. Tarin (SD) R. Pina (GS)

General Plan Dated: 11/2/10 Foundation Plan Dated:

☒ No changes. ☐ The following changes are necessary.

FOUNDATION CHECKLIST

- ___ Pile Types and Design Loads
- ___ Pile Lengths
- ___ Predrilling
- ___ Pile Load Test
- ___ Substitution of H Piles For Concrete Piles ☐ Yes ☒ No
- ___ Footing Elevations, Design Loads, and Locations
- ___ Seismic Data
- ___ Location of Adjacent Structures and Utilities
- ___ Stability of Cuts or Fills
- ___ Fill Time Delay
- ___ Effect of Fills on Abutments and Bents
- ___ Fill Surcharge
- ___ Approach Paving Slabs
- ___ Scour
- ___ Ground Water
- ___ Tremie Seals/Type D Excavation

Eyal Hall 17
Structure Design Bridge Design Branch No.

Geotechnical Services

Rev. 08/02

GEOTECHNICAL DESIGN REPORT

for the

19TH AVENUE INTERCHANGE
Br. No. 45-0104

State Highway 198
Lemoore, California
06-KIN-198-PM 9.4/10.2
EA: 06-325501

Prepared for:

California Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Structural Design

By:

California Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design – North

June 23, 2010

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1. INTRODUCTION

Per your request, the Office of Geotechnical Design - North (OGDN) has prepared a Geotechnical Design Report for the proposed 19th Avenue Interchange (IC) where it intersects with State Route 198 in the City of Lemoore in Kings County (see **Figure 1**). The newly assigned bridge number for the overcrossing (OC) is 45-0104. The proposed OC project is part of a roadway widening and improvement program along the SR 198 corridor. The purpose of this GDR is to advise the designer regarding project-specific geotechnical issues, including expected embankment fill settlement.

The following 19th Avenue Interchange project information was provided to this Office by the Office of Structure Design and the consultant, AECON:

- 19th Avenue Overcrossing Retaining Wall Layout No.1, dated 04-15-2010
- 19th Avenue Overcrossing Retaining Wall Details, dated 04-15-2010
- 19th Avenue Overcrossing Abutment 3 Layout, dated 05-06-2010
- Contour Grading Sheets G-3 & G-8, dated 09-22-2009
- Layout Sheet L-3, dated 09-22-2009
- Park Grading with Section A-A' irrigation canal, undated
- Preliminary Utility Relocation Map, dated 04-07-2009
- Sound Wall Plan SW-1 and SW-2, dated 03-17-2010
- Typical Cross Sections X-4, X-5 & X-7, dated 09-23-2009

Separate Foundation Reports were prepared for the bridge design, the MSE wall, and for the Type 1 cantilever wall founded on driven piles.

2. EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

Based on project information received through June 16, 2010, the proposed improvements are as follows:

The current facility consists of an at-grade intersection bordered by residential properties to the northwest (see **Photo 1**), a municipal park with detention basin to the northeast, a fallow agricultural field to the southeast, and commercial properties and another fallow field to the southwest. Traffic control is provided by stop signs on 19th Avenue.

According to the design information provided to this Office, the proposed improvements will convert the existing at-grade intersection at SR 198/19th Avenue to a 2-quadrant clover interchange (see **Figure 2**). The OC construction will raise the existing 19th Avenue roadway onto the new bridge, Br. No. 45-0104. This proposed structure will consist of a 2-span cast-in-place/prestressed (CIP/PS) concrete box girder bridge with a four column bent and abutments.

Fill embankments will be constructed to a maximum height of about 28 feet on the south end of the bridge, with a 30-foot high mechanically stabilized earth or embankment (MSE) wall to the north, adjacent to the residential area. The approach embankment will be approximately 80 feet wide by 875 feet long at the north approach and 353 feet long for the south approach. The system to be used for the MSE wall may incorporate welded wire mat soil reinforcement with 5-foot by 5-foot precast concrete panel facing or an approved alternate design. Prior to the settlement period, a temporary shoring backfill will be constructed to provide surcharge prior to construction of Abutment 3.

The surface structures on the MSE embankment will include a concrete traffic barrier with a 6-foot tall sound wall founded on eccentrically loaded pile foundations (as depicted on Caltrans Bridge Standard Detail Sheets, Section 13, "*Mechanically Stabilized Embankment Walls*", Details No. 5, dated March 2010). The project will also include construction of a Type 1 cantilever retaining wall founded on driven piles as well as additional masonry sound walls along the north side of SR 198 and at the intersection of 19th Avenue and Silverado Drive. Two new overhead signs on CIDH pile foundations will be built on SR 198.

The proposed project will require abandonment or relocation of several utilities, including an underground 4-inch diameter gas line, telephone cable, television cable, 36" RCP irrigation canal, overhead electrical and Comcast and ATT fiber and cable, as well as several water supply valves. An existing sewer pump station adjacent to the residential properties will be relocated. Auxiliary lanes will be constructed on SR 198 between SR 41 and 19th Avenue, and the at-grade access at 18 ½ Avenue will be removed. A "knuckle" configuration will be constructed at Beech Lane and a cul-de-sac will be constructed south of SR 198.

3. PERTINENT REPORTS AND INVESTIGATIONS

- Bloomfield, R.A., Soliman, A.F., Abraham, A.; "Performance of Mechanically Stabilized Earth Walls Over Compressible Soils", Landmarks in Earth Reinforcement, Swets & Zeitlinger Publishers, The Netherlands, 2003

- California Department of Water Resources web site for groundwater level data: http://www.water.ca.gov/waterdatalibrary/groundwater/hydrographs/township_wells.cfm

- *Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes – Vol. 1,* Publication No. FHWA-NHI-10-024, U. S. Department of Transportation, Federal Highway Administration, November 2009

- Foundation Report for 19th Avenue MSE Retaining Wall, Caltrans Office of Geotechnical Design, dated June 1, 2010

- Foundation Report for the 19th Avenue OC, Caltrans Office of Geotechnical Design, May 10, 2009

- Galloway, D., and Riley, F.S., "San Joaquin Valley, California: Largest Human Alteration of the Earth's Surface", in U.S. Geological Survey Circular 1182, *Land Subsidence in the United States*, pp. 23-34, 1999

- "Geologic Map of California – Fresno Sheet", California Department of Conservation, Division of Mines and Geology, 1965

- *Mechanically Stabilized Embankment*", Caltrans Bridge Design Aids, March 2009

- *Mechanically Stabilized Embankment Walls*, Caltrans Bridge Standard Detail Sheets, Section 13, Details No. 5, March 2010

- National Resource Conservation Soil Survey, U.S. Department of Agriculture website, http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

- Western Regional Climate Data Center website, www.wrcc.dri.edu, February 2010

- Zeevaert, L., *Interaccion Suelo-Estructura de Cimentaciones Superficiales y Profundas, Sujetas a Cargas Estaticas y Sismicas*, Editorial Limusa, Mexico, First edition, 1980

4. PHYSICAL SETTING

The physical setting of the project site and the surrounding area was reviewed to provide climate, topography and drainage, geology, and seismicity characteristics to aid in the project design and construction.

4.1 Climate

The proposed 19th Avenue OC will be constructed in the city of Lemoore in Kings County. Lemoore is located within the San Joaquin Valley, which comprises the southernmost two-thirds of California's Great Valley geomorphic province. The valley floor climate is generally hot and dry in the summer. During the winter the valley is cool and damp, and often covered by a ground or "tule" fog. The annual rainfall varies from five to sixteen inches, usually occurring from November through April. Evapotranspiration rates are high in the San Joaquin Valley and reportedly cause perennial water shortages in the region.

The nearest weather station to the proposed OC that has complete climate data is the "Hanford 1 S" station, located approximately nine miles southeast of Lemoore. The following data are based on monthly climate records maintained by the Hanford 1 S station for the period from July 1, 1899 through August 31, 2009: Average yearly precipitation is 8.3 inches and air temperatures range from an average maximum of 98°F in July to a minimum of 35°F December. There is no historic record of snowfall in this locality.

4.2 Topography and Drainage

The Great Valley geomorphic province is an elongate structural trough, about 400 miles long and 50 miles wide, that is filled with very deep marine and continental sedimentary deposits which are overlain by more recent alluvial sediments. The San Joaquin Valley, comprising the southernmost two-thirds of the Great Valley, is bound on the north by the Sacramento Valley and Sacramento-San Joaquin Delta, on the east by the

Sierra Nevada, the Tehachapi Mountains to the south, and the Coast Ranges to the west.

The San Joaquin Valley is further divided hydrographically into two basins, the San Joaquin Basin and the Tulare Basin. The Kings River, one of the large rivers descending westward from the Sierras through steep canyons and onto the relatively flat Great Valley, usually delineates the boundary between these two basins. Over thousands of years these rivers formed a system of streams that terminated in large topographic sinks on the valley floor, forming marshes and lakes. Many of these features have shrunk or dried up as population growth and development in the area has increased. The former Tulare Lake is now virtually dry but it was once recognized as the largest freshwater lake west of the Mississippi River.

Shallow groundwater occurs within unconfined to semi-confined aquifers but there is also a deep aquifer confined by an areally extensive, thick lacustrine clay layer known as the Corcoran clay (or E clay) member of the Tulare Formation. As the San Joaquin Valley developed into one of the world's most productive agricultural regions, increased rates of deep groundwater extraction, exacerbated by periods of drought, caused significant and unrecoverable land subsidence. Historically, fluid withdrawal associated with oil and gas field operations has also caused extensive land subsidence in the valley. According to the USGS (1999), aquifer levels have dropped more than 400 feet since 1961. The maximum amount of historic subsidence in the area, over twenty eight feet, was measured in Mendota (see **Figure 3**). Federal reclamation projects and the California Water Project were constructed to relieve stress on the deep aquifer, and by the 1960s they began to divert surface water for irrigation. This helped to minimize groundwater overdraft and lowered the rate of land subsidence in many areas. More recently, water banking strategies have been employed to store excess water accumulated during wet periods for use during dry periods. Groundwater recharge occurs primarily from surface water (stream recharge) and the deep percolation of irrigation water into the more permeable layers.

4.3 Man-made and Natural Features of Engineering and Construction Significance

The San Joaquin Valley supports a diverse agricultural economy, with products including livestock and livestock products, fruits and nuts, cotton, hay and grains. The proposed 19th Avenue IC project is located in an agricultural area that is gradually undergoing urbanization. As a result,

there currently exists a mix of remnant agricultural appurtenances with more recently constructed residential and commercial structures. These include agricultural irrigation control systems, single family residences, apartment buildings with large paved parking areas, a sewage pump, underground and overhead utilities, a 36" diameter RCP irrigation canal, a detention basin, and municipal park. Recent improvements south of the existing intersection include a service station and commercial lodging.

4.4 Regional Geology and Seismicity

The city of Lemoore is located in northern Kings County, within the San Joaquin Valley. The project area is underlain by the Plio-Pleistocene Tulare Formation, which is composed of lacustrine and alluvial sediments. Within this formation is the Corcoran clay, a thick lake deposit that is considered the boundary between an upper and lower zone of regional aquifers. It appears to be the thickest in the northern part of the San Joaquin Valley and tapers or disappears entirely toward the southernmost part of the valley. The Tulare Formation has been structurally deformed by faulting, with evidence of both strike-slip and thrust motion, and is an oil-bearing formation. Overlying the Tulare lacustrine deposits are geologically recent alluvial fan deposits (Qf) that consist mostly of continental sands, silts, silty clays and clays that originated in the Sierran granites to the east. The contact between the two units can be difficult to ascertain, because the deposits can appear so similar lithologically.

The following discussion on regional seismicity is derived from the Foundation Report (FR) for this project, dated May 10, 2010:

Based on the Department of Transportation (Caltrans) Seismic Hazard Map of 1996, the controlling fault for the proposed project site is the Coast Ranges-Sierran Block Boundary Zone (CSB). The CSB fault zone is located approximately 28 miles west of the project site and is capable of generating a Maximum Credible Earthquake moment magnitude of M_W=7.0. Based on the above-referenced map, the recommended estimate for Peak Horizontal Bedrock Acceleration at this site is 0.2g. There are no known faults projecting towards or passing directly through the project site, therefore the potential for surface rupture at the site due to fault movement is considered insignificant.

Data from the LOTB developed from the 2009 field exploration for this project indicates the soil profile at the site may be classified Type D, as defined by the Department's Seismic Design Criteria (SDC). The

recommended design Acceleration Response Spectrum curve included in the PFR was obtained from Figure B.8 of the SDC. According to the SDC guidelines, the ARS curve should be modified for structures that are within 10 miles of a fault. However, since the distance to the CSB fault zone to the project site is greater than 10 miles, no modification to the ARS curve is required.

4.5 Soil Survey Data

Information on the soils at the project area was obtained from the National Resource Conservation Soil Survey (NRCSS) website, which provides characterizations of soils for the first few feet below ground surface. The project area is underlain by Lemoore Series soils, which includes dark grayish brown, deep, somewhat poorly drained sandy loams formed in alluvium from igneous and sedimentary rock sources. Below a depth of seven inches the soils are described as very slightly to moderately saline, and slightly effervescent with disseminated lime. Soil pH increases (becomes more alkaline) with depth, ranging from 7.1 (neutral) at the surface to 10 (very strongly alkaline) at a depth of approximately three feet.

The NRCSS website further describes Lemoore Series soils as corrosive to steel and to concrete; however, our laboratory tests determined the collected soil samples to be non-corrosive based on Caltrans criteria. Nonetheless, the existing soil may not be suitable for MSE backfill material if alternate criteria are applied when using soil reinforcement products.

5. FIELD EXPLORATION

5.1 Drilling and Sampling

The information and recommendations included in this report are based on subsurface explorations conducted from May through July of 2009 for the 19th Avenue Overcrossing foundation investigation. In addition to the three borings for the bridge foundation investigation, nine additional 5 in-diameter rotary borings and seven CPT borings were drilled to further characterize the subsurface materials.

As noted above, the 2009 subsurface exploration for the bridge foundation consisted of three exploratory mud rotary sample borings (R-09-001, R-09-002, and R-09-003). The mud rotary borings were advanced using a self-casing wire-line drilling method to a maximum depth of 121.5 ft below ground surface or approximate elevation 92.5 ft. Equipment used for the

subsurface investigation consisted of CS 2000 and Acker drill rigs, both equipped with automatic hammers. Sampling was achieved by utilizing continuous Standard Penetration Tests (SPT) for the first 10 feet and at 5-foot intervals thereafter. Shelby tubes and brass tube samples were collected at various depths based on the investigator's criteria. Selected soil samples were either bagged or cased in brass tubes and Shelby tubes for subsequent laboratory testing.

For the structures, subsurface exploration for characterization of the underlying material consisted of all twelve 5-in rotary borings to a maximum depth of 121.5 ft below ground surface.

5.2 Piezometers

Two of these borings were completed as standpipe piezometers to collect perched water level measurements over several months. The measured water levels did not indicate significant seasonal change over time, varying by only a couple of inches from summer to winter months.

5.3 Cone Penetrometer Tests (CPT)

Three separate measurements are taken vertically with depth during a cone penetrometer test: tip resistance (q_t), sleeve friction (f_s), and porewater pressure (u). These measured readings are used to develop soil profiles by delineating between soil layers and provide engineering parameters for design. In addition to rotary borings, OGDN's geotechnical investigation included seven CPT borings completed to a maximum depth of 50 ft below ground surface. See **Figure 5** for a map showing all boring and CPT locations. Printouts of the CPT graphs and inferred soil profiles are available in **Appendix A**.

6. GEOTECHNICAL TESTING

6.1 In-situ Testing

Four percolation test sites were hand-dug, one in each proposed detention basin as shown in **Figure 5,** to a depth of one foot. The results of the percolation tests are as follows:

Detention Basin 1:	2874 gal/ft^2/day, or 192 inches per hour
Detention Basin 2:	861 gal/ft^2/day, or 57.6 inches per hour

Detention Basin 3: 49 gal/ft^2/day, or 3.3 inches per hour
Detention Basin 4: 423 gal/ft^2/day, or 28.3 inches per hour

6.2 Laboratory Testing

The subsurface investigation for the proposed detention basins and fills for the on and off ramps consisted of seven borings of variable depths: the four hand-dug percolation test sites and three rotary borings (R09-05, R09-06, and R09-09). Soil samples from all locations were submitted to the Translab soils laboratory for the following soil tests:

- Moisture Content (ASTM D 2216-05)
- Unit Weight (ASTM D 4767-04)
- Particle-Size Analysis (ASTM D 422-63)
- Liquid Limit, Plastic Limit and Plasticity Index (AASHTO T 89-02 & 90-00)
- Consolidation Remolded (ASTM D 2435-04)
- Direct Shear Remolded (ASTM D 3080-04)
- Relative Compaction (CTM 216)
- R-Value (CTM 301, AASHTO T 190-02)

The referenced tests were used to assist in classifying the soil encountered during the subsurface investigation. A summary of these soil laboratory analyses is provided in **Appendix B**.

6.3 Corrosion Potential

Several composite soil samples were collected from Borings R-09-001, R-09-006, R-09-007, R-09-009 and R-09-010 during the 2009 subsurface investigation. The Office of Testing and Technology Services, Corrosive Technology Branch tested the samples for corrosive potential. For structural elements such as sound walls, the Corrosion Technology Branch considers a site to be corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site: chloride concentration of 500 ppm or greater, sulfate concentration of 2000 ppm or greater, or if pH is 5.5 or less.

Minimum resistivity serves only as an indicator parameter for the possible presence of soluble salts and is not included to define a corrosive site. It is the practice of the Corrosion Technology Branch that if the minimum resistivity of a sample is greater than 1000 ohm-cm, the sample is considered to be non-corrosive and testing to determine sulfate and chloride content is not performed. The results of our laboratory tests determined

that the composite soil samples collected during our geotechnical investigation are non-corrosive. For MSE structure backfill material, a different set of criteria applies (see SIC Corrosion No.C644089 in Table 6.3 below): Minimum resistivity >1500 ohm-cm, chloride concentration <500 ppm, sulfate concentration <2000 ppm, and pH between 5.5-10.

Corrosion test results from the Caltrans Corrosion Technology Branch are shown in the following table:

Table 6.3 - Corrosion Test Summary of Composite Samples

SIC Corrosion Number	Boring Number	Sample Depth (ft)	pH	Minimum Resistivity (ohm-cm)	Sulfate Content (PPM)*	Chloride Content (PPM)*
C644089	R-09-001	12.0-15.0	9.26	1171	110	32
C644090	R-09-001	51.5-55	9.00	408	1500	99
C644091	R-09-006	0.0-5.0	8.08	5676	---	---
C644092	R-09-006	61.5-70.0	9.51	558	110	46
C749321	R-09-007	0.0-1.5	8.80	2761	---	---
C749322	R-09-009	0.0-1.5	8.14	627	389	384
C703564	R-09-010	2.5-4.0	7.91	837	30	1758

7. SUBSURFACE CONDITIONS

7.1 Site Geology and Borings

The project is located in the southern San Joaquin Valley and is underlain by deep alluvial and lacustrine deposits derived from igneous and sedimentary rock. The field investigation for this project began in May of 2009, with rotary borings to a maximum depth of 121 feet. Based on the findings of these borings, the subsurface material consists of interbedded granular and cohesive soils comprised of sand, silt, silty clay and clay. The granular soil consists mostly of loose to medium dense, fine to medium grained layers of micaceous sand and silty sand. The cohesive fraction consists of soft to mostly medium stiff to very stiff clay, sandy clay, silty clay, sandy silt, and silt with a few hard layers. Some cohesive layers contain yellow/brown oxides and calcite veins and veinlets. The granular soil encountered below elevation 120 feet is generally dense to very dense. More detailed descriptions of the borings will be available in the LOTBs

for the bridge foundation. Logs in gINT format are available by request from this Office.

Table 7.1 : Summary of the Geotechnical Exploration Information

Boring Number	Station (ft)	Offset (ft)	Top of Borehole Elevation (ft)	Bottom of Borehole Elevation (ft)
R-09-001	23+97.5	111'Rt. CL	214	±92.
R-09-002*	25+63.7	25' Rt. CL	217	±115
R-09-003*	26+80.6	46' Lt. CL	214	±92
R-09-004*	28+22.5	34' Lt. CL	214	±172
R-09-005	23+85	650' Rt. CL	215	±158
R-09-006	25+20	250' Rt. CL.	214	±142
R-09-007	22+82.5	35' Rt. CL.	214	±147
R-09-008	30+24	42' Lt. CL	213	±162
R-09-009	31+84	165' Rt. CL.	216	±164
R-09-010	32+90	47' Lt. CL.	213	±162
R-09-011	504+15	"XA1" line CL.	216	±164
R-09-012	500+90	45' Lt. CL.	216	±151
CPT 1	22+66	27' Rt. CL.	214	164
CPT 2	505+87	60' Lt. "XA1" line CL	216	166
CPT 3	517+63	340' Lt. "XA1" line CL	213	163
CPT 4	323+80	"XA1" line CL	213	163
CPT 5	521+17	22.2' LT "XA1" line CL	213	163
CPT 6	31+84	160' Rt. CL	216	166
CPT 7	35+85	63' Lt. CL	213	163

* These borings are included in the Foundation Report for the new bridge.

7.2 Soils

As noted earlier in this GDR, the subsurface investigation indicates the project area is underlain by interbedded granular and cohesive soils comprised of sand, silt, silty clay and clay. The granular soil consists mostly of loose to medium dense, fine to medium grained layers of micaceous sand and silty sand. The cohesive fraction consists of soft to mostly medium stiff to very stiff clay, sandy clay, silty clay, sandy silt, and silt with a few hard layers. Some cohesive layers contain yellow/brown

oxides and calcite veins and veinlets. The granular soil encountered below elevation 120 feet is generally dense to very dense.

7.3 Surface Water

The southern part of the San Joaquin Valley has closed drainage except during the wettest years. The ground surface within the project area has very low relief and no creeks or streams. However, rainfall tends to pond in low areas due to the poorly draining soils, and many surface soils in the valley are clayey and very saline. Local water agencies report that water sources in the area are characterized by high total dissolved solids, containing significant concentrations of calcium, magnesium, sodium, bicarbonates, selenium, sulfates and chlorides. During our field review we observed significant deposits of soluble salt minerals accumulating in the agricultural fields to the southeast, left behind as surface waters with high total dissolved solids repeatedly collected and evaporated. Ponded areas in the vicinity had a brackish odor.

7.4 Groundwater

Mineralized, perched water was encountered during our subsurface investigation at relatively uniform depths. Water level measurements taken in May and June 2009 ranged from about 10 to 11 feet below the ground surface. Subsequent measurements of the perched water level, taken in February 2010 from four wells within the project area, were slightly higher and ranged from about 9.6 to 10 feet below ground surface.

The groundwater aquifer used for water supply is confined by the E clay layer, is located significantly deeper, and does not affect this project.

8. PROJECT SITE SEISMICITY

8.1 Fault Surface Rupture Hazard

There are no known faults that cross the project site; therefore the probability of fault surface rupture is considered negligible.

8.2 Liquefaction

Liquefaction can occur when loose to medium dense, granular, saturated soils located within fifty feet of the ground surface are subject to ground shaking. The distance from the project site to the Coast Ranges- Sierran

Block fault zone is greater than 10 miles and there are no known faults projecting towards or passing directly through the project site. The recommended estimate for Peak Horizontal Bedrock Acceleration at this site is 0.2g. The analysis of the subsurface conditions at the proposed new bridge location, based on the LOTB generated between May through July 2009 for this project, indicates that liquefaction potential at this site is considered negligible.

9. GEOTECHNICAL ANALYSIS AND DESIGN

9.1 Approach Embankments

The proposed project will elevate the existing 19th Avenue roadway by as much as 30 feet to create adequate clearance for the new overcrossing and to accommodate the proposed interchange. This will involve placement of new fill and construction of earth retaining structures to reduce the footprint of the high embankment. The proposal is to construct an MSE wall on the west side of the north approach embankment to protect existing adjacent underground utilities and residential dwellings. The east slopes of the embankments will be constructed at a slope ratio of 4:1 behind a Type 1 retaining wall.

The height of the proposed embankments will decrease away from the bridge abutments as shown in the following table. The north and south approach embankments will be approximately 875 and 353 feet long, respectively. The north embankment will be a maximum of 30 feet high and 88 feet wide. Total settlement of 12 to 14 inches was calculated at the maximum height of the embankments.

Where reinforcement of the temporary wall and the permanent MSE wall intersect, a temporary Hilfiker or half-gabion type wall (henceforth referred to as "temporary half-gabion wall"), will be installed to allow construction of the Abutment 3 foundation. Details for the temporary half-gabion wall are provided in the Foundation Report for Temporary MSE Wall, dated June 21, 2010. To protect and shore the temporary half-gabion wall and to provide surcharge during the settlement period, a reinforced shoring backfill will be constructed on the footprints for Abutment 3 and the Type 1 retaining wall. See **Figure 9.3.0**.

Our Office calculates that 90% of the total embankment foundation settlement will occur during the first four month period (120 days) after construction of the embankment. Additional surcharge is not recommended.

The calculated settlements are discussed in **Section 9.2**, "Settlement Analyses". Embankments shall be constructed and new fill shall be placed in accordance with Caltrans "Standard Specifications".

Table 9.1 - North and South Embankment Heights and Stationing

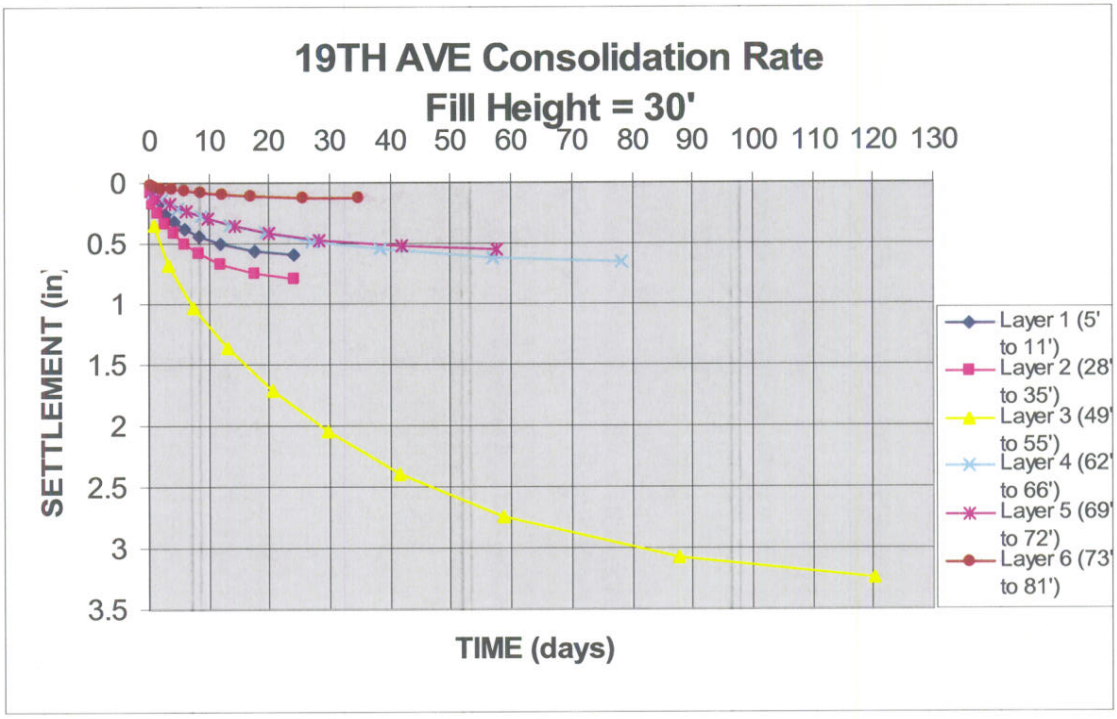
North Embankment: (875 ft long)			**South Embankment: (353 ft long)**		
Design height 'H' (ft)	STATION (from Abut 3) START	END	Design height 'H' (ft)	STATION (from Abut 1) START	END
30	26+65	27+40	28	23+00	23+37
28	27+40	28+20	26	22+24	23+00
26	28+20	29+00	24	21+54	22+24
24	29+00	29+50	22	20+74	21+54
22	29+50	30+00	20	20+14	20+74
20	30+00	30+50	18	20+14	20+14
18	30+50	31+00	16	20+10	20+14
16	31+00	31+50	12	20+00	20+10
14	31+50	32+00	6	19+84	20+00
12	32+00	32+50			
10	32+50	33+00			
8	33+00	33+50			
6	33+50	35+45			

9.2 Settlement Analyses

The presence of clay and sand layers in the underlying soils will produce consolidation and settlement, respectively, under the weight of the proposed embankment and the external static loads from the overlying structures. Settlement will take place both during and after the construction of the embankment and may be affected by natural variations in the underlying lithology. Calculations using the Frohlich method, and another by Terzaghi based on consolidation test data to evaluate settlement, indicate the estimated maximum total settlement of north and south embankments will be approximately 12 and 14 inches, respectively, including settlement in the granular material. The initial settlement will occur during the construction of the embankment due to immediate compression of the soil layers. It is estimated to be on the order of 7 inches and will occur primarily in the upper granular layers. The settlement for cohesionless material was calculated using the Hough method, as well as the Frohlich equation for granular material, and was based on the Standard Penetration Test (SPT) blow counts. Stress distribution in the foundation soils caused by the weight of the embankment was calculated using a model that simulates a linearly increasing load and Frohlich's influence factor (see

Appendix C). Incremental stresses were then applied to the settlement equation for overconsolidated clays. Most of the settlement in cohesive materials is expected to occur in a clay layer located approximately fifty feet below the existing ground surface. A schedule showing the calculated settlements for different layers vs. time is presented in **Figure 9.2.0** below.

Figure 9.2.0 - Settlement vs. Time for 19th Avenue Embankment Fill



As noted earlier, this Office anticipates that approximately 90% of the total settlement in the cohesive soils within the embankment foundation will take place during the 120 days after construction of the embankment has been completed. Additional settlement of the embankment fill itself may take place but is expected to be insignificant and occur during construction.

An existing 36" diameter reinforced concrete pipe (RCP) carrying irrigation water currently trends generally westward from the city park toward the residential properties at a gradient of 0.16%. The proposed project would install a 48" diameter or greater steel sleeve over the RCP from where it enters below the MSE embankment at Station 31+60, 87 feet right CL "19th" to where it emerges at Station 30+95, 45 feet left of CL, "19th". **Figure 9.2.1** and **Table 9.2** illustrate the calculated settlements along the pipe at ten-foot intervals. The maximum settlement is expected to occur below the centerline of the MSE embankment.

Figure 9.2.1 - Settlement Along the 36-inch Irrigation Canal Pipe

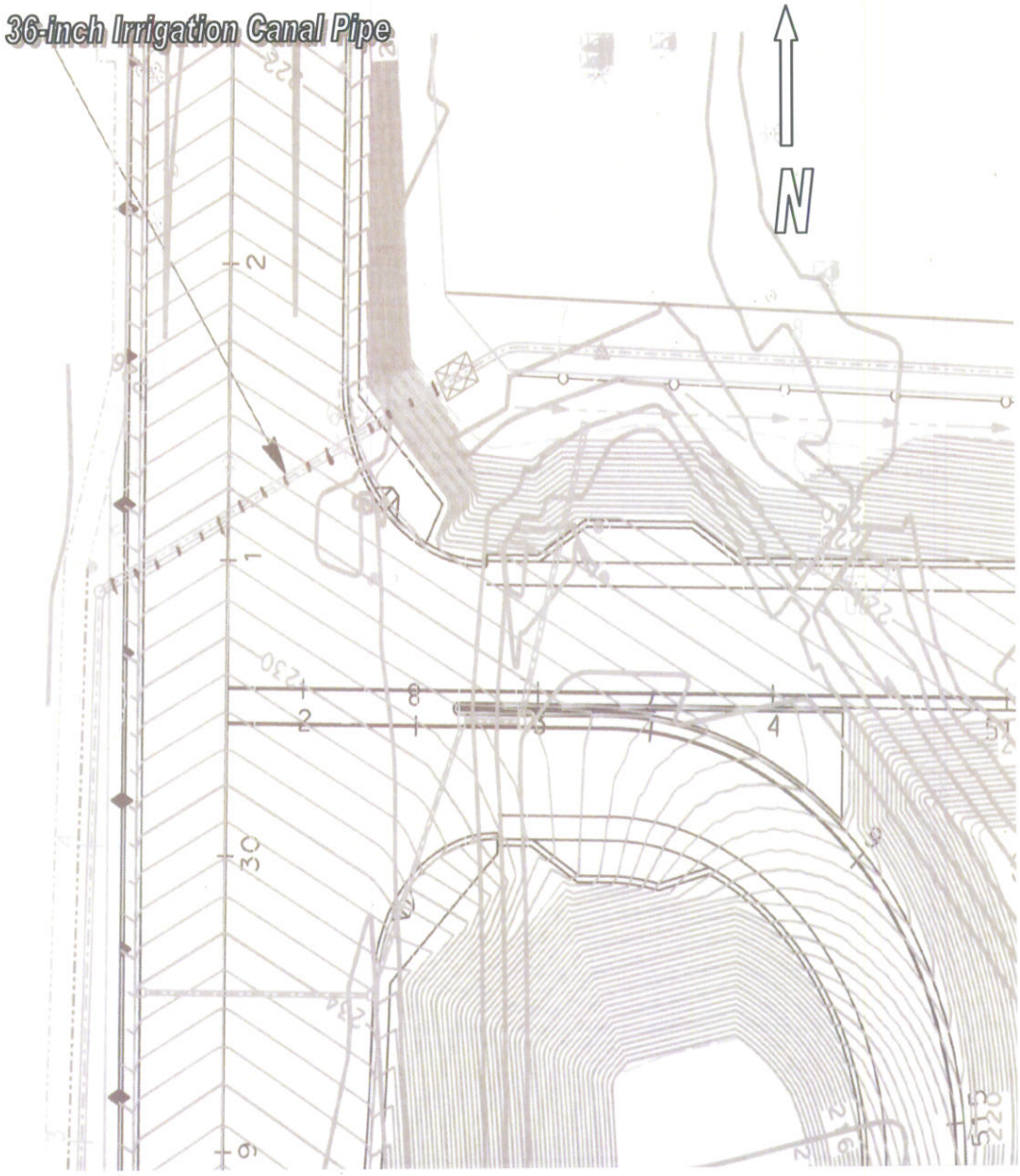


Table 9.2 – Settlement Along Irrigation Canal Pipe

Calculated Settlement along 36-inch Irrigation Canal Pipe						
Interval along pipe	Elevation (ft)		Embankment (ft)		Settlement	
(ft)	Ground	Pipe Crown	Elevation	height	(in)	Landmark
-5	217.5	211.0	217.5		1.2	5 feet away from slope edge
0	217.0	211.0	217.0	0.0	1.7	slope edge
10	216.0	211.0	221.0	5.0	2.7	
20	215.5	211.0	226.0	10.5	3.2	
30	215.0	211.0	226.0	11.0	3.6	
40	214.7	211.0	226.5	11.8	3.9	
50	214.5	211.0	226.7	12.2	4.2	
60	214.5	211.0	227.0	12.5	5.4	
70	214.5	211.0	227.5	13.0	6.7	
80	214.7	211.0	227.7	13.0	6.9	
90	214.9	211.0	228.2	13.3	6.7	
100	214.7	211.0	228.4	13.7	6.6	"19th" Line
110	214.5	211.0	228.4	13.9	6.2	
120	214.5	211.0	228.4	13.9	5.7	
130	214.5	211.0	228.4	13.9	5.0	
140	214.5	211.0	228.4	13.9	3.8	
145	214.5	211.0	228.4	13.9	3.0	Edge of MSE Wall
150	214.5	211.0	214.5		1.8	5 feet away from MSE Wall

9.3 Temporary Shoring Backfill

As noted earlier, a temporary backfill is required to shore the temporary half-gabion wall and to surcharge the footprints of Abutment 3 and the Type 1 retaining wall. Our Office estimates this backfill will measure approximately 205 feet long by 50 feet wide. It will vary in height from a maximum of 25 feet at Abutment 3's footprint, and from there it will taper eastward down to grade at Station 27+83, 145 feet right CL "19th" line. See **Figure 9.3.1** for schematics.

According to the 19th Avenue Foundation Plan dated 10-29-09, the approximate backfill limits at the northern face are: Station 26+85, 53 feet left of CL "19th" line to Station 27+28, 50 feet right of CL "19th" line, where it intersect with wing wall LOL. It then continues parallel to the LOL of the Type 1 retaining wall from Station 511+30, 56 feet right of "WBO" line to Station 512+53, 51 feet right of "WBO" line. For the southern face, the approximate backfill limits are: Station 26+33, 58 feet left of CL "19th" line to Station 26+82, right 55 feet CL "19th" line or

Station 511+28, 30 feet left of "WBO" line to Station 512+52, 10 feet left of "WBO" line. Depending on the available distance from the traveled way to the face of the temporary MSE wall, the southern face of the shoring backfill may be vertical, battered or sloped. In any case, the hinge point of the shoring backfill slope shall coincide with the outer edge of the abutment foundation footprint. Our Office recommends all sides of the shoring backfill be reinforced and fabric-wrapped, including the side facing the Hilfiker or half-gabion type wall. The gap between this reinforced temporary wall and the shoring backfill face will be backfilled with granular material. The earthen materials used for the remaining length of the temporary shoring backfill shall meet the same specifications as the adjacent un-reinforced embankment. See **Figures 9.3.0 and 9.3.1** below.

Figure 9.3.0 – Limits of Temporary Shoring Backfill

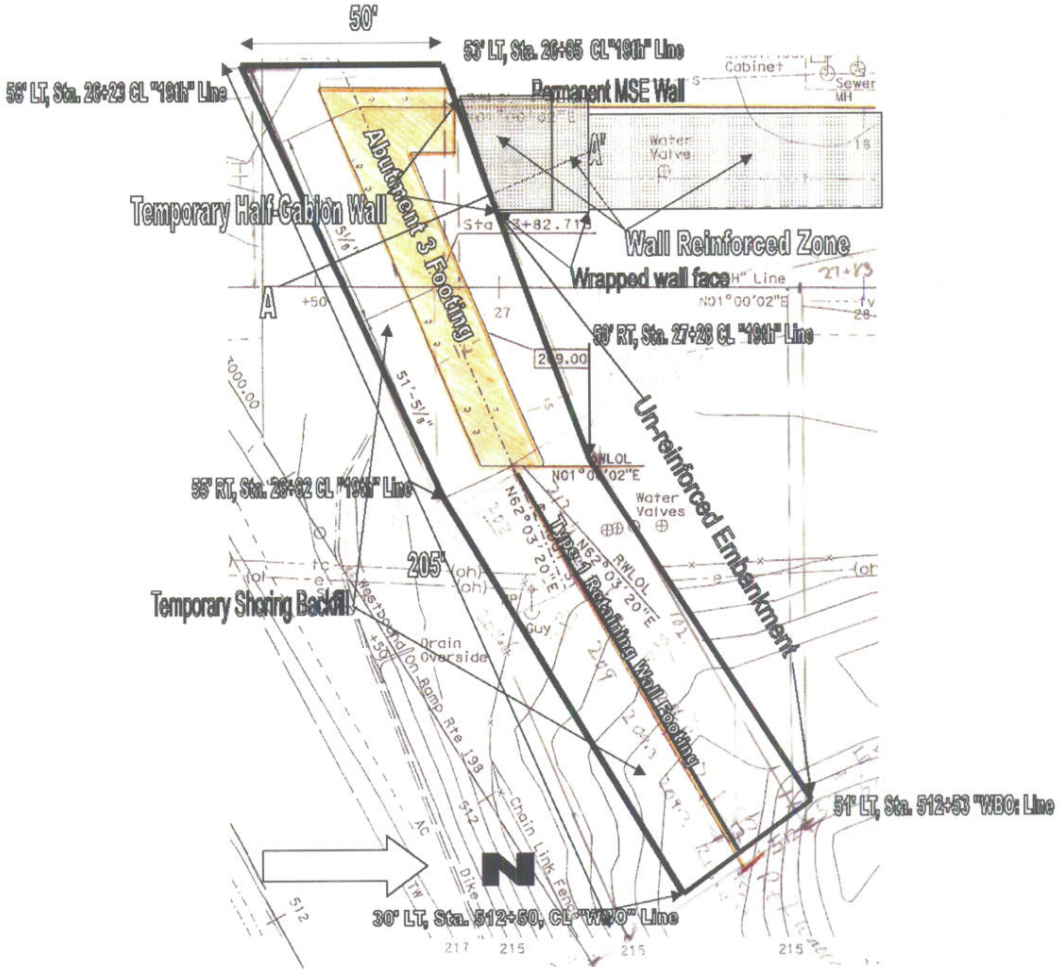
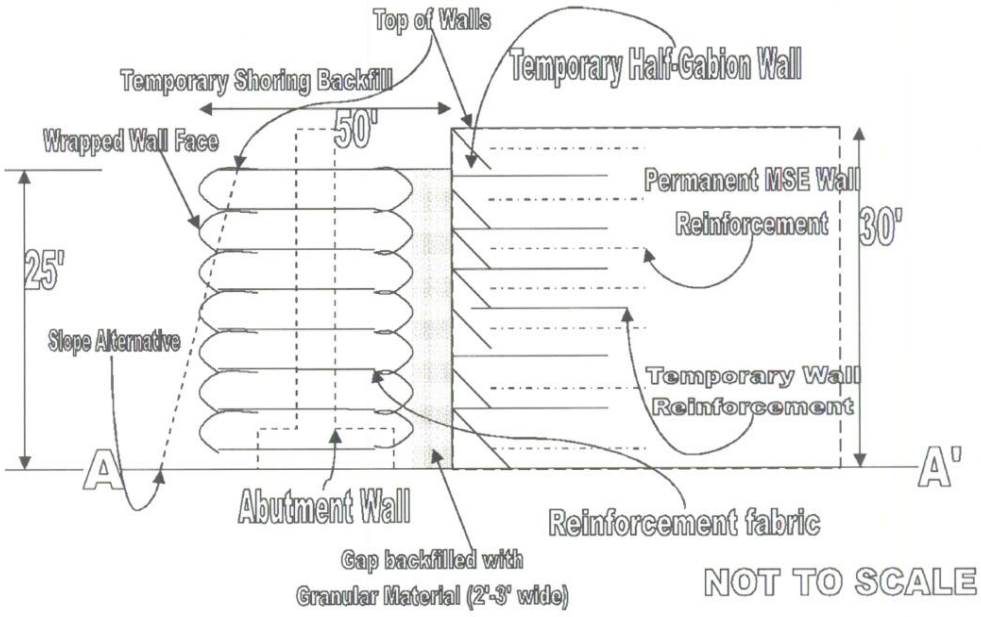


Figure 9.3.1 - Cross Section (A-A') of Temporary Shoring Backfill



A reinforced, fabric-wrapped face is not required on the area that extends beyond the intersection of the temporary and permanent MSE wall reinforcements.

The excavation for the temporary shoring backfill shall not be deeper than that of the temporary half-gabion wall and the Type 1 Retaining Wall. Our Office recommends that both foundation excavations extend to the same depth.

After completion of the settlement period, the temporary shoring backfill shall be removed. Special attention should be given to the temporary half-gabion wall during the removal of the temporary shoring backfill. If the temporary half-gabion wall face or reinforcement is damaged during this operation, the Contractor shall make any necessary repairs at his own expense. After removal of the temporary shoring backfill, the front section of the un-reinforced embankment shall be sloped for stability and to allow construction of the Abutment 3 and Type 1 retaining wall foundations.

9.4 Expansion Potential

Based on our subsurface investigation and the results of soils laboratory tests (Liquid Limit, Plastic Limit, and Plasticity Index), the potential for expansive soils for the proposed project is considered very low.

9.5 Rippability

No rock-like materials were encountered during the field investigation.

10. PROJECT DESIGN RECOMMENDATIONS

The recommendations contained in this report are based on specific project information regarding the structure type, its location and design loads received from the designer through May 28, 2010.

10.1 Compaction of Materials from Proposed Basins

Soil samples taken from the proposed Basins 1, 2, 3, and 4 were collected and submitted to the Caltrans Materials Laboratory to evaluate moisture content, density and degree of compaction.

The Relative Compaction (CTM 216) tests performed on soils obtained from detention basins 3 and 4 (combined) indicate that the soils could be compacted to a maximum dry density of 117 pcf at optimum moisture content of 10%. In general, at the time the samples were collected the in-situ moisture content was lower than optimum moisture content; therefore, water may need to be added the excavated soils before they are used as embankment material.

10.2 Grading Factors

This Office recommends a grading factor (in-place material/re-compacted density) of 85 ± 5 percent be used for material placed at 90 to 95% relative compaction (CTM 216). In this case, the grading factor is based on the samples in-situ dry densities and the maximum dry densities obtained from the Relative Compaction (CTM 216) test. The grading factor also includes material loss during transport. This Office recommends a grading factor of 85 percent be used for purposes of construction bidding.

10.3 Material Sources

At the time this is report was prepared, the project borrow area had not yet been selected. For design purposes OGDN assumed the borrow material to be granular and non-cohesive, and having a wet density (γ_s) of 125 pcf and an angle of internal friction (Φ) of 35°, and that the majority of soil material used for construction of the EB and WB on and off ramps will be from the same source location. A minimal amount of soil material for construction of the proposed ramp fills would be excavated from the proposed detention basins located inside of the loop on and off ramps and between the on and off diagonal ramps and SR 198 (see **Figure 2**). The current proposal is for all the basins to be excavated to an average depth of 1 foot.

10.4 Embankments and Fills

All the proposed fills for this project are part of the on and off ramps that will be constructed in the north-east and south-east quadrants of the project. The maximum height of 16 feet for the north-east on and off ramps will be at their junction with the MSE fill. For the south-east quadrant the maximum height will be 20 feet where they join with the south abutment fill.

Calculated total settlement for these fills at their maximum height will be approximately 7 inches for the northeast quadrant fills and 8 inches for the southeast quadrant fills. Our Office recommends a 120 day settlement waiting period for these on and off ramp fills, and that they be monitored as described in the next section.

Our Office considers the proposed 4:1and 2:1 side slopes to be adequate for the proposed embankments. Embankments shall be constructed and new fill shall be placed in accordance with Standard Specifications Section 16, *Clearing and Grubbing*, and Section 19-6, *Embankment Construction* (2006).

10.5 Differential Settlement Mitigation and Monitoring (Sta. 26+25 to Sta. 35+50 CL "19th" and Station 507+00 Route 198 EB on-ramp)

MSE WALL - The most significant geotechnical issue for the proposed project is differential settlement.

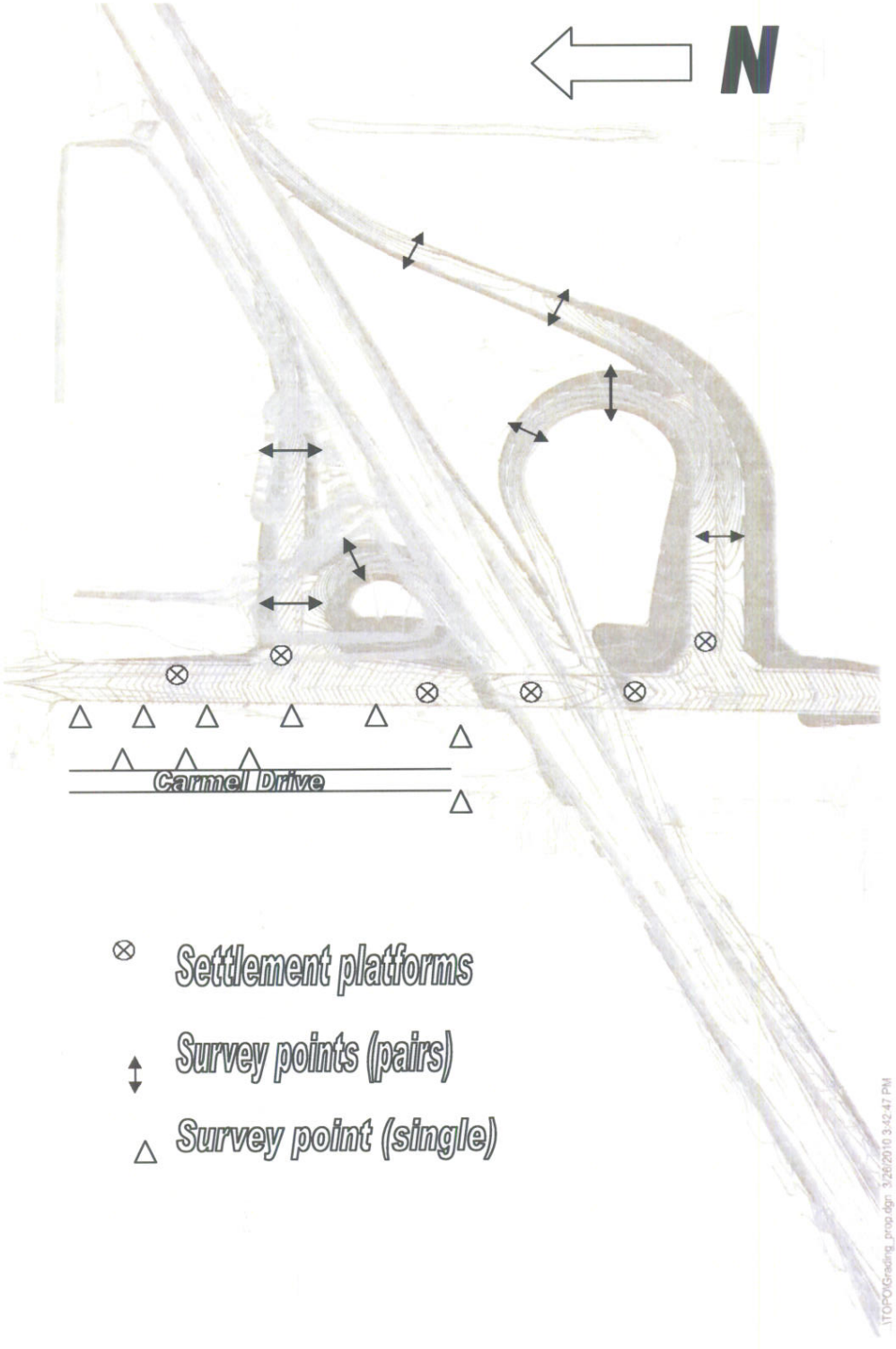
a) MONITORING PROGRAM FOR 19TH AVENUE FILLS - This Office recommends utilization of fluid level settlement devices as described in California Testing Method 112, "*Method for Installation and Use of Embankment Settlement Devices*" for monitoring settlement of the embankment foundation and fill. Six fluid level settlement platforms shall be installed at the following locations, and as shown on Figure 10.5.

1) Station 24+00 Center Line 19th
2) Station 27+00 CL 19th
3) Station 28+00 CL 19th
4) Station 29+00 CL 19th
5) Station 30+00 CL 19th
6) Station 507+00 Route 198 EB on-ramp

In addition to these settlement platforms, a minimum of sixteen survey targets points (8 pairs) are recommended at the locations illustrated on. **Figure 10.5**

The embankment foundation and fill settlement shall be monitored for at least 120 days. The monitored rate of actual settlement measured during construction will assist in determining when 90% of the settlement in the embankment and subgrade is complete, regardless of the target settlement (7 to 8 inches) or the estimated settlement time period (120 days). That is, if the measured settlement rate is noticeably attenuated prior to the end of the calculated settlement time period, it would be acceptable for construction operations to resume at that location. But in the opposite case, should the measured rate of settlement continue up to the time the calculated settlement time period is reached, this Office recommends that monitoring activities be continued and that the settlement time period be extended until the settlement rate diminishes.

Figure 10.5 – Settlement Monitor Location Map



ADJACENT HOUSES AND STRUCTURES (Station 26+50 to Station 35+50, approx. 60' left of "19th"CL)

In the residential area, approximately 1" of settlement is anticipated for the interval between Station 31+50 to Station 33+50, where the minimum distance from the toes of the MSE wall and the exterior wall of the houses is fifteen feet (see **Photo 2**). A table of calculated settlements adjacent to the toe of the MSE wall and cross-sections at selected stations depicting distances from the MSE wall to residential structures is provided in **Appendix C**. The cross-sections were provided by the consultant on this project, AECON.

This Office recommends the following monitoring programs to assess settlement adjacent to and within the residential properties, both pre- and post-construction:

a) PRE-CONSTRUCTION SURVEY - Beginning approximately two months before construction activities: A pre-construction photographic survey shall be conducted to document the condition of the residential and other structures or improvements prior to use of heavy construction equipment or fill emplacement. All existing cracks, uplift, misalignment or other visible structural features in the masonry block wall, concrete slabs/patio, or residential structures, including chimneys, doors and windows, should be videotaped or described in detail, measured and photographed. Specifically, the pre-construction survey must include the following:

    1) Inspector's name and contact information
    2) Date and time of survey
    3) Location and/or property address
    4) Name of property owner and/or occupant
    5) Detailed description of structure or other improvements
    6) Detailed description, photographs or videotape of existing condition of structure's foundations, exterior walls, chimneys, doors, windows, roofs, porches, sidewalks, driveways, garages or outbuildings, swimming pools and any other features (see **Photo 3**)
    7) Detailed description, photographs or videotape of utility access, light fixtures, mailboxes, overhead power lines, and traffic signs (see **Photo 4**)
    8) Measurements and photographs of existing cracks, uplift or other indication of pre-construction condition

9) Scaled map or aerial photograph showing the location of all structures included in the survey

Three copies of this pre-construction survey are to be provided to the Engineer no less than one month before construction activities are scheduled to begin.

b) Approximately two months before construction activities near the residential properties begins, the contractor is to install survey targets every 100 feet along the masonry block wall that separates the residential properties from the construction area, or as directed by the Engineer (see **Figure 10.5**). Additional survey targets are to be installed every 100 feet along the sidewalks on Carmel Drive. All targets are to be surveyed on a weekly basis to establish a pre-construction baseline and record of any existing movement that may be occurring, or may have occurred in the past, that is unrelated to the proposed construction activities. Weekly reports with the target measurements are to be provided to the Engineer within 48 hours of each survey.

c) Prior to the commencement of field construction activities, the Engineer and the Contractor shall meet to review the site and pre-construction survey data together and to identify existing structures or properties that may be affected by differential settlement or vibration. At that time the Engineer may choose to modify or refine the proposed monitoring program as deemed necessary.

d) Unless otherwise directed by the Engineer, all survey targets will be measured and plotted on a weekly basis. Three copies of the survey data shall be delivered to the Engineer within 48 hours of each weekly survey.

e) POST-CONSTRUCTION SURVEY A post-construction photographic survey shall be conducted at the end of field construction activities, using the same format as the pre-construction survey, to document the condition of the residential and other structures or improvements.

f) To prepare a post-construction assessment, all survey measurements shall continue for two weeks beyond the end of field construction activities. Three copies of the survey data shall be delivered to the Engineer within 48 hours of each weekly survey.

10.8 Tangent Wall Adjacent to MSE Wall (Sta. 26+25 to Sta. 35+50 on CL "19th")

OGDN engineering staff does not support the use of a tangent or secant pile wall between the MSE Wall and the houses as described in the Bridge Foundation Report for 19th Avenue IC. Although initially proposed to reduce settlement / consolidation at the houses, upon further review, they have determined it is not likely to provide the desired mitigation.

10.9 Traffic Barriers and Sound Walls (Sta 10+00 to Sta 21+92 on CL "19th")

The proposed project includes sound walls on the north MSE and at ground level along eastbound SR 198. The traffic barriers with sound walls proposed for construction on top of the MSE are founded on eccentrically loaded piles to divert load from the MSE wall panels. These walls would be installed after the mechanically-stabilized earth has been allowed to settle for approximately 120 days, to minimize the effects of differential settlement. These piles will be approximately ten feet deep, as depicted on Caltrans Standard Drawing – Mechanically Stabilized Embankment Detail No. 5, and would need to be installed in a manner that will not damage or interfere with the soil reinforcement system.

Along SR 198, the sound walls would be constructed on trench footings (Case 1), using a minimum angle of internal friction equal to 25°. Based on our field investigation, this Office considers this proposal to be appropriate for the existing soil conditions and the presence of shallow perched water. The depth of the footing excavation shall not exceed 9 feet below natural ground or approximate elevation of 203 feet due to shallow perched water.

In the case where the sound wall foundation intercepts underground utilities, it is our understanding that modifications to the trench footing foundation will be adopted. OGDN recommends that the use of cast in drilled hole piles be avoided if possible due to the shallow water levels and the potential for caving.

Sound wall along 19th Ave exit ramp (Station 4+88.37 to Station 15+49.2 "SW2" Line)

A six-foot high sound wall along the 19th Avenue westbound offramp will be constructed on an earthen berm. This berm will be constructed to protect the 36-inch diameter irrigation canal pipe. The sound wall footing

design will utilize Case 2, with a minimum angle of internal friction of 30°. Our Office recommends a minimum of one foot distance between the outer edge of the trench footings and the slope hinge point.

10.10 Overhead Sign Foundations (Station 526+42 "A" Line and Station 506+07 "C" Line

The proposed project includes the installation of two new overhead signs on CIDH piles. One will be located at Station 526+42 "A" Line on post type VI and the other at Station 506+07 "C" Line on post type VIII, both on flat terrain (4:1 or flatter). Sign foundation details provided by the designer indicate that 5-foot diameter CIDH piles would extend 22 feet deep (for post type VI) or 25 feet deep (for post type VIII). Our Office concurs with the proposed foundation design; however, advises the construction of the CIDH piles may require temporary casing and the use of wet method due to shallow perched water and the potential for caving.

11. CONSTRUCTION CONSIDERATIONS

11.1 Perched Groundwater

Shallow, mineralized groundwater may be encountered during the construction of this project. During the geotechnical investigation, OGDN measured this water about ten to eleven feet below ground surface, depending on the season. OGDN recommends that sump pumps be available if needed to facilitate construction operations. .

12. 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:

1. Log of Test Borings (19 Ave OC, Br. No. 45-0104

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

1. "Geotechnical Design Report for the 19th Avenue Overcrossing", dated June 23, 2010

2. "Foundation Report for 19th Avenue Overcrossing", dated June 1, 2010

3. "Foundation Report for MSE Wall", dated May 26, 2010

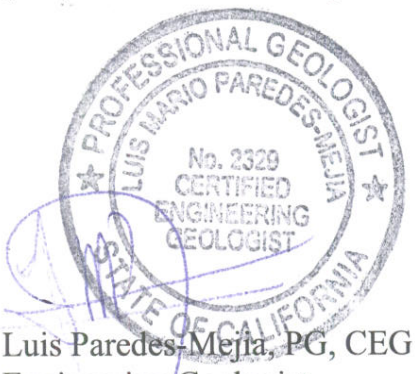
Data and Information available for inspection at the District Office:

None

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

None

If you have any questions or comments, please call Luis Paredes-Mejia (916) 227- 1047 or Douglas Brittsan at (916) 227-1079.



Luis Paredes-Mejia, PG, CEG # 2329
Engineering Geologist
Office of Geotechnical Design- North

c:

Jim Heinen, PM (e-copy)
D06 Construction Pending File, C/o Keenyong Poong (AECON)
Mark Willian, GS Corporate
Douglas Brittsan, OGDN
Douglas Lambert, D06-DME (e-copy)
Roy Bibbens, OGDN File

FIGURES

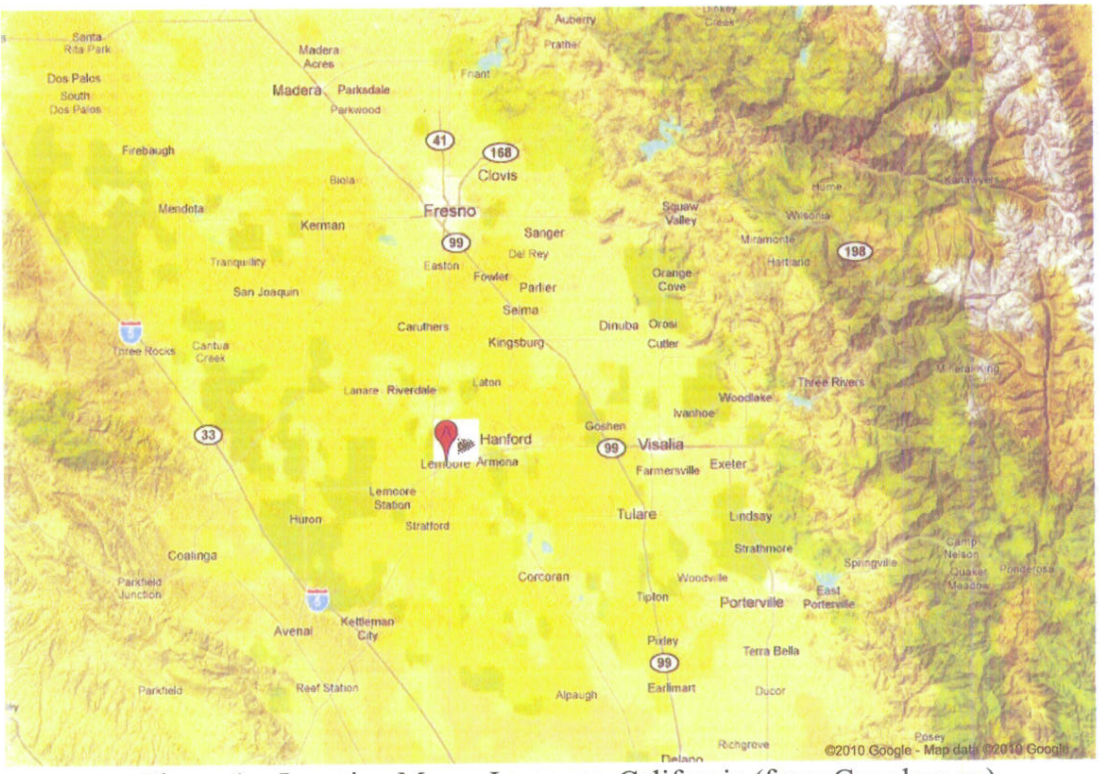


Figure 1. Location Map - Lemoore, California (from Google map)

Figure 2. Proposed 19th Avenue Overcrossing

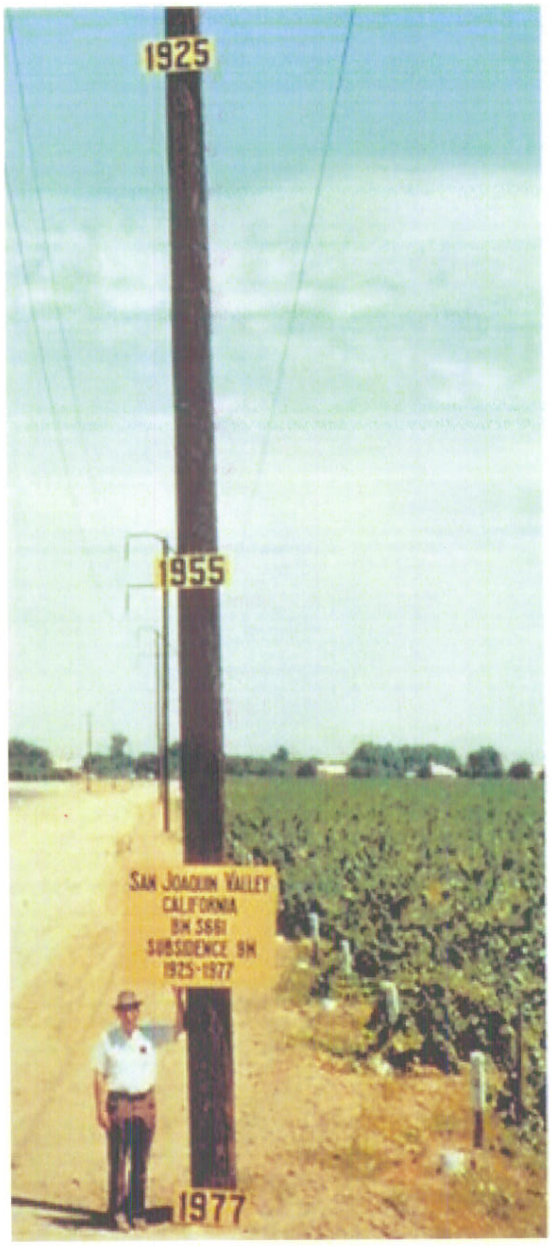


Figure 3. The late Dr. Joseph Poland demonstrates over twenty eight feet of land subsidence in Mendota area. (from USGS website)

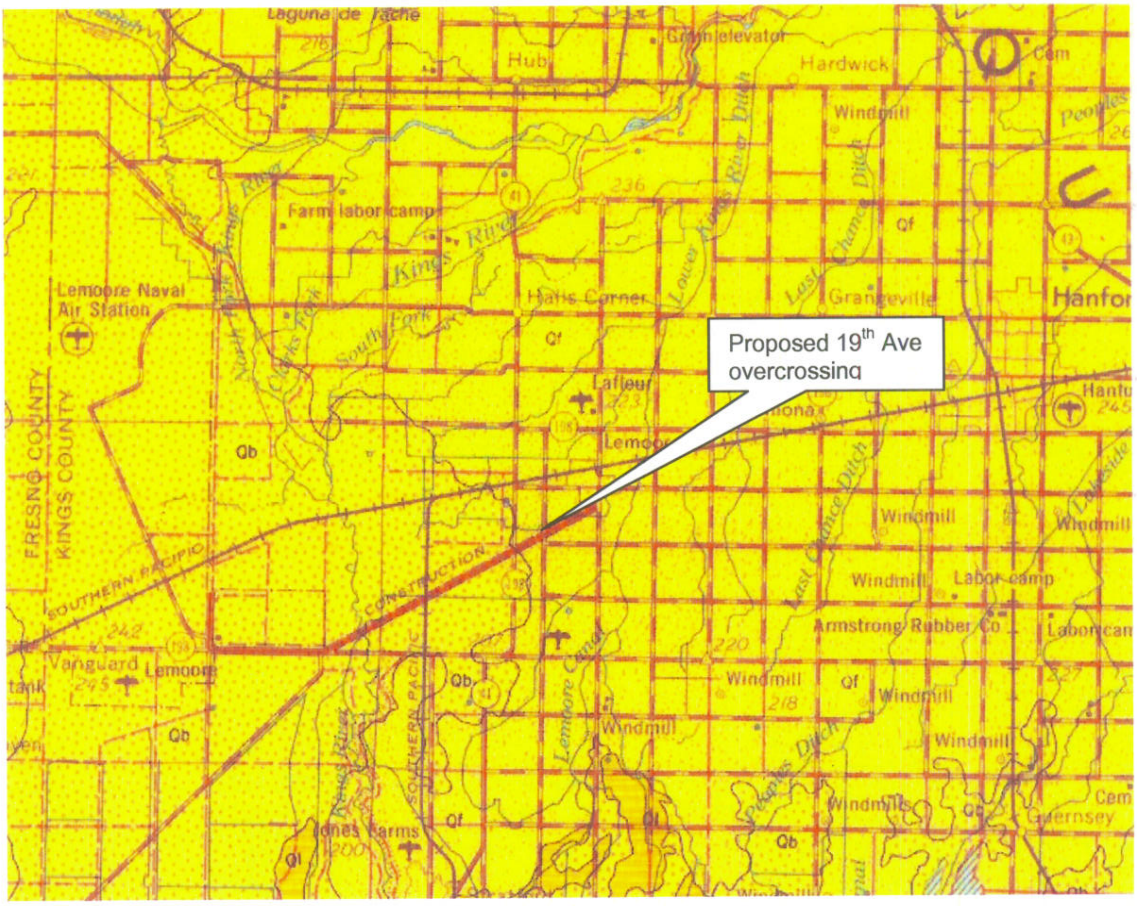
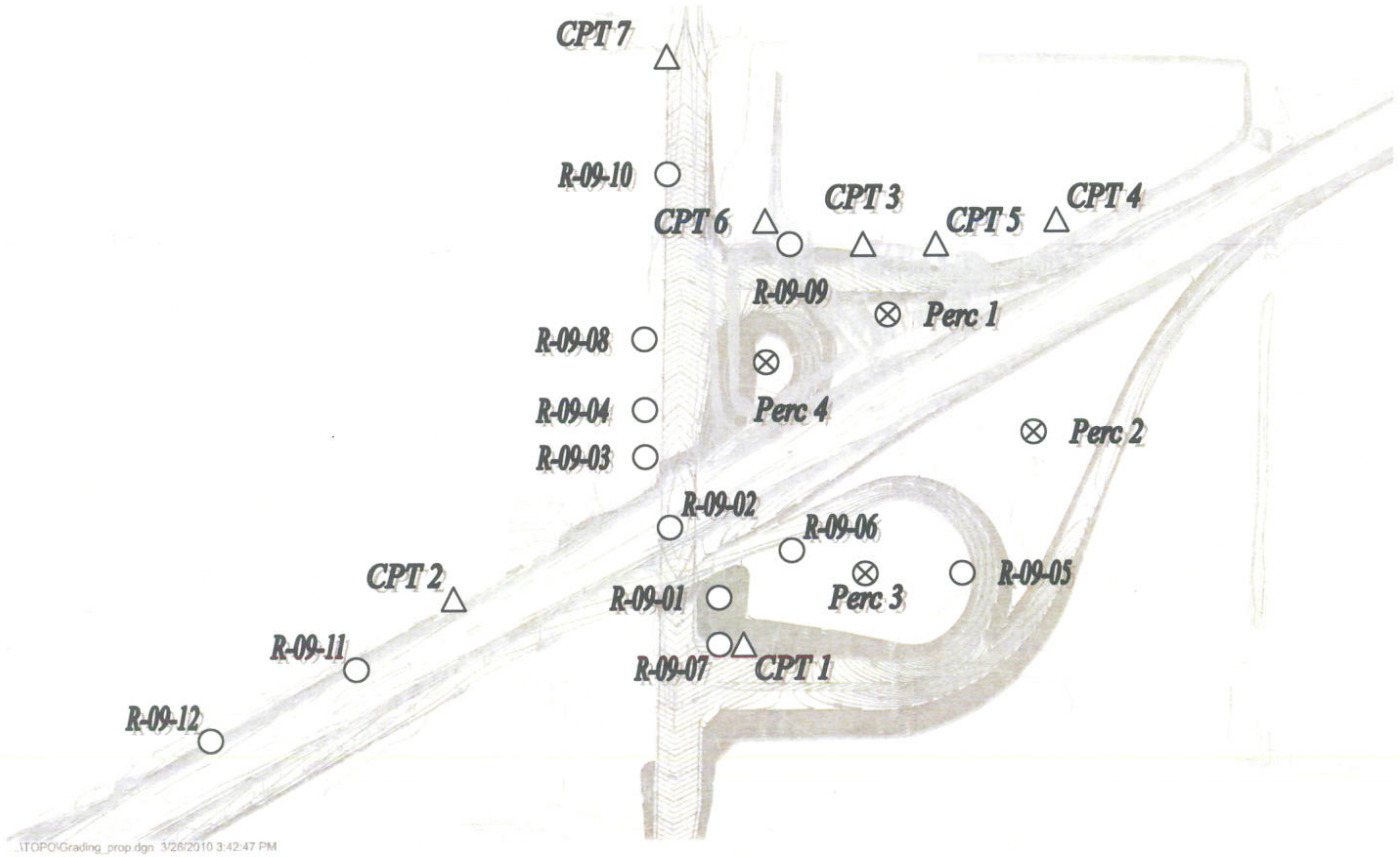


Figure 4. Geologic map of the Lemoore area (from CDMG 1965)

Figure 5. Boring, CPT and Percolation Test Locations



PHOTOGRAPHS

Photo 1. View south toward intersection of 19th Avenue and SR 198

Photo 2. Residential properties adjacent to 19th Avenue are separated by concrete block wall.

Photo 3. View east from residential properties. 19th Avenue is on other side of block wall.

Photo 4. Vacant lot at NW corner of 19th Avenue and SR 198

APPENDICES

A. LOG OF TEST BORINGS AND CPT GRAPHS

B. LABORATORY TEST DATA SUMMARY

C. 1. SETTLEMENT ANALYSES

2. SETTLEMENT ADJACENT TO TOE OF MSE WALL
3. MSE CROSS- SECTIONS IN RESIDENTIAL AREA

Appendix A.

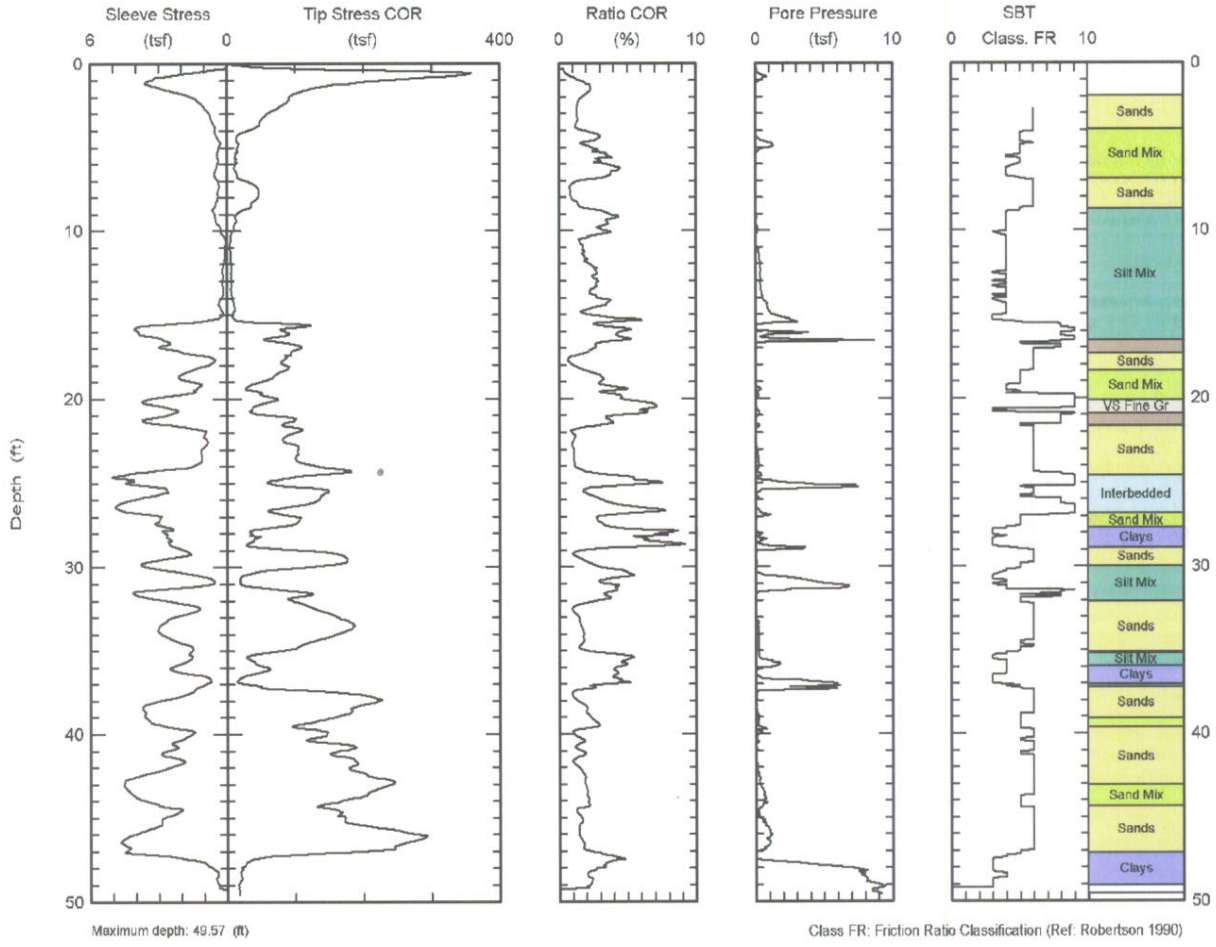
LOG OF TEST BORINGS AND CPT GRAPHS

(LOTBs to be provided upon completion)

Cone Penetration Test Results

Cone Penetration Test 1 (CPT 1)

Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 06/Jul/2009 Test ID: 06L902-1 Project: 06-325500
	Customer: HAMID AKDARZADEGON Job Site: 19TH AVEOVERCROSSING	

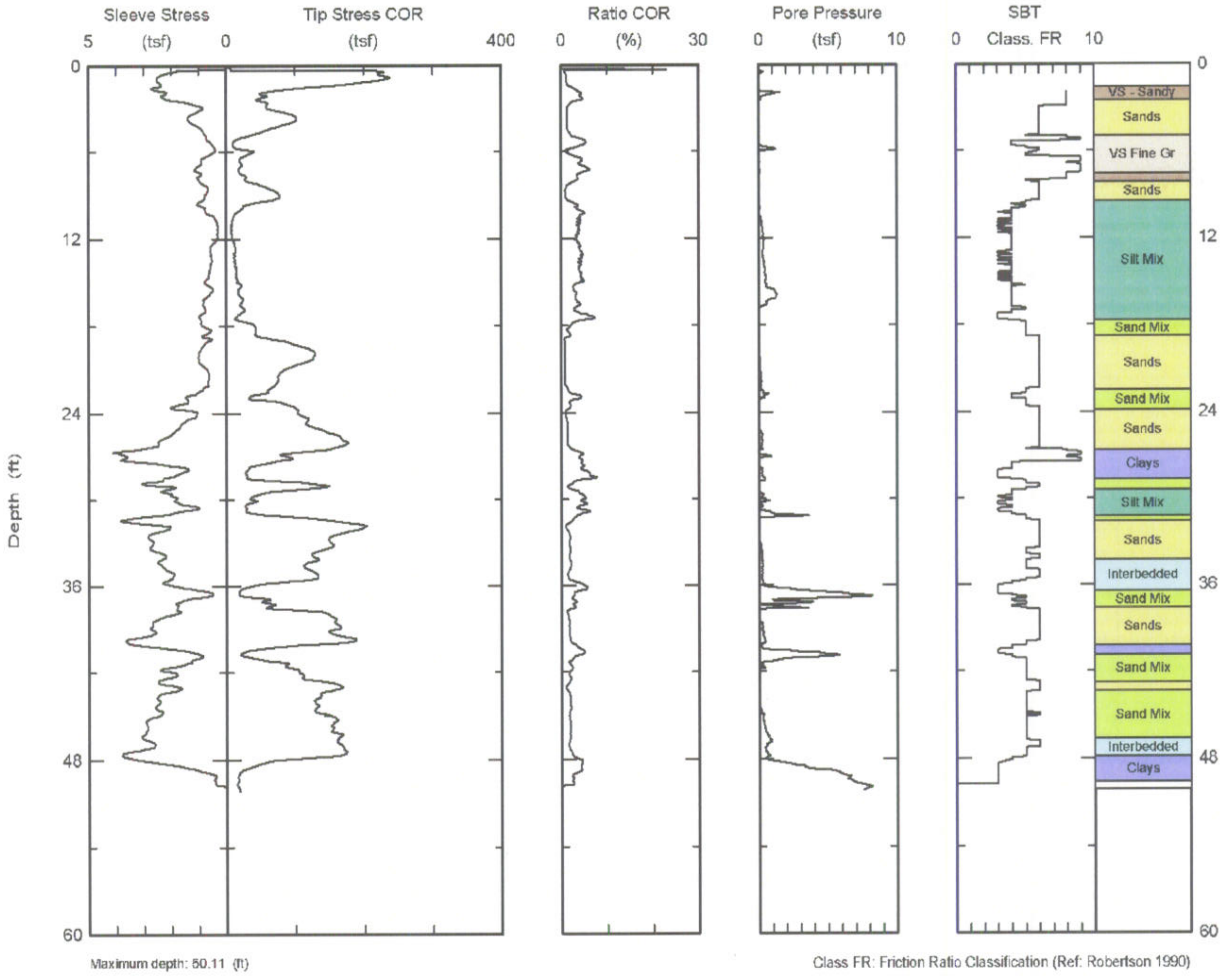


Maximum depth: 49.57 (ft)

Class FR: Friction Ratio Classification (Ref: Robertson 1990)

Cone Penetration Test 2 (CPT 2)

Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 07/Jul/2009 Test ID: 07L901-2 Project: 06-325500
	Customer: HAMID AKDARZADEGON Job Site: 19TH AVEOVERCROSSING	

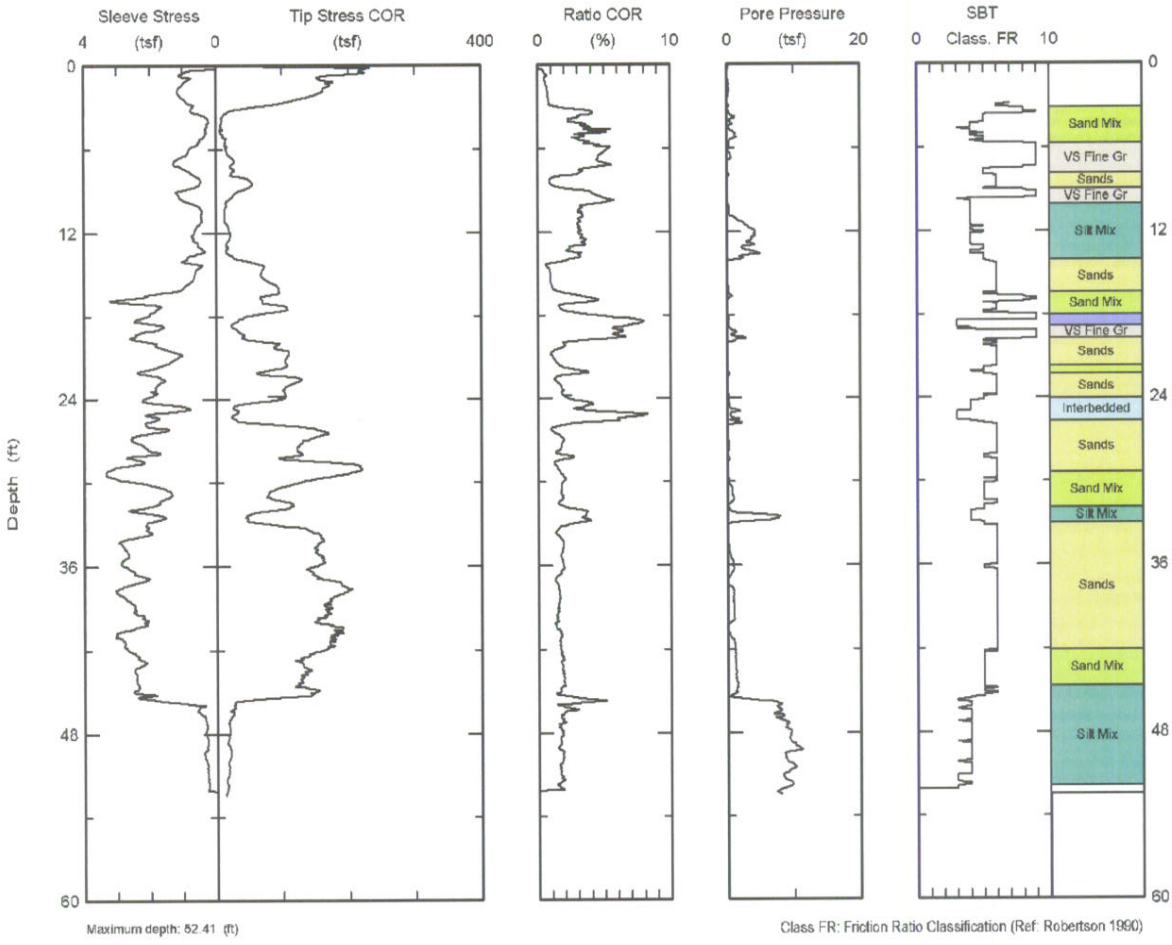


Maximum depth: 60.11 (ft)

Class FR: Friction Ratio Classification (Ref: Robertson 1990)

Cone Penetration Test 3 (CPT 3)

Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 25/Jun/2009 Test ID: 25U901-3 Project: 06-325500
	Customer: HAMID AKBARZADEGAN Job Site: 19th AVE OVERCROSSING	



Maximum depth: 52.41 (ft)

Class FR: Friction Ratio Classification (Ref: Robertson 1990)

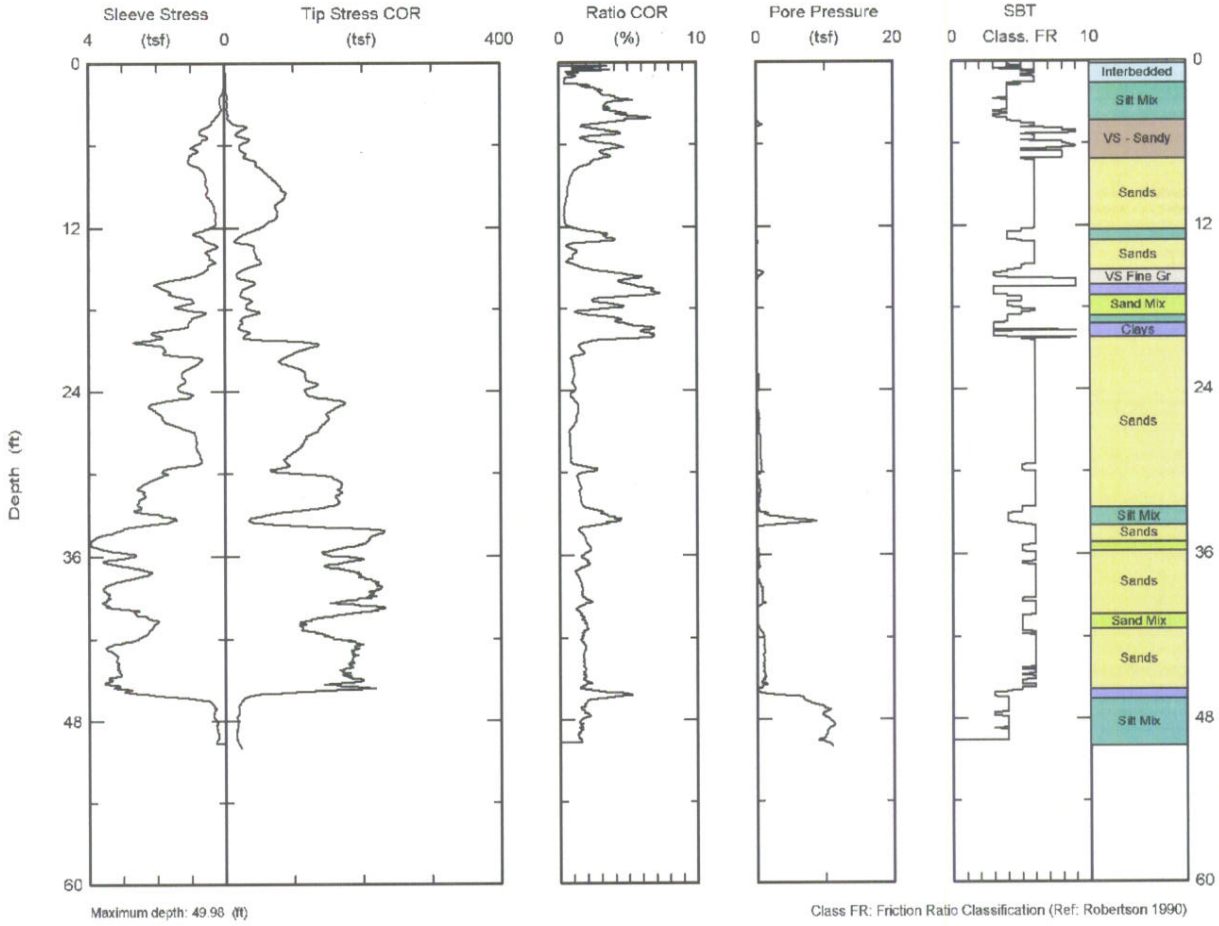
Cone Penetration Test 4 (CPT 4)

Division of Engineer Service
Geotechnical Service
5900 Folsom Blvd. Sac., CA 95819
www.dot.ca.gov

Lat:
Lon:
Elevation:

Date: 25/Jun/2009
Test ID: 25U904-4
Project: 06-325500

Customer: HAMID AKDARZADEGON
Job Site: 19TH AVEOVERCROSSING

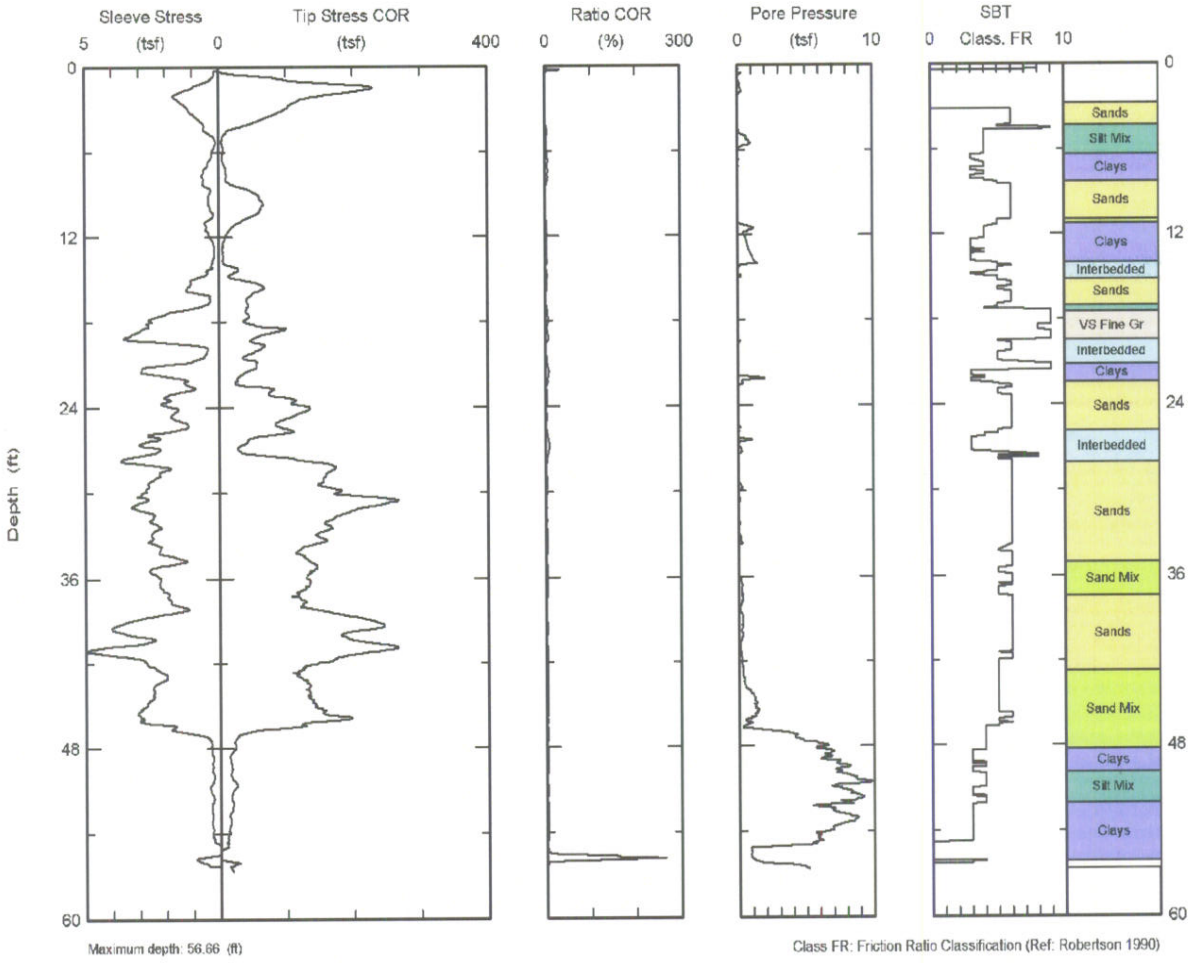


Maximum depth: 49.98 (ft)

Class FR: Friction Ratio Classification (Ref: Robertson 1990)

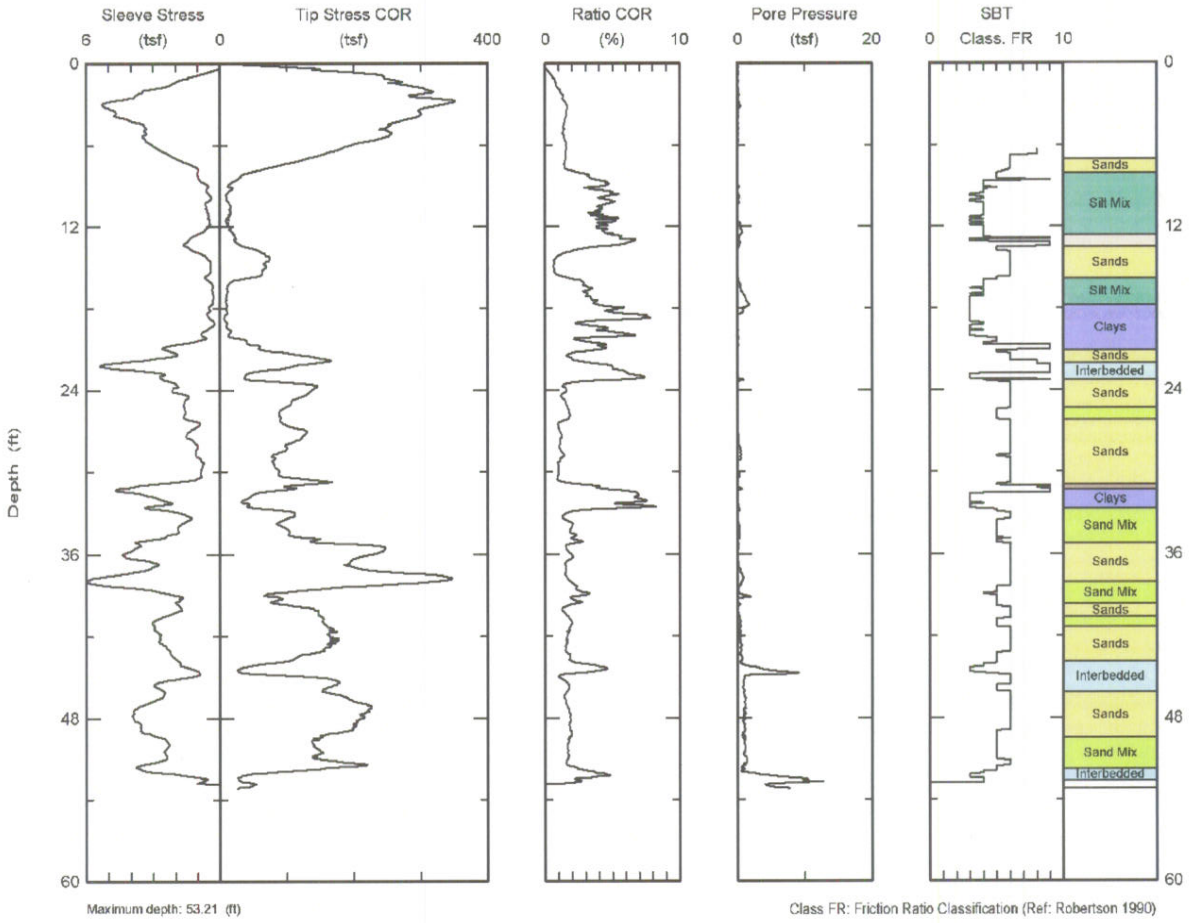
Cone Penetration Test 5 (CPT 5)

Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 07/Jul/2009 Test ID: 07L902-5 Project: 06-325500
	Customer: HAMID AKDARZADEGON Job Site: 19TH AVEOVERCROSSING	



Cone Penetration Test 6 (CPT 6)

Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 08/Jul/2009 Test ID: 08L901-6 Project: 06-325500
	Customer: HAMID AKDARZADEGON Job Site: 19TH AVEOVERCROSSING	

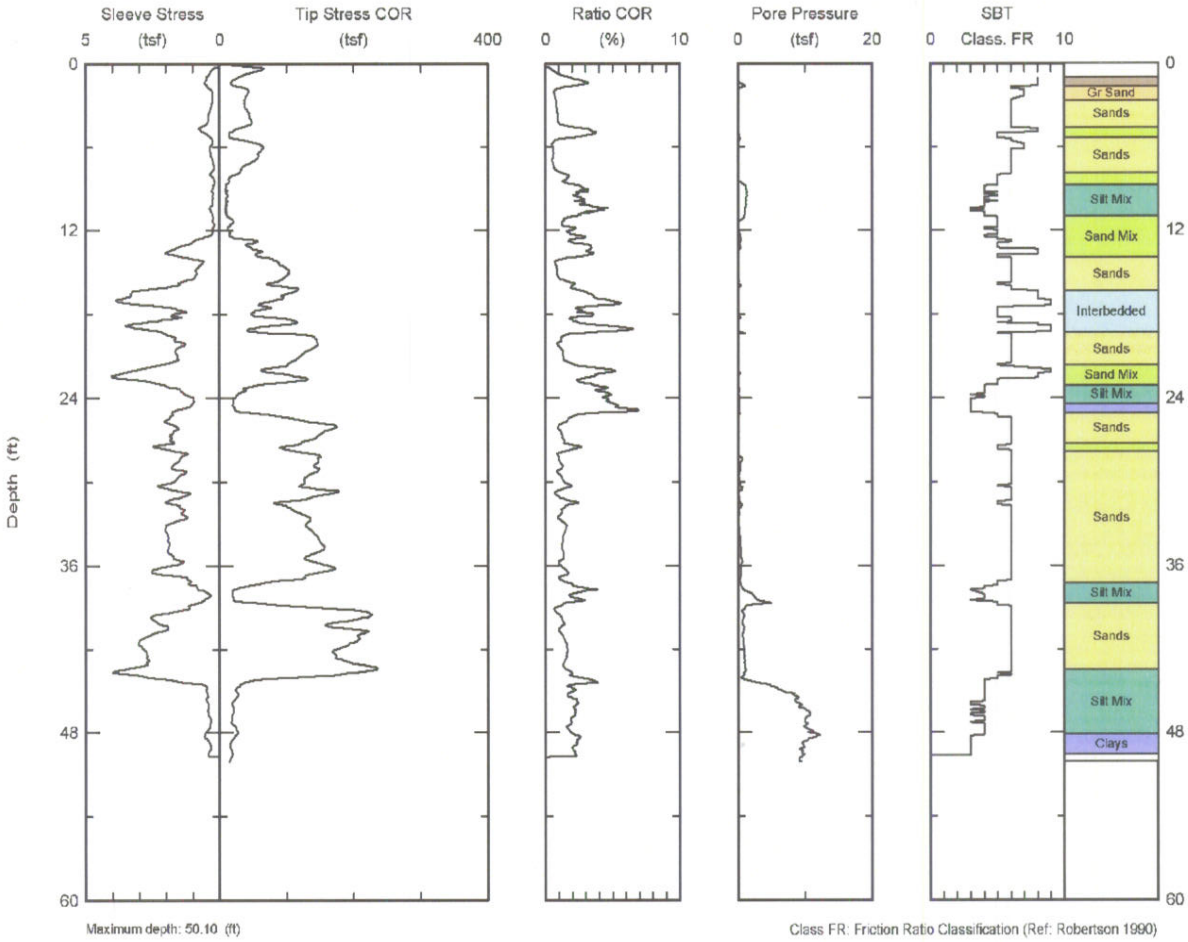


Maximum depth: 53.21 (ft)

Class FR: Friction Ratio Classification (Ref: Robertson 1990)

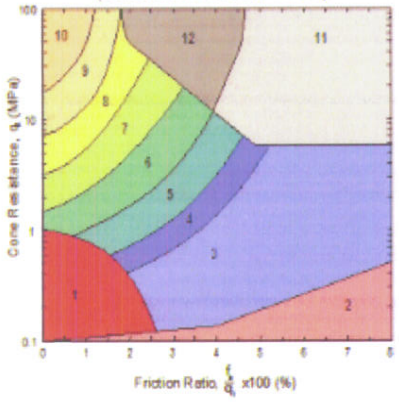
Cone Penetration Test 7 (CPT 7)

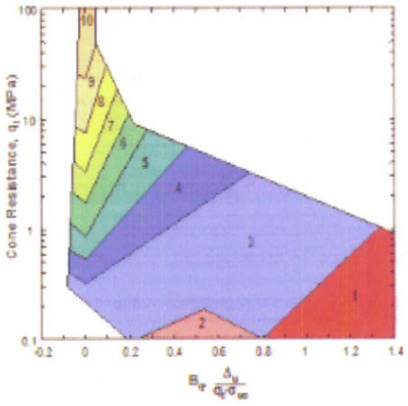
Division of Engineer Service Geotechnical Service 5900 Folsom Blvd. Sac., CA 95819 www.dot.ca.gov	Lat: Lon: Elevation:	Date: 08/Jul/2009 Test ID: 08L902-7 Project: 06-325500
	Customer: HAMID AKDARZADEGON Job Site: 19TH AVEOVERCROSSING	



CPT Soil Behavior Type Legend

(Robertson et al. 1986)

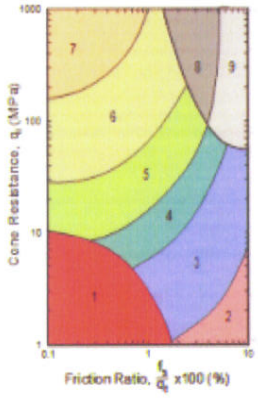


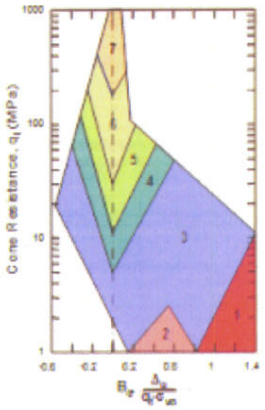


Zone	Soil Behavior Type
1	Sensitive, Fine Grained
2	Organic Material
3	Clay
4	Silty Clay to Clay
5	Clayey Silt to Silty Clay
6	Sandy Silt to Clayey Silt
7	Silty Sand to Sandy Silt
8	Sand to Silty Sand
9	Sand
10	Gravelly Sand to Sand
11	Very Stiff Fine Grained*
12	Sand to Clayey Sand*

*Overconsolidated or Cemented

(Robertson et al. 1990)





Zone	Soil Behavior Type
1	Sensitive, Fine Grained
2	Organic Soils-Peats
3	Clays; Clay to Silty Clay
4	Silt Mixtures; Clayey Silt to Silty Clay
5	Sand Mixtures; Silty Sand to Sandy Silt
6	Sands; Clean Sands to Silty Sands
7	Gravelly Sand to Sand
8	Very Stiff Sand to Clayey Sand*
9	Very Stiff Fine Grained*

*Overconsolidated or Cemented

Appendix B.

Summary of Laboratory Tests (Boring R-09-001)

Sample (R-09-..)	Sample Depth (ft)	Moisture Content %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (ncf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
001-01	0-1.5	1.4			99	28						
001-04	6-6.5	23.2	27	11	100	52						
001-06A	10-10.5	23.9	25	5	100	55	100.6	23.08	0.69	0.43	0.0058	2600
001-06A (Swell Test)	10-10.5	23.9	25	5	100	55	102.3	24.03	0.66			
001-06B	10.5-11	26.7										
001-06-C	11-11.5	21.4										
001-10	20-21.5	27.1			100	38						
001-11	21.5-25	24.9			100	47						
001-13	26.5-30	24.3	25	6	100	92						
001-14	30-31.5	28.7	30	10	100	94						
001-15A (swell Test)	33-33.5	30.1		NP	100	31	92.27	29.73	0.81			
001-15B	33.5-34	29.6										
001-15C	34-34.5											
001-19	41.5-45	28			100	69						
001-21	46.5-50	28.8		NP	100	66						
001-22	50-51.5	43.5	60	34	100	97						
001-24A	55-55.5	32.7	52	31	100	65	90.64	27.42	0.88	0.313	0.04	3400
001-24A (Swell Test)	55-55.5	32.7	52	31	100	65	87.2	33.14	0.96			
001-24B	55.5-56	42.2										
001-24C	56-56.5	32.1										

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

(Continued): Summary of Laboratory Tests (Boring R-09-001)

Sample (R-09-..)	Sample Depth (ft)	Moisture Conten %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (ncf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
001-28	65-66.5	35.5	97	74	100	83						
001-29	66.5-70	27.5	44	26	99	86						
001-32	75-76.5	37.1	73	46	100	97						
001-36	85-86.5	27.7			100	46						
001-40	96.5-100	25.1			100	12						
001-43	101.5-105	28.4	48	29	100	69						
001-46	110-111.5	22.2			100	15						
001-49	116.5-120	28.3	49	31	100	86						
001-50	120-121.5	20.1	33	13	100	62						

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

Summary of Laboratory Tests (Boring R-09-002 and R-09-003)

Sample (R-09-..)	Sample Depth (ft)	Moisture Conten %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (ncf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
002-02	10-11.5	23.3	28	6	100	60						
002-03	15-16.5	23.5	27	10	100	63						
002-04	20-21.5	24.8	25	5	100	78						
002-11A 3	58.5-59	41.5										
002-11A 4	58-58.5	49.9					66.90	55.78	1.5	0.51	0.14	6400
002-13A	66-66.5	35.8										
003-01	0.0-1.5	9.1			89	25						
003-02	2.5-3.5	5.6			100	25						
003-03	4-5.5	7.4			100	26						
003-04	6-7.5	65.7			100	87						
003-06	10-11.5	21.3			100	74						
003-07	15-16.5	26.3			100	8						
003-08	20-21.5	22.3			100	14						
003-09	25-26.8	21.1			100	77						
003-14A 1	54.5-55	57.0			100	96						
003-14A 4	53-53.5	39.0					79.63	41.47	1.15	0.41	0.08	5600
003-14A 4(Swell test)	53-56.5						79.97	40.97	1.01			
003-14A 5	52.5-53	45.8										
003-16A 1	64-64.5	36.6										
003-16A 2	63.5-64						88.74	34.11	0.94	0.3	0.06	6000
003-21A 1	86.5-87						101.9	22.87	0.66	0.017	0.006	6000

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

Summary of Laboratory Tests (Boring R-09-004)

Sample (R-09-..)	Sample Depth (ft)	Moisture Conten %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (pcf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
004-02	2-3.5	0.5			100	21						
004-03	4-5.5	34.2			100	26						
004-05	8-9.5	25.6			100	71						
004-06	10-11.5	24.5			100	9						
004-07A 1	19-19.5	23.1					100.4	24.83	0.69	0.63	0.019	2200
004-07A 2 (Swell test)	18.5-19	21.4			100	70	107.0	21.22	0.57			
004-07A 3	18-18.5	18.2										
004-10	26-26.5	27.6			100	85						
004-11A 1	34-34.5	24.4					98.3	24.58	0.72			
004-11A 2	33.5-34	30.5										
004-14A 4 (Swell Test)	53-53.5						79.97	40.97	1.14			

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

Summary of Laboratory Tests (Boring R-09-005)

Sample (R-09-..)	Sample Depth (ft)	Moisture Conten %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (pcf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
005-02	2-3.5	17.9			99	11						
005-05	8-9.5	18.9	25	11	100	58						
005-09	20-21.5	30.2			100	9						
005-10	24.5-25	22.4	21	3	100	73						
005-12	26.5-30	26.8	25	6	100	96						
005-16	36.5-40	26.9	19	3	100	85						
005-20	46.5-50	30.1	NP		100	38						
005-21	50-51.5	43.8	45	19	100	98						
005-22A	52-52.5	47	62	34	100	97						
005-22B	52.5-53	44										
005-22C	53-53.5	46.2										

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

Summary of Laboratory Tests (Boring R-09-006, R-09-007, R-09-008, R-09-010, and R-09-011)

Sample (R-09-..)	Sample Depth (ft)	Moisture Conten %	Atterberg		Mechanical Analysis		Consolidation					
			LL	PI	Passing # 4 Sieve (Sand %)	Passing # 200 Sieve (Clay & Silt %)	Dry Density (ncf)	Water Content (%)	Void Ratio	Cc	Cr	σ'p (psf)
006-04	5.5-6	17.8	23	7	100	34						
006-07	11.5-15	23.9			100	14						
006-12	25-26.5	28.9	22	4	100	87						
006-13	26.5-30	26	27	6	100	98						
006-15	31.5-35	25	NP		100	54						
006-19	41.5-45	30.5			100	22						
006-21	46.5-50	29.6	26	2	100	93						
006-23A	52-52.5	41.1	46	17	100	96	79.9	40.80	1.13	0.199	0.02	6300
006-23B	52.5-53	46.5										
006-23C	53-53.5	54.7										
006-26	60-61.5	29.5	43	23	100	92						
006-28	65-66.5	32.3	90	58	100	94						
007-05	9-10.5	27.5			100	78						
007-08	20-21.5	25.6			100	94						
007-10	30-31.5	32.3			100	90						
007-11	31.5-35	24.8			100	84						
007-15	50-51.5	40.6			100	99						
008-14	50-51.5	42.5			100	96						
010-06	15-16.5	21.2			100	68						
011-04		14.3			100	39						

Note: OMC= Optimum Moisture Content-CTM 216 NP=Non-Plastic

Summary of Laboratory Tests

Sample Ref.(R-09)	Sample Depth (ft)	Dry Density (pcf)	Water Content %	Direct Shear		Unconfined Compression (psi)	Relative Compaction		Sand Equivalent	Expansion Index & Swell Potential (%)
				$\phi°$	C (psf)		γ_{max} pcf	OMC %		
001-06A	10-10.5	106	21.43			11.57				
001-6B	10.5-11			40.4	1130					
001-15B	33.5-34			40	1270					
001-24A	55-55.5	89.04	32.14			8.706				
001-24B	55.5-56			36.9	110					
002-11A-3	58.5-59	79.12	41.52			21.28				
002-13A	66-66.5	84.44	35.81			27.7				
003-14A-5	52.5-53	76.06	45.82			13.56				
003-16A-1	64-64.5	85.04	36.64			22.22				
004-07A-3	19-19.5	112.4	18.21			13.14				
005-22B	52.5-53			31	938					
005-22C	53-53.5	74.21	46.21			22.97				
006-23B	52.5-53			20.9	1260					
006-23C	53-53.5	67.19	54.72			42.33				
O-09-1-1	0.0-1						116.8	10.1		

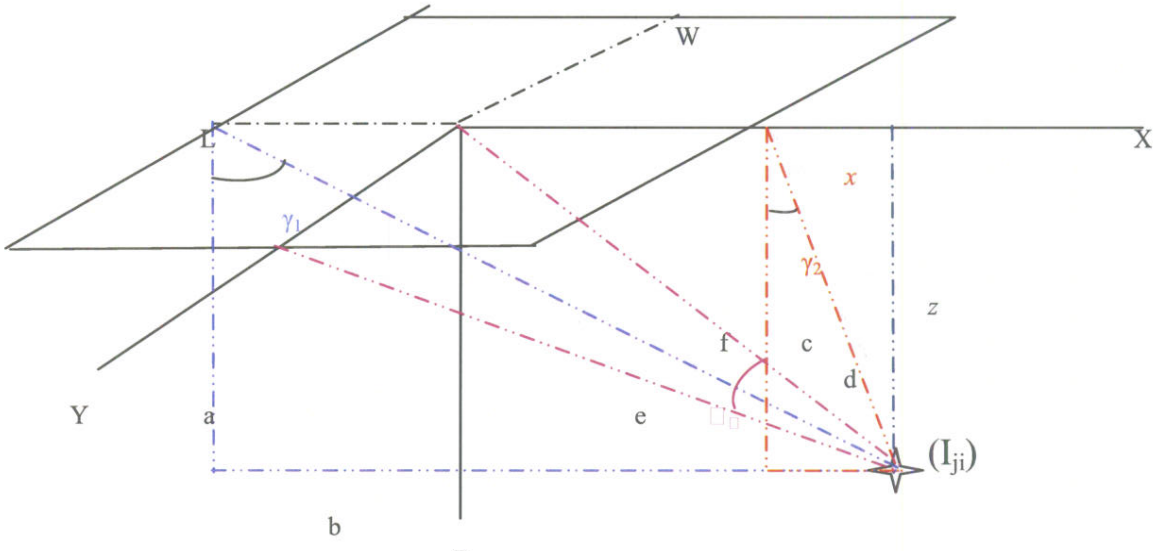
Note: OMC= Optimum Moisture Content-CTM 216. *Combined sample from borings B07-B3-4, 5, and 6. **Combined sample from borings B07-B4-7, 8, and 9. NP=Non-Plastic

Appendix C.

1. Settlement Analyses

SETTLEMENT ANALYSIS BASED ON SOIL STRUCTURE INTERACTION OF SHALLOW AND DEEP FOUNDATIONS, SUBJECT TO STATIC AND SEISMIC LOADS (From Zeevaert, 1980)

Once the stresses at the base of the structure are known, the stress distribution in the foundation soils can be estimated through a influence factor using Frolich solution for X=2 and X=4. The first solution is for a stratified soil with layers of different deformability, whereas the second is for a homogenous soil whose compressibility decreases with depth, such as the case of sand.



γ_1= Tg-1((b+x)/(a))

γ_2= Tg-1(x/c)

□□ Tg-1((L/2+x)/□L/2+x)^2+z^2

The figure above shows the parameters that contribute to the determination of the above equations.

The equations that define the factor of influence for the first case is as follows:

$$I_{ji} = 1/\pi\{\alpha_o + \tfrac{1}{2}\sin 2\alpha_o](\sin\psi_1 - \sin\psi_2)$$

For the second case the equation is as follows:

$$I_{ji} = 1/\pi\{3/2\alpha_o + 3/4\sin 2\alpha_o + \sin\alpha_o \cos^3\alpha_o]\{(\sin\psi_1 - \sin\psi_2) - 1/3(\sin^3\psi_1 - \sin^3\psi_2)\}$$

Once the stress distribution in the foundation soils is calculated, settlement can be calculated by the following equation.

$$\delta p = \Sigma \Delta\sigma m_v d \qquad \text{or,}$$
$$\delta p = (q I_{ji} D_c)/E$$

Where $\Delta\sigma$ is the increment of stresses with respect to the stresses in situ at the center of each layer, m_v is the modulus of plastic deformation to the depth of the layer, and d is the compressible thickness of each layer.

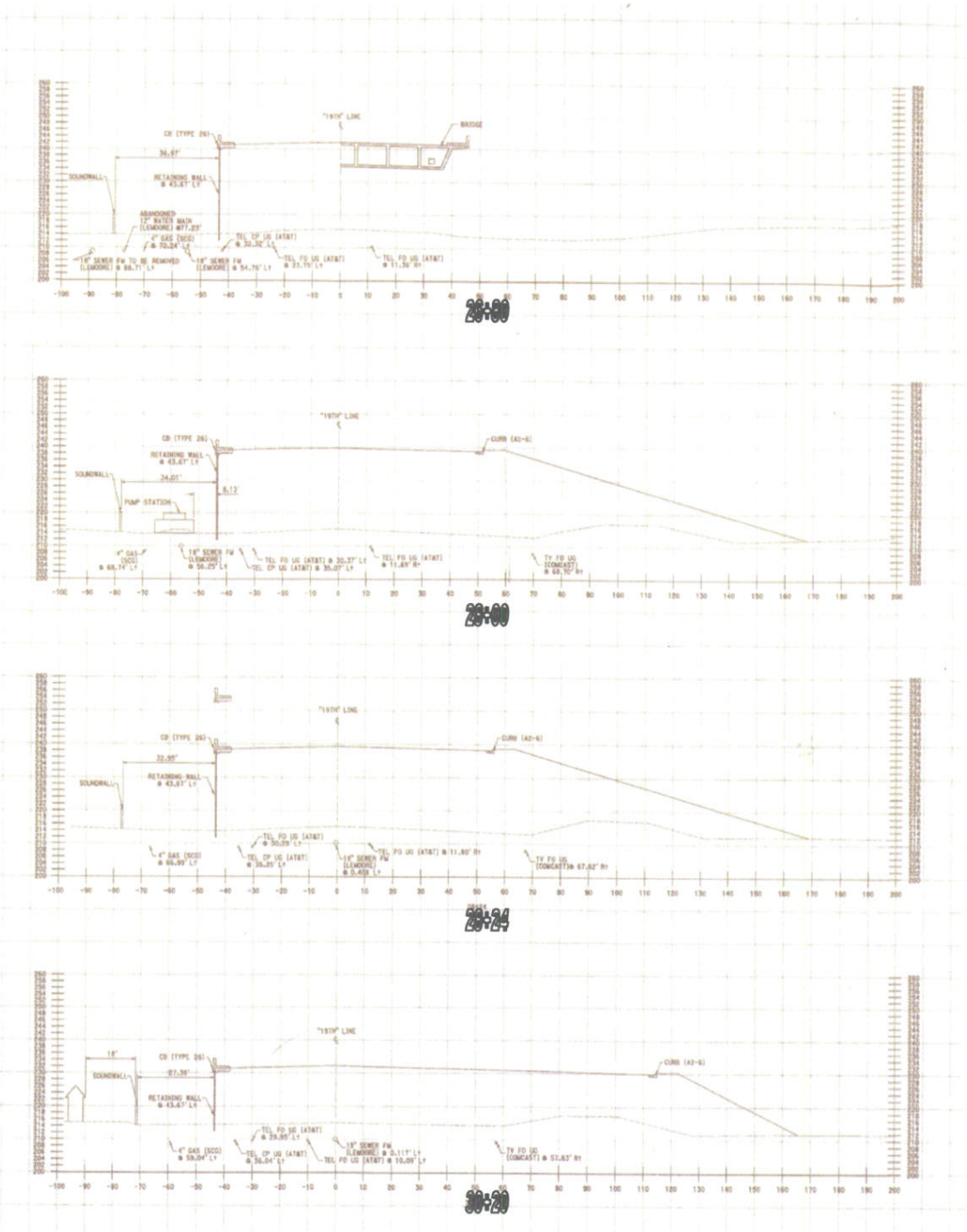
APPENDIX C.2 - SETTLEMENT ADJACENT TO TOE OF MSE WALL

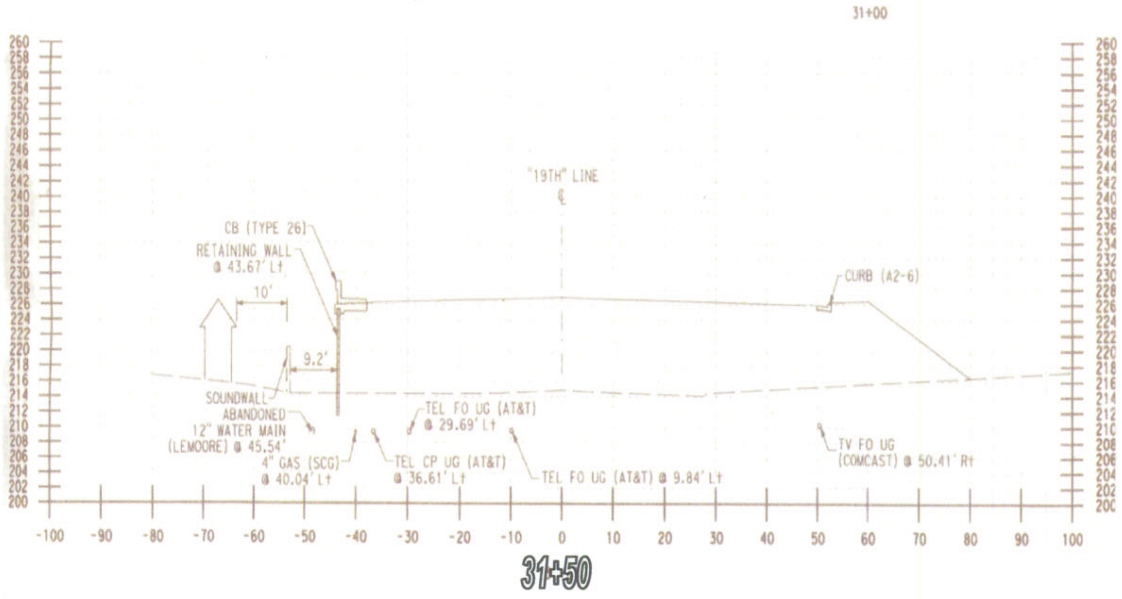
Wall Height & Station Interval (ft)	Distance from Wall Toe (ft)	Total Settlement (in)	Wall Height & Station Interval (ft)	Distance from Wall Toe (ft)	Total Settlement (in)	Wall Height & Station Interval (ft)	Distance from Wall Toe (ft)	Total Settlement (in)
30.0	Center	11.7	20.0	Center	10.2	10.0	Center	4.6
26+65 to								
27+40	0.0	6.4	30+00 to 30+50	0.0	4.3	32+50 to 33+00	0.0	2.8
	5.0	4.5		5.0	2.6		5.0	1.7
	10.0	3.3		15.0	1.6		15.0	1.0
	20.0	2.2		20.0	1.4	■	17.0	0.9
	40.0	1.3		40.0	0.9		25.0	0.7
	50.0	1.0	■	45.0	0.8		30.0	0.6
	60.0	0.7		50.0	0.7		40.0	0.4
	70.0	0.6		60.0	0.6		50.0	0.3
				70.0	0.5		70.0	0.2
28.0	Center	10.9	18.0	Center	9.2	8.0	Center	3.6
🛠	0.0	6.2	30+50 to 31+00	0.0	3.9	33+00 to 33+50	0.0	2.4
28+20 to								
29+00	6.0	4.1		5.0	2.3		5.0	1.4
	10.0	3.2		15.0	1.5	■	13.0	0.9
	20.0	2.1		20.0	1.3		15.0	0.8
	25.0	1.8		40.0	0.8		20.0	0.7
	30.0	1.4	■	45.0	0.7		30.0	0.5
	40.0	1.2		50.0	0.7		40.0	0.4
	50.0	0.9		60.0	0.5		50.0	0.3
	60.0	0.7		70.0	0.4		70.0	0.2
26.0	Center	11.2	16.0	Center	8.2	6.0	Center	2.7
28+20 to								
29+00	0.0	6.2		0.0	3.5	33+50 to 35+45	0.0	1.9
	5.0	4.1	31+00 to 31+50	5.0	2.1		5.0	1.2
	15.0	2.4		15.0	1.4	■	13.0	0.7
	25.0	1.6		20.0	1.2		15.0	0.7
	30.0	1.3		40.0	0.7		20.0	0.5
	40.0	0.9	■	50.0	0.6		30.0	0.4
■	50.0	0.7		60.0	0.5		40.0	0.3
	60.0	0.6		70.0	0.4		50.0	0.2
	70.0	0.5					70.0	0.2
24.0	Center	10.3	14.0	Center	4.3			
29+00 to								
29+50	0.0	5.7		0.0	2.6			
	5.0	3.8	31+50 to 32+00	5.0	1.8			
	15.0	2.3		15.0	1.2			
	25.0	1.5	■	20.0	1.0			
	35.0	1.0		25.0	0.8			
■	45.0	0.8		30.0	0.7			
	50.0	0.7		40.0	0.5			
	60.0	0.6		50.0	0.4			
	70.0	0.5		70.0	0.3			
22.0	Center	11.2	12.0	Center	3.7			
29+50 to								
30+00	0.0	4.6		0.0	2.3			
	5.0	2.8	32+00 to 32+50	5.0	1.6			
	15.0	1.8	■	15.0	1.1			
	25.0	1.4		17.0	1.0			
	35.0	1.1		20.0	0.9			
■	45.0	0.9		30.0	0.6			
	50.0	0.8		40.0	0.5			
	60.0	0.6		60.0	0.3			
	70.0	0.5		70.0	0.2			

🛠 Distance to the pump station structure from the edge of the wall.

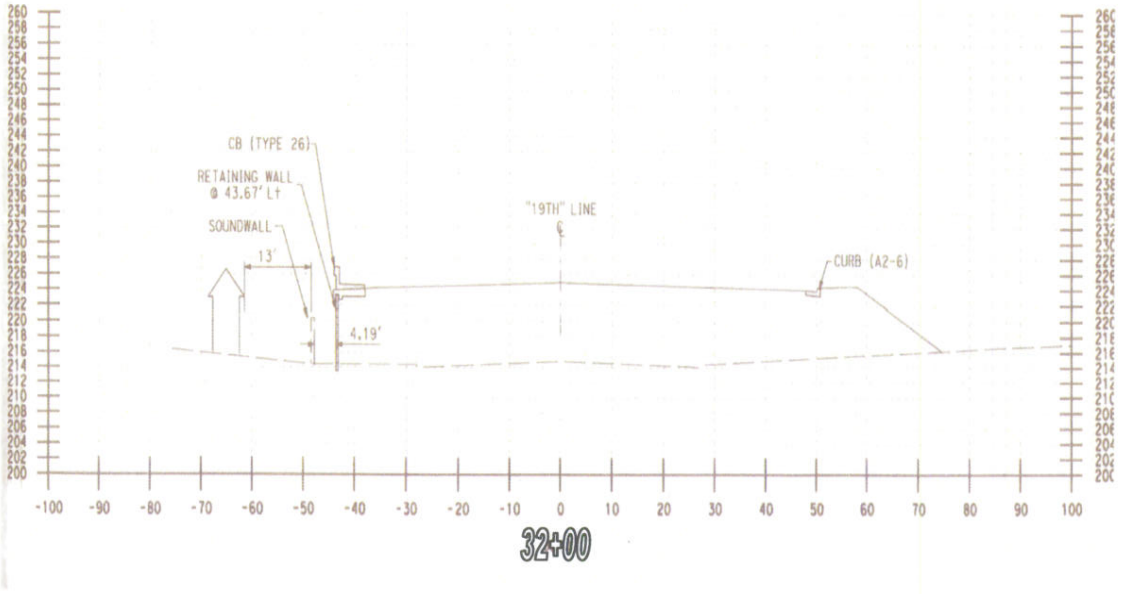
■ Nearest distance to the residential units from the edge of the wall.

APPENDIX C.3 MSE WALL CROSS SECTIONS SHOWING DISTANCE TO RESIDENTIAL UNITS

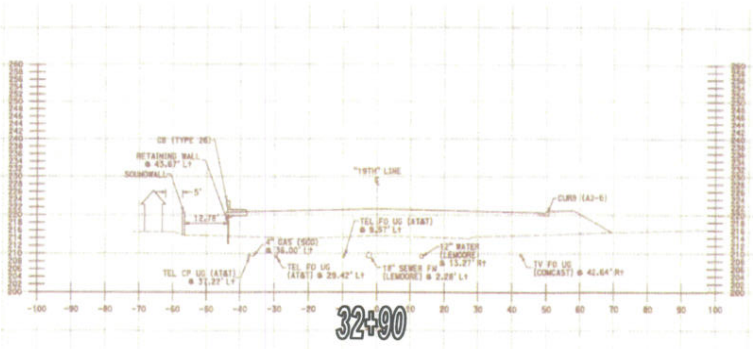



31+00
"19TH" LINE
CB (TYPE 26)
RETAINING WALL
@ 43.67' Lt
10'
9.2'
CURB (A2-6)
SOUNDWALL
ABANDONED
12" WATER MAIN
(LEMOORE) @ 45.54'
4" GAS (SCG)
@ 40.04' Lt
TEL CP UG (AT&T)
@ 36.61' Lt
TEL FO UG (AT&T)
@ 29.69' Lt
TEL FO UG (AT&T) @ 9.84' Lt
TV FO UG
(COMCAST) @ 50.41' Rt

31+50


CB (TYPE 26)
RETAINING WALL
@ 43.67' Lt
SOUNDWALL
13'
4.19'
"19TH" LINE
CURB (A2-6)

32+00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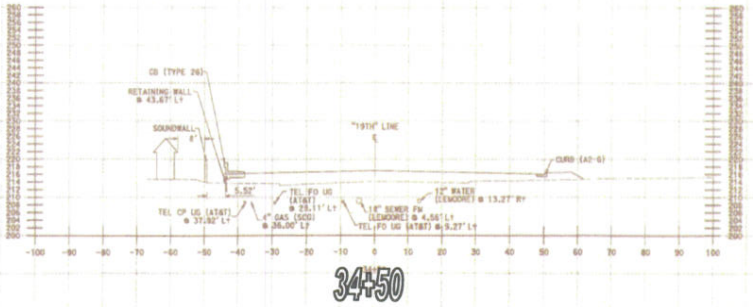
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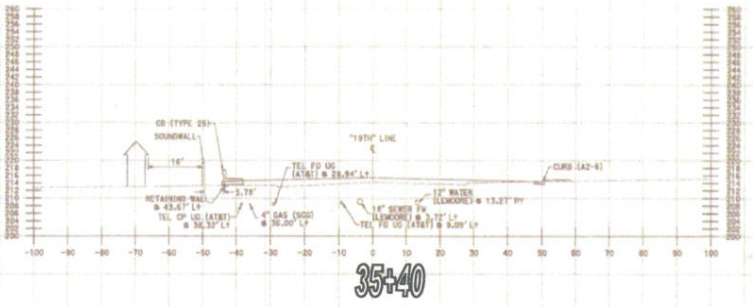

35+40

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: GARY JOE
Chief,
Bridge Design Branch 17
Bridge Office of Bridge Design Services
Structure Design
Division of Engineering Services MS 9-DES 17

Date: November 3, 2011

File: 06-KIN-198-PM 9.4/10.2
EA 06-325501
19th Ave OC
Br. No. 45-0104

Attention: Rene Coria & Elijah Hall
(For Structure Specifications Engineer)

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

Subject: Summary of Geotechnical Recommendations for 19th Ave Interchange.

In response to the electronic mail from the Structure Specifications Engineer dated June 8, 2011, we have provided the following clarifications on the settlement periods for the embankments and other issues at the proposed 19th Ave Interchange.

1. **Pile Installation**

All pile installations for the 19th Ave OC and the retaining walls at Abutments 1 and 3 shall commence only after the Engineer has determined that settlement of all the new fills is complete.

2. **Settlement Waiting Period**

Settlement shall be monitored and the Engineer shall use the rate of settlement to determine whether the recommended waiting period of 120 days is adequate.

Table 1 below summarizes the settlement periods for the proposed new approach embankments as provided in the Geotechnical Design Report for 19th Avenue Interchange, dated June 23, 2010 under EA 06-325501.

Table 1: Settlement of approach embankments and other fills at 19th Ave Interchange

Fill	Approx. Station Location (19th Ave line)		Height for settlement (ft)		Settlement Period (Days[1&2])	Comments
	From	To	Max.	Min.		
Abutment 1 Approach Embankment (353ft long)	20+19	23+72	28	6	120	No surcharge required
Abutment 3 Approach Embankment (875 ft long)	26+85	35+60	30	6	120	Includes MSE wall with Half Gabion-Faced wall
North Embankment	Westbound On and Off Ramps		16	0	120	No surcharge required
South Embankment	Eastbound On and Off Ramps		20	0	120	No surcharge required

[1] The Engineer shall determine when settlement is complete based on the results of settlement monitoring.
[2] Period includes immediate and long term post construction settlement.

3. Earth Retaining Systems

Earth retaining structures include the MSE/Half Gabion-faced wall at the north approach embankment, the Type 1 retaining wall at Abutment 3 and the wing walls/retaining walls at Abutment1.

The Temporary Shoring Backfill is a temporary earth retaining structure that will be located as a surcharge over the footprints of Abutment 1 & 3 footings, and the Type 1 retaining wall at Abutment 3.

Table 2 below summarizes the characteristics of the above noted structures.

Table 2: Earth Retaining Structures

Structure	Approximate Location		Height (ft)		Settlement Period (Days[1&2])	Comments
	From	To	Max.	Min.		
MSE Wall with Half Gabion- Faced wall at north approach embankment	9+79 (RWLOL)	18+44 (RWLOL)	32	2	120	Sound wall over Barrier wall. Settlement monitoring begins when construction is 5 ft from maximum height.
Retaining Wall No.1 at Abutment 3	511+30 (WOB Line)	512+63 (WOB Line)	30	4	NA	To be constructed after settlement is complete. Temporary Shoring Backfill as surcharge over footing location.
Type 1 retaining walls or wing walls at Abutment1	In approach embankment east and west behind Abutment 1		16	4	NA	To be constructed after settlement is complete. Footings in embankment fill. No surcharge required.
Temporary Shoring Backfill at Abutment 3	510+00 (WOB Line)	512+50 (WOB Line)	25	10	120	As surcharge over the footprints of Abutment 3 & Retaining Wall No. 1 and shall be 50 ft wide.
Temporary Shoring Backfill at Abutment 1.	508+75 (EBE)	510+10 (EBE)	25	25	120	As surcharge over the footprint of Abutment 1 location similar to Abutment 3.
Abutment1	23+72 (19th Line)		28	NA	NA	To be constructed after settlement is complete. Footing below original ground surface similar to Abutment 3.

[1] The Engineer shall determine when settlement is complete based on the results of settlement monitoring.
[2] Period includes immediate and long term post construction settlement.

4. Abutment Footings

Abutments 1 and 3 will be high cantilever abutments with footings constructed below native ground surface at approximate elevations of 213 and 209 feet respectively.

5. Temporary Shoring Backfill

A Temporary Shoring Backfill (as that proposed for Abutment 3), shall be constructed over the footprints of Abutment 1 as a surcharge. The location of the said Temporary Shoring Backfill is described in Table 2 above. We recommend this temporary surcharge to be 135 feet long (see stationing in Table 2) by 50 feet wide by 25 feet high.

6. Settlement Monitoring Devices

Settlement of the original ground below the approach embankments, the MSE wall, and the On and Off Ramps, shall be monitored by settlement-measuring devices as provided in California Testing Method 112, as recommended in the Geotechnical Design Report (GDR) dated June 23,

2010. Settlement platforms and survey points shall be installed in the fill area as indicated in figure 10.5 on page 23 of the GDR. Refer to Section 19-6.025 "Settlement Period" of the Standard Specifications (2006) for settlement platforms. Additionally, survey points shall be installed along Carmel Drive to monitor settlement around the private residences. Settlement monitoring is not required in the new fills.

7. **Bent Footings**

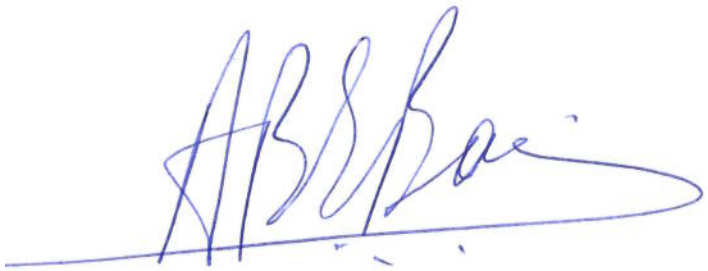
Bent 2 footing excavation and installation of the piles can be done prior to, or during the, settlement periods of Abutments 1 and 3.

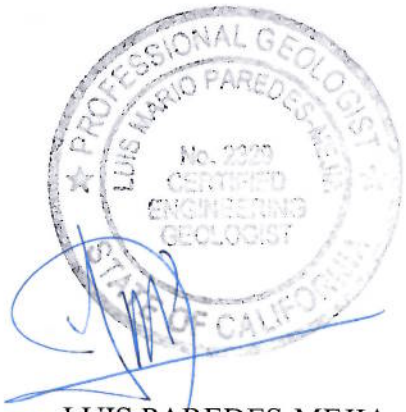
8. **Material Requirements for Half Gabion Return Wall**

For this section, please refer to the nSSP for the Half Gabion Return Wall attached to the letter with subject "Non-Standard Contract Special Provision Concurrence" dated November 1, 2011.

If you have any questions regarding this report, please contact Abu Barrie at (916) 227-1043, Luis Paredes-Mejia at (916) 227-1081or Reid Buell at (916) 227-1012.

Report by:





ABUBAKARR BARRIE
Engineering Geologist
Office of Geotechnical Design-North

LUIS PAREDES-MEJIA
Engineering Geologist
Office of Geotechnical Design-North

Attachment

c: Jim Heinen (E-copy)
Mark Willian (E-copy)
Struct. Cons. R.E. Pending File
DES OE, PS&E (E-copy)
Mike Webber DME (E-copy)

State of California Business, Transportation and Housing Agency

Memorandum

To: **ERNIE PENUNA**, Chief
Design Branch U
Office of Design II
Central Region Project Development

Date: May 10, 2011

File: 06-Kin-198-PM 9.4/10.2
Ea: 06-325501
Project No: 0600000367

From: **TED MOORADIAN,** Chief
District Materials Engineer
Materials Engineering Branch – Fresno
Central Region Construction Deflection Testing

Subject: Materials Information Handout

The Materials Engineering Branch has completed the necessary tests and has compiled the attached Materials Information requested for the potential imported borrow material sources for this project. A copy is attached. The District Office Engineer is being furnished with the reproducible package.

If you have any questions or need additional information, please call me at 488-4148 or Ahmad Shokrpoor at 488-4119.

C: OE
Attachments: Materials Information Handout

MATERIALS INFORMATION HANDOUT
(Not a Part of the Contract)

For

Contract No. 06-325504
06-Kin-198-PM 9.4/10.2

In Kings County, in and near Lemoore, from 0.5 mile West to 0.7 mile East of 19th Avenue.

Note: The records from which this compilation was made may be inspected at the Caltrans District 06 Materials Engineering Branch at 1352 West Olive Avenue, Fresno, California.

CONTENTS

Investigated Materials Sources

1. Owner: **City of Lemoore**

    a. Basin (350,000 cubic yards)
    On North-East corner of Route 41 and Idaho Avenue.

2. Owner: **Lakeside Irrigation Water District**

    a. Future Basin (142,000 cubic yards)
    On South-East corner of Route 198 and 7th Avenue.

    b. Basin (1,482,000 cubic yards)
    South of Route 198 and West of 5th Avenue.

3. Owner: **Laguna Irrigation District**

    a. Everett Pond (100,000 cubic yards)
    At North-East corner of Everett Avenue and 20th Avenue intersection,
    On East side of 20th Avenue.

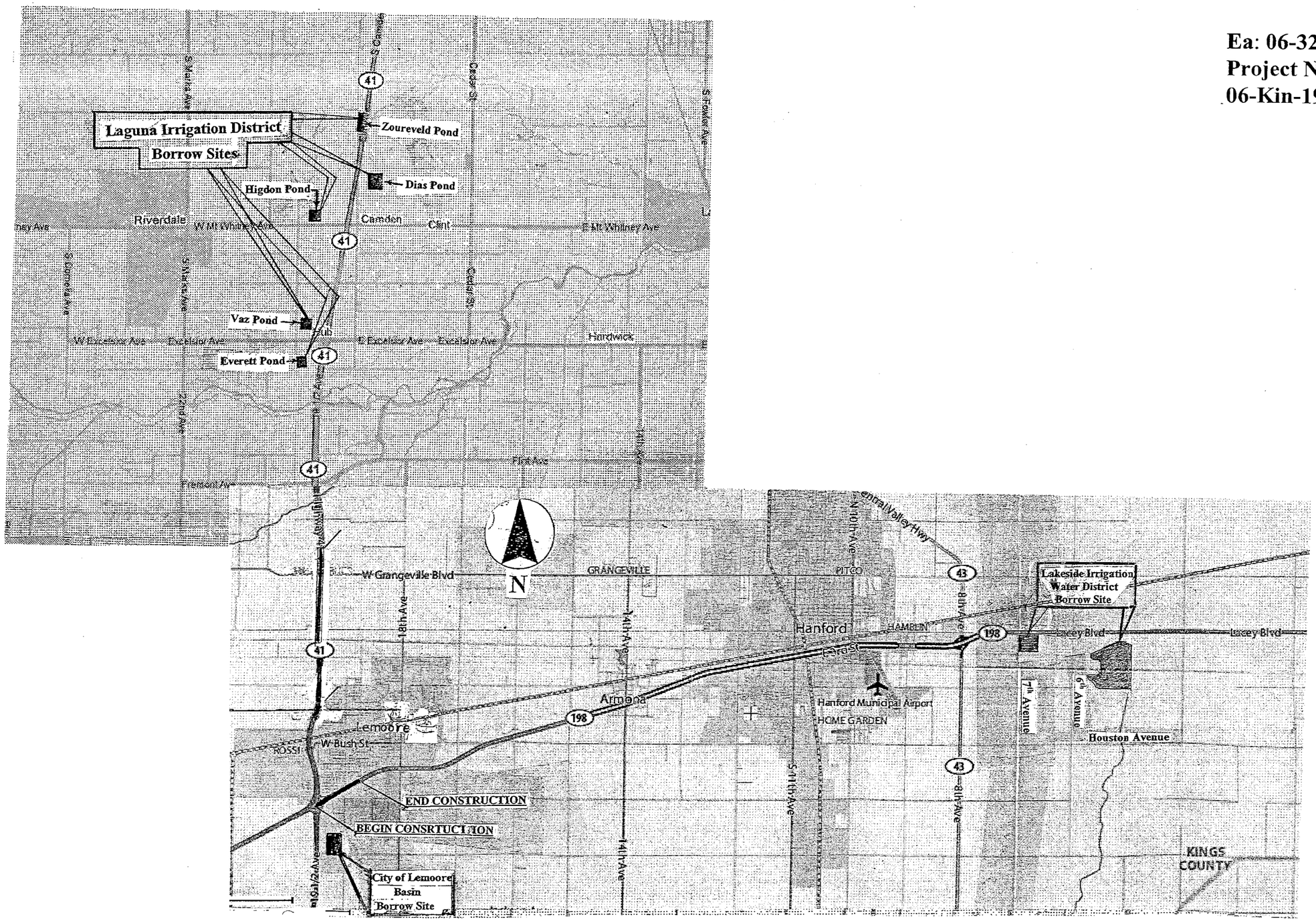
    b. Vaz Pond (100,000 cubic yards)
    At 20th Avenue between Excelsior Avenue and Lewiston Avenue,
    On East side of 20th Avenue.

    c. Higdon Pond (100,000 cubic yards)
    At South-Eest corner Riverdale Avenue and Walnut Avenue intersection,
    On East side of Walnut

    d. Dias Pond (100,000 cubic yards)
    At Elm Avenue between Riverdale Avenue and Harlan Avenue intersection,
    On East side of Elm Avenue.

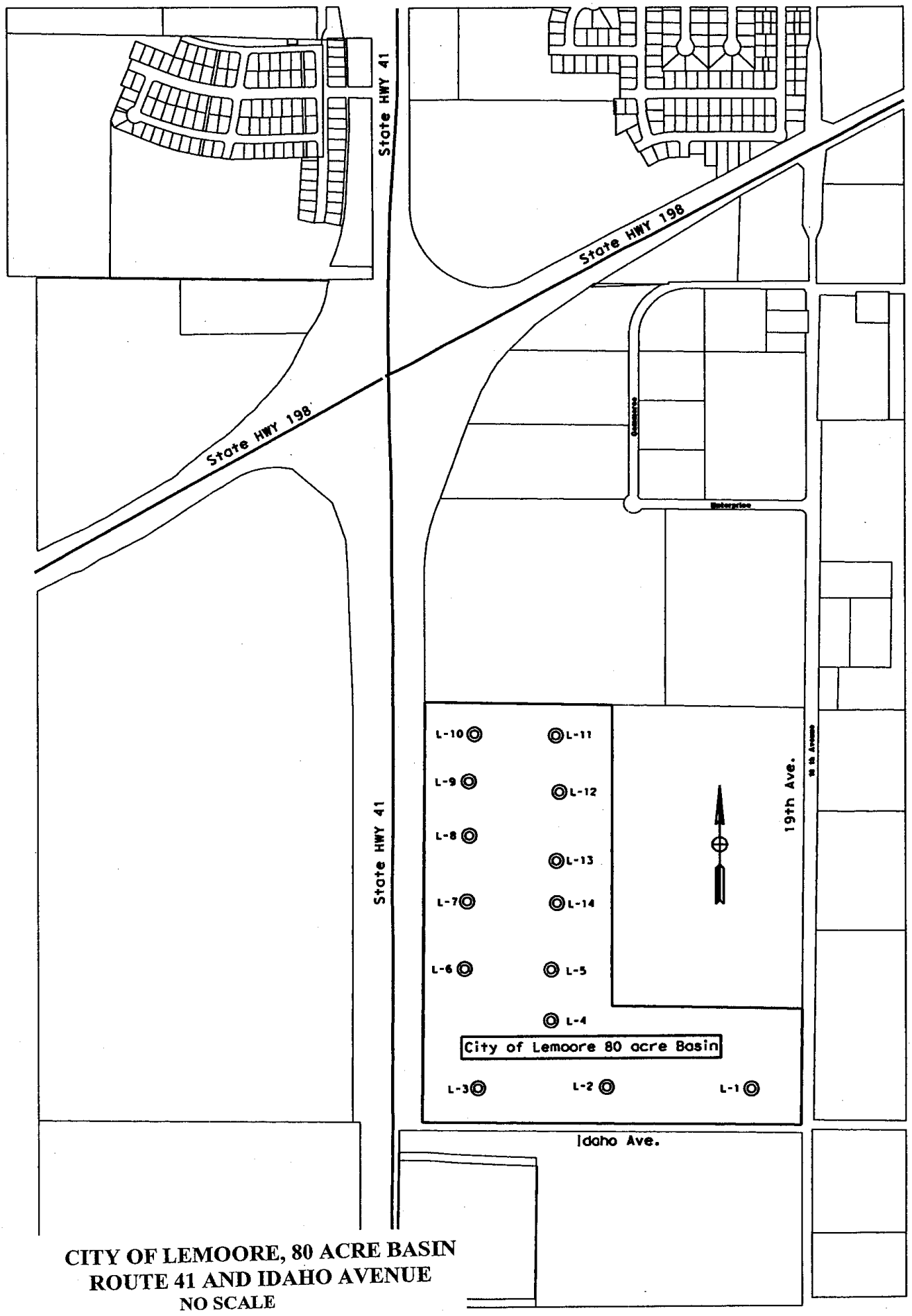
    e. Zoureveld Pond (100,000 cubic yards)
    At Elm Avenue between Route 41 and Elm Avenue,
    On South side of Harlan Avenue.

Ea: 06-325501
Project No: 0600000367
06-Kin-198-PM 9.4/10.2

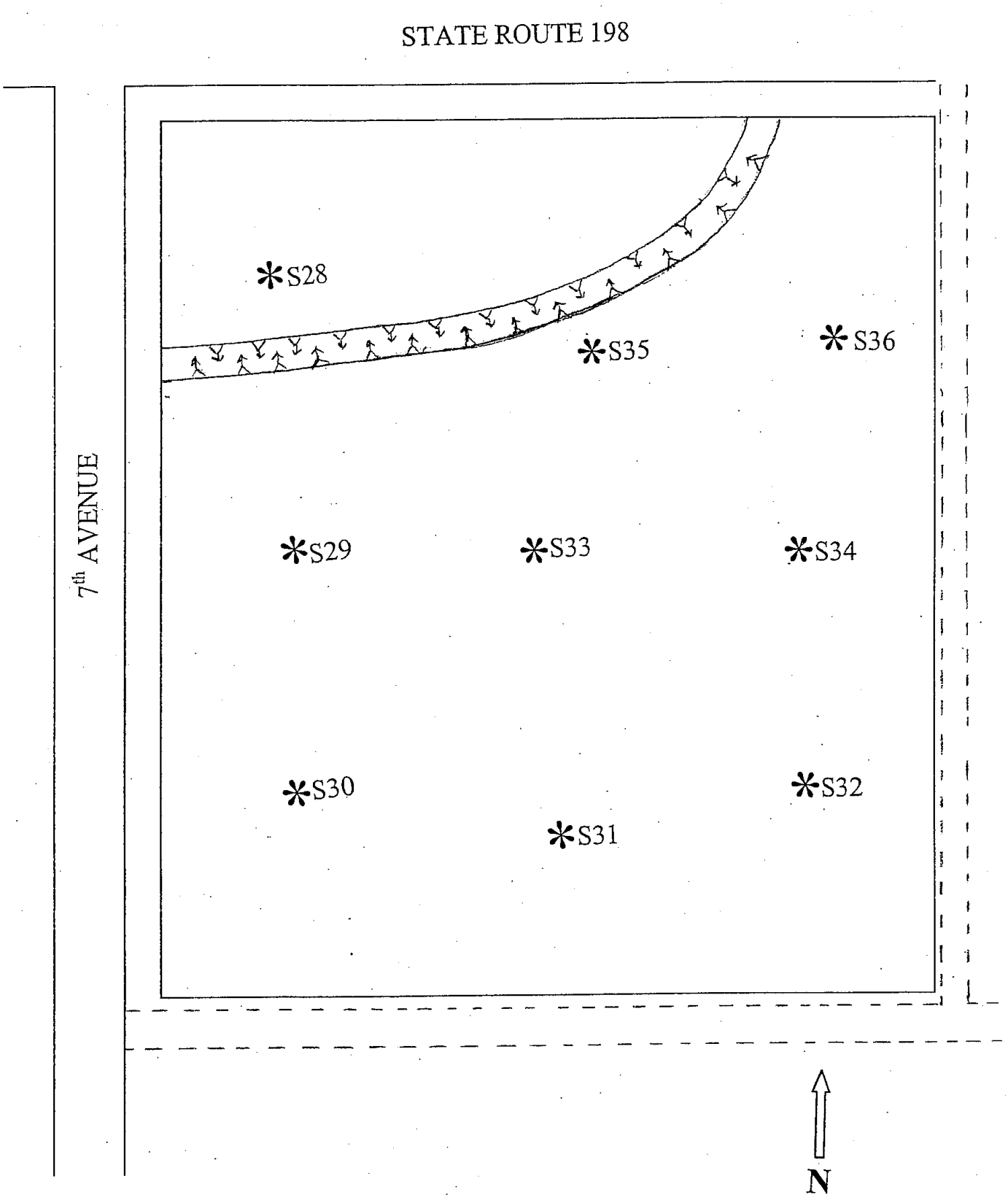


MATERIALS INFORMATION HANDOUT VICINITY MAP

NO SCALE

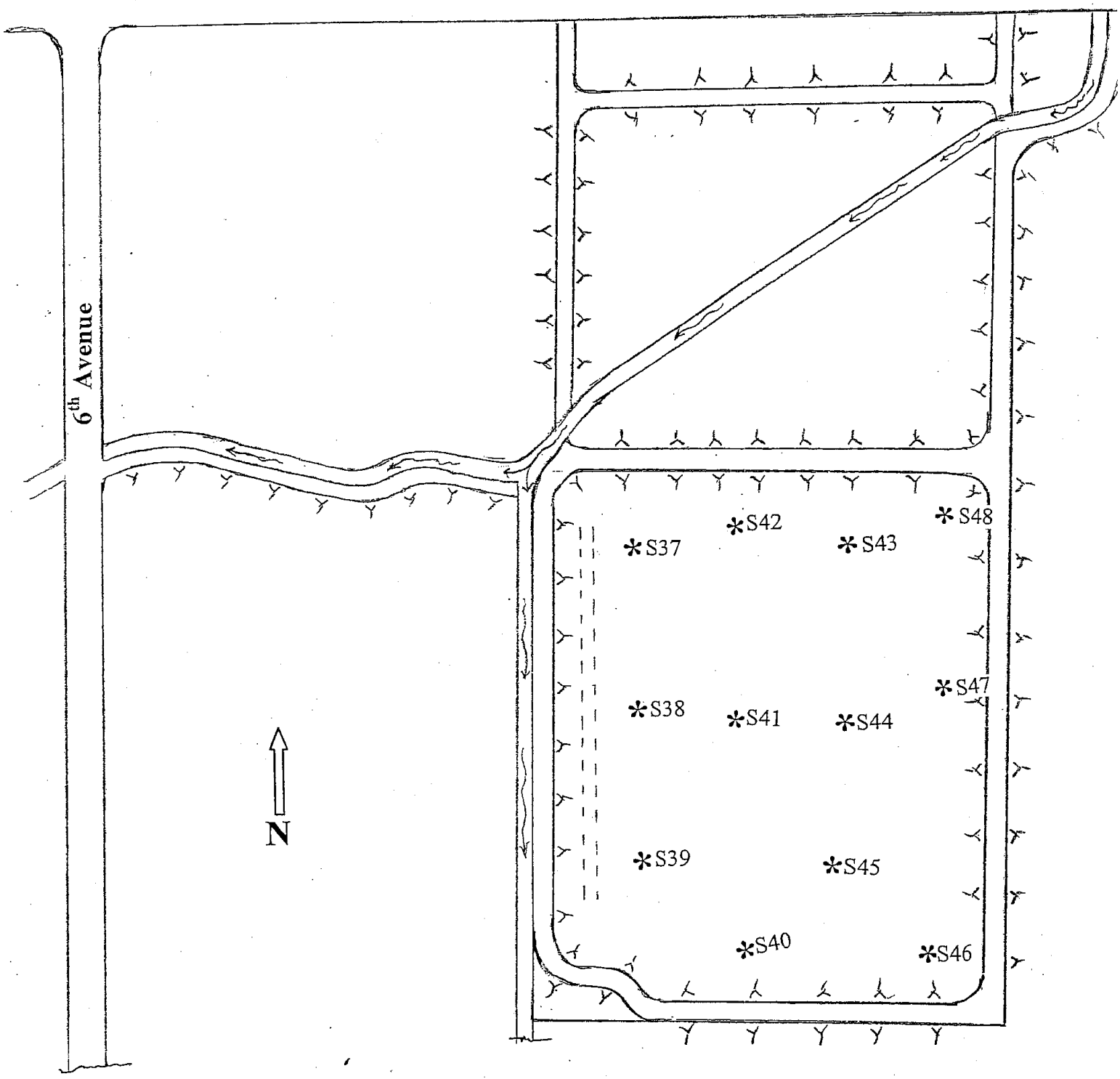


CITY OF LEMOORE, 80 ACRE BASIN
ROUTE 41 AND IDAHO AVENUE
NO SCALE



BORROW SITE No. 3
NO SCALE
LAKESIDE IRRIGATION WATER DISTRICT

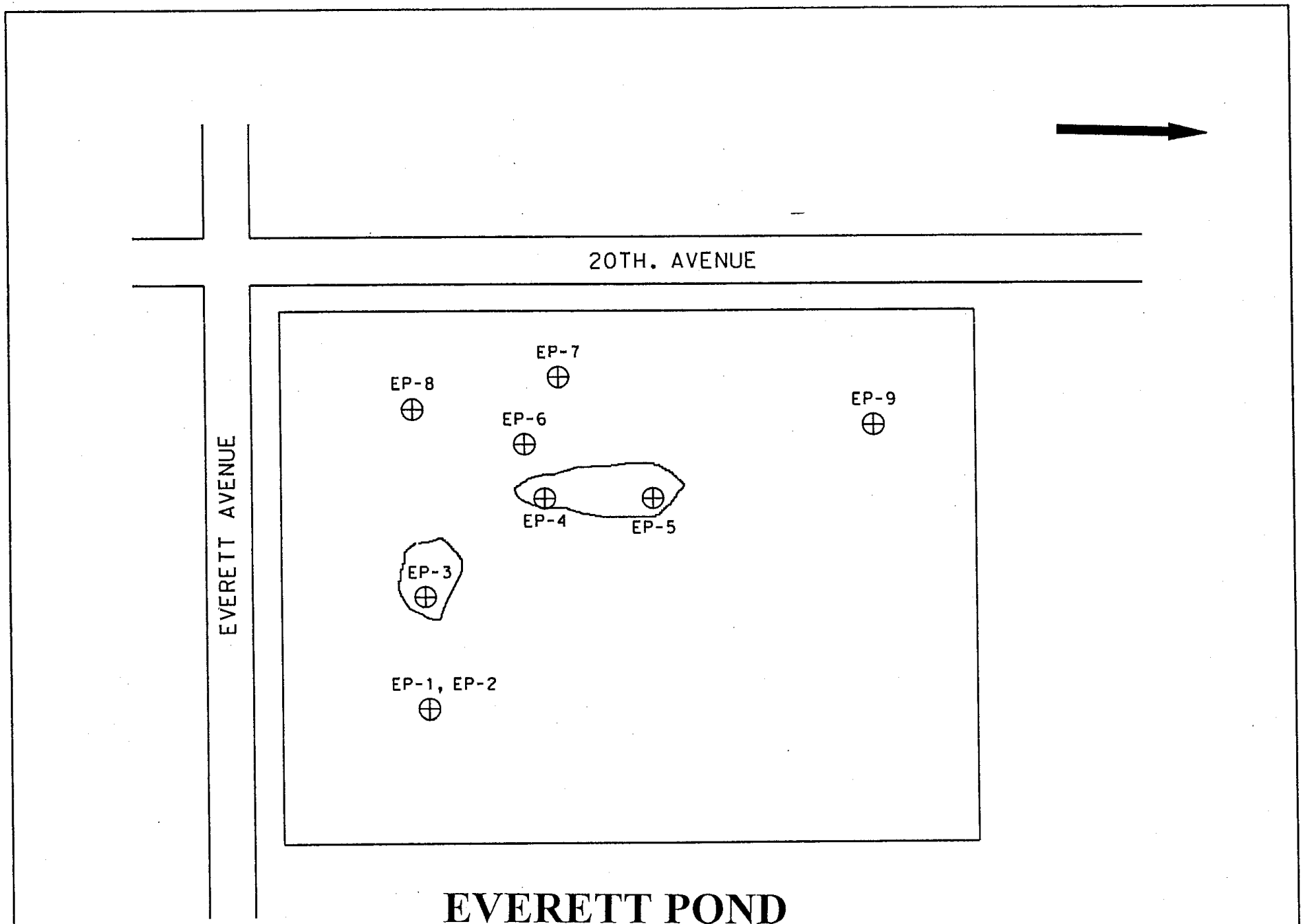
STATE ROUTE 198



BORROW SITE No. 4

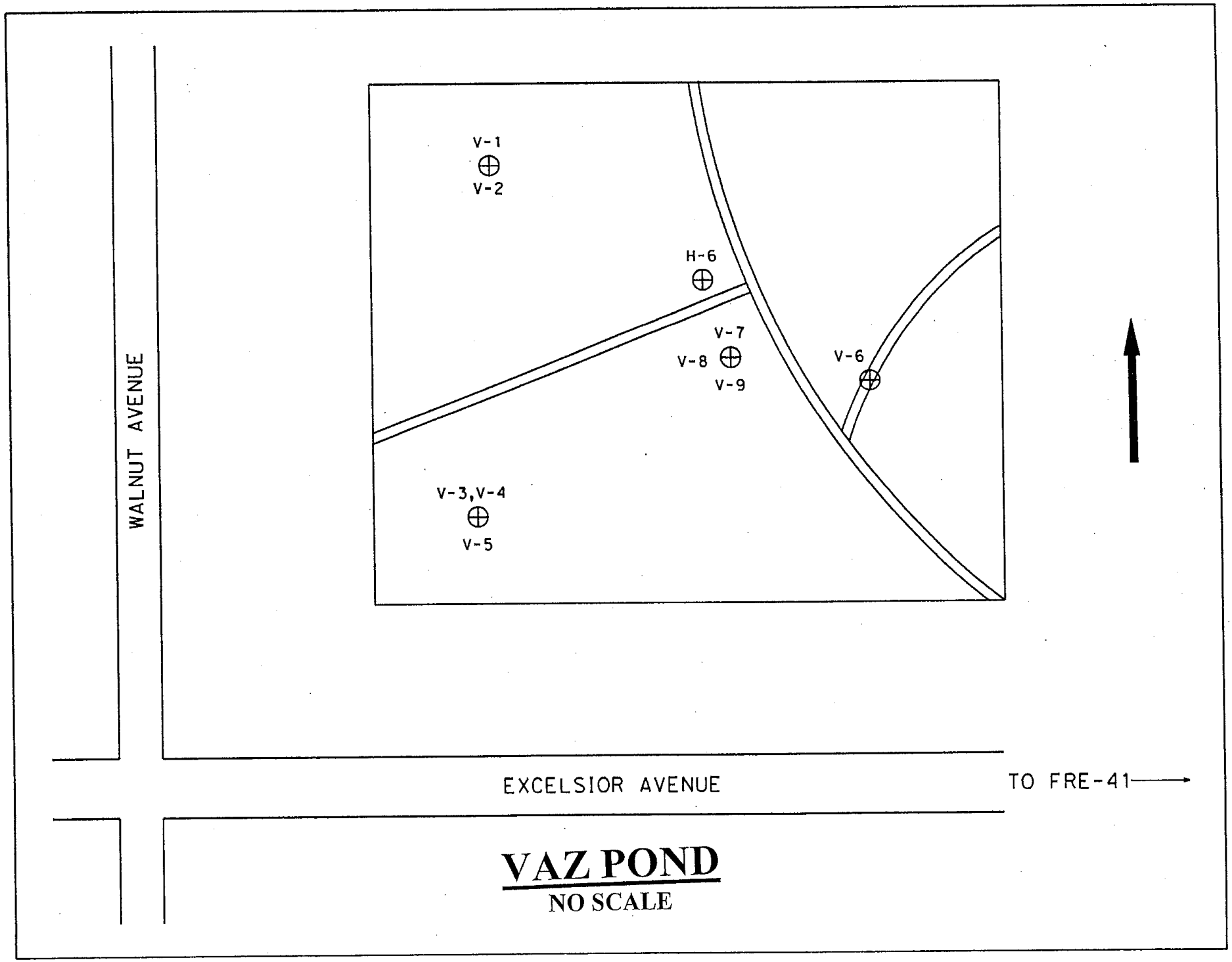
NO SCALE

LAKESIDE IRRIGATION WATER DISTRICT BASIN



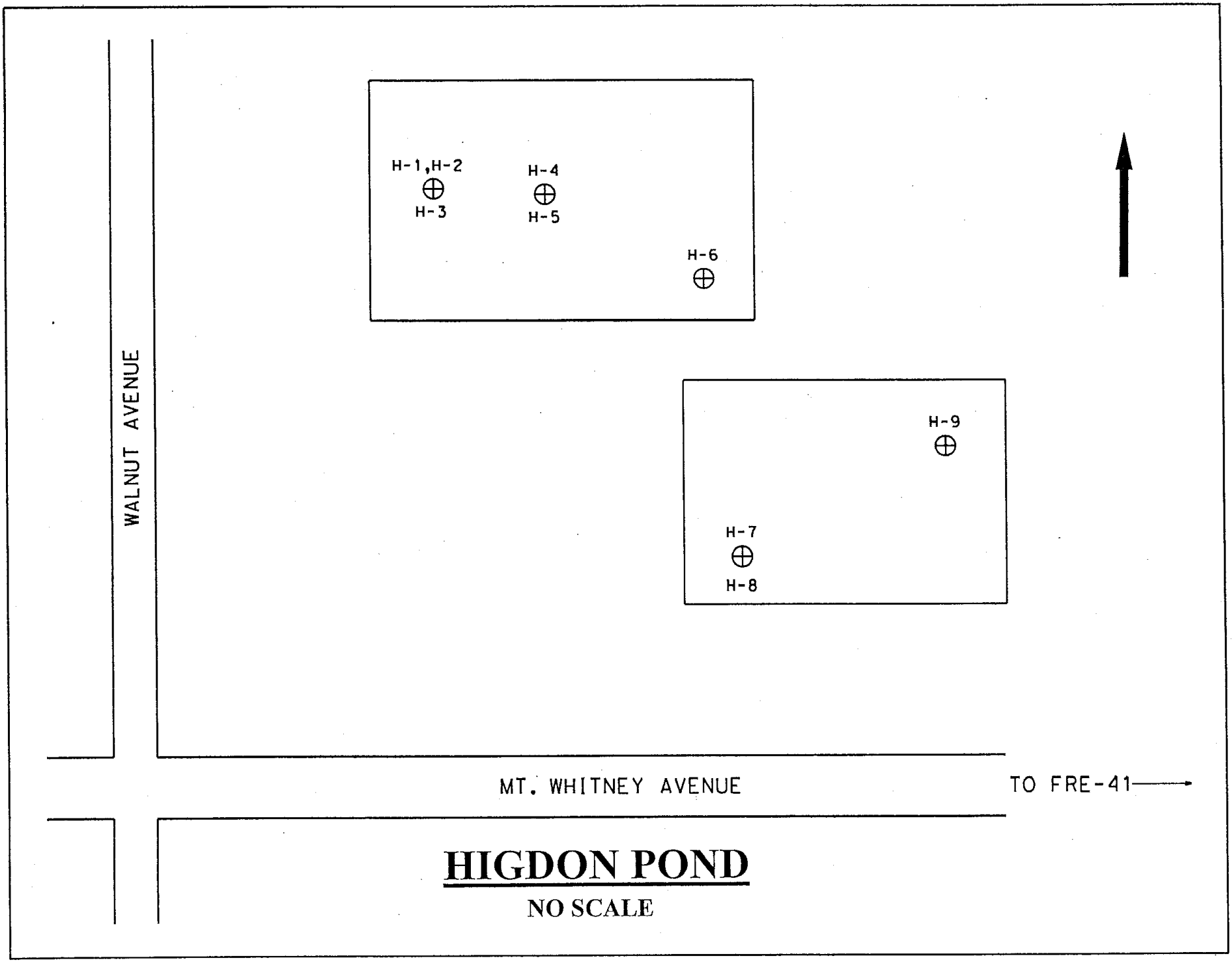
EVERETT POND

NO SCALE



VAZ POND

NO SCALE



HIGDON POND

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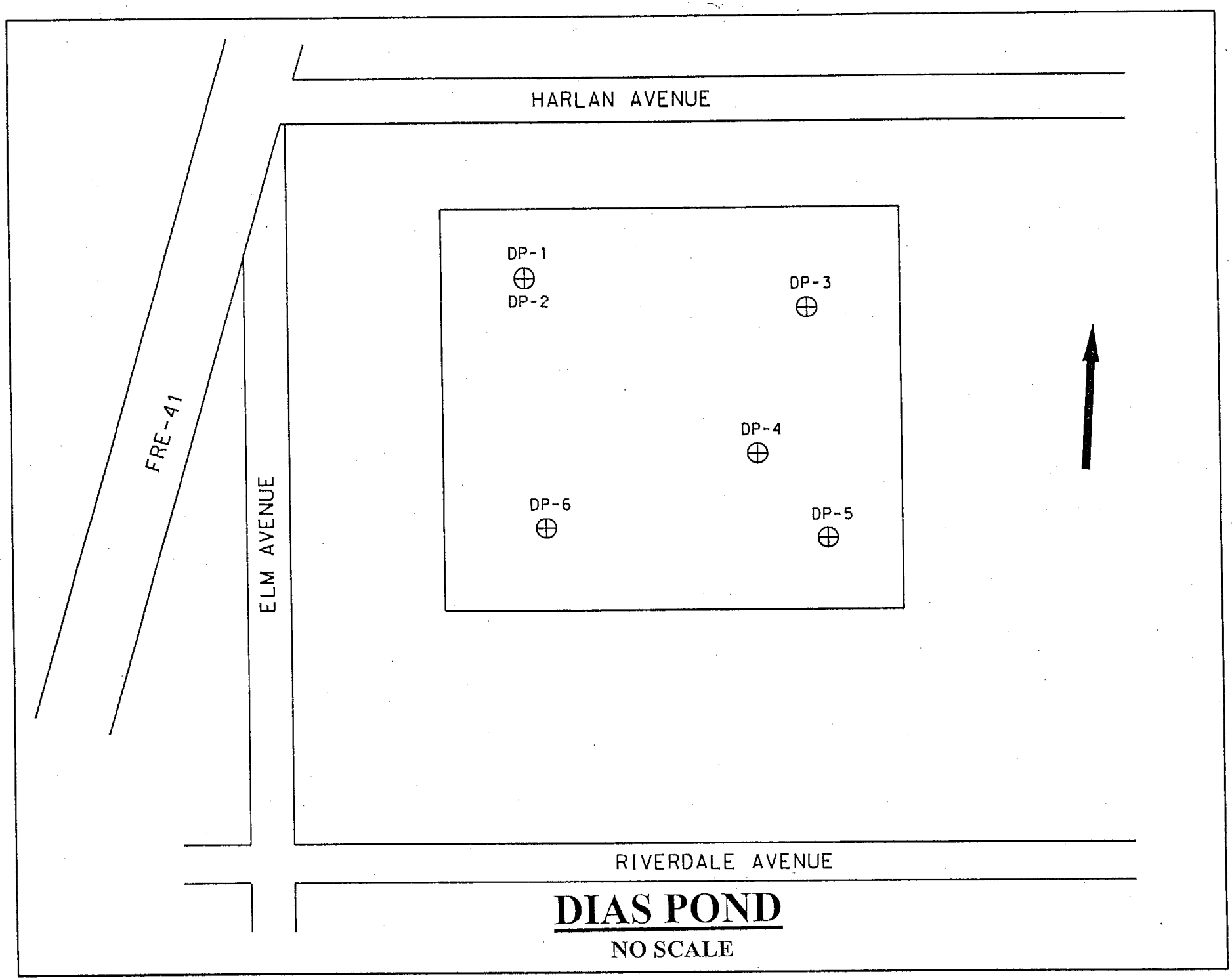

DIAS POND

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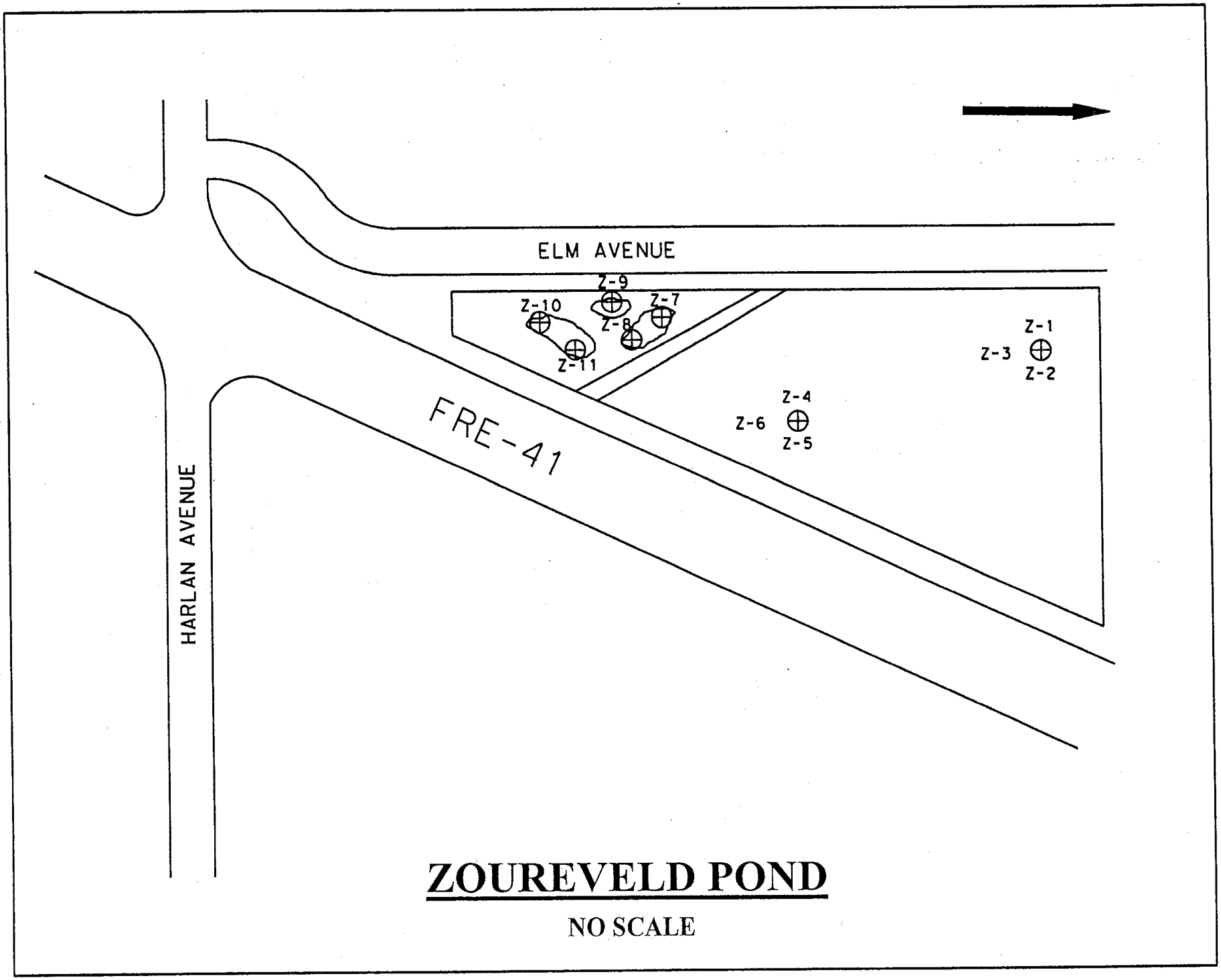

ZOUREVELD POND

NO SCALE

Test Data Tabulation

City of Lemoore, BASIN at the NE Corner of
Route 41 and Idaho Avenue

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)	Chloride	Sulfate
C1984101	L1	1' – 3.5'	23	8	55.2	8.90	90	1800	10800
C1984102	L2	1' – 3.5'	15	9	55.0	8.61	120	1500	5500
C1984103	L3	1' – 3.5'	41	6	67.7	8.27	220	800	2400
C1984104	L4	1' – 3.5'	67	11	52.4	8.71	280	575	1800
C1984105	L5	1' – 3.5'	21	9	51.5	8.58	100	1800	8700
C1984106	L6	1' – 3.5'	17	5	66.2	8.41	110	1100	8700
C1984107	L7	1' – 3.5'	50	11	43.4	8.44	120	1300	7600
C1984108	L8	1' – 3.5'	16	4	73.2	8.66	90	2200	9300
C1984109	L9	1' – 3.5'	20	6	72.9	8.46	90	1700	11300
C1984110	L10	1' – 3.5'	27	7	58.6	9.22	120	1190	5700
C1984111	L11	1' – 3.5'	17	6	58.4	8.78	150	740	4800
C1984112	L12	1' – 3.5'	56	11	43.8	8.70	3600	-	-
C1984113	L13	1' – 3.5'	11	4	78.8	8.90	625	27	940

Test Data Tabulation

Lakeside Irrigation Water District, property at the SE corner of State Route 198 and 7th Avenue

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)	In Situ Relative Compaction @0.5'–2.0'
C555192	S28	0.5' – 5'	67	22	32.9	7.30	5400	77
C555193	S29	0 – 5'	70	29	22.7	7.22	13000	
C555194	S30	0 – 5'	55	20	38.4	10.15	2300	
C555195	S31	1' – 5.5'	67	17	48.9	9.23	1400	
C555196	S32	1' – 5.5'	68	9	57.9	9.76	1100	
C555197	S33	0.5' – 5.5'	70	21	38.4	9.45	4500	
C555198	S34	0.5' – 5'	68	19	46.2	8.78	5200	
C555199	S35	0 – 5.5'	68	13	54.0	6.82	1600	
C555200	S36	1' – 5.5'	59	10	62.2	7.70	4200	

Lakeside Irrigation Water District, BASIN at the South of State Route 198 and West of 5th Avenue

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)	In Situ Relative Compaction @0.5'–2.0'
C584892	S37	0 – 6'	38	7	63.1	7.93	2800	83
C584893	S38	0 – 6'	58	13	55.4	6.80	5800	
C584894	S39	0 – 6'	69	56	13.8	6.91	13000	
C584895	S40	1' – 6'	10	9	61.3	9.87	1400	
C584896	S41	0.5' – 6'	11	13	49.6	9.73	3000	
C584897	S42	1' – 6'	9	9	55.5	7.80	4300	
C584898	S43	0.5' – 6.5'	41	10	56.5	8.24	4500	
C584899	S44	0.5' – 6'	40	15	-	8.57	3500	
C584900	S45	0.5' – 6'	8	5	73.5	9.84	1100	
C584901	S46	0.5' – 6.5'	38	11	55.6	8.11	2700	
C584902	S47	0.5' – 6'	9	12	46.1	9.15	1500	
C584903	S48	0' – 4'	11	9	61.2	8.96	2400	

Test Data Tabulation

Everett Pond

At North-East corner of Everett Avenue and 20th Avenue intersection, on East side of 20th Avenue.

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)
EP-1	C410053	0'-5'	60	13	77.1	8.22	4900
EP-2	C410054	5'-10'	64	50	33.5	8.29	10200
EP-3	C410055	7'-10'	63	8	61.7	7.69	1900
EP-4	C410056	6'-9'	72	28	1.2	6.84	8500
EP-5	C410057	5'-8'	71	22	36.2	6.37	8800
EP-6	C410058	10'-15'	61	96	33.5	6.52	41000
EP-7	C410059	15'-20'	66	79	6.2	6.60	24500
EP-8	C410060	8'-10'	74	20	39.6	6.94	11000
EP-9	C410061	0'-7'	66	23	34.1	6.70	16000

Vaz Pond

At 20th Avenue between Excelsior Avenue and Lewiston Avenue, on East side of 20th Avenue.

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)
V-1	C410035	0'-4'	62	12	51.1	7.15	3350
V-2	C410036	4'-10'	60	85	2.8	7.03	19500
V-3	C410037	0'-4'	42	17	33.7	6.41	7850
V-4	C410038	4'-7.5'	66	34	12.4	6.74	17000
V-5	C410039	7.5'-11'	67	7	70.5	6.85	8900
V-6	C410040	0'-4'	75	17	35.5	6.42	10900
V-7	C410041	0'-3'	18	12	76.0	7.66	2450
V-8	C410042	3'-5'	72	17	39.9	8.12	8400
V-9	C410043	5'-8'	64	3	86.0	7.99	5580

Test Data Tabulation

Zoureveld Pond
At Elm Avenue between Route 41 and Elm Avenue,
on South side of Harlan Avenue

Boring No.	Sample Designation	Depth	R-Value	Sand Equivalent	% Passing No.200 Sieve	PH	Resistivity (ohm-cm)
Z-1	C410062	1'-4'	10	6	69.7	9.60	2150
Z-2	C410063	4'-7'	59	32	30.3	10.0	6600
Z-3	C410064	7'-10'	18	5	76.4	9.96	3600
Z-4	C410065	0'-3.5'	68	16	51.1	7.45	6100
Z-5	C410066	3.5'-6'	66	47	23.2	8.98	10000
Z-6	C410067	6'-10'	7	4	75.3	10.1	2100
Z-7	C410068	8'-11'	23	13	49.0	9.52	3700
Z-8	C410069	7'-9'	16	8	68.4	9.93	2900
Z-9	C410070	6'-9'	59	88	5.8	7.59	28000
Z-10	C410071	8'-11'	10	13	52.1	8.83	2800
Z-11	C410072	7'-10'	31	16	46.7	8.64	4400

AGREEMENTS

1. City of Lemoore

Agreement has been made between Caltrans and City of Lemoore regarding the City's willingness to negotiate with potential Caltrans bidders for any of their possible materials sources.

No other agreement has been made.

Information concerning availability, SMARA, volume, cost, conditions, permits, and environmental issues may be obtained by contacting:

David Wlaschin
Public Works Manager
559-924-6735 (Office)

Office Address
City of Lemoore
711 W. Cinnamon Dr.
Lemoore, CA 93245

2. Lakeside Irrigation Water District

Agreement has been made between Caltrans and Lakeside Irrigation Water District regarding the City's willingness to negotiate with potential Caltrans bidders for any of their possible materials sources.

No other agreement has been made.

Information concerning availability, SMARA, volume, cost, conditions, permits, and environmental issues may be obtained by contacting:

Andrew C Hemans, Manager
559-584-3396 (Office),
559-816-0761 (Cell)

Office Address
Lakeside Irrigation Water District
9304 Houston Ave.
Hanford, CA 93230

3. Laguna Irrigation District

Agreement has been made between Caltrans and Laguna Irrigation District regarding the Laguna Irrigation District willingness to negotiate with potential Caltrans bidders for any of their possible materials sources.

No other agreement has been made.

Information concerning availability, SMARA, volume, cost, conditions, permits, and environmental issues may be obtained by contacting:

Scott Sills
General Manager
559-923-4239 (Office),
559-352-7947 (Cell),

Office Address
Laguna Irrigation District
5065 19 $^{1/2}$ Avenue
Riverdale, CA 93656

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DISTRICT 6
P.O. Box 12616
Fresno, California 93778

MATERIAL SOURCE AGREEMENT

Project: Conversion of @ grade intersection @ SR 198/19th Ave.

EA: 06-325501

The undersigned owner is willing to enter into negotiations with potential bidders and/or the successful bidder for earth materials for use in the construction of this project.

Limited access shall be granted to Department of Transportation personnel for purposes of soil sampling.

Print Name: David Wlaschin City of Lemoore
Property Owner

Signature: _____ Date: 3-1-10
Owner/Authorized Representative

Address: 711 W. Cinnamon Dr.
Lemoore 93245

Phone: 559 924-6735

California Department of Transportation

By: _____
Ted Mooradian
Central Region Materials Engineer

RECEIVED
MAR 25 2010

STATE OF CALIFORNIA
DEPARTEMENT OF TRANSPORTATION
DISTRICT 6
P.O.BOX 12616
FRESNO, California 93778

MATERIAL SOURCE AGREEMENT

Project: The conversion of the existing at-grade intersection at State Route 198/19th Avenue to a 2-quadrant clover interchange.

EA: 06-325501

The undersigned owner is willing to enter into negotiations with potential bidders and/or the successful bidder for earth materials for use in the construction of this project.

Limited access shall be granted to Department of Transportation personnel for purposes of soil sampling.

Print Name: Lakeside Irrigation Water District.
Property Owner

Signature: Andrew C. Hanson
Owner/ Authorized Representative

Address 9304 Houston Ave

Hanford, CA 93656-4239

Phone: 559-584-3396 CELL 559-[redacted]. 816.0761

California Department of Transportation

By: Ted B. McMooradian

TED MOORADIAN
Central Region Materials Engineer

STATE OF CALIFORNIA
DEPARTEMENT OF TRANSPORTATION
DISTRICT 6
P.O.BOX 12616
FRESNO, California 93778

MATERIAL SOURCE AGREEMENT

Project: The conversion of the existing at-grade intersection at State Route 198/19th Avenue to a 2-quadrant clover interchange.

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The undersigned owner is willing to enter into negotiations with potential bidders and/or the successful bidder for earth materials for use in the construction of this project.

Limited access shall be granted to Department of Transportation personnel for purposes of soil sampling.

Print Name: Laguna Irrigation District.
Property Owner

Signature: _____
Owner/ Authorized Representative

Address 5065 19 ½ Avenue

Riverdale, CA 93656

Phone: Scott Sills (559) 932-4239
(559) 352-9947

California Department of Transportation

By: _____
TED MOORADIAN
Central Region Materials Engineer

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:
81420-2010-F-0481-R001-1

JUL 19 2011

Mr. Zachary Parker
Biology Branch Chief
California Department of Transportation, District 6
855 M Street, Suite 200
Fresno, California 93721

Subject: Reinitiation of the *Biological Opinion for the State Route 198/19th Avenue Interchange Project, Kings County, California* (Service File number 1-1-03-F-0140)

Dear Mr. Parker:

This is the U.S. Fish and Wildlife Service's (Service) response to the California Department of Transportation's (Caltrans) request to amend the *Biological Opinion for the State Route 198/19th Avenue Interchange Project,* in Kings County, California (Service file numbers 1-1-03-F-0140; 81420-2010-TA-0481), issued January 5, 2005. Your letter, dated May 11, 2011, was received in this office on May 17, 2011. Under consideration is Caltrans' request to add eight nights of work to the construction schedule and to include a new activity to the scope of the project description, but which is independent of the roadway construction: the modification and expansion of a stormwater drainage basin located in the northeast quadrant of the State Route 198 and 19th Avenue intersection. This is expected to further affect the San Joaquin kit fox (*Vulpes macrotis mutica*; SJKF) through temporary disturbance to 10.1 acres of ruderal/park habitat. This response was prepared in accordance with section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

In reviewing the request, the Service has relied upon: (1) the Service's January 5, 2005, biological opinion for the project; (2) telephone discussions and electronic-mail (e-mail) correspondence between Caltrans and the Service from April and May 2011; (3) Caltrans' May 11, 2011, amendment request letter to the Service and the accompanying habitat impact mapping delineating the new stormwater drainage basin, new park, utility easement, and right-of-way (ROW) boundaries; and (4) other information available to the Service.

Consultation History

April 15, 2011. The Service received a letter from Caltrans requesting the allowance of eight nights of work now deemed necessary for increasing public and worker safety during the installation and removal of bridge falsework.

April 19, 2011. Caltrans e-mailed the Service to note that the Service should disregard the previous amendment request as there were some further changes occurring in development and a new request would be submitted to also include the improvement and extension of an adjacent park which is used as a stormwater drainage basin.

May 10, 2011. Caltrans e-mailed the Service a map of the proposed addition of work surrounding the stormwater drainage basin, showing the boundaries of the existing park, new park, ROW, existing stormwater basin area, new basin area, and existing overflow basin.

May 11, 2011. Caltrans telephoned the Service to discuss the addition of the drainage basin and park boundary extensions to the project description. Caltrans requested guidance on how to compensate for this area, i.e. how to quantify it as suitable SJKF habitat. Temporary effects are more likely to occur as there will be no lost habitat through permanent paving. Surveys done on-site observed no dens and no other SJKF signs; however, the park/basin remains potentially suitable habitat for the SJKF. Following a brief internal Service discussion, the Service telephoned Caltrans later the same day to further discuss the issues. The area within the drainage basin will be cleared and graded, and vegetation will be removed, but the area will be left to return to its original use value. They discussed an appropriate compensation ratio (0.3:1) for addressing temporary effects to the area, as well as a possible staging area for both the roadwork and basin work (likely at the intersection site itself). The new drainage basin will be maintained by the City of Lemoore (City) (and will accommodate runoff for development). The construction of the State Route 198/19th Avenue interchange, as discussed in the original biological opinion, will remove a holding basin area used by the City for runoff, so the expansion of the park drainage basin will offset the City's loss.

May 17, 2011. The Service received a letter from Caltrans requesting to amend the biological opinion to include eight nights of work needed to increase public and worker safety during installation and removal of bridge falsework, and additional effects to 10.1 acres (ac) of ruderal SJKF habitat resulting from the expansion and modification of a stormwater drainage basin located in the northeast quadrant of State Route 198/19th Avenue. A revised impact map was provided with the letter delineating boundaries for the new stormwater drainage basin, ROW, utility easement, and new park.

May 18, 2011. The Service e-mailed Caltrans to follow-up on several minor points concerning the construction schedule and night work, as well as the replacement of the loss of the holding basin at the interchange site with the park drainage basin expansion. Caltrans promptly responded.

The Service approves Caltrans' request to expand the scope of the project description to include eight nights of work and the extension of the stormwater drainage basin in the northeast quadrant of the State Route 198/19th Avenue intersection.

The following changes are to be made to the biological opinion. All alterations and additions are in **bold**:

On page 2, the **Description of the Proposed Action** is currently written as:

"The California Department of Transportation and the Federal Highway Administration are proposing improvements to improve traffic continuity and safety on State Route 198 in Kings County. The proposed project is located on State Route 198 between the State Route 41/198 Separation and 18 ½ (Vine) Avenue in the City of Lemoore in Kings County, California. The project includes the conversion of at-grade access at State Route 198/19th Avenue to an overhead interchange and an auxiliary lane on State Route 198 from east of State Route 41 to west of 18 ½ (Vine) Avenue. In addition, at-grade access at 18 ½ (Vine) Avenue would be closed and replaced with cul-de-sacs for turnarounds and local roads would be modified as necessary to meet highway standards.

According to the biological assessment, the habitats in the action area consist of ruderal and agricultural. The ruderal habitat within the study area reportedly contains non-native, weedy species such as filaree (*Erodium* ssp.), bromus (*Bromus* ssp.), yellow star-thistle (*Centaurea solstitialis*), telegraph plant (*Heterotheca grandiflora*), barnyard grass (*Echinochloa crusgalli*), wild oats (*Avena fatua*), tolguacha (*Datura meteloides*), and common sunflower (*Helianthus annus*). The agricultural lands in the action area consist primarily of row crops. Agricultural areas will not be directly impacted by construction activities."

Add descriptions of the proposed addition of nightwork to the construction schedule and the expansion of the stormwater drainage basin located northeast of the SR 198/19th Avenue intersection. The project description is amended to include:

"Project construction for the interchange and auxiliary lane is anticipated to take a total of 735 working days. Eight nights of work will be required during the installation and removal of the overhead bridge falsework at the SR 198/19th Avenue interchange site in order to better address driver and worker safety. Traffic will be reduced to one lane in each direction on SR 198 during falsework assembly and deconstruction.

Work at the interchange site will result in the removal of an existing drainage basin utilized by the City. Drainage relocation will be necessary since this basin will be paved over by the highway off-ramp. Therefore, prior to, and independent of, roadway construction at the SR 198/19th Avenue Interchange, the City proposes to modify and expand the public park located in the northeast quadrant of the intersection within the City limits; this area is surrounded by housing developments to the west, north, and east. This park is currently used for stormwater drainage/ponding purposes by the City. Within the ponding area are

two ball fields and a soccer field. Parking spaces, picnic areas, and public facilities are located around the basin, mainly to the west. The area is landscaped with trees and grass.

The City proposes to grade the ponding area up to two feet deeper in order to increase the basin's holding capacity; the resulting fill material will be used for construction at the interchange site. To offset the loss of the holding basin at the interchange site, the City proposes to expand the stormwater basin (and park boundary) by annexing City-owned parcels to the east (an existing overflow ponding basin used by the City which is bordered by SR 198, residential housing, and the park) and to the north (existing vacant lots which are bordered by a local roadway and the park). This expanded drainage basin will be used for the City's development runoff only and will not be utilized for any highway runoff. Some of the highway runoff will be captured within two basins designed in the half-cloverleaf of the roadway project and other portions of highway runoff will be distributed into the existing drainage system south of the project."

On page 3, #1 under Proposed Avoidance and Minimization Measures is currently written as:

"The California Department of Transportation will permanently protect 17.7885 acres of San Joaquin kit fox habitat as partial compensation for the 16.1714 acres of this animal's habitat that will be permanently affected (1.1:1 ratio)."

Add the amount of SJKF habitat acreage that will be affected by construction activities associated with the drainage basin modification and expansion. Also, condense the existing acreage amounts to display hundredths of an acre. This is amended to read:

"The California Department of Transportation will permanently protect **17.79** acres of San Joaquin kit fox habitat as partial compensation for the **16.17** acres of this animal's habitat that will be permanently affected (1.1:1 ratio). **Caltrans also proposes to compensate for an additional 10.1 ac of suitable SJKF ruderal habitat that will be temporarily affected (0.3:1 compensation ratio) by purchasing 3.03 conservation credits at the Kreyenhagen Hills Conservation Bank, or at another Service-approved bank whose service area appropriately covers the project area."**

On pages 16-17, the first paragraph under **Effects of the Proposed Action** is currently written as:

"The San Joaquin kit fox will be adversely affected by the construction of the roadway and associated structures on 16.1714 acres of its foraging, denning, and travel corridor habitat. San Joaquin kit foxes inhabiting the project area and surrounding vicinity (for purposes of this biological opinion the surrounding vicinity is described as 1,000 feet outside and adjacent to the project footprint) are likely to be subject to indirect effects including temporary harassment from noise associated with project activities and human presence, and a reduction in natural food sources as a result of habitat disturbance."

Add a discussion of the additional effects to the SJKF resulting from the new drainage expansion and the addition of night work. This section is amended to include:

"Temporary effects to 10.1 ac of potential SJKF foraging and denning habitat will occur as a result of activities associated with the modification and expansion of the stormwater drainage basin/park located to the northeast of the SR 198/19th Avenue intersection. The expansion will assimilate new land parcels adjacent to the existing basin in the forms of an overflow ponding basin to the east and vacant ruderal lots to the north. The entire area, including the annexed parcels, will be cleared of vegetation and graded to increase the drainage basin's holding capacity. Habitat therefore will be disturbed temporarily during these activities but will be left to return to its pre-existing conditions and prior use value for the SJKF. Such earthmoving activities will also likely preclude access to these habitats for a short-term period of time. Individuals attempting to cross through or access suitable habitat within the proposed 10.1 ac stormwater drainage basin may be harassed by construction vehicle and personnel movement.

Since the SJKF is primarily nocturnal, the presence of construction activities during night hours can be disruptive to its foraging activities, particularly at dusk and dawn, as these are the prime hours of SJKF above-ground activity. The necessity for night work often results from activities that are more highly disruptive to traffic and which cannot be otherwise undertaken safely during daylight hours under normal traffic conditions. Eight nights are anticipated for this project during the installation and removal of falsework for the overhead interchange. The increased presence and activity of construction equipment and personnel could serve to harass those SJKF inhabiting or foraging in the area."

On pages 28-29, the first paragraph under **Amount or Extent of Take** is currently written as:

"Incidental take of the San Joaquin kit fox is anticipated to occur as a result of the proposed project. However, incidental take will be difficult to detect or quantify because it lives for a portion of its life in dens or burrows, it has a wide ranging territory, is primarily active at night, is often extremely shy in its behavior around humans, and losses of this animal may be difficult to quantify due to seasonal fluctuations in its numbers. For these reasons, the Service is quantifying take incidental to the proposed action as the number of acres of habitat that will become unsuitable for the San Joaquin kit fox as a result of the action. Loss of habitat is a reasonable surrogate for expressing the amount or extent of take because it accurately reflects the biological effects to this species. Therefore, the Service estimates that all San Joaquin kit foxes inhabiting 16.1714 ac will be subject to take in the form of harm and harassment as a result of the proposed action."

Add the extent of take anticipated to result from the additional temporary disturbance to the 10.1 ac drainage basin. Also, condense the existing acreage amount to display hundredths of an acre. This is amended to read:

"Incidental take of the San Joaquin kit fox is anticipated to occur as a result of the proposed project. However, incidental take will be difficult to detect or quantify because it lives for a

portion of its life in dens or burrows, it has a wide ranging territory, is primarily active at night, is often extremely shy in its behavior around humans, and losses of this animal may be difficult to quantify due to seasonal fluctuations in its numbers. For these reasons, the Service is quantifying take incidental to the proposed action as the number of acres of habitat that will become unsuitable for the San Joaquin kit fox as a result of the action. Loss of habitat is a reasonable surrogate for expressing the amount or extent of take because it accurately reflects the biological effects to this species. Therefore, the Service estimates that all San Joaquin kit foxes inhabiting, **utilizing, or moving through the 16.17 ac that will be permanently lost due to construction of the interchange and auxiliary lane, in addition to the 10.1 ac that will be temporarily disturbed during the clearing, grading, and expansion of the adjacent drainage basin,** will be subject to take **incidental to the project. Upon implementation of the following *Reasonable and Prudent Measures*, incidental take associated with the project** in the form of harm and harassment as a result of the proposed action **will become exempt from the prohibitions described under section 9 of the Act."**

On page 32, letter 'P' under Terms and Conditions is currently written as:

"Because dusk and dawn are often the times when the San Joaquin kit fox is most actively foraging, all construction activities will cease one half hour before sunset and will not begin prior to one half hour before sunrise. Except when necessary for driver or pedestrian safety, lighting of a project site by artificial lighting during night time hours is prohibited."

Modify the term and condition to reflect the addition of short-term night work to the project schedule. This is amended to read:

"**A maximum of eight work nights will be allowed in order to install and remove the falsework associated with the overhead interchange structure.** Otherwise, because dusk and dawn are often the times when the San Joaquin kit fox is most actively foraging, all construction activities **other than those associated with the proposed eight nights of work,** will cease one half hour before sunset and will not begin prior to one half hour before sunrise. Except when necessary for authorized nightwork, or for driver or pedestrian safety, lighting of a project site by artificial lighting during night time hours is prohibited."

The remainder of the January 5, 2005, biological opinion is unchanged. This concludes formal reinitiation of consultation on the State Route 198/19th Avenue Interchange Project. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

Please contact Jen Schofield or Thomas Leeman, San Joaquin Valley Division Chief, at the letterhead address, or at (916) 414-6600 if you have any questions regarding this letter.

Sincerely,

Kenneth Sanchez
Assistant Field Supervisor

cc:
Ms. Annee Ferranti, California Department of Fish and Game, Fresno, California

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In reply refer to:
1-1-03-F-00140

January 5, 2005

Mr. Gene K. Fong
Federal Highway Administration
U.S. Department of Transportation
650 Capitol Mall Room 4-100
Sacramento, California 95814

Subject: Biological Opinion on State Road 198/19th Avenue Interchange Project in Kings County, California

Dear Mr. Fong:

This is the U.S. Fish and Wildlife Service's (Service) biological opinion on State Road 198/19th Avenue Interchange Project in Kings County, California. Your March 13, 2003, request for formal consultation was received in this Field Office on March 17, 2003. At issue are the effects of this proposed project on the endangered San Joaquin kit fox (*Vulpes macrotis mutica*). This biological opinion was prepared in accordance with section 7 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*)(Act).

This biological opinion is based on: (1) *Biological Assessment State Route 198 – Kings County, California Lemoore 7.5-minute Quadrangle Maps Township 198, Range 20E, Section 9 06-KIN-198-KP-13.8/15.6 (PM 8.6/9.7) 06-325500* dated Match 2003 (biological assessment), that was prepared by the California Department of Transportation; (2) a letter from the Federal Highway Administration to the Service dated March 13, 2003; (3) a letter from the California Department of Transportation to the Service dated March 13, 2003, that was received by this Field Office on March 17, 2003; (4) a letter from the California Department of Transportation to the Service dated June 16, 2004, and two maps, that were received by this Field Office on June 21, 2004; (5) electronic mail messages from the Service to the California Department of Transportation dated December 31, 2004, and January 3, 2005; (6) an electronic mail message from the California Department of Transportation to the Service dated January 4, 2005; and (7) other information available to the Service.

Consultation History

May 2000: The Service sent a species list for the proposed 1 State Route 198 Interchange in Kings County, California, to Todd Gardner of California Department of Transportation.

July 13, 2000: Todd Gardner of the California Department of Transportation spoke with Susan Jones of the Service on the telephone. Mr. Gardner described the project study area and Ms. Jones indicated that the project study area was contained suitable habitat for the enangered San Joaquin kit fox. Ms. Jones recommended that surveys be conducted for the species.

June 11, 2002: Christina Clifton of the California Department of Transportation contacted Brian Peterson of the Service to discuss the project. Mr. Peterson requested a copy of the project description, maps, and surveys results.

June 3, 2004: Tamara Nunes of the California Department of Transportation and Brian Peterson met at the project site.

December 31, 2004: Chris Nagano of the Service sent an e-mail to the California Department of Transportation requesting additional information on the amount of habitat that will be affected by the proposed project.

January 4, 2005: Terry Marshall of the California Department of Transportation sent an e-mail, including a map, to Chris Nagano, in response to his December 31, 2004, e-mail.

Description of the Proposed Action

The California Department of Transportation and the Federal Highway Administration are proposing improvements to improve traffic continuity and safety on State Route 198 in Kings County. The proposed project is located on State Route 198 between the State Route 41/198 Separation and 18 ½ (Vine) Avenue in the City of Lemoore in Kings County, California. The project includes the conversion of at-grade access at State Route 198/19th Avenue to an overhead interchange and an auxiliary lane on State Route 198 from east of State Route 41 to west of 18 ½ (Vine) Avenue. In addition, at-grade access at 18 ½ (Vine) Avenue would be closed and replaced with cul-de-sacs for turnarounds and local roads would be modified as necessary to meet highway standards.

According to the biological assessment, the habitats in the action area consist of ruderal and agricultural. The ruderal habitat within the study area reportedly contains non-native, weedy species such as filaree (*Erodium* ssp.), bromus (*Bromus* ssp.), yellow star-thistle (*Centaurea solstitialis*), telegraph plant (*Heterotheca grandiflora*), barnyard grass (*Echinochloa crusgalli*), wild oats (*Avena fatua*), tolguacha (*Datura meteloides*), and common sunflower (*Helianthus annus*). The agricultural lands in the action area consist primarily of row crops. Agricultural areas will not be directly impacted by construction activities.

Proposed Avoidance and Minimization Measures

According to the biological assessment, the California Department of Transportation will implement the following actions:

1. The California Department of Transportation will permanently protect 17.7885 acres of San Joaquin kit fox habitat as partial compensation for the 16.1714 acres of this animal's habitat that will be permanently affected (1.1:1 ratio).

2. Project-related traffic will observe a 32-kilometer per hour speed limit except on roads or highways open for public use.

3. Entrance in areas within the right-of-way not required for construction activities will be restricted to the highway and associated paved or graded shoulders. Staging, parking, storage, and other project related use areas will be clearly marked on the ground.

4. At the end of each working day, the contractor will take measures to prevent the entrapment of San Joaquin kit foxes in all excavated, steep-walled holes or trenches more than 0.6 meter deep. Such measures may include covering excavations with plywood or providing dirt or plank escape ramps from the trenches.

5. The contractor will inspect all pipes and culverts with a diameter greater than or equal to 100 millimeters before burying, capping, or other use. If a San Joaquin kit fox is discovered during this inspection, the pipe or culvert will not be disturbed (other than to move it to a safe location if necessary) until after the fox has escaped.

6. The contractor will immediately notify the engineer if a dead, injured or entrapped San Joaquin kit fox is found. Work in the immediate area may be temporarily halted while the California Department of Transportation biologist at the direction of the engineer consults with the California Department of Fish and Game, and the Service. The disposition of an carcasses or recovering animal will be coordinated through the engineer.

7. If a San Joaquin kit fox den is discovered, all construction activity within a 46 meter radius of the den will be halted while the California Department of Transportation consults with the Service and the California Department of Fish and Game. An environmental sensitive area will be established around the den and entry into the area will be restricted.

8. The contractor will provide closed garbage containers where food-related trash is generated and garbage will be disposed of daily.

9. Pets will be prohibited at the work site.

Status of the San Joaquin Kit Fox

The San Joaquin kit fox was listed as an endangered species on March 11, 1967 (Service 1967) and was listed by the State of California as a threatened species on June 27, 1971. The Recovery Plan includes this canine (Service 1998).

In the San Joaquin Valley before 1930, the range of the San Joaquin kit fox extended from southern Kern County north to Tracy, San Joaquin County, on the west side, and near La Grange, Stanislaus County, on the east side (Grinnell *et al.* 1937; Service 1998). Historically, this species occurred in several San Joaquin Valley native plant communities. In the southernmost portion of the range, these communities included Valley Sink Scrub, Valley Saltbush Scrub, Upper Sonoran Subshrub Scrub, and Annual Grassland. San Joaquin kit foxes also exhibit a capacity to utilize habitats that have been altered by man. The animals are present in many oil fields, grazed pasturelands, and "wind farms" (Cypher 2000). Kit foxes can inhabit the margins and fallow lands near irrigated row crops, orchards, and vineyards, and may forage occasionally in these agricultural areas (Service 1998). The San Joaquin kit fox seems to prefer more gentle terrain and decreases in abundance as terrain ruggedness increases (Grinnell *et al.* 1937; Morrell 1972; Warrick and Cypher 1998).

The kit fox is often associated with open grasslands, which form large contiguous blocks within the eastern portions of the range of the animal. The listed canine also utilizes oak savanna and some types of agriculture (e.g. orchards and alfalfa), although the long-term suitability of these habitats is unknown (Jensen 1972; Service 1998). In eastern Merced County, the lands between the urban corridor along Highway 99 and the open grasslands to the east are a mixture of orchards and annual crops, mostly alfalfa. Orchards occur in large contiguous blocks in the northwest portions of the study area and at scattered locations in the southwest portions. Orchards sometimes support prey species if the grounds are not manicured; however, denning potential is typically low and kit foxes can be more susceptible to coyotes predation within the orchards (Orloff 2000). Alfalfa fields provide an excellent prey base (Woodbridge 1987; Young 1989), and berms adjacent to alfalfa fields sometimes provide good denning habitat (Orloff 2000). Kit foxes often den adjacent to, and forage within, agricultural areas (Bell 1994; Scott-Graham 1994). Although agricultural areas are not traditional kit fox habitat and are often highly fragmented, they can offer sufficient prey resources and denning potential to support small numbers of kit foxes.

Adult San Joaquin kit foxes are usually solitary during late summer and fall. In September and October, adult females begin to excavate and enlarge natal dens (Morrell 1972), and adult males join the females in October or November (Morrell 1972). Typically, pups are born between February and late March following a gestation period of 49 to 55 days (Egoscue 1962; Morrell 1972; Spiegel and Tom 1996; Service 1998). Mean litter sizes reported for San Joaquin kit foxes include 2.0 on the Carrizo Plain (White and Ralls 1993), 3.0 at Camp Roberts (Spencer *et al.* 1992), 3.7 in the Lokern area (Spiegel and Tom 1996), and 3.8 at the Naval Petroleum Reserve (Cypher *et al.* 2000). Pups appear above ground at about age 3-4 weeks, and are weaned at age 6-8 weeks. Reproductive rates, the proportion of females bearing young, of adult San Joaquin kit foxes vary annually with environmental conditions, particularly food availability. Annual rates range from 0-100%, and reported mean rates include 61% at the Naval Petroleum Reserve (Cypher *et al.* 2000), 64% in the Lokern area (Spiegel and Tom 1996), and 32% at Camp Roberts (Spencer *et al.* 1992). Although some yearling female kit foxes will produce young, most do not reproduce until age 2 years (Spencer et al. 1992; Spiegel and Tom 1996; Cypher *et al.* 2000). Some young of both sexes, but particularly females may delay dispersal, and may assist their parents in raising in the following year's litter of pups (Spiegel and Tom 1996). The

young kit foxes begin to forage for themselves at about four to five months of age (Koopman *et al.* 2000; Morell 1972).

Although most young kit foxes disperse less than 5 miles(Scrivner *et al.* 1987a), dispersal distances of up to 76.3 miles have been documented for the San Joaquin kit fox (Scrivner *et al.* 1993; Service 1998). Dispersal can be through disturbed habitats, including agricultural fields, and across highways and aqueducts. The age at dispersal ranges from 4-32 months (Cypher 2000). Among juvenile kit foxes surviving to July 1 at the Naval Petroleum Reserve, 49% of the males dispersed from natal home ranges while 24% of the females dispersed (Koopman *et al.* 2000). Among dispersing kit foxes, 87% did so during their first year of age. Most, 65.2%, of the dispersing juveniles at the Naval Petroleum Reserve died within 10 days of leaving their natal home den (Koopman *et al.* 2000). Some kit foxes delay dispersal and may inherit their natal home range.

Kit foxes are reputed to be poor diggers, and their dens are usually located in areas with loose-textured, friable soils (Morrell 1972; O'Farrell 1983). However, the depth and complexity of their dens suggest that they possess good digging abilities, and kit fox dens have been observed on a variety of soil types (Service 1998). Some studies have suggested that where hardpan layers predominate, kit foxes create their dens by enlarging the burrows of California ground squirrels (*Spermophilus beecheyi*) or badgers (*Taxidea taxus*)(Jensen 1972; Morrell 1972; Orloff *et al.* 1986). In parts of their range, particularly in the foothills, kit foxes often use ground squirrel burrows for dens (Orloff *et al.* 1986). Kit fox dens are commonly located on flat terrain or on the lower slopes of hills. About 77 percent of all kit fox dens are at or below midslope (O'Farrell 1983), with the average slope at den sites ranging from 0 to 22 degrees (California Department of Fish and Game 1980; O'Farrell 1983; Orloff *et al.* 986). Natal and pupping dens are generally found in flatter terrain. Common locations for dens include washes, drainages, and roadside berms. Kit foxes also commonly den in human-made structures such as culverts and pipes (O'Farrell 1983; Spiegel *et al.* 1996a).

Natal and pupping dens may include from two to 18 entrances and are usually larger than dens that are not used for reproduction (O'Farrell *et al.* 1980; O'Farrell and McCue 1981). Natal dens may be reused in subsequent years (Egoscue 1962). It has been speculated that natal dens are located in the same location as ancestral breeding sites (O'Farrell 1983). Active natal dens are generally 1.2 to 2 miles from the dens of other mated kit fox pairs (Egoscue 1962; O'Farrell and Gilbertson 1979). Natal and pupping dens usually can be identified by the presence of scat, prey remains, matted vegetation, and mounds of excavated soil (i.e. ramps) outside the dens (O'Farrell 1983). However, some active dens in areas outside the valley floor often do not show evidence of use (Orloff *et al.* 1986). During telemetry studies of kit foxes in the northern portion of their range, 70 percent of the dens that were known to be active showed no sign of use (e.g., tracks, scats, ramps, or prey remains)(Orloff *et al.* 1986). In another more recent study in the Coast Range, 79 percent of active kit fox dens lacked evidence of recent use other than signs of recent excavation (Jones and Stokes Associates 1997).

A kit fox can use more than 100 dens throughout its home range, although on average, an animal will use approximately 12 dens a year for shelter and escape cover (Cypher *et al.* 2001). Kit

foxes typically use individual dens for only brief periods, often for only one day before moving to another den (Ralls *et al.* 1990). Possible reasons for changing dens include infestation by ectoparasites, local depletion of prey, or avoidance of coyotes (*Canis latrans*). Kit foxes tend to use dens that are located in the same general area, and clusters of dens can be surrounded by hundreds of hectares of similar habitat devoid of other dens (Egoscue 1962). In the southern San Joaquin Valley, kit foxes were found to use up to 39 dens within a denning range of 320 to 482 acres (Morrell 1972). An average den density of one den per 69 to 92 acres was reported by O'Farrell (1984) in the southern San Joaquin Valley.

Dens are used by kit foxes for temperature regulation, shelter from adverse environmental conditions, and escape from predators. Kit foxes excavate their own dens, use those constructed by other animals, and use human-made structures (culverts, abandoned pipelines, and banks in sumps or roadbeds). Kit foxes often change dens and may use many dens throughout the year; however, evidence that a den is being used by kit foxes may be absent. San Joaquin kit foxes have multiple dens within their home range and individual animals have been reported to use up to 70 different dens (Hall 1983). At the Naval Petroleum Reserve, individual kit foxes used an average of 11.8 dens per year (Koopman *et al.* 1998). Den switching by the San Joaquin kit fox may be a function of predator avoidance, local food availability, or external parasite infestations (e.g., fleas) in dens (Egoscue 1956).

The diet of the San Joaquin kit fox varies geographically, seasonally, and annually, based on temporal and spatial variation in abundance of potential prey. In the portion of their geographic range that includes Merced County, known prey species of the kit fox include white-footed mice (*Peromyscus* spp.), insects, California ground squirrels, kangaroo rats (*Dipodomys* spp.), San Joaquin antelope squirrels, black-tailed hares (*Lepus californicus*), and chukar (*Alectoris chukar*) (Jensen 1972, Archon 1992), listed in approximate proportion of occurrence in fecal samples. Kit foxes also prey on desert cottontails (*Sylvilagus audubonii)*, ground-nesting birds, and pocket mice (*Perognathus* spp.).

The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar. Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts, which are quite common in semi-arid, central California. Competition for resources between coyotes and kit foxes may result in kit fox mortalities. Coyote-related injuries accounted for 50-87 per cent of the mortalities of radio collared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserves (Cypher and Scrivner 1992; Standley *et al.* 1992).

San Joaquin kit foxes are primarily nocturnal, although individuals are occasionally observed resting or playing (mostly pups) near their dens during the day (Grinnell *et al.* 1937). Kit foxes occupy home ranges that vary in size from 1.7 to 4.5 square miles (White and Ralls 1993). A mated pair of kit foxes and their current litter of pups usually occupy each home range. Other adults, usually offspring from previous litters, also may be present (Koopman *et al.* 2000), but individuals often move independently within their home range (Cypher 2000). Average distances traveled each night range from 5.8 to 9.1 miles and are greatest during the breeding season (Cypher 2000).

Kit foxes maintain core home range areas that are exclusive to mated pairs and their offspring (White and Ralls 1993, Spiegel 1996, White and Garrott 1997). This territorial spacing behavior eventually limits the number of foxes that can inhabit an area owing to shortages of available space and per capita prey. Hence, as habitat is fragmented or destroyed, the carrying capacity of an area is reduced and a larger proportion of the population is forced to disperse. Increased dispersal generally leads to lower survival rates and, in turn, decreased abundance because greater than 65 percent of dispersing juvenile foxes die within 10 days of leaving their natal range (Koopman *et al.* 2000).

Estimates of fox density vary greatly throughout its range, and have been reported as high as 1.3 animals per square mile in optimal habitats in good years (Service 1998). At the Elk Hills in Kern County, density estimates varied from 1.86 animals per square mile in the early 1980s to 0.03 animals per square mile in 1991 (Service 1998). Kit fox home ranges vary in size from approximately 1 to 12 square miles (Spiegel *et al.* 1996b; Service 1998). Knapp (1978) estimated that a home range in agricultural areas is approximately 1 square mile. Individual home ranges overlap considerably, at least outside the core activity areas (Morrell 1972; Spiegel *et al.* 1996b).

Mean annual survival rates reported for adult San Joaquin kit foxes include 0.44 at the Naval Petroleum Reserve (Cypher *et al.* 2000), 0.53 at Camp Roberts (Standley *et al.* 1992), 0.56 at the Lokern area (Spiegel and Disney 1996), and 0.60 on the Carrizo Plain (Ralls and White 1995). However, survival rates widely vary among years (Spiegel and Disney 1996; Cypher *et al.* 2000). Mean survival rates for juvenile San Joaquin kit foxes (<1 year old) are lower than rates for adults. Survival to age 1 year was 0.14 at the Naval Petroleum Reserve (Cypher *et al.* 2000), 0.20 at Camp Roberts (Standley *et al.* 1992), and 0.21 on the Carrizo Plain (Ralls and White 1995). For both adults and juveniles, survival rates of males and females are similar. San Joaquin kit foxes may live to ten years in captivity (McGrew 1979) and 8 years in the wild (Berry et al. 1987), but most kit foxes do not live past 2-3 years of age.

The status (i.e., distribution, abundance) of the kit fox has decreased since its listing in 1967. This trend is reasonably certain to continue into the foreseeable future unless measures to protect, sustain, and restore suitable habitats, and alleviate other threats to their survival and recovery, are implemented. Threats that are seriously affecting kit foxes are described in further detail in the following paragraphs.

Loss of Habitat

Less than 20 percent of the habitat within the historical range of the kit fox remained when the subspecies was listed as federally-endangered in 1967, and there has been a substantial net loss of habitat since that time. Historically, San Joaquin kit foxes occurred throughout California's Central Valley and adjacent foothills. Extensive land conversions in the Central Valley began as early as the mid-1800s with the Arkansas Reclamation Act. By the 1930's, the range of the kit fox had been reduced to the southern and western parts of the San Joaquin Valley (Grinnell *et al.* 1937). The primary factor contributing to this restricted distribution was the conversion of native habitat to irrigated cropland, industrial uses (e.g., hydrocarbon extraction), and urbanization

(Laughrin 1970, Jensen 1972; Morrell 1972, 1975). Approximately one-half of the natural communities in the San Joaquin Valley were tilled or developed by 1958 (Service 1980).

This rate of loss accelerated following the completion of the Central Valley Project and the State Water Project, which diverted and imported new water supplies for irrigated agriculture (Service 1995a). Approximately 1.97 million acres of habitat, or about 66,000 acres per year, were converted in the San Joaquin region between 1950 and 1980 (California Department of Forestry and Fire Protection 1988). The counties specifically noted as having the highest wildland conversion rates included Kern, Tulare, Kings and Fresno, all of which are occupied by kit foxes. From 1959 to 1969 alone, an estimated 34 percent of natural lands were lost within the then-known kit fox range (Laughrin 1970).

By 1979, only approximately 370,000 acres out of a total of approximately 8.5 million acres on the San Joaquin Valley floor remained as non-developed land (Williams 1985, Service 1980). Data from the CDFG (1985) and Service file information indicate that between 1977 and 1988, essential habitat for the blunt-nosed leopard lizard, a species that occupies habitat that is also suitable for kit foxes, declined by about 80 percent – from 311,680 acres to 63,060 acres, an average of about 22,000 acres per year (Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056, February 29, 2000). Virtually all of the documented loss of essential habitat was the result of conversion to irrigated agriculture.

During 1990 to 1996, a gross total of approximately 71,500 acres of habitat were converted to farmland in 30 counties (total area 23.1 million acres) within the Conservation Program Focus area of the Central Valley Project. This figure includes 42,520 acres of grazing land and 28,854 acres of "other" land, which is predominantly comprised of native habitat. During this same time period, approximately 101,700 acres were converted to urban land use within the Conservation Program Focus area (California Department of Conservation 1994, 1996, 1998). This figure includes 49,705 acres of farmland, 20,476 acres of grazing land, and 31,366 acres of "other" land, which is predominantly comprised of native habitat. Because these assessments included a substantial portion of the Central Valley and adjacent foothills, they provide the best scientific and commercial information currently available regarding the patterns and trends of land conversion within the kit fox's geographic range.

In summary, more than one million acres of suitable habitat for kit foxes have been converted to agricultural, municipal, or industrial uses since the listing of the kit fox. In contrast, less than 500,000 acres have been preserved or are subject to community-level conservation efforts designed, at least in part, to further the conservation of the kit fox (Service 1998).

Land conversions contribute to declines in kit fox abundance through direct and indirect mortalities, displacement, reduction of prey populations and denning sites, changes in the distribution and abundance of larger canids that compete with kit foxes for resources, and reductions in carrying capacity. Kit foxes may be buried in their dens during land conversion activities (C. Van Horn, Endangered Species Recovery Program, Bakersfield, personal communication to S. Jones, Fish and Wildlife Service, Sacramento, 2000), or permanently displaced from areas where structures are erected or the land is intensively irrigated (Jensen

1972, Morrell 1975). Furthermore, even moderate fragmentation or loss of habitat may significantly impact the abundance and distribution of kit foxes. Capture rates of kit foxes at the Naval Petroleum Reserve in Elk Hills were negatively associated with the extent of oil-field development after 1987 (Warrick and Cypher 1998). Likewise, the California Energy Commission found that the relative abundance of kit foxes was lower in oil-developed habitat than in nearby undeveloped habitat on the Lokern (Spiegel 1996). Researchers from both studies inferred that the most significant effect of oil development was the lowered carrying capacity for populations of both foxes and their prey species owing to the changes in habitat characteristics or the loss and fragmentation of habitat (Spiegel 1996, Warrick and Cypher 1998).

Dens are essential for the survival and reproduction of kit foxes that use them year-round for shelter and escape, and in the spring for rearing young. Hence, kit foxes generally have dozens of dens scattered throughout their territories. However, land conversion reduces the number of typical earthen dens available to kit foxes. For example, the average density of typical, earthen kit fox dens at the Naval Hills Petroleum Reserve was negatively correlated with the intensity of petroleum development (Zoellick *et al.* 1987), and almost 20 percent of the dens in developed areas were found to be in well casings, culverts, abandoned pipelines, oil well cellars, or in the banks of sumps or roads (Service 1983). These results are important because the California Energy Commission found that, even though kit foxes frequently used pipes and culverts as dens in oil-developed areas of western Kern County, only earthen dens were used to birth and wean pups (Spiegel 1996). Similarly, kit foxes in Bakersfield use atypical dens, but have only been found to rear pups in earthen dens (P. Kelly, Endangered Species Recovery Program, Fresno, personal communication to P. White, Fish and Wildlife Service, Sacramento, April 6, 2000). Hence, the fragmentation of habitat and destruction of earthen dens could adversely affect the reproductive success of kit foxes. Furthermore, the destruction of earthen dens may also affect kit fox survival by reducing the number and distribution of escape refuges from predators. Land conversions and associated human activities can lead to widespread changes in the availability and composition of mammalian prey for kit foxes. For example, oil field disturbances in western Kern County have resulted in shifts in the small mammal community from the primarily granivorous species that are the staple prey of kit foxes (Spiegel 1996), to species adapted to early successional stages and disturbed areas (e.g., California ground squirrels)(Spiegel 1996). Because more than 70 percent of the diets of kit foxes usually consist of abundant leporids (*Lepus*, *Sylvilagus*) and rodents (e. g., *Dipodomys* spp.), and kit foxes often continue to feed on their staple prey during ephemeral periods of prey scarcity, such changes in the availability and selection of foraging sites by kit foxes could influence their reproductive rates, which are strongly influenced by food supply and decrease during periods of prey scarcity (White and Garrott 1997, 1999).

Extensive habitat destruction and fragmentation have contributed to smaller, more-isolated populations of kit foxes. Small populations have a higher probability of extinction than larger populations because their low abundance renders them susceptible to stochastic (i.e., random) events such as high variability in age and sex ratios, and catastrophes such as floods, droughts, or disease epidemics (Lande 1988, Frankham and Ralls 1998, Saccheri *et al.* 1998). Similarly, isolated populations are more susceptible to extirpation by accidental or natural catastrophes because their recolonization has been hampered. These chance events can adversely affect small,

isolated populations with devastating results. Extirpation can even occur when the members of a small population are healthy, because whether the population increases or decreases in size is less dependent on the age-specific probabilities of survival and reproduction than on raw chance (sampling probabilities). Owing to the probabilistic nature of extinction, many small populations will eventually lose out and go extinct when faced with these stochastic risks (Caughley and Gunn 1995).

Oil fields in the southern half of the San Joaquin Valley also continue to be an area of expansion and development activity. This expansion is reasonably certain to increase in the near future owing to market-driven increases in the price of oil. The cumulative and long-term effects of oil extraction activities on kit fox populations are not fully known, but recent studies indicate that moderate- to high-density oil fields may contribute to a decrease in carrying capacity for kit foxes owing to habitat loss or changes in habitat characteristics (Spiegel 1996, Warrick and Cypher 1998). There are no limiting factors or regulations that are likely to retard the development of additional oil fields. Hence, it is reasonably certain that development will continue to destroy and fragment kit fox habitat into the foreseeable future.

Competitive Interactions with Other Canids

Several species prey upon San Joaquin kit foxes. Predators (such as coyotes, bobcats, non-native red foxes, badgers, and golden eagles [*Aquila chrysaetos*]) will kill kit foxes. Badgers, coyotes, and red foxes also may compete for den sites (Service 1998). The diets and habitats selected by coyotes and kit foxes living in the same areas are often quite similar (Cypher and Spencer 1998). Hence, the potential for resource competition between these species may be quite high when prey resources are scarce such as during droughts (which are quite common in semi-arid, central California). Land conversions and associated human activities have led to changes in the distribution and abundance of coyotes, which compete with kit foxes for resources.

Coyotes occur in most areas with abundant populations of kit foxes and, during the past few decades, coyote abundance has increased in many areas owing to a decrease in ranching operations, favorable landscape changes, and reduced control efforts (Orloff *et al.* 1986, Cypher and Scrivner 1992, White and Ralls 1993, White *et al.* 1995). Coyotes may attempt to lessen resource competition with kit foxes by killing them. Coyote-related injuries accounted for 50-87 percent of the mortalities of radio collared kit foxes at Camp Roberts, the Carrizo Plain Natural Area, the Lokern Natural Area, and the Naval Petroleum Reserves (Cypher and Scrivner 1992, Standley *et al.* 1992, Ralls and White 1995, Spiegel 1996). Coyote-related deaths of adult foxes appear to be largely additive (i.e., in addition to deaths caused by other mortality factors such as disease and starvation) rather than compensatory (i.e., tending to replace deaths due to other mortality factors; White and Garrott 1997). Hence, the survival rates of adult foxes decrease significantly as the proportion of mortalities caused by coyotes increase (Cypher and Spencer 1998, White and Garrott 1997), and increases in coyote abundance may contribute to significant declines in kit fox abundance (Cypher and Scrivner 1992, Ralls and White 1995, White *et al.* 1996). There is some evidence that the proportion of juvenile foxes killed by coyotes increases as fox density increases (White and Garrott 1999). This density-dependent relationship would provide a feedback mechanism that reduces the amplitude of kit fox population dynamics and

keeps foxes at lower densities than they might otherwise attain. In other words, coyote-related mortalities may dampen or prevent fox population growth, and accentuate, hasten, or prolong population declines.

Land-use changes also contributed to the expansion of nonnative red foxes into areas inhabited by kit foxes. Historically, the geographic range of the red fox did not overlap with that of the San Joaquin kit fox. By the 1970's, however, introduced and escaped red foxes had established breeding populations in many areas inhabited by San Joaquin kit foxes (Lewis *et al.* 1993). The larger and more aggressive red foxes are known to kill kit foxes (Ralls and White 1995), and could displace them, as has been observed in the arctic when red foxes expanded into the ranges of smaller arctic foxes (Hersteinsson and Macdonald 1982). The increased abundance and distribution of nonnative red foxes will also likely adversely affect the status of kit foxes because they are closer morphologically and taxonomically, and would likely have higher dietary overlap than coyotes; potentially resulting in more intense competition for resources. Two documented deaths of kit foxes due to red foxes have been reported (Ralls and White 1995), and red foxes appear to be displacing kit foxes in the northwestern part of their range (Lewis *et al.* 1993). At Camp Roberts, red foxes have usurped several dens that were used by kit foxes during previous years (California Army National Guard, Camp Roberts Environmental Office, unpubl. data). In fact, opportunistic observations of red foxes in the cantonment area of Camp Roberts have increased 5-fold since 1993, and no kit foxes have been sighted or captured in this area since October 1997. Also, a telemetry study of sympatric red foxes and kit foxes in the Lost Hills area has detected spatial segregation between these species, suggesting that kit foxes may avoid or be excluded from red fox-inhabited areas (P. Kelly, Endangered Species Recovery Program, Fresno, pers. comm. to P. White, Fish and Wildlife Service, Sacramento, April 6, 2000). Such avoidance would limit the resources available to local populations of kit foxes and possibly result in decreased fox abundance and distribution.

Disease

Wildlife diseases do not appear to be a primary mortality factor that consistently limits kit fox populations throughout their range (McCue and O'Farrell 1988, Standley and McCue 1992). However, central California has a high incidence of wildlife rabies cases (Schultz and Barrett 1991), and high seroprevalences of canine distemper virus and canine parvovirus indicate that kit fox populations have been exposed to these diseases (McCue and O'Farrell 1988; Standley and McCue 1992). Hence, disease outbreaks could potentially cause substantial mortality or contribute to reduced fertility in seropositive females, as was noted in closely-related swift foxes (*Vulpes velox*).

For example, there are some indications that rabies virus may have contributed to a catastrophic decrease in kit fox abundance at Camp Roberts, San Luis Obispo County, California, during the early 1990's. San Luis Obispo County had the highest incidence of wildlife rabies cases in California during 1989 to 1991, and striped skunks (*Mephitis mephitis*) were the primary vector (Barrett 1990, Schultz and Barrett 1991, Reilly and Mangiamele 1992). A rabid skunk was trapped at Camp Roberts during 1989 and two foxes were found dead due to rabies in 1990 (Standley *et al.* 1992). Captures of kit foxes during annual live trapping sessions at Camp

Roberts decreased from 103 to 20 individuals during 1988 to 1991. Captures of kit foxes were positively correlated with captures of skunks during 1988 to 1997; suggesting that some factor(s) such as rabies virus was contributing to concurrent decreases in the abundances of these species. Also, captures of kit foxes at Camp Roberts were negatively correlated with the proportion of skunks that were rabid when trapped by County Public Health Department personnel two years previously. These data suggest that a rabies outbreak may have occurred in the skunk population and spread into the fox population. A similar time lag in disease transmission and subsequent population reductions was observed in Ontario, Canada, although in this instance the transmission was from red foxes to striped skunks (Macdonald and Voigt 1985).

Pesticides and Rodenticides

Pesticides and rodenticides pose a threat to kit foxes through direct or secondary poisoning. Kit foxes may be killed if they ingest rodenticide in a bait application, or if they eat a rodent that has consumed the bait. Even sublethal doses of rodenticides may lead to the death of these animals by impairing their ability to escape predators or find food. Pesticides and rodenticides may also indirectly affect the survival of kit foxes by reducing the abundances of their staple prey species.

For example, the California ground squirrel, which is the staple prey of kit foxes in the northern portion of their range, was thought to have been eliminated from Contra Costa County in 1975, after extensive rodent eradication programs. Field observations indicated that the long-term use of ground squirrel poisons in this county severely reduced kit fox abundance through secondary poisoning and the suppression of populations of its staple prey (Orloff *et al.* 1986).

Kit foxes occupying habitats adjacent to agricultural lands are also likely to come into contact with insecticides applied to crops owing to runoff or aerial drift. Kit foxes could be affected through direct contact with sprays and treated soils, or through consumption of contaminated prey. Data from the California Department of Pesticide Regulation indicate that acephate, aldicarb, azinphos methyl, bendiocarb, carbofuran, chlorpyrifos, endosulfan, s-fenvalerate, naled, parathion, permethrin, phorate, and trifluralin are used within one mile of kit fox habitat. A wide variety of crops (alfalfa, almonds, apples, apricots, asparagus, avocados, barley, beans, beets, bok choy, broccoli, cantaloupe, carrots, cauliflower, celery, cherries, chestnuts, chicory, Chinese cabbage, Chinese greens, Chinese radish, collards, corn, cotton, cucumbers, eggplants, endive, figs, garlic, grapefruit, grapes, hay, kale, kiwi fruit, kohlrabi, leeks, lemons, lettuce, melons, mustard, nectarines, oats, okra, olives, onions, oranges, parsley, parsnips, peaches, peanuts, pears, peas, pecans, peppers, persimmons, pimentos, pistachios, plums, pomegranates, potatoes, prunes, pumpkins, quinces, radishes, raspberries, rice, safflower, sorghum, spinach, squash, strawberries, sugar beets, sweet potatoes, Swiss chard, tomatoes, walnuts, watermelons, and wheat), as well as buildings, Christmas tree plantations, commercial/industrial areas, greenhouses, nurseries, landscape maintenance, ornamental turf, rangeland, rights of way, and uncultivated agricultural and non-agricultural land, occur in close proximity to San Joaquin kit fox habitat.

Efforts have been underway to reduce the risk of rodenticides to kit foxes (Service 1993). The Federal government began controlling the use of rodenticides in 1972 with a ban of Compound

1080 on Federal lands pursuant to Executive Order. Above-ground application of strychnine within the geographic ranges of listed species was prohibited in 1988. A July 28, 1992, biological opinion regarding the Animal Damage Control (now known as Wildlife Services) Program by the U.S. Department of Agriculture found that this program was likely to jeopardize the continued existence of the kit fox owing to the potential for rodent control activities to take the fox. As a result, several reasonable and prudent measures were implemented, including a ban on the use of M-44 devices, toxicants, and fumigants within the recognized occupied range of the kit fox. Also, the only chemical authorized for use by Wildlife Services within the occupied range of the kit fox was zinc phosphide, a compound known to be minimally toxic to kit foxes (Service 1993).

Despite these efforts, the use of other pesticides and rodenticides still pose a significant threat to the kit fox, as evidenced by the death of 2 kit foxes at Camp Roberts in 1992 owing to secondary poisoning from chlorophacinone applied as a rodenticide, (Berry *et al.* 1992, Standley *et al.* 1992). Also, the livers of 3 foxes that were recovered in the City of Bakersfield during 1999 were found to contain detectable residues of the anticoagulant rodenticides chlorophacinone, brodifacoum, and bromadiolone (California Department of Fish and Game 1999).

To date, no specific research has been conducted on the effects of different pesticide or rodent control programs on the kit fox (Service 1998). This lack of information is problematic because Williams (in lit., 1989) documented widespread pesticide use in known kit fox and Fresno kangaroo rat habitat adjoining agricultural lands in Madera County. In a separate report, Williams (in lit., 1989) documented another case of pesticide use near Raisin City, Fresno County, where treated grain was placed within an active Fresno kangaroo rat precinct. Also, farmers have been allowed to place bait on Bureau of Reclamation property to maximize the potential for killing rodents before they entered adjoining fields (Biological Opinion for the Interim Water Contract Renewal, Ref. No. 1-1-00-F-0056, February 29, 2000).

A September 22, 1993, biological opinion issued by the Service to the Environmental Protection Agency (EPA) regarding the regulation of pesticide use (31 registered chemicals) through administration of the Federal Insecticide, Fungicide, and Rodenticide Act found that use of the following chemicals would likely jeopardize the continued existence of the kit fox: (1) aluminum and magnesium phosphide fumigants; (2) chlorophacinone anticoagulants; (3) diphacinone anticoagulants; (4) pival anticoagulants; (5) potassium nitrate and sodium nitrate gas cartridges; and (6) sodium cyanide capsules (Service 1993). Reasonable and prudent alternatives to avoid jeopardy included restricting the use of aluminum/magnesium phosphide, potassium/sodium nitrate within the geographic range of the kit fox to qualified individuals, and prohibiting the use of chlorophacinone, diphacinone, pival, and sodium cyanide within the geographic range of the kit fox, with certain exceptions (e.g., agricultural areas that are greater than 1 mile from any kit fox habitat)(Service 1999).

Endangered Species Act Section 9 Violations and Noncompliance with the Terms and Conditions of Existing Biological Opinions

The intentional or unintentional destruction of areas occupied by kit foxes is an issue of serious concern. Section 9 of the Act prohibits the "take" (e.g., harm, harass, pursue, injure, kill) of federally-listed wildlife species. "Harm" (i.e., "take") is further defined to include habitat modification or degradation that kills or injures wildlife by impairing essential behavioral patterns including breeding, feeding, or sheltering. Congress established two provisions (under sections 7 and 10 of the Act) that allow for the "incidental take" of listed species of wildlife by Federal agencies, non-Federal government agencies, and private interests. Incidental take is defined as "incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." Such take requires a permit from the Secretary of the Interior that anticipates a specific level of take for each listed species. If no permit is obtained for the incidental take of listed species, the individuals or entities responsible for these actions could be liable under the enforcement provisions of potential section 9 of the Act if any unauthorized take occurs.

Risk of Chance Extinction Owing to Small Population Size, Isolation, and High Natural Fluctuations in Abundance

Historically, kit foxes may have existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (Service 1998). Today's populations exist in an environment drastically different from the historic one, however, and extensive habitat fragmentation will result in geographic isolation, smaller population sizes, and reduced genetic exchange among populations; all of which increase the vulnerability of kit fox populations to extirpation. Populations of kit foxes are extremely susceptible to the risks associated with small population size and isolation because they are characterized by marked instability in population density. For example, the relative abundance of kit foxes at the Naval Petroleum Reserves, California, decreased 10-fold during 1981 to 1983, increased 7-fold during 1991 to 1994, and then decreased 2-fold during 1995 (Cypher and Scrivner 1992, Cypher and Spencer 1998).

Many populations of kit fox are at risk of chance extinction owing to small population size and isolation. This risk has been prominently illustrated during recent, drastic declines in the populations of kit foxes at Camp Roberts and Fort Hunter Liggett. Captures of kit foxes during annual live trapping sessions at Camp Roberts decreased from 103 to 20 individuals during 1988 to 1991. This decrease continued through 1997 when only three kit foxes were captured (White *et al.* 2000). A similar decrease in kit fox abundance occurred at nearby Fort Hunter Liggett, and only 2 kit foxes have been observed on this installation since 1995 (L. Clark, Wildlife Biologist, Fort Hunter Liggett, pers. comm. to P. White, Service, Sacramento, February 15, 2000). It is unlikely that the current low abundances of kit foxes at Camp Roberts and Fort Hunter Liggett will increase substantially in the near future owing to the limited potential for recruitment. The chance of substantial immigration is low because the nearest core population on the Carrizo Plain is distant (greater than 16 miles) and separated from these installations by barriers to kit fox movement such as roads, developments, and irrigated agricultural areas. Also, there is a relatively high abundance of sympatric predators and competitors on these installations that

contribute to low survival rates for kit foxes and, as a result, may limit population growth (White *et al.* 2000). Hence, these populations may be on the verge of extinction.

The destruction and fragmentation of habitat could also eventually lead to reduced genetic variation in populations of kit foxes that are small and geographically isolated. Historically, kit foxes likely existed in a metapopulation structure of core and satellite populations, some of which periodically experienced local extinctions and recolonization (Service 1998). Preliminary genetic assessments indicate that historic gene flow among populations was quite high, with effective dispersal rates of at least one to 4 dispersers per generation (M. Schwartz, University of Montana, Missoula, pers. comm. on March 23, 2000, to P. White, Service, Sacramento, California). This level of genetic dispersal should allow for local adaptation while preventing the loss of any rare alleles. Based on these results, it is likely that northern populations of kit foxes were once panmictic (i.e., randomly mating in a genetic sense), or nearly so, with southern populations. In other words, there were no major barriers to dispersal among populations.

Current levels of gene flow also appear to be adequate, however, extensive habitat loss and fragmentation continues to form more or less geographically distinct populations of foxes, which could potentially reduce genetic exchange among them. An increase in inbreeding and the loss of genetic variation could increase the extinction risk for small, isolated populations of kit foxes by interacting with demography to reduce fecundity, juvenile survival, and lifespan (Lande 1988, Frankham and Ralls 1998, Saccheri *et al.* 1998).

An area of particular concern is Santa Nella in western Merced County where pending development plans threaten to eliminate the little suitable habitat that remains and provides a dispersal corridor for kit foxes between the northern and southern portions of their range. Preliminary estimates of expected heterozygosity from foxes in this area indicate that this population may already have reduced genetic variation.

Other populations that may be showing the initial signs of genetic isolation are the Lost Hills area and populations in the Salinas-Pajaro River watershed (i.e., Camp Roberts and Fort Hunter Liggett). Preliminary estimates of the mean number of alleles per locus from foxes in these populations indicate that allelic diversity is lower than expected. Although these results may, in part, be due to the small number of foxes sampled in these areas, they may also be indicative of an increase in the amount of inbreeding due to population subdivision (M. Schwartz, University of Montana, Missoula, pers. comm. on March 23, 2000, to P. J. White, Fish and Wildlife Service, Sacramento, California). Further sampling and analyses are necessary to adequately assess the effects of these potential genetic bottlenecks.

Arid systems are characterized by unpredictable fluctuations in precipitation, which lead to high frequency, high amplitude fluctuations in the abundance of mammalian prey for kit foxes (Goldingay *et al.* 1997, White and Garrott 1999). Because the reproductive and neonatal survival rates of kit foxes are strongly depressed at low prey densities (White and Ralls 1993; White and Garrott 1997, 1999), periods of prey scarcity owing to drought or excessive rain events can contribute to population crashes and marked instability in the abundance and distribution of kit foxes (White and Garrott 1999). In other words, unpredictable, short-term fluctuations in

precipitation and, in turn, prey abundance can generate frequent, rapid decreases in kit fox density that increase the extinction risk for small, isolated populations.

The primary goal of the recovery strategy for kit foxes identified in the Recovery Plan is to establish a complex of interconnected core and satellite populations throughout the species' range. The long-term viability of each of these core and satellite populations depends partly upon periodic dispersal and genetic flow between them. Therefore, kit fox movement corridors between these populations must be preserved and maintained. In the northern range, from the Ciervo Panoche in Fresno County northward, kit fox populations are small and isolated, and have exhibited significant decline. The core populations are the Ciervo Panoche area, the Carrizo Plain area, and the western Kern County population, as shown on Figure 10 (enclosed). Satellite populations are found in the urban Bakersfield area, Porterville/Lake Success area, Creighton Ranch/Pixley Wildlife Refuge, Allensworth Ecological Reserve, Semitropic/Kern National Wildlife Refuge (NWR), Antelope Plain, eastern Kern grasslands, Pleasant Valley, western Madera County, Santa Nella, Kesterson NWR, and Contra Costa County. Major corridors connecting these population areas are on the east and west side of the San Joaquin Valley, around the bottom of the Valley, and cross-valley corridors in Kern, Fresno, and Merced counties.

In response to the drastic loss of habitat and steadily increasing fragmentation, California Department of Transportation and the Service convened a San Joaquin Kit Fox Conservation and Planning Team to address the rapid decline of kit fox habitat in the northern range, and increasing barriers to kit fox dispersal. Consisting of Federal, State, and local agencies, local land trusts, environmental groups, researchers, and other concerned individuals, the goal of this team was to coordinate agency actions that will recover the species, and troubleshoot threats to San Joaquin kit foxes as they emerge. Between the years 2001-2003, the team addressed connectivity issues at specific points along the west-side corridor north of the Ciervo Panoche core population.

There are recent records of the San Joaquin kit fox in the project area (California Department of Fish and Game 2004). The biological assessment contains data collected by California Department of Transportation biologists who observed San Joaquin kit fox(es) in July 2000 on two separate occasions within in the project study area. The observation were made in an urban area adjacent to a disked field with an abundant prey base consisting of ground squirrels and black-tailed hares. Suitable habitat for the San Joaquin kit fox in the form of ruderal and agricultural habitat is located within the action area. Given the recent sightings of the listed canine, biology and ecology of the animal, the prescence of suitable habitat in the action area, and the fact that San Joaquin kit fox has been documented to move 9 miles or more in a single night, the Service believes that it is reasonable to assume that this species inhabits the action area.

Effects of the Proposed Action

The San Joaquin kit fox will be adversely affected by the construction of the roadway and associated structures on 16.1714 acres of its foraging, denning, and travel corridor habitat. San Joaquin kit foxes inhabiting the project area and surrounding vicinity (for purposes of this

biological opinion the surrounding vicinity is described as 1000 feet outside and adjacent to the project footprint) are likely to be subject to indirect effects including temporary harassment from noise associated with project activities and human presence, and a reduction in natural food sources as a result of habitat disturbance.

The likelihood of direct mortality to San Joaquin kit foxes from either crushing or entombment in dens is low because of avoidance measures included in the project description. San Joaquin kit foxes may be adversely affected by vehicle strikes, and harassment from noise and vibration. The listed canine also may be adversely affected by construction activities temporarily blocking travel corridors in grassland and agricultural areas, or by evening construction activities disturbing night time foraging, falling into trenches or pits, being shot, being buried after becoming trapped in pipes, injured or killed by pet cats or dogs owned by construction related personnel, poisoned by rodenticides, and injured or killed by predators attracted to construction-related food or trash at the site.

The range-wide habitat loss, fragmentation, and degradation from multiple factors are the primary threat to the survival and recovery of the San Joaquin kit fox (U.S. Fish and Wildlife Service 1998). Approximately 95% of native habitat for the kit fox in the San Joaquin Valley has been destroyed by agricultural, industrial, and urban development (Service 1998). Loss of natural lands continues to occur, further reducing its habitat.

The amount of habitat loss directly attributable to roads has not been calculated. Estimates of the area occupied by roads under the jurisdiction of California Department of Transportation include 3,669 acres for Kern County, 591 acres for Kings County, 1,065 acres for Merced County, and 2,019 acres for Fresno County (Cypher 2000). These estimates are based on a standard lane width of 11.8 feet. Though not all areas included in this estimate are kit fox habitat, the estimates may nonetheless under represent the effects of roads as these totals do not include road shoulders, medians, or associated developments (e.g., interchanges, signs, drain facilities, weigh stations); nor do they include the area occupied by county and city roads. Furthermore, the above totals do not reflect the arrangement or density of San Joaquin Valley roads or the traffic volume on these roads.

The importance of road density to the ecological effects on species is indicated by research coordinated at the national level. The National Academy of Science (NAS) has formed a committee to review the scientific findings pertaining to road density. The NAS committee is focusing on hard-surfaced roads and will assess data and ecological indicators needed to measure effects, including cumulative effects. The NAS committee will produce a conceptual framework for the development of a rapid assessment methodology that transportation and regulatory agencies can use to assess and measure the ecological impact of road density (NAS 2003). The project is being sponsored by the Federal Highways Administration.

Although the effects of road density are unstudied relative to the San Joaquin kit fox, road density appears to adversely affect other diminishing species, for example wolves (*Canus lupis*) and mountain lions (*Felis concolor*). According to Forman *et al.* (2003), wolves in Minnesota, Wisconsin, and Michigan and mountain lions in Utah appear to thrive only where road density is

less than 1.0 mile/square mile. In an examination of radio-collared wolves in Wisconsin, a total of 60% of human-induced mortality occurred at road densities above 1.0 mile/square mile (Wydeven *et al.* 2001). In areas where road density is high, San Joaquin kit fox are likely to be adversely affected by several factors including direct mortality due to vehicle strikes, alteration of behavior patterns due to road and road zone avoidance, road barrier effects which reduce reproductive potential due to the inaccessibility of mates, prey, and shelter. Additionally roads are documented as serving as conduits for invasion by non-native plants and animals as well as the means by which contaminants and toxins are introduced to habitat.

Habitat Fragmentation

The area or diameter of patches enclosed within a network, referred to by Forman *et al.* (2003) as mesh size, is inversely related to road density. As road density increases, mesh size decreases. As the landscape becomes more fragmented, the fragments become progressively smaller (Forman *et al.* 2003). Patches within dense road networks are constrained in terms of ecosystem functioning and are thus degraded. As patches become progressively smaller, they become unsuitable to support the San Joaquin kit fox and its prey.

If a habitat fragment is too small to support a home range, animals may abandon it. Abandonment increases the probability that the animals will be extirpated from each patch. Estimates of home range size for the San Joaquin kit fox vary from 1.7 square miles to 4.5 square miles (White and Ralls 1993). Typically, a mated pair will share a home range. As mesh size becomes smaller, the patches themselves can function as barriers with habitat degraded to the point that it offers little in the way of foraging grounds or refuge from predators. These remnant patches interrupt dispersal corridors and reduce genetic exchange and mating opportunities.

Road density and mesh size are directly related to the total surface area occupied by roads in a given region. On a local scale, the surface area of a road may be the major contributor to adverse effects to San Joaquin kit foxes depending on lane width and kit fox occupation of or dispersal through adjacent habitat.

Direct Mortality

San Joaquin kit fox mortality and injury occurs when the animals attempt to cross roads and are hit by cars, trucks, or motorcycles. The majority of strikes likely occur at night when the animals are most active. Such strikes are usually fatal for an animal the size of a kit fox. If vehicle strikes are sufficiently frequent in a given locality, they could result in reduced kit fox abundance. The death of kit foxes during the December through March breeding season could result in reduced reproductive success. Death of females during gestation or prior to pup weaning could result in the loss of an entire litter of young, and therefore, reduced recruitment of new individuals into the population.

The local and range-wide effects of vehicle strikes on San Joaquin kit foxes have not been adequately assessed. Vehicle strikes appear to occur most frequently where roads transverse areas where kit foxes are abundant. However, the linear quantity of roads in a given area may not

be directly related to the number of vehicle strikes in a given area. The type of road (e.g., number of lanes) traffic volume, and average speed of vehicles likely all influence the number of vehicle strikes for which San Joaquin kit foxes are as risk. The number of strikes likely increases with road size, traffic volume, and average speed (Clevenger and Waltho 1999). Another factor influencing the number of vehicles striking San Joaquin kit foxes, but for which little data is available, is the frequency with which the animals cross roads and are therefore at risk. The proportion of successful road crossings by these animals likely declines with increasing road size, traffic volume and density, and vehicle speeds. The proportion of San Joaquin kit foxes successfully crossing roads may increase in areas where they obtain more experience crossing roads, such as in and near urban areas.

Occurrences of vehicle strikes involving San Joaquin kit foxes have been well documented, and such strikes occur throughout the range of the species. Sources of kit fox mortality were examined during the period 1980-1995 at the Naval Petroleum Reserves in California in western Kern County (Cypher *et al.* 2000). During this period, 341 adult San Joaquin kit foxes were monitored using radio telemetry, and 225 of these animals were recovered dead. Of these, 20, or 9% were struck and killed by vehicles. During this same period, 184 juvenile (<1 year old) kit foxes were monitored. Of these, 142 were recovered dead and 11 or 8%were killed by vehicles. For both adults and juveniles, vehicle strikes accounted for less than 10% of all San Joaquin kit fox deaths in most years. However, in some years, vehicles accounted for about 20% of deaths. Predators, primarily coyotes and bobcats, were the primary source of mortality at the Naval Petroleum Reserves. In addition, 70 kit foxes, both radio collared and non-collared, were found dead on roads in and around the Naval Petroleum Reserves during the period 1980-1991 (Scrivner *et al.* 1993). Of these, 34 were hit by vehicles on the approximately 1,600 km (990 miles) of roads at the Reserve, and 36 were struck on the approximately 80 km (50 miles) of State and County roads (e.g., State Route 119, Elk Hills Road), where traffic volumes and average vehicle speeds were higher than those on the Reserve.

In other areas of western Kern County, 49 kit foxes were radio-collared in the highly developed Midway-Sunset oil field, and 54 kit foxes were radio-collared in the Lokern Natural Area, a nearby undeveloped area, during the period 1989-1993 (Spiegel and Disney 1996). Of these animals, 60 were recovered dead; 1 (2%) was killed by a vehicle, and it was found in an undeveloped area along the access road adjacent to the California Aqueduct. Though six non-collared kit foxes were killed by vehicles on the access road, predators, primarily coyotes, bobcats, and feral dogs were responsible for most deaths in this study. Forty-one San Joaquin kit foxes were radio-collared and monitored during 1989-1991 on the Carrizo Plain National Monument in eastern San Luis Obispo County (Ralls and White 1995). Twenty-two were found dead; 1 (5%) was attributed to a vehicle strike. At the Camp Roberts National Guard Training Facility in Monterey and San Luis Obispo counties, 94 San Joaquin kit foxes were radio-collared during the period 1988-1992 (Standley *et al.* 1992). Forty-nine were found dead of which two were attributed to vehicle strikes. In western Merced County, 28 San Joaquin kit foxes were radio-collared during the period 1985-1987 (Briden *et al.* 1992). Seventeen were found dead and two (12%) of these deaths were attributed to vehicles.

According to Morrell (1970), "The automobile is by far the major cause of reported San Joaquin kit fox deaths - 128 of 152 deaths reported were caused by automobiles." Morrell acknowledged that the numbers were based on non-radio-collared kit foxes and therefore were biased because road-killed foxes are conspicuous and easily observed compared to animals dying from other causes. Though predators such as coyotes, bobcats, non-native red foxes, and domestic dogs likely constitute a higher source of mortality than vehicle strikes (Service 1998; Cypher 2000), predation as a source of mortality is likely dependent upon local conditions. Where abundance of predators has also been reduced due to road density and loss of habitat, vehicle strikes may present a significant threat to kit fox survival and recovery.

Based on a study of another kit fox subspecies, Egoscue (1962) reported that eight tagged foxes (*Vulpes macrotis nevadensis*) in Utah were killed by vehicles, and five of these were pups. Pups appeared to be more vulnerable to vehicle strikes. Many of the foxes killed were residents that were using dens located near roads. O'Neal *et al.* (1987) examined 23 dead kit foxes in western Utah in 1983. None were killed by vehicles, possibly due to the remoteness of the study site.

The swift fox (*Vulpes velox*) is closely related to the San Joaquin kit fox, and is listed as endangered in Canada. They show numerous ecological similarities with the San Joaquin kit fox. Hines (1980) reported that roads were a major source of swift fox mortality in Nebraska. In Alberta, where the swift fox was extirpated and recently reintroduced, vehicles were responsible for five of 89 (6%) of the foxes found dead (Carbyn *et al.* 1994). Pups appeared to be especially vulnerable, particularly if the natal dens were located near roads (Carbyn 1998). In western Kansas, 41 adults and 24 juvenile swift foxes were radio collared and monitored during 1996-97 on two study sites (Sovada *et al.* 1998). Among the adults, 18 were found dead, but none were killed by vehicles. Among the juveniles, 14 were found dead and four (29%) of these had been struck by vehicles. All seven of the juveniles killed by vehicles were found on the same study site. This study site had 90% more roads compared to the other study site where no foxes were killed by vehicles (78 mi vs. 41 mi). At a remote site in Colorado with few roads and restricted public access, swift foxes were rarely struck by vehicles (Covell 1992; Kitchen *et al.* 1999).

Vehicle-related mortality has significantly affected other listed or rare species. Vehicles caused 49% of the mortality documented among endangered Florida panthers (*Felis concolor coryi*) (Maehr *et al.* 1991). With a remaining population of 20-30 animals, the loss of any to vehicles likely constitutes a significant population effect. Similarly, Tubak in 1999 estimated at least 15% of the remaining 250-300 key deer (*Odocileus virginianus clavium*) are killed annually by vehicles, and this mortality is considered to be a limiting factor for this endangered species (Service 1985). Mortality from vehicles was the primary source of mortality for endangered ocelots (*Felis pardalis*) in Texas (Tubak 1999), and also contributed to the failure of a lynx (*Lynx lynx*) reintroduction project in New York (Aubrey *et al.* 1999). Rudolph *et al.* (1999) estimated that road-associated mortality may have depressed populations of Louisiana pine snakes (*Pituophis ruthveni*) and timber rattlesnakes (*Crotalus horridus*) by over 50% in eastern Texas, and this mortality may be a primary factor in local extirpations of timber rattlesnakes (Rudolph *et al.* 1998). Mortality from vehicles also is contributing to the reduction in the status of the prairie garter snake (*Thamnophis radix radix*) in Ohio (Dalrymple and Reichenbach 1984), and was a limiting factor in the recovery of the endangered American crocodile (*Crocodylus acutus*) in

Florida (Kushland 1998). In Florida, threatened Florida scrub-jays (*Aphelocoma coerulescens*) suffered higher mortality in territories near roads, as well as reduced productivity due to vehicle strikes of both breeding adults and young (Mumme *et al.* 1999).

Barrier Effects

Roads constitute barriers to San Joaquin kit fox movements, dispersal, and gene flow. Movements and dispersal corridors are critical to kit fox population dynamics, particularly because the animals currently persist as metapopulations with multiple disjunct population centers. Movement and dispersal corridors are important for alleviating over-crowding and intraspecific competition during years when San Joaquin kit fox abundance is high, and also they are important for facilitating the recolonization of areas where the animal has been extirpated. Movement between population centers maintains gene flow and reduced genetic isolation. Genetically isolated populations are at greater risk of deleterious genetic effects such as inbreeding, genetic drift, and founder effects.

Roads have been documented to act as barriers to a number of species. Bobcats in Wisconsin readily crossed dirt roads, but were reluctant to cross paved roads (Lovallo and Anderson 1996). Lynx also exhibit a reluctance to cross roads (Barnum 1999) as do mountain lions (Van Dyke *et al.* 1986). In a study in North Carolina, the number of road crossings by black bears (*Ursus americanus*) was inversely related to traffic volume, and bears almost never crossed an interstate highway (Brody and Pelton 1989). Endangered Sonoran pronghorn (*Antilocarpa americana*) in Mexico are reluctant to cross a 2-lane highway, and the planned expansion of the road could further restrict movements (Castillo-Sanchez 1999). Many rodents are reluctant to cross roads (Oxley *et al.* 1974). Forman *et al.* (2003) suggests that road crossings are as much about individual behavior as they are about habitat requirements and reports that a four-lane divided highway in Canada served as a complete barrier to adult female grizzly bears (*Ursus arctos*) and a partial filter-barrier for adult male grizzlies.

Roads were found to be significant barriers to gene flow among common frogs (*Rana temporaria*) in Germany and this has resulted in genetic differentiation among populations separated by roads (Reh and Seitz 1990). Similarly, significant genetic subdivision was detected in bank vole (*Clethrionomys glarelous*) populations separated by a 164 foot wide highway in Germany (Gerlach and Musolf 2000). In California, local extinctions of mountain lions have occurred when roads and other developments fragmented habitat in small patches and blocked movement corridors thereby isolating the patches and preventing recolonization (Beier 1993).

Traffic Volume

Traffic volume influences the permeability (the likelihood of crossings) of roads and the probability for mortality due to vehicle strikes. Factors such as the width of the road, the presence of a median with or without Jersey or "K" rail concrete barriers, the velocity of the traffic, the physical nature of the approach and shoulder of the road, and the behavior of the animals attempting to cross determine probabilities for mortality. Clevenger *et al.* (2003) studying roads in Canada found that a low volume road (1,068 to 3,231 vehicles per day) resulted

in higher mortalities of small vertebrate fauna than high volume roads (14,000 to 35,000 vehicles per day). These and other results indicate that the disturbance generated from roads with high traffic volume may deter animal movements onto or across the roadway. Multi-lane roads with high traffic volume may produce the greatest barrier effect to the San Joaquin kit fox.

Knapp (1978) monitored movements of radio-collared San Joaquin kit foxes in the vicinity of Interstate 5, a divided four-lane freeway in Kern County. Many of the foxes used areas within three km (two miles) of the highway, and most exhibited movement and home range patterns that paralleled the highway, but did not cross it. Only on two occasions were animals located on the opposite side of the highway from their primary area of use.

Noise Harassment

Disturbance from the construction of minor transportation projects and from roads and road networks could induce stress in the San Joaquin kit fox which may affect physiological parameters or behavior. The resulting effects could include increased energetic requirements, decreased reproductive output, decreased immunological functions, altered space use patterns, displacement, or possibly death. Observations from a variety of sources and situations suggest that San Joaquin kit foxes may not be significantly affected by disturbance, even when the source is prolonged or continuous (Cypher 2000). However, individual animals may be more affected than others, and it is unknown whether different types of disturbance may result in reduced local abundance.

One type of disturbance that may adversely affect San Joaquin kit foxes is an increase in the ambient noise level. Minor transportation projects may result in an increase in the ambient noise level during and after project construction. Harassment from long-term noise may cause kit foxes to eventually vacate the project site and adjacent areas. Projects that have the effect of enhancing traffic flow or increasing traffic volume have the potential to result in higher associated noise levels. When traffic volume increases up to 1,000 vehicles per day, noise rises to over 50 decibels (dBA). As the speed of traffic flow increases, noise levels increase. Noise levels also increase as a result of increased truck usage. Traffic flow that includes medium to heavy trucks (i.e., six or more tires on two axles to three or more axles) noticeably increases the noise level. A heavy truck passing produces approximately 10 dBA more noise than a passing automobile (Forman *et al.* 2003). Traffic noise likely contributes to San Joaquin kit fox behaviors with regard to road avoidance and decisions as to when and where to attempt road crossings.

No specific research on the physiological effects of noise on San Joaquin kit foxes has been conducted, but a "safe, short-term level" for humans has been determined to be 75 decibels by the National Institutes of Health (NIH)(NIH 1990, Burglund and Lindvall 1995). The mechanisms leading to permanent hearing damage are the same for all mammals (NIH 1990). However, the enlarged pinna and reduced tragi of kit foxes indicate that their hearing is more acute than that of humans (Jameson and Peeters 1988). However, variation in response to intense noise has been found to vary, in humans, by as much as 30 to 50 dBA between individuals (NIH 1990). Similar variation has been found in animal studies as well (NIH 1990). Also, younger animals have been shown to be more susceptible to noise-induced hearing loss

(NIH 1990). The ability to habituate to noise appears to vary widely between species (U.S. National Park Service 1990). Typical construction machinery produces noise in the range of 75 dBA (arc-welder) to 85 dBA (bulldozer) (Burglund and Lindvall 1995).

Long-term noise levels of 85 dBA are recognized to cause permanent hearing damage in humans (NIH 1990). Noise at the 85 dBA level has been correlated with hypertension in Rhesus monkeys (*Macaca fasicularis*)(Cornman 2001). Increased reproductive failure in laboratory mice (*Mus musculus*) was found to occur after a level of 82-85 dBA for one week (Cornman 2001). However, measurable loss of hearing was found to occur in chinchillas (*Chinchilla laniger*) at a sustained level of 70 dBA (Peters 1965). Hearing loss from motorcycle traffic has been documented for the kangaroo rat (*Dipodomys* species) (Bondello and Brattstrom 1979) and desert kangaroo rats (*Dipodomys deserti*) showed a significant reduction in reaction distance to the sidewinder (*Crotalus cerastes*) after exposure to 95 dBA (Cornman 2001). Other desert mammals appear to sustain the same impacts from noise (Bondello and Brattstrom 1979). Aircraft noise has produced accelerated heart-rates in pronghorn (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), and elk (*Cervus elaphus*) (MacArthur 1976; Workman *et al.* 1992; all in U.S. National Park Service 1994).

Hearing loss is correlated with distance from the source of the noise. At a level of 110 dBA, guinea pigs (*Cavia porcellus*) suffered long-term hearing loss at distances of 25 and 50 meters, temporary loss at a distance of 100 meters, and no measurable loss at 1,500 meters (Gonzales *et al.* 1970). Over clear (i.e. unobstructed) land as in San Joaquin fox habitat, sound diminishes slightly more quickly at 6 dBA per doubling of distance:

$$(\text{noise at }) D = D_1 - 19.93 [\log (D/D_{\text{land}})],$$

(Komanoff & Shaw 2000). The effects of cumulative noise (α) are computed as the sum of the log of each component, multiplied by a magnitude of 10:

$$\alpha = 10 [\Sigma (\log A + \log B + \log C.....)],$$

where A, B, C, etc. are individual components of the total ambient noise. Thus, the total synergistic impact from noise will be greater than the sum of the individual components (Komanoff & Shaw 2000).

Contaminants

The presence of roads in an area could result in the introduction of chemical contaminants to the site. Contaminants could be introduced in several ways. Substances used in road building materials or to recondition roads can leach out or wash off roads adjacent to habitat. Vehicle exhaust emissions can include hazardous substances which may concentrate in soils along roads. Heavy metals such as lead, aluminum, iron, cadmium, copper, manganese, titanium, nickel, zinc, and boron are all emitted in vehicle exhaust (Trombulak and Frissell 2000). Concentrations of

organic pollutants (i.e. dioxins, polychlorinated biphenyls) are higher in soils along roads (Benfenati *et al.* 1992). Ozone levels are higher in the air near roads (Trombulak and Frissell 2000). Vehicles may leak hazardous substances such as motor oil and antifreeze. Although the quantity leaked by a given vehicle may be minute, these substances can accumulate on roads and may be washed into the adjacent environment by runoff during rain storms. An immense variety of substances, including fertilizers, pesticides, and herbicides from vehicles traveling through agricultural zones, could be introduced during accidental spills of materials. Such spills can result from small containers falling off passing vehicles, or from accidents resulting in whole loads being spilled. Large spills may be partially or completely mitigated by clean-up efforts, depending on the substance.

San Joaquin kit foxes using areas adjacent to roads could be exposed to any contaminants that are present at the site. Exposure pathways include inhalation, dermal contact, direct ingestion, ingestion of contaminated soil or plants, or consumption of contaminated prey. Exposure to contaminants may cause short- or long-term morbidity, possibly resulting in reduced productivity or mortality. Carcinogenic substances may cause genetic damage resulting in sterility, reduced productivity, or reduced fitness among progeny. Contaminants also may have the same effect on kit fox prey species. This could result in reduced prey abundance and diminished local carrying capacity for the kit fox.

Little information is available on the effects of contaminants on the San Joaquin kit fox. The effects may be difficult to detect. Morbidity or mortality likely would occur after the animals had left the contaminated site, and more subtle effects such as genetic damage could only be detected through intensive study and monitoring. However, effects have been detected on some occasions. At the Naval Petroleum Reserve, three kit foxes are known to have been killed by drowning in spills of crude oil (Cypher *et al.* 2000). Spiegel and Disney (1996) reported that a kit fox was found covered with crude oil at the Midway-Sunset oil field, and this individual died despite treatment. Other animals, some of which were prey species for the kit fox, were found drowned in crude oil at the Naval Petroleum Reserve (Scrivner *et al.* 1993). Such spills potentially can cause local reductions in the abundance of kit foxes and their prey.

Invasive Species

Construction of roads can facilitate the invasion and establishment by species not native to the area. Disturbance and alteration of habitat adjacent to roads may create favorable conditions for non-native plants and animals. Non-native plants can spread along roadsides and then into adjacent habitat (Gelbard and Harrison 2003). Non-native animals may use modified habitats adjacent to road to disperse into kit fox habitat. These exotic animals could compete with kit foxes for resources such as food or dens, or directly injure or kill kit foxes. Non-native plants and animals may reduce habitat quality for kit foxes or their prey, and reduce the productivity or the local carrying capacity for the kit fox. Introductions of non-native species could cause kit foxes to alter behavioral patterns by avoiding or abandoning areas near roads (Cypher 2000).

Disturbed areas adjacent to roads provide favorable habitat conditions for a number of non-native plant species. Some of these taxa are aggressively invasive and they can alter natural

communities and potentially affect habitat quality. A problematic species within the range of the San Joaquin kit fox is yellow star thistle (*Centaurea solstitialis*). Dense stands of this plant can form along roadsides and then spread into adjacent habitat. This plant displaces native vegetation, competes with native plants for resources, does not appear to be used by kit fox prey, exhibits dense growth, and may be difficult for kit foxes to move through due its large size (up to 3.3 feet tall), and numerous sharp spines (Cypher 2000). Other species that may disperse along roads and invade adjacent habitat include mustards (*Brassica* spp.) and Russian thistle (*Salsola tragus*)(Tellman 1997).

Disturbed soils and reduced competition from native plants are some of the conditions that facilitate invasion along roads by non-native plant species. Nitrogen from vehicle exhaust is deposited in habitats adjacent to roads, and the resulting enhanced nitrogen levels appear to promote growth of non-native species, particularly non-native grasses (Weiss 1999). These grasses, such as red brome (*Bromus madritensis rubens*) create dense ground cover in the San Joaquin Valley, and this dense cover appears to reduce habitat quality for various small mammal species, such as kangaroo rats, which are an important prey for kit foxes (Goldingay *et al.* 1997, Cypher 2000).

Roads may serve as travel corridors for non-native red foxes. Red foxes can kill San Joaquin kit foxes (Ralls and White 1995, Service 1998), and likely compete with kit foxes for food and dens. Red foxes are considered a threat to the swift fox in Canada (Carbyn 1989). Red foxes are infrequently observed in large blocks of undisturbed habitat within the range of the San Joaquin kit fox, possibly due to the absence of permanent water or the presence of coyotes which prey upon red foxes. Along roads, water availability may be higher due to pooling of precipitation runoff or human development, and coyotes may be less abundant due to the presence of humans. Roads may facilitate movements of red foxes and increase access to kit fox habitat. Non-native red foxes and feral cats (*Felis catus*) are reported to use roads as movement corridors in Australia (Bennett 1991).

Road Effect Zone

Adverse effects to wildlife populations from roads may extend some distance from the actual road. The phenomenon can result from any of the effects already described in this biological opinion (e.g. vehicle-related mortality, habitat degradation, invasive exotic species, etc.). Forman and Deblinger (2000) described the effect as the "road effect" zone. Along a 4-lane road in Massachusetts, they determined that this zone extend for an average of approximately 980 ft to either side of the road for an average total zone width of approximately 1970 feet. However, in places they detected an effect > 0.6 miles from the road. Rudolph *et al.* (1999) detected reduced snake abundance up to 2,790 feet from roads in Texas. They estimated snake abundance out to 2,790 feet, so the effect may have been greater. Extrapolating to a landscape sale, they concluded the effect of roads on snake populations in Texas likely was significant, given that approximately 79% of the land area of Texas is within 1,640 feet of a road.

Effects within the road zone can be subtle. Van der Zande *et al.* (1980) reported that lapwings (*Vanellus vanellus*) and black-tailed godwits (*Limosa limosa*) feeding at 1,575-6,560 feet from

roads were disturbed by passing vehicles. The heart rate, metabolic rate and energy expenditure of female bighorn sheep (*Ovis canadensis*) increases near roads (MacArthur *et al.* 1979). Trombulak and Frissell (2000) described another type of road zone effect. Heavy metal concentrations from vehicle exhaust were greatest within 66 feet of roads, but elevated levels of metals in both soil and plants were detected at ≥660 feet of roads. The road effect zone apparently varies with habitat type and traffic volume. Based on responses by birds, Forman (2000) estimated the effect zone along primary roads at 1,000 feet in woodlands, 1,197 feet in grasslands, and 2,657 feet in natural lands near urban areas. Along secondary roads with lower traffic volumes, the effect zone was 656 feet. The road effect zone and the San Joaquin kit fox have not been adequately investigated; however, it is possible it exists given the effects of roads on the animal.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Numerous non-Federal activities continue to eliminate habitat for the San Joaquin kit fox in the action area. Loss and degradation of habitat affecting both animals and plants with or without Service authorization continues as a result of: urbanization; oil and gas development on private lands; road and utility right-of-way management; flood control and water banking projects that may not be funded, permitted, or constructed by a Federal agency; overgrazing by livestock; and continuing agricultural expansion including the building of new dairies and stockyards. Listed and proposed animal species are also affected by poisoning, shooting, increased predation associated with human development, ground squirrel reduction efforts, mosquito control, and reduction of food sources. Unauthorized take may be occurring, and the Service continues to request re-initiation of projects when project descriptions have changed markedly since the original biological opinion were issued, and Service Law Enforcement continues to investigate potential violations of the Act.

Existing habitat is so fragmented in the San Joaquin Valley that extirpation of certain remaining populations of San Joaquin kit fox appears likely, due to chance fluctuation of small populations, unusual climatic events, the loss of genetic fitness commonly associated with very small populations, and other factors discussed previously. The cumulative effects of these threats pose a significant impediment to the survival and recovery of these species.

The following list provides the names or descriptors of projects in Kings County for which the Service has received limited information. The project descriptions when initially provided to the Service, lacked a Federal nexus and were therefore not considered Federal projects that would be subject to a section 7 consultation under the Act. Some of these projects may eventually become Federal projects whereas others may be abandoned for reasons unknown to the Service. The list therefore provides an example of the projects that are representative of development throughout Kings County. The size of such projects and the habitat loss consequential to each is often

unknown; however, some of the projects listed are known to range in size from less than 25 acres to more than 100 acres. If habitat conservation plans were in place in these counties or around growing urban areas such as Lemoore and Hanford, they would provide a locally-designed mechanism for complying with the Act and for project proponents to make targeted and effective contributions to the survival and recovery of listed species.

Kings County

EVMS land development
Lealand/Peichoto land development
Stryd land development
Bailon land development
Subdivision
Dairy new
Feedlot new
Ramirez Travel Plaza
Nextel Land development
Soales Land development
Westlake Farms
Azevedo Ag land division
Veterinary Pharmecuticals Land development
Wireless communications facilities

As the human population of central California increases, and land continues to be converted to municipal and industrial uses, the amount and quality of habitat suitable for the species considered in this biological opinion will decrease. Between 1970 and 2000, California's total population increased by approximately 71% while the Central Valley's population increased 200%. Of the Sacramento and San Joaquin Valleys within the Central Valley, the San Joaquin Valley had the greater population growth (California Department of Finance (CDF) 2002). Among counties in the San Joaquin Valley, Tulare experienced the least increase percentage in population at 226% from 1940 to 1995, while Stanislaus experienced the greatest increase at 453% during the same period. Also during the period 1940 to 1995, the increase in population for Fresno was 322%; for Kern and Madera: 356% each, for Kings: 227%, for Merced: 322% (CDF 2002). (Information for the valley portions of Mariposa and Tuolumne was unavailable). During the period 1988 to 1998, 82,756 acres in the San Joaquin Valley were converted to urban and built-up land uses (California Department of Conservation 2000). Although not each of the converted acres can be considered habitat, this trend indicates that habitat loss continues to threaten the survival and recovery of listed species.

The cumulative effects of all the future State, Tribal, local, and private actions that are reasonably certain to occur in the action area will continue to have a deleterious effect on the reproduction, numbers, and distribution of the species considered herein. The adverse cumulative effects described in this section serve to magnify the adverse effects of the proposed action and diminish any beneficial effects.

Conclusion

After reviewing the current status of the San Joaquin kit fox, the environmental baseline for the action area, the effects of the proposed State Route 198/19th Avenue Project, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the San Joaquin kit fox. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Federal Highway Administration has a continuing duty to regulate the activity covered by this incidental take statement. If the Federal Highway Administration (1) fails to require the California Department of Transportation to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

Incidental take of the San Joaquin kit fox is anticipated to occur as a result of the proposed project. However, incidental take will be difficult to detect or quantify because it lives for a portion of its life in dens or burrows, it has a wide ranging territory, is primarily active at night, is often is extremely shy in its behavior around humans, and losses of this animal may be difficult to quantify due to seasonal fluctuations in its numbers. For these reasons, the Service is quantifying take incidental to the proposed action as the number of acres of habitat that will become unsuitable for the San Joaquin kit fox as a result of the action. Loss of habitat is a reasonable surrogate for expressing the amount or extent of take because it accurately reflects the biological effects to this species. Therefore, the Service estimates that all San Joaquin kit foxes

inhabiting 16.1714 will be subject to take in the form of harm and harassment as a result of the proposed action.

Effect of Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the San Joaquin kit fox. Critical habitat for this species has not been designated or proposed; therefore none will be affected.

Reasonable and Prudent Measures

The following reasonable and prudent measures are necessary and appropriate to minimize the effects of the State Route 198/19th Avenue project on the San Joaquin kit fox.

1. The California Department of Transportation shall implement conservation measures for the San Joaquin kit fox to minimize (1) the effects of the loss of habitat that will occur as a result of the project; (2) the potential for harassment, harm, injury, and mortality to the San Joaquin kit fox; and (3) the potential for inadvertent capture or inadvertent capture or entrapment of this listed wildlife species during construction activities.

2. The California Department of Transportation shall ensure their compliance with this biological opinion.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Federal Highway Administration shall ensure the California Department of Transportation complies with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are nondiscretionary.

1. The following Terms and Conditions implement Reasonable and Prudent Measure one (1):

   A. The California Department of Transportation shall minimize the potential for harm or harassment of the San Joaquin kit fox resulting from the project related activities by implementation of the conservation measures as described in the biological assessment and the *Project Description* of this biological opinion.

   B. The California Department of Transportation shall include Special Provisions that include the avoidance and minimisation measures of this biological opinion in the solicitation for bid information. The California Department of Transportation will educate and inform contractors involved in the project as to the requirements of the biological opinion.

C. Prior to initiation of any site preparation/construction activities, the California Department of Transportation biologist or Service-approved biologist will conduct an education and training session for all construction personnel. All available individuals who will be involved in the site preparation or construction will be present, including the project representative(s) responsible for reporting take to the Service and the California Department of Fish and Game. Training sessions will be repeated for all new employees before they are allowed to access the project site. Sign up sheets identifying attendees and the contractor/company they represent will be provided to the Service with the post-construction compliance report. At a minimum, the training will include a description of the natural history of the San Joaquin kit fox and its habitat. Training will included the general measures that are being implemented to conserve these species as they relate to the project, the penalties for non-compliance, and the boundaries (work area) within which the project must be accomplished. To ensure that employees and contractors understand their roles and responsibilities, training may have to be conducted in languages other than English.

D. The resident engineer or their designee shall be responsible for implementing these conservation measures and shall be the point of contact for each project.

E. If borrow material is going to be used for the State Route 198/19th Avenue project, the California Department of Transportation shall follow the procedures outlined below:

1. California Department of Transportation shall require as part of the construction contract that all contractors comply with the Act in the performance of the work necessary for project completion performed inside and outside the project right-of-way.

2. California Department of Transportation shall require documentation from the contractor that aggregate, fill, or borrow material provided for each project was obtained in compliance with the Act. Evidence of compliance with the Act shall be demonstrated by providing the Resident Engineer (RE) any one of the following:

   a. a letter from the Service stating use of the borrow pit area will not result in the incidental take of listed species;
   b. an incidental take permit for contractor-related activities issued by the Service pursuant to section 10(a)(1)(B) of the Act;
   c. a biological opinion or a letter concurring with a "not likely to adversely affect" determination issued by the Service to the Federal agency having jurisdiction over contractor-related activities;
   d. a letter from the Service concurring with the "no effect" determination for contractor-related activities; or
   e. Contractor submittal of information to the California Department of Transportation Resident Engineer indicating compliance with the State

Mining and Reclamation Act (SMARA) and provide the County land use permits and CEQA clearance.

f. If a borrow site that is in compliance with the Act is not available, the California Department of Transportation will either:

i. identify/select a site that the Service has concurred with the "no effect" determination, or;
ii. request reinitiation of formal consultation on the action considered herein based on new information.

F. The California Department of Transportation biologist shall have oversight over implementation of all the measures described in the *Terms and Conditions* of this biological opinion, and he/she shall have the authority to stop project activities, through communication with the California Department of Transportation Resident Engineer, if any of the requirements associated with these measures are not being fulfilled. If the biologist/construction liaison has requested a stop work do to take of any of the listed species the Service and Fish and Game will be notified within one (1) day via email or telephone.

G. Prior to any ground disturbance, pre-construction surveys shall be conducted for the San Joaquin kit fox. These surveys will consist of walking surveys of the project limits and adjacent areas accessible to the public to determine presence of this species (i.e., kit fox dens and related sign).

H. Project employees shall be directed to exercise caution when commuting within the habitat of the San Joaquin kit fox. A 20-mile per hour speed limit will be strongly encouraged on unpaved roads within the habitat of this species. Cross-country travel by vehicles will be prohibited, unless authorized by the Service. Project employees shall be provided with written guidance governing vehicle use, speed limits on unpaved roads, fire prevention, and other hazards.

I. A litter control program shall be instituted at each project site. All workers ensure their food scraps, paper wrappers, food containers, cans, bottles, and other trash from the project area are deposited in covered or closed trash containers. The trash containers shall be removed from the project area at the end of each working day.

J. No canine or feline pets or firearms (except for Federal, State, or local law enforcement officers and security personnel) shall be permitted on construction sites to avoid harassment or killing or injuring of listed species.

K. Maintenance and construction excavations greater than 2 feet deep either shall be covered, filled in at the end of each working day, or have earthen escape ramps no greater than 200 feet apart provided to prevent entrapment of the San Joaquin kit fox.

L. All construction activity shall be confined within the project site, which may include temporary access roads, haul roads, and staging areas specifically designated and marked for these purposes. At no time shall equipment or personnel be allowed to adversely affect habitat areas outside the project site without authorization from the Service.

M. The project construction area shall be delineated with high visibility temporary fencing at least five (5) feet in height, flagging, or other barrier to prevent encroachment of construction personnel and equipment onto any sensitive areas during project work activities. Such fencing shall be inspected and maintained daily until completion of the project. The fencing will be removed only when all construction equipment is removed from the site.

N. Only Service-approved workers holding valid permits issued pursuant to section 10(a)(1)(A) of the Act are allowed to trap or capture the San Joaquin kit fox. Any relocation plan will be approved by the Service prior to release of any kit foxes.

O. All grindings and asphaltic-concrete waste shall be stored within previously disturbed areas absent of habitat and at a minimum of 150 feet from any culvert, wash, pond, vernal pool, or stream crossing

P. Because dusk and dawn are often the times when the San Joaquin kit fox is most actively foraging, all construction activities will cease one half hour before sunset and will not begin prior to one half hour before sunrise. Except when necessary for driver or pedestrian safety, lighting of a project site by artificial lighting during night time hours is prohibited.

Q. Use of rodenticides and herbicides at the project site shall be utilized in such a manner to prevent primary or secondary poisoning of the San Joaquin kit fox, and the depletion of prey populations on which its depends. All uses of such compounds hall observe label and other restrictions mandated by the U.S. Environmental Protection Agency, California Department of Pesticide Regulation, and other appropriate State and Federal regulations, as well as additional project-related restrictions deemed necessary by the Service or the California Department of Fish and Game.

R. The following actions shall be taken to minimize the effect on denning San Joaquin kit foxes:

1. Determine the presence of kit fox dens (natural or in pipes and culverts).

a. Pre-construction surveys within the project area shall be conducted no more than 30 calendar days prior to the start of construction in accordance with

the most current protocols approved by the Service and the California Department of Fish and Game.

b. Surveys for dens shall be conducted by qualified biologists with demonstrated experience in identifying San Joaquin kit fox dens.

2. Protect all San Joaquin kit fox dens to the maximum extent practicable as determined by the on-site biologist.

3. Identify type of den (natal or non-natal) and its status (occupied or unoccupied) based on the current Service guidance (Service 1999). Identify and execute appropriate action(s) regarding notification, buffers, excavation and fill, or seal-off:

a. Occupied natal den: if an occupied natal den is is visible or encountered within the project limits, or other accessible land, or on publicly accessible land within 1000 feet of the project construction area, the project will be constructed between August 1 and November 30 and the Service shall be contacted immediately, before any project action occurs.

b. A buffer or exclusion zone shall be established to protect the physical den and surrounding habitat of unoccupied natal dens and all non-natal dens that can be avoided:

i. unoccupied natal dens shall be surrounded with a 200 feet buffer and the Service will be contacted. Occupied and unoccupied non-natal dens shall be surrounded with a 100 feet buffer.

ii When occupied dens have been found on or near the project site, ground disturbing activities shall be restricted during the period December 1 to July 31.

iii During this period, project activities within 0.3 mi of occupied natal dens are prohibited. Buffer zones shall be delineated with a temporary fence or other suitable barrier that does not prevent disbursal of the fox. Alternately, the project construction area can be delineated with temporary fence, flagging, or other barrier.

S. Pipes or culverts with a diameter greater than 4 inches shall be capped or taped closed when it is ascertained that no San Joaquin kit fox is present. Any kit fox found in a pipe or culvert shall be allowed to escape unimpeded.

T. If a natural den cannot be avoided and must be destroyed, the following guidelines shall be followed:

1. Prior to the destruction of any den, the den shall be monitored for at least 3 consecutive days to determine its current status. Activity at the den shall be monitored by placing tracking medium at the entrance and by standard spotlighting detection techniques. If no kit fox activity is observed during this period, the den shall be destroyed immediately to preclude subsequent use. If kit fox activity is observed at the den during this period, the den shall be monitored for at least 5 consecutive days from the time of observation to allow any resident animal to move to another den during its normal activities. Use of the den can be discouraged during this period by partially plugging the entrance(s) with soil in such a manner that any resident animal can escape easily. Destruction of the den may begin when, in the judgment of a Service or Service-approved biologist, the animal has moved to a different den. The biologist shall be trained and familiar with kit fox biology. If the animal is still present after five or more consecutive days of plugging and monitoring, the den may be excavated when, in the judgment of the Service-approved biologist, it is temporarily vacant, for example during the animal's normal foraging activities.

2. All dens shall be excavated by hand, by or under the supervision of, a Service-approved biologist.

3. The den shall be fully excavated and then filled with dirt and compacted to ensure that kit foxes cannot reenter or use the den during the construction period. If, at any point during excavation a kit fox is discovered inside the den, the excavation activity shall cease immediately and monitoring of the den shall be resumed. Destruction of the den may be resumed, when in the judgment of the Service-approved biologist, the animal has escaped from the partially destroyed den.

4. Non-natal dens may be excavated at any time of the year natal dens shall be excavated only between August 15 and November 1.

5. Within ten (10) working days of the completion of earthmoving, California Department of Transportation will replace all excavated kit fox dens with artificial dens on a 2:1 basis. The location and design of the artificial dens will be approved by the Service prior to installation

U. Restoration and revegetation work associated with temporary effects shall be done using California endemic plant material from on-site or local sources (i.e., local ecotype). Plant materials from non-local sources shall be allowed only with written authorization from the Service. To the maximum extent practical (i.e., presence of natural lands), topsoil shall be removed, cached, and returned to the site according to successful restoration protocols. Loss of soil from run-off or erosion shall be prevented with straw bales, straw wattles, or similar means provided they do not entangle, block escape or dispersal routes of the San Joaquin kit fox.

V. As described in biological assessment and the *Project Description* of this biological opinion, fee title or conservation easements shall be obtained by the California Department of Transportation for 17.7885 acres of habitat for the San Joaquin kit fox. The California Department of Transportation shall obtain the written approval of the Service that the parcel(s) are suitable compensation lands for the San Joaquin kit fox prior to acquiring interest in those lands. The fee title or conservation easement shall be obtained by the California Department of Transportation at least sixty (60) calendar days prior to the date of initial groundbreaking, or on or before a date that the Service has agreed to in writing with the California Department of Transportation.

W. If conservation easements are used by the California Department of Transportation, they shall include, but not be limited to, provisions and responsibilities of the project proponent and the land trust organization approved by the Service for the protection of all habitats set aside including any future transfers of the easements or fee interest that may be anticipated. The easements shall specify the purposes for which it is established (*i.e.*, measures to minimize effects to the San Joaquin kit fox associated with the State Route 198/19th Avenue project). The California Department of Transportation shall provide the Service with a true copy of the recorded conservation easements within thirty (30) calendar days of its recordation. The conservation easements shall be held by a third party approved by the Service. The conservation easement shall include a list of prohibited activities that are inconsistent with the maintenance of the preserve for the listed species including, but not limited to:

1. leveling, grading, landscaping, cultivation, or any other alterations of existing topography for any purposes, including the exploration for, or development of, mineral resources;
2. placement of any new structures on the preserve, including buildings and billboards;
3. discharge, dumping, burning, or storing of rubbish, garbage, grass clippings, dredge material, household chemicals, or any other wastes or fill materials within the preserve;
4. building of any roads or trails within the preserve areas;
5. killing, removal, alteration, or replacement of any existing native vegetation except in Service-approved prescribed burning situations, or as otherwise authorized in writing by the Service;
6. activities that may alter the hydrology of the preserve and the associated watersheds, including but not limited to: excessive pumping of groundwater, manipulation or blockage of natural drainages, inappropriate water application or placement of storm water drains, etc. unless authorized in writing by the Service;
7. incompatible fire protection activities;
8. use of pesticides, herbicides, or rodenticides on the preserve or within the watershed that can contaminate the preserve except as authorized in writing by

the Service; and

9. introduction of any exotic species or species not native to the area, including aquatic species, except as approved by the Service.

X. In the event the California Department of Transportation seeks to obtain a conservation easement in lieu of fee title acquisitions for the purposes of satisfying the requirements of the terms and conditions of this biological opinion, the California Department of Transportation shall provide the language of the proposed conservation easements to the Service for prior review and approval. The conservation easements shall include language establishing a right of entry by the Service to determine compliance with the terms and conditions of this biological opinion and the terms of the conservation easements, as well as identifying the Service as a third party beneficiary with the standing to take whatever legal action is necessary to enforce the terms of this conservation easement. Should the California Department of Transportation make fee title acquisition of lands to satisfy the terms and conditions of this biological opinion, the California Department of Transportation shall encumber such lands with restrictive covenants that provide the same rights to the Service as will be established under the conservation easement described above. Such restrictive covenants shall be provided to the Service for prior review and approval before they are recorded against the conservation lands.

Y. If the California Department of Transportation plans to acquire fee title or a conservation easement for lands that are not in a Service-approved conservation bank, then at least sixty (60) calendar days prior to the date of initial ground breaking at the proposed State Route 198/ 19th Avenue project, the California Department of Transportation shall endow a Service-approved fund for monitoring and perpetual management and maintenance of the 17.7885 acres for the San Joaquin kit fox. The principal in the endowment must generate sufficient revenue to fully cover the costs of ongoing operations and management actions as described in the Service-approved management plan and this biological opinion, without the need to make use of the principal to adequately fund such expenditures. Specific actions funded by the endowment shall be addressed in the Service-approved management plan. The California Department of Transportation shall utilize an appropriate third party who has been approved by the Service to determine what amount of money is necessary for an endowment fund to adequately finance the monitoring and perpetual management and maintenance of the preserve for the San Joaquin kit fox. The California Department of Transportation shall empower the Service to access and expend such funds to implement Service-approved remedial measures in the event the responsible preserve managers fail to adequately implement the Service-approved management plan. The final determination of success or failure of the management plan shall be made solely by the Service. Prior to the date of initial groundbreaking at the State Route 198/19th Avenue, the California Department of Transportation shall provide the Service with documentation that: (1) funds for the perpetual management and maintenance of the 17.7885 acres for the San Joaquin kit fox have been transferred to the appropriate

third party approved by the Service; (2) the third party has accepted the funds and considers them adequate; and (3) that these funds have been deposited in an account (*i.e.*, endowment) that will provide adequate financing for the monitoring and perpetual management and maintenance of the 17.7885 acres for the San Joaquin kit fox.

2. The following Terms and Conditions implement Reasonable and Prudent Measure two (2):

A. If requested, before, during, or upon completion of ground breaking and construction activities, the California Department of Transportation shall allow access by Service and/or California Department of Fish and Game personnel to the project site to inspect project effects to the San Joaquin kit fox and its habitat.

B. The California Department of Transportation shall comply with the *Reporting Requirements* of this biological opinion.

Reporting Requirements

1. Before construction starts on a project, the Service shall be provided with the final documents, including but not limited to, recorded conservation easements, PAR analyses, management plans, or proof of purchase of credits. Please see draft guidance from the Service, *Selected Review Criteria for Conservation Banks and Section 7 Off Site Compensation* dated August 4, 2004, or Service guidance that supercedes this document.

4. A post-construction report detailing compliance with the project design criteria described under the *Description of the Proposed Action* section of this biological opinion shall be provided to the Service within 30 calendar days of completion of the project.

6. The California Department of Transportation shall notify the Service via electronic mail and telephone within one (1) working day of the death or injury to a San Joaquin kit fox and/or other listed species that occurs due to project related activities or is observed at the project site. Notification must include the date, time, location of the incident or of the finding of a dead or injured animal, and photographs of the specific animal. In the case of an injured animal, the animal shall be cared for by a licensed veterinarian or other qualified person. In the case of a dead animal, the individual animal should be preserved, as appropriate, and held in a secure location until instructions are received from the Service regarding the disposition of the specimen or the Service takes custody of the specimen. The Service contacts are Chris Nagano, Chief of the Endangered Species Division (Central Valley) at 916/414-6600, and Scott Heard, Resident Agent-in-Charge of the Service's Law Enforcement Division at 916/414-6660. The California Department of Fish and Game contact is Mr. Ron Schlorff at 916/654-4262.

7. Any contractor or employee who, during routine operations and maintenance activities inadvertently kills or injures a State listed wildlife species shall immediately report the incident to her or his supervisor or representative. The supervisor or representative must

contact the California Department of Fish and Game immediately in the case of a dead or injured State listed wildlife species. The California Department of Fish and Game contact for immediate assistance is State Dispatch at (916) 445-0045.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

The Service has developed the following conservation recommendations based, in part, on *The Recovery Plan for Upland Species of the San Joaquin Valley, California* (U.S. Fish and Wildlife Service 1998).

1. Sightings of any sensitive animal species should be reported to the California Natural Diversity Database of the California Department of Fish and Game. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

3. Locate, map, and protect existing populations of the San Joaquin kit fox (Recovery Plan Tasks 2.2.17 and 2.2.24).

4. Protect and create additional habitat for the San Joaquin kit fox in key portions of its range (Recovery Plan Tasks 2.1.19 and 5.1.5).

5. Gather additional data on population responses to environmental variation at representative sites in the San Joaquin kit fox's geographic range (Recovery Plan Tasks 3.2.21 and 3.2.22).

6. Determine appropriate habitat management and compatible land uses for the San Joaquin kit fox (Recovery Plan Task 4.5.7).

9. Provide habitat for bats, including surfaces for bat roosts on the underside of bridges and other structures whenever possible.

In order for the Service to be kept informed of conservation actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, we request notification of the implementation of any of the conservation recommendations.

REINITIATION NOTICE

This concludes formal consultation on the State Route 198/19th Avenue project. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and

if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

If you have any questions concerning this biological opinion on the State Route 198/ 19th Avenue project, please contact Brian Peterson or Chris Nagano at the letterhead address or at telephone 916/414-6630.

Sincerely,

Chris Nagano

for Ken Sanchez
Acting Field Supervisor

cc:
Brett Dickerson, FWS, Clovis, California
Carrie Bowen, Jennifer Taylor, Terry Marshall, California Department of Transportation, Fresno, California
Bill Loudermilk, Annette Tenneboe, Clarence Mayott, Dan Applebee, Jeff Single, California Department of Fish and Game, Fresno, California
Janice Gan, California Department of Fish and Game, Tracy, California
Dan Gifford ,California Department of Fish and Game, Lodi, California
Ron Schlorff, California Department of Fish and Game, Sacramento, California
Dee Warenycia, California Department of Fish and Game, Sacramento, California

Literature Cited

Archon, M. 1992. Ecology of the San Joaquin kit fox in western Merced County, California. M.A. thesis, California State University, Fresno, California, 62 pp.

Aubrey, K.B., G.M. Koehler, and J. R. Squires. 1999. Ecology of Canada lynx in southern boreal forests. *In* L.F. Ruggiero, K.B. Aubrey, S.W. Buskirk, G. Koehler, C. Krebs, K. McKelvey, and J. Squires (eds.). The scientific basis for lynx conservation. General Technical Report RMRS-GTR-30, U.S.D.A. Forest Service, Ogden, Utah.

Barnum, S. 1999. A programmatic agreement to minimize highway project impacts on Canada lynx (*Lynx canadensis*) in Colorado. Pages 67-74 *in* G.L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99, Florida Department of Transportation, Tallahassee.

Barrett, L. 1990. Annual review of animal rabies in California. 1989. California Veterinarian 44:52-54.

Beier, P. 1993. Determining minimum habitat areas and habitat corridors for cougars. Conservation Biology 7:940-108.

Bell, H. M. 1994. Analysis of habitat characteristics of San Joaquin kit fox in its northern range. Master Thesis. California State University, Hayward, California.

Benfenati, E., S. Valzacchi, G. Maniani, L. Airoldi, and R. Farnelli. 1992. PCDD, PCDF, PCB, PAH, cadmium, and lead in roadside soil: relationship between road distance and concentration. Chemosphere 24:1077-1083.

Bennett, A.F. 1991. Roads, roadsides, and wildlife conservation: a review. Pages 99-108 *in* D. A. Saunders and R. J. Hobbs (eds.). Nature conservation: the role of corridors. Surrey Beatty ad Sons, Melbourne, Australia.

Berry, W. H., J. H. Scrivner, T. P. O'Farrell, C. E. Harris, T. T. Kato, and P. M. McCue. 1987. Sources and rates of mortality of the San Joaquin kit fox, Naval petroleum reserve #1, Kern County, California, 1980-1986. U. S. Dept. of Energy Topical Report, EG&G/EM Santa Barbara Operations Report No. EGG 10282-2154. 34 pages.

Berry, W. H., W. G. Standley, T. P. O'Farrell, and T. T. Kato. 1992. Effects of military-authorized activities on the San Joaquin kit fox (*Vulpes velox macrotis*) at Camp Roberts Army National Guard Training Site, California. U. S. Department of Energy Topical Report No. EGG 10617-2159, EG&G/EM Santa Barbara Operations, National Technical Information Service, Springfield, Virginia.

Bondello, M. and B. Brattstrom. 1979. The experimental effects of off-road vehicle sounds on three species of vertebrates. Report to the Bureau of Land Management.

Briden, L.E., M. Archon, and D.L. Chesemore. 1992. Ecology of the San Joaquin kit fox, (*Vulpes macrotis mutica*) in western Merced County, California. Pages 81-88 *in* D.F. Williams, S. Byrne, and T.A.Rado (eds.). Endangered and Sensitive Species of the San Joaquin Valley, California. California Energy Commission, Sacramento, California.

Brody, A.J., and M.R. Pelton. 1989. The effects of roads on black bear movements in western North Carolina. Wildlife Society Bulletin 17:5-10.

Burglund, B. and T. Lindvall. 1995. Effects of Community Noise. Archives of the Center for Sensory Research 2(1): 1-195.

California Army National Guard, undated. unpublished data. Environmental Office, Camp Roberts, California.

California Department of Conservation. 1994. Division of Land Resource Protection Farmland Mapping and Monitoring Program, Sacramento, California.

_____ 1996. Division of Land Resource Protection Farmland Mapping and Monitoring Program, Sacramento, California.

_____ 1998. Division of Land Resource Protection Farmland Mapping and Monitoring Program, Sacramento, California.

_____ 2000. Division of Land Resource Protection Farmland Mapping and Monitoring Program, Sacramento, California.

California Department of Finance 2002. Human population history and trends in California counties. Accessed July 2003.

California Department of Fish and Game. 1980. At the crossroads, a report on California's endangered and rare fish and wildlife. Sacramento, California. 147 pp.

_____ 1990. Approved survey methodologies for sensitive species. San Joaquin kit fox. Fresno, California.

_____ 1999. Rodenticide use in Distribution and abundance of the San Joaquin kit fox, draft report by Heather M. Bell, Jeffrey A. Alvarez, Lee L. Eberhardt, and Katherine Ralls. Unpublished draft report.

_____ 2001. The status of rare, threatened, and endangered animals and plants of California. Annual Rep. for 2000, 225 pp.

_____ 2004. RAREFIND. California Natural Diversity Data Base, Sacramento, California.

California Department of Forestry and Fire Protection. 1988. California's Forests and Rangelands: growing conflict over changing uses. Forest and Rangeland Resources Assessment Program, Sacramento, California. 348 pp. & appendices.

Caughley, G., and Gunn, A. 1993. Dynamics of large herbivores in deserts: kangaroos and caribou. Oikos 67: 47-55.

Carbyn, L.N. 1989. Swift foxes in Canada. Recovery. Canadian Wildlife Service, Ottawa, Ontario. 1:8-9.

Carbyn, L.N., H.J. Armbuster, and C. Mamo. 1994. The swift fox reintroduction program in Canada from 1983 to 1992. Pages 247-270 *in* M.L. Bowles and C.J. Whelan (eds.). Restoration of endangered species: conceptual issues, planning and implementation. Cambridge University Press, Cambridge, Great Britain

Carbyn, L.N. 1998. Update, COSEWIC status report on swift fox (*Vulpes velox*). Committee on the Status of Endangered Wildlife in Canada. Ottawa, Ontario.

Castillo-Sanchez, C. 1999. Highways and wildlife conservation in Mexico: the Sonoran pronghorn at El Pinacate y Gran Desierto de Altar Biosphere Reserve on the Mexico-USA border. Pages 289-292 in G.L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99, Florida Department of Transportation, Tallahassee.

Clevenger, A. P., B. Chruszcz, and K. E. Gunson. 2003. Spatial patterns and factors influencing small vertebrate fauna road-kill aggregations. Biological Conservation 109: 15-26.

Clevenger, A.P. and N. Waltho. 1999. Dry culvert use and design considerations for small- and medium-sized mammal movement across a major transportation corridor. Pages 263-178 *in* G. L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the third international conference on wildlife ecology and transportaion. FL-ER-73-99, Florida Department of Transportation. Tallahassee, Florida.

Cornman, David. 2001. Effects of Noise on Wildlife. Nature Sound Society. San Francisco State University, San Francisco, California

Covell, D.F. 1992. Ecology of the swift fox (*Vulpes velox*) in southeastern Colorado. Master of Science thesis, University of Wisconsin, Madison, Wisconsin.

Cypher, B.L. 2000. Effects of roads on San Joaquin kit foxes: a review and synthesis of existing data. Endangered Species Recovery Program, Fresno, California, 59 pp.

Cypher, B. L., and Scrivner, J. H. 1992. Coyote control to protect endangered San Joaquin kit foxes at the Naval Petroleum Reserves, California. Pp. 42-47 *in* J. E. Borrecco and R. E.

Marsh (eds.). Proceedings of the 15th Vertebrate Pest Conference, March 1992, Newport Beach, California. University of California, Davis, California.

Cypher, B. L., and Spencer, K. A. 1998. Competitive interactions between coyotes and San Joaquin kit foxes. J. Mammalogy 79: 204-214.

Cypher, B. L., G. D. Warrick, M. R. Otten, T. P. O'Farrell, W. H. Berry, C. E. Harris, T. T. Kato, P. M. McCue, J. H. Scrivner, and B. W. Zoellick. 2000. Population dynamics of San Joaquin kit foxes at the Naval Petroleum Reserves in California. Wildlife Monographs.

Dalrymple, G.H., and N.G. Reichenbach. 1984. Management of an endangered species of snake in Ohio, USA. Biological Conservation 30:195-200.

Disney, M., and Spiegel, L. K. 1992. Sources and rates of San Joaquin kit fox mortality in western Kern County, California. Transactions of the Western Section, The Wildlife Society 28: 73-82.

EDAW. 2000. Current status of the San Joaquin kit fox and Tipton kangaroo rat at Delano II Prison Site. November 2000. Sacramento, California, 27 pp.

Egoscue, H.J. 1956. Preliminary studies of the kit fox in Utah. J. Mammalogy 37:351-357.

_____ 1962. Ecology and life history of the kit fox in Tooele County, Utah. Ecology 43:481-497.

Fahrig, Lenore. 1997. Relative effects of habitat loss and fragmentation on population extinction. Journal of Wildlife Management 61(3):603-610.

Forman, Richard T.T. 2000. Estimate of the area affected ecologically by the road system in the United States. Conservation Biology 14: 31-35.

Forman, Richard T.T. and Robert D. Deblinger. 2000. The ecological road-effect zone of a Massachusetts (U.S.A.) suburban highway. Conservation Biology 14: 36-46.

Forman, Richard T.T., Daniel Sperling, John A. Bissonette, Anthony P. Clevenger, Carol D. Cutshall, Virginia H. Dale, Lenor Fahrig, Robert France, Charles R. Goldman, Kevin Heanue, Julia A. Jones, Frederick J. Swanson, Thomas Turrentine, Thomas C. Winter. 2003. Road Ecology: Science and Solutions. Island Press: Washington, Covelo, London.

Frankham, R., and K. Ralls. 1998. Inbreeding leads to extinction. Nature 241:441-442.

Fresno Bee. 2003. article at www.fresnobee.com. Site accessed June 26, 2003.

Gerlach, G., and K. Musolf. 2000. Fragmentation of landscapes as a cause for genetic subdivision in bank voles. Conservation Biology 14:1066-1074.

Gonzalez, G., N. Miller, and C. Istre Jr. 1970. Influence of rocket noise upon hearing in guinea pigs. Aerospace Medicine 41: 21-25.

Grinnell, J. 1932. Habitat relations of the giant kangaroo rat. J. Mammalogy 13:305-320.

Grinnell, J., J.S. Dixon, and J.M. Lindsdale. 1937. Fur-bearing mammals of California. Vol. 2. University of California Press, Berkeley, California.

Hall, H. M. 1983. Status of the kit fox at the Bethany wind turbine generating (WTC) project site, Alameda County, California. California Department of Fish and Game, Sacramento, California.

Hersteinsson, P., and D.W. Macdonald. 1982. Interspecific competition and the geographical distribution of red and arctic foxes (*Vulpes vulpes* and *Alopex lagopus*). Oikos 64:505-515.

Hines, T.D. 1980. An ecology study of *Vulpes velox* in Nebraska. Master of Science thesis, University of Nebraska, Lincoln, Nebraska.

Hirano, T., M. Kiyota, I. Aiga. 1995. Physical effects of dust on leaf physiology of cucumber and kidney bean plants. Environmental Pollution 89(3): 255-261.

Holland, R.F. 1986. Preliminary descriptions of terrestrial natural communities of California. California Department of Fish and Game, Sacramento, California 156 pp.

Jameson, E.W. and H.J. Peeters. 1988. California Mammals. University of California Press. Berkeley, California.

Jensen, C.C. 1972. San Joaquin kit fox distribution. U.S. Fish and Wildlife Service, Sacramento, California, Unpubl. Rep., 18 pp.

Jones and Stokes Associates. 1989. Draft environmental impact report: Vasco Road and Utility Relocation Project SCH#: 89032123. Prepared for Contra Costa Water District, Concord, California.

Kitchen, A.M. E.M. Gese, and E.R. Schauster. 1999. Resource partitioning between coyotes and swift foxes: space, time, and diet. Canadian J. Zoology 77:1645-1656.

Knapp, D.K. 1979. Effects of agricultural development in Kern County, California, on the San Joaquin kit fox. In 1977 Final Report, Project E-1-1, Job V-1.21, Non-game Wildlife Investigations, California Department of Fish and Game, Sacramento, California, 48 pages.

Knapp, D.K., and D.L. Chesemore. 1992. Impact of agricultural development on San Joaquin kit foxes , Kern County, California. Page 378 *in* D.F. Williams, S. Byrne, and T.A. Rado (eds.). Endangered and sensitive species of the San Joaquin Valley, California (California Energy Commission, Sacramento, California ,388 pp.

Komanoff, C. and H. Shaw. 2000. Drowning in Noise: Noise costs of jet skis in America. The Noise Pollution Clearinghouse. Montpelier, Vermont.

Koopman, M.E., B.L. Cypher, and J.H. Scrivner. 2000. Dispersal patterns of San Joaquin kit foxes (*Vulpes macrotis mutica*). J. Mammalogy 81:213-222.

Kushland, J.A. 1988. Conservation and management of the American crocodile. Environmental Management 12:777-790.

La Paloma Generating Company, LLC. 1998. Biological assessment, La Paloma Generating Project. Submitted to the U.S. Fish and Wildlife Service, September 18, revised December 1.

Lande, R. 1988. Genetics and demography in biological conservation. Science 241:1455-1460.

Laughrin, L. 1970. San Joaquin kit fox: its distribution and abundance. California Dept. Fish and Game, Sacramento, Wildlife Management Branch, Admin. Rep. No. 70-2, 20 pp.

Lewis, J.C., K.L. Sallee, and R.T. Golightly, Jr. 1993. Introduced red fox in California. California Dept. Fish and Game, Sacramento, Nongame Bird and Mammal Sec., Rep. 93-10, 70 pp.

Lovallo, M.J., and E.M. Anderson. 1996. Bobcat movements and home ranges relative to roads in Wisconsin. Wildlife Society Bulletin 24:71-76.

MacArthur, R.A., R.H. Johnston, and V. Geist. 1979. Factors influencing heart rate in free ranging bighorn sheep: a physiological approach to the study of wildlife harassment, Canadian J. Zoology 57:2010-2021.

Macdonald, D.W., and D.R. Voigt. 1985. The biological basis of rabies models. Pp. 71-108 *in* P.J. Bacon (ed.). Population dynamics of rabies in wildlife Academic Press, London, Great Britain.

Maehr, D.S., E.D. Land, and M.E. Roelke. 1991. Mortality patterns of panthers in southwest Florida. Proceedings of the annual conference of the Southeastern Association of Fish and Wildlife Agencies 45:201-207.

May, R.M. 1986. The cautionary tale of the black-footed ferret. Nature 320:13-14.

McCue, P.M., and T.P. O'Farrell. 1988. Serological survey for selected diseases in the endangered San Joaquin kit fox (*Vulpes macrotis mutica*). J. Wildlife Diseases 24(2)274-281.

McGrew, J. C. 1979. *Vulpes macrotis*. Mammal Species 123:1-6.

Miller, D.S., B.G. Campbell, R.G. McLean, E. Campos, and D.F. Covell. 1998. Parasites of swift fox (*Vulpes velox*) from southeastern Colorado. Southwestern Naturalist 43:476-479.

Morrell, S. H. 1970. Life history study of the San Joaquin kit fox. California Department of Fish and Game, Federal Aid in Wildlife Restoration Project W-54R-2. Sacramento, California.

Morrell, S.H. 1972. Life history of the San Joaquin kit fox. California Department of Fish and Game 58:162-174.

_____ 1975. San Joaquin kit fox distribution and abundance in 1975. California Department of Fish and Game, Sacramento, California, Wildlife Management Branch, Administrative Report No. 75-3, 28 pp.

Mumme, R.L., S.J. Schoech, G.E. Woolfenden, and J.W. Fitzpatrick. 1999. Life and death in the fast lane: demographic consequences of road mortality in the Florida scrub jay. Conservation Biology 14:501-512.

National Academy of Science. 2003. Ecological Impacts of Road Density (Project Identification Number BEST-K-00-03-A) in The Current Projects System. Http://www4.nas.edu/webcr.nsf/ProjectScopeDisplay/BEST-K-00-03-A. Site accessed June 14, 2003.

National Institutes of Health (NIH). 1990. Noise and hearing loss. NIH Consensus Statement, January 22-24; 8(1):1-24.

National Park Service (NPS). 1994. Report on effects of aircraft overflights on the National Park System. Report to Congress. Technical Report No. NPSD1062.

O'Farrell, T. P. 1984. Conservation of the endangered San Joaquin kit fox (*Vulpes macrotis mutica*) on the Naval Petroleum Reserves, California. Acta Zool. Finnica 172:207-208.

O'Farrell, T. P. and L. Gilbertson. 1979. Ecological life history of the desert kit fox in the Mojave Desert of southern California. Final Report. Bureau of Land Management, Riverside, California.

O'Farrell, T. P., T. Kato, P. McCue, and M. L. Sauls. 1980. Inventory of San Joaquin kit fox on Bureau of Land Management lands in southern and southwestern San Joaquin Valley. Final Report. EG&G, U. S. Department of Energy, Goleta, California. EGG 1183-2400.

O'Farrell, T. P., and P. McCue. Inventory of San Joaquin kit fox on Bureau of Land Management lands in the western San Joaquin Valley. Final report. EG&G. U. S. Department of Energy, Goleta, California. EGG-1183-2416.

O'Neal, G.T., J.T. Flinders, and W.P. Clary. 1987. Behavioral ecology of the Nevada kit fox (*Vulpes macrotis nevadensis*) on a managed desert rangeland. Pages 443-481 *in* H.H. Genoways (ed.). Current Mammalogy Vol. 1. Plenum Press, New York, New York.

Orloff, S., L. Spiegel, and F. Hall. 1986. Distribution and habitat requirements of the San Joaquin kit fox in the northern extreme of its range. Trans. Western Section, The Wildlife Society 22:60-70.

Ottawa-Carleton, L. F. 2001. Animal populations and roads. *In* 2001 Proceedings, International Conference on Ecology and Transportation. Center for Transportation and the Environment, Institute for Transportation Research and Education, North Carolina State University, North Carolina.

Oxley, D.J., M.B. Fenton, and G.R. Carmody. 1974. The effects of roads on populations of small mammals. J. Applied Ecology 11:51-59.

Peters, P.N. 1965. Temporary shifts in auditory thresholds of chinchilla after exposure to noise. J. Acoustical Society of America 37(5): 831-833.

Ralls, K., and P. J. White. 1995. Predation on endangered San Joaquin kit foxes by larger canids. J. Mammalogy 276:723-729.

Ralls, K., P. J. White, J. Cochram, and D. B. Siniff. 1990. Kit fox – coyotes relationships in the Carrizo Plain Natural Area. Annual report to the U. S. Fish and Wildlife Service. Department of Zoological Research, Smithsonian Institution, Washington, D.C.

Randall, J.A. 1997. Social organization communication in *Dipodomys ingens*. Report for Research during 1995-96, Permit PR-799486, on the endangered giant kangaroo rat, *Dipodomys ingens* to U.S. Fish and Wildlife Service.

Reh, W., and A. Seitz. 1990. The influences of land use on the genetic structure of populations of the common frog *Rana temporaria*. Biological Conservation 54:239-249.

Reilly, K., and D. Mangiamele. 1992. California rabies surveillance. 1991. California Veterinarian 46:47-51.

Rudolph, D.C., S.J. Burgdorf, R.N.Conner, and J. Dickson. 1998. The impact of roads on the timber rattlesnake (*Crotalus horridus*) in eastern Texas. Pages 236-240 *in* G.L. Evink, P. Garrett, D. Ziegler, and J. Berry (eds.). Proceedings of the international conference on wildlife ecology and transportation. FL-ER-69-98. Florida Department of Transportation, Tallahassee, Florida.

Rudolph, D.C., S.J. Burgdorf, R.N. Conner, and R.R. Schaefer. 1999. Preliminary evaluation of the impact of roads and associated vehicular traffic on snake populations in eastern Texas. Pages 129-136 *in* G.L. Evink, P. Garrett, and D. Zeigler (eds.). Proceedings of the third international conference on wildlife ecology and transportation. FL-ER-73-99. Florida Department of Transportation, Tallahassee, Florida.

Saccheri, I., M. Kuussaari, M. Kankare, P. Vikman, W. Fortelius, and I. Hanski. 1998. Inbreeding and extinction in a butterfly population. Nature 392:491-494.

Schultz, L.J., and L.R. Barrett. 1991. Controlling rabies in California 1990. California Vet. 45:36-40.

Scrivner, J. H., T. P. O'Farrell, and T. Kato. 1987. Dispersal of San Joaquin kit foxes, , on Naval Petroleum Reserve # 1, Kern County, California. EG&G, Goleta, *Vulpes macrotis mutica* California. EGG 10282-2190.

Scrivner, J.H., T.P. O'Farrell, and K.L. Hammer. 1993. Summary and evaluation of the kit fox relocation program, Naval Petroleum Reserve #1, Kern County, California. U.S. Department of Energy Topical Report, EG&G/EM Santa Barbara Operations Report No. EGG 10282-2168. 26 pages.

Sovada, M.A.., C.C. Roy, J.B. Bright, and J.R. Gillis. 1998. Causes and rates of mortality of swift foxes in western Kansas. Journal of Wildlife Management 62:1300-1306.

Soule, M. 1990. The onslaught of alien species and other challenges in the coming decades. Conservation Biology 4:233-239.

Spencer, K.A., W.H. Berry, W.G. Standley, and T. P. O'Farrell. 1992. Reproduction of the San Joaquin kit fox on Camp Roberts Army National Guard Training site, California. U.S. Department of Energy Topical Report EGG 10617-2154.

Spiegel, L.K. 1996. Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission Publ. No P700-96-003. California Energy Commission Publication Unit, Sacramento, California.

Spiegel, L.K. and M. Disney. 1996. Mortality sources and survival rates of San Joaquin kit foxes in oil-developed and undeveloped lands of southwestern Kern County, California. Pages 71-92 *in* L.K. Spiegel (ed.). Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, California

Spiegel, L.K. and J. Tom. 1996. Reproduction of San Joaquin kit fox undeveloped and oil-developed habitats of Kern County, California. Pages 53-69 *in* L.K. Spiegel (ed.). Studies of the San Joaquin kit fox in undeveloped and oil-developed areas. California Energy Commission, Sacramento, California.

Standley, W.G., and P.M. McCue. 1992. Blood characteristics of San Joaquin kit fox (*Vulpes velox macrotis*) at Camp Roberts Army National Guard Training Site, California. U.S. Dept. of Energy Topical Rep., EG&G/EM Santa Barbara Operations Report No. EGG 10617-2160.

Standley, W.G., W.J. Berry, T.P. O'Farrell, and T.T. Kato. 1992. Mortality of San Joaquin kit fox (*Vulpes macrotis mutica*) at Camp Roberts Army National Guard Training Site, California. Rep. No. EGG 10617-2157, EG&G Energy Measurements, Goleta, California, 19 pp.

Tellman, B. 1997. Exotic pest-plant introduction in the American southwest. Desert Plants 13:3-10.

Theobald, D.M., D. Schrupp, and L.E. O'Brien. 2002. A method to assess risk of habitat loss to development: a Colorado case study. U.S. Geological Survey, Gap Analysis Bulletin No. 10., 8 pp.

Trombulak, S.C., and C.A. Frissell. 2000. The ecological effects of roads on terrestrial and aquatic communities: a review. Conservation Biology 14:18-30.

Turbak, G. 1999. Can American motorists yield the right-of-way to wild creatures? National Wildlife 37(6):66-68.

U.S. Department of Energy and Chevron U.S.A. Production Company. 1996. Annual report FY95, endangered species and cultural resources program, Naval Petroleum Reserves in California, Tupman, California. Prepared by EG&G Energy Measurements, Inc.

U.S. Fish and Wildlife Service. 1983. San Joaquin kit fox recovery plan. Portland, Oregon, 84 pp.

_____ 1993. Biological opinion on effects of 16 vertebrate control agents on threatened and endangered species. Washington, DC, 172 pp.

_____ 1994. The Impact of Federal Programs on Wetlands Vol. II, A Report to Congress by the Secretary of the Interior, Washington D.C. March 1994.

_____ 1995a. Biological opinion for interim water renewal contracts, Central Valley, California, with the Bureau of Reclamation, Sacramento, California. Sacramento, California, 160 pp.

_____ 1996b. Formal consultation on the oil and gas programmatic in Kings and Kern Counties, California, with the Bureau of Land Management, Bakersfield Office. Sacramento Field Office, Sacramento, California. File No. 1-1-96-F-0036.

_____ 1998. Recovery plan for upland species of the San Joaquin Valley, California. Portland, Oregon. 319 pp.

_____ 1999. National Pesticide Consultation with the U.S. Environmental Protection Agency. Sacramento, California.

_____ 1999. U. S. Fish and Wildlife Service San Joaquin kit fox survey protocol for the northern range. Sacramento, California

_____ 2000. Biological Opinion for the Interim Water Contract Renewals, with the Bureau of Reclamation, Sacramento, California. Sacramento, California. File No. 1-1-00-F-0056,

_____ 2001. Dissemination of standard recommendations for the protection of the San Joaquin kit fox prior to or during ground disturbance [attached recommendations dated 1999]. From Field Supervisor, Sacramento Fish and Wildlife Office, Sacramento, California. February 15.

Van der Zande, A.N., W.J. der Keurs, and W.J. Van der Weijden. 1980. The impact of roads on the densities of four bird species in an open field habitat - evidence of a long-distance effect. Biological Conservation 18: 299-321.

Van Dyke, F.G., R.H. Brocke, and H.G. Shaw. 1986. Use of road track counts as indices of mountain lion presence. J. Wildlife Management 50:102-109.

Warrick, G.D., and B.L. Cypher. 1998. Factors affecting the spatial distribution of San Joaquin kit foxes. J. Wildlife Management, 62:707-717.

Weiss, S.B. 1999. Cars, cows, and checkerspot butterflies: nitrogen deposition and management of nutrient-poor grasslands for a threatened species. Conservation Biology 13:1476-1486.

White, P.J., and R.A. Garrott. 1997. Factors regulating kit fox populations. Canadian J. Zoology 75:1982-1988.

_____ 1999. Population dynamics of kit foxes. Canadian J. Zoology 77:486-493.

White, P.J., and K. Ralls. 1993. Reproduction and spacing patterns of kit foxes relative to changing prey availability. J. Wildlife Management, 57:861-867.

White, P.J., K. Ralls, and C.A. Vanderbilt-White. 1995. Overlap in habitat and food use between coyotes and San Joaquin kit foxes. Southwestern Naturalist 40:342-349.

White, P.J., C.A. Vanderbilt-White, and K. Ralls. 1996. Functional and numerical responses of kit foxes to a short-term decline in mammalian prey. J. Mammal. 77(2):370-376.

White, P.J., W.H. Berry, J.J. Eliason, and M.T. Hanson. 2000. Catastrophic decrease in an isolated population of kit foxes. Southwest Naturalist 45(2):204-211.

Williams, D.F. 1985. A review of the population status of the Tipton kangaroo rat, *Dipodomys nitratoides nitratoides*. U.S. Fish and Wildlife Service, Sacramento, Endangered Species Office, California, Final Rep., 44 pp.

_____ 1989. Letter to R. Schlorff, California Department of Fish and Game, Sacramento, California, 2pp.

_____ 1992. Geographic distribution and population status of the giant kangaroo rat, *Dipodomys ingens* (Rodentia, Heteromyidae). H.H. Genoways in Endangered and sensitive species of the San Joaquin Valley, California. Pages 301-328 *in* D.F. Williams, S. Byrne, and T.A. Rad (eds.). California Energy Commission, Sacramento, California, 388 pp.

Wydeven, A. P., D. J. Mladenoff, B.E. Kohn. 2001. Road density as a factor in habitat selection and other carnivores in the Great Lakes region. Endangered Species Update, University of Michigan, East Lansing, Michigan.

Young, L. S. 1989. Effects of agriculture on raptors in the western United States: an overview. Proc. West. Raptor Manage. Symp. And Workshop. Nat. Sci. and Tech. Ser. 12.

Zoellick, B. W., T. P. O'Farrell, and T. T. Kato. 1987. Movements and home range of San Joaquin kit foxes on the Naval Petroleum Reserves, Kern County, California. Rep. No. EGG 10282-2184. EG&G Energy Measurements. Goleta, California. 38 pp.