GEOTECHNICAL DESIGN & MATERIALS REPORT
WILLOW ROAD/ROUTE 101 INTERCHANGE AND WILLOW ROAD EXTENSION
SAN LUIS OBISPO COUNTY, CALIFORNIA
05-SLO-101 5.8/6.9 EA 474503
(100% PS&E)

For

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April 30, 2010

Job No.: 203125.GD1

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Materials Testing ■
Construction Inspection ■

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Job No.: 203125.GD1
April 30, 2010

Attn: Mr. Keith Meyer:

Sub: GEOTECHNICAL DESIGN & MATERIALS REPORT
Willow Road/Route 101 Interchange & Willow Road Extension
San Luis Obispo County, CA
05-SLO-101 5.8/6.9 EA 474503 (100% PS&E)

Dear Mr. Meyer:

Transmitted herewith is the Geotechnical Design & Materials Report for the subject project (Caltrans' right-of-way) including Willow Road extension between Hetrick Avenue and N. Thompson Avenue (County's right-of-way). The report was prepared in accordance with the scope of work outlined in our proposal. The report is for submittal to Caltrans for their review and approval.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning our findings or conclusions, please feel free to contact this office at (408) 452-9000.

Very truly yours,
PARIKH CONSULTANTS, INC.

Gary Parikh, P.E., G.E., 666
Project Manager

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"Approved as to impact on State facilities and conformance with applicable State standards and practices, and the technical oversight were performed as described in the California Department of Transportation A&E Consultant Services Manual."

Caltrans_____

Title_____

Date_____

Caltrans_____

Title_____

Date_____

TABLE OF CONTENTS

Page No.

1. Introduction 1

2. Existing Facilities and Proposed Improvements 2

3. Pertinent Reports and Investigation 3

4. Physical Setting 3

   4.1 Climate 3

   4.2 Topography and Drainage 3

   4.3 Man-Made and Natural Features of Engineering and Construction Significance 4

   4.4 Regional Geology and Seismicity 4

5. Exploration 4

   5.1 Drilling and Sampling 4

   5.2 Geologic Mapping 7

   5.3 Geophysical Studies 7

   5.4 Instrumentation 7

   5.5 Exploration Notes 7

6. Geotechnical Testing 7

   6.1 In-Situ Testing 7

   6.2 Laboratory Testing 7

7. Geotechnical Conditions 8

   7.1 Site Geology 8

      7.1.1 Lithology 9

      7.1.2 Structure 9

TABLE OF CONTENTS (Cont.)

Page No.

7.1.3 Existing Slope Stability 9

7.2 Subsurface Soil Conditions 9

7.3 Water 10

7.3.1 Surface Water 10

7.3.1.1 Scour 10

7.3.1.2 Erosion 11

7.3.2 Groundwater 11

7.4 Project Site Seismicity 12

7.4.1 Ground Motions 12

7.4.2 Ground Rupture 13

8. Geotechnical Analyses and Design 13

8.1 Dynamic Analysis 13

8.1.1 Parameter Selection 13

8.1.2 Analysis 14

8.1.3 Liquefaction Potential 14

8.2 Cuts and Excavations 15

8.2.1 Stability 16

8.2.2 Rippability 16

8.2.3 Grading Factor 16

8.3 Embankments 17

8.3.1 Evaluation of Embankment Settlements 17

TABLE OF CONTENTS (Cont.)

Page No.

8.3.2 Evaluation of Embankment Stability 17

8.3.3 Existing utilities under the proposed Embankment 17

8.4 Earth Retaining Systems 17

8.5 Culverts 19

8.5.1 Corrosion Investigation 19

8.6 Minor Structure Foundations 23

9. Pavement Structural Sections 23

10. Material Sources 27

11. Material Disposal 27

12. Construction Considerations 27

12.1 Construction Advisories 27

12.2 Construction Consideration that Influence Specifications 28

12.3 Construction Monitoring and Instrumentation 29

12.4 Hazardous Waste Considerations 29

12.5 Differing Site Conditions 29

13. Recommendations and Specifications 29

13.1 Summary of Recommendations 29

13.2 Recommended Materials Specifications 30

13.2.1 Standard Specifications 30

13.2.2 Special Provisions 30

14. Investigation Limitations 31

References

LIST OF TABLES

Table		Page No.
1A	Summary of Borings (for Pavement Design)	6
1B	Summary of Borings (for Retaining Walls, Ramps and UC Structure)	6
2	Summary of Groundwater Elevations	11
3	Earthquake Data	12
4	Summary of Proposed Retaining Walls	18
5A	Summary of Corrosion Test Results (Caltrans' R/W)	20
5B	Summary of Corrosion Test Results (County's R/W)	20
6	Drainage System Summary for Corrosion Analysis (AltPipe)	21
7	Summary of Pavement Coring Data	23
8A	Summary of R-Value Test Results (Caltrans' R/W)	24
8B	Summary of R-Value Test Results (County's R/W)	25
9A	Structural Pavement Structural Sections (Caltrans' R/W)	26
9B	Structural Pavement Structural Sections (County's R/W)	26
10	Sources of Imported Borrow	27

PLATES

Project Location Map ..... Plate 1

Site Plan ..... Plates 2A thru 2E

Geologic Map ..... Plate 3A

Geologic Section C-C' ..... Plate 3B

Fault Map ..... Plate 4

ARS Design Curve ..... Plate 5

APPENDICES

Appendix A

Log of Test Borings
Willow Road/Route 101 Interchange (Caltrans Right-Of-Way)
Nipomo Creek Bridge & Willow Road Extension at Route 101 (County's Right-Of-Way)

Appendix B

Laboratory Tests ..... Plate B-1
Plasticity Chart ..... Plate B-2
Grain Size Distribution Curves ..... Plates B-3A thru B-3J
R-Value Tests ..... Plates B-4A thru B-4G
Unconfined Compressive Strength (Cal Test 373 of Lime Treated Sample) ..... Plate B-5A
Corrosion Tests ..... Plates B-6A thru B-6M

Appendix C

Slope Stability Evaluation C-1
Retaining Wall Bearing Capacity Evaluation C-2
Pavement Structural Sections Design C-3
AltPipe Analysis Results C-4
CPT Data Correlation & Liquefaction Analysis Results C-5
Pictures of Pavement Coring C-6

Appendix D

Results of Geophysical Survey (NORCAL Consultants, March 27, 2007)

Appendix E

Review Comment & Response Form (Responses for 30% Comments of 2/27/2009 are incorporated into 65% Comments & Response of 9/11/2009)

Amendment Letter for Pavement Sections dated April 22, 2010 (for Response & Comment on 2nd submittal of 65% PS&E)

GEOTECHNICAL DESIGN & MATERIALS REPORT
WILLOW ROAD/ROUTE 101 INTERCHANGE AND
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

1. INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed Interchange of Willow Road at Route 101 and Willow Road Extension (Hetrick Avenue to N. Thompson Avenue) in Nipomo, an unincorporated area located in southwestern San Luis Obispo County, California. The work was performed generally in accordance with the scope of work as per our agreement. The general location of the project site and its vicinity are shown on the Location Map, Plate 1 and Site Plan, Plate 2.

This report addresses the design of embankment ramps, structural pavement sections, retaining walls, and corrosion recommendations. The investigation included review of readily available soils and geologic literature pertaining to the site, site reconnaissance, obtaining representative soil samples and logging soil materials encountered in exploratory borings, laboratory testing of the representative soil samples, performing engineering analyses, and preparation of this report.

The purpose of this report is to document subsurface geotechnical conditions, provide analyses of anticipated site conditions as they pertain to the project described herein, and to recommend design and construction criteria for the roadway portions of the project. This report also establishes a geotechnical baseline to be used in assessing the existence and scope of changed site conditions, if any.

The geotechnical recommendations presented in this report are intended for use by the project roadway design engineer, construction personnel, bidders and contractors for information and reference purposes only and should not be construed as project specifications.

Due to limitations inherent in geotechnical investigations, it is neither uncommon to encounter unforeseen variations in the soil conditions during construction nor is it practical to determine all such variations during an acceptable program of drilling and sampling for a project of this scope. Such variations, when encountered, generally require additional engineering services to attain a properly constructed project. We, therefore, recommend that a contingency fund be provided to accommodate any additional charges resulting from technical services that may be required during construction.

2. EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

The existing facility includes Highway 101, a 4-lane freeway, generally trending in the northwest/southeast direction. The surrounding areas are relatively level open lands. The area immediately west of Route 101 is moderately populated with residential dwellings, while the area immediately east of route 101 is open agricultural fields and an existing nursery is located at the southeast corner of the proposed interchange. Also there is an existing undercrossing (as local farm access) structure to the south of the proposed interchange.

Based on the plans provided by Rajappan & Meyer Consulting Engineers Inc., the project consists of extension of the future Willow Road from Hetrick Avenue to Route 101 and the North Frontage Road connecting to Sandydale Drive. The road extension will continue eastbound with an interchange at Route 101, an undercrossing under the existing Route 101, a bridge crossing over Nipomo Creek, and ends by joining at grade with the existing North Thompson Avenue. This report covers the results of our geotechnical engineering investigation for the proposed Willow Road Interchange at Route 101 (Caltrans' right-of-way), and the planned Willow Road Extension from Hetrick Avenue to N. Thompson Avenue (County's right-of-way).

Based on the layout plans for Willow Road at Route 101 Interchange provided to us from Rajappan & Meyer, the interchange is comprised of two on-ramps and two off-ramps to Route 101 from the proposed Willow Road Extension. The interchange limits will be approximately 3,700 feet in length along Route 101 from Sta. 333+49 to Sta. 370+38. The northbound off- and on-ramps will require the construction of three retaining walls along the ramp to facilitate the grade change from the existing highway to Willow Road. The other ramp areas will be constructed on open cut and fill slopes.

Our recommendations presented in this report are based on the above information. Any major deviation should be reported to us for consideration. Foundation recommendations for the undercrossing structure, which is part of the interchange project, are addressed in a separate report.

3. PERTINENT REPORTS AND INVESTIGATION

We have referred to the as-built Log of Test Borings of the Tefft Street OC/Route 101 (Br. No. 49-133) located at approximately 1.6 miles southeast of the project site. However, because of its distance from our current project site, the Tefft Street as-built results were only used as a reference.

4. PHYSICAL SETTING

4.1 Climate

The project site is located in the southwestern part of San Luis Obispo County, California. The climate at the project site is influenced by the Pacific Ocean and can generally be characterized as Mediterranean, with warm, dry summers and cooler, relatively damp winters. The average temperature ranges in the project vicinity are from 52.2° F to 74.4° F in summer and from 38.8° F to 63.1° F in winter. Maximum summertime temperatures generally reach the high 80's and 90's whereas minimum winter temperatures can range down to the low 20's. The average annual precipitation in the area ranges between 15 and 28 inches, of which about 95% of the total precipitation falls between October and April. 1

4.2 Topography and Drainage

The topography of the project site consists of gently undulating older sand dune deposits. The project area is nearly level to gently sloping and is characterized by open flat areas. The project area is located within the Nipomo Creek watershed area leading to the Santa Maria River. As described in the Natural Resources Conservation Service (NRCS) Soil Survey, the soil is considered well drained. Nipomo Creek is located approximately 500 feet to the northeast of the project site.

General drainage condition pertaining to the site was reviewed with the reference obtained from National Soil Survey; Natural Resources Conservative Service (NRCS), USAD, and Web Soil Survey 1.1 URL: http://websoilsurvey.nrcs.usda.gov. Based on this Soil Survey Map (a copy of the excerpt is attached in Plate 3C), soil at the project site mainly consist of Oceano Sand (184) with permeability of 6 – 20 in/hr.

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[1] Information extracted from world wide web (Worldclimate.com)

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

The subject was considered and was determined to be not applicable to the project.

4.4 Regional Geology and Seismicity

The proposed project lies within the southwestern portion of San Luis Obispo County. General geologic features pertaining to the site were evaluated by reference to the geology map titled "Generalized Geology of the Arroyo Grande-Nipomo Mesa Area" by the Department of Water Resources, Southern District, 2002. The accompanied geologic section C-C' was also referenced in our evaluation. Based on the map and the section, the subject site is generally underlain by older dune sand. The bedrock in the area is typical of the Monterey and Franciscan formations of the California Coastal Range and is composed primarily of shale, chert, and other mélange components (Chipping 1985). The geologic map and the geologic section C-C' are shown on Plates 3A and 3B, respectively.

The project site is located within a seismically active region. A Fault Map, showing the site location relative to the major active faults in the vicinity, is presented on Plate 4. Significant earthquakes, which have occurred in this area, are generally associated with crustal movements along well-defined active fault zones. As per Caltran map, faults in the vicinity of the site include the Santa Maria River-Foxen Canyon, Oceano, Los Osos, Casmalia, and Oceanic-West Huasna. San Luis Obispo County Local Hazard Mitigation Plan (LHMP) has also referenced the Wilmar Avenue Fault as a potential active fault. This fault is mapped as a Northwest trending fault (late Quaternary) located along/near Nipomo Creek to the east of the project area.

5. EXPLORATION

5.1 Drilling and Sampling

Based on the preliminary plans, discussions with the design team, and readily available geotechnical data in the area, 21 borings were drilled at selected locations to depths ranging from 10 to 90 feet below the existing ground surface for the proposed interchange in Caltrans' Right-Of-Way.

- Borings A-07-101 through A-07-108, A-07-110 through A-07-117, and A-09-112A & A-09-114A (18 borings) were drilled to depths ranging from 10 ft to 30 ft and collect bulk samples for the pavement design, and ramps;

- Borings A-07-009 and CPT-07-002 were drilled for the design of retaining walls for the northbound off ramp from Route 101 to Willow Road. These borings were drilled to approximate depths of 30 ft to 60 ft;

- Borings A-07-001, A-07-002 and CPT-07-001 were drilled in the vicinity of the proposed Willow Road Undercrossing. The borings were also used for the retaining walls. These borings were drilled to approximate depths of 90 ft below the existing ground surface.

Within the County's right-of-way for the Willow Road extension between Hetrick Avenue and N. Thompson Avenue, additional 10 borings were explored.

The approximate locations of these borings are shown on the attached Site Plans, Plates 2A through 2E. The detail results of the field exploration are presented in the LOTB in Appendix A. The test borings were advanced using a truck-mounted drill rig using hollow stem auger drilling method. Selected samples were obtained from 2.5-inch I.D. (Modified California, MC) and 1.4-inch I.D. (Standard Penetration Test, SPT) samplers at various depths. The samplers were driven into subsurface soils under the impact of a 140-pound hammer having a free fall of 30 inches. The blow counts are presented on the Log of Test Boring (LOTB) in Appendix A. (When correlating standard penetration data, the blow counts for the Modified California Sampler may be converted to equivalent SPT blow counts by multiplying a conversion factor of 0.65.) The samples were sealed and transported to our laboratory for further evaluation and testing. The field investigation was conducted under the supervision of our field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation.

The descriptions of the soil materials encountered in the exploratory borings and relevant boring information are presented on the LOTB attached in Appendix A. The laboratory test methods and results are presented in Appendix B. The logs presented in Appendix A were prepared from the field logs which were edited after visual re-examination of the soil samples in the laboratory and results of classification tests on selected soil samples as indicated on the LOTB.

TABLE 1A: SUMMARY OF BORINGS (FOR PAVEMENT DESIGN)

Boring No.	Station (ft)	Offset (ft)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Soil Description
A-07-101	"U" Line 316+00	50 Rt.	10	358	Silty Sand
A-07-102	"U" Line 326+05	80 Rt.	10	361	Silty Sand
A-07-103	"U" Line 330+00	60 Lt.	10	362.5	Silty Sand
A-07-106	"U" Line 339+50	60 Lt.	10	366	Silty Sand
A-07-110	"U" Line 345+85	60 Lt.	10	369	Silty Sand
A-07-111	"U" Line 351+30	150 Lt.	30	375	Silty Sand
A-07-112	"F2" Line 352+75	20 Lt.	10	379	Silty Sand
A-07-113	"U" Line 354+15	70 Rt.	10	371	Silty Sand
A-o7-114	"U" Line 360+10	80 Lt.	10	374	Silty Sand
A-07-115	"U" Line 363+15	50 Rt.	10	370	Silty Sand
A-07-116	"U" Line 370+20	70 Lt.	10	377.5	Silty Sand
A-07-117	"U" Line 372+80	50 Rt.	10	380.5	Silty Sand

TABLE 1B: SUMMARY OF BORINGS (FOR RETAINING WALLS, RAMPS, AND UNDERCROSSING STRUCTURE)

Boring No.	Station (ft)	Offset (ft)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)
A-07-104	"U" Line 334+05	50 Rt.	30	364.5	337
A-07-105	"U" Line 337+00	50 Rt.	30	365.5	335
A-07-107	"U" Line 340+00	50 Rt.	35	366	338
A-07-108	"U" Line 342+10	50 Rt.	30	365	339
A-07-009	"U" Line 345+70	60 Rt.	30	360	340.5
CPT-07-002	"U" Line 345+12	49 Rt.	60	360	-
A-09-112A	"U" Line 351+45	405 Lt.	30	377	-
A-09-114A	"U" Line 356+50	305 Lt.	30	385	-
A-07-001	"U" Line 350+00	0	90	370	341.0
A-07-002	"U" Line 352+30	0	90	371	341.4
CPT-07-001	"U" Line 350+00	0	70	370	-

5.2 Geologic Mapping

The site consists of roadway fill and native soils. The subject was considered and was determined to be not applicable to the project.

5.3 Geophysical Studies

The subject was considered and was determined to be not applicable to the project.

5.4 Instrumentation

The subject was considered and was determined to be not applicable to the project.

5.5 Exploration Notes

Roadway material consists of silty sand and was typically encountered in all the borings. In general, drilling did not encounter any unusual conditions. Caving was observed during drilling at boring A-07-101 and A-07-102 where granular soil was encountered below the water table.

6. GEOTECHNICAL TESTING

6.1 In-Situ Testing

In-situ testing consists of recording blow counts during sampling (using either Modified California sampler or Standard Penetration Test Sampler) in the field. Based on our previous experience, when correlating standard penetration data in similar soils, the blow counts for the Modified California Sampler may be converted to equivalent SPT blow counts by multiplying a conversion factor of 0.65.

6.2 Laboratory Testing

Laboratory tests performed for the study include the following: Laboratory determination of Moisture-Density (California Test Method T226), Atterberg Limits (California Test Method T204),

Grain Size Distribution Analysis (California Test Method T203), Unconfined Compression Test (California Test Method T221), R-value Test (California Test Method T301), and Corrosion Test (California Test Method T 643). The test results are included in Appendix B.

In general, the natural moisture content is approx. less than 10% for the upper sandy material. The natural moisture content of the underlying clay is on the order of 25% to 35%. The unconfined compressive strengths of the cohesive soils ranged from 3.0 tsf to 3.1 tsf. Laboratory unconfined compression test results; moisture content and total unit weight of the subsurface soils are presented on the LOTB at the appropriate sample depths.

7. GEOTECHNICAL CONDITIONS

7.1 Site Geology

General geologic features pertaining to the site were evaluated by reference to the geology map titled "Generalized Geology of the Arroyo Grande-Nipomo Mesa Area" by the Department of Water Resources, Southern District, 2002. The accompanied geologic section C-C' was also referenced in our evaluation. Based on the map and the section, the proposed Willow Road/Route 101 Interchange (Caltrans' Right-Of-Way) is underlain by older dune sands (Qos). Toward the east and further east of Nipomo Creek (County's Right-Of-Way), the area is underlain by older alluvium (Qoal). The geologic map and the geologic section C-C' are shown on Plates 3A and 3B, respectively. Descriptions of the main geologic units are as follows:

Qoal- The older alluvium consists of sand, gravel and other coarse detrital material imbedded in a dense matrix of silt and clay.

Qos- The dune sands consist of coarse- to fine-grained, well-rounded, massive sand with some silt and clay. The sands are largely quartz and are loosely to slightly compacted. The older dune sands are anchored by vegetation and have a well-developed soil mantle. Also, iron oxides many locally cement the dune surface into a crust and stain the sand dark reddish-brown. Lithologs of water wells indicate that the dune sands may contain perching layers of clay.

The older dunes have a maximum thickness of about 60 feet on the Tri-Cities Mesa and about 300 feet near the southern edge of Nipomo Mesa. The younger dunes along the coast are generally less

than 50 feet thick, but may reach about 100 feet thick.

7.1.1 Lithology

The site consists of roadway fill and alluvium. The subject was considered and was determined to be not applicable for the project. Detailed description of subsurface soil conditions are presented in Section 7.2.

7.1.2 Structure

The site consists of roadway fill, native dune sand and alluvium. The subject was considered and was determined to be not applicable for the project.

7.1.3 Existing Slope Stability

The slopes at the project site are generally vegetated and relatively gentle. The subject was considered and anticipated to be not a concern for the project.

7.2 Subsurface Soil Conditions

Caltrans' Right-Of-Way

Based on the current boring data, the project site generally consists of an upper layer of loose to dense silty sand and poorly graded sand with silt with approximate thickness of 40 feet. Underlay this sand layer is a layer of stiff to very stiff clay with approximate thickness of 25 feet. Medium to very dense silty sand was encountered to the maximum depth of exploration (i.e. 90 feet below existing grade) beneath this clay layer in Boring A-07-001. A layer of very stiff clay was encountered in Boring A-07-002 within this sand and gravel layer.

Based on the typical SPT-N values for the soil encountered in the field exploration, the consistency of the subsurface sandy soils is generally loose to medium dense in the upper 15 feet. Below that, the consistency is generally medium dense to dense. The fine contents of the silty sand and poorly graded sand with silt are generally between 12% and 22% and between 9% and 12%, respectively. The in-situ test results are presented on the LOTB in Appendix A.

County's Right-Of-Way

West of Route 101. The area west of Route 101 is underlain by old dune sand deposits. The subsoil along the proposed Willow Road extension (Hetrick Avenue to Route 101 and the Frontage Road) is in sand, similar to the soil conditions at the proposed interchange.

East of Route 101. The area east of Route 101 towards Nipomo Creek and N. Thompson Avenue generally consists of stiff to hard clay with interbedded layers of medium to very dense silty sand and gravel to maximum depth (90 ft) explored. The clays are of high plasticity.

Detailed descriptions of the materials encountered in the exploratory borings are presented in the LOTB in Appendix A. It should be noted that these descriptions and related information depict subsurface conditions only at the locations indicated and on the particular date noted on the LOTB. Because of the variability from place to place within soil/rock in general, subsurface soil conditions at other locations may differ from conditions occurring at the locations explored. The abrupt stratum changes shown on the logs may be gradational and relatively minor changes in soil types within a stratum may not be noted due to field limitations. Also, the passage of time may result in a change in the soil conditions at the locations due to environmental changes.

7.3 Water

7.3.1 Surface Water

The terrain at the project site is gently sloping from west to east across Route 101. Nipomo Creek is located approximately 500 feet to the northeast. Generally surface water drains to the sides of the highway and presumably percolates into the sandy soil.

7.3.1.1 Scour

The subject was considered and was determined to be not applicable for the project. Within the County's Right-Of-Way, the hydraulic report for the Nipomo Creek Bridge has determined a total scour of approx. 5 feet in the main channel. The scour has been considered in foundation design of the Nipomo Creek Bridge.

7.3.1.2 Erosion

The soil type mapped for the project site is Oceano sand (0-9% slope). As described in the United States Natural Resources Conservation Service (NRCS) Soil Survey, the soil has a high erodibility and low shrink swell characteristics. The existing slopes have established landscaping to help control erosion. Future improvements should incorporate appropriate erosion control measures to protect the newly constructed slopes and ground surfaces.

7.3.2 Groundwater

Groundwater was encountered in the borings during drilling. The boring numbers, stations, offsets, approximate ground elevations and groundwater elevations are summarized in Table 2 below. In general, groundwater was encountered at elevations between Elev. +335 ft and Elev. +341 ft (approximately 30 ft below existing ground surface) during the field exploration in January 2007.

TABLE 2: SUMMARY OF GROUNDWATER ELEVATIONS

Boring No.	Station (ft)	Offset (ft)	Boring Depth (ft)	Approx. Ground Elev. (ft)	Approx. Groundwater Elev. (ft)
A-07-104	"U" Line 334+05	50 Rt.	30	364.5	337
A-07-105	"U" Line 337+00	50 Rt.	30	365.5	335
A-07-107	"U" Line 340+00	50 Rt.	35	366	338
A-07-108	"U" Line 342+10	50 Rt.	30	367	339
A-07-009	"U" Line 345+70	60 Rt.	30	369	340.5
A-07-001	"U" Line 350+00	0	90	370.1	341.0
A-07-002	"U" Line 352+30	0	90	370.7	341.4

Within the County's Right-Of-Way, groundwater was encountered during field exploration in January 2007 at approximately 47 feet depth (approx. Elev. 286 ft) in Borings 07-B-13. The groundwater level is anticipated to vary with the passage of time due to seasonal groundwater fluctuation, surface and subsurface flows, ground surface run-off, change in the water level in the nearby creeks and other factors which may not have been present at the time of our investigation.

7.4 Project Site Seismicity

7.4.1 Ground Motions

The project is located in a seismically active part of central California. Many faults along the Californian Central Coast Area are capable of producing earthquakes that may cause strong ground shaking at the site. Active faults in the vicinity include the Santa Maria River-Foxen Canyon, Oceano, Oceanic-West Huasna, Casmalia, and the Los Osos Fault. These faults are capable of producing earthquakes, and may cause strong ground shaking at the site. The attached Fault Map, Plate 4, presents the locations of the fault systems relative to the project site.

The Fault Map has been prepared from the Caltrans Seismic Hazard Map (Mualchin, 1996) and presents the maximum credible earthquake magnitudes for the fault systems and the anticipated peak bedrock accelerations at various locations due to seismic activity in the area. Wilmar Avenue Fault is not included in the Caltrans map.

Maximum credible earthquake magnitudes for some of the major faults in the area determined by Mualchin (California Seismic Hazard Map 1996) are summarized below. These maximum credible earthquake magnitudes represent the largest earthquakes that could occur on the given fault based on the current understanding of the regional tectonic structure.

TABLE 3: EARTHQUAKE DATA

Fault	Estimated Distance From Project Site	Maximum Credible Earthquake	Peak Bedrock Acceleration (g)
SMF – Santa Maria River-Foxen Canyon	< 0.3 mile	6.5	0.7
OCO – Oceano	2.7 miles	6.0	0.4

Based on available geological and seismic data, the possibility of the site to experience strong ground shaking may be considered moderate to high.

7.4.2 Ground Rupture

According to the County of San Luis Obispo Local Hazard Mitigation Plan (LHMP), the Santa Maria River and Foxen Canyon faults are buried northwest-striking reverse faults. The fault trace is buried and is inferred to parallel the Santa Maria River and U.S. Highway 101. The fault zone is mapped as extending into the southern segment of the Wilmar Avenue fault zone and appears to coincide with Nipomo Creek, which trends parallel to, and about 500 feet northeast of US Route 101 in the project vicinity.

The northwest-trending Wilmar Avenue Fault is a late Quaternary reverse fault which is exposed only at a sea cliff in Pismo Beach. The fault separates the uplifting San Luis/Pismo structural block from the subsiding Santa Maria Valley block. Along the southerly segment, the fault is inferred by the alignment of subtle geomorphic and geologic features, including a straight segment of Nipomo Creek. The Wilmar Avenue fault is considered as potentially active by the County's LHMP. According to USGS Bulletin 1995-AA, the Wilmar Avenue Fault is a moderately to steeply northeast-dipping reverse fault with late Quaternary slip rate of 0.01 to 0.1 mm/yr. For the proposed Willow Road/Route 101 interchange, fault rupture potential is considered low. The impact of fault displacement of the Wilmar Avenue Fault on the County's Nipomo Creek Bridge is discussed in a separate geotechnical report prepared for the bridge.

Due to the proximity of the Wilmar Avenue Fault, a geophysical/resistivity survey was performed by NORCAL Geophysical Consultants in March 2007 across Nipomo Creek within the County's Right-Of-Way. Based on the results of the geophysical survey, the fault trace was estimated to be located at approx. 400 feet northeast of Route 101. A copy of the geophysical survey result is attached in Appendix D.

8. GEOTECHNICAL ANALYSES AND DESIGN

8.1 Dynamic Analysis

8.1.1 Parameter Selection

Based on the seismic hazard map prepared by Mualchin (Caltrans 1996), the governing fault for the proposed structure is the Santa Maria River-Foxen Canyon Fault (SMF, Mw=6.5, style of

faulting: Reverse) located within 0.3 mile from the site. The recommended Peak Bedrock Acceleration for design is 0.7 g.

The recommended curve is based on Caltrans Seismic Design Criteria (Version 1.4). A fault map and the ARS Design Curve are attached. The seismic design criteria were submitted before in previous reports. The criteria are as follows:

1. Soil Profile D
2. ARS Design Curve – modified Figure B.7 (Caltrans SDC v. 1.4). The base curve is obtained by multiplying the 0.6 g curve data by 1.2. The curve is then modified for directivity by 20% increase of Sa for T > 1 sec., no change of Sa for T < 0.5 sec., and linear interpolation between 0.5 & 1 sec.

A copy of the "ARS Design Curve" (Plate No. 5) is included.

8.1.2 Analysis

Based on the plans and sections provided to us, embankment slopes for the project will have a gradient of 4H:1V or flatter, while cut slopes for the project will have maximum gradient up to 2H:1V with erosion control measures. Maximum height of embankment slopes will be about 6 feet at the northbound off-ramp, while maximum cut slopes will be about 15 feet at the southbound off-ramp. Stability of the embankment slopes were judged to be adequate based on the cross sections and stated geometry.

8.1.3 Liquefaction Potential

In response to comments of Caltrans (October 2007), a supplemental investigation consisting of two CPTs were carried out in November 2007 by Gregg Drilling & In Situ, Inc. to verify the soil information from the hollow stem auger borings carried out earlier in 2007. Two CPTs, CPT-1 and CPT-2 (CPT-1 = CPT-07-001 & CPT-2 = CPT-07-002 per Caltrans designation guidelines), were carried out at locations near previous borings, A-07-001 (bridge location) and A-07-009 (wall location), respectively.

Methodology. The liquefaction potential evaluation was performed in accordance with the methods proposed by Youd, et al. (2001) using the CPT procedures. The hollow-stem auger

boring data were used for reference. The CPT-based liquefaction analysis results are attached with this memo. In the attachments, the CPT Data Correlations showing soil strength, correlated SPT-N60, soil behavior index (Ic) and generalized soil profile are presented along with liquefaction analysis results. Based on Youd, et al (2001), soils with (N1)60-cs less than 30 (SPT procedures), or corrected Cone Tip Resistance (qc1N)cs less than 160 (CPT procedures) are found to be potentially liquefiable. Soils with CPT data showing Soil Index (Ic) < 2.6 (most likely granular) and (qc1N)cs less than 160 are considered liquefiable, unless sampling and laboratory data from neighboring borings suggested otherwise.

Liquefaction Potential Zone. Based on the high PGA and Mw for the design earthquake, the analysis results indicated that the submerged medium dense sandy soil at approximate depth of 36 to 39 feet (Elev. 331 to 334 ft) below existing ground level may be prone to triggering of liquefaction. The CPT provides continuous data through the profile, and the sporadic small/thin sand lenses (less than 2 feet thick) embedded in generally stiff clay strata are considered insignificant in terms of liquefaction potential and impact. Although the results from CPT-2 show thin layers (1 ft or so) with liquefaction potential (thus insignificant impact), the data together with CPT-1 and auger borings indicate a general trend of the medium dense layer up to about 3 ft thick at approx. 40-ft depth below grade, just above the clay. Post liquefaction settlement on the order of half an inch may be anticipated.

Therefore, we have assumed liquefaction condition (Elev. 331 to 334 ft) for design of the bridge foundations and lagging wall. For the bridge foundations, the impact is small since the thin layer does not cause concern of down drag load, and the impact on roadway is insignificant. For the lagging wall, we have considered the effect of liquefaction on lateral earth (active and passive) pressures for design of soldier piles. The geotechnical recommendations for the planned soldier pile-lagging wall are presented in a separate report. The impact on the roadway is insignificant.

8.2 Cuts and Excavations

Cut slopes are proposed for the construction of the southbound on- and off-ramps and northbound on-ramps. Based on information provided by the designer, the maximum height of the cut slopes is approximately 15 feet. The recommended maximum gradient of the cut is 2H:1V with erosion control.

8.2.1 Stability

Slope stability analyses were performed to evaluate the stability of proposed cut slopes. The analyses were performed using Program STABL5M to search critical failure surfaces using a random technique. The minimum requirements for calculated factors of safety are adopted as follows: (1) Static (Long-Term) stability - 1.50, and (2) Seismic (Pseudo-static at 0.2 g) stability -1.10.

Under static long-term conditions, the stability is governed by effective strength parameters (c' & ϕ') of the soils. The selection of ϕ' was based on standard penetration resistance, relative density, and effective overburden pressure (U.S. Navy 1971, and Ladd 1977). We adopted ϕ' = 32 degree for loose to medium dense sand and ϕ' = 34 degree for medium dense sand (Average SPT 'N" Value on the order of 11 and 14, respectively). Groundwater level was assumed to be approximately 30 feet below existing ground surface.

For seismic loading condition, we performed pseudo-static analysis with a horizontal coefficient of 0.2 g. We adopted Caltrans design guidelines for seismic slope stability, which employ pseudo-static analysis with a horizontal coefficient of up to 0.2 g. Sites with a pseudo-static factor of safety equal to or greater than 1.10 are considered to have adequate stability and require no further stability analyses.

According to the stability analyses, the proposed cut slopes have the following minimum factor of safety: 1.69 (Long-Term) and 1.14 (Seismic Case, pseudo-static w/ 0.2g). The stability analyses results are attached in Appendix C. The slope stability of the proposed cut slopes is acceptable.

8.2.2 Rippability

The proposed cuts are anticipated to be in roadway fill and native soils. Based on the investigation, rippability does not appear to be a concern for construction.

8.2.3 Grading Factor

The on-site native soil meeting the project specifications may be used as engineered fill. For

preliminary estimate, a grading factor of approx. 0.8 to 0.9 may be assumed for the to-be-cut sandy material at the planned interchange.

8.3 Embankments

8.3.1 Evaluation of Embankment Settlements

Based on the plans and sections provided to us, the northbound on ramp will be constructed on fill/embankment slopes. It is our understanding that these embankment slopes will have a gradient of 4:1 (H:V) and have maximum height of approximately six feet. Due to the small embankment height and sandy nature of he subsoils, that settlement at these embankment slopes will be negligible.

8.3.2 Evaluation of Embankment Stability

It is our understanding that the embankment slopes for this project will have a gradient of 4H:1V in accordance with Caltrans landscape requirements. The maximum embankment height is approx. six feet. Due to the small embankment height and sandy nature of the subsoils, and relatively deep groundwater, we judge that the stability of these embankments is not a design concern.

8.3.3 Existing utilities under the proposed Embankment

Based on the plans and site reconnaissance, there are existing utilities such as petroleum pipe lines underneath the proposed embankments of the project. These utility lines shall be protected and preserved during construction and/or relocated.

8.4 Earth Retaining Systems

Due to right-of-way and other geometric constraints, the project requires construction of three retaining walls. Information of approximate wall locations, lengths and maximum wall heights provided by the designer are summarized in the table below. The subsurface soil conditions and design considerations are discussed below.

TABLE 4. SUMMARY OF PROPOSED RETAINING WALLS

Wall No.	Approximate Wall Location	Max. Wall Height (ft)	Approx. Length (ft)	Proposed Wall Type
RW No. 1	Along Route 101 NB off-ramp, on the east side	23	1094	Std. Type 5 (Wall No. 1A) & Type 7SW modified (Wall No. 1B)
RW No. 2	Along Route 101 NB off-ramp, on the west side	16	492	Type 1 & modified
RW No. 3	Along Route 101 NB on-ramp, on the west side	16	328	Type 1 & modified

The walls are along Route 101 NB off- and on-ramps to provide grade separation. The wall heights vary from 6/8 ft to 22 to 23 ft near the bridge abutments/future Willow Road. The lowest elevation of the footing bottom is anticipated approximately at 336 to 337 ft.

Based on the exploration results, the subsurface material at the planned footing subgrade generally consists of medium sand. The sand grades to dense through approx. Elev. 330 ft overlying stiff to very stiff clay. Groundwater was encountered at approx. Elev. 341 ft in 2007.

Detail design recommendations including bearing capacities, lateral earth pressures and tiedowns (for the Type 7 SW modified wall) are provided in a separate Foundation Report, dated April 30, 2010, for the project.

Excavation & Shoring. Due to close proximity of the walls to existing Route 101 and private properties, temporary shoring is expected for wall construction when open cut is not feasible. For on-site sandy soils, the recommended maximum slope gradient is 1.5H:1V for temporary construction purposes. The selection and design of the shoring system should be the contractor's responsibility. The contractor should have the shoring system designed and signed by a California Registered Engineer. The shoring system should be designed to be relatively rigid and with as many supports as necessary to prevent excessive straining and deformation of the supported soils. This is important with regard to protection and movement within the existing Route 101 traffic and existing utilities. Temporary tiebacks may be required for higher portion of the shoring.

Construction Dewatering. Groundwater is anticipated at lower portion of the footing excavation. Caltrans standard specifications (Section 19-3.04) for "Water Control and Foundation Treatment" should apply. Construction dewatering is expected during construction. Dewatering of excavations is normally the responsibility of the contractor and should be a design-build system. It appears that shallow sumps may be used when needed. The contractor should satisfy himself/herself with the prevailing conditions and obtain additional information if needed to design the required dewatering method. The native sand is anticipated to have relatively high permeability. The selected shoring system should be designed to assist the dewatering program.

Controlled dewatering should be performed to avoid possible piping/blowout at the base of excavation or to avoid excessive settlement problems in the surrounding areas. All dewatering systems should be properly designed to prevent pumping soil fines with the discharge water. This work should be closely monitored during construction. If soil fines are pumped, the contractor should revise the dewatering operations. Otherwise, failure of shoring wall, partial instability of excavation bottom resulting in intolerable settlement of the surrounding ground (affecting existing Route 101 and private properties), and unsafe working conditions may occur. The contractor should provide sampling locations for discharge of each pump for their monitoring purposes.

8.5 Culverts

8.5.1 Corrosion Investigation

The corrosion investigation for this project was performed in general accordance with the provisions of California Test Method 643.

Caltrans' Right-Of-Way

In Caltrans' right-of-way, chemical tests were performed on representative soil samples to evaluate the corrosion potential of the subsurface soil. Majority of samples were obtained within the upper 5 to 10 ft depth in 2007 exploration. Per Caltrans review comments, an additional near-surface sample (HA-ED-1) was obtained near the existing RCB (Sta. 346+90 approx., "U" Line, as shown on the Site Plan 2B) in December 2009 for corrosion study. A summary of the corrosion test results is presented in Table 5A.

TABLE 5A: SUMMARY OF CORROSION TEST RESULTS (CALTRANS' R/W)

Boring No.	Depth (ft)	Resistivity (ohm-cm)	pH	Sulfate (ppm)	Chloride (ppm)
A-07-104	4.5	14470	7.19	5.9	6.6
A-07-108	4	20100	7.29	4.8	9.0
A-07-109	4.5	29210	7.26	1.1	8.4
A-07-112	4.5	37520	6.43	0.5	9.4
A-07-113	9.5	25460	6.64	5.1	18.9
A-07-114	4.5	27600	5.73	4.6	7.2
A-07-001	9.5	11520	6.77	9.6	6.3
A-07-002	4.5	29480	6.80	5.5	3.1
HA-ED-1	Surface, near existing RCB	9110	6.89	1.0	13.7

Based on the Corrosion Guidelines by Caltrans Division of Engineering Services, the test results indicate that the near surface soil of the proposed interchange is sandy and non-corrosive.

County's Right-Of-Way

In County's Right-Of-Way (east of Route 101), chemical tests were performed on representative soil samples to evaluate the corrosion potential of the subsurface soil. A summary of the corrosion test results is presented in Table 5B.

TABLE 5B: SUMMARY OF CORROSION TEST RESULTS (COUNTY'S R/W)

Boring No.	Depth (ft)	Resistivity (ohm-cm)	pH	Sulfate (ppm)	Chloride (ppm)
07-NP-1	7	880	7.38	35.9	20.0
07-NP-2	6	700	7.38	19.4	21.4
07-B-13	4.5	540	7.92	120	38.1
07-B-14	5	640	7.38	95.9	48.6

Based on the Corrosion Guidelines by Caltrans Division of Engineering Services, the test results indicate that the resistivity values are low due to clayey nature of the soils.

Culvert Analysis (AltPipe Program)

For selection of pipe material for culvert and drainage applications, AltPipe program is used by Caltrans to assist designers. AltPipe program is a web-based tool and updates and supersedes the previous CULVERT4 program. The analyses performed by AltPipe are based on the procedures

and California Test Methods described in Chapter 850 of the Highway Design Manual (HDM). AltPipe program incorporates current requirements from the HDM supplemented by Caltrans Design Information Bulletin No. 83 (D.I.B. No. 83, June 30, 2003) for abrasion potential for material selection.

The AltPipe program is intended for final design by the civil or hydraulic designer. In addition to soil corrosivity data, the input requires data such as Abrasion Level, 2- to 5- year Flow Velocity and cover height that should be determined while finalizing the drainage design. Based on discussion with the designer, the AltPipe analyses were performed by Parikh with the design information provided. The design is based on HDM (November 2, 2009) Chapter 850 Physical Standards. The drainage system is summarized below with Flow Velocity provided the designer.

TABLE 6: DRAINAGE SYSTEM SUMMARY FOR CORROSION ANALYSIS (ALTPIPE)

Drainage System	Pipe Size (in.)	Approx. Cover (ft.) per the Drainage Plans	2- to 5-yr Flow Velocity (ft/sec) Provided by the Designer
Caltrans Right-Of-Way			
1	24	3	6.3
1	54	2	7.9
1	60	2	7. 5
2	24	3	5.04
2	36	3	4.92
3	36	5	6.5
3	48	6	7.74
4	24	3	6.48
4	36	3	5.76
4	48	4	5.4
5	36	4	4.68
6	24	3	4.0
6	36	12	6.48
7	18	3	5.9
7	24	3	7.9
7	36	4	7.4
8	24	3	7.44
9	24	4	7.7
10	24	3	4.4
11	24	5	4.4
12	24	5	7.7
13	24	3	6.3
13	36	3	7.9
14	18	2	5.4
14	24	2	6.78
14	60	3	6.42

County's Right-Of-Way			
W1 (West of Route 101)	18	9	4.2
W2	18	8	5.88
W3	18	7	5.16
W4	18	7	7.5
W5	18	8	5.9
W6	36	6	5.2
W7	18	4	6.8
W8	18	5	4.7
W9 (East of Nipomo Crk)	18	3	5.7
W10 (East of Nipomo Crk)	18	4	6.2
W11 (East of Nipomo Crk)	18	2	6.0
W12 (East of Nipomo Crk)	18	2	6.9
W13 (East of Nipomo Crk)	18	2	7.6
F1 (Frontage Road)	23	2	4.8
F2	23	2	4.8
F3	23	2	4.8
F4	23	2	4.8
F5	23	2	4.8
F6	23	2	4.8
F7	23	2	4.7
F8	18	3	4.7
F9	18	3	4.7
F10	18	5	4.7
F11	18	3	4.7
F12	18	3	4.7
F13	18	3	6.3
F14	18	3	6.3
F15	18	2	6.3
F16	36	3	6.3
F17	36	3	6.3
F18	18	2	6.3
C1 (Cherokee Road)	18	2	4.8

Based on the AltPipe analyses, the following is a brief summary of the results. The AltPipe program output is attached in Appendix C of the report. The designer needs to refer to the output for detail information and requirements.

- Various steel pipes and steel spiral rib pipes may be allowed; the thickness ranges from 0.052 inch to 0.109 inch.
- Various aluminum pipes may be allowed; the thickness ranges from 0.060 inch to 0.135 inch.
- HDPE corrugated pipes (Type S) are allowed for majority of the system.

- Reinforced Concrete Pipes (RCP) are allowed; need to verify the AltPipe output for required cover thickness, cement content and water content.
- On the east side of Nipomo Creek within the County's right-of-way, steel pipes and aluminum pipes are not allowed

8.6 Minor Structure Foundations

Minor structures, such as lighting systems and drainage structures, are anticipated for this project. The foundation design of these minor structures should be according to the Caltrans Standard Plans. The native sandy soil on site should provide adequate bearing capacity for these minor structures.

9. PAVEMENT STRUCTURAL SECTIONS

Pavement Coring on Route 101

Per discussion with Caltrans, we performed four cores on the existing Route 101 travel lanes to obtain information of the as-built pavement conditions. Two cores were obtained on SB outside lane and two cores were obtained on NB outside lane. The pictures of the cores are presented in Appendix C of the report. The as-built pavement sections consist of Asphaltic Concrete (AC) over Portland Cement Concrete (PCC) and select sandy fill. Route 101 in the project area was recently overlaid with Open Graded Friction Course (OGFC). The results of the coring are summarized below.

TABLE 7: SUMMARY OF PAVEMENT CORING DATA

Core Location	Approx. Stations (Route 101, "U" Line)	Coring Data
Core -1	Sta. 333+86, SB outside lane	6" AC (including 1.5" OGFC overlay) 8-1/4" PCC over 5" to 6" Select Sandy Fill
Core -2	Sta. 365+75, SB outside lane	5-3/4" AC (including 1.5" OGFC overlay) 8-5/8" PCC over 5" to 6" Select Sandy Fill
Core-3	Sta. 340+90, NB outside lane	5-3/4" AC (including 1.0" OGFC overlay) 8-1/4" PCC over 5" to 6" Select Sandy Fill
Core-4	Sta. 367+80, NB outside lane	6" AC (including 1.5" OGFC overlay) 8-1/2" PCC over 5" to 6" Select Sandy Fill

Design Considerations (Caltrans' Right-Of-Way)

R-value tests were conducted on representative samples collected at subgrade level. The test results are summarized in Table 8A.

TABLE 8A: SUMMARY OF R-VALUE TEST RESULTS (CALTRANS' R/W)

Test Boring	Approx. Station & Offset (ft)	Approx. Existing Ground Elevation (ft)	R-value
A-07-101	"U" Line 316+00, 50 Rt.	358	74
A-07-103	"U" Line 330+00, 60 Lt.	362.5	71
A-07-104	"U" Line 334+05, 50 Rt.	364.5	68
A-07-110	"U" Line 345+85, 60 Lt.	369	73
A-07-114	"U" Line 360+10, 80 Lt.	374	75
A-07-115	"U" Line 363+15, 50 Rt.	370	44

Based on the laboratory test results, the R-values of the soil samples from the project site generally ranged from 44 to 76. The design approaches are as follows:

- The design is based on a 20-year design life, using Hot Mix Asphalt Concrete (HMA) and Lean Concrete Base (LCB) and Aggregate Subbase (Class 1 AS) per Caltrans review comments.
- Based on the R-value test data, a design R-value of 40 is adopted for the native sand.
- Fill material to be placed within 4 ft of the pavement finish subgrade should have a minimum R-value of 40.

The undercrossing requires excavation of approx. 25 feet from existing Route 101 grade (Elev. 370 feet). The excavation will be approx. 4 feet above the groundwater level (Elev. 341 feet). Caltrans review comments (5/21/09) on the foundation report indicated concern of pumping subgrade due to fluctuation of groundwater or additional excavation for the roadway sections. To facilitate construction and compaction operation, it is recommended that, at deeper part of the cut, a layer of geotextile fabric (Class B2, Section 88-1.08 of standard specifications, June 2009) with a foot of Aggregate Base be used below the pavement subgrade. This applies to location where the subgrade is below Elev. 343 feet. The intention is to mitigate potential pumping subgrade by creating a "working platform".

Design Considerations (County's Right-Of-Way)

West of Route 101. The subgrade soils along the Willow Road extension and Frontage Road generally consist of silty sand and poorly-graded sand, similar to the conditions of the soils at the proposed interchange site. One R-value test was performed on a representative sample obtained from Boring B-10, and an R-value of 72 was obtained. Based on the data, the design approaches for the area within County's Right-Of-Way west of Route 101, are the same as that of the interchange (Caltrans' Right-Of-Way). Therefore, a design R-value of 40 is adopted.

East of Route 101. Five plasticity limits tests and one R-value test were conducted on representative soil samples collected from the top ten feet of soil at the eastern portion (Willow Road extension to N. Thompson Avenue) of the site. The results indicated the top ten feet of soil are generally very consistent and consisted of fat clay (CH). One representative soil sample was also treated with lime admixtures. The percentage of lime admixtures used for treatment was determined according to the pH test results of the treated materials on selected samples (ASTM C977). Therefore, the samples were treated with 5% lime admixtures (5% lime) by dry weight of the soil. Unconfined compression test (California Test Method No. 373) was performed on the treated soil sample. For fine-grained soils, only lime was used for treatment. The admixture used for laboratory tests was determined after consultation with industry contractors. The laboratory test results are summarized below in Table 8B.

TABLE 8B: SUMMARY OF TEST RESULTS (COUNTY'S R/W, EAST OF ROUTE 101)

Boring No.	Station (ft)	Offset From "A" Line (ft)	Sample Depth (ft)	Plasticity Limits Test Results	R-Value Test Results	Compressive Strength of Lime Treated Soil (psi)
B-13	373+30	Lt. 110	2	LL=81, PI = 52	-	325
B-13	373+30	Lt. 110	9.5	LL=78, PI = 50	<5	-
B-14	384+00	Rt. 2	5	LL=79, PI = 50	-	-
B-15	384+00	Rt. 3	2	LL=49, PI = 31	-	-
B-15	384+00	Rt. 3	9.5	LL=91, PI = 48	-	-

Based on the test results and the subgrade conditions, relatively low R-values are expected for the portion of the Willow Road extension east of route 101. Due to the low R-value of the subgrade soils, the soils may be treated with lime to increase the strength or over-excavated and replace with select fill below pavement subgrade. Based on discussion with the designer and construction

considerations, it is recommended that the pavement subgrade be replaced with select fill (min. R-value = 40) for pavement support.

Caltrans Highway Design Manual (HDM, Section 614.6) indicates that a minimum R-value for the imported borrow placed within 4 feet of the grading plane must be specified. Therefore, 4 feet of over-excavation and replacement with fill (min. R-value = 40) below pavement subgrade is recommended for the area. Based on the geophysical survey data, it appears that 4 feet over-excavation and replacement may start at Sta. 371+50, "A" Line along the planned Willow Road extension through N. Thompson Avenue.

Structural Sections

Based on the Traffic Indices provided by the designer, the recommended typical structural pavement sections for 20-year design life are shown in Tables 9A & 9B below.

TABLE 9A: SUMMARY OF PAVEMENT STRUCTURAL SECTIONS (CALTRANS R/W)

Location	Composite Pavement Sections	Full Depth Section
Route 101 Widening (TI=13.5)	0.55' HMA (A) 0.55' LCB 0.70' AS (Class 1)	1.30' HMA
Ramps (TI=10.0)	0.50' HMA (A) 0.50' LCB 0.55' AS (Class 1)	0.75' HMA
Temporary Route 101 for Construction Duration (design for TI = 8.5)	0.40' HMA (A) 0.80' AB (Class 2)	0.80' HMA

TABLE 9B: SUMMARY OF PAVEMENT STRUCTURAL SECTIONS (COUNTY'S R/W)

Location	Composite Pavement Sections	Full Depth Section
Willow Road Extension & Frontage Road – West of Sta. 371+50 "A" Line (TI =9.5)	0.20' RHMA-G 0.30' HMA 0.85' AB (Class 2 or 3)	0.90' HMA
Willow Road Extension – East of Sta. 371+50 "A" Line (TI =9.5)	0.20' RHMA-G 0.30' HMA 0.85' AB (Class 2 or 3) Over 4' select fill (min. R = 40)	0.90' HMA Over 4' select fill (min. R = 40)

Hot Mix Asphalt (Asphalt Concrete), Aggregate Bases (Class 2, AB) and Aggregate Subbase (Class 1, AS) should conform to the Caltrans Standard Specifications in Sections 39, 26 and 25 respectively. RHMA-G is the gap-graded rubberized asphalt. It is our understanding that the County prefers to use rubberized asphalt on Willow Road extension for better noise control. Per discussion with the designer and comment from the County, the upper 0.20' of HMA is replaced with RHMA-G. Due to native sandy soil conditions, open-graded rubberized asphalt is not desirable. Pavement subgrade and structural sections should be prepared and compacted in accordance with the project specifications and Caltrans standard.

10. MATERIAL SOURCES

There are several commercial sources of asphalt, concrete, and aggregate products in the vicinity of the project area. Some of the available commercial suppliers in the vicinity of the project area are listed in the following table:

TABLE 10: SOURCES OF IMPORTED BORROW

Source	Location	Approx. Haul Distance (One way, miles)
Hanson Aggregates	131 Suburban Rd., San Luis Obispo, CA	20
San Luis Obispo Ready Mix	209 Tank Farm Rd., San Luis Obispo, CA	21
Wade E Johnston Rebar Detail	977 Pismo St., San Luis Obispo, CA	23
Freshcrete	1900 San Bernardo Creek Road, Morro Bay, CA	34
Roy Burch Concrete	1148 16th Ave., Los Osos, CA	31

11. MATERIAL DISPOSAL

The project will require imported borrow material for the project. Disposal of ADL contaminated material (if any) is beyond the scope of this report.

12. CONSTRUCTION CONSIDERATIONS

12.1 Construction Advisories

The following sections are written primarily for the engineer responsible for the preparation of plans and specifications. Since these sections identify potential construction issues related to the

project, it may also be of use to the Agency's representatives involved in monitoring of construction activity. The field investigation performed by PARIKH primarily addresses design issues and was not planned specifically to identify construction issues.

Part of the project consists of pavement construction on the ramps where they will join with existing highway. As such, traffic control maybe required to maintain traffic flow during construction. There may be various existing utility lines at the site. The contractor should verify the utility lines, be aware of the existing conditions and plan the construction activities accordingly to minimize the construction impact on the integrity of the existing utilities.

Prospective contractors for the project must evaluate construction-related issues on the basis of their own knowledge and experience in the local area, on the basis of similar projects in other localities, or on the basis of field investigation on the site performed by them, taking into account their proposed construction methods and procedures. In addition, construction activities related to excavation and lateral earth support must conform to safety requirements of Occupational Safety Health Administration (OSHA) and other applicable municipal and State regulatory agencies.

Due to close proximity of the walls to existing Route 101 and private properties, temporary shoring is expected for wall construction when open cut is not feasible. For on-site sandy soils, the recommended maximum slope gradient is 1.5H:1V for temporary construction purposes.

Groundwater is anticipated at lower portion of the footing excavation for construction of the retaining walls. Caltrans standard specifications (Section 19-3.04) for "Water Control and Foundation Treatment" should apply. Construction dewatering is expected during construction. Dewatering of excavations is normally the responsibility of the contractor and should be a design-build system. . All dewatering systems should be properly designed to prevent pumping soil fines with the discharge water. This work should be closely monitored during construction.

12.2 Construction Consideration that Influence Specifications

The contractor should verify the existing utility line conditions. These locations should not be used for stockpiling of borrow materials. Any utility conflicts with proposed construction should also be reviewed prior to construction.

12.3 Construction Monitoring and Instrumentation

The construction monitoring and instrumentation subject was considered and was determined to be not applicable for the project.

12.4 Hazardous Waste Considerations

The project environmental study report should be referred to for further details about any hazardous materials within the project.

12.5 Differing Site Conditions

The soil conditions described in this report are based on available boring data. It should be noted that these borings depict subsurface soil conditions and groundwater conditions only at the locations drilled and at the time drilled. Because of the variability from place to place within soils in general, and the nature of geologic depositions, subsurface soil conditions and groundwater conditions could change between the explored boring locations.

Early communication should be made between the Resident Engineer, the Contractor and the Geotechnical Engineer as soon as conditions that differ from those established in this report are recognized by any of the parties. Additional recommendations could be provided if such conditions arise.

13. RECOMMENDATIONS AND SPECIFICATIONS

13.1 Summary of Recommendations

If the designer has questions or concerns with any of these recommendations, or, if conditions are found to be different during construction, the Geotechnical Engineer who prepared this report should be contacted. Additional fieldwork, analysis or changes in recommendations may be required during the construction phase. These services may be provided under a separate authorization, as necessary. A concise summary of the geotechnical recommendations is presented below:

- Design peak bedrock acceleration (PBA) = 0.7 g (Ref.: Section 8.1)

- The boring data indicates that the subsurface soil conditions generally consist of loose to very dense silty sand with interbedded layers of stiff to very stiff clay. Groundwater was encountered at elevations between Elev. 335 and 341 ft during the field exploration. The impact of liquefaction potential is considered moderate at the site. (Ref.: Section 8.1.3)

- Three retaining walls are planned along the Route 101 NB off- and on-ramps. Due to close proximity of the walls to existing Route 101 and private properties, temporary shoring is expected for wall construction when open cut is not feasible. Groundwater is anticipated at lower portion of the footing excavation for construction of the retaining walls. Caltrans standard specifications (Section 19-3.04) for "Water Control and Foundation Treatment" should apply. Construction dewatering is expected during construction. (Ref.: Section 8.4)

- Pavement structural sections for the project (Ref: Section 9): Refer to Tables 9A & 9B for the design structural pavement sections. Pavement coring performed on existing Route 101 travel lanes indicated as-built AC over PCC sections.

13.2 Recommended Materials Specifications

13.2.1 Standard Specifications

Unless otherwise stated in the special provisions, all materials specifications should conform to the latest edition of Caltrans Standard Specifications, including but not limited to the following: Earthwork, Structure Backfill, Pervious Backfill Material, Asphalt Concrete, Aggregate Base, Aggregate Subbase etc.

13.2.2 Special Provisions

Imported Borrow: Imported material should be in accordance with the specifications set forth in Caltrans Standard Specification Section 19. In particular, the import fill material to be placed within 4 ft of the finished pavement subgrade should meet the following requirements:

1. Free of organic or other deleterious materials,
2. Free of rocks or lumps greater than 3 inches in diameter,
3. An R-value of not less than 40.

Aggregate Base: Class 3 aggregate base shall conform to the provisions in Section 26 of the Standard Specifications and to these Special Provisions. It shall also be clean and free from organic matter and other deleterious substances. The percentage composition by weight of Class 3 aggregate base shall conform to the following grading as determined by California Test Method No. 202.

Gradation Requirement (Percent Passing)

Sieve Sizes	1-1/2 inch Maximum		¾ inch Maximum	
	Operating Range	Contract Compliance	Operating Range	Contract Compliance
2"	100	100		
1-1/2"	90 – 100	87 - 100		
1"	--	--	100	100
¾"	50 – 85	45 – 90	90 – 100	87 – 100
No. 4	24 - 45	20 – 50	35 – 60	30 – 65
No. 30	10 – 25	6 – 29	10 – 30	5 – 35
No. 200	2 -11	0 -14	2 -11	0 - 14

Quality requirements

California Test Method	Operating Range	Contract Compliance
Sand Equivalent (217)	25 Min.	22 Min.
Resistance (R-value) (301)	-	78 Min.
Durability Index	-	35 Min.

Aggregate Subbase: Aggregate Subbase shall be Class 1 and shall conform to the provisions in Section 25 of the Standard Specifications.

14. INVESTIGATION LIMITATIONS

Our services consist of professional opinions and recommendations made in accordance with generally accepted geotechnical engineering principles and practices and are based on our field exploration and the assumption that the soil conditions do not deviate from observed conditions.

No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work or by the furnishing of oral or written reports or findings. The scope of our services did not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in structures, soil, surface water, groundwater or air, below or around this site. Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings; different soil conditions may require that

additional expenditures be made during construction to attain a properly constructed project. Some contingency fund is thus recommended to accommodate these possible extra costs.

This report has been prepared for the "Willow Road/Route 101 Interchange" project including the Willow Road extension between Route 101 and N. Thompson Avenue as described earlier, to assist the engineer in the design of this project. In the event any changes in the design or location of the facilities are planned, or if any variations or undesirable conditions are encountered during construction, our findings and recommendations shall not be considered valid unless the changes or variations are reviewed and our recommendations modified or approved by us in writing.

This report is issued with the understanding that it is the designer's responsibility to ensure that the information and recommendations contained herein are incorporated into the project and that necessary steps are also taken to see that the recommendations are carried out in the field.

The findings in this report are valid as of the present date. However, changes in the soil conditions can occur with the passage of time, whether they are due to natural processes or to the works of man, on this or adjacent properties. In addition, changes in applicable or appropriate standards occur, whether they result from legislation or from the broadening of knowledge. Accordingly, the findings in this report might be invalidated, wholly or partially, by changes outside of our control.

Very truly yours,
PARIKH CONSULTANTS, INC.

Y. David Wang, Ph.D., P.E., C52911
Senior Engineer

Gary Parikh, P.E., G.E., 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

REFERENCES

1. California Department of Transportation, 2006, Standard Specifications, Sections 1 through 95.

2. California Department of Transportation, Highway Design Manual, July, 2008.

3. California Seismic Hazard 1996, by L. Mualchin, California Department of Transportation, 1996, Scale 1:500,000, Revision 1.

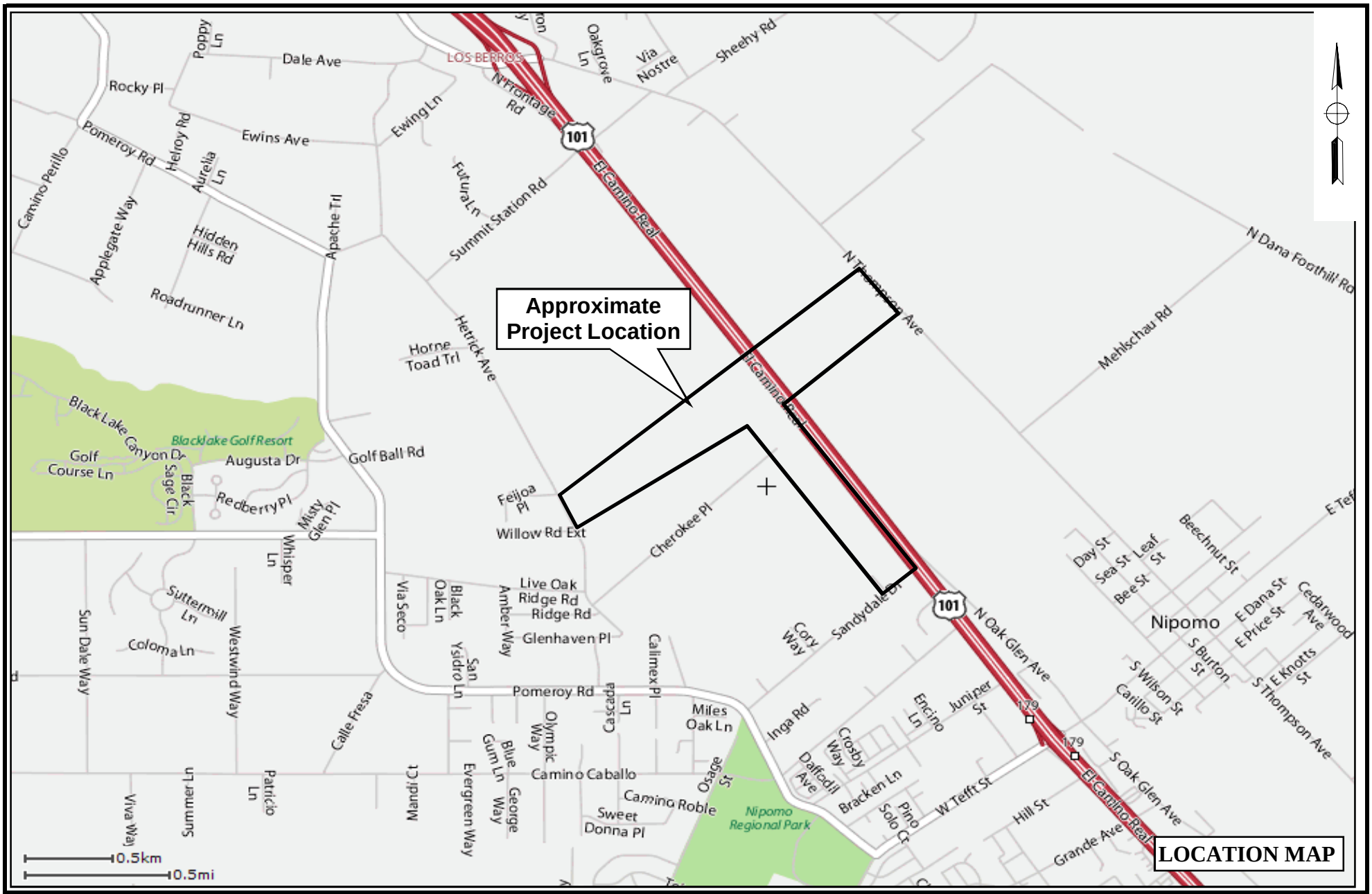
4. "Nipomo Creek Watershed Management Plan", Central Coast Salmon Enhancement, The Land Conservancy of San Luis Obispo County, The Nipomo Creek Watershed Forum, December 2005.

5. "Local Hazard Mitigation Plan", County of San Luis Obispo, November 2005

6. "Quaternary Tectonic Setting of South-Central Coastal California, Chapter AA of Evolution of Sedimentary Basins/Offshore Oil and Gas Investigations-Santa Maria Province", U.S. Geological Survey Bulletin 1995-AA

7. "Water Resources of the Arroyo Grande-Nipomo Mesa", Department of Water Resources, Southern District, 2002.

8. "Corrosion Guidelines Version 1.0", California Department of Transportation, Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch, September 2003



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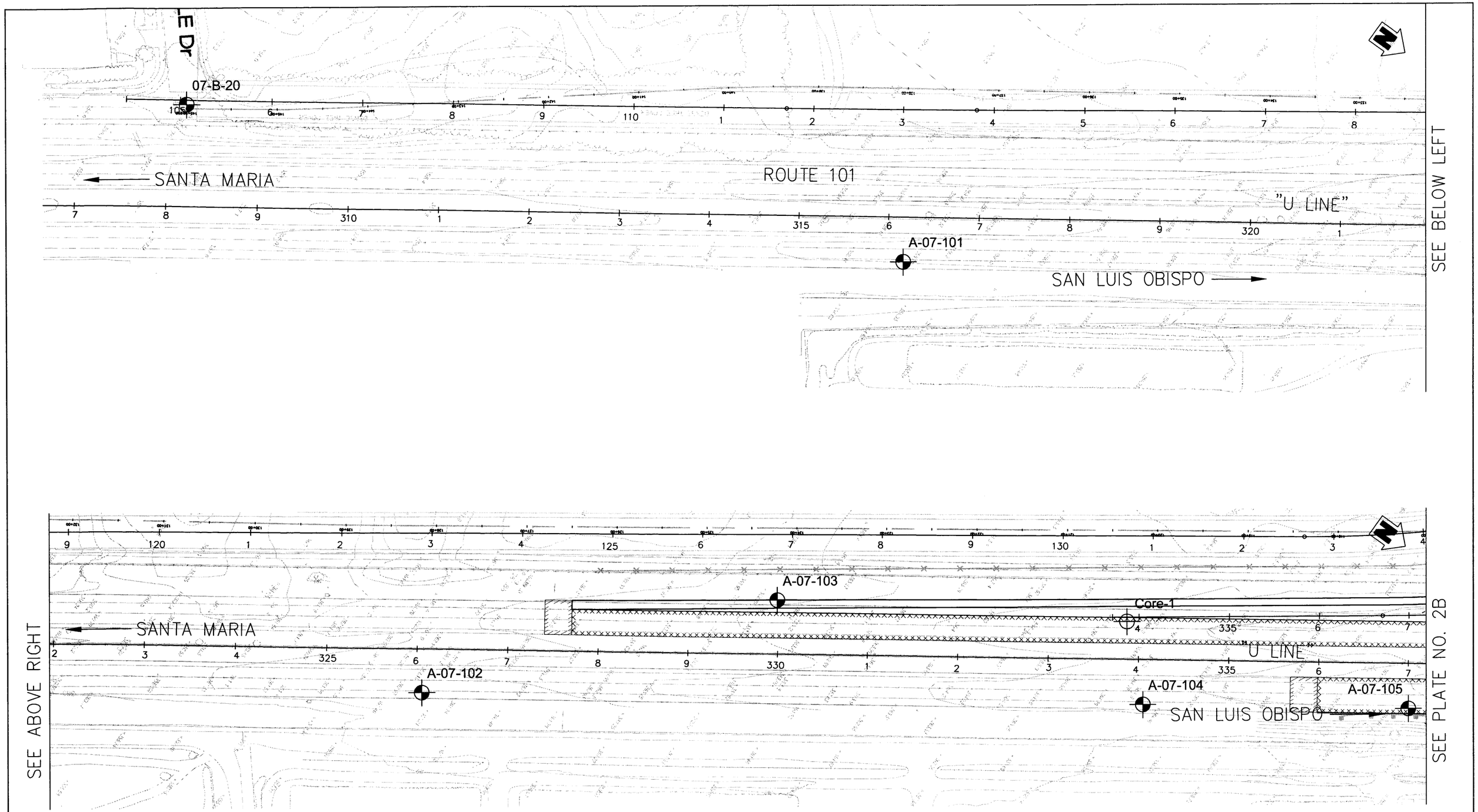
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
SAN LUIS OBISPO COUNTY, CALIFORNIA

JOB NO.: 203125.10	PLATE NO.: 1



LEGEND

07-R-1 — Approx. Boring Location (PARIKH)

CPT-2 — Approx. Cone Penetration Test Location (PARIKH)

Core-1 — Approx. Coring Location (PARIKH)

HA-ED-1 — Approx. Bulk Sample Location

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by Rajappan & Meyer

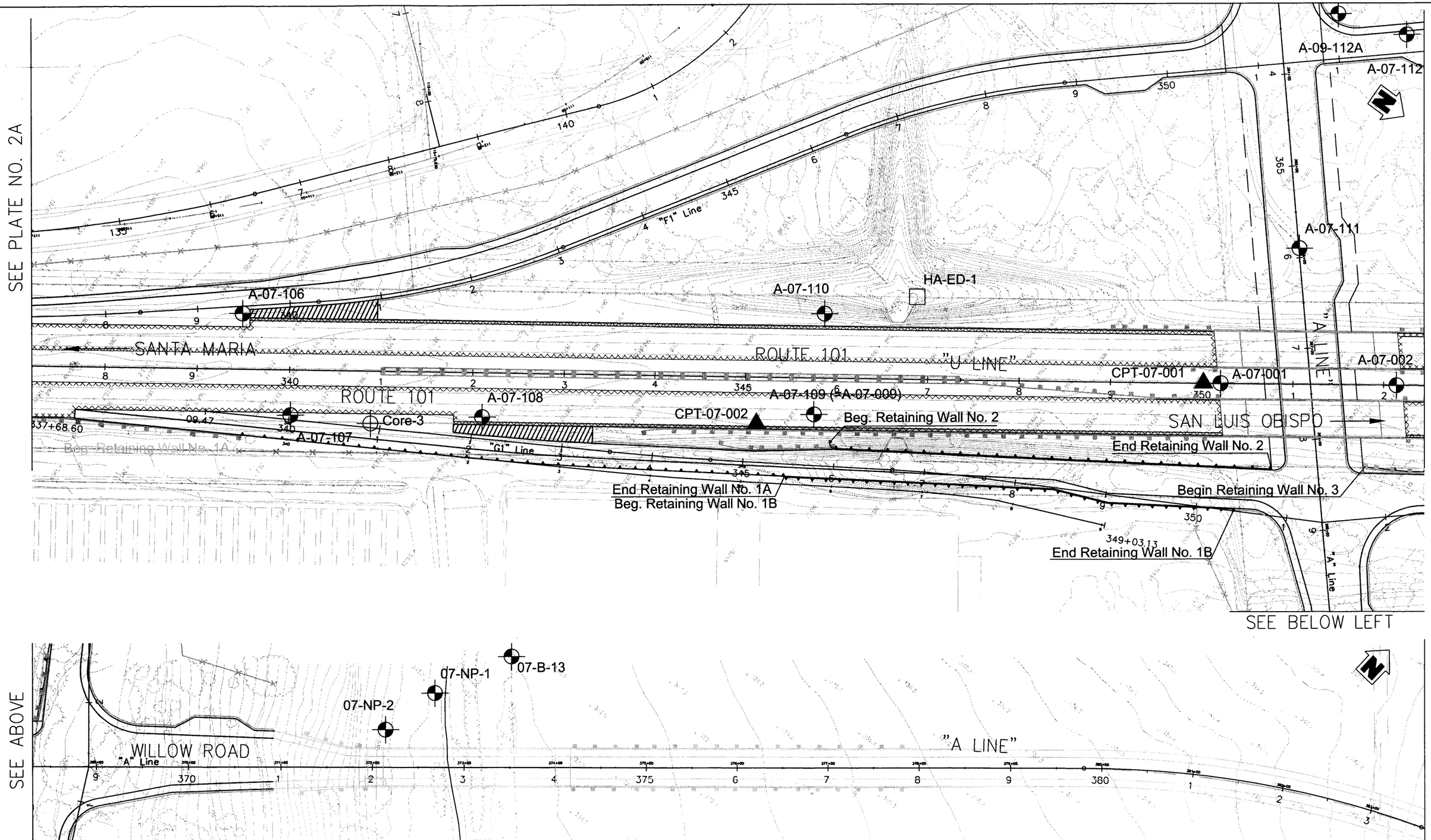
SITE PLAN

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.:203125.10

PLATE NO: 2A



LEGEND

07-R-1 — Approx. Boring Location (PARIKH)

CPT-2 — Approx. Cone Penetration Test Location (PARIKH)

Core-1 — Approx. Coring Location (PARIKH)

HA-ED-1 — Approx. Bulk Sample Location

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by Rajappan & Meyer

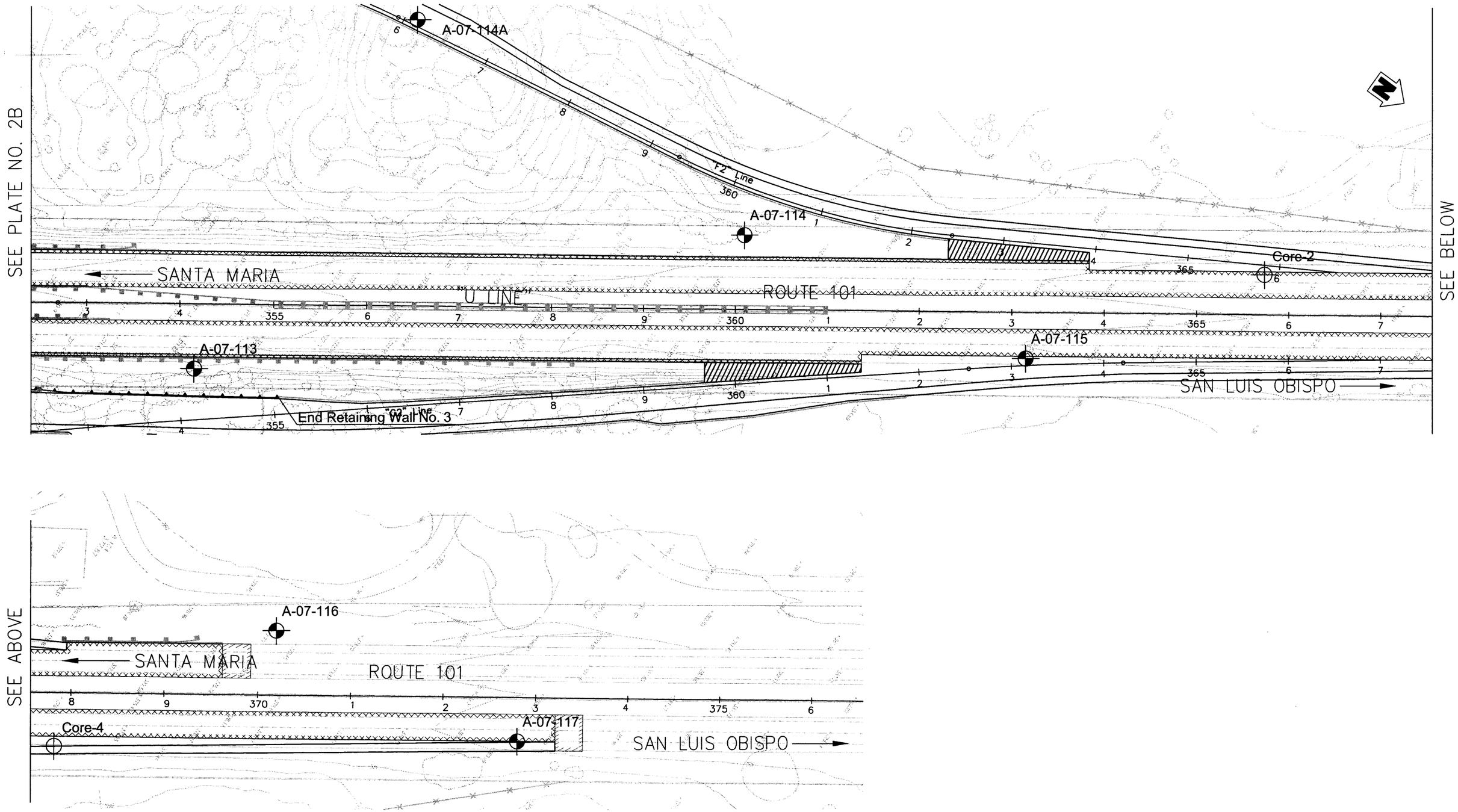
SITE PLAN

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.:203125.10

PLATE NO: 2B



LEGEND

- 07-R-1 — Approx. Boring Location (PARIKH)
- CPT-2 — Approx. Cone Penetration Test Location (PARIKH)
- Core-1 — Approx. Coring Location (PARIKH)
- HA-ED-1 — Approx. Bulk Sample Location

SCALE 1 inch = 100 feet

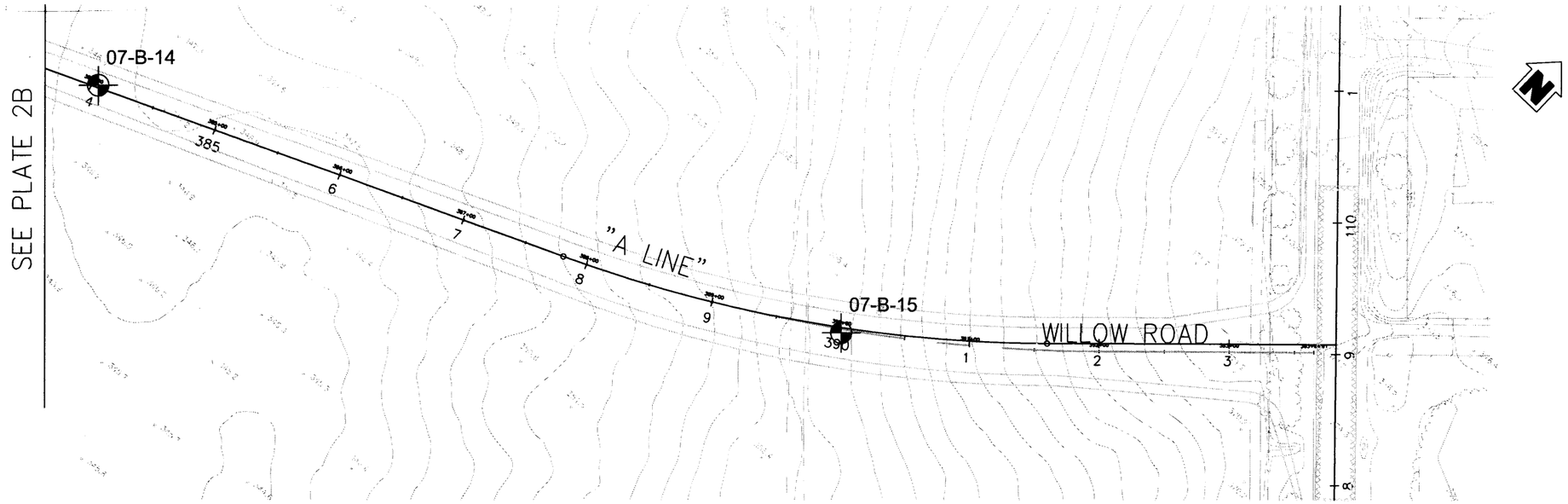
Note: All units are in feet unless otherwise specified
Reference Map was provided by Rajappan & Meyer

SITE PLAN

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.:203125.10 | PLATE NO: 2C



SITE PLAN

LEGEND

07-R-11
Approx. Boring Location (PARIKH)

CPT-1
Approx. Cone Penetration Test Location (PARIKH)

SCALE 1 inch = 100 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by Rajappan & Meyer

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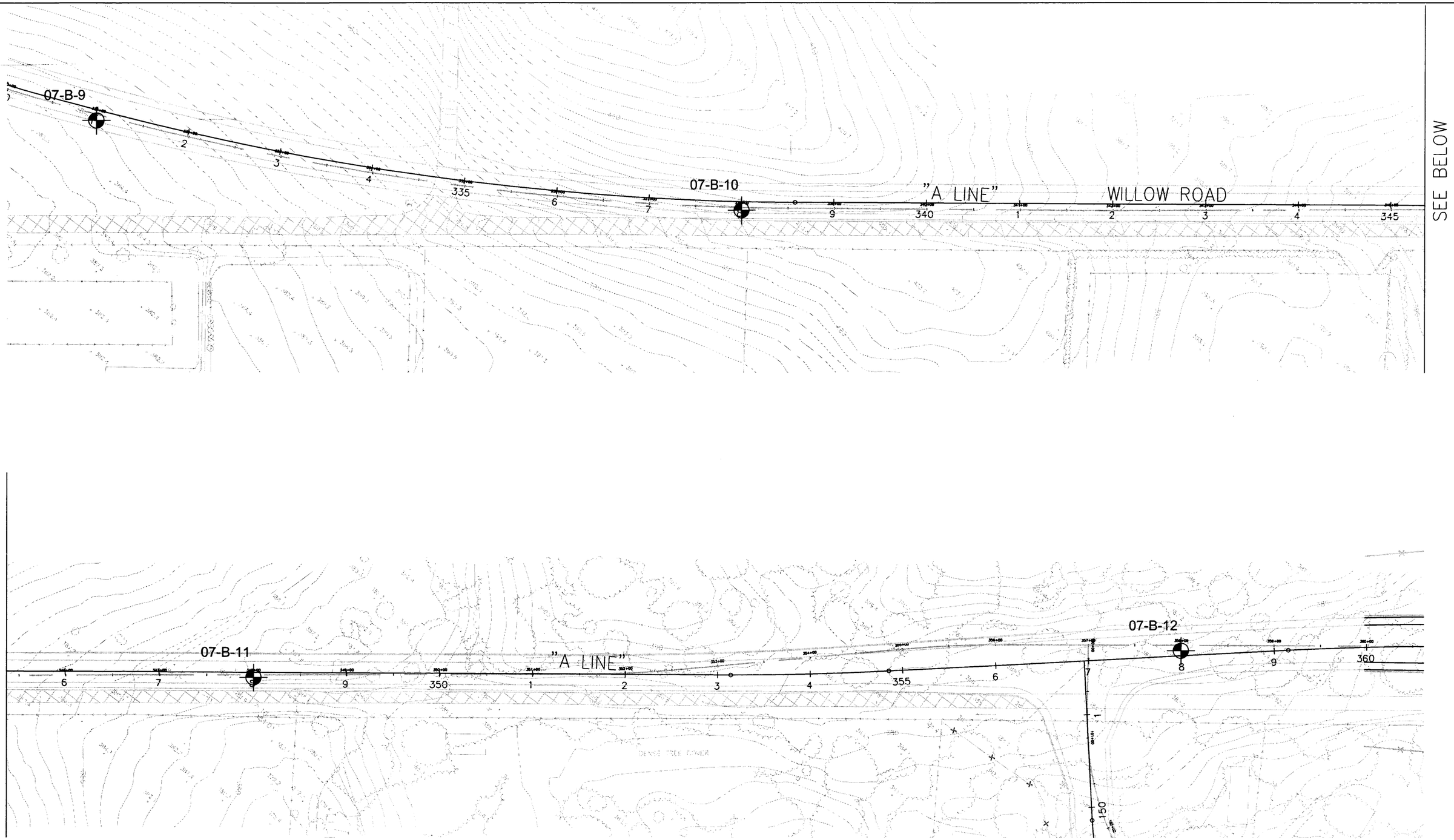
MATERIALS ENGINEERING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.:203125.10

PLATE NO: 2D



SITE PLAN

LEGEND

07-R-11
Approx. Boring Location (PARIKH)

CPT-1
Approx. Cone Penetration Test Location (PARIKH)

SCALE 1 inch = 100 feet

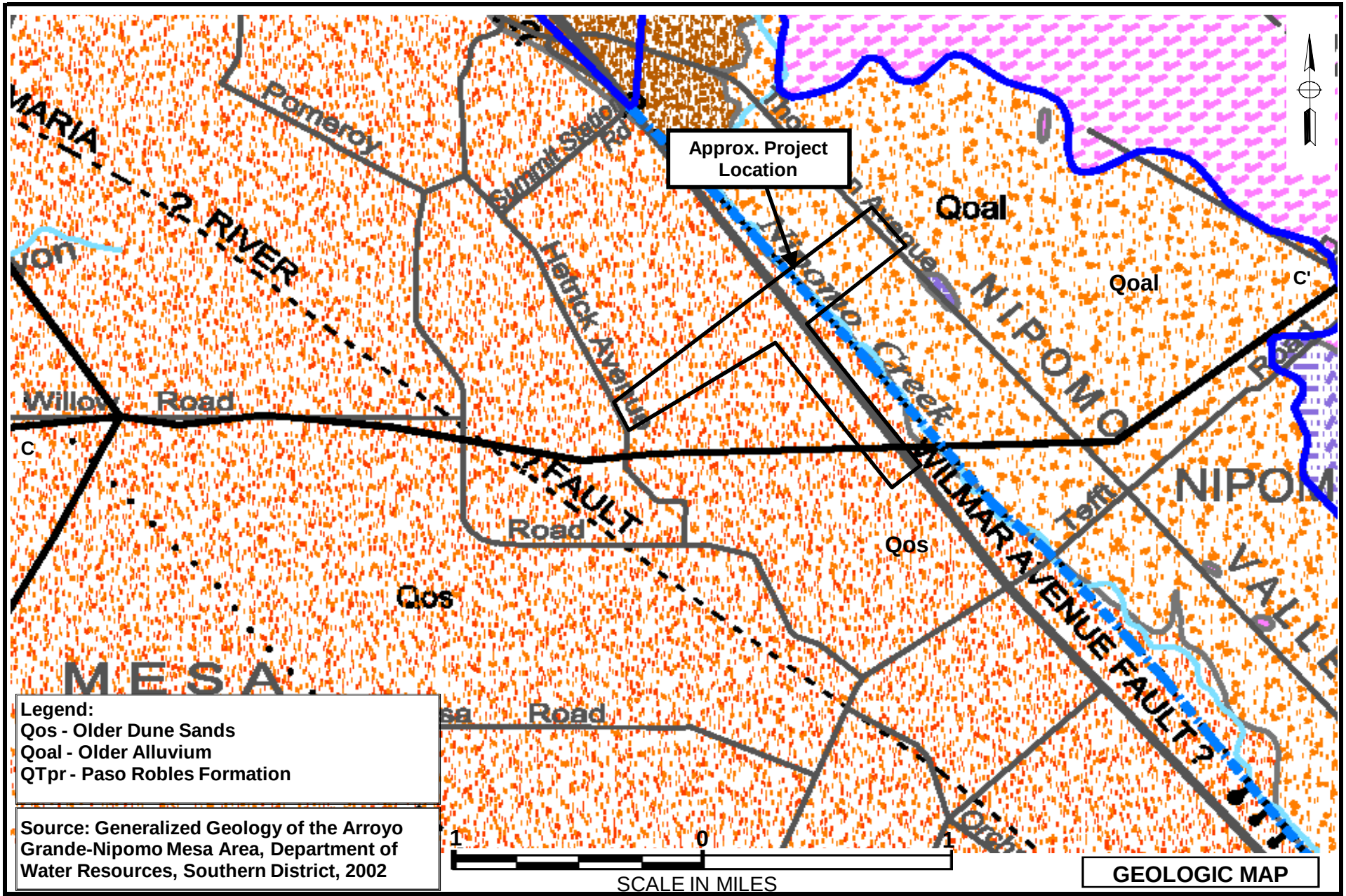
Note: All units are in feet unless otherwise specified
Reference Map was provided by Rajappan & Meyer

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.:203125.10

PLATE NO: 2E



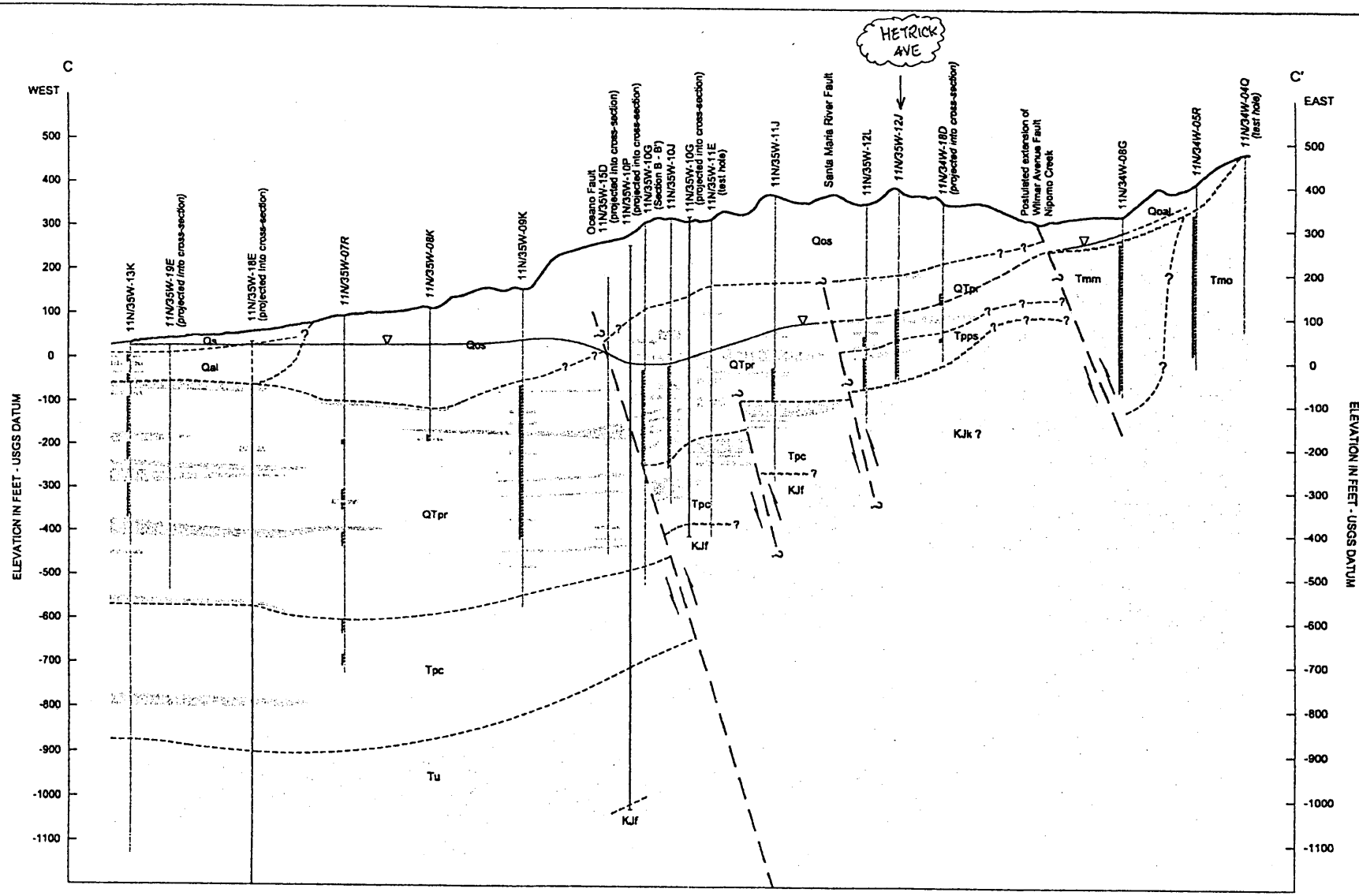
GEOLOGIC MAP

PARIKH CONSULTANTS, INC.

GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
SAN LUIS OBISPO COUNTY, CALIFORNIA

JOB NO.: 203125.10	PLATE NO.: 3A



EXPLANATION

Formation and Symbol

Qs	Dune Sand
Qal	Alluvial Deposits
Qos	Older Dune Sand
Qoal	Older Alluvial Deposits
QTpr	Paso Robles Formation
Tpc	Careaga Formation
Tpps	Squire Member, Pismo Formation
Tmm	Monterey Formation
Tmo	Obispo Formation
Tu	Undifferentiated Tertiary Deposits
KJk	Knoxville Formation
KJf	Franciscan Complex

12N/36W-36L	Water well with electric and geologic log
32S/12E-13L	Water well with geologic log
10N/36W-02G	Oil well with electric log, dashed above record
11N/35W-10P	Oil well with geologic log, dashed above record

Hydrogeologic Unit

- Unconsolidated to weakly cemented clayey silt to silty clay with minor sand and gravel
- Unconsolidated to weakly cemented sand, gravel, silt, sandstone with minor clay and silty clay
- Bedrock

- Perforated interval
- Fault, arrows indicate relative vertical movement
- Unconformity
- Contact
- 1995 Groundwater Elevation

Note: References include: Department of Water Resources, 1970; Buchanan-Banks et al., 1978; Hall, 1981; Nitchman, 1988; Hanson et al., 1994; Lettis et al., 1994.

Location of geologic section shown on Plate 2

Vertical scale 20 times horizontal scale

Horizontal scale in feet

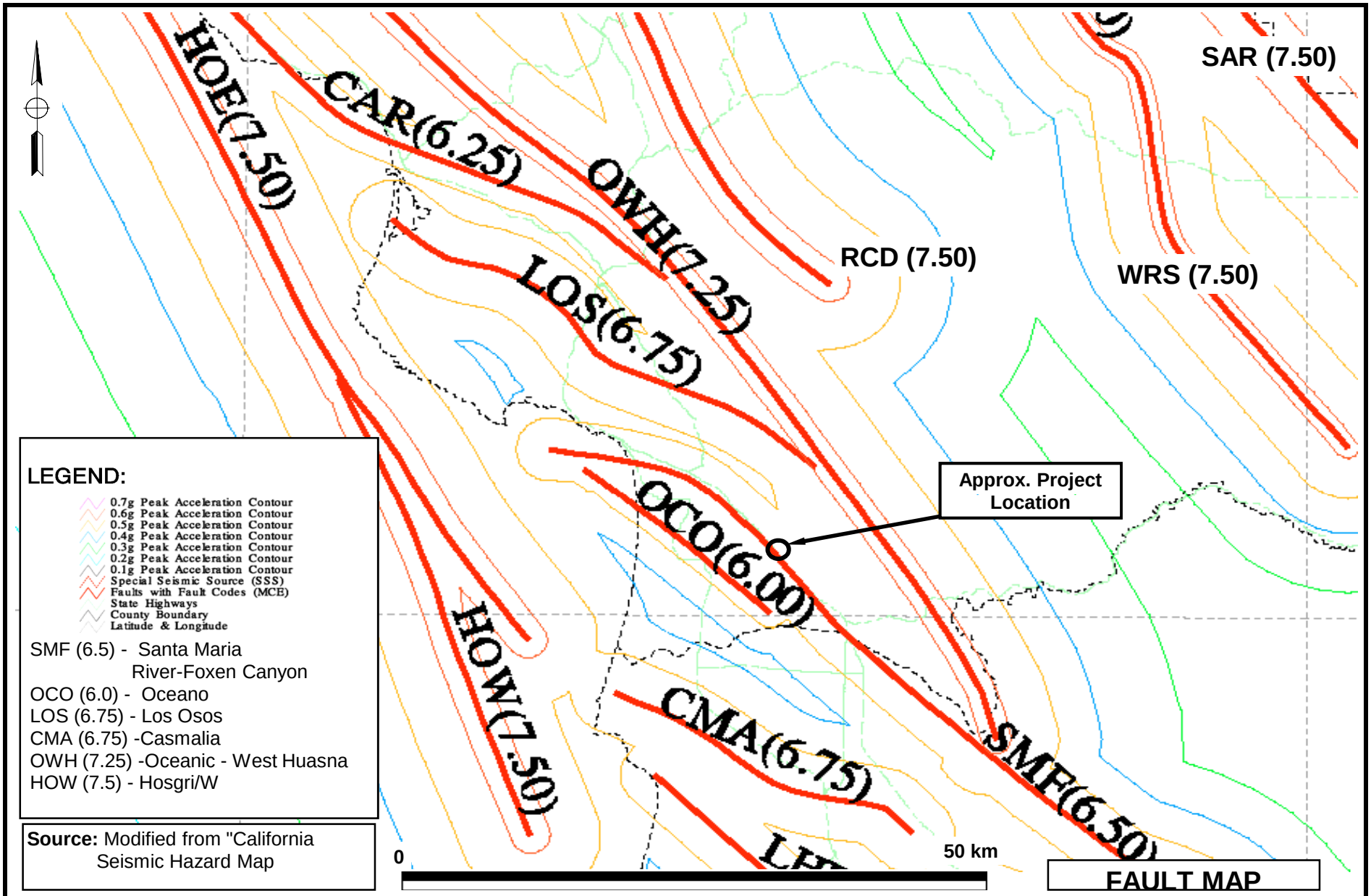
4000 0 4000

WATER RESOURCES OF THE ARROYO GRANDE - NIPOMO MESA AREA

◇◇◇

PLATE NO.: 3-B

GEOLOGIC SECTION C - C'



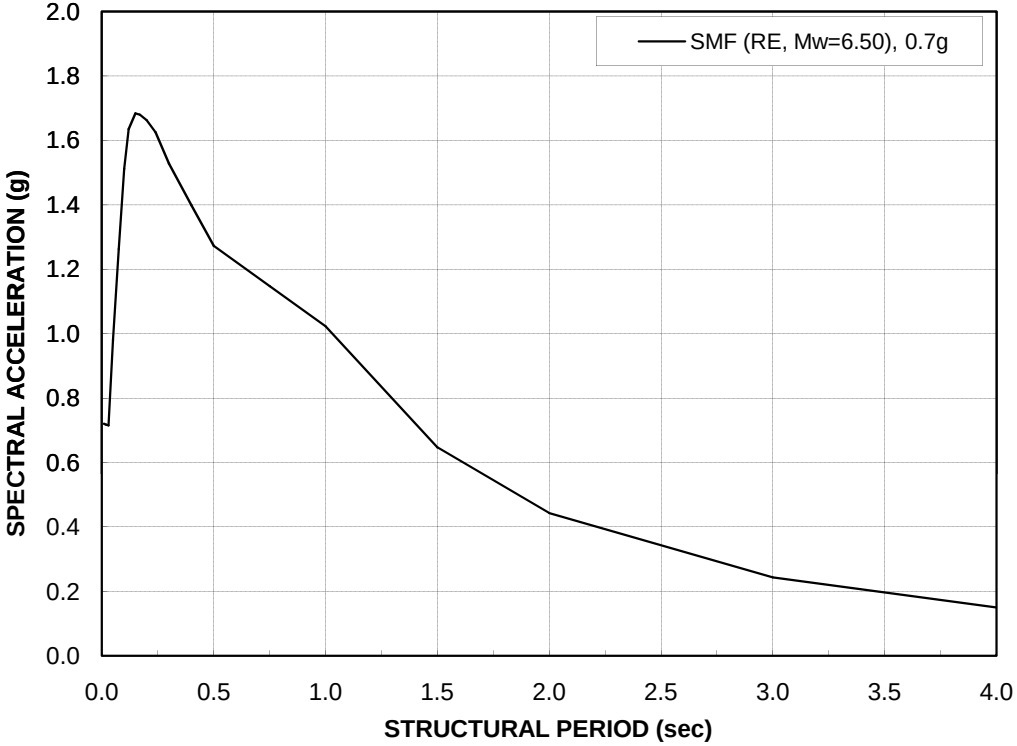
FAULT MAP

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD / ROUTE 101 INTERCHANGE &
WILLOW ROAD EXTENSION
SAN LUIS OBISPO COUNTY, CALIFORNIA

JOB NO.: 203125.10	PLATE NO.: 4

ARS DESIGN CURVE
WILLOW ROAD UNDERCROSSING
SAN LUIS OBISPO COUNTY, CALIFORNIA



Spectral Data

Period (sec)	Spectral Accel. (g)
0.010	0.720
0.020	0.717
0.030	0.716
0.050	0.980
0.075	1.263
0.100	1.512
0.120	1.635
0.150	1.684
0.170	1.680
0.200	1.663
0.240	1.626
0.300	1.528
0.400	1.399
0.500	1.272
0.750	1.148
1.000	1.024
1.500	0.647
2.000	0.443
3.000	0.243
4.000	0.150

Caltrans SDC (v 1.4), Figure B.7,
Governing Fault: Santa Maria River - Foxen Canyon Fault
(Mw = 6.5, Soil Profile Type D, PBA = 0.7 g)
The base curve is obtained by multiplying the 0.6g curve data by 1.2.
The curve is then modified for directivity by 20% increase of Sa for T > 1sec., no change of Sa for T < 0.5 sec. and linear interpolation between 0.5 and 1 sec.

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GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD UNDERCROSSING AT ROUTE 101
SAN LUIS OBISPO COUNTY, CALIFORNIA

JOB NO.: 203125.WIL | **PLATE NO.: 5**

APPENDIX A

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (JUNE 2007)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SOL	101	–	----	----

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of scanned copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names	Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND	CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
GP	Poorly graded GRAVEL Poorly graded GRAVEL with SAND		
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND	CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GP-GM	Poorly graded GRAVEL with SILT Poorly graded GRAVEL with SILT and SAND	ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
GP-GC	Poorly graded GRAVEL with CLAY (or SILTY CLAY) Poorly graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)		
GM	SILTY GRAVEL SILTY GRAVEL with SAND	OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND		
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND	OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL		
SP	Poorly graded SAND Poorly graded SAND with GRAVEL	CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL		
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
SP-SM	Poorly graded SAND with SILT Poorly graded SAND with SILT and GRAVEL		
SP-SC	Poorly graded SAND with CLAY (or SILTY CLAY) Poorly graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)	OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
SM	SILTY SAND SILTY SAND with GRAVEL		
SC	CLAYEY SAND CLAYEY SAND with GRAVEL	OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL		
PT	PEAT	OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND
	COBBLES COBBLES and BOULDERS BOULDERS		

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (PP) Pocket Penetrometer
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (TV) Pocket Torvane
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)
- (VS) Vane Shear (AASHTO T 223)

APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 inches)
Very loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	> 50

MOISTURE

Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

PARTICLE SIZE

Description		Size
Boulder		> 12"
Cobble		3" to 12"
Gravel	Coarse	3/4" to 3"
	Fine	No. 4 to 3/4"
Sand	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40

CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

CONSISTENCY OF COHESIVE SOILS

Description	Unconfined Compressive Strength (tsf)	Pocket Penetrometer Measurement (tsf)	Torvane Measurement (tsf)	Field Approximation
Very Soft	< 0.25	< 0.25	< 0.12	Easily penetrated several inches by fist
Soft	0.25 to 0.50	0.25 to 0.50	0.12 to 0.25	Easily penetrated several inches by thumb
Medium Stiff	0.50 to 1.0	0.50 to 1.0	0.25 to 0.50	Penetrated several inches by thumb with moderate effort
Stiff	1 to 2	1 to 2	0.50 to 1.0	Readily indented by thumb but penetrated only with great effort
Very Stiff	2 to 4	2 to 4	1.0 to 2.0	Readily indented by thumbnail
Hard	> 4.0	> 4.0	> 2.0	Indented by thumbnail with difficulty

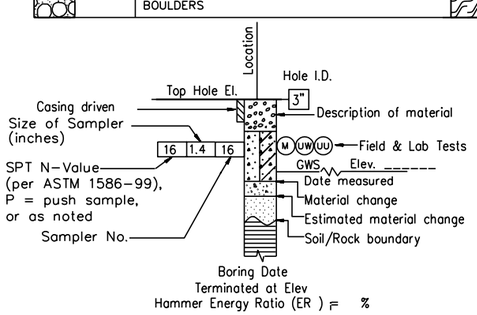
PLASTICITY OF FINE-GRAINED SOILS

Description	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

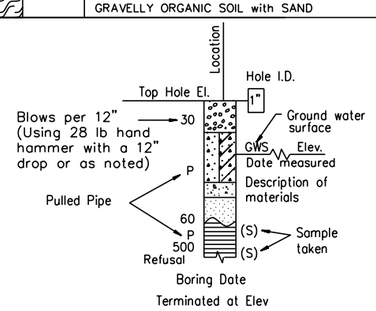
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring
Size	R P	Rotary drilled boring Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
●	D	Dynamic Cone Penetration Boring
▲	CPT	Cone Penetration Test (ASTM D 5778-95)
□	O	Other

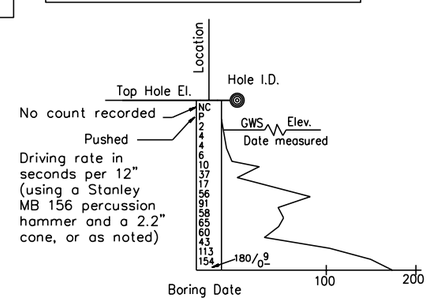
Note: Size in inches.



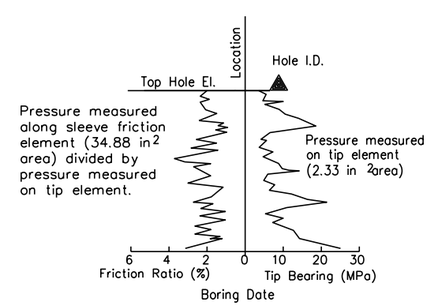
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) SOUNDING

DESIGN OVERSIGHT	DRAWN BY	L. TRAN	L. BHANGOO FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. WANG PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	D. WANG	DATE: JANUARY 2007		

BRIDGE NO. –
POST MILES –

SOIL LEGEND
LOG OF TEST BORINGS

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: 11/07/08 04/30/09 07/08/09 1/15/10

SHEET OF

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–	----	----

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

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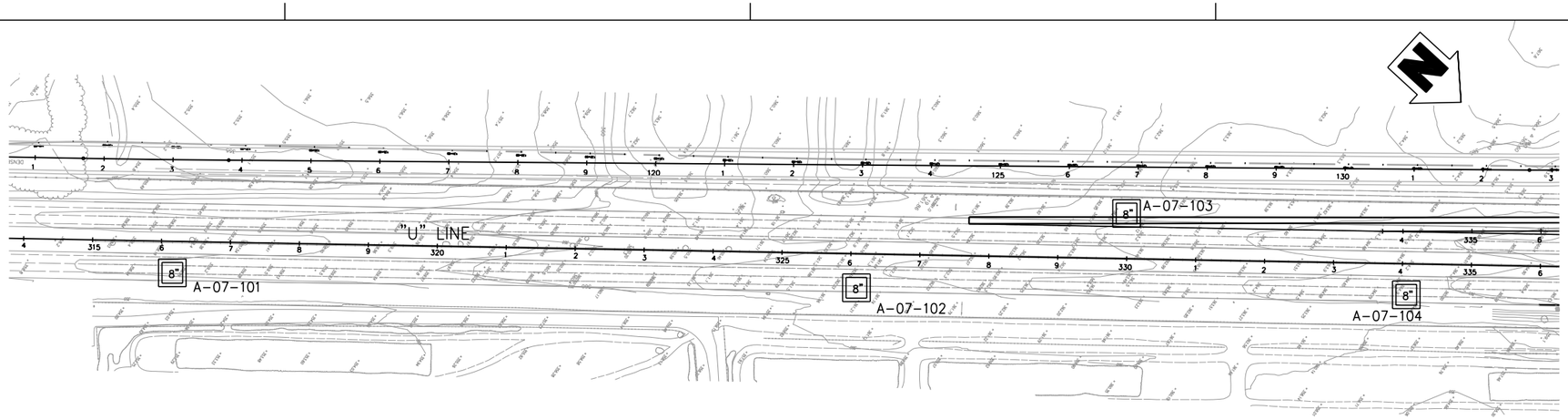
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131



PLAN
1" = 100'

Notes:
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BENCHMARK
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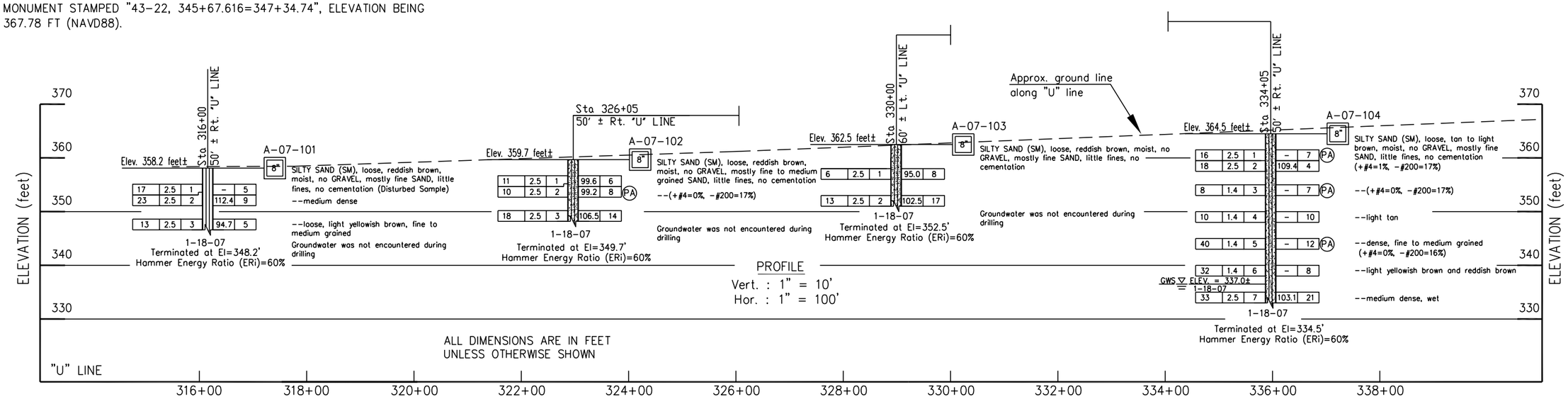

DESIGN OVERSIGHT	DRAWN BY	W. LI	P. CHAN	D. WANG	BRIDGE NO. –
SIGN OFF DATE	CHECKED BY	D. WANG	FIELD INVESTIGATION BY: DATE: JANUARY 2007	PROJECT ENGINEER	POST MILES –

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

CU 05 EA 474503

WILLOW ROAD/ROUTE 101 INTERCHANGE

LOG OF TEST BORINGS 1 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: 11/7/08 4/30/09 7/30/09 1/15/10

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–	----	----

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

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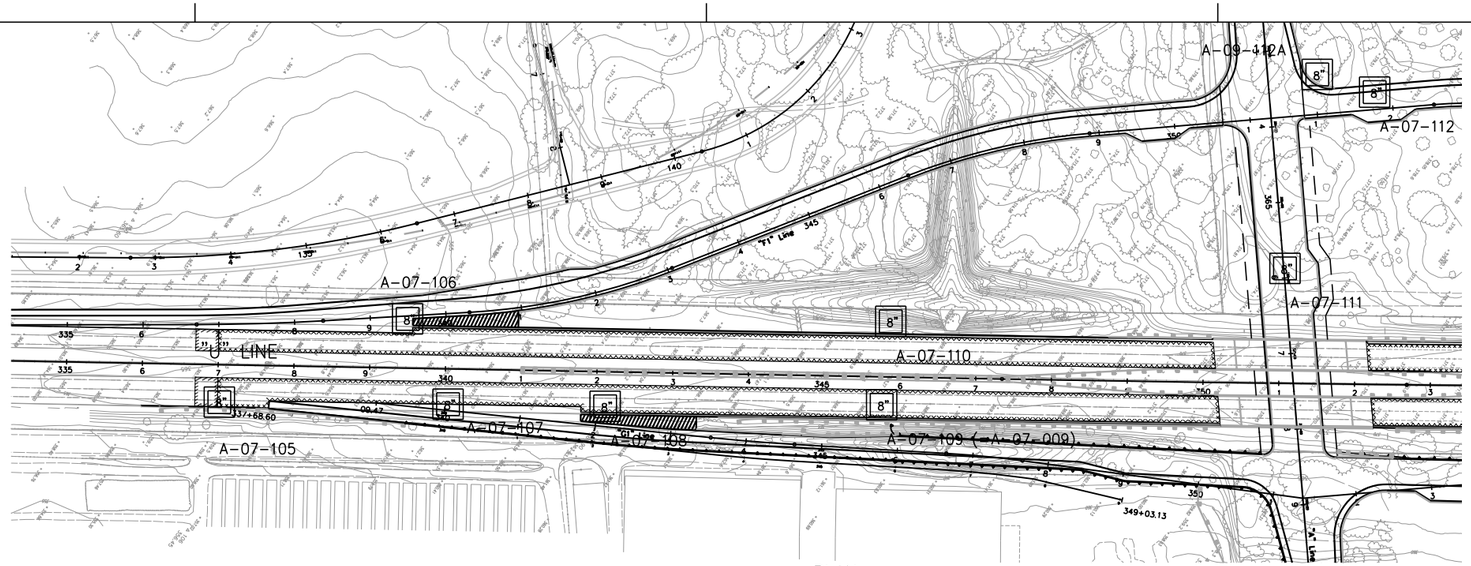

PLAN
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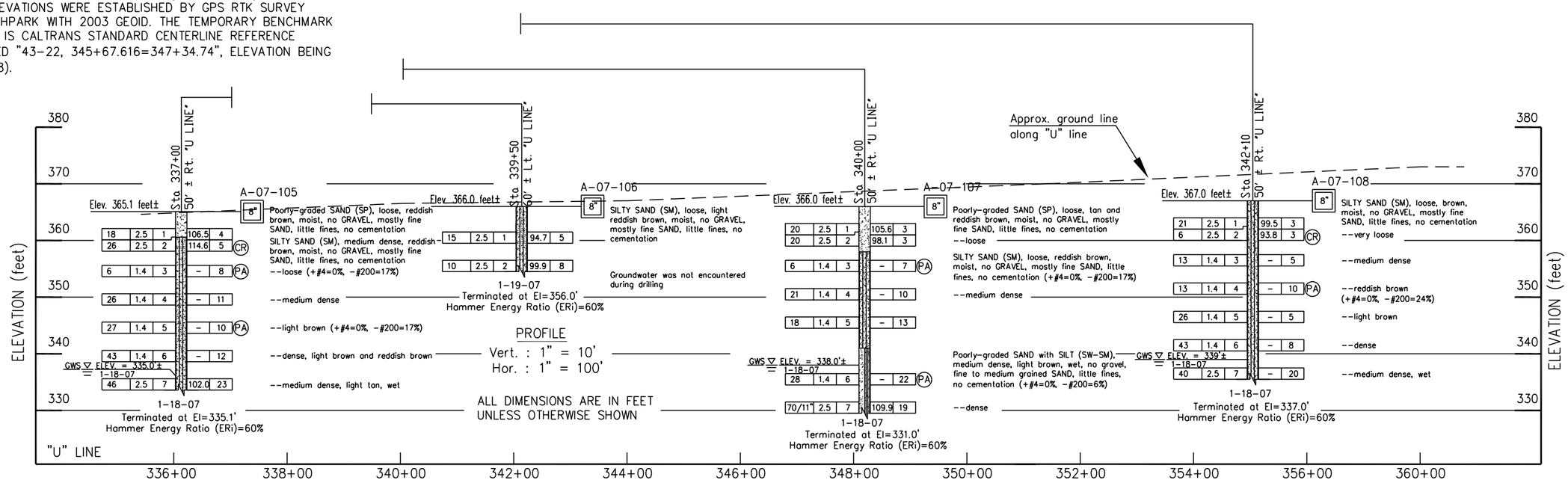

DESIGN OVERSIGHT	DRAWN BY W. LI	P. CHAN FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. WANG PROJECT ENGINEER	BRIDGE NO. –
SIGN OFF DATE	CHECKED BY D. WANG	DATE: JANUARY 2007			POST MILES –

WILLOW ROAD/ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 2 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11/17/08 4/30/09 7/10/09 1/15/10 SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–	----	----

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

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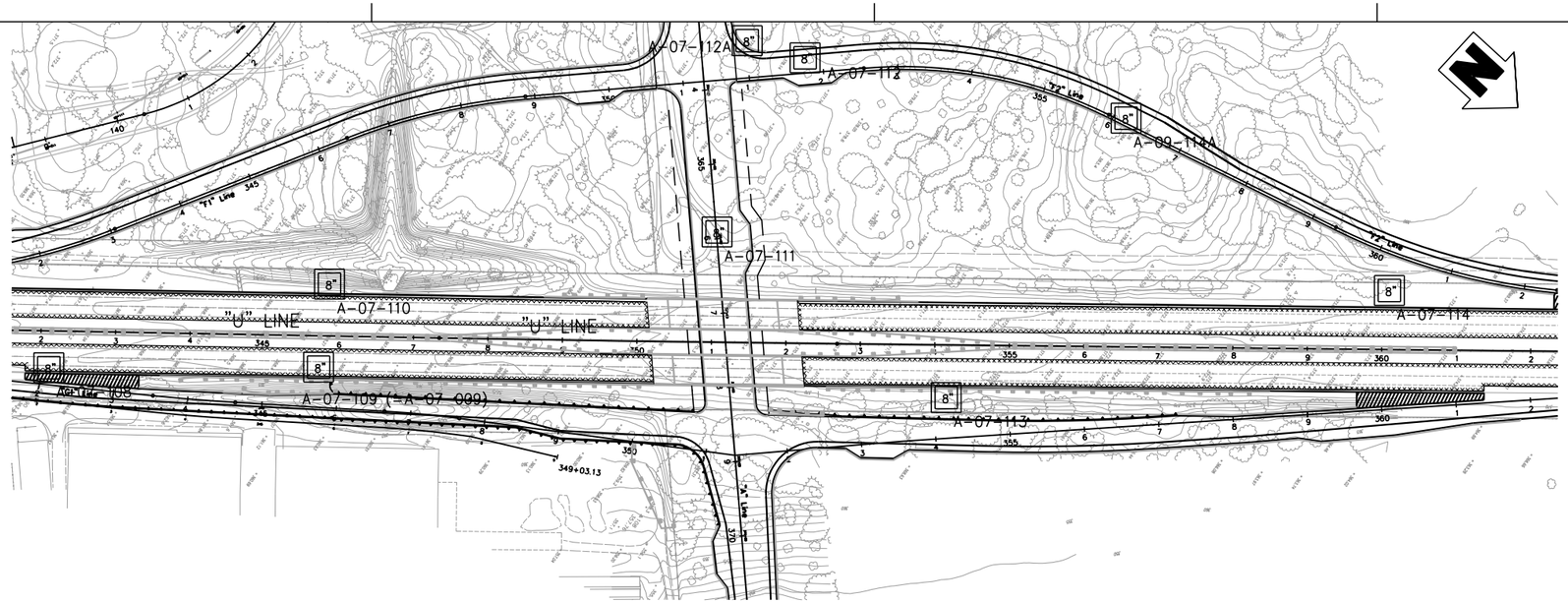

PLAN
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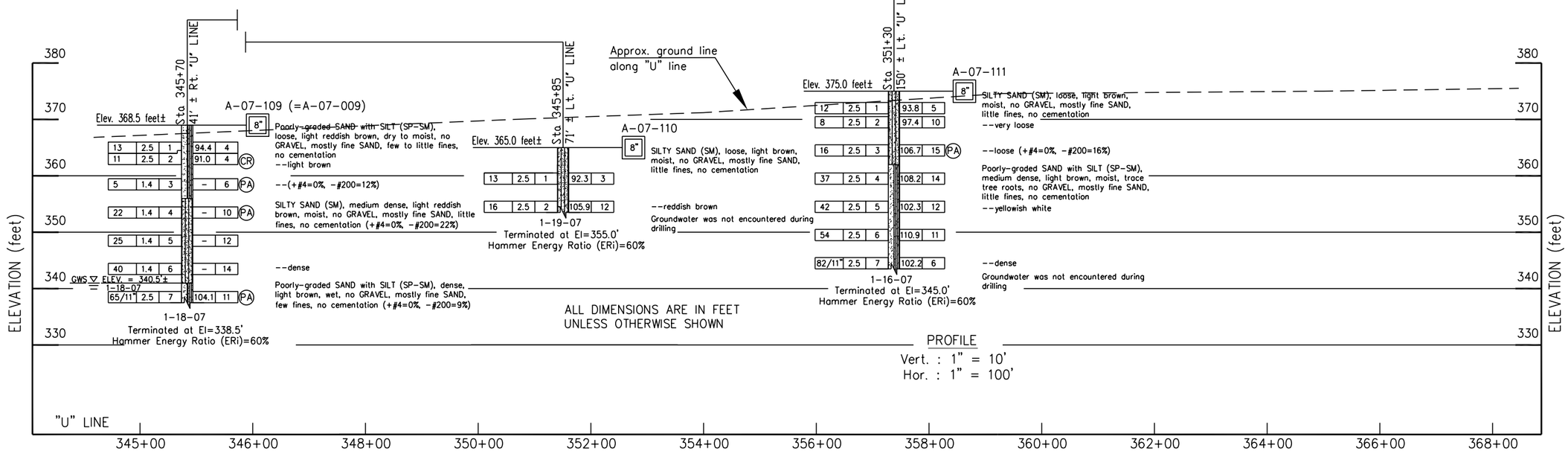

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 100'

DESIGN OVERSIGHT	DRAWN BY	W. LI	P. CHAN	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. WANG	BRIDGE NO. –
SIGN OFF DATE	CHECKED BY	D. WANG	FIELD INVESTIGATION BY: DATE: JANUARY 2007		PROJECT ENGINEER	POST MILES –

WILLOW ROAD/ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 3 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11/21/08 4/30/09 7/10/09 1/15/10 SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–	–	–

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

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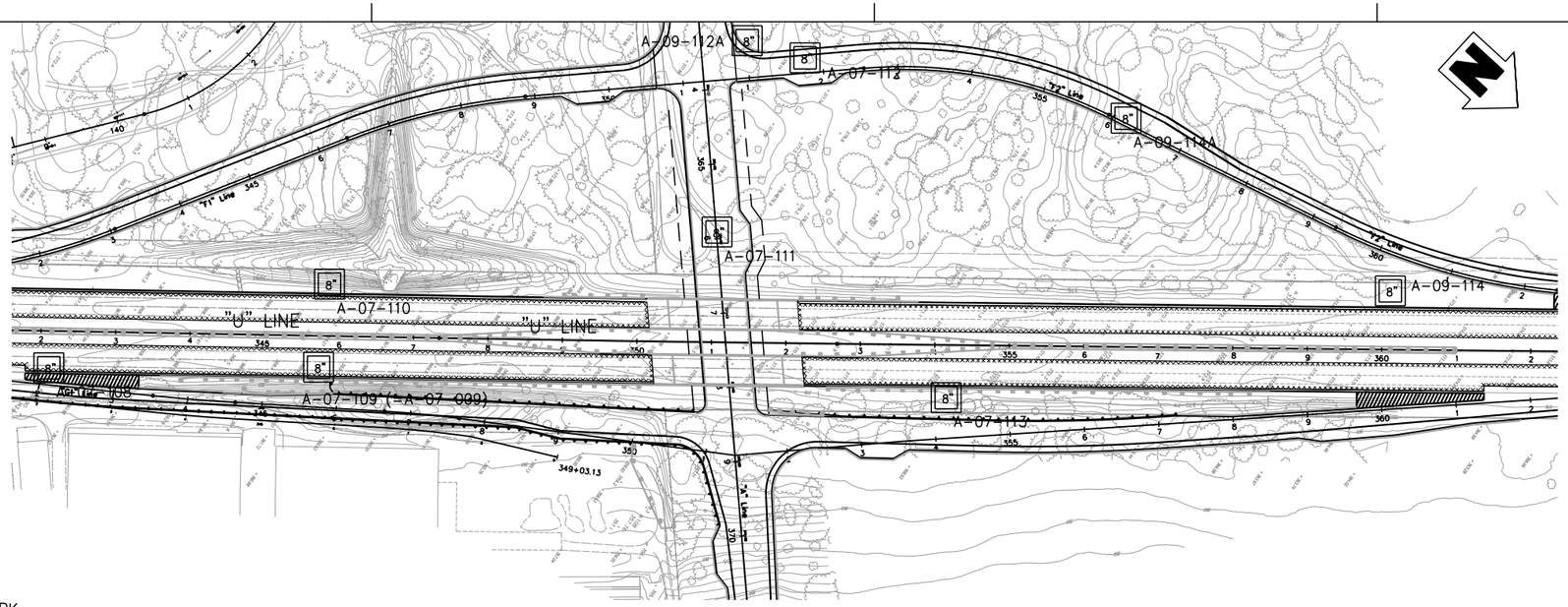

PLAN
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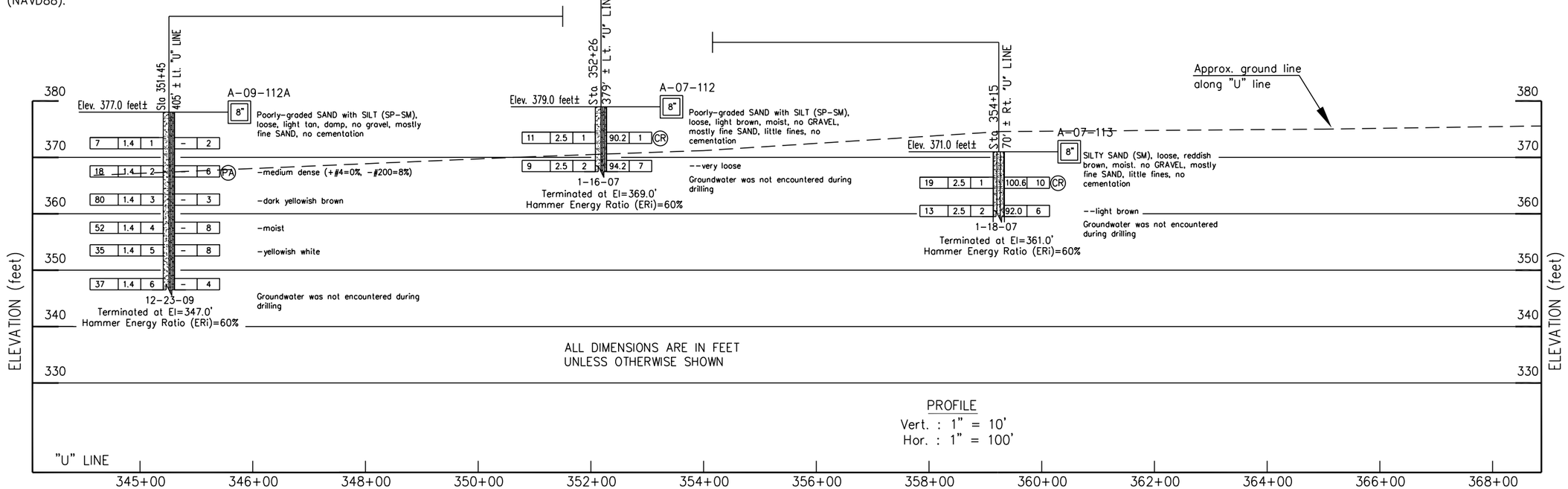

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 100'

DESIGN OVERSIGHT	DRAWN BY	W. LI	P. CHAN FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. WANG PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	D. WANG	DATE: JANUARY 2007		

BRIDGE NO. –
POST MILES –

WILLOW ROAD/ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 4 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11/21/08 4/30/09 7/10/09 1/15/10

SHEET OF

FILE => $REQUEST

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USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–	----	----

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

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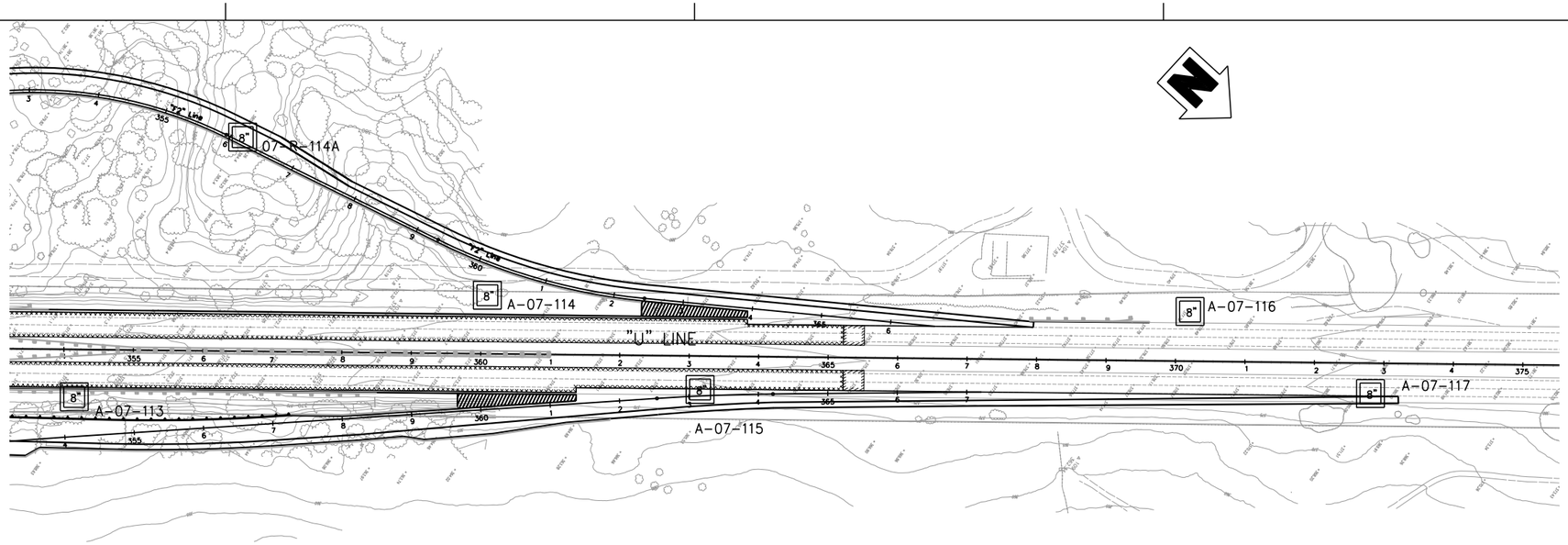

PLAN
1" = 100'

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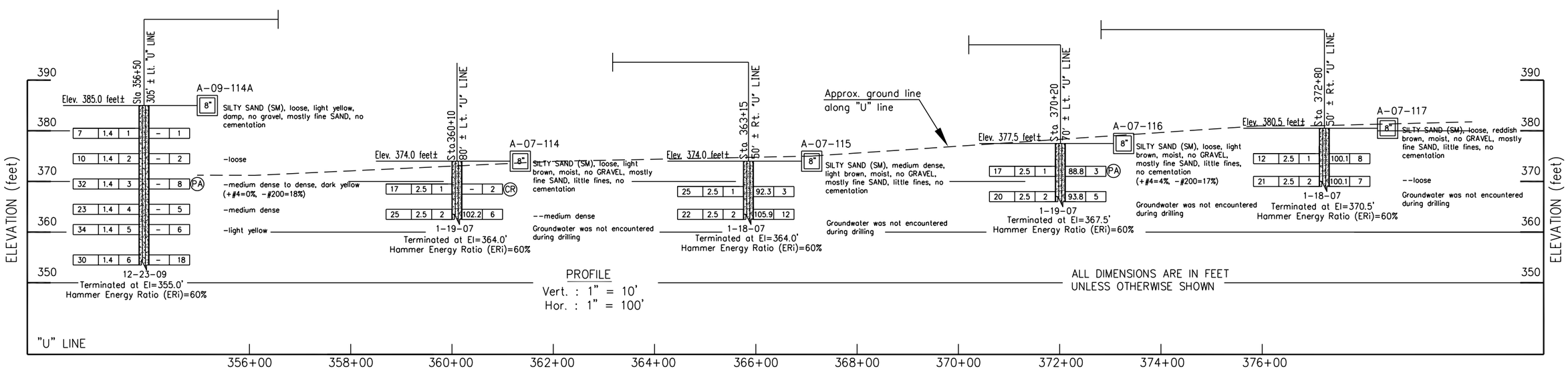

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 100'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	W. LI	P. CHAN FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	D. WANG PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	D. WANG	DATE: JANUARY 2007		

BRIDGE NO. –
POST MILES –

WILLOW ROAD/ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 5 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11/21/08 4/30/09 7/10/09 1/15/10

SHEET OF

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

Jan 15, 2010 – 10:00am S:\ACAD\203125.gt1\LOTB (Interchange Borings 1 thru 17) (GDMR).dwg

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	–		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/11 GEOTECHNICAL STATE OF CALIFORNIA

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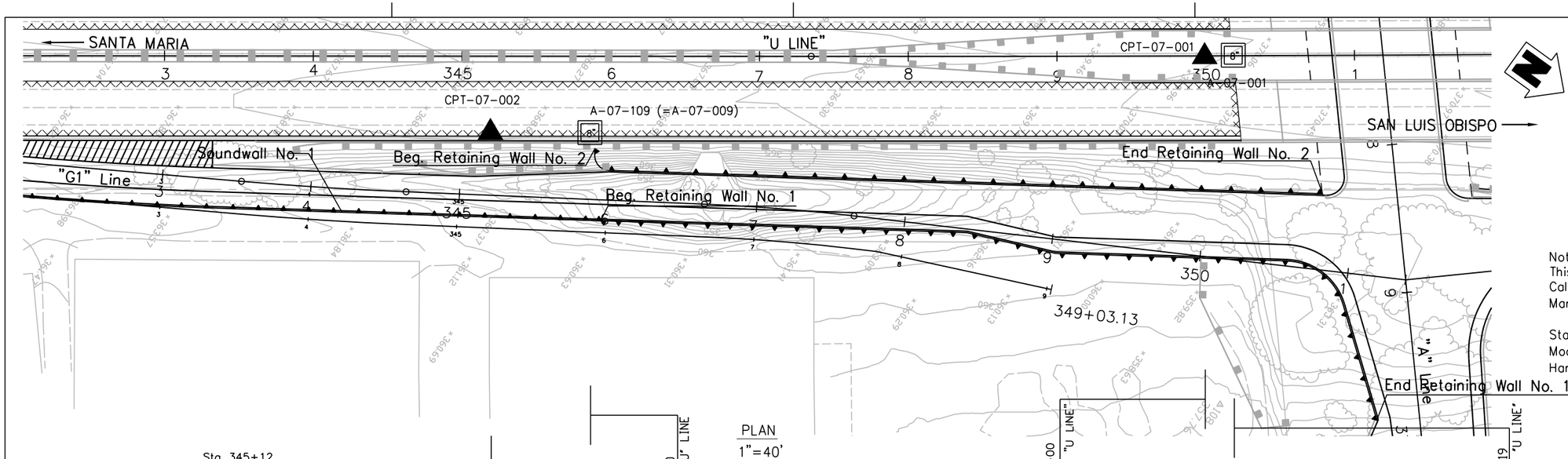

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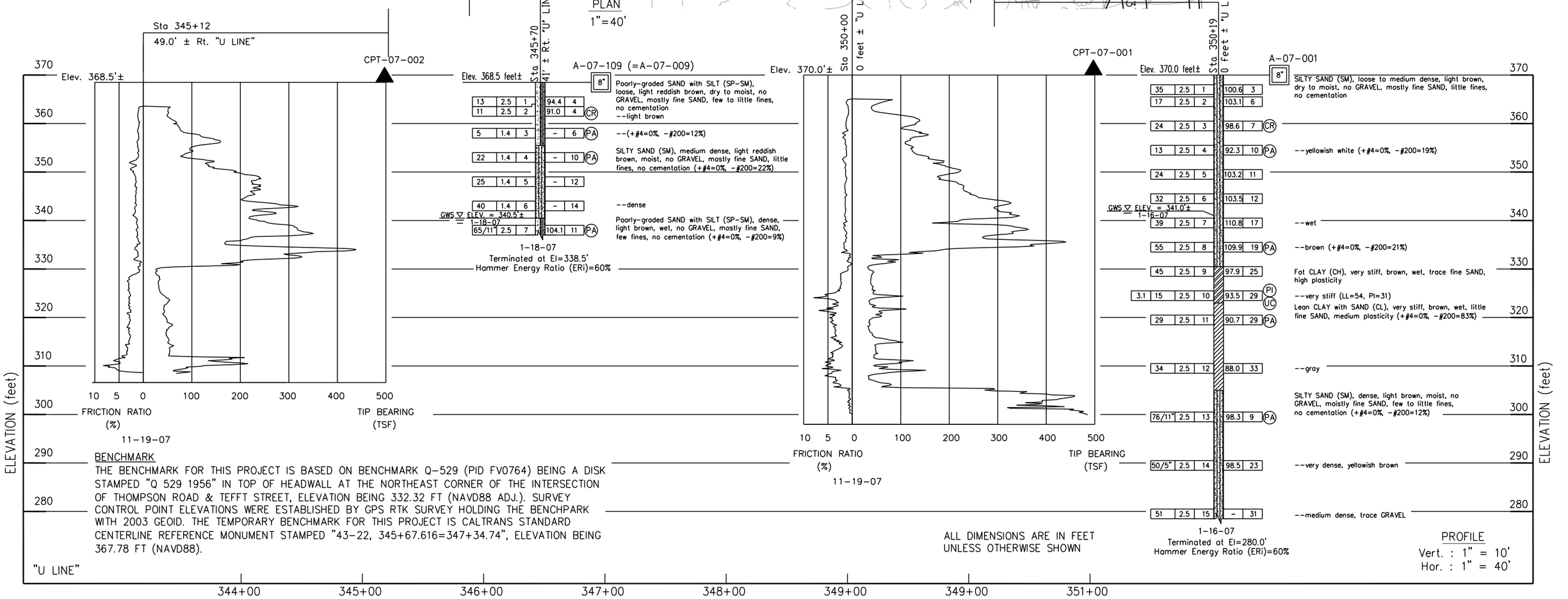

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DESIGN OVERSIGHT	DRAWN BY L. TRAN	L. BHANGOO FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY D. WANG	DATE: JANUARY AND NOVEMBER 2007	D. WANG PROJECT ENGINEER

BRIDGE NO. –
POST MILES –

WILLOW ROAD / ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 6 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11/07/08 4/30/09 7/30/09 1/15/10 SHEET OF

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

Jan 15, 2010 - 10:00am S:\ACAD\203125.gpt\LOTB (Ret Wall).dwg

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	101	5.9/6.9		

GEOTECHNICAL PROFESSIONAL — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — GARY PARIKH — No. G.E. 666 — Exp. 12/31/11 — GEOTECHNICAL — STATE OF CALIFORNIA

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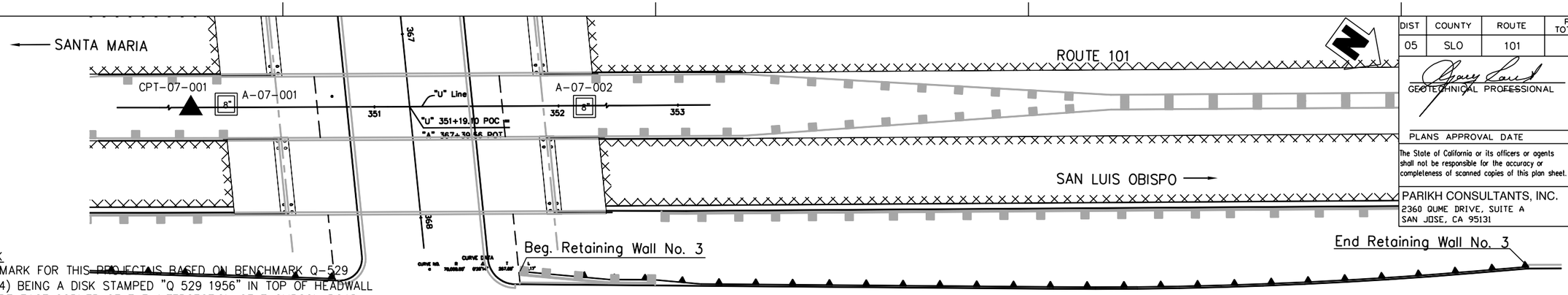
SAN JOSE, CA 95131



PLAN
1"=30'

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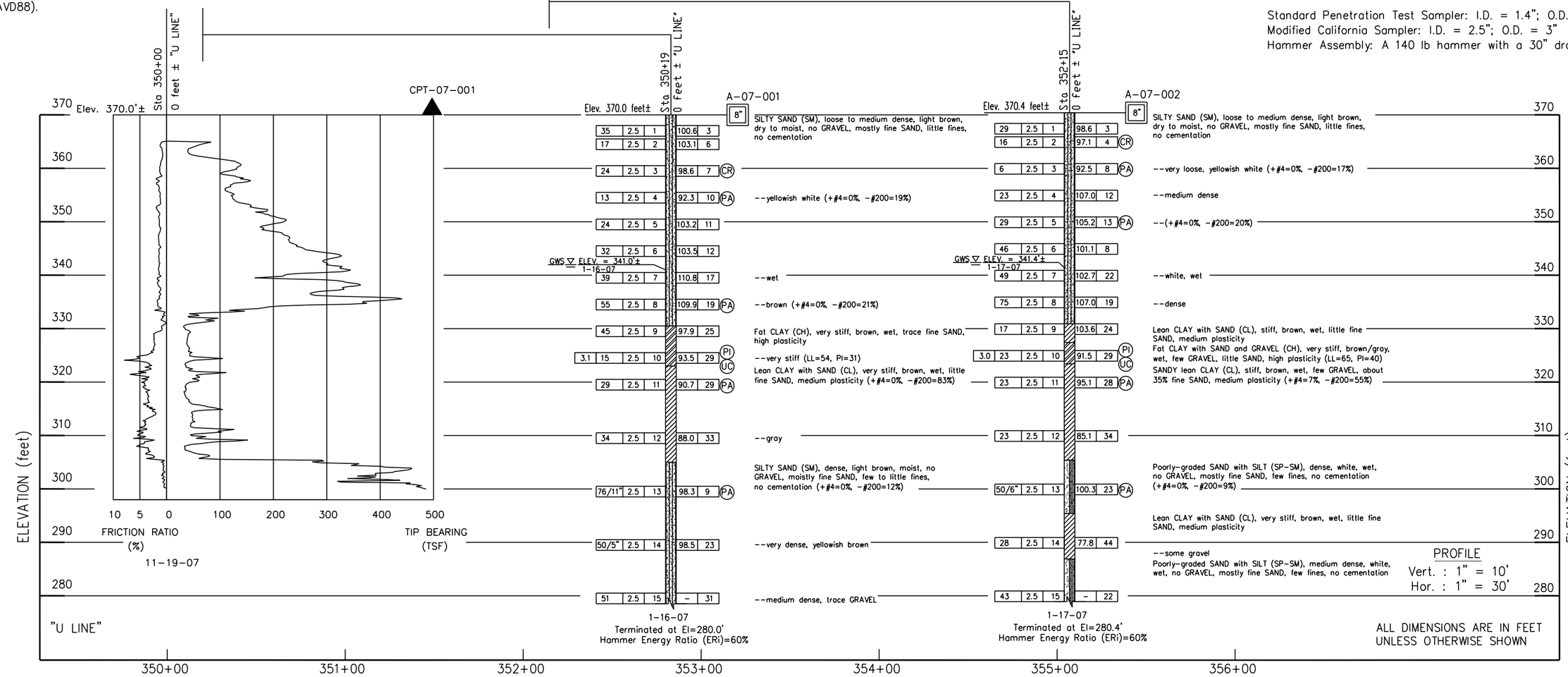

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 30'

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	DRAWN BY	L. TRAN	L. BHANGOO — FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	D. WANG	DATE: JANUARY AND NOVEMBER 2007

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

D. WANG — PROJECT ENGINEER

BRIDGE NO. –
POST MILES –

WILLOW ROAD / ROUTE 101 INTERCHANGE
LOG OF TEST BORINGS 7 OF 7

OGS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 06-01-09)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA 05-474503

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES 11/07/08 04/30/09 07/08/09 1/15/10 — SHEET — OF

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USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

Jan 15, 2010 - 10:01am S:\ACAD\203125.gpl\LOTB (Bridge).dwg

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	RTE 101	–		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

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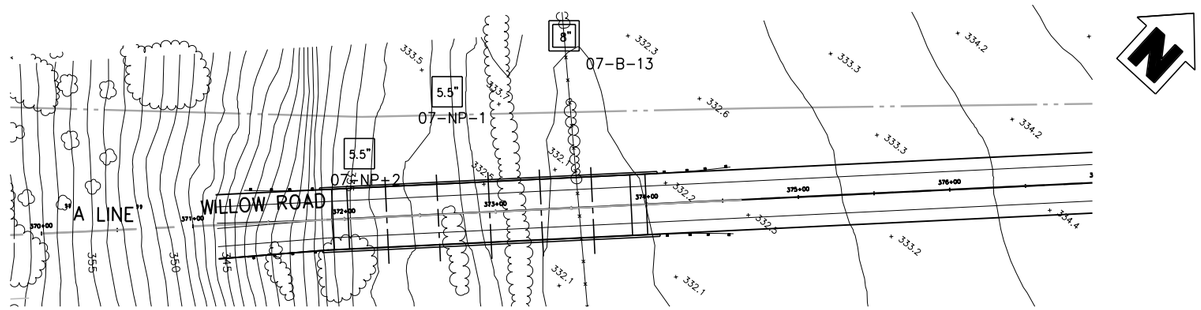
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131

BENCHMARK
THE BENCHMARK FOR THIS PROJECT IS BASED ON BENCHMARK Q-529 (PID FV0764) BEING A DISK STAMPED "Q 529 1956" IN TOP OF HEADWALL AT THE NORTHEAST CORNER OF THE INTERSECTION OF THOMPSON ROAD & TEFFT STREET, ELEVATION BEING 332.32 FT (NAVD88 ADJ.). SURVEY CONTROL POINT ELEVATIONS WERE ESTABLISHED BY GPS RTK SURVEY HOLDING THE BENCHPARK WITH 2003 GEOID. THE TEMPORARY BENCHMARK FOR THIS PROJECT IS CALTRANS STANDARD CENTERLINE REFERENCE MONUMENT STAMPED "43-22, 345+67.616=347+34.74", ELEVATION BEING 367.78 FT (NAVD88).

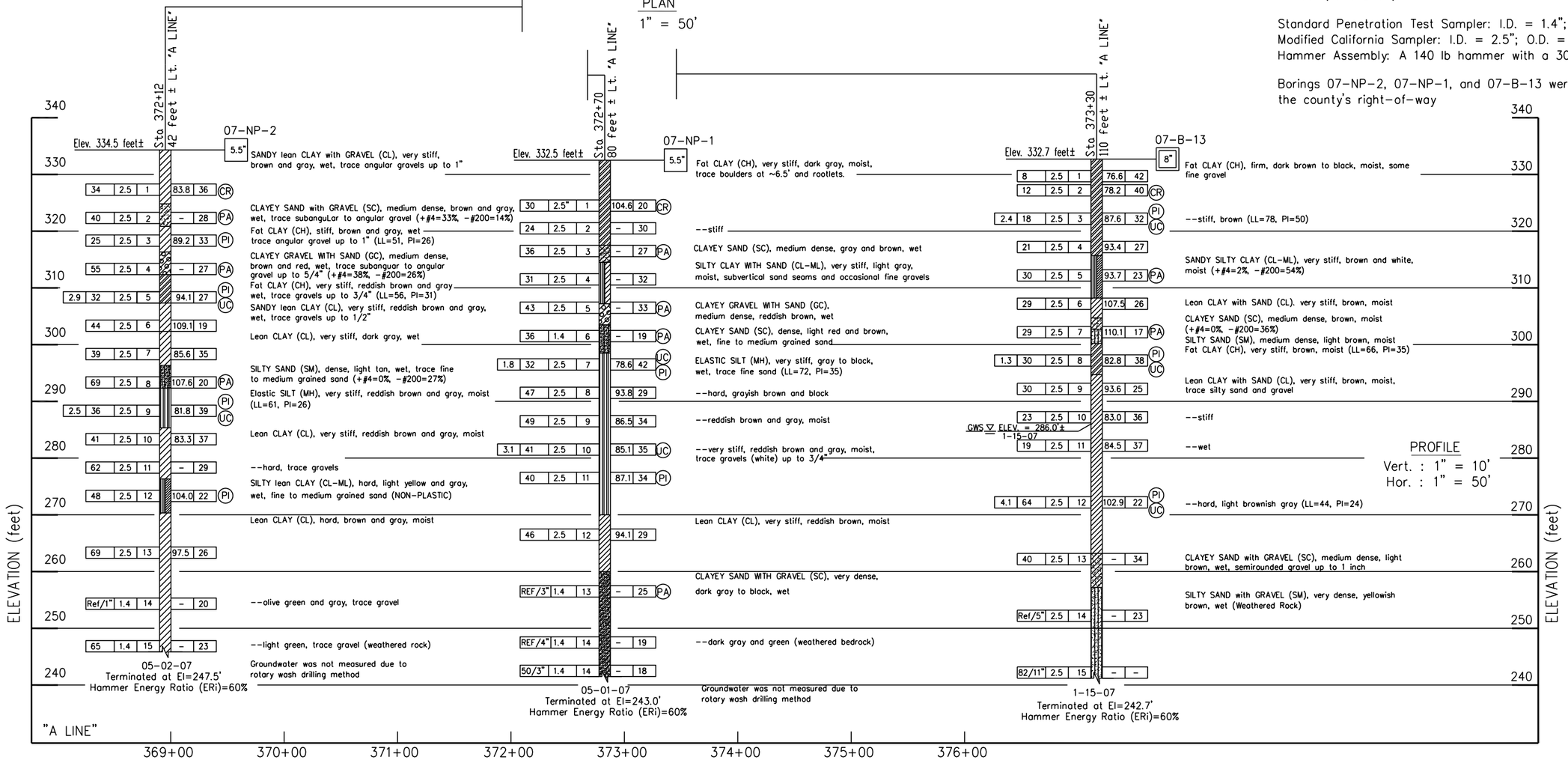


PLAN
1" = 50'

Notes:
This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock Logging Classification, and Presentation Manual (June 2007)

Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
Modified California Sampler: I.D. = 2.5"; O.D. = 3"
Hammer Assembly: A 140 lb hammer with a 30" drop

Borings 07-NP-2, 07-NP-1, and 07-B-13 were drilled in the county's right-of-way



X DESIGN OVERSIGHT	DRAWN BY	LAM TRAN	L. Bhangoo FIELD INVESTIGATION BY:	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	PERRY CHAN PROJECT ENGINEER
X SIGN OFF DATE	CHECKED BY	PERRY CHAN	DATE: Jan 2007		

BRIDGE NO. –
POST MILE –

NIPOMO CREEK BRIDGE
LOG OF TEST BORINGS 2 OF 2

OSF GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 2/25/05)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA

DISREGARD PRINTS BEARING EARLIER REVISION DATES 07/10/09

REVISION DATES (PRELIMINARY STAGE ONLY) SHEET OF

FILE => $REQUEST

USERNAME => $USER

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	RTE 101	–		

GEOTECHNICAL PROFESSIONAL DATE

REGISTERED PROFESSIONAL ENGINEER
GARY PARIKH
No. G.E. 666
Exp. 12/31/09
GEOTECHNICAL
STATE OF CALIFORNIA

PLANS APPROVAL DATE

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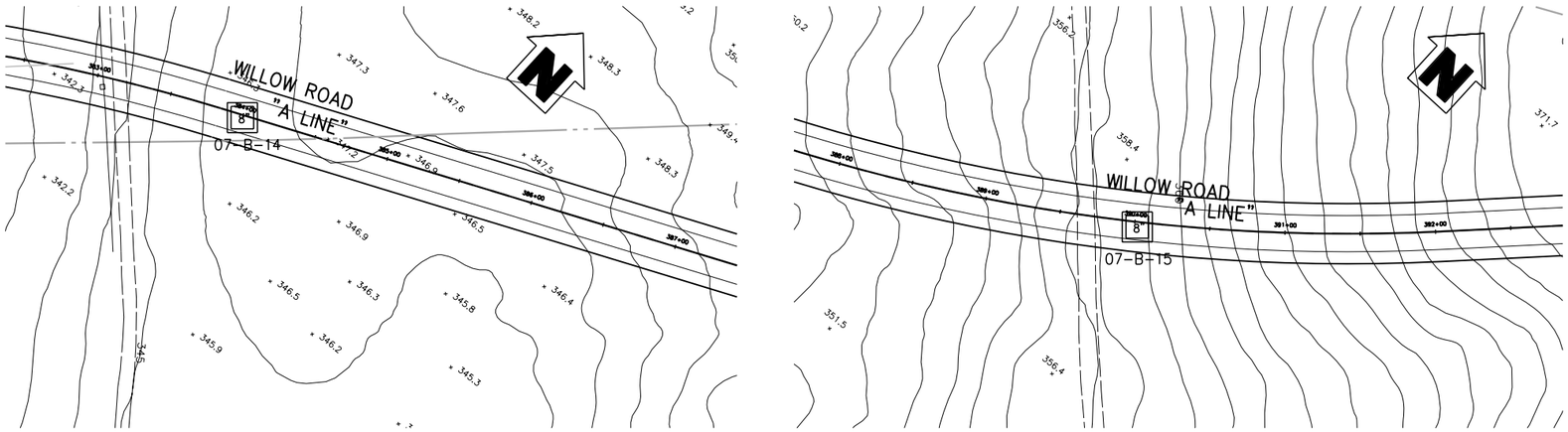
SAN JOSE, CA 95131



PLAN
1" = 50'

Notes:
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Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2"
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Borings 07-B-14 and 07-B-15 were drilled in the county's right-of-way

BENCHMARK
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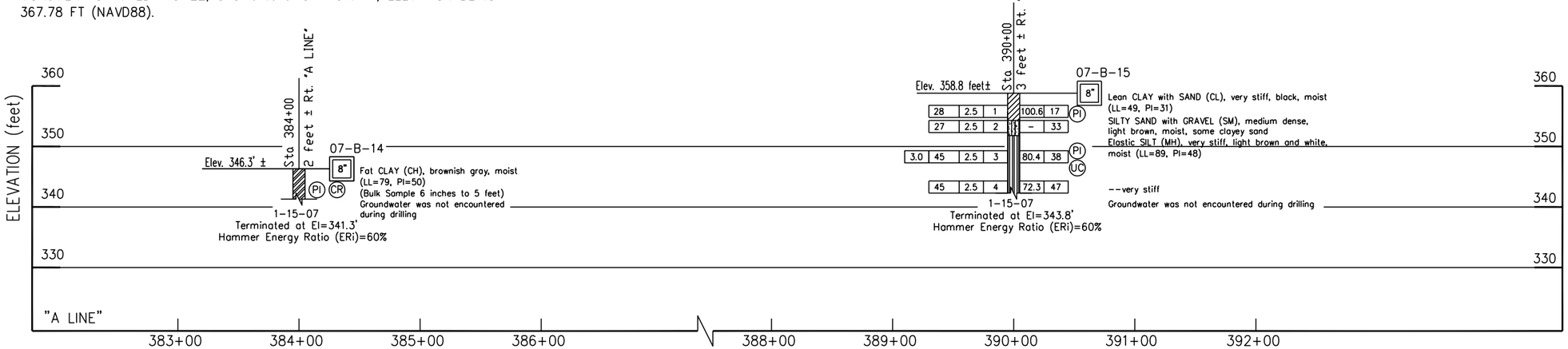

ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SHOWN

PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

X DESIGN OVERSIGHT	DRAWN BY	LAM TRAN	L. Bhangoo FIELD INVESTIGATION BY:	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	PERRY CHAN PROJECT ENGINEER	BRIDGE NO. –	WILLOW ROAD EXTENSION AT ROUTE 101
X SIGN OFF DATE	CHECKED BY	PERRY CHAN	DATE: Jan 2007			POST MILE –	LOG OF TEST BORINGS
OSF GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 2/25/05)				ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3	CU EA	DISREGARD PRINTS BEARING EARLIER REVISION DATES	REVISION DATES (PRELIMINARY STAGE ONLY) 07/10/09 SHEET OF

FILE => $REQUEST

USERNAME => $USER

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	RTE 101	–		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

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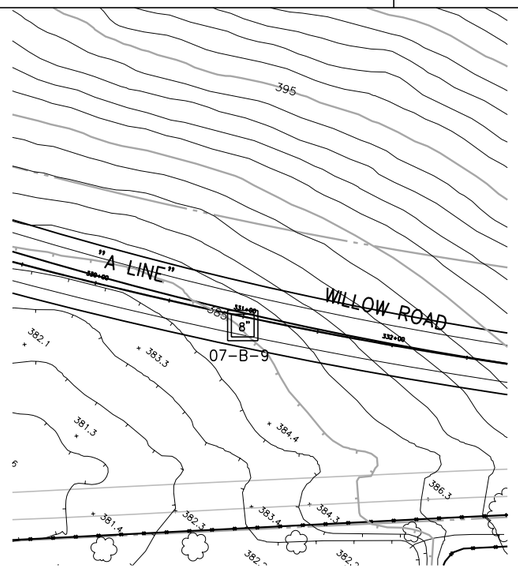
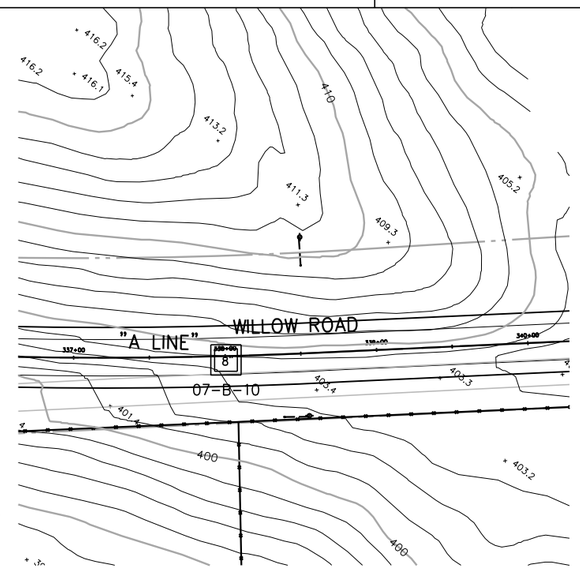
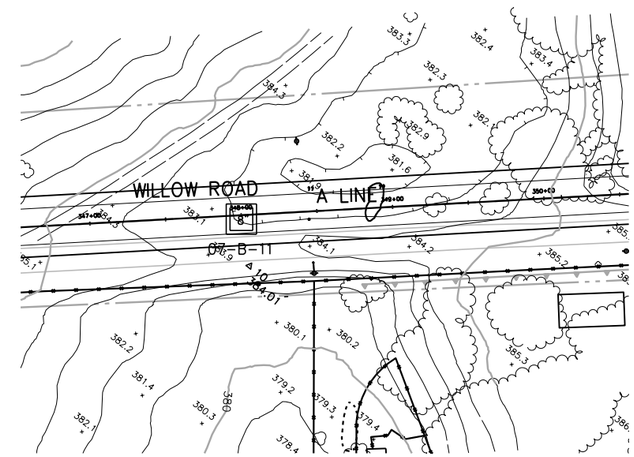
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131







Notes:
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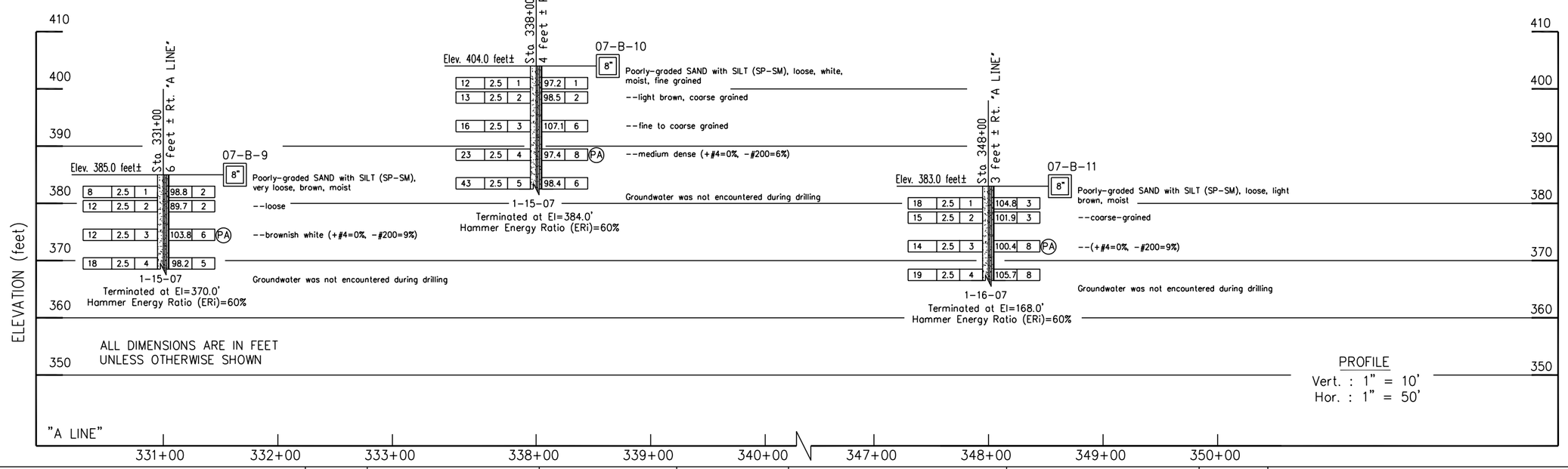
PLAN
1" = 50'



X DESIGN OVERSIGHT	DRAWN BY	LAM TRAN	L. Bhangoo FIELD INVESTIGATION BY:	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	DAVID WANG PROJECT ENGINEER
X SIGN OFF DATE	CHECKED BY	PERRY CHAN	DATE: Jan 2007		

BRIDGE NO. –
POST MILE –

WILLOW ROAD EXTENSION
LOG OF TEST BORINGS

OSF GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 2/25/05)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 10/30/08 7/30/09 SHEET OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
05	SLO	RTE 101	–		

GEOTECHNICAL PROFESSIONAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/09 GEOTECHNICAL STATE OF CALIFORNIA

PLANS APPROVAL DATE

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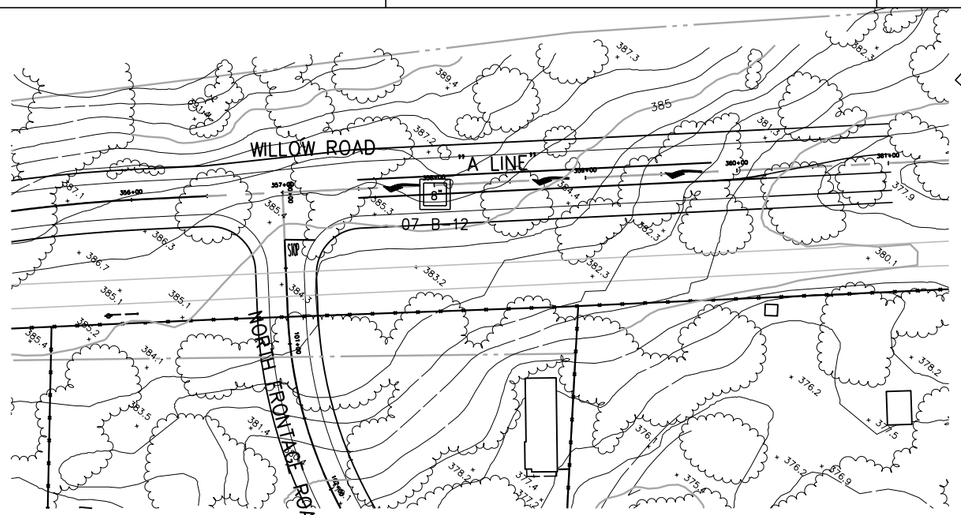
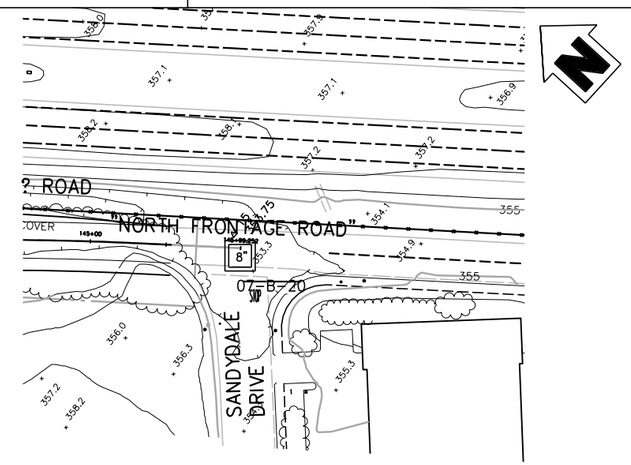
PARIKH CONSULTANTS, INC.
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131





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PLAN
1" = 50'

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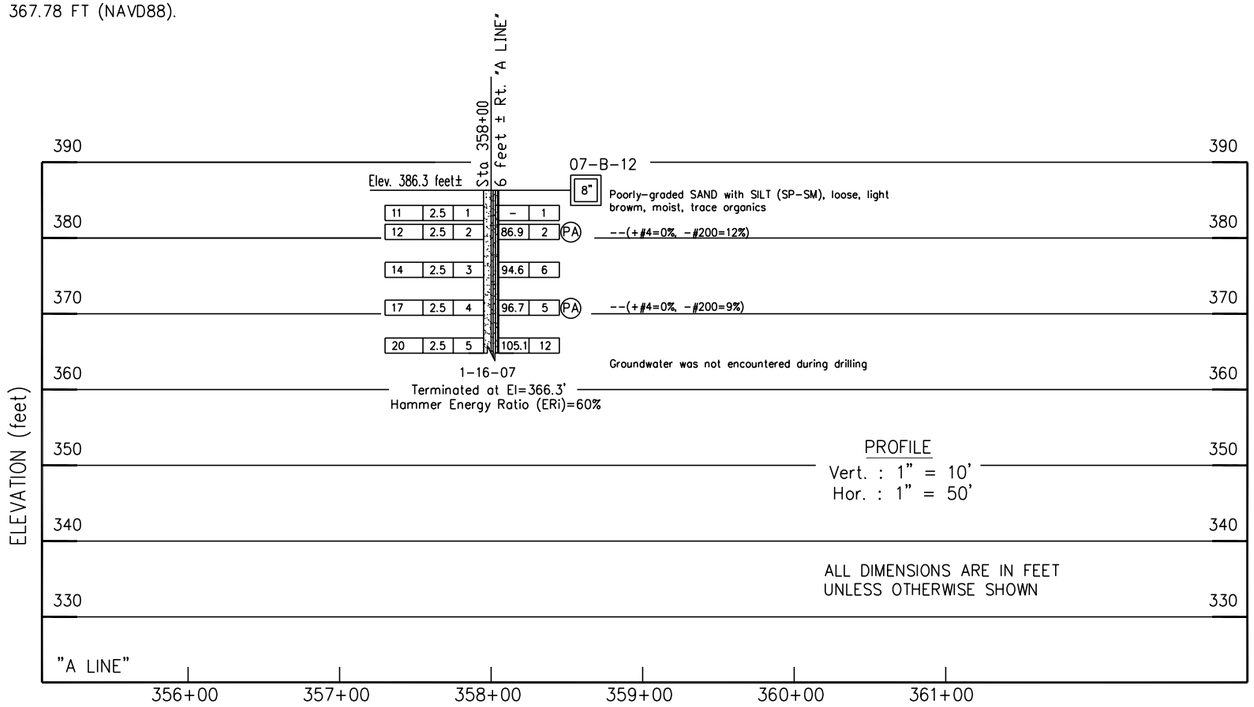
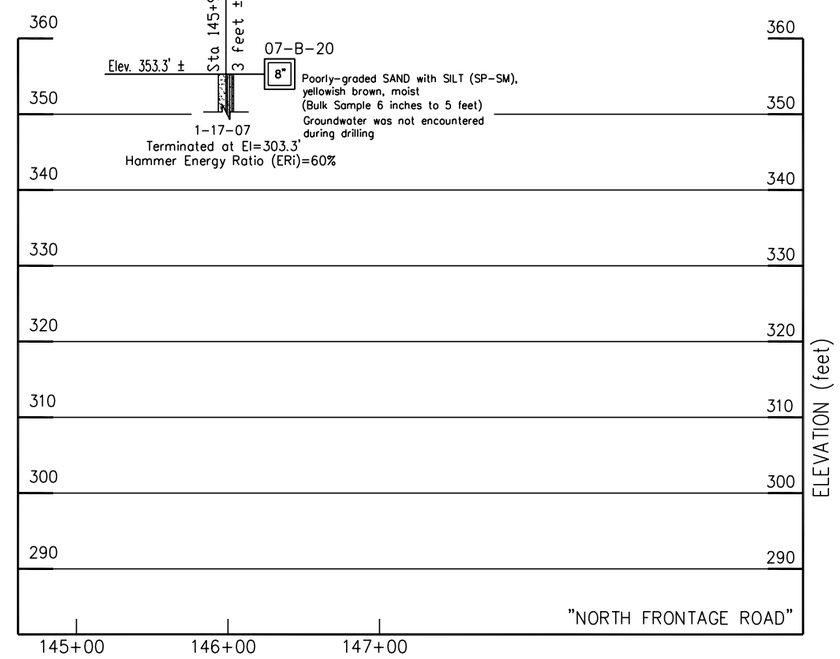


PROFILE
Vert. : 1" = 10'
Hor. : 1" = 50'

ALL DIMENSIONS ARE IN FEET
UNLESS OTHERWISE SHOWN



X DESIGN OVERSIGHT	DRAWN BY	LAM TRAN	L. Bhangoo FIELD INVESTIGATION BY:	PREPARED FOR THE COUNTY OF SAN LUIS OBISPO DEPARTMENT OF PUBLIC WORKS	DAVID WANG PROJECT ENGINEER
X SIGN OFF DATE	CHECKED BY	PERRY CHAN	DATE: Jan 2007		

BRIDGE NO. –
POST MILE –

WILLOW ROAD EXTENSION
LOG OF TEST BORINGS

OSF GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 2/25/05)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU
EA

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 10/30/08 7/30/09 SHEET OF

Jul 13, 2009 - 5:35pm S:\VCAD\203125.gd\LOTB (Willow Rd Extension - Phase 2).dwg

PARIKH CONSULTANTS

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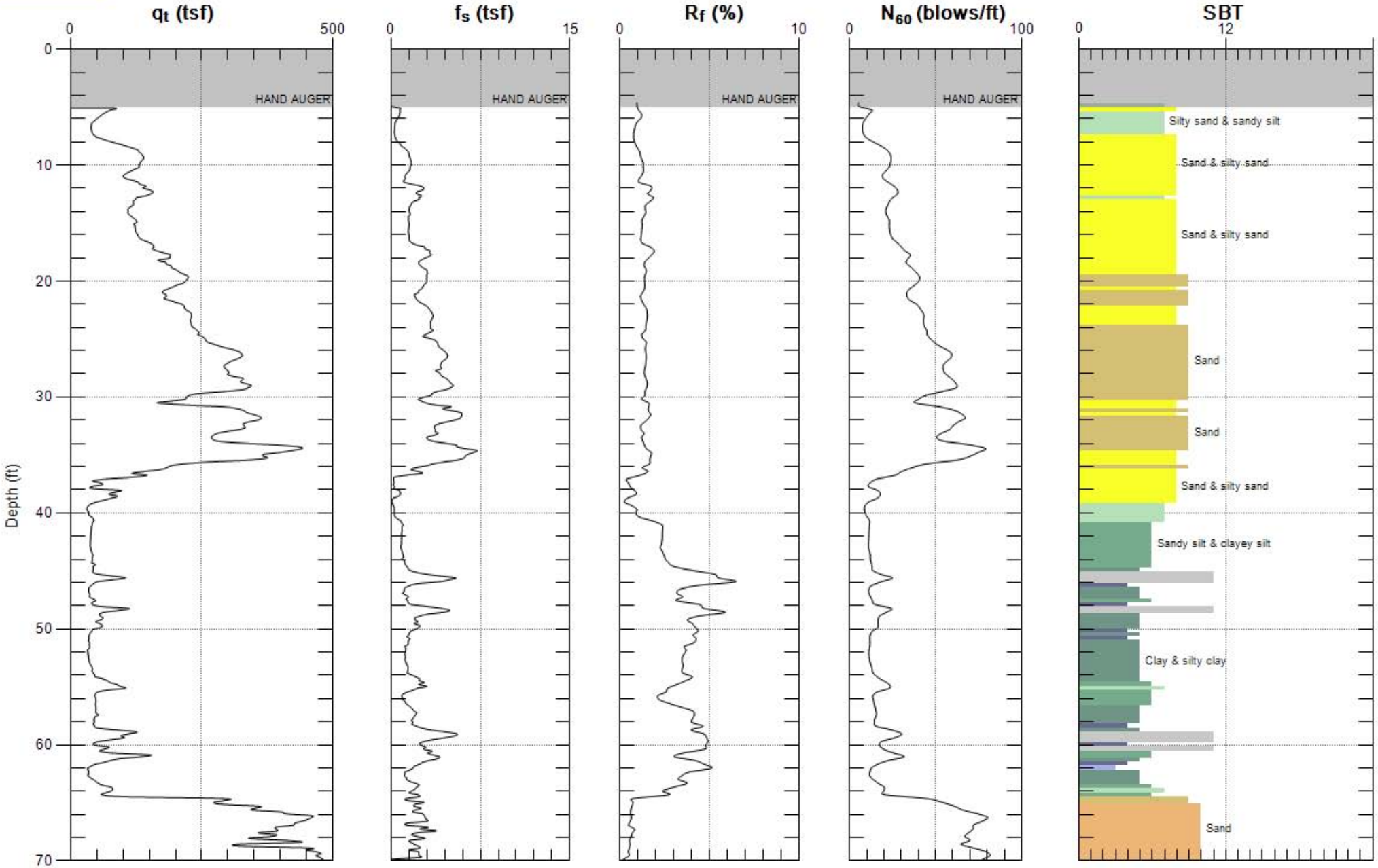
Sounding: CPT-01

Engineer: P.CHAN
Date: 11/19/2007 01:43



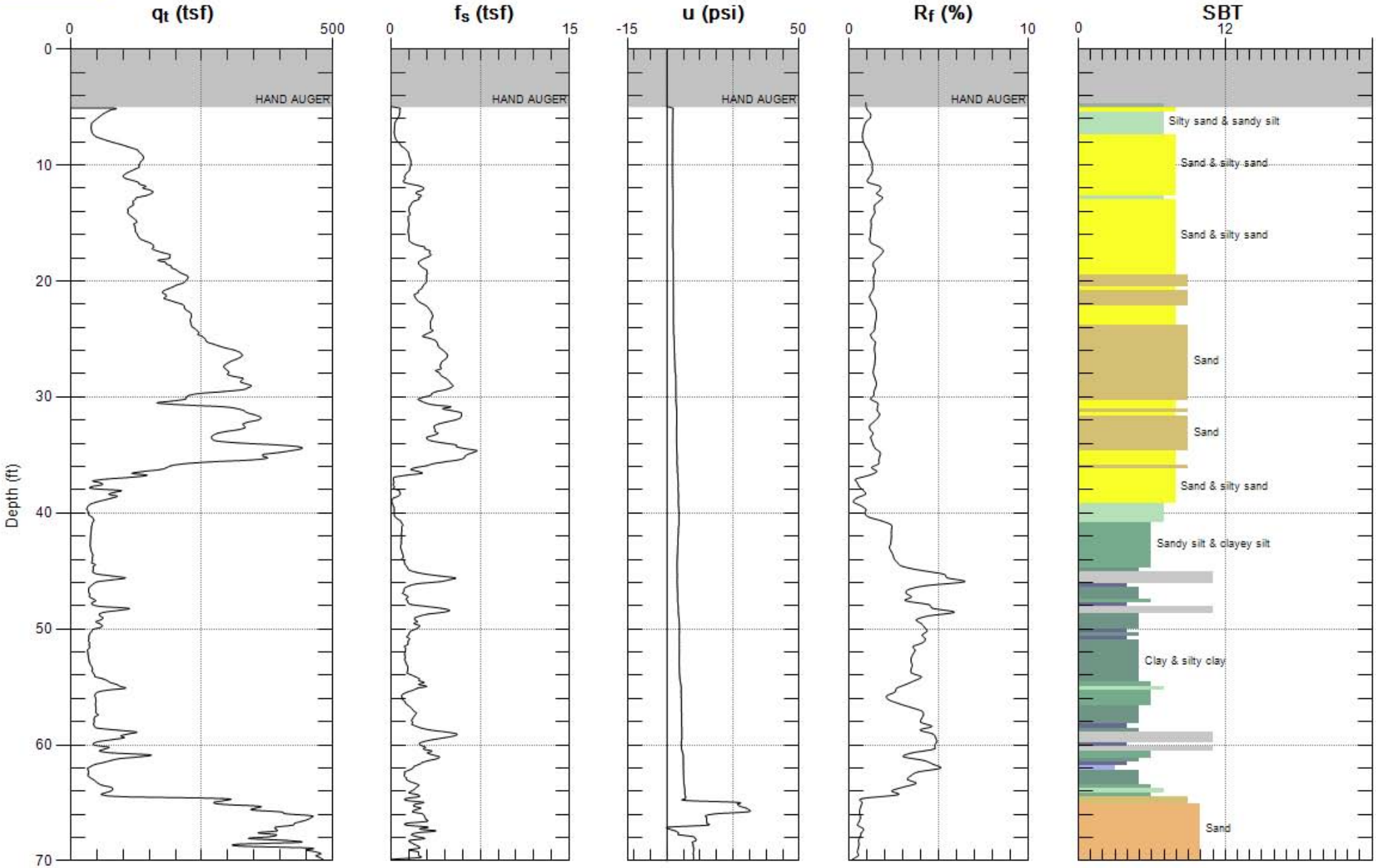
Max. Depth: 70.046 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

PARIKH CONSULTANTS

Site: WILLOW RD. EXT.
Sounding: CPT-01

Engineer: P.CHAN
Date: 11/19/2007 01:43



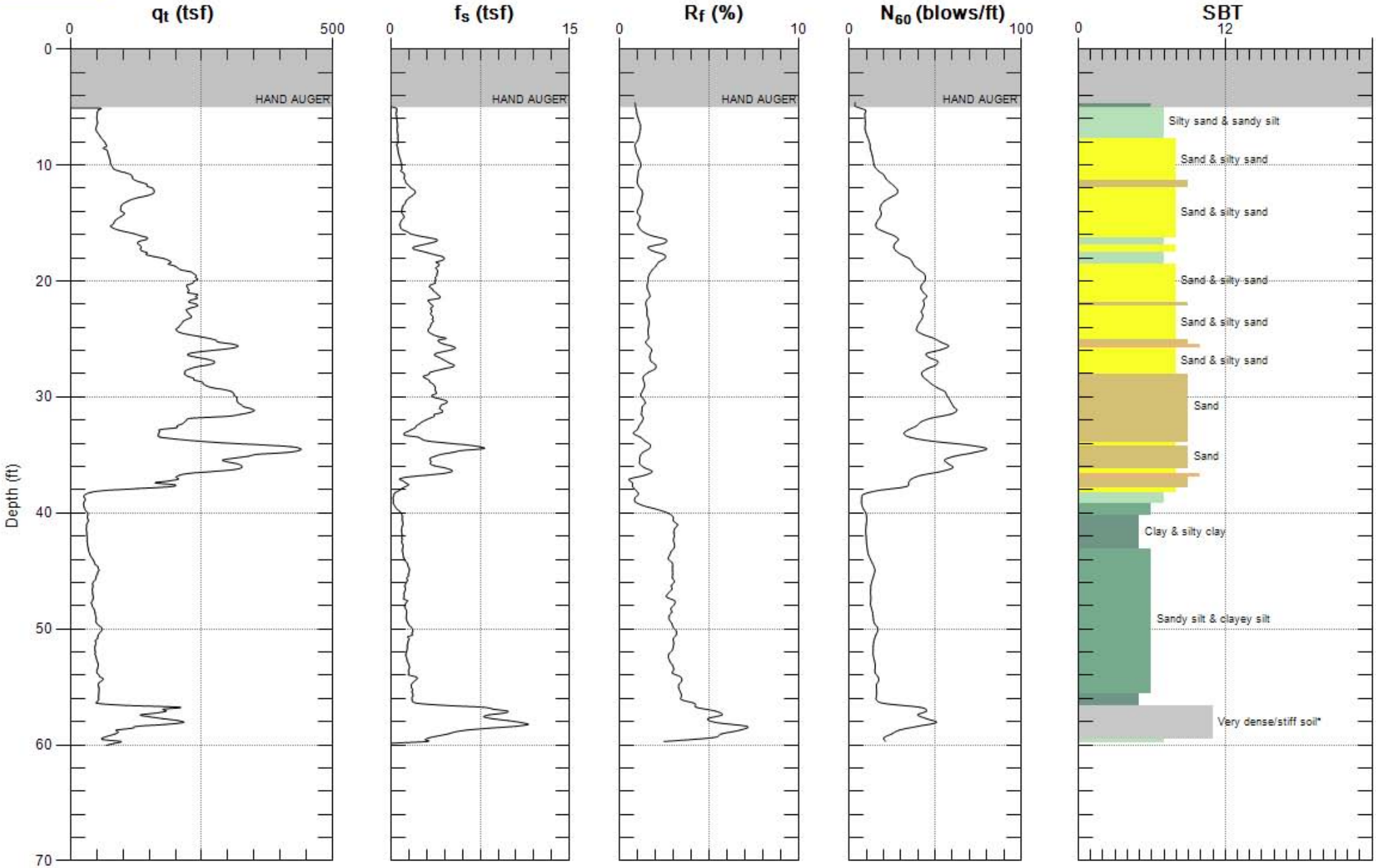
Max. Depth: 70.046 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

PARIKH CONSULTANTS

Site: WILLOW RD. EXT.
Sounding: CPT-02

Engineer: P.CHAN
Date: 11/19/2007 12:59



Max. Depth: 60.039 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

PARIKH CONSULTANTS

Site: WILLOW RD. EXT.
Sounding: CPT-02

Engineer: P.CHAN
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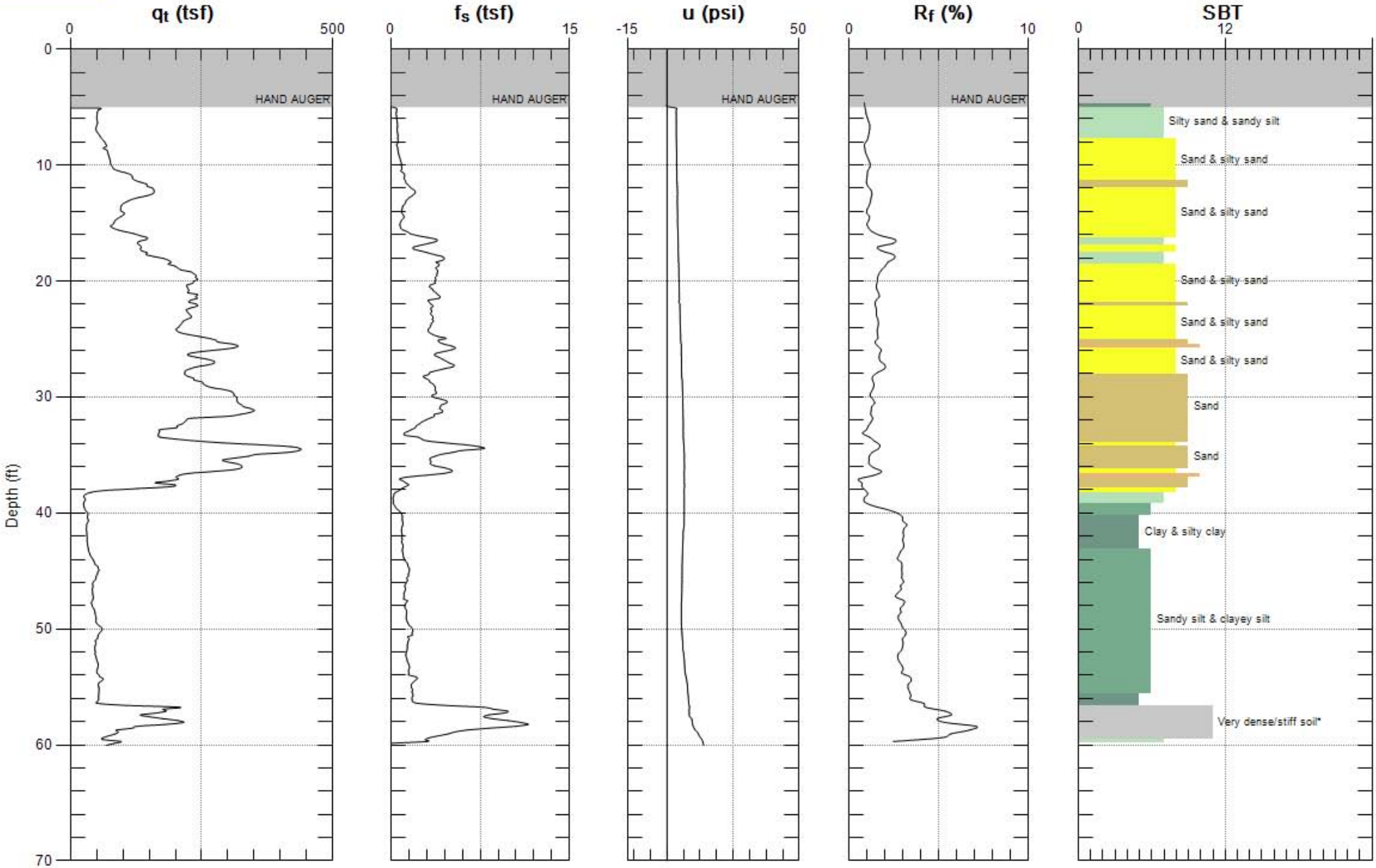


Max. Depth: 60.039 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

APPENDIX B

APPENDIX B

LABORATORY TESTS

Classification Tests
The field classification of the samples was visually verified in the laboratory according to the Unified Soil Classification System. The results are presented in “Log of Test Borings”, Appendix A.

Moisture-Density
The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with ASTM Test Method D 2216-92. This information was used to classify and correlate the soils. The results are presented at the appropriate depths on the "Log of Test Borings", Appendix A.

Atterberg Limits
The Atterberg Limits were determined for selected samples of the fine-grained materials. These results were used to classify the soils, as well as to obtain an indication of the effective strength characteristics and expansion potential with variations in moisture content. The Atterberg Limits were determined in general accordance with ASTM Test Method D 4318-93. The results of these tests are presented on Plate B-2, “Plasticity Chart”.

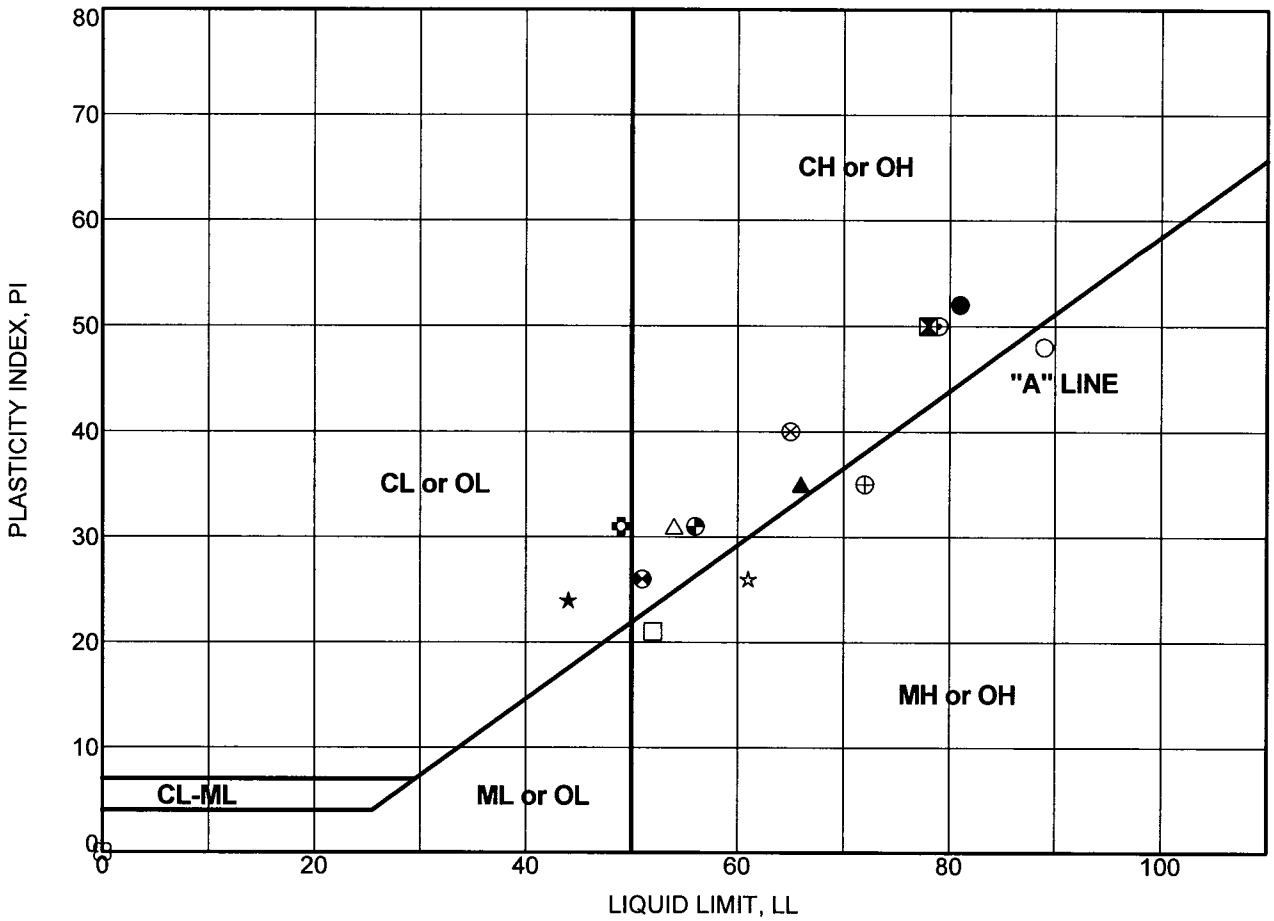
Grain Size Classification
Grain size classification tests (ASTM Test Method D422-63) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plate B-3A and Plate B-3I, “Grain Size Distribution Curves”.

Unconfined Compression Tests
Strength tests were performed on selected undisturbed samples using unconfined compression machine. Unconfined compression tests were performed in general accordance with ASTM Test Method D 2166-91. The results are presented on “Log of Test Borings”, Appendix A.

R-value Tests
R-value tests were performed on representative bulk samples for pavement design. The tests were performed according to California Test Method 301. The test results are presented on Plates B-4A and B-4F. Strength tests were performed on selected treated samples per California Test Method 373. The results are presented on Plate B-5A.

Corrosion Tests
Corrosion tests were performed on selected samples to determine the corrosion potential of the soils. The pH and minimum resistively tests were performed according to California Test Method 643. The tests were performed by Sunland Analytical. The test results are presented on Plate B-6A thru Plate B-6L.

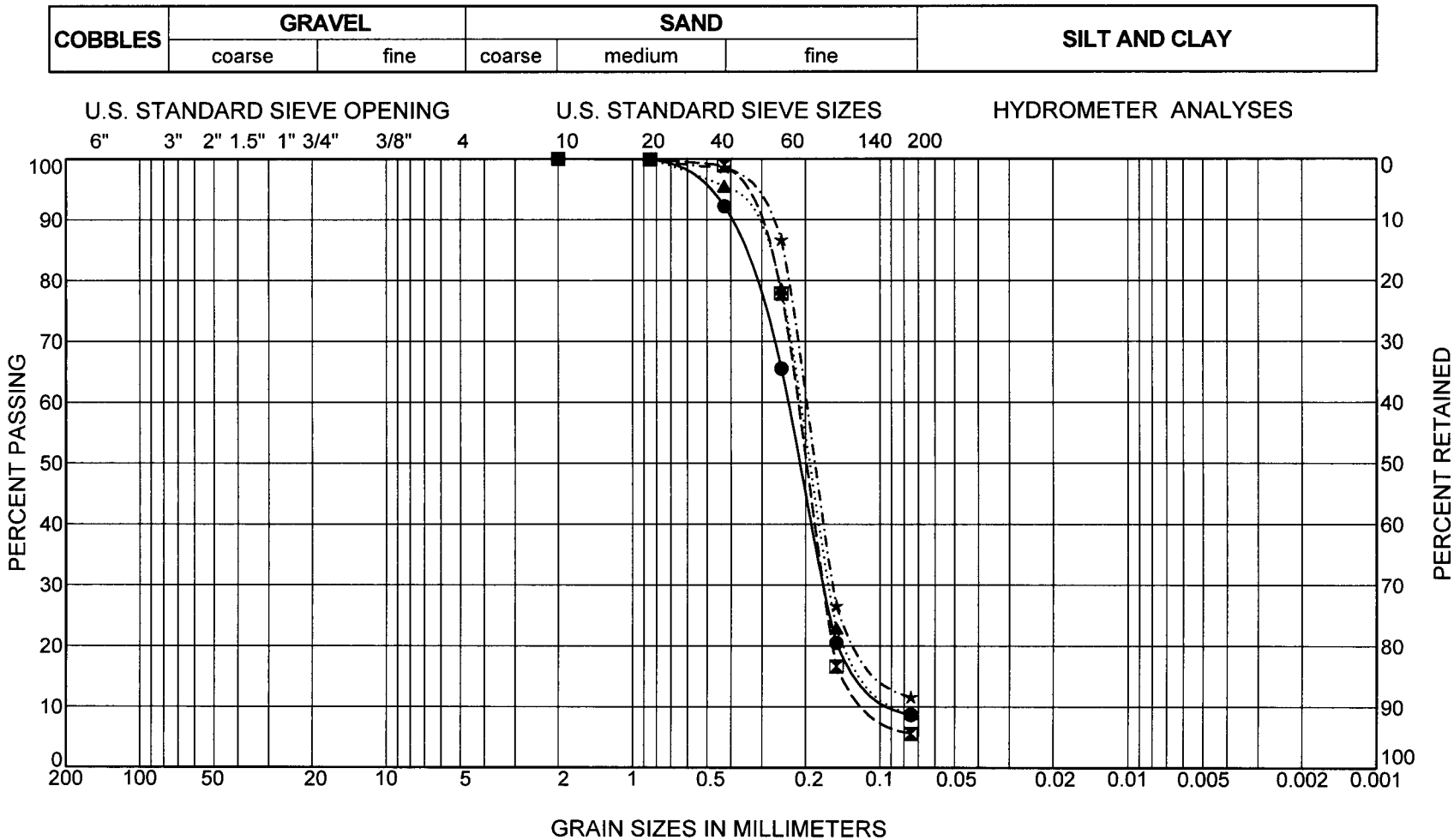
Boring No. as Drilled in 2007 (in Caltrans Right-of-Way)	Boring Designation as per Caltrans 2007 Soil and Rock Logging, Classification, and Presentation Manual
R-1	A-07-101
R-2	A-07-102
R-3	A-07-103
RW-4	A-07-104
RW-5	A-07-105
R-6	A-07-106
RW-7	A-07-107
RW-8	A-07-108
RW-9	A-07-109 (=A-07-009)
R-10	A-07-110
R-11	A-07-111
R-12	A-07-112
R-12A	A-09-112A
R-13	A-07-113
R-14	A-07-114
R-14A	A-09-114A
R-15	A-07-115
R-16	A-07-116
R-17	A-07-117
CPT-1	CPT-07-001
CPT-2	CPT-07-002
BR-1	A-07-001
BR-2	A-07-002



PLASTICITY CHART

Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
B-13	MC-1	2.0	●	77	81	29	52	FAT CLAY (CH)
B-13	MC-3	9.5	⊠	32	78	28	50	FAT CLAY (CH)
B-13	MC-8	34.5	▲	38	66	31	35	FAT CLAY (CH)
B-13	MC-12	59.5	★	22	44	20	24	LEAN CLAY (CL)
B-14	BULK	5.0	⊙	-	79	29	50	FAT CLAY (CH)
B-15	MC-1	2.0	✿	17	49	18	31	LEAN CLAY (CL)
B-15	MC-3	9.5	○	38	89	41	48	ELASTIC SILT (MH)
BR-1	MC-10	44.5	△	28	54	23	31	FAT CLAY (CH)
BR-2	MC-10	44.5	⊗	29	65	25	40	FAT CLAY (CH)
NP-1	MC-7	35.0	⊕	42	72	37	35	ELASTIC SILT (MH)
NP-1	MC-11	55.0	□	34	52	31	21	ELASTIC SILT (MH)
NP-2	MC-3	15.0	⊗	33	51	25	26	FAT CLAY (CH)
NP-2	MC-5	25.0	◕	27	56	25	31	FAT CLAY (CH)
NP-2	MC-9	45.0	☆	39	61	35	26	ELASTIC SILT (MH)
NP-2	MC-12	60.0	✿	22	NP	NP	NP	SILTY CLAY (CL-ML)

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
B-09	MC-3	9.5	●			POORLY-GRADED SAND WITH SILT (SP-SM)
B-10	MC-4	14.5	⊠			POORLY-GRADED SAND WITH SILT (SP-SM)
B-11	MC-3	9.5	▲			POORLY-GRADED SAND WITH SILT (SP-SM)
B-12	MC-2	5.0	★			POORLY-GRADED SAND WITH SILT (SP-SM)

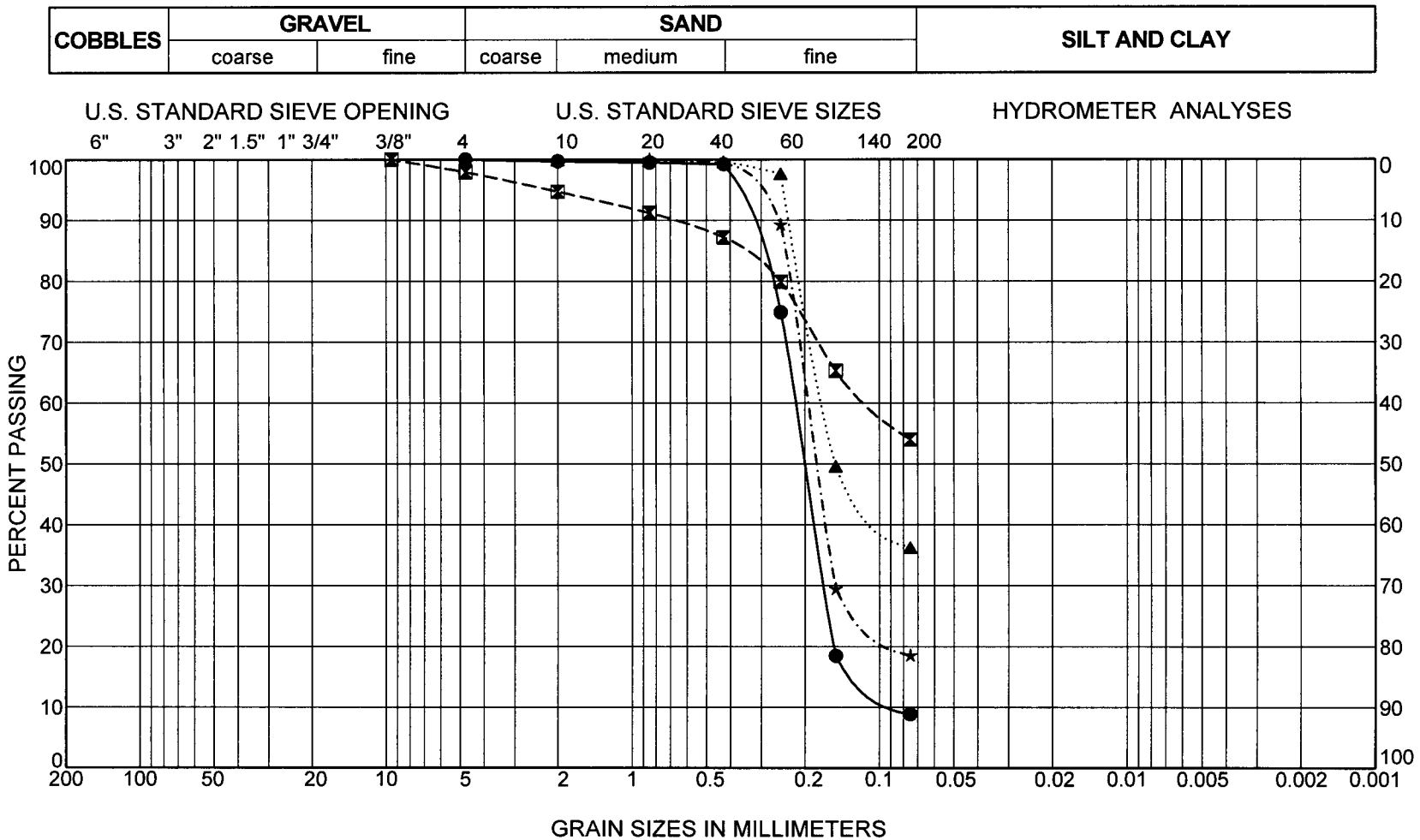
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3A

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
B-12	MC-4	14.5	●			POORLY-GRADED SAND WITH SILT (SP-SM)
B-13	MC-3	9.5	⊠	78	50	FAT CLAY (CH)
B-13	MC-7	29.5	▲			CLAYEY SAND (SC)
BR-1	MC-4	14.5	★			SILTY SAND (SM)

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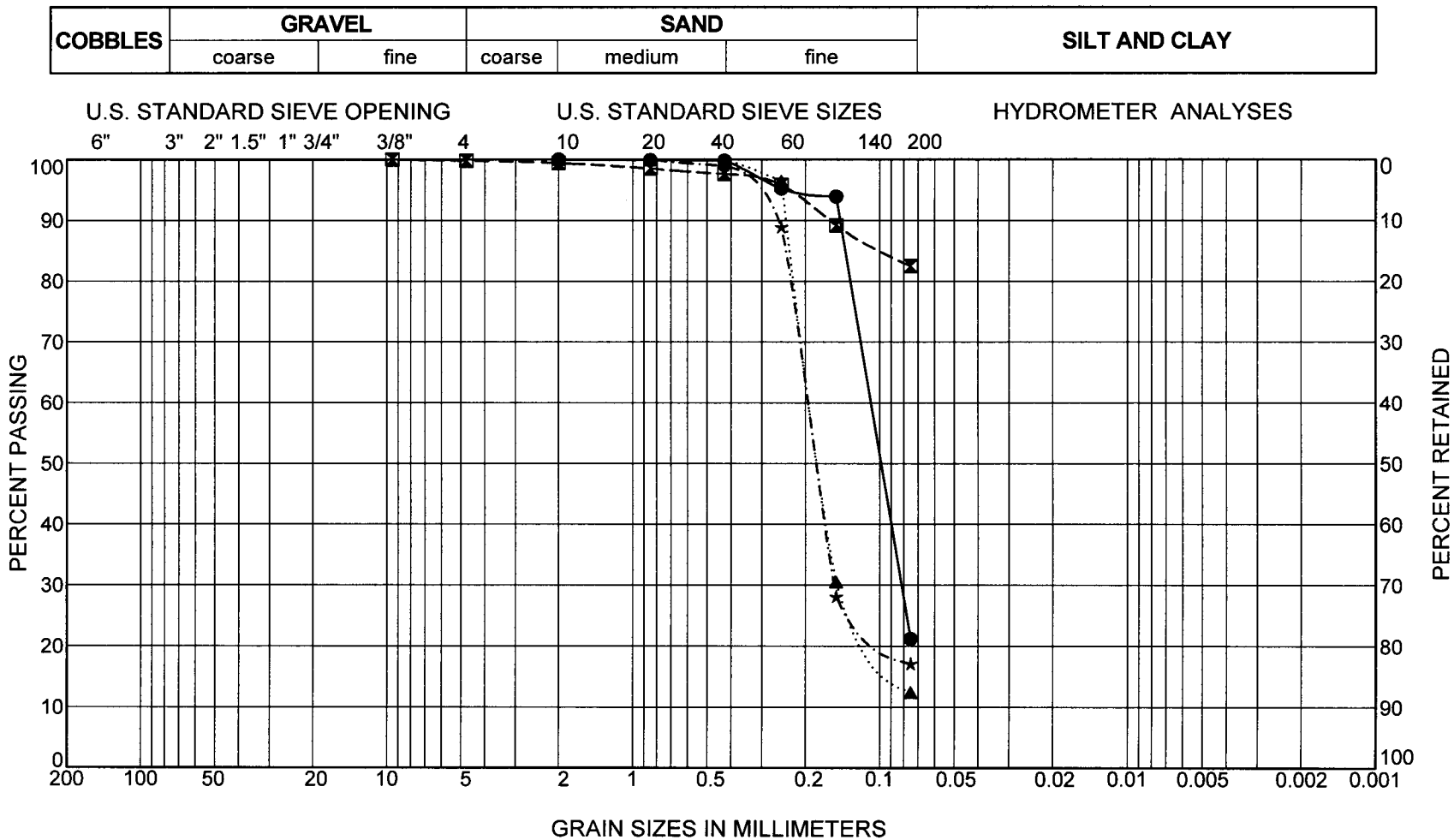
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3B

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
BR-1	MC-8	34.5	●			SILTY SAND (SM)
BR-1	MC-11	49.5	⊠			LEAN CLAY WITH SAND (CL)
BR-1	MC-13	69.5	▲			SILTY SAND (SM)
BR-2	MC-3	9.5	★			SILTY SAND (SM)

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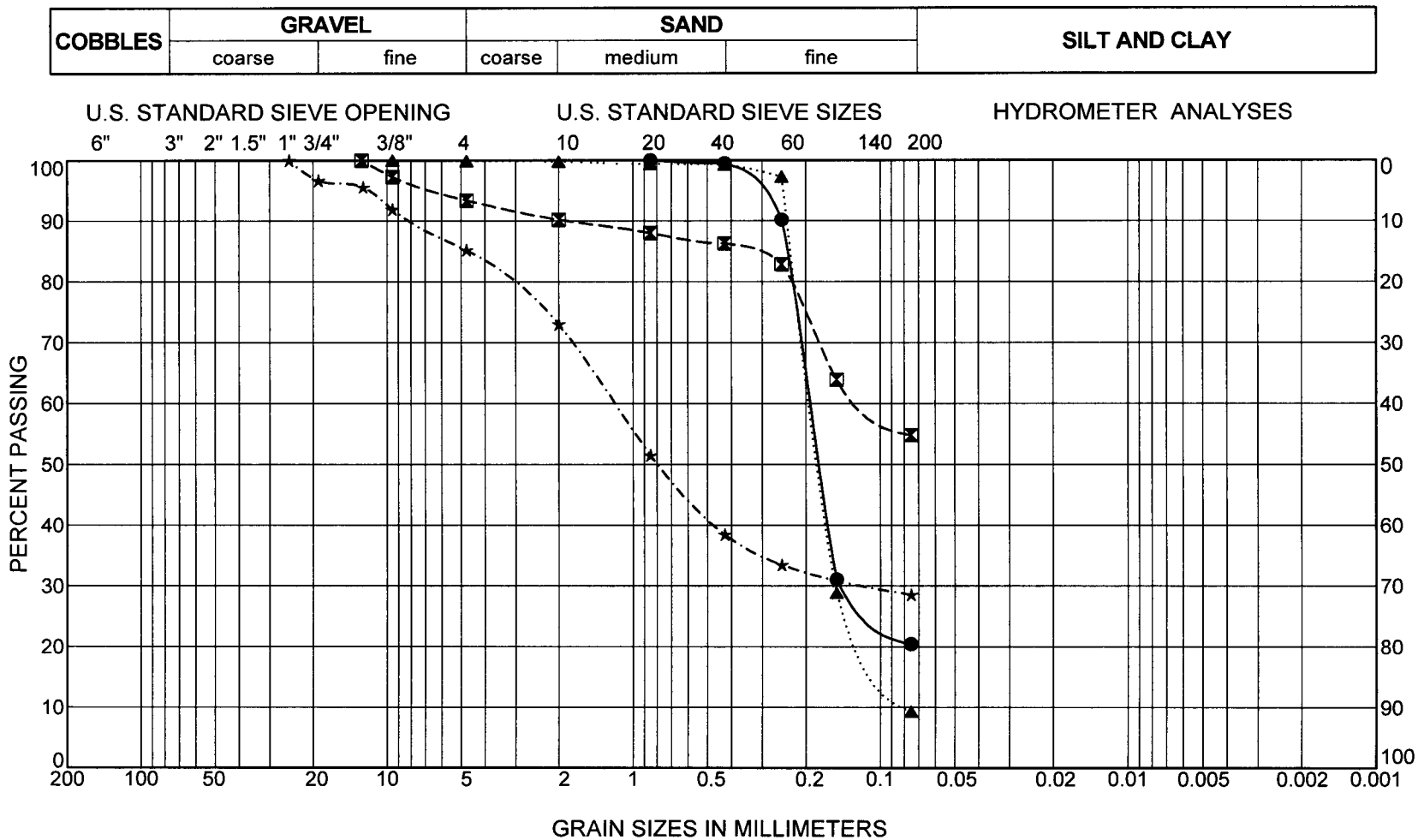
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3C

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
BR-2	MC-5	19.5	●			SILTY SAND (SM)
BR-2	MC-11	49.5	⊠			SANDY LEAN CLAY (CL)
BR-2	MC-13	69.5	▲			POORLY- GRADED SAND WITH SILT (SP-SM)
NP-1	MC-3	15.0	★			CLAYEY SAND (SC)

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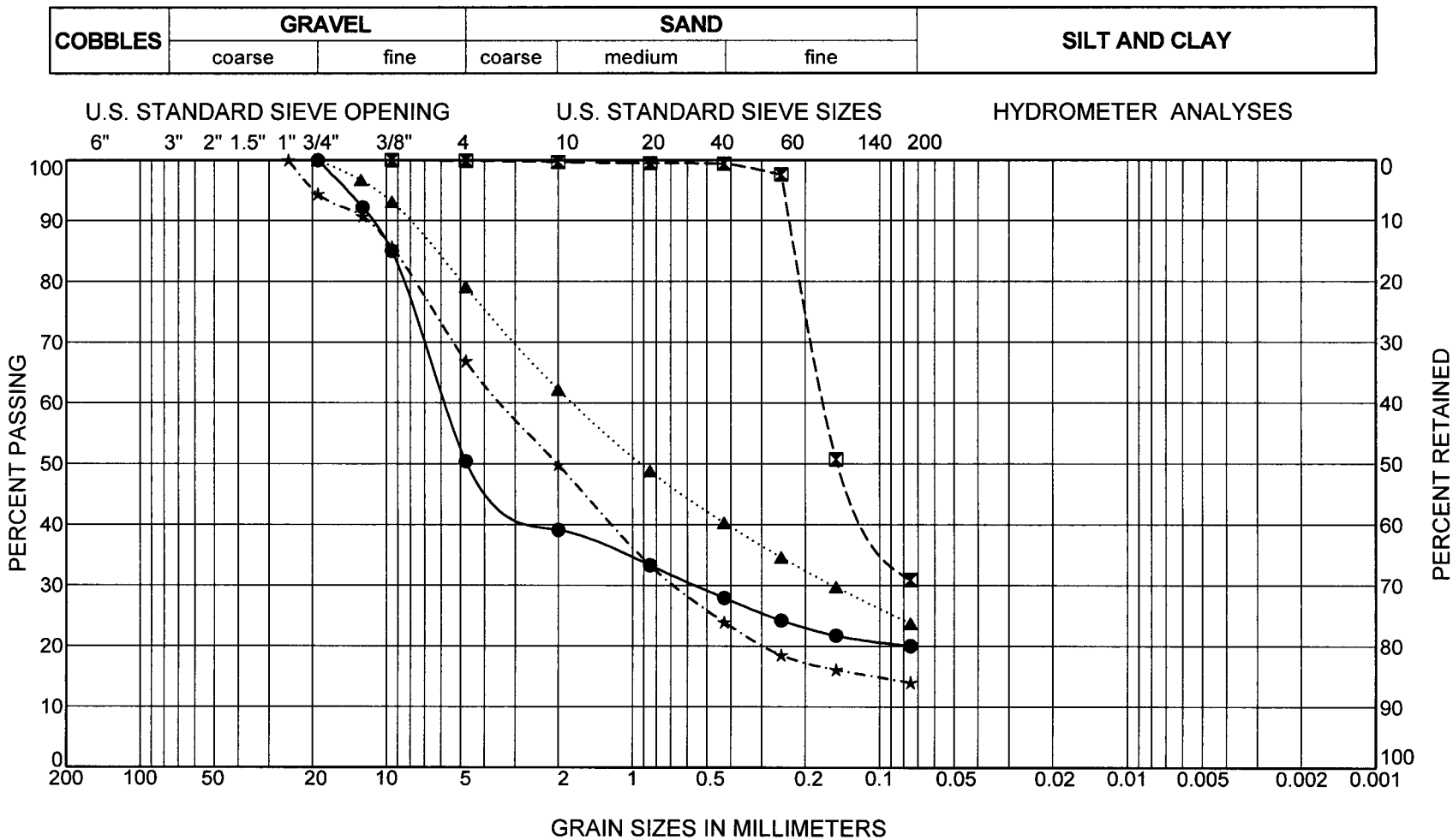
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3D

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
NP-1	MC-5	25.0	●			CLAYEY GRAVEL WITH SAND (GC)
NP-1	SPT-6	30.0	⊠			CLAYEY SAND (SC)
NP-1	SPT-13	75.0	▲			CLAYEY SAND WITH GRAVEL (SC)
NP-2	MC-2	11.0	★			CLAYEY SAND WITH GRAVEL (SC)

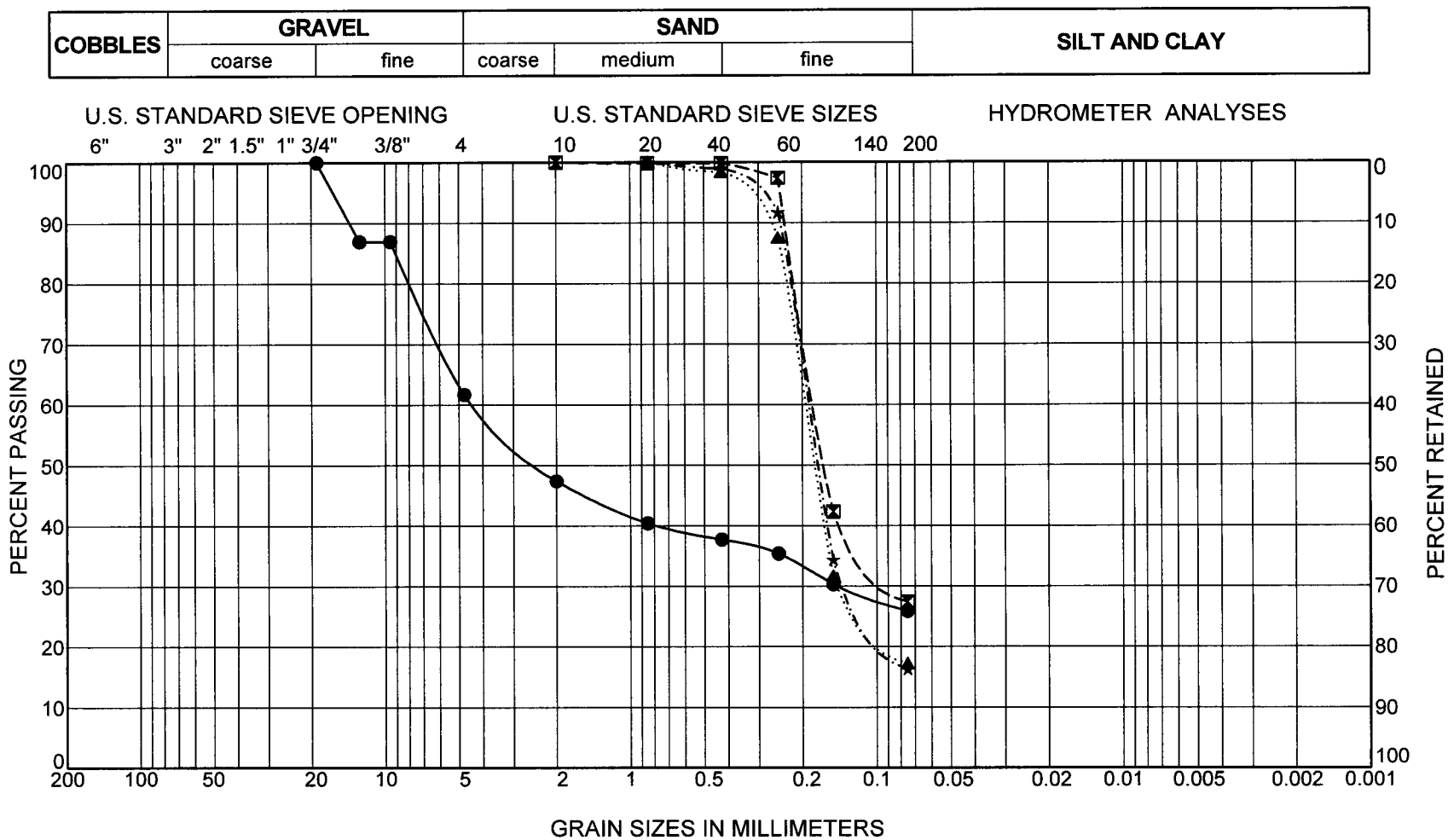
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3E

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
NP-2	MC-4	20.0	●			CLAYEY GRAVEL WITH SAND (GC)
NP-2	MC-8	40.0	⊠			SILTY SAND (SM)
R-02	MC-2	4.5	▲			SILTY SAND (SM)
R-11	MC-3	9.5	★			SILTY SAND (SM)

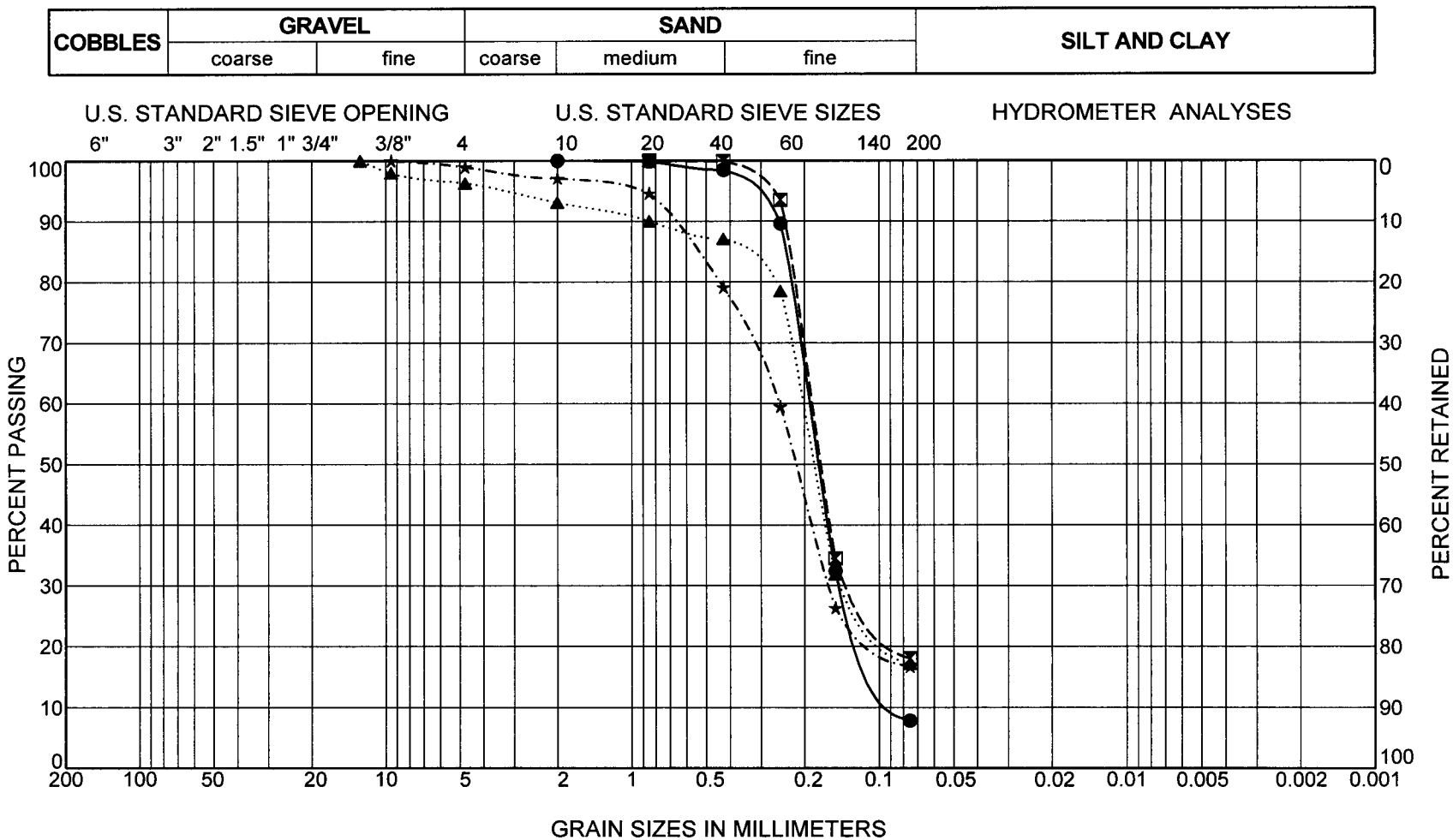
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3F

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
R-12A	SPT-2	9.5	●			POORLY-GRADED SAND WITH SILT (SP-SM)
R-14A	SPT-3	14.5	⊠			SILTY SAND (SM)
R-16	MC-1	5.0	▲			SILTY SAND (SM)
RW-4	MC-1	5.0	★			SILTY SAND (SM)

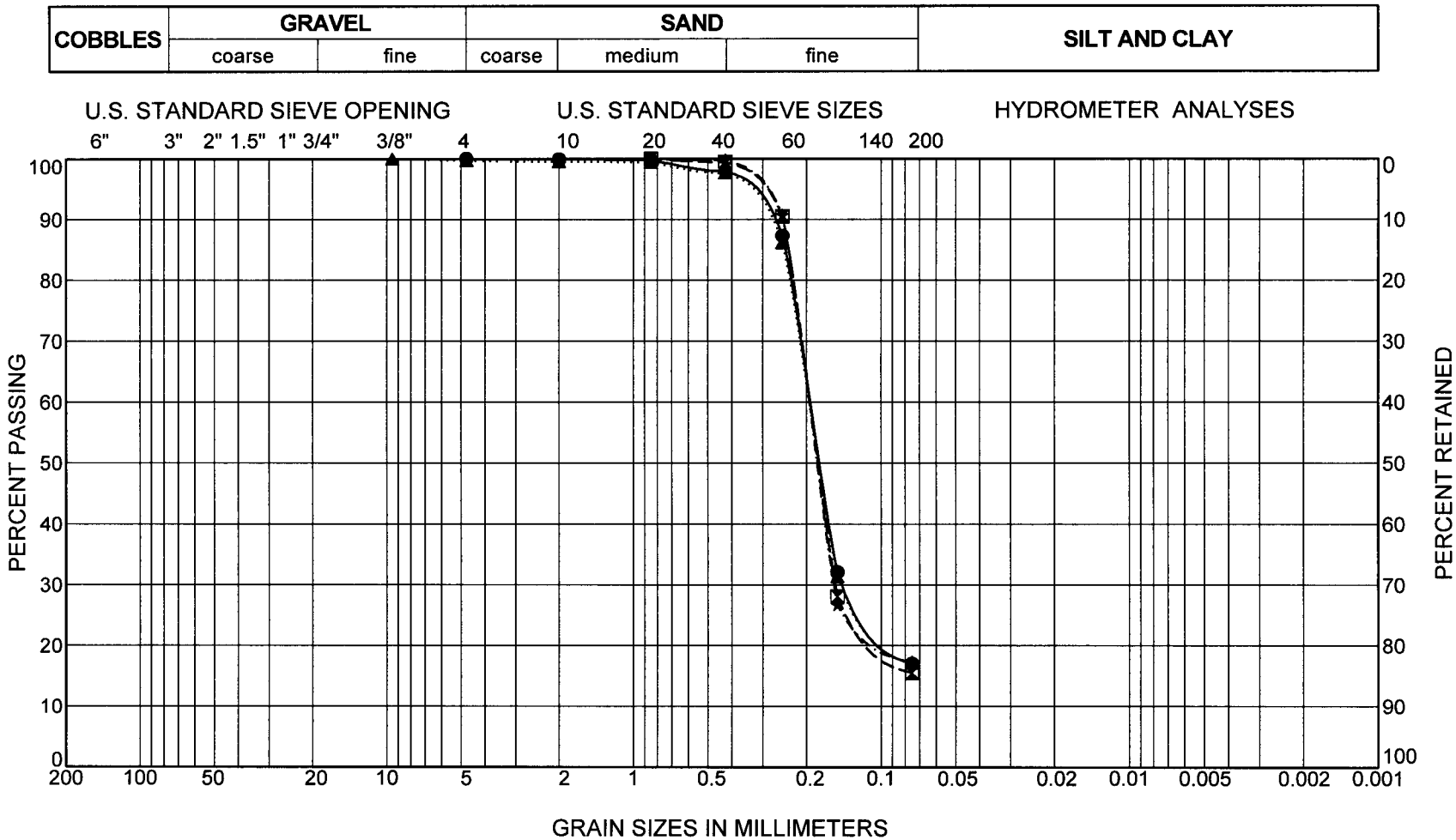
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3G

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW-4	MC-3	9.5	●			SILTY SAND (SM)
RW-4	MC-5	19.5	⊠			SILTY SAND (SM)
RW-5	SPT-3	9.5	▲			SILTY SAND (SM)
RW-5	SPT-5	19.5	★			SILTY SAND (SM)

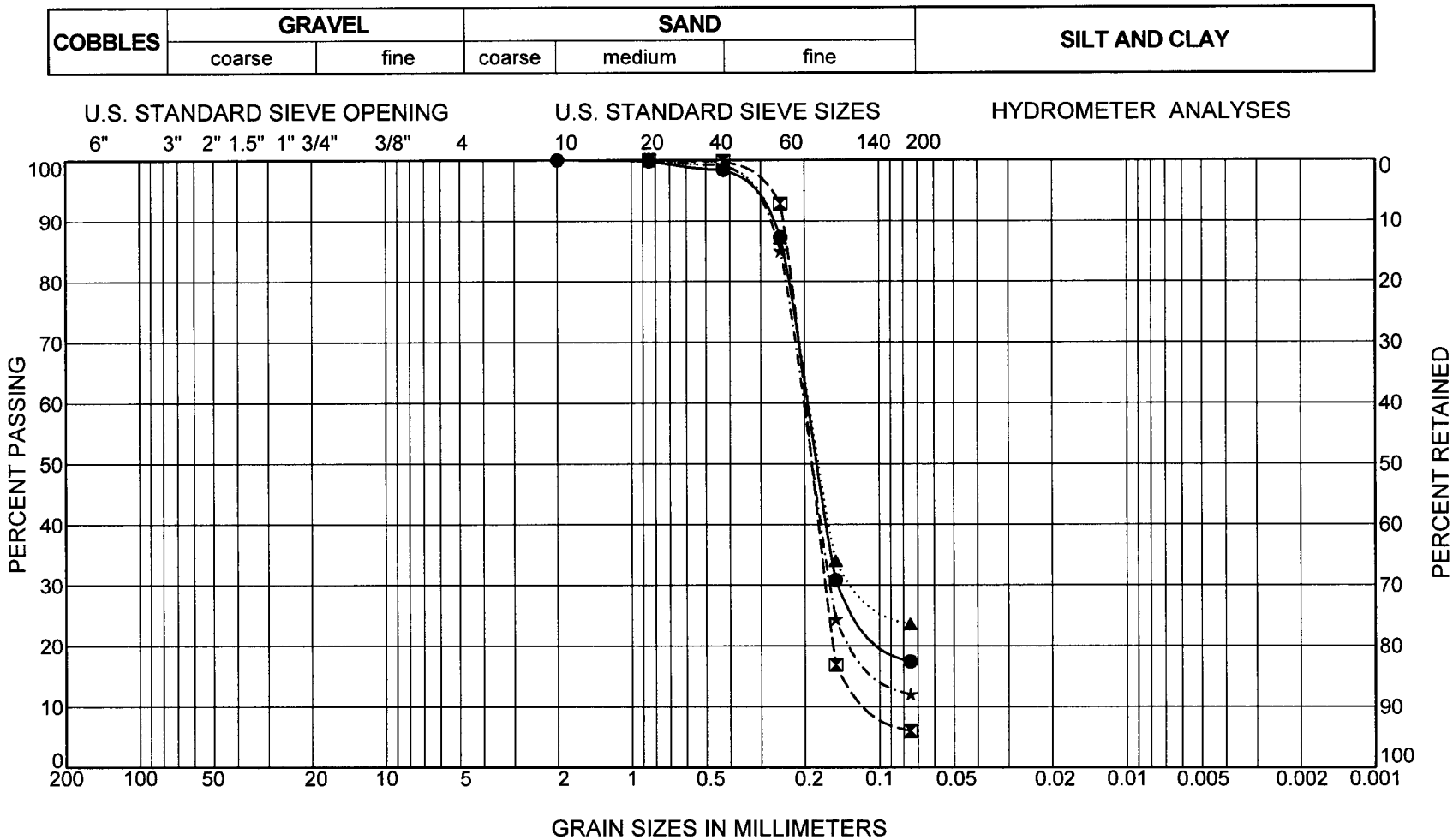
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-3H

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW-7	SPT-3	9.5	●			SILTY SAND (SM)
RW-7	SPT-6	29.5	⊠			POORLY-GRADED SAND WITH SILT (SP-SM)
RW-8	SPT-4	14.5	▲			SILTY SAND (SM)
RW-9	SPT-3	9.5	★			POORLY-GRADED SAND WITH SILT (SP-SM)

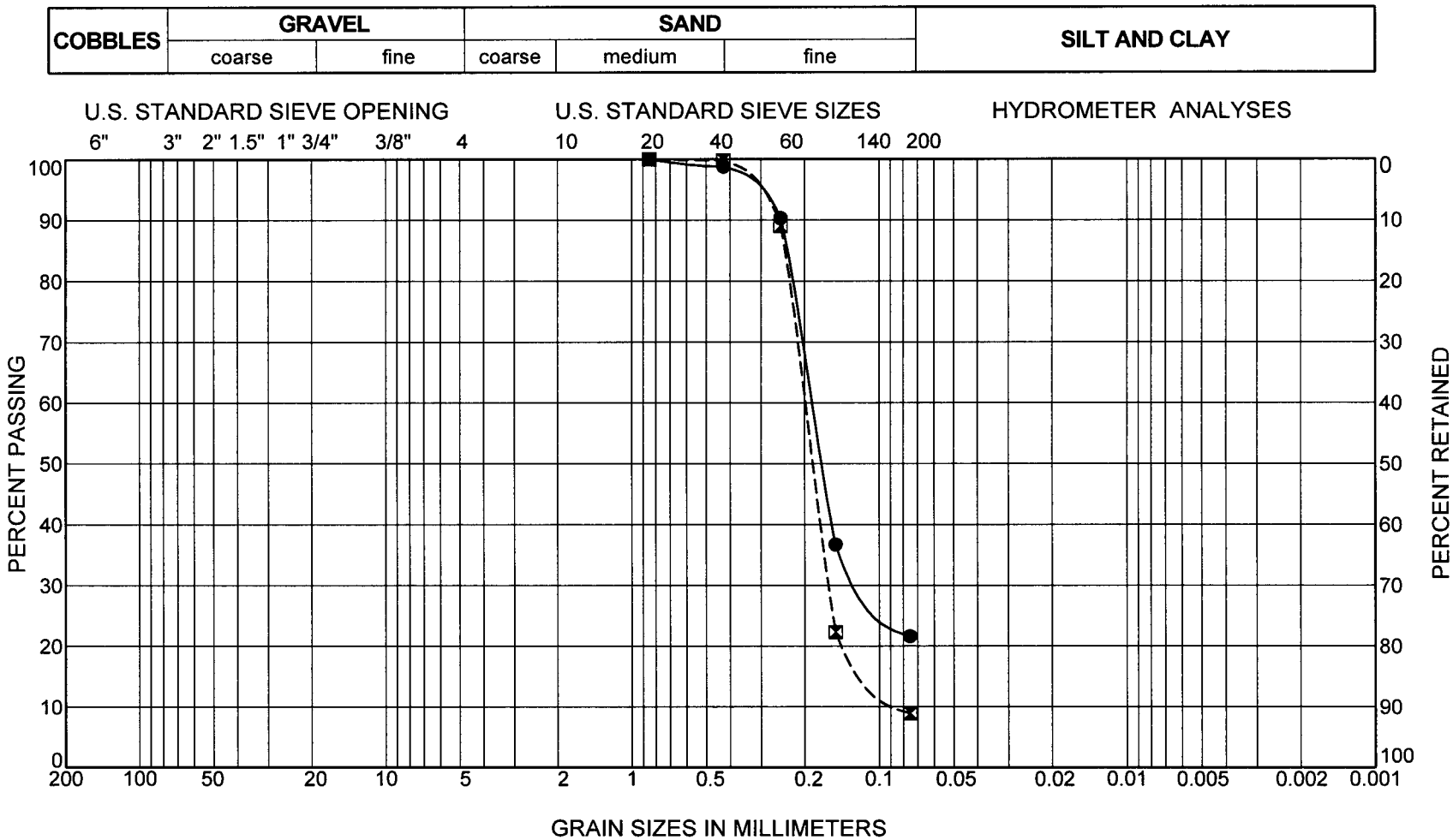
PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO: 203125.10

PLATE NO: B-31

GRAIN SIZE DISTRIBUTION CURVES



Boring Number	Sample Number	Depth (feet)	Symbol	LL	PI	Description
RW-9	SPT-4	14.5	●			SILTY SAND (SM)
RW-9	MC-7	29.5	⊠			POORLY-GRADED SAND WITH SILT (SP-SM)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS ENGINEERING

WILLOW ROAD / RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

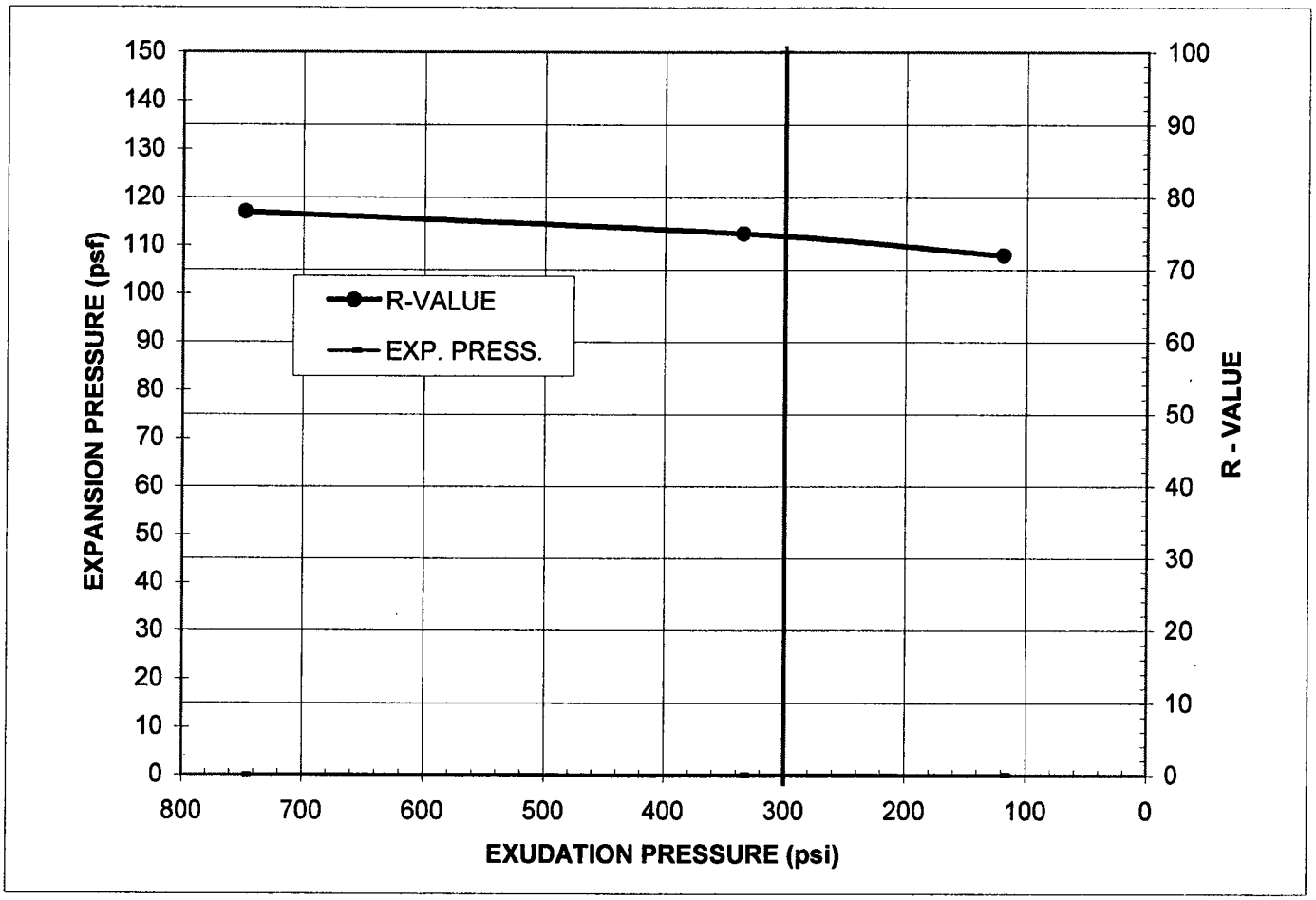
JOB NO: 203125.10

PLATE NO: B-3J

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/7/07
Client:	Caltrans	Project #:	203125.GD1
Sample #: R1	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Sand, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	119	335	748
Expansion Pressure, psf	0	0	0
R-Value	72	75	78
Moisture Content at Test, %	11.9	11.6	11.0
Dry Density at Test, pcf	111.6	112.3	112.9

R-Value @ 300 psi Exudation Pressure = 74

Expansion Pressure @300 psi Exudation, psf = **0**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

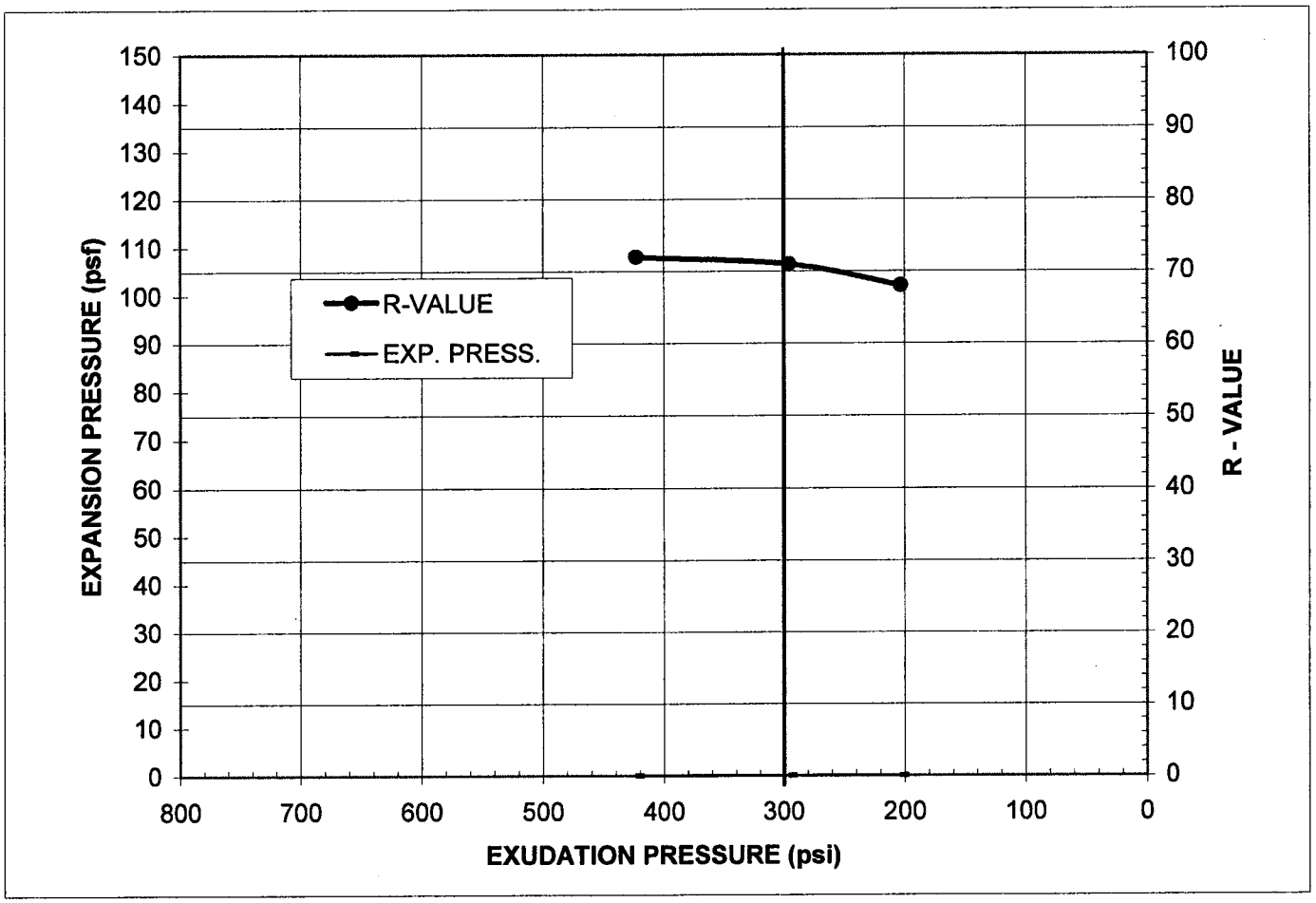
RVALUE with calcs pdp

PLATE NO.: B-4A

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/7/07
Client:	Caltrans	Project #:	203125.GD1
Sample #: R3	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Sand, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	203	295	423
Expansion Pressure, psf	0	0	0
R-Value	68	71	72
Moisture Content at Test, %	13.8	13.4	12.9
Dry Density at Test, pcf	104.1	105.0	106.2

R-Value @ 300 psi Exudation Pressure = 71

Expansion Pressure @300 psi Exudation, psf = **0**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

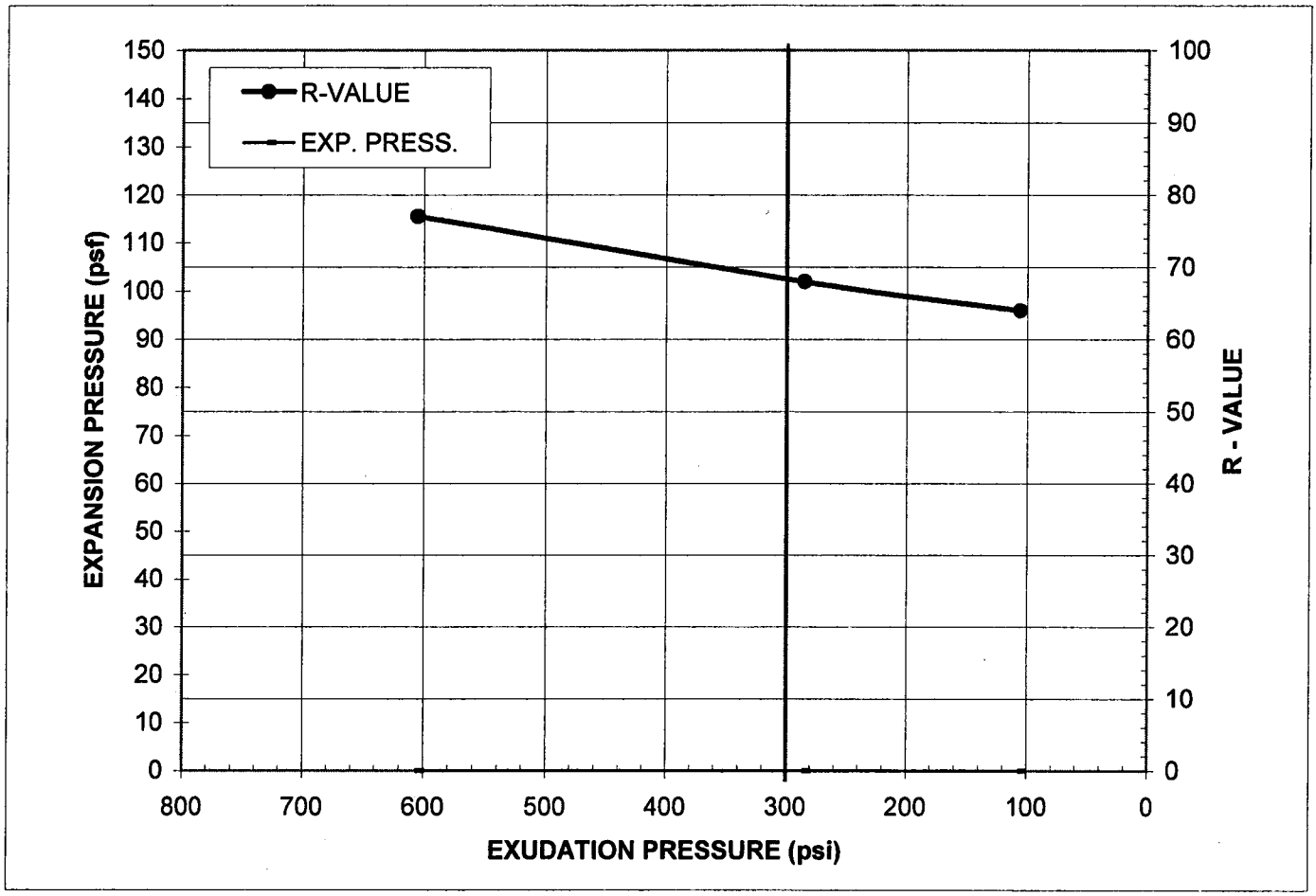
RVALUE with calcs pdp

PLATE NO.: B-4B

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	2/28/07
Client:	Caltrans	Project #:	203125.GD1
Sample #: RW4	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Silty sand, reddish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	106	285	605
Expansion Pressure, psf	0	0	0
R-Value	64	68	77
Moisture Content at Test, %	11.6	11.3	11.0
Dry Density at Test, pcf	114.2	114.4	114.8

R-Value @ 300 psi Exudation Pressure = 68

Expansion Pressure @300 psi Exudation, psf = **0**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

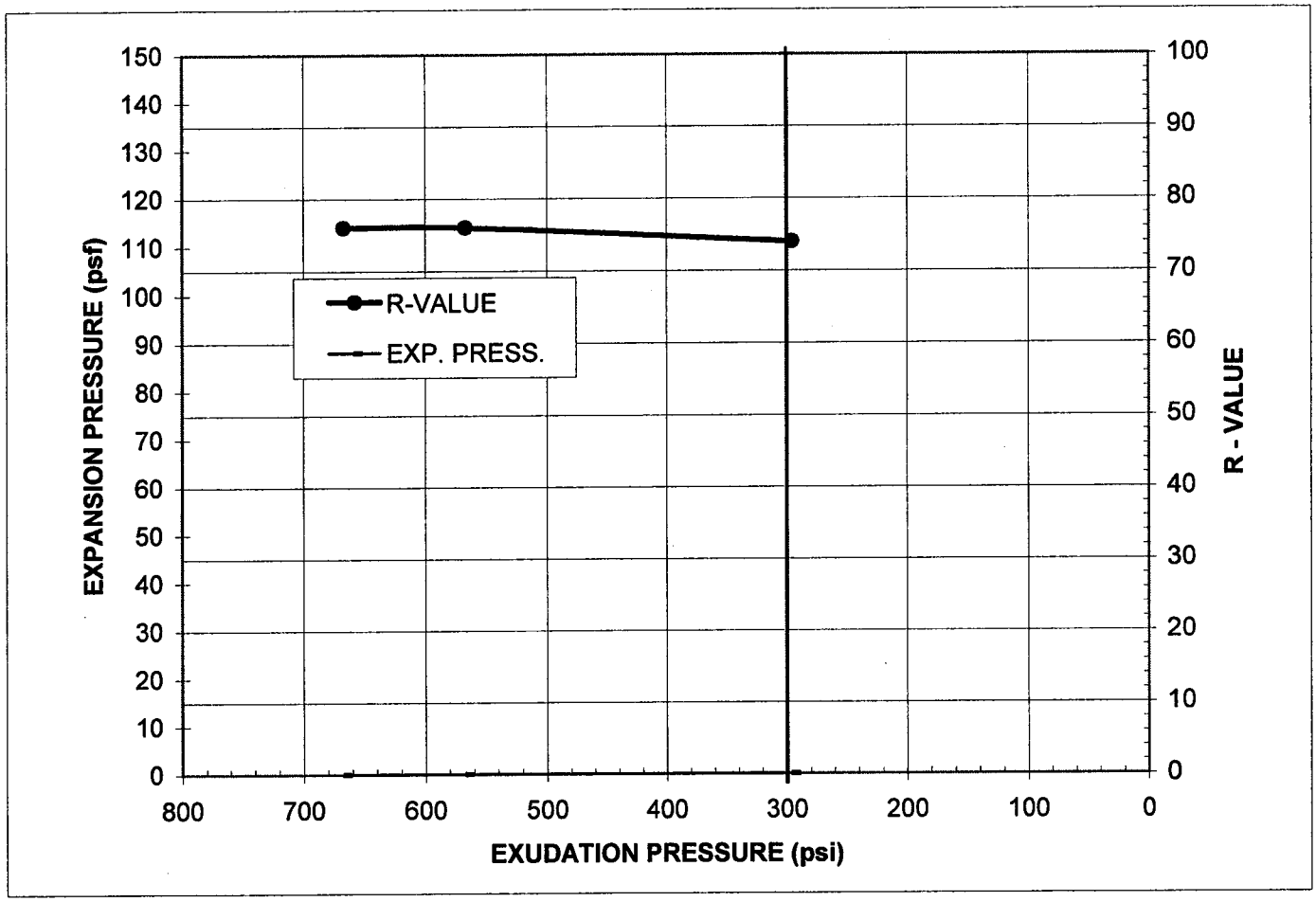
RVALUE with calcs pdp

PLATE NO.: B-4C

R-VALUE REPORT

Parikh Consultants, Inc. — ASTM D2844 or CTM 301 — (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/7/07
Client:	Caltrans	Project #:	203125.GD1
Sample #: R10	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Sand, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	295	567	667
Expansion Pressure, psf	0	0	0
R-Value	74	76	76
Moisture Content at Test, %	12.8	12.4	12.0
Dry Density at Test, pcf	105.3	105.5	106.1

R-Value @ 300 psi Exudation Pressure = 73

Expansion Pressure @300 psi Exudation, psf = 0

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

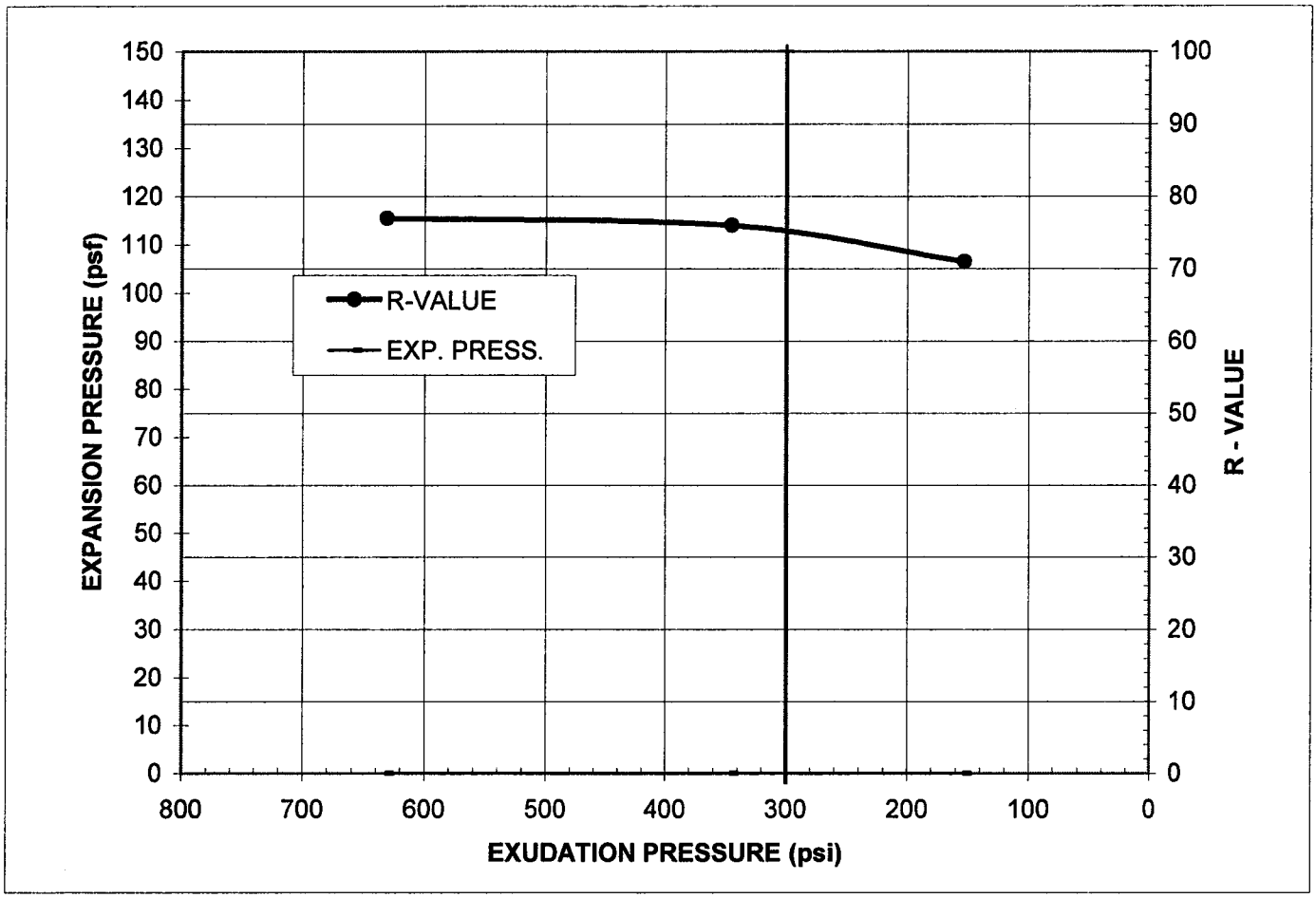
RVALUE with calcs pdp

PLATE NO.: B-4D

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/7/07
Client:	Caltrans	Project #:	203125.GD1
Sample #: R14	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Sand, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	153	345	631
Expansion Pressure, psf	0	0	0
R-Value	71	76	77
Moisture Content at Test, %	13.8	13.3	12.8
Dry Density at Test, pcf	105.4	105.9	106.3

R-Value @ 300 psi Exudation Pressure = 75

Expansion Pressure @300 psi Exudation, psf = **0**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

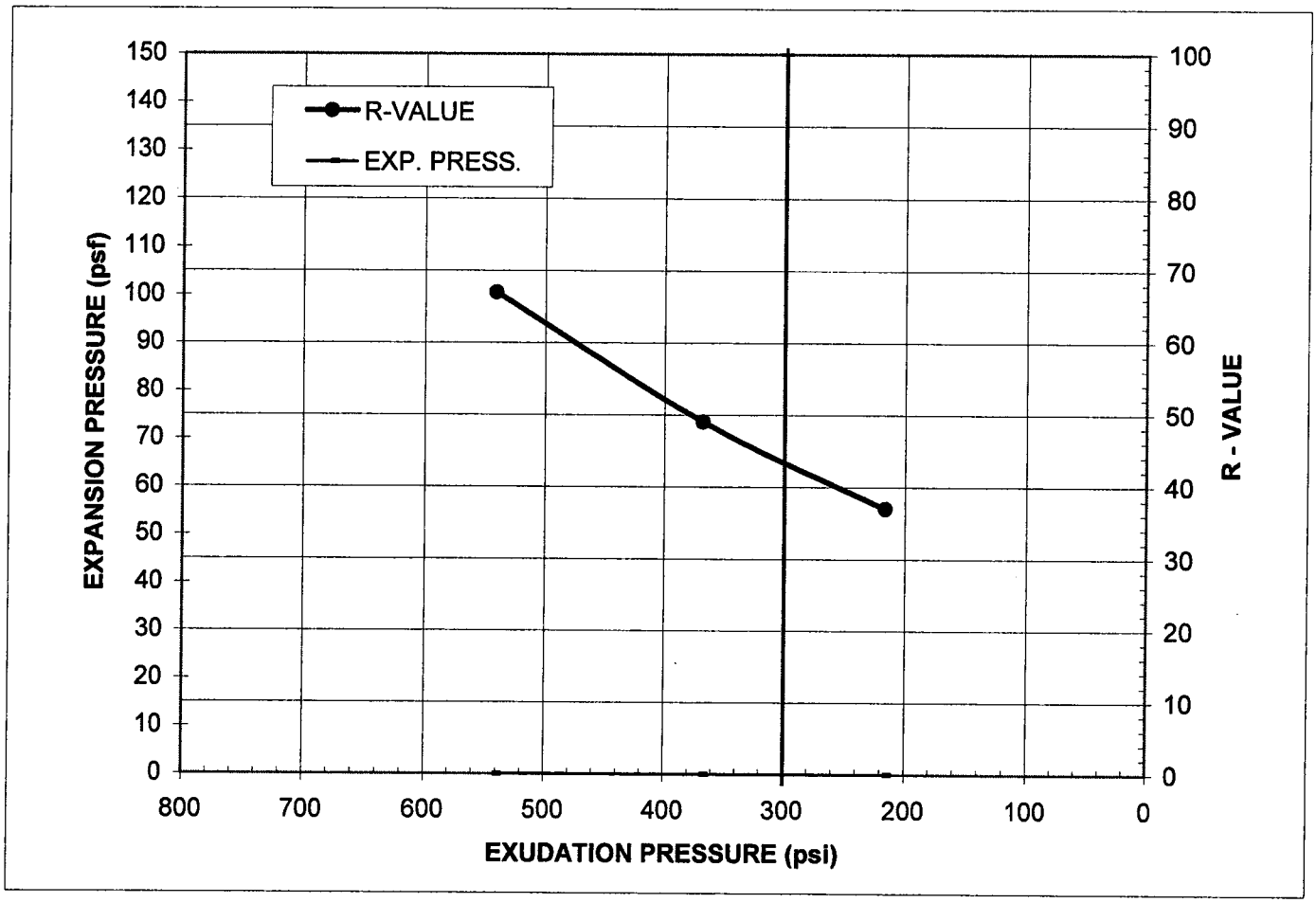
RVALUE with calcs pdp

PLATE NO.: B-4E

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/7/07
Client:	Caltrans	Project #:	203125.GD1
Sample #:	R15 Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Clayey sand, Brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	216	368	541
Expansion Pressure, psf	0	0	0
R-Value	37	49	67
Moisture Content at Test, %	20.9	19.8	18.9
Dry Density at Test, pcf	100.2	103.0	104.4

R-Value @ 300 psi Exudation Pressure = 44

Expansion Pressure @300 psi Exudation, psf = **0**

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

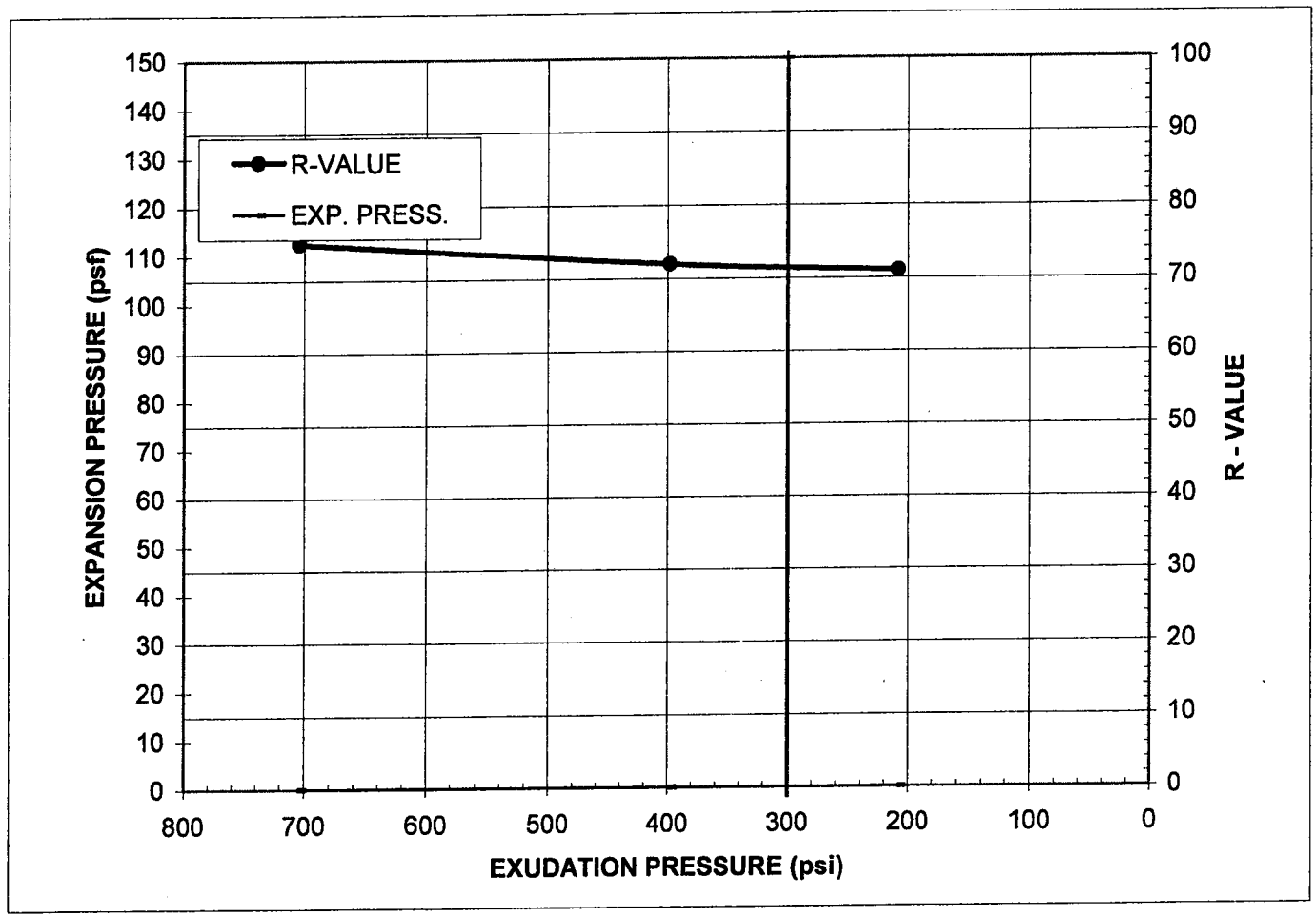
RVALUE with calcs pdp

PLATE NO.: B-4F

R-VALUE REPORT

Parikh Consultants, Inc. ASTM D2844 or CTM 301 (408) 945-1011

Project Name:	Willow Road at Rte 101 Interchange	Date:	3/01/07
Client:	Caltrans	Project #:	203125.EXT
Sample #: B10	Depth: 5'	Lab #:	M608
Location / Source:	Nipomo	Sample Date:	
Material :	Silty sand, reddish brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	208	398	704
Expansion Pressure, psf	0	0	0
R-Value	71	72	75
Moisture Content at Test, %	12.4	11.8	11.2
Dry Density at Test, pcf	108.9	109.8	109.9

R-Value @ 300 psi Exudation Pressure = 72

Expansion Pressure @300 psi Exudation, psf = 0

Minimum R-Value Requirement:

Comments:

Report By: Prav Dayah

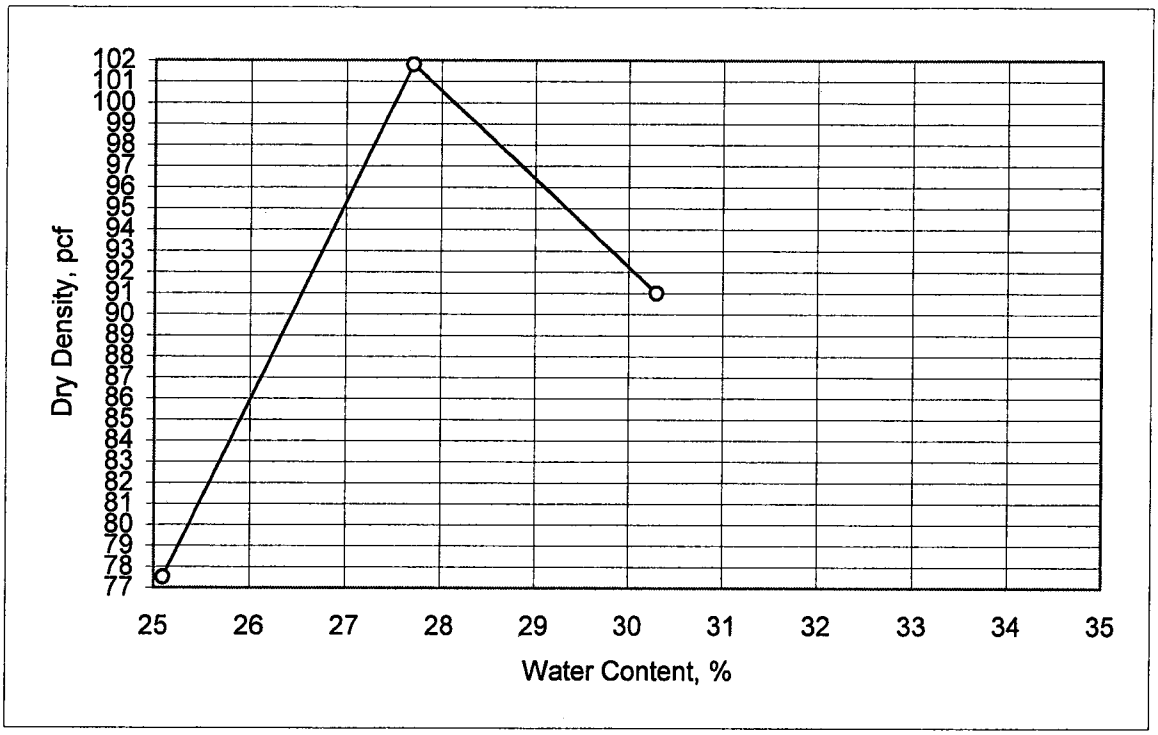
RVALUE with calcs pdp

PLATE NO.: B-4G

UNCONFINED COMPRESSIVE STRENGTH REPORT

Parikh Consultants, Inc. **California Test 373** (408) 945-1011

Project Name:	Willow Road Extension at Route 101	Date:	3/26/07
Client:	Rajappan & Meyer Engineers	Project #:	203125.EXT
Sample #:	B13 Depth: 0'-5'	Lab #:	M608
Location / Source:	Nipoma, California	Sample Date:	
Material :	Fat clay, black + 6% SS Lime	Sampled By:	



Moisture - Density Relationship

Trial #	1	2	3	4
Water Content,%	25.1	27.7	30.3	
Dry Density, pcf	77.5	101.8	91	

MAX. DRY DENSITY, pcf:	**101.8**	**OPTIMUM MOISTUR**	**27.7**

UNCONFINED COMPRESSION TEST RESULTS

Specimen Number	Cast Date	Test Date	Age Days	Total Load lbs.	Compressive Strength, psi
1	3/23/2007	3/30/2007	7	4,150	330
2	3/23/2007	3/30/2007	7	4,020	320
AVERAGE				**4,085**	**325**

Comments:

The minimum percent of lime to use in the trial batch was 6%, this was established using pH values as described in the appendix of ASTM Designation : C 977

Reported By: Prav D Dayah

pdp 12/01/01

PLATE NO.: B-5A

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : RW5#2 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99410.

EVALUATION FOR SOIL CORROSION

Soil pH	7.19		
Minimum Resistivity	14.47	ohm-cm (x1000)	
Chloride	6.6 ppm	00.00066	%
Sulfate	5.9 ppm	00.00059	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : RW8#2 @ 4..
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99414.

EVALUATION FOR SOIL CORROSION

Soil pH	7.29		
Minimum Resistivity	20.10	ohm-cm (x1000)	
Chloride	9.0 ppm	00.00090	%
Sulfate	4.8 ppm	00.00048	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : RW9#2 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99413.

EVALUATION FOR SOIL CORROSION

Soil pH	7.26		
Minimum Resistivity	29.21	ohm-cm (x1000)	
Chloride	8.4 ppm	00.00084	%
Sulfate	1.1 ppm	00.00011	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical

11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney RH
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : R12#1 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99415.

EVALUATION FOR SOIL CORROSION

Soil pH	6.43		
Minimum Resistivity	37.52	ohm-cm (x1000)	
Chloride	9.4 ppm	00.00094	%
Sulfate	0.5 ppm	00.00005	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

PLATE NO.: B-6D

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : R13#2 @ 9.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99412.

EVALUATION FOR SOIL CORROSION

Soil pH	6.64		
Minimum Resistivity	25.46	ohm-cm (x1000)	
Chloride	18.9 ppm	00.00189	%
Sulfate	5.1 ppm	00.00051	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 02/16/2007
Date Submitted 02/12/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.GR1\WILLOWS R Site ID : R14#1 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 49870-99411.

EVALUATION FOR SOIL CORROSION

Soil pH	5.73		
Minimum Resistivity	27.60	ohm-cm (x1000)	
Chloride	7.2 ppm	00.00072	%
Sulfate	4.6 ppm	00.00046	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 03/15/2007
Date Submitted 03/13/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.WIL/RTE 101 Site ID : BR1 #3 @ 9.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50037-99701.

EVALUATION FOR SOIL CORROSION

Soil pH	6.77		
Minimum Resistivity	11.52	ohm-cm (x1000)	
Chloride	9.6 ppm	00.00096	%
Sulfate	6.3 ppm	00.00063	%

METHODS
pH and Min.Resistivity CA DOT Test #643 Mod.(Sm.Cell)
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 04/11/2007
Date Submitted 04/05/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.WIL\RTE 101 Site ID : BR2#2 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50227-100068.

EVALUATION FOR SOIL CORROSION

Soil pH	6.80		
Minimum Resistivity	29.48	ohm-cm (x1000)	
Chloride	5.5 ppm	00.00055	%
Sulfate	3.1 ppm	00.00031	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 05/23/2007
Date Submitted 05/18/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125 NPO WILLOW RD Site ID : NP-2 #1@6'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50573-100954.

EVALUATION FOR SOIL CORROSION

Soil pH	7.38	
Minimum Resistivity	0.70 ohm-cm (x1000)	
Chloride	21.4 ppm	00.00214 %
Sulfate	19.4 ppm	00.00194 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 05/23/2007
Date Submitted 05/18/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125 NPO WILLOW RD Site ID : NP-1 #1@7'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50573-100953.

EVALUATION FOR SOIL CORROSION

Soil pH	7.38		
Minimum Resistivity	0.88 ohm-cm (x1000)		
Chloride	20.0 ppm	00.00200	%
Sulfate	35.9 ppm	00.00359	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 06/08/2007
Date Submitted 06/04/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.EXT/WILLOW RD Site ID : B13#2 @ 4.5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50689-101201.

EVALUATION FOR SOIL CORROSION

Soil pH	7.92		
Minimum Resistivity	0.54 ohm-cm (x1000)		
Chloride	38.1 ppm	00.00381	%
Sulfate	120.0 ppm	00.01200	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 03/15/2007
Date Submitted 03/13/2007

To: Prav Dayah
Parikh Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, Ca 95035

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : 203125.EXT/WILLOW RD Site ID : B14 @ 0-5'.
Thank you for your business.

* For future reference to this analysis please use SUN # 50036-99699.

EVALUATION FOR SOIL CORROSION

Soil pH	7.38	
Minimum Resistivity	0.64 ohm-cm (x1000)	
Chloride	48.6 ppm	00.00486 %
Sulfate	95.9 ppm	00.00959 %

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

PLATE NO.: B-6L

Sunland Analytical
11353 Pyrites Way, Suite 4
Rancho Cordova, CA 95670
(916) 852-8557

Date Reported 12/23/2009
Date Submitted 12/16/2009

To: Prav Dayah
Parikh Consultants, Inc.
2360 Qume Dr, Ste.A
San Jose, CA 95131

From: Gene Oliphant, Ph.D. \ Randy Horney
General Manager \ Lab Manager

The reported analysis was requested for the following location:
Location : WILLO RD 203125.GDR Site ID : EXIT DRAIN. (HA-ED-1)
Thank you for your business.

* For future reference to this analysis please use SUN # 57204-115941.

EVALUATION FOR SOIL CORROSION

Soil pH	6.89		
Minimum Resistivity	9.11 ohm-cm (x1000)		
Chloride	13.7 ppm	00.00137	%
Sulfate	1.0 ppm	00.00010	%

METHODS
pH and Min.Resistivity CA DOT Test #643
Sulfate CA DOT Test #417, Chloride CA DOT Test #422

RECEIVED
DEC 28 2009
By

PLATE NO.: B-6M

APPENDIX C

APPENDIX C-1

SLOPE STABILITY EVALUATION

SLOPE STABILITY ANALYSIS:

- The purpose of this calculation is to check the stability of the proposed cut slopes at the undercrossing. Two borings had been drilled, one on each of the abutment, 07-BR-1 and 07-BR-2. The results indicated the top ten feet of the subsoils is consisted of loose to medium dense sand, and medium dense sand was found below from ten feet to approximately 40 feet below existing ground level.

- The existing stability of the slopes was check for the exposed sections of the slope (i.e. outside the footprint of the undercrossing structure). The results indicated the factor of safety (FOS) for the existing slopes was > 1.5. The soil parameters adopted for the stability analysis are listed below.

Soil	Unit Wt. (pcf)	Cohesion (psf)	Friction Angle (°)
Loose Sand	115	0	32
Med. Dense Sand	120	0	34

The stability of the proposed cut slope is:

min. FOS = 1.69

Seismic

The stability of the slopes was also evaluated for seismic scenario. A 0.2g horizontal acceleration was applied to the existing slopes.

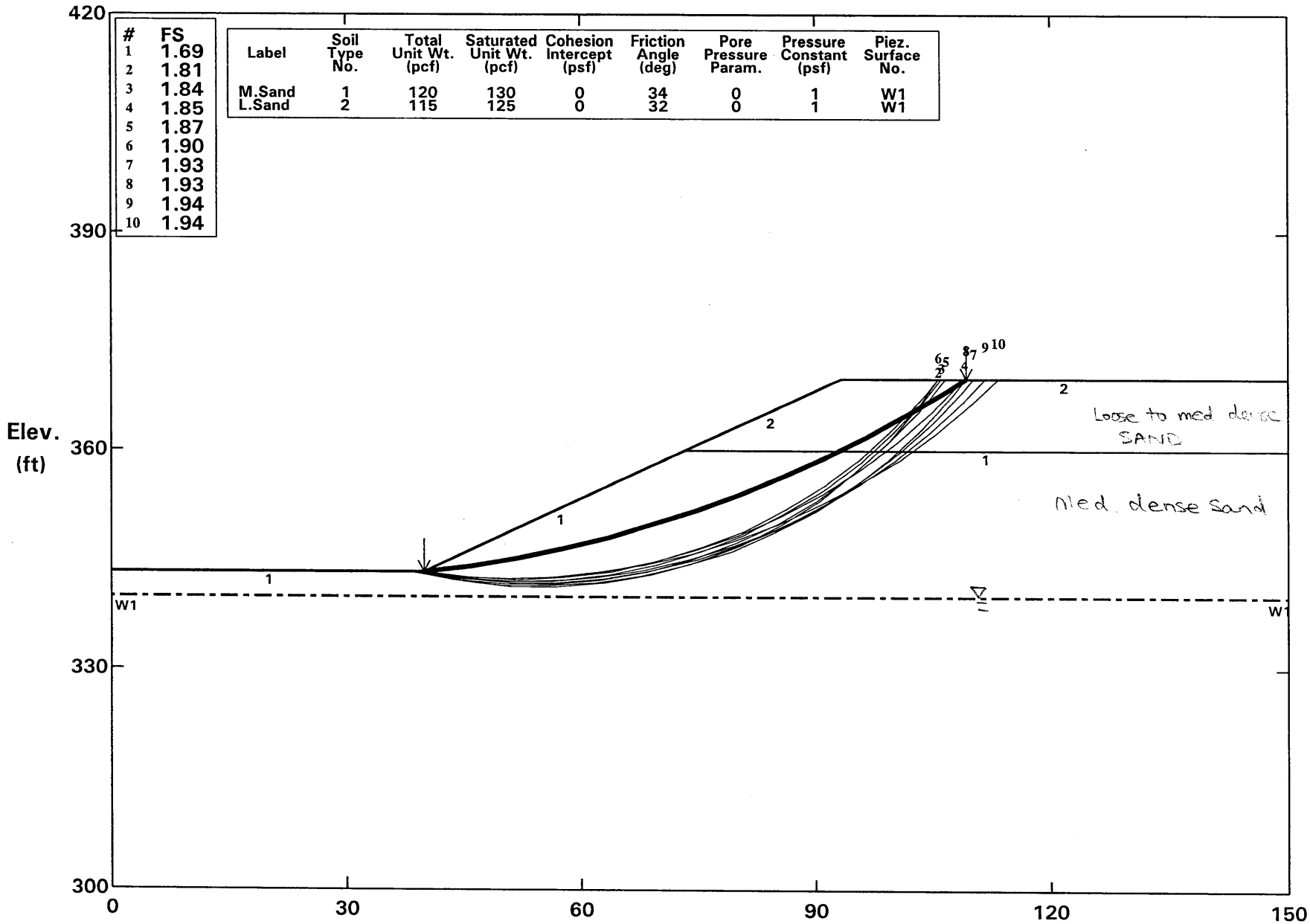
The stability of the proposed cut slopes during an seismic event is:

min. FOS = 1.14

Results of the slope stability analysis are included in this appendix.

Willow Road Undercrossing at Rte101 Slope Stability Analysis

Ten Most Critical. S:WILL_UC.PLT By: PCCY 04-05-07 6:07pm



#	FS
1	1.69
2	1.81
3	1.84
4	1.85
5	1.87
6	1.90
7	1.93
8	1.93
9	1.94
10	1.94

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
M.Sand	1	120	130	0	34	0	1	W1
L.Sand	2	115	125	0	32	0	1	W1

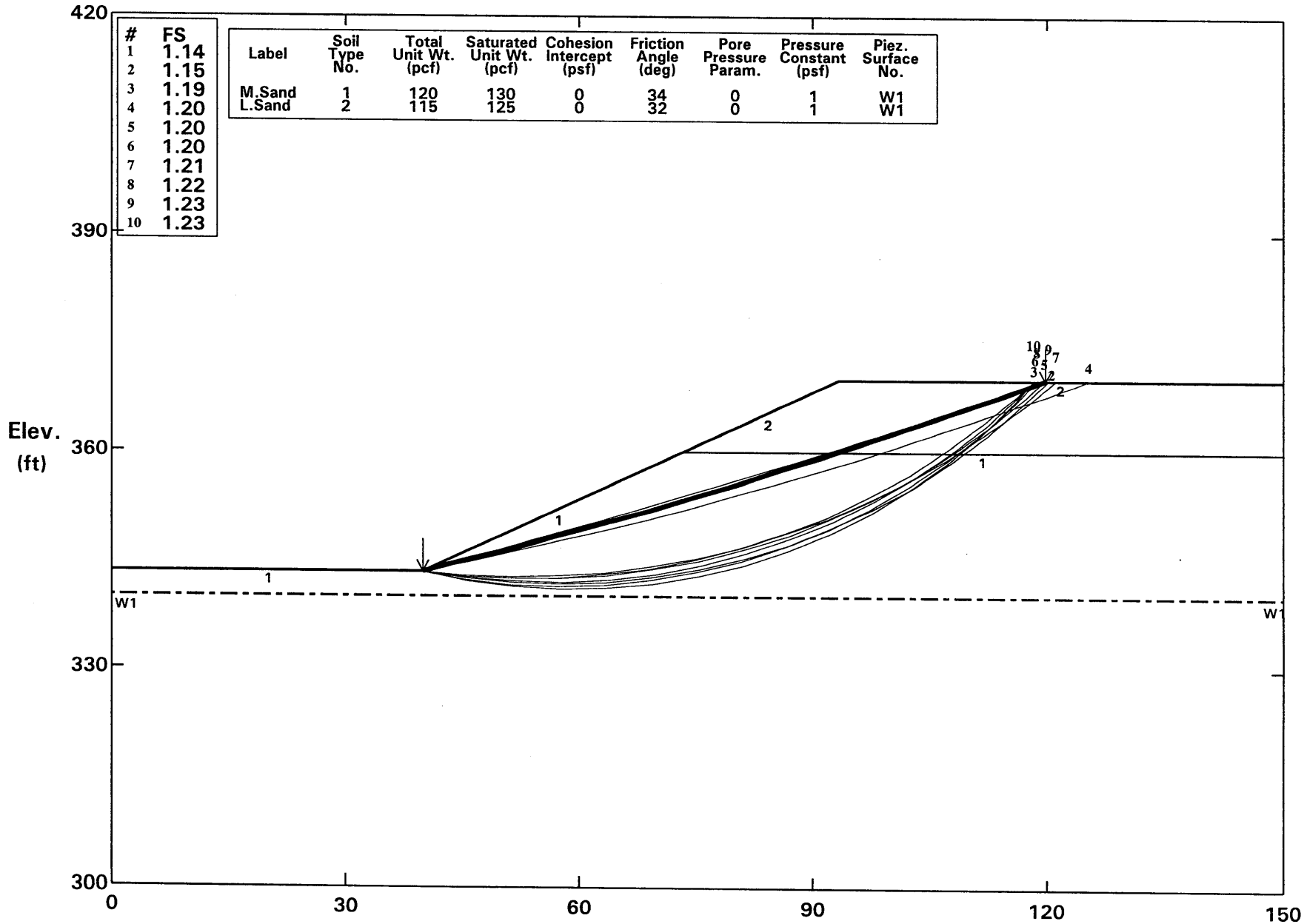
PCSTABL5M FSmin = 1.69 X-Axis (ft)

Willow Road Undercrossing at Rte101 Slope Stability Analysis / Seismic

Ten Most Critical. S:WIL_SEIS.PLT By: PCCY 04-06-07 11:29am

#	FS
1	1.14
2	1.15
3	1.19
4	1.20
5	1.20
6	1.20
7	1.21
8	1.22
9	1.23
10	1.23

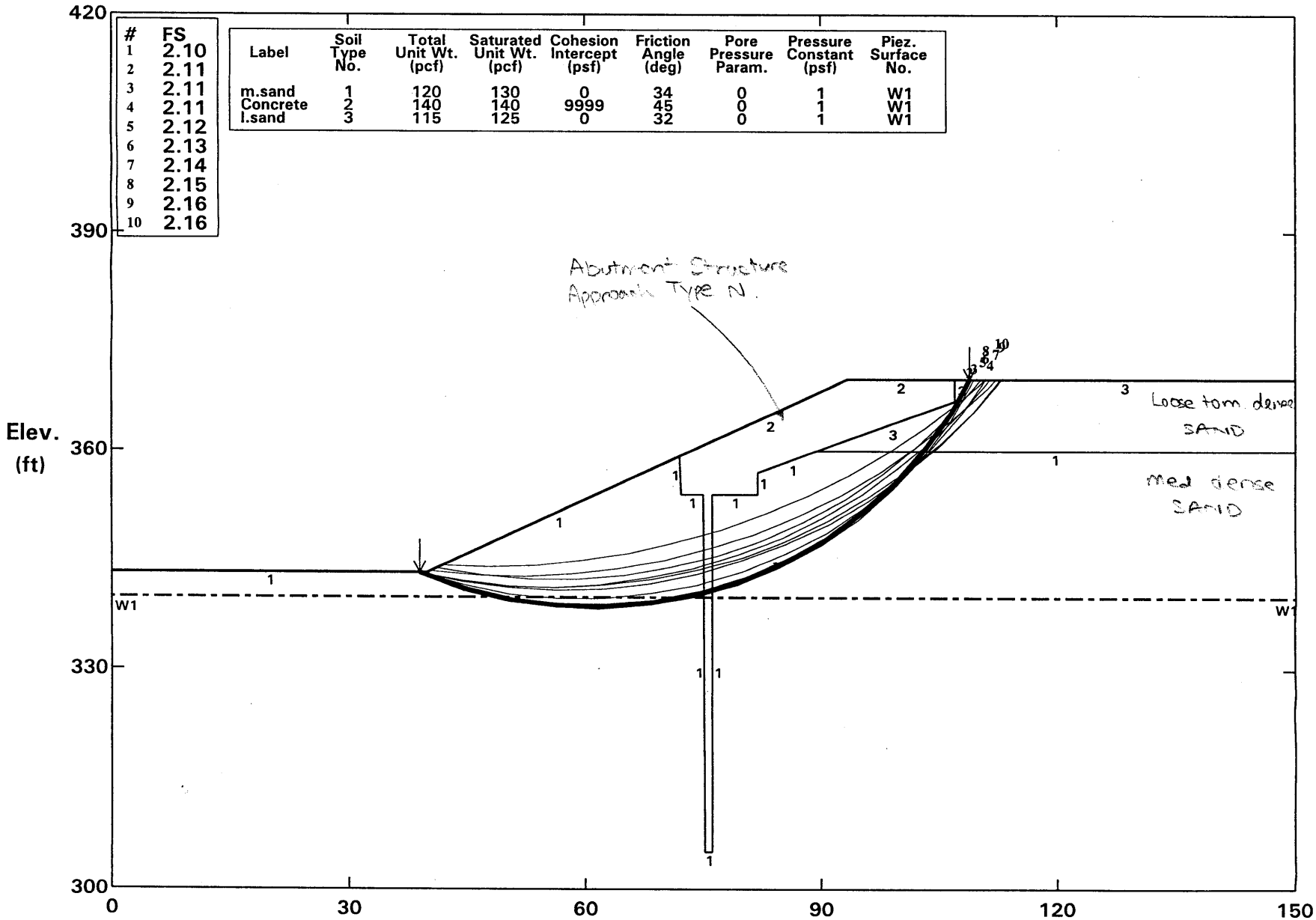
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
M.Sand	1	120	130	0	34	0	1	W1
L.Sand	2	115	125	0	32	0	1	W1



PCSTABL5M FSmin = 1.14 X-Axis (ft)

Willow Road Undercrossing at Rte101 Slope Stability with Abutment

Ten Most Critical. S:WIL_UC_N.PLT By: PCCY 04-06-07 9:50am



#	FS
1	2.10
2	2.11
3	2.11
4	2.11
5	2.12
6	2.13
7	2.14
8	2.15
9	2.16
10	2.16

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
m.sand	1	120	130	0	34	0	1	W1
Concrete	2	140	140	9999	45	0	1	W1
l.sand	3	115	125	0	32	0	1	W1

PCSTABL5M FSmin = 2.10 X-Axis (ft)

APPENDIX C-2

RETAINING WALL BEARING CAPACITY EVALUATION

WILLOW ROAD / ROUTE 101 INTERCHANGE

BEARING CAPACITY EVALUATION FOR RETAINING WALLS NO. 1, 2 & 3

FOOTING SUBGRADE IN MEDIUM DENSE SAND
ASSUME SATURATED CONDITION, $\gamma' = 63$ pcf, USE $\phi = 33°$ (CONSERVATIVE)

FOR BEARING EVALUATION, LIMIT THE EFFECTIVE FOOTING WIDTH, B, TO 7'

$\phi = 33°$, $N_q = 26$, $N_\gamma \approx 35$, FOOTING EMBEDMENT $\approx 3.5'$.

$$q_{ult} = \gamma' D N_q + \tfrac{1}{2}\gamma B N_\gamma$$
$$= (63)(3.5')(26) + \tfrac{1}{2}(63)(7')(35)$$
$$= 5.7 + 7.7 = 13.4 \text{ ksf}$$

$$q_{allow} = q_{ult} / FS_{R3} = 4.5 \text{ ksf (SERVICE)}$$

FOR THE PLANNED STADARD TYPE I WALLS, RECOMMEND ALLOWABLE BEARING = 4.5 ksf. FOR FOUNDATION LOADS HIGHER THAN 4.5 ksf, USE PILE FOUNDATIONS FOR SUPPORT. BASED ON THE STANDARD PLANS, USE PILES FOR WALL H ≥ 20'.

FOR PILES, USE CALTRANS STD CLASS 90 ALT "W", PP 14x0.375
USE 35-ft PILE LENGTH FOR 45-TON DESIGN CAPACITY
(CALCS SHOWN IN SPREAD SHEET PRINTOUT)

APPENDIX C-3

PAVEMENT STRUCTURAL SECTIONS DESIGN

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

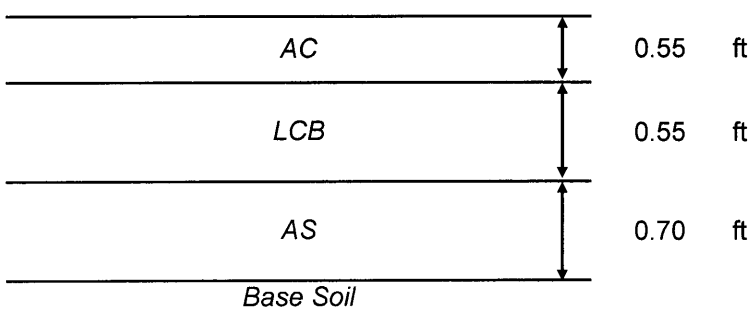
PROJECT NAME: *Route 101/Willow Rd I/C (Mainline Widening)*
PROJECT NO.: *203125.GDR*

Design Case: AC over LCB over AS (Class 1 w/ R = 60)

Design TI=	***13.5***
R_{BS}=	***40***
R_{AB}=	78
R_{AS}=	60

$GE_{TOTAL} = 0.0032*TI*(100-R_{BS}) =$		2.59	
$GE_{AC+LCB} = 0.0032*TI*(100-R_{AS}) =$		1.73	
$GE_{AC} = 0.4*GE_{AC+LCB} =$		0.69	
=>	GE'_{AC} =	0.89	(add 0.2 ft safety factor)
	AC thickness =	0.57	ft
=>	AC Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f,\ AC}$=	1.56	
	GE_{AC}=	0.86	
$GE_{LCB} = (GE_{AC+LCB})-GE_{AC} =$		0.87	
=>	GE_{AC+AB}=	1.07	(add 0.2 ft safety factor)
	$G_{f,\ LCB}$=	1.90	
	LCB thickness=	0.56	
=>	LCB Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	GE_{LCB}=	1.05	
$GE_{AS} = GE_{TOTAL}-GE_{LCB}-GE_{AC} =$		0.69	
=>	AS Thickness=	**0.70**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

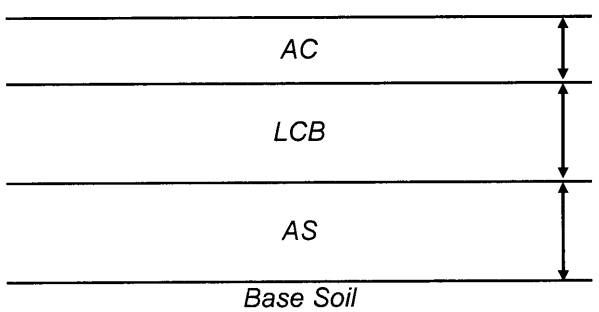
PROJECT NAME: *Route 101/Willow Rd I/C (Ramp)*
PROJECT NO.: *203125.GDR*

Design Case: AC over LCB over AS (Class 1 w/ R = 60)

Design TI=	***10***
R_{BS}=	***40***
R_{AB}=	78
R_{AS}=	60

$GE_{TOTAL} = 0.0032*TI*(100-R_{BS}) =$		1.92	
$GE_{AC+LCB} = 0.0032*TI*(100-R_{AS}) =$		1.28	
$GE_{AC} = 0.4*GE_{AC+LCB} =$		0.51	
=>	GE'_{AC} =	0.71	(add 0.2 ft safety factor)
	AC thickness =	0.40	ft
=>	AC Thickness=	**0.50**	ft (round up to the nearest 0.05 ft)
	$G_{f,\,AC}$=	1.79	
	GE_{AC}=	0.90	
$GE_{LCB} = (GE_{AC+LCB})-GE_{AC} =$		0.38	
=>	GE_{AC+AB}=	0.58	(add 0.2 ft safety factor)
	$G_{f,\,LCB}$=	1.90	
	LCB thickness=	0.31	
=>	LCB Thickness=	**0.50**	ft (round up to the nearest 0.05 ft)
	GE_{LCB}=	0.95	
$GE_{AS} = GE_{TOTAL}-GE_{LCB}-GE_{AC} =$		0.07	
=>	AS Thickness=	**0.10**	ft (round up to the nearest 0.05 ft)
		(Caltran Dist. 5 Material uses 0.55' AS Class 1 - ok)	

Design Section:



0.50	ft	
0.50	ft	
0.55	ft	(Use 0.55' per Caltrans Dist. 5 Materials)

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Route 101/Willow Rd I/C (Main Line Widening)*
PROJECT NO.: *203125.GDR*

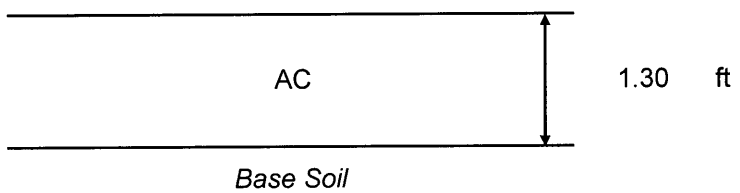
Design Case: Full depth AC

Design TI= ***13.5***
R_{BS}= ***40***

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$ 2.59
=> GE'_{AC}= 2.69 (add 0.1 ft safety factor)
=> AC Thickness= 1.30

=> AC Thickness= **1.30** ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Route 101/Willow Rd I/C (Ramps)*
PROJECT NO.: *203125.GDR*

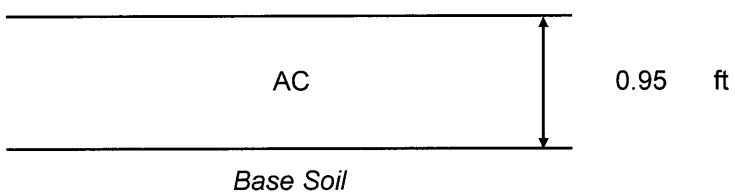
Design Case: Full depth AC

Design TI= ***10***
R_{BS}= ***40***

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$ 1.92
=> GE'_{AC}= 2.02 (add 0.1 ft safety factor)
=> AC Thickness= 0.93

=> AC Thickness= **0.95** ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

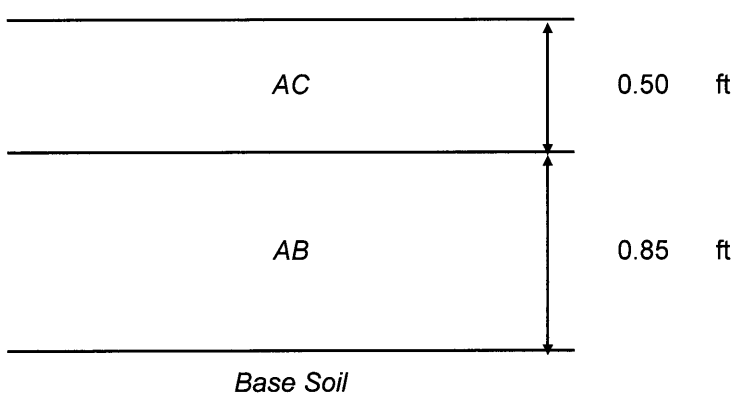
PROJECT NAME: *Willow Road Ext. (Route 101 to Thompson Ave)* County's R/W

PROJECT NO.: *203125.GDR*

Design Case: AC over AB

Design TI=	***9.5***		
R_{BS}=	***40***		
R_{AB}=	78		
$GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =$		1.82	
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$		0.67	
=>	GE'_{AC} =	0.87	(add 0.2 ft safety factor)
	AC Thickness =	0.47	ft
=>	AC Thickness =	**0.50**	ft (round up to the nearest 0.05 ft)
	$G_{f,\,AC}$ =	1.84	
	GE_{AC} =	0.92	
$GE_{AB} = GE_{AC+AB} - GE_{AC} =$		0.90	
	AB thickness=	0.82	ft
=>	AB Thickness=	**0.85**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	0.94	$G_{f,\,AB}$=1.1

Design Section:



Use 4 ft Select Fill w/ min. R = 40 below Pavement

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Willow Road Ext. (Route 101 to Thompson Ave)* County's R/W
PROJECT NO.: *203125.GDR*

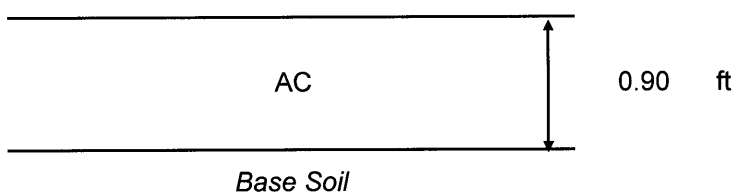
Design Case: Full depth AC

Design TI= ***9.5***
R_{BS}= ***40***

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$ 1.82
=> GE'_{AC}= 1.92 (add 0.1 ft safety factor)
=> AC Thickness= 0.88

=> AC Thickness= **0.90** ft (round up to the nearest 0.05 ft)

Design Section:



Use 4 ft Select Fill w/
min. R=40 below Pavement

APPENDIX C-4

ALTPIPE ANALYSIS RESULTS

Willow Road/Route 101, San Luis Obispo County
Drainage System Summary for Corrosion Analysis (AltPipe Program)

Drainage System	Pipe Size (in.)	Approx. Cover (ft.) per the Drainage Plans	2- to 5-yr Flow Velocity (ft/sec) Provided by the Designer
Caltrans Right-Of-Way			
1	24	3	6.3
1	54	2	7.9
1	60	2	7. 5
2	24	3	5.04
2	36	3	4.92
3	36	5	6.5
3	48	6	7.74
4	24	3	6.48
4	36	3	5.76
4	48	4	5.4
5	36	4	4.68
6	24	3	4.0
6	36	12	6.48
7	18	3	5.9
7	24	3	7.9
7	36	4	7.4
8	24	3	7.44
9	24	4	7.7
10	24	3	4.4
11	24	5	4.4
12	24	5	7.7
13	24	3	6.3
13	36	3	7.9
14	18	2	5.4
14	24	2	6.78
14	60	3	6.42
County's Right-Of-Way			
W1 (West of Route 101)	18	9	4.2
W2	18	8	5.88
W3	18	7	5.16
W4	18	7	7.5
W5	18	8	5.9
W6	36	6	5.2
W7	18	4	6.8
W8	18	5	4.7
W9 (East of Nipomo Crk)	18	3	5.7
W10 (East of Nipomo Crk)	18	4	6.2

Willow Road-Route 101, San Luis Obispo County
Drainage System Summary for Corrosion Analysis

Drainage System	Pipe Size (in.)	Approx. Cover (ft.) per the Drainage Plans	2- to 5-yr Flow Velocity (ft/sec) Provided by the Designer
W11 (East of Nipomo Crk)	18	2	6.0
W12 (East of Nipomo Crk)	18	1	6.9
W13 (East of Nipomo Crk)	18	1	7.6
F1 (Frontage Road)	23	2	4.8
F2	23	2	4.8
F3	23	2	4.8
F4	23	2	4.8
F5	23	2	4.8
F6	23	2	4.8
F7	23	2	4.7
F8	18	3	4.7
F9	18	3	4.7
F10	18	5	4.7
F11	18	3	4.7
F12	18	3	4.7
F13	18	3	6.3
F14	18	3	6.3
F15	18	1	6.3
F16	36	3	6.3
F17	36	3	6.3
F18	18	1	6.3
C1 (Cherokee Road)	18	1	4.8

AltPipe

Project EA: 203125.GDR
Project Engineer: D. WANG
Location: SAN LUIS OBISPO COUNTY
Description: WILLOW RD/RTE 101 INTERCHANGE

Steel Pipes

DSN/U		1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)		24	54	60	24	36	36	48	24	36	48
Pipe Type	Coat	Minimum Thickness (in)									
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	AL2		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	BC		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	BCI	0.079	0.109	0.109	0.079	0.079	0.079	0.109	0.079	0.079	0.079
	PA	0.079	0.079	0.109	0.052	0.052	0.079	0.079	0.079	0.064	0.064
	PS	0.079	0.079	0.109	0.052	0.052	0.079	0.079	0.079	0.064	0.064
Corrugated Steel Pipe - Helical Corrugations - 3" X 1" Corrugations	GAL			0.109				0.109			0.109
	AL2			0.109				0.109			0.109
	BC			0.109				0.109			0.109
	BCI			0.109				0.109			0.079
	PA			0.079				0.079			0.064
	PS			0.079				0.079			0.064
Corrugated Steel Pipe - Helical Corrugations - 5" X 1" Corrugations	GAL		0.109	0.109				0.109			0.109
	AL2		0.109	0.109				0.109			0.109
	BC		0.109	0.109				0.109			0.109
	BCI		0.109	0.109				0.109			0.079
	PA		0.079	0.079				0.079			0.064
	PS		0.079	0.079				0.079			0.064
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	AL2		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	BC		0.109	0.109		0.109	0.109	0.109		0.109	0.109
	BCI	0.079	0.109	0.109	0.079	0.079	0.079	0.109	0.079	0.079	0.079
	PA	0.079	0.079	0.109	0.064	0.064	0.079	0.079	0.079	0.064	0.064
	PS	0.079	0.079	0.109	0.064	0.064	0.079	0.079	0.079	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BCI	0.079	0.109	0.109	0.079	0.079	0.079	0.109	0.079	0.079	0.079
	PA	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
	PS	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BCI	0.079	0.109	0.109	0.079	0.079	0.079	0.109	0.079	0.079	0.079
	PA	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
	PS	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109	0.109
	BCI	0.079	0.109	0.109	0.079	0.079	0.079	0.109	0.079	0.079	0.079

DSN/U			1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)			24	54	60	24	36	36	48	24	36	48
Pipe Type		Coat	Minimum Thickness (in)									
		PA	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
		PS	0.079	0.079	0.079	0.064	0.064	0.079	0.079	0.079	0.064	0.064
		CSS		0.064	0.079		0.064	0.064	0.064		0.064	0.064
Structural Steel Plate Pipe - 6" X 2" Corrugations	Thickness	GAL			0.109							
		AL2			0.109							
		BC			0.109							
		BCI			0.109							
		PA			0.109							
		PS			0.109							
	Diameter				60							

Aluminum Pipes

DSN/U	1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)	24	54	60	24	36	36	48	24	36	48
Pipe Type	Minimum Thickness (in)									
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	0.060	0.135	0.135	0.060	0.075	0.075	0.105	0.060	0.075	0.105
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		0.060	0.060		0.060	0.060	0.060		0.060	0.060
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	0.060	0.135	0.135	0.060	0.075	0.075	0.105	0.060	0.075	0.105
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		0.060	0.060		0.060	0.060	0.060		0.060	0.060
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	0.060	0.105	0.105	0.060	0.060	0.060	0.105	0.060	0.060	0.105
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	0.060	0.105	0.105	0.060	0.060	0.060	0.105	0.060	0.060	0.105
Structural Aluminum Plate Pipe - 9" X 2½" Corrugations - Thickness			0.100							
Structural Aluminum Plate Pipe - 9" X 2½" Corrugations - Diameter			60							

Plastic Pipes

DSN/U	1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)	24	54	60	24	36	36	48	24	36	48
Pipe Type	Availability									
PVC Corrugated	Allowable			Allowable	Allowable	Allowable		Allowable	Allowable	
PVC Ribbed	Allowable			Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable			Allowable				Allowable		

DSN/U	1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)	24	54	60	24	36	36	48	24	36	48
Pipe Type	Availability									
HDPE Corrugated - Type C	Allowable			Allowable				Allowable		

Reinforced Concrete Pipes

DSN/U	1	1a	1b	2	2a	3	3a	4	4a	4b
Pipe Diameter (in)	24	54	60	24	36	36	48	24	36	48
Steel Cover (in)	1	1	1	1	1	1	1	1	1	1
Sacks of Cement	5	5	5	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	1	1a	1b	2	2a	3	3a	4	4a	4b
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	3	3	3	3	2	3	3	3	3	3
2–5 Year Flow Velocity (ft/sec)	6.3	7.9	7.5	5.04	4.92	6.5	7.74	6.48	5.76	5.4
Design Service Life (years)	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)	3	2	2	3	3	5	6	3	3	4

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AltPipe

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Steel Pipes

DSN/U		5	6	6a	7	7a	7b	8	9	10
Pipe Diameter (in)		36	24	36	18	24	36	24	24	24
Pipe Type	Coat	Minimum Thickness (in)								
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL	0.109		0.109			0.109			
	AL2	0.109		0.109			0.109			
	BC	0.109	0.079	0.109			0.109			0.079
	BCI	0.079	0.079	0.079			0.109			0.079
	PA	0.052	0.052	0.079	0.064	0.079	0.079	0.079	0.079	0.052
	PS	0.052	0.052	0.079	0.064	0.079	0.079	0.079	0.079	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL	0.109		0.109			0.109			
	AL2	0.109		0.109			0.109			
	BC	0.109	0.079	0.109			0.109			0.079
	BCI	0.079	0.079	0.079			0.109			0.079
	PA	0.064	0.064	0.079	0.064	0.079	0.079	0.079	0.079	0.064
	PS	0.064	0.064	0.079	0.064	0.079	0.079	0.079	0.079	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.079	0.109		0.109	0.109	0.109	0.109	0.079
	BCI	0.079	0.079	0.079		0.109	0.109	0.109	0.109	0.079
	PA	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
	PS	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.079	0.109		0.109	0.109	0.109	0.109	0.079
	BCI	0.079	0.079	0.079		0.109	0.109	0.109	0.109	0.079
	PA	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
	PS	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	AL2	0.109	0.109	0.109		0.109	0.109	0.109	0.109	0.109
	BC	0.109	0.079	0.109		0.109	0.109	0.109	0.109	0.079
	BCI	0.079	0.079	0.079		0.109	0.109	0.109	0.109	0.079
	PA	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
	PS	0.064	0.064	0.079		0.079	0.079	0.079	0.079	0.064
	CSS	0.064		0.064			0.064			

Aluminum Pipes

DSN/U	5	6	6a	7	7a	7b	8	9	10
Pipe Diameter (in)	36	24	36	18	24	36	24	24	24
Pipe Type	Minimum Thickness (in)								
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	0.075	0.060	0.075	0.060	0.060	0.075	0.060	0.060	0.060
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations	0.060		0.060			0.060			
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	0.075	0.060	0.075	0.060	0.060	0.075	0.060	0.060	0.060
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations	0.060		0.060			0.060			
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	0.060	0.060	0.060		0.060	0.060	0.060	0.060	0.060
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	0.060	0.060	0.060		0.060	0.060	0.060	0.060	0.060

Plastic Pipes

DSN/U	5	6	6a	7	7a	7b	8	9	10
Pipe Diameter (in)	36	24	36	18	24	36	24	24	24
Pipe Type	Availability								
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable

DSN/U	5	6	6a	7	7a	7b	8	9	10
Pipe Diameter (in)	36	24	36	18	24	36	24	24	24
Pipe Type	Availability								
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed		Allowable		Allowable	Allowable		Allowable	Allowable	Allowable
HDPE Corrugated - Type C		Allowable		Allowable	Allowable		Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	5	6	6a	7	7a	7b	8	9	10
Pipe Diameter (in)	36	24	36	18	24	36	24	24	24
Steel Cover (in)	1	1	1	0.75	1	1	1	1	1
Sacks of Cement	5	5	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	5	6	6a	7	7a	7b	8	9	10
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	2	2	3	3	3	3	3	3	2
2–5 Year Flow Velocity (ft/sec)	4.68	4	6.48	5.9	7.9	7.4	7.44	7.7	4.4
Design Service Life (years)	50	50	50	50	50	50	50	50	50
Height of Cover (ft)	4	3	12	3	3	4	3	4	3

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AltPipe

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Steel Pipes

DSN/U		11	12	13	13a	14	14a	14b
Pipe Diameter (in)		24	24	24	30	18	24	60
Pipe Type	Coat	Minimum Thickness (in)						
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL				0.109			0.109
	AL2				0.109			0.109
	BC	0.079			0.109			0.109
	BCI	0.079		0.079	0.109		0.079	0.109
	PA	0.052	0.079	0.079	0.079	0.064	0.079	0.109
	PS	0.052	0.079	0.079	0.079	0.064	0.079	0.109
Corrugated Steel Pipe - Helical Corrugations - 3" X 1" Corrugations	GAL							0.109
	AL2							0.109
	BC							0.109
	BCI							0.079
	PA							0.079
	PS							0.079
Corrugated Steel Pipe - Helical Corrugations - 5" X 1" Corrugations	GAL							0.109
	AL2							0.109
	BC							0.109
	BCI							0.079
	PA							0.079
	PS							0.079
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL							0.109
	AL2							0.109
	BC	0.079						0.109
	BCI	0.079		0.079			0.079	0.109
	PA	0.064	0.079	0.079	0.079	0.064	0.079	0.109
	PS	0.064	0.079	0.079	0.079	0.064	0.079	0.109
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL	0.109	0.109	0.109	0.109		0.109	0.109
	AL2	0.109	0.109	0.109	0.109		0.109	0.109
	BC	0.079	0.109	0.109	0.109		0.109	0.109
	BCI	0.079	0.109	0.079	0.109		0.079	0.079
	PA	0.064	0.079	0.079	0.079		0.079	0.079
	PS	0.064	0.079	0.079	0.079		0.079	0.079
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL	0.109	0.109	0.109	0.109		0.109	0.109
	AL2	0.109	0.109	0.109	0.109		0.109	0.109
	BC	0.079	0.109	0.109	0.109		0.109	0.109
	BCI	0.079	0.109	0.079	0.109		0.079	0.079
	PA	0.064	0.079	0.079	0.079		0.079	0.079
	PS	0.064	0.079	0.079	0.079		0.079	0.079
	GAL	0.109	0.109	0.109	0.109		0.109	0.109
	AL2	0.109	0.109	0.109	0.109		0.109	0.109

DSN/U			11	12	13	13a	14	14a	14b
Pipe Diameter (in)			24	24	24	30	18	24	60
Pipe Type		Coat	Minimum Thickness (in)						
		BC	0.079	0.109	0.109	0.109		0.109	0.109
		BCI	0.079	0.109	0.079	0.109		0.079	0.079
		PA	0.064	0.079	0.079	0.079		0.079	0.079
		PS	0.064	0.079	0.079	0.079		0.079	0.079
		CSS				0.064			0.079
Structural Steel Plate Pipe - 6" X 2" Corrugations	Thickness	GAL							0.109
		AL2							0.109
		BC							0.109
		BCI							0.109
		PA							0.109
		PS							0.109
	Diameter								60

Aluminum Pipes

DSN/U		11	12	13	13a	14	14a	14b
Pipe Diameter (in)		24	24	24	30	18	24	60
Pipe Type		Minimum Thickness (in)						
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.135
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations					0.060			0.060
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.135
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations					0.060			0.060
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		0.060	0.060	0.060	0.060		0.060	0.105
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		0.060	0.060	0.060	0.060		0.060	0.105
Structural Aluminum Plate Pipe - 9" X 2½" Corrugations	Thickness							0.100
	Diameter							60

Plastic Pipes

DSN/U	11	12	13	13a	14	14a	14b
Pipe Diameter (in)	24	24	24	30	18	24	60
Pipe Type	Availability						
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	

DSN/U	11	12	13	13a	14	14a	14b
Pipe Diameter (in)	24	24	24	30	18	24	60
Pipe Type	Availability						
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable	Allowable	Allowable		Allowable	Allowable	
HDPE Corrugated - Type C	Allowable	Allowable	Allowable		Allowable	Allowable	

Reinforced Concrete Pipes

DSN/U	11	12	13	13a	14	14a	14b
Pipe Diameter (in)	24	24	24	30	18	24	60
Steel Cover (in)	1	1	1	1	0.75	1	1
Sacks of Cement	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	11	12	13	13a	14	14a	14b
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	2	3	3	3	3	3	3
2–5 Year Flow Velocity (ft/sec)	4.4	7.7	6.3	7.9	5.4	6.78	6.42
Design Service Life (years)	50	50	50	50	50	50	50
Height of Cover (ft)	5	5	3	3	2	2	3

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AltPipe

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Steel Pipes

DSN/U		W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Pipe Diameter (in)		18	18	18	18	18	36	18	18
Pipe Type	Coat	Minimum Thickness (in)							
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL						0.109		
	AL2						0.109		
	BC						0.109		
	BCI						0.079		
	PA	0.052	0.064	0.064		0.064	0.064		0.052
	PS	0.052	0.064	0.064		0.064	0.064		0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL						0.109		
	AL2						0.109		
	BC						0.109		
	BCI						0.079		
	PA	0.064	0.064	0.064		0.064	0.064		0.064
	PS	0.064	0.064	0.064		0.064	0.064		0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL						0.109		
	AL2						0.109		
	BC						0.109		
	BCI						0.079		
	PA						0.064		
	PS						0.064		
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL						0.109		
	AL2						0.109		
	BC						0.109		
	BCI						0.079		
	PA						0.064		
	PS						0.064		
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL						0.109		
	AL2						0.109		
	BC						0.109		
	BCI						0.079		
	PA						0.064		
	PS						0.064		
	CSS						0.064		

Aluminum Pipes

DSN/U	W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Pipe Diameter (in)	18	18	18	18	18	36	18	18
Pipe Type	Minimum Thickness (in)							
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	0.060	0.060	0.060	0.060	0.060	0.075	0.060	0.060
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations						0.060		
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	0.060	0.060	0.060	0.060	0.060	0.075	0.060	0.060
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations						0.060		
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch						0.060		
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch						0.060		

Plastic Pipes

DSN/U	W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Pipe Diameter (in)	18	18	18	18	18	36	18	18
Pipe Type	Availability							
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable

DSN/U	W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Pipe Diameter (in)	18	18	18	18	18	36	18	18
Pipe Type	Availability							
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable		Allowable	Allowable
HDPE Corrugated - Type C	Allowable	Allowable	Allowable	Allowable	Allowable		Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Pipe Diameter (in)	18	18	18	18	18	36	18	18
Steel Cover (in)	0.75	0.75	0.75	0.75	0.75	1	0.75	0.75
Sacks of Cement	5	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	W1(West of Route 101)	W2	W3	W4	W5	W6	W7	W8
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	2	3	3	3	3	3	3	2
2–5 Year Flow Velocity (ft/sec)	4.2	5.88	5.16	7.5	5.9	5.2	6.8	4.7
Design Service Life (years)	50	50	50	50	50	50	50	50
Height of Cover (ft)	9	8	7	7	8	6	4	5

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AltPipe

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Plastic Pipes

DSN/U	W9(East of Nipomo Crk)	W10(East of Nipomo Crk)	W11(East of Nipomo Crk)	W12(East of Nipomo Crk)	W13(East of Nipomo Crk)
Pipe Diameter (in)	**18**	**18**	**18**	**18**	**18**
Pipe Type	**Availability**				
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type C	Allowable	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	W9(East of Nipomo Crk)	W10(East of Nipomo Crk)	W11(East of Nipomo Crk)	W12(East of Nipomo Crk)	W13(East of Nipomo Crk)
Pipe Diameter (in)	**18**	**18**	**18**	**18**	**18**
Steel Cover (in)	0.75	0.75	0.75	0.75	0.75
Sacks of Cement	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	W9(East of Nipomo Crk)	W10(East of Nipomo Crk)	W11(East of Nipomo Crk)	W12(East of Nipomo Crk)	W13(East of Nipomo Crk)
Soil pH	7.92	7.92	7.92	7.92	7.92
Minimum Soil Resistivity (ohm-cm)	540	540	540	540	540
Sulfate Concentration (ppm)	120	120	120	120	120
Chloride Concentration (ppm)	38.1	38.1	38.1	38.1	38.1
Abrasion Level	3	3	3	3	3
2–5 Year Flow Velocity (ft/sec)	5.7	6.2	6.0	6.9	7.6
Design Service Life (years)	50	50	50	50	50
Height of Cover (ft)	3	4	2	2	2

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Caltrans

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Steel Pipes

DSN/U		F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pipe Diameter (in)		24	24	24	24	24	24	24	18	18	18
Pipe Type	Coat	Minimum Thickness (in)									
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	BCI	0.079	0.079	0.079	0.079	0.079	0.079	0.079			
	PA	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	BCI	0.079	0.079	0.079	0.079	0.079	0.079	0.079			
	PA	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	PS	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BCI	0.079	0.079	0.079	0.079	0.079	0.079	0.079			
	PA	0.064	0.064	0.064	0.064	0.064	0.064	0.064			
	PS	0.064	0.064	0.064	0.064	0.064	0.064	0.064			
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BCI	0.079	0.079	0.079	0.079	0.079	0.079	0.079			
	PA	0.064	0.064	0.064	0.064	0.064	0.064	0.064			
	PS	0.064	0.064	0.064	0.064	0.064	0.064	0.064			
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	AL2	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BC	0.109	0.109	0.109	0.109	0.109	0.109	0.109			
	BCI	0.079	0.079	0.079	0.079	0.079	0.079	0.079			
	PA	0.064	0.064	0.064	0.064	0.064	0.064	0.064			
	PS	0.064	0.064	0.064	0.064	0.064	0.064	0.064			

Aluminum Pipes

DSN/U	F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pipe Diameter (in)	24	24	24	24	24	24	24	18	18	18
Pipe Type	Minimum Thickness (in)									
Corrugated Aluminum	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060

DSN/U	F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pipe Diameter (in)	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**18**	**18**	**18**
Pipe Type	**Minimum Thickness (in)**									
Pipe - Annular Corrugations - 2⅔" X ½" Corrugations										
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	0.060	0.060	0.060	0.060	0.060	0.060	0.060			
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	0.060	0.060	0.060	0.060	0.060	0.060	0.060			

Plastic Pipes

DSN/U	F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pipe Diameter (in)	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**18**	**18**	**18**
Pipe Type	**Availability**									
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type C	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Pipe Diameter (in)	**24**	**24**	**24**	**24**	**24**	**24**	**24**	**18**	**18**	**18**
Steel Cover (in)	1	1	1	1	1	1	1	0.75	0.75	0.75
Sacks of Cement	5	5	5	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	F1(Frontage Rd)	F2	F3	F4	F5	F6	F7	F8	F9	F10
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	2	2	2	2	2	2	2	2	2	2
2–5 Year Flow Velocity (ft/sec)	4.8	4.8	4.8	4.8	4.8	4.8	4.7	4.7	4.7	4.7
Design Service Life (years)	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)	2	2	2	2	2	2	2	3	3	5

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AltPipe

Project EA: **203125.GDR**
Project Engineer: **D. WANG**
Location: **SAN LUIS OBISPO COUNTY**
Description: **WILLOW RD/RTE 101 INTERCHANGE**

Steel Pipes

DSN/U		F11	F12	F13	F14	F15	F16	F17	F18	C1
Pipe Diameter (in)		18	18	18	18	18	36	36	18	18
Pipe Type	Coat	Minimum Thickness (in)								
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL						0.109	0.109		
	AL2						0.109	0.109		
	BC						0.109	0.109		
	BCI						0.079	0.079		
	PA	0.052	0.052				0.079	0.079		0.052
	PS	0.052	0.052				0.079	0.079		0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL						0.109	0.109		
	AL2						0.109	0.109		
	BC						0.109	0.109		
	BCI						0.079	0.079		
	PA	0.064	0.064				0.079	0.079		0.064
	PS	0.064	0.064				0.079	0.079		0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL						0.109	0.109		
	AL2						0.109	0.109		
	BC						0.109	0.109		
	BCI						0.079	0.079		
	PA						0.079	0.079		
	PS						0.079	0.079		
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL						0.109	0.109		
	AL2						0.109	0.109		
	BC						0.109	0.109		
	BCI						0.079	0.079		
	PA						0.079	0.079		
	PS						0.079	0.079		
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL						0.109	0.109		
	AL2						0.109	0.109		
	BC						0.109	0.109		
	BCI						0.079	0.079		
	PA						0.079	0.079		
	PS						0.079	0.079		
	CSS						0.064	0.064		

DSN/U	F11	F12	F13	F14	F15	F16	F17	F18	C1
Pipe Diameter (in)	**18**	**18**	**18**	**18**	**18**	**36**	**36**	**18**	**18**
Pipe Type	**Availability**								
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
HDPE Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable			Allowable	Allowable
HDPE Corrugated - Type C	Allowable	Allowable	Allowable	Allowable	Allowable			Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	F11	F12	F13	F14	F15	F16	F17	F18	C1
Pipe Diameter (in)	**18**	**18**	**18**	**18**	**18**	**36**	**36**	**18**	**18**
Steel Cover (in)	0.75	0.75	0.75	0.75	0.75	1	1	0.75	0.75
Sacks of Cement	5	5	5	5	5	5	5	5	5
Percentage Water	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Other Information

DSN/U	F11	F12	F13	F14	F15	F16	F17	F18	C1
Soil pH	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89	6.89
Minimum Soil Resistivity (ohm-cm)	9110	9110	9110	9110	9110	9110	9110	9110	9110
Sulfate Concentration (ppm)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Chloride Concentration (ppm)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
Abrasion Level	2	2	3	3	3	3	3	3	2
2–5 Year Flow Velocity (ft/sec)	4.7	4.7	6.3	6.3	6.3	6.3	6.3	6.3	4.8
Design Service Life (years)	50	50	50	50	50	50	50	50	50
Height of Cover (ft)	3	3	3	3	2	3	3	2	2

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Aluminum Pipes

DSN/U	F11	F12	F13	F14	F15	F16	F17	F18	C1
Pipe Diameter (in)	18	18	18	18	18	36	36	18	18
Pipe Type	Minimum Thickness (in)								
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	0.060	0.060	0.060	0.060	0.060	0.075	0.075	0.060	0.060
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations						0.060	0.060		
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	0.060	0.060	0.060	0.060	0.060	0.075	0.075	0.060	0.060
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations						0.060	0.060		
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch						0.060	0.060		
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch						0.060	0.060		

Plastic Pipes

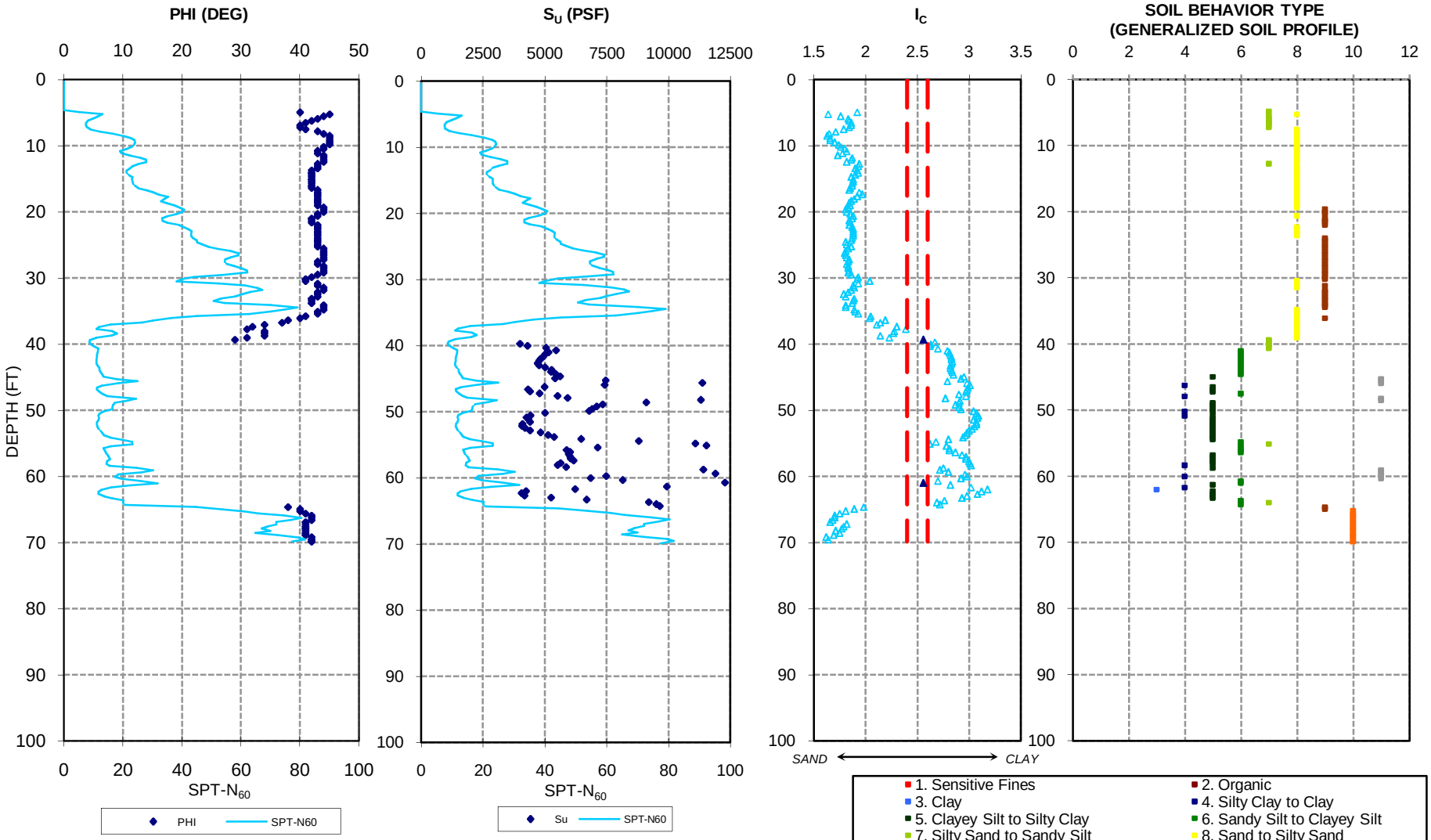
DSN/U	F11	F12	F13	F14	F15	F16	F17	F18	C1
Pipe Diameter (in)	18	18	18	18	18	36	36	18	18
Pipe Type	Availability								
PVC Corrugated	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable

APPENDIX C-5

CPT DATA CORRELATION & LIQUEFRACTION ANALYSIS

CPT DATA CORRELATION

CPT-1



Reference: CPT data and correlation provided by Gregg Drilling and Testing, Inc.

PARIKH

Practicing in the Geosciences

WILLOW ROAD EXTENSION AT ROUTE 101
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.: 203125.EXT

PLATE NO.:

LIQUEFACTION POTENTIAL ANALYSIS (per Youd & Idriss, 2001)

PROJECT NAME	***WILLOW ROAD EXTENSION AT ROUTE 101***	*FAULT INFO*		*FAULT M_w =*	6.5
PROJECT NO.	***203125.EXT***	*SANTA MARIA RIVER - FOXEN CANYON FAULT*		*MSF =*	1.44
CPT NO.	***CPT-1***	*a_{max} (g)=*	0.8		
				DESIGN GW DEPTH=	30

		CPT RESULT INPUT							*CSR*		*CRR 7.5*						*F.S.=(CRR 7.5/CSR)*MSF*Kσ*Kα*		
Depth (ft)	Soil Behavior Type	qc (tsf)	fs (tsf)	σ_v (tsf)	u (tsf)	σ_v' (tsf)	Ic*	C_N*	γ_d	CSR	Ic	C_Q	q_{c1N}	K_C	$(q_{c1N})_{cs}$	$CRR_{7.5}$	Kσ	Kα	F.S.
0.328																			
0.656																			
0.984																			
1.312																			
1.64																			
1.969																			
2.297																			
2.625								1.7	1.00									1	
2.953								1.7	1.00									1	
3.281								1.7	0.99									1	
3.609								1.7	0.99									1	
3.937								1.7	0.99									1	
4.265								1.7	0.99									1	
4.593								1.7	0.99									1	
4.921	7 Silty Sand to Sandy Silt	27.664	0.26	0.29		0.29	1.92	1.47651	0.99	0.515	1.920	1.48	40.85	1.208	49.353	0.09	1.00	1	
5.249	8 Sand to Silty Sand	76.043	0.778	0.31		0.31	1.64	1.45695	0.99	0.515	1.640	1.46	110.79	1.000	110.791	0.21	1.00	1	
5.577	7 Silty Sand to Sandy Silt	63.036	0.749	0.329		0.329	1.76	1.43885	0.99	0.514	1.760	1.44	90.70	1.078	97.814	0.17	1.00	1	
5.906	7 Silty Sand to Sandy Silt	53.072	0.624	0.348		0.348	1.83	1.42119	0.99	0.514	1.830	1.42	75.43	1.129	85.169	0.14	1.00	1	
6.234	7 Silty Sand to Sandy Silt	44.388	0.427	0.368		0.368	1.84	1.40306	0.99	0.513	1.840	1.40	62.28	1.137	70.813	0.11	1.00	1	
6.562	7 Silty Sand to Sandy Silt	40.027	0.341	0.387		0.387	1.86	1.38626	0.99	0.513	1.860	1.39	55.49	1.153	63.997	0.10	1.00	1	
6.89	7 Silty Sand to Sandy Silt	39.875	0.32	0.406		0.406	1.86	1.36986	0.99	0.513	1.860	1.37	54.62	1.153	62.999	0.10	1.00	1	
7.218	7 Silty Sand to Sandy Silt	42.141	0.315	0.426		0.426	1.84	1.35301	0.99	0.512	1.840	1.35	57.02	1.137	64.831	0.11	1.00	1	
7.546	8 Sand to Silty Sand	50.559	0.375	0.445		0.445	1.79	1.33739	0.98	0.512	1.790	1.34	67.62	1.099	74.341	0.12	1.00	1	
7.874	8 Sand to Silty Sand	69.843	0.537	0.465		0.465	1.71	1.32132	0.98	0.512	1.710	1.32	92.29	1.045	96.401	0.16	1.00	1	
8.202	8 Sand to Silty Sand	94.331	0.798	0.485		0.485	1.65	1.30564	0.98	0.511	1.650	1.31	123.16	1.003	123.573	0.26	1.00	1	
8.53	8 Sand to Silty Sand	117.445	1.125	0.505		0.505	1.63	1.29032	0.98	0.511	1.630	1.29	151.54	1.000	151.542	0.40	1.00	1	
8.858	8 Sand to Silty Sand	131.059	1.433	0.525		0.525	1.66	1.27536	0.98	0.510	1.660	1.28	167.15	1.010	168.887		1.00	1	
9.186	8 Sand to Silty Sand	137.477	1.558	0.545		0.545	1.66	1.26074	0.98	0.510	1.660	1.26	173.32	1.010	175.127		1.00	1	
9.514	8 Sand to Silty Sand	137.363	1.66	0.564		0.564	1.7	1.24717	0.98	0.510	1.700	1.25	171.31	1.038	177.800		1.00	1	
9.843	8 Sand to Silty Sand	132.31	1.713	0.584		0.584	1.74	1.23318	0.98	0.509	1.740	1.23	163.16	1.065	173.737		1.00	1	
10.171	8 Sand to Silty Sand	128.243	1.647	0.604		0.604	1.76	1.21951	0.98	0.509	1.760	1.22	156.39	1.078	168.661		1.00	1	
10.499	8 Sand to Silty Sand	115.71	1.505	0.624		0.624	1.8	1.20614	0.98	0.509	1.800	1.21	139.56	1.107	154.448	0.42	1.00	1	
10.827	8 Sand to Silty Sand	103.594	1.26	0.644		0.644	1.82	1.19306	0.98	0.508	1.820	1.19	123.59	1.122	138.612	0.33	1.00	1	
11.155	8 Sand to Silty Sand	108.249	1.16	0.664		0.664	1.78	1.18026	0.98	0.508	1.780	1.18	127.76	1.092	139.560	0.33	1.00	1	
11.483	8 Sand to Silty Sand	126.593	1.325	0.683		0.683	1.73	1.16835	0.98	0.508	1.730	1.17	147.90	1.058	156.492	0.44	1.00	1	
11.811	8 Sand to Silty Sand	137.657	2.335	0.703		0.703	1.87	1.15607	0.98	0.507	1.870	1.16	159.14	1.162	184.896		1.00	1	
12.139	8 Sand to Silty Sand	148.721	2.551	0.723		0.723	1.86	1.14405	0.97	0.507	1.860	1.14	170.14	1.153	196.234		1.00	1	
12.467	8 Sand to Silty Sand	151.451	2.316	0.743		0.743	1.82	1.13227	0.97	0.506	1.820	1.13	171.48	1.122	192.321		1.00	1	
12.795	7 Silty Sand to Sandy Silt	131.315	2.439	0.762		0.762	1.94	1.1213	0.97	0.506	1.940	1.12	147.24	1.229	180.961		1.00	1	
13.123	8 Sand to Silty Sand	120.99	2.019	0.782		0.782	1.93	1.10999	0.97	0.506	1.930	1.11	134.30	1.218	163.637		1.00	1	
13.451	8 Sand to Silty Sand	117.795	1.677	0.802		0.802	1.9	1.0989	0.97	0.505	1.900	1.10	129.45	1.189	153.890	0.42	1.00	1	
13.78	8 Sand to Silty Sand	110.96	1.549	0.822		0.822	1.92	1.08803	0.97	0.505	1.920	1.09	120.73	1.208	145.873	0.37	1.00	1	
14.108	8 Sand to Silty Sand	110.268	1.578	0.842		0.842	1.93	1.07738	0.97	0.505	1.930	1.08	118.80	1.218	144.753	0.36	1.00	1	
14.436	8 Sand to Silty Sand	116.411	1.529	0.862		0.862	1.9	1.06693	0.97	0.504	1.900	1.07	124.20	1.189	147.656	0.38	1.00	1	
14.764	8 Sand to Silty Sand	124.09	1.5	0.881		0.881	1.86	1.05718	0.97	0.504	1.860	1.06	131.19	1.153	151.303	0.40	1.00	1	
15.092	8 Sand to Silty Sand	123.266	1.522	0.901		0.901	1.88	1.04712	0.97	0.504	1.880	1.05	129.07	1.171	151.091	0.40	1.00	1	
15.42	8 Sand to Silty Sand	123.218	1.502	0.921		0.921	1.88	1.03725	0.97	0.503	1.880	1.04	127.81	1.171	149.608	0.39	1.00	1	
15.748	8 Sand to Silty Sand	124.981	1.487	0.941		0.941	1.87	1.02756	0.97	0.503	1.870	1.03	128.43	1.162	149.209	0.39	1.00	1	
16.076	8 Sand to Silty Sand	128.802	1.523	0.961		0.961	1.87	1.01805	0.97	0.502	1.870	1.02	131.13	1.162	152.348	0.41	1.00	1	
16.404	8 Sand to Silty Sand	136.444	1.559	0.981		0.981	1.85	1.00871	0.97	0.502	1.850	1.01	137.63	1.145	157.601	0.44	1.00	1	
16.732	8 Sand to Silty Sand	151.461	1.878	1		1	1.84	1	0.96	0.502	1.840	1.00	151.46	1.137	172.216		1.00	1	
17.06	8 Sand to Silty Sand	157.367	2.646	1.02		1.02	1.94	0.99099	0.96	0.501	1.940	0.99	155.95	1.229	191.660		0.99	1	
17.388	8 Sand to Silty Sand	165.558	3.143	1.04		1.04	1.97	0.98214	0.96	0.501	1.970	0.98	162.60	1.263	205.321		0.99	1	
17.717	8 Sand to Silty Sand	184.823	3.279	1.06		1.06	1.92	0.97345	0.96	0.500	1.920	0.97	179.92	1.208	217.388		0.98	1	
18.045	8 Sand to Silty Sand	181.059	2.848	1.08		1.08	1.89	0.96491	0.96	0.500	1.890	0.96	174.71	1.180	206.078		0.97	1	
18.373	8 Sand to Silty Sand	176.746	2.406	1.1		1.1	1.86	0.95652	0.96	0.500	1.860	0.96	169.06	1.153	194.986		0.97	1	
18.701	8 Sand to Silty Sand	189.203	2.534	1.119		1.119	1.84	0.94868	0.96	0.499	1.840	0.95	179.49	1.137	204.090		0.96	1	
19.029	8 Sand to Silty Sand	200.191	2.923	1.139		1.139	1.85	0.94057	0.96	0.499	1.850	0.94	188.29	1.145	215.612		0.95	1	
19.357	8 Sand to Silty Sand	213.653	3.042	1.159		1.159	1.83	0.9326	0.96	0.498	1.830	0.93	199.25	1.129	224.992		0.95	1	
19.685	9 Sand	222.783	3.006	1.18		1.18	1.81	0.92437	0.96	0.498	1.810	0.92	205.93	1.114	229.412		0.94	1	
20.013	9 Sand	218.394	2.981	1.2		1.2	1.82	0.91667	0.96	0.498	1.820	0.92	200.19	1.122	224.521		0.93	1	
20.341	9 Sand	203.708	2.784	1.22		1.22	1.85	0.90909	0.96	0.497	1.850	0.91	185.19	1.145	212.057		0.93	1	
20.669	8 Sand to Silty Sand	186.245	2.524	1.24		1.24	1.88	0.90164	0.96	0.497	1.880	0.90	167.93	1.171	196.569		0.93	1	
20.997	9 Sand	178.063	2.207	1.26		1.26	1.87	0.89431	0.95	0.496	1.870	0.89	159.24	1.162	185.015		0.93	1	
21.325	9 Sand	180.585	2.039	1.281		1.281	1.84	0.88674	0.95	0.496	1.840	0.89	160.13	1.137	182.075		0.92	1	
21.654	9 Sand	188.814	2.257	1.301		1.301	1.85	0.87965	0.95	0.495	1.850	0.88	166.09	1.145	190.186		0.92	1	
21.982	9 Sand	209.397	2.713	1.322		1.322	1.84	0.87232	0.95	0.495	1.840	0.87	182.66	1.137	207.692		0.91	1	
22.31	8 Sand to Silty Sand	217.891	3.138	1.341		1.341	1.87	0.8658	0.95	0.494	1.870	0.87	188.65	1.162	219.181		0.90	1	
22.638	8 Sand to Silty Sand	225.001	3.375	1.361		1.361	1.88	0.85904	0.95	0.494	1.880	0.86	193.28	1.171	226.254		0.89	1	
22.966	8 Sand to Silty Sand	230.14	3.502	1.381		1.381	1.88	0.85238	0.95	0.493	1.880	0.85	196.17	1.171	229.628		0.89	1	
23.294	8 Sand to Silty Sand	229.012	3.427	1.401		1.401	1.88	0.84583	0.95	0.493	1.880	0.85	193.70	1.171	226.746		0.89	1	
23.622	8 Sand to Silty Sand	229.353	3.336	1.421		1.421	1.88	0.83937	0.95	0.492	1.880	0.84	192.51	1.171	225.351		0.88	1	
23.95	9 Sand	233.278	3.344	1.441		1.441	1.87	0.83302	0.95	0.492	1.870	0.83	194.32	1.162	225.773		0.88	1	
24.278	9 Sand	241.175	3.383	1.461		1.461	1.86	0.82676	0.94	0.491	1.860	0.83	199.39	1.153	229.969		0.87	1	
24.606	9 Sand	246.228	2.951	1.482		1.482	1.81	0.82028	0.94	0.490	1.810	0.82	201.98	1.114	225.004		0.86	1	
24.934	9 Sand	254.874	3.227	1.502		1.502	1.82	0.81421	0.94	0.490	1.820	0.81	207.52	1.122	232.738		0.86	1	
25.262	9 Sand	263.397	3.833	1.523		1.523	1.86	0.80793	0.94	0.489	1.860	0.81	212.81	1.153	245.440		0.85	1	
25.591	9 Sand	282.851	4.008	1.543		1.543	1.83	0.80204	0.94	0.489	1.830	0.80	226.86	1.129	256.164		0.84	1	
25.919	9 Sand	307.947	4.322	1.563		1.563	1.81	0.79624	0.94	0.488	1.810	0.80	245.20	1.114	273.154		0.84	1	
26.247	9 Sand	324.215	4.661	1.584		1.584	1.8	0.79023	0.94	0.487	1.800	0.79	256.20	1.107	283.531		0.83	1	
26.575	9 Sand	322.243	4.697	1.604		1.604	1.81	0.78459	0.94	0.487	1.810	0.78	252.83	1.114	281.655		0.83	1	
26.903	9 Sand	307.245	4.386	1.624		1.624	1.82	0.77904	0.93	0.486	1.820	0.78	239.36	1.122	268.440		0.82	1	
27.231	9 Sand	295.176	4.192	1.645		1.645	1.84	0.77329	0.93	0.485	1.840	0.77	228.26	1.137	259.534		0.82	1	
27.559	9 Sand	295.508	4.055	1.665		1.665	1.83	0.76789	0.93	0.485	1.830	0.77	226.92	1.129	256.231		0.82	1	
27.887	9 Sand	300.059	3.995	1.685		1.685	1.82	0.76256	0.93	0.484	1.820	0.76	228.81	1.122	256.618		0.81	1	
28.215	9 Sand	312.459	4.362	1.706		1.706	1.83	0.75705	0.93	0.483	1.830	0.76	236.55	1.129	267.106		0.81	1	
28.543	9 Sand	326.254	4.794	1.726		1.726	1.83	0.75188	0.93	0.482	1.830	0.75	245.30	1.129	276.992		0.80	1	
28.871	9 Sand	334.653	5.09	1.747		1.747	1.84	0.74652	0.93	0.482	1.840	0.75	249.83	1.137	284.060		0.80	1	
29.199	9 Sand	337.033	4.951	1.767		1.767	1.83	0.74149	0.92	0.481	1.830	0.74	249.91	1.129	282.190		0.80	1	
29.528	9 Sand	288.502	3.97	1.787		1.787	1.86	0.73652	0.92	0.480	1.860	0.74	212.49	1.153	245.073		0.80	1	
29.856	9 Sand	230.566	3.193	1.808		1.808	1.93	0.73138	0.92	0.479	1.930	0.73	168.63	1.218	205.472		0.82	1	
30.184	9 Sand	211.036	2.54	1.828		1.828	1.92	0.72655	0.92	0.478	1.920	0.73	153.33	1.208	185.263		0.82	1	
30.512	8 Sand to Silty Sand	191.327	3.039	1.848		1.848	2.04	0.72178	0.92	0.477	2.040	0.72	138.10	1.356	187.243		0.83	1	

LIQUEFACTION POTENTIAL ANALYSIS (per Youd & Idriss, 2001)

PROJECT NAME	***WILLOW ROAD EXTENSION AT ROUTE 101***	*FAULT INFO*		*FAULT M_w =* 6.5
PROJECT NO.	***203125.EXT***	*SANTA MARIA RIVER - FOXEN CANYON FAULT*		*MSF =* 1.44
CPT NO.	***CPT-1***	*a_{max} (g)=*	0.8	
				DESIGN GW DEPTH= 30

		CPT RESULT INPUT							*CSR*		*$CRR_{7.5}$*						*F.S.=($CRR_{7.5}$/CSR)*MSF*K_σ*K_α*		
Depth (ft)		Soil Behavior Type	qc (tsf)	fs (tsf)	σ_v (tsf)	u (tsf)	σ_v' (tsf)	Ic*	C_N*	γ_d	CSR	Ic	C_Q	q_{c1N}	K_C	$(q_{c1N})_{cs}$	$CRR_{7.5}$	$K\sigma$	$K\alpha$	F.S.
30.84	8	Sand to Silty Sand	274.186	4.34	1.868		1.868	1.93	0.71708	0.92	0.476	1.930	0.72	196.61	1.218	239.566		0.80	1	
31.168	9	Sand	327.543	5.102	1.888		1.888	1.88	0.71244	0.91	0.476	1.880	0.71	233.35	1.171	273.157		0.78	1	
31.496	8	Sand to Silty Sand	347.101	5.902	1.908		1.908	1.89	0.70785	0.91	0.475	1.890	0.71	245.70	1.180	289.815		0.77	1	
31.824	9	Sand	359.625	5.694	1.928		1.928	1.86	0.70332	0.91	0.474	1.860	0.70	252.93	1.153	291.719		0.77	1	
32.152	9	Sand	341.745	4.686	1.949		1.949	1.83	0.69863	0.91	0.473	1.830	0.70	238.75	1.129	269.597		0.77	1	
32.48	9	Sand	330.577	3.779	1.969		1.969	1.79	0.69423	0.91	0.472	1.790	0.69	229.49	1.099	252.316		0.76	1	
32.808	9	Sand	316.166	3.695	1.989		1.989	1.81	0.68987	0.90	0.471	1.810	0.69	218.11	1.114	242.981		0.77	1	
33.136	9	Sand	282.434	3.761	2.01		2.01	1.89	0.68536	0.90	0.470	1.890	0.69	193.57	1.180	228.328		0.78	1	
33.465	9	Sand	270.1	3.24	2.03		2.03	1.88	0.68111	0.90	0.468	1.880	0.68	183.97	1.171	215.349		0.78	1	
33.793	9	Sand	289.668	3.639	2.05		2.05	1.87	0.67692	0.90	0.467	1.870	0.68	196.08	1.162	227.816		0.77	1	
34.121	9	Sand	381.572	5.124	2.071		2.071	1.81	0.67258	0.90	0.466	1.810	0.67	256.64	1.114	285.896		0.75	1	
34.449	9	Sand	432.388	6.317	2.091		2.091	1.81	0.66849	0.89	0.465	1.810	0.67	289.05	1.114	322.001		0.74	1	
34.777	8	Sand to Silty Sand	396.514	6.867	2.111		2.111	1.89	0.66445	0.89	0.464	1.890	0.66	263.46	1.180	310.775		0.74	1	
35.105	8	Sand to Silty Sand	370.025	6.275	2.131		2.131	1.9	0.66046	0.89	0.463	1.900	0.66	244.39	1.189	290.538		0.74	1	
35.433	8	Sand to Silty Sand	327.78	5.419	2.151		2.151	1.93	0.65652	0.89	0.462	1.930	0.66	215.19	1.218	262.206		0.75	1	
35.761	8	Sand to Silty Sand	224.394	3.688	2.171		2.171	2.05	0.65263	0.89	0.460	2.050	0.65	146.45	1.371	200.784		0.79	1	
36.089	9	Sand	182.064	2.274	2.191		2.191	2.04	0.64878	0.88	0.459	2.040	0.65	118.12	1.356	160.155		0.80	1	
36.417	8	Sand to Silty Sand	142.872	2.207	2.211		2.211	2.19	0.64497	0.88	0.458	2.190	0.64	92.15	1.643	151.365	0.40	0.83	1	0.88
36.745	8	Sand to Silty Sand	127.504	1.424	2.231		2.231	2.14	0.64121	0.88	0.456	2.140	0.64	81.76	1.532	125.249	0.26	0.83	1	0.58
37.073	8	Sand to Silty Sand	76.916	0.285	2.25		2.25	2.11	0.63768	0.88	0.455	2.110	0.64	49.05	1.473	72.256	0.12	0.85	1	0.25
37.402	8	Sand to Silty Sand	53.527	0.247	2.27		2.27	2.3	0.63401	0.87	0.454	2.300	0.63	33.94	1.949	66.133	0.11	0.85	1	0.24
37.73	8	Sand to Silty Sand	47.593	0.267	2.29		2.29	2.39	0.63037	0.87	0.452	2.390	0.63	30.00	2.272	68.164	0.11	0.85	1	0.24
38.058	8	Sand to Silty Sand	73.939	0.584	2.31		2.31	2.28	0.62678	0.87	0.451	2.280	0.63	46.34	1.886	87.412	0.14	0.85	1	0.32
38.386	8	Sand to Silty Sand	82.168	0.743	2.33		2.33	2.27	0.62323	0.86	0.450	2.270	0.62	51.21	1.856	95.049	0.16	0.84	1	0.36
38.714	8	Sand to Silty Sand	77.74	0.33	2.35		2.35	2.14	0.61972	0.86	0.448	2.140	0.62	48.18	1.532	73.805	0.12	0.84	1	0.26
39.042	8	Sand to Silty Sand	51.716	0.119	2.369		2.369	2.23	0.61642	0.86	0.447	2.230	0.62	31.88	1.743	55.579	0.10	0.84	1	0.21
39.37	7	Silty Sand to Sandy Silt	35.343	0.23	2.389		2.389	2.56	0.61298	0.86	0.445	2.560	0.61	21.66	3.091	66.956	0.11	0.84	1	0.24
39.698	7	Silty Sand to Sandy Silt	32.405	0.304	2.408		2.408	2.67	0.60976	0.85	0.444							0.84	1	
40.026	7	Silty Sand to Sandy Silt	34.557	0.302	2.427		2.427	2.63	0.60656	0.85	0.442							0.84	1	
40.354	7	Silty Sand to Sandy Silt	40.216	0.438	2.447		2.447	2.62	0.60324	0.85	0.441							0.84	1	
40.682	7	Silty Sand to Sandy Silt	43.42	0.784	2.466		2.466	2.7	0.60011	0.84	0.439							0.83	1	
41.011	6	Sandy Silt to Clayey Silt	41.155	0.962	2.485		2.485	2.79	0.59701	0.84	0.438							0.83	1	
41.339	6	Sandy Silt to Clayey Silt	39.913	0.948	2.504		2.504	2.81	0.59395	0.84	0.436							0.83	1	
41.667	6	Sandy Silt to Clayey Silt	39.287	0.924	2.522		2.522	2.82	0.59108	0.84	0.435							0.83	1	
41.995	6	Sandy Silt to Clayey Silt	38.633	0.911	2.541		2.541	2.83	0.58808	0.83	0.433							0.83	1	
42.323	6	Sandy Silt to Clayey Silt	38.178	0.896	2.56		2.56	2.83	0.58511	0.83	0.431							0.83	1	
42.651	6	Sandy Silt to Clayey Silt	37.78	0.878	2.579		2.579	2.84	0.58216	0.83	0.430							0.83	1	
42.979	6	Sandy Silt to Clayey Silt	38.282	0.859	2.598		2.598	2.83	0.57925	0.82	0.428							0.83	1	
43.307	6	Sandy Silt to Clayey Silt	40.017	0.938	2.616		2.616	2.82	0.57652	0.82	0.427							0.83	1	
43.635	6	Sandy Silt to Clayey Silt	42.171	1.035	2.635		2.635	2.82	0.57366	0.82	0.425							0.82	1	
43.963	6	Sandy Silt to Clayey Silt	41.982	1.055	2.654		2.654	2.83	0.57084	0.81	0.423							0.82	1	
44.291	6	Sandy Silt to Clayey Silt	43.373	1.173	2.673		2.673	2.84	0.56804	0.81	0.422							0.82	1	
44.619	6	Sandy Silt to Clayey Silt	44.852	1.342	2.692		2.692	2.85	0.56526	0.81	0.420							0.82	1	
44.948	5	Clayey Silt to Silty Clay	43.231	1.723	2.71		2.71	2.95	0.56266	0.80	0.418							0.82	1	
45.276	11	Sitff Fine-Grained	58.618	3.087	2.732		2.732	2.92	0.55951	0.80	0.416							0.82	1	
45.604	11	Sitff Fine-Grained	87.979	4.826	2.753		2.753	2.79	0.55654	0.80	0.415							0.82	1	
45.932	11	Sitff Fine-Grained	58.362	3.757	2.775		2.775	2.98	0.55346	0.79	0.413							0.82	1	
46.26	4	Silty Clay to Clay	40.083	1.732	2.793		2.793	3.01	0.55096	0.79	0.411							0.81	1	
46.588	5	Clayey Silt to Silty Clay	35.116	1.171	2.812		2.812	2.99	0.54835	0.79	0.410							0.81	1	
46.916	5	Clayey Silt to Silty Clay	35.713	1.133	2.831		2.831	2.98	0.54577	0.78	0.408							0.81	1	
47.244	5	Clayey Silt to Silty Clay	38.709	1.346	2.85		2.85	2.97	0.54321	0.78	0.406							0.81	1	
47.572	6	Sandy Silt to Clayey Silt	44.208	1.391	2.869		2.869	2.9	0.54067	0.78	0.404							0.81	1	
47.9	4	Silty Clay to Clay	47.184	2.088	2.887		2.887	2.97	0.53829	0.77	0.403							0.81	1	
48.228	11	Sitff Fine-Grained	87.581	4.089	2.909		2.909	2.77	0.53541	0.77	0.401							0.81	1	
48.556	11	Sitff Fine-Grained	71.189	4.177	2.93		2.93	2.91	0.53269	0.77	0.399							0.81	1	
48.885	5	Clayey Silt to Silty Clay	57.945	2.545	2.949		2.949	2.9	0.53025	0.76	0.397							0.81	1	
49.213	5	Clayey Silt to Silty Clay	56.21	2.108	2.968		2.968	2.87	0.52783	0.76	0.396							0.80	1	
49.541	5	Clayey Silt to Silty Clay	54.882	2.21	2.987		2.987	2.9	0.52544	0.76	0.394							0.80	1	
49.869	5	Clayey Silt to Silty Clay	53.963	2.267	3.005		3.005	2.92	0.52319	0.75	0.392							0.80	1	
50.197	4	Silty Clay to Clay	40.501	1.76	3.024	0.006	3.018	3.04	0.52157	0.75	0.391							0.80	1	
50.525	5	Clayey Silt to Silty Clay	36.13	1.475	3.043	0.016	3.027	3.07	0.52046	0.75	0.391							0.80	1	
50.853	4	Silty Clay to Clay	34.935	1.483	3.062	0.026	3.036	3.09	0.51936	0.74	0.390							0.80	1	
51.181	5	Clayey Silt to Silty Clay	35.504	1.463	3.081	0.036	3.044	3.08	0.51838	0.74	0.390							0.80	1	
51.509	5	Clayey Silt to Silty Clay	36.017	1.288	3.099	0.047	3.053	3.04	0.51728	0.74	0.389							0.80	1	
51.837	5	Clayey Silt to Silty Clay	33.826	1.249	3.118	0.057	3.061	3.07	0.51631	0.73	0.389							0.80	1	
52.165	5	Clayey Silt to Silty Clay	33.713	1.204	3.137	0.067	3.07	3.07	0.51522	0.73	0.388							0.80	1	
52.493	5	Clayey Silt to Silty Clay	34.595	1.201	3.156	0.077	3.078	3.05	0.51426	0.73	0.388							0.80	1	
52.822	5	Clayey Silt to Silty Clay	36.083	1.246	3.175	0.088	3.087	3.03	0.51318	0.72	0.387							0.80	1	
53.15	5	Clayey Silt to Silty Clay	39.24	1.384	3.193	0.098	3.096	3	0.5121	0.72	0.387							0.80	1	
53.478	5	Clayey Silt to Silty Clay	41.62	1.437	3.212	0.108	3.104	2.98	0.51115	0.72	0.386							0.80	1	
53.806	5	Clayey Silt to Silty Clay	43.544	1.521	3.231	0.118	3.113	2.96	0.51009	0.71	0.386							0.80	1	
54.134	5	Clayey Silt to Silty Clay	51.631	2.08	3.25	0.129	3.121	2.94	0.50914	0.71	0.385							0.80	1	
54.462	5	Clayey Silt to Silty Clay	69.236	2.53	3.269	0.139	3.13	2.8	0.50808	0.71	0.385							0.80	1	
54.79	6	Sandy Silt to Clayey Silt	86.349	2.73	3.287	0.149	3.138	2.68	0.50715	0.71	0.384							0.80	1	
55.118	7	Silty Sand to Sandy Silt	89.762	2.383	3.307	0.159	3.147	2.62	0.5061	0.70	0.384							0.80	1	
55.446	6	Sandy Silt to Clayey Silt	56.732	1.447	3.325	0.17	3.156	2.78	0.50505	0.70	0.383							0.79	1	
55.774	6	Sandy Silt to Clayey Silt	47.317	0.99	3.344	0.18	3.165	2.81	0.50401	0.70	0.382							0.79	1	
56.102	6	Sandy Silt to Clayey Silt	48.427	1.066	3.363	0.19	3.173	2.81	0.50309	0.69	0.382							0.79	1	
56.43	6	Sandy Silt to Clayey Silt	48.057	1.315	3.382	0.2	3.182	2.87	0.50205	0.69	0.381							0.79	1	
56.759	5	Clayey Silt to Silty Clay	48.436	1.653	3.401	0.21	3.19	2.93	0.50114	0.69	0.381							0.79	1	
57.087	5	Clayey Silt to Silty Clay	48.711	1.978	3.419	0.221	3.199	2.97	0.50011	0.68	0.380							0.79	1	
57.415	5	Clayey Silt to Silty Clay	49.621	2.057	3.438	0.231	3.207	2.97	0.49921	0.68	0.380							0.79	1	
57.743	5	Clayey Silt to Silty Clay	45.743	1.845	3.457	0.241	3.216	3	0.49819	0.68	0.379							0.79	1	
58.071	5	Clayey Silt to Silty Clay	44.805	1.802	3.476	0.251	3.224	3.01	0.49729	0.68	0.379							0.79	1	
58.399	4	Silty Clay to Clay	47.422	2.189	3.495	0.262	3.233	3.02	0.49628	0.67	0.378							0.79	1	
58.727	5	Clayey Silt to Silty Clay	89.07	3.535	3.513	0.272	3.242	2.75	0.49527	0.67	0.377							0.79	1	
59.055	11	Sitff Fine-Grained	110.998	5.173	3.535	0.282	3.253	2.72	0.49405	0.67	0.377							0.79	1	
59.383	11	Sitff Fine-Grained	92.795	4.473	3.556	0.292	3.264	2.8	0.49283	0.66	0.376							0.79	1	
59.711	11	Sitff Fine-Grained	59.547	2.916	3.578	0.303	3.275	2.96	0.49162	0.66	0.376							0.79	1	
60.039	4	Silty Clay to Clay	54.902	2.616	3.596	0.313	3.284	2.98	0.49063	0.66	0.375							0.79	1	
60.367	11	Sitff Fine-Grained	64.553	3.043	3.618	0.323	3.295	2.92	0.48943	0.66	0.375							0.79	1	
60.696	6	Sandy Silt to Clayey Silt	95.63	3.35	3.637	0.333	3.303	2.7	0.48856	0.65	0.374							0.79	1	
61.024	6	Sandy Silt to Clayey Silt	126.527	3.831	3.655	0.344	3.312	2.56	0.48759	0.65	0.374	2.560	0.49	61.69	3.091	190.666		0.79	1	
61.352	5	Clayey Silt to Silty Clay	78.205	3.262	3.674	0.354	3.321	2.82	0.48662	0.65	0.373							0.79	1	
61.68	4	Silty Clay to Clay	50.209	2.354	3.693	0.364	3.329	3.02	0.48576	0.65	0.373							0.79	1	

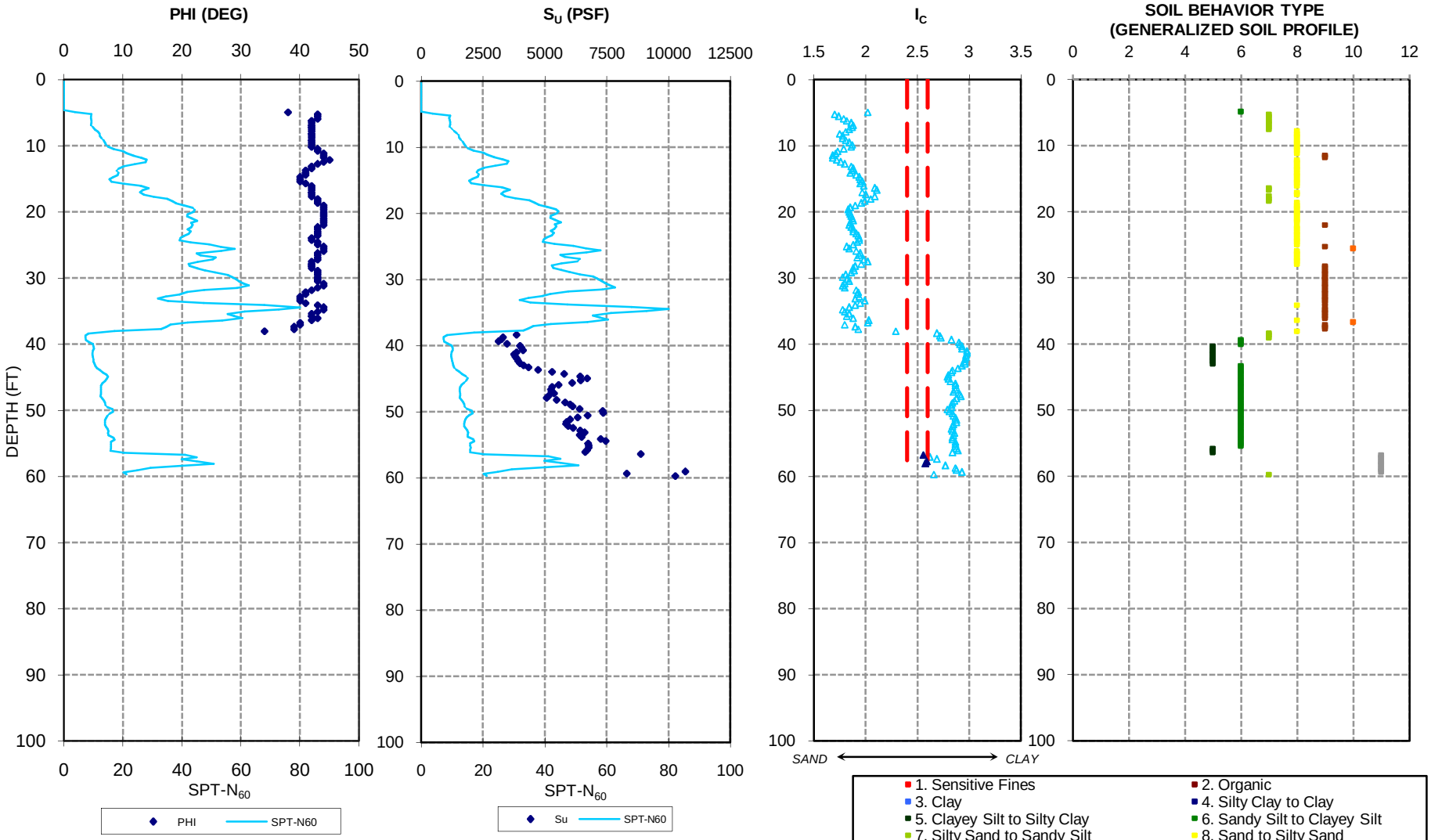
LIQUEFACTION POTENTIAL ANALYSIS (per Youd & Idriss, 2001)

PROJECT NAME	***WILLOW ROAD EXTENSION AT ROUTE 101***	*FAULT INFO*		*FAULT M_w =* 6.5
PROJECT NO.	***203125.EXT***	*SANTA MARIA RIVER - FOXEN CANYON FAULT*		*MSF =* 1.44
CPT NO.	***CPT-1***	*a_{max} (g)=*	0.8	
				DESIGN GW DEPTH= 30

		CPT RESULT INPUT							*CSR*		*$CRR_{7.5}$*						*F.S.=($CRR_{7.5}$/CSR)*MSF*K_σ*K_α*		
Depth (ft)		Soil Behavior Type	qc (tsf)	fs (tsf)	σ_v (tsf)	u (tsf)	σ_v' (tsf)	Ic*	C_N*	γ_d	CSR	Ic	C_Q	q_{c1N}	K_C	$(q_{c1N})_{cs}$	$CRR_{7.5}$	$K\sigma$	$K\alpha$	F.S.
62.008	3	Clay	35.419	1.809	3.711	0.374	3.337	3.18	0.4849	0.64	0.372							0.79	1	
62.336	5	Clayey Silt to Silty Clay	34.082	1.315	3.73	0.384	3.346	3.12	0.48394	0.64	0.372							0.79	1	
62.664	5	Clayey Silt to Silty Clay	35.059	1.206	3.749	0.395	3.354	3.08	0.48309	0.64	0.371							0.79	1	
62.992	5	Clayey Silt to Silty Clay	43.155	1.41	3.768	0.405	3.363	2.98	0.48214	0.64	0.371							0.78	1	
63.32	5	Clayey Silt to Silty Clay	53.735	2.01	3.787	0.415	3.371	2.93	0.4813	0.63	0.370							0.78	1	
63.648	6	Sandy Silt to Clayey Silt	72.649	2.19	3.805	0.425	3.38	2.76	0.48035	0.63	0.370							0.78	1	
63.976	7	Silty Sand to Sandy Silt	74.915	1.775	3.825	0.436	3.389	2.69	0.47941	0.63	0.369							0.78	1	
64.304	6	Sandy Silt to Clayey Silt	76.062	2.067	3.843	0.446	3.398	2.72	0.47847	0.63	0.369							0.78	1	
64.633	9	Sand	228.538	1.672	3.864	0.456	3.408	1.98	0.47743	0.62	0.368	1.980	0.48	109.11	1.275	139.088	0.33	0.71	1	0.90
64.961	9	Sand	284.909	2.054	3.884	0.466	3.418	1.89	0.4764	0.62	0.368	1.890	0.48	135.73	1.180	160.103		0.68	1	
65.289	10	Gravelly Sand to Sand	333.364	2.175	3.905	0.477	3.428	1.81	0.47537	0.62	0.367	1.810	0.48	158.47	1.114	176.538		0.66	1	
65.617	10	Gravelly Sand to Sand	366.081	2.145	3.926	0.487	3.439	1.75	0.47424	0.62	0.367	1.750	0.47	173.61	1.072	186.040		0.64	1	
65.945	10	Gravelly Sand to Sand	422.746	2.433	3.947	0.497	3.45	1.7	0.47312	0.62	0.366	1.700	0.47	200.01	1.038	207.581		0.62	1	
66.273	10	Gravelly Sand to Sand	456.07	2.893	3.968	0.507	3.46	1.7	0.4721	0.61	0.366	1.700	0.47	215.31	1.038	223.463		0.61	1	
66.601	10	Gravelly Sand to Sand	439.451	2.454	3.989	0.518	3.471	1.68	0.47099	0.61	0.366	1.680	0.47	206.98	1.024	211.999		0.61	1	
66.929	10	Gravelly Sand to Sand	413.683	1.948	4.009	0.528	3.482	1.66	0.46988	0.61	0.365	1.660	0.47	194.38	1.010	196.406		0.61	1	
67.257	10	Gravelly Sand to Sand	391.698	3.121	4.03	0.538	3.492	1.82	0.46888	0.61	0.365	1.820	0.47	183.66	1.122	205.978		0.63	1	
67.585	10	Gravelly Sand to Sand	380.492	2.59	4.051	0.548	3.503	1.79	0.46779	0.61	0.364	1.790	0.47	177.99	1.099	195.689		0.63	1	
67.913	10	Gravelly Sand to Sand	370.651	2.265	4.072	0.558	3.514	1.77	0.46669	0.60	0.364	1.770	0.47	172.98	1.085	187.745		0.64	1	
68.241	10	Gravelly Sand to Sand	395.518	2.044	4.093	0.569	3.524	1.71	0.46571	0.60	0.363	1.710	0.47	184.20	1.045	192.410		0.62	1	
68.57	10	Gravelly Sand to Sand	360.962	1.981	4.114	0.579	3.535	1.75	0.46463	0.60	0.363	1.750	0.46	167.71	1.072	179.720		0.64	1	
68.898	10	Gravelly Sand to Sand	410.156	2.11	4.135	0.589	3.546	1.69	0.46355	0.60	0.363	1.690	0.46	190.13	1.031	196.037		0.61	1	
69.226	10	Gravelly Sand to Sand	464.034	2.075	4.156	0.599	3.556	1.62	0.46257	0.60	0.362	1.620	0.46	214.65	1.000	214.650		0.60	1	
69.554	10	Gravelly Sand to Sand	473.041	2.382	4.177	0.61	3.567	1.64	0.46151	0.59	0.362	1.640	0.46	218.31	1.000	218.311		0.60	1	
69.882	10	Gravelly Sand to Sand	480.179	0.826	4.197	0.62	3.578	1.42	0.46044	0.59	0.361	1.420	0.46	221.10	1.000	221.095		0.60	1	

CPT DATA CORRELATION

CPT-2



Reference: CPT data and correlation provided by Gregg Drilling and Testing, Inc.

PARIKH

Practicing in the Geosciences

WILLOW ROAD EXTENSION AT ROUTE 101
COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.: 203125.EXT

PLATE NO.:

LIQUEFACTION POTENTIAL ANALYSIS (per Youd & Idriss, 2001)

PROJECT NAME	***WILLOW ROAD EXTENSION AT ROUTE 101***	*FAULT INFO*		*FAULT M_w =*	6.5
PROJECT NO.	***203125.EXT***	*SANTA MARIA RIVER - FOXEN CANYON FAULT*		*MSF =*	1.44
CPT NO.	***CPT-2***	*a_{max} (g)=*	0.8		
				DESIGN GW DEPTH=	18

		CPT RESULT INPUT							*CSR*		*$CRR_{7.5}$*						*$F.S.=(CRR_{7.5}/CSR)*MSF*K_\sigma*K_\alpha$*		
Depth (ft)		Soil Behavior Type	qc (tsf)	fs (tsf)	σ_v (tsf)	u (tsf)	σ_v' (tsf)	Ic*	C_N*	γ_d	CSR	Ic	C_Q	q_{c1N}	K_C	$(q_{c1N})_{cs}$	$CRR_{7.5}$	$K\sigma$	$K\alpha$	F.S.
0.328																				
0.656																				
0.984																				
1.312																				
1.64																				
1.969																				
2.297																				
2.625																				
2.953																				
3.281																				
3.609																				
3.937																				
4.265																				
4.593																				
4.921	6	Sandy Silt to Clayey Silt	18.497	0.159	0.282		0.282	2.02	1.48448	0.99	0.515	2.020	1.48	27.46	1.327	36.438	0.08	1.00	1	
5.249	7	Silty Sand to Sandy Silt	53.328	0.49	0.301		0.301	1.7	1.46569	0.99	0.515	1.700	1.47	78.16	1.038	81.121	0.13	1.00	1	
5.577	7	Silty Sand to Sandy Silt	51.015	0.48	0.321		0.321	1.74	1.44642	0.99	0.514	1.740	1.45	73.79	1.065	78.571	0.13	1.00	1	
5.906	7	Silty Sand to Sandy Silt	50.541	0.512	0.34		0.34	1.79	1.42857	0.99	0.514	1.790	1.43	72.20	1.099	79.381	0.13	1.00	1	
6.234	7	Silty Sand to Sandy Silt	51.3	0.553	0.359		0.359	1.82	1.41116	0.99	0.513	1.820	1.41	72.39	1.122	81.189	0.13	1.00	1	
6.562	7	Silty Sand to Sandy Silt	50.219	0.578	0.379		0.379	1.86	1.39329	0.99	0.513	1.860	1.39	69.97	1.153	80.699	0.13	1.00	1	
6.89	7	Silty Sand to Sandy Silt	49.024	0.56	0.398		0.398	1.88	1.37672	0.99	0.513	1.880	1.38	67.49	1.171	79.005	0.13	1.00	1	
7.218	7	Silty Sand to Sandy Silt	52.096	0.581	0.417		0.417	1.87	1.36054	0.99	0.512	1.870	1.36	70.88	1.162	82.350	0.13	1.00	1	
7.546	7	Silty Sand to Sandy Silt	57.016	0.604	0.437		0.437	1.84	1.34392	0.98	0.512	1.840	1.34	76.63	1.137	87.125	0.14	1.00	1	
7.874	8	Sand to Silty Sand	62.771	0.625	0.456		0.456	1.81	1.3285	0.98	0.512	1.810	1.33	83.39	1.114	92.899	0.15	1.00	1	
8.202	8	Sand to Silty Sand	67.539	0.572	0.476		0.476	1.75	1.31265	0.98	0.511	1.750	1.31	88.66	1.072	95.003	0.16	1.00	1	
8.53	8	Sand to Silty Sand	67.075	0.586	0.496		0.496	1.78	1.29717	0.98	0.511	1.780	1.30	87.01	1.092	95.042	0.16	1.00	1	
8.858	8	Sand to Silty Sand	70.753	0.639	0.516		0.516	1.78	1.28205	0.98	0.510	1.780	1.28	90.71	1.092	99.085	0.17	1.00	1	
9.186	8	Sand to Silty Sand	73.019	0.714	0.536		0.536	1.81	1.26728	0.98	0.510	1.810	1.27	92.54	1.114	103.086	0.18	1.00	1	
9.514	8	Sand to Silty Sand	75.105	0.813	0.556		0.556	1.84	1.25285	0.98	0.510	1.840	1.25	94.10	1.137	106.989	0.19	1.00	1	
9.843	8	Sand to Silty Sand	76.622	0.893	0.575		0.575	1.87	1.23944	0.98	0.509	1.870	1.24	94.97	1.162	110.337	0.20	1.00	1	
10.171	8	Sand to Silty Sand	80.357	0.933	0.595		0.595	1.86	1.22563	0.98	0.509	1.860	1.23	98.49	1.153	113.590	0.22	1.00	1	
10.499	8	Sand to Silty Sand	93.345	0.964	0.615		0.615	1.79	1.21212	0.98	0.509	1.790	1.21	113.15	1.099	124.397	0.26	1.00	1	
10.827	8	Sand to Silty Sand	112.942	1.142	0.635		0.635	1.73	1.19891	0.98	0.508	1.730	1.20	135.41	1.058	143.269	0.35	1.00	1	
11.155	8	Sand to Silty Sand	120.043	1.174	0.655		0.655	1.71	1.18598	0.98	0.508	1.710	1.19	142.37	1.045	148.719	0.39	1.00	1	
11.483	9	Sand	134.662	1.297	0.675		0.675	1.68	1.17333	0.98	0.508	1.680	1.17	158.00	1.024	161.837		1.00	1	
11.811	9	Sand	149.309	1.559	0.695		0.695	1.68	1.16095	0.98	0.507	1.680	1.16	173.34	1.024	177.546		1.00	1	
12.139	8	Sand to Silty Sand	158.183	1.917	0.715		0.715	1.72	1.14883	0.97	0.507	1.720	1.15	181.72	1.051	191.052		1.00	1	
12.467	8	Sand to Silty Sand	154.059	1.964	0.735		0.735	1.76	1.13695	0.97	0.506	1.760	1.14	175.16	1.078	188.897		1.00	1	
12.795	8	Sand to Silty Sand	130.784	1.595	0.755		0.755	1.8	1.12532	0.97	0.506	1.800	1.13	147.17	1.107	162.871		1.00	1	
13.123	8	Sand to Silty Sand	108.922	1.302	0.775		0.775	1.86	1.11392	0.97	0.506	1.860	1.11	121.33	1.153	139.936	0.33	1.00	1	
13.451	8	Sand to Silty Sand	98.418	1.104	0.795		0.795	1.88	1.10276	0.97	0.505	1.880	1.10	108.53	1.171	127.044	0.27	1.00	1	
13.78	8	Sand to Silty Sand	95.82	0.971	0.815		0.815	1.87	1.09181	0.97	0.505	1.870	1.09	104.62	1.162	121.548	0.25	1.00	1	
14.108	8	Sand to Silty Sand	99.877	0.972	0.834		0.834	1.85	1.08161	0.97	0.505	1.850	1.08	108.03	1.145	123.701	0.26	1.00	1	
14.436	8	Sand to Silty Sand	95.839	1.08	0.854		0.854	1.91	1.07108	0.97	0.504	1.910	1.07	102.65	1.198	123.018	0.25	1.00	1	
14.764	8	Sand to Silty Sand	86.282	0.938	0.874		0.874	1.94	1.06075	0.97	0.504	1.940	1.06	91.52	1.229	112.482	0.21	1.00	1	
15.092	8	Sand to Silty Sand	80.376	0.8	0.894		0.894	1.95	1.05062	0.97	0.504	1.950	1.05	84.44	1.240	104.700	0.19	1.00	1	
15.42	8	Sand to Silty Sand	82.689	0.893	0.914		0.914	1.97	1.04068	0.97	0.503	1.970	1.04	86.05	1.263	108.661	0.20	1.00	1	
15.748	8	Sand to Silty Sand	105.765	1.369	0.934		0.934	1.95	1.03093	0.97	0.503	1.950	1.03	109.04	1.240	135.190	0.31	1.00	1	
16.076	8	Sand to Silty Sand	133.107	2.333	0.953		0.953	1.98	1.02183	0.97	0.502	1.980	1.02	136.01	1.275	173.380		1.00	1	
16.404	7	Silty Sand to Sandy Silt	140.701	3.589	0.973		0.973	2.09	1.01243	0.97	0.502	2.090	1.01	142.45	1.437	204.688		1.00	1	
16.732	7	Silty Sand to Sandy Silt	130.225	3.22	0.992		0.992	2.11	1.00365	0.96	0.502	2.110	1.00	130.70	1.473	192.543		1.00	1	
17.06	8	Sand to Silty Sand	133.363	2.141	1.012		1.012	1.97	0.99458	0.96	0.501	1.970	0.99	132.64	1.263	167.487		1.00	1	
17.388	8	Sand to Silty Sand	138.368	2.492	1.032		1.032	2	0.98566	0.96	0.501	2.000	0.99	136.38	1.300	177.299		0.99	1	
17.717	7	Silty Sand to Sandy Silt	149.679	3.694	1.051		1.051	2.09	0.97734	0.96	0.500	2.090	0.98	146.29	1.437	210.204		0.98	1	
18.045	7	Silty Sand to Sandy Silt	174.309	4.38	1.07		1.07	2.05	0.96916	0.96	0.500	2.050	0.97	168.93	1.371	231.617		0.98	1	
18.373	7	Silty Sand to Sandy Silt	188.265	4.064	1.09		1.09	1.99	0.9607	0.96	0.500	1.990	0.96	180.87	1.287	232.803		0.97	1	
18.701	8	Sand to Silty Sand	196.522	3.946	1.11		1.11	1.96	0.95238	0.96	0.499	1.960	0.95	187.16	1.251	234.161		0.96	1	
19.029	8	Sand to Silty Sand	214.355	3.877	1.129		1.129	1.9	0.94461	0.96	0.499	1.900	0.94	202.48	1.189	240.719		0.96	1	
19.357	8	Sand to Silty Sand	234.312	3.897	1.149		1.149	1.85	0.93657	0.96	0.498	1.850	0.94	219.45	1.145	251.287		0.95	1	
19.685	8	Sand to Silty Sand	240.104	3.802	1.169		1.169	1.83	0.92866	0.96	0.498	1.830	0.93	222.98	1.129	251.780		0.94	1	
20.013	8	Sand to Silty Sand	236.909	3.74	1.189		1.189	1.84	0.92089	0.96	0.498	1.840	0.92	218.17	1.137	248.062		0.94	1	
20.341	8	Sand to Silty Sand	225.826	3.439	1.209		1.209	1.85	0.91324	0.96	0.497	1.850	0.91	206.23	1.145	236.154		0.93	1	
20.669	8	Sand to Silty Sand	224.139	3.434	1.229		1.229	1.86	0.90572	0.96	0.497	1.860	0.91	203.01	1.153	234.138		0.93	1	
20.997	8	Sand to Silty Sand	230.567	3.762	1.248		1.248	1.87	0.89869	0.95	0.496	1.870	0.90	207.21	1.162	240.743		0.92	1	
21.325	8	Sand to Silty Sand	240.692	4.039	1.268		1.268	1.88	0.89141	0.95	0.496	1.880	0.89	214.56	1.171	251.153		0.91	1	
21.654	8	Sand to Silty Sand	231.985	3.482	1.288		1.288	1.85	0.88424	0.95	0.495	1.850	0.88	205.13	1.145	234.892		0.91	1	
21.982	9	Sand	235.71	3.393	1.308		1.308	1.84	0.87719	0.95	0.495	1.840	0.88	206.76	1.137	235.096		0.90	1	
22.31	8	Sand to Silty Sand	230.519	3.449	1.328		1.328	1.86	0.87025	0.95	0.494	1.860	0.87	200.61	1.153	231.372		0.90	1	
22.638	8	Sand to Silty Sand	222.812	3.395	1.348		1.348	1.88	0.86342	0.95	0.494	1.880	0.86	192.38	1.171	225.196		0.90	1	
22.966	8	Sand to Silty Sand	228.073	3.458	1.368		1.368	1.88	0.8567	0.95	0.493	1.880	0.86	195.39	1.171	228.718		0.89	1	
23.294	8	Sand to Silty Sand	222.157	3.547	1.388		1.388	1.91	0.85008	0.95	0.493	1.910	0.85	188.85	1.198	226.320		0.89	1	
23.622	8	Sand to Silty Sand	212.212	3.464	1.408		1.408	1.93	0.84356	0.95	0.492	1.930	0.84	179.01	1.218	218.121		0.89	1	
23.95	8	Sand to Silty Sand	205.889	3.29	1.428		1.428	1.94	0.83714	0.95	0.492	1.940	0.84	172.36	1.229	211.825		0.89	1	
24.278	8	Sand to Silty Sand	204.343	3.188	1.447		1.447	1.94	0.83113	0.94	0.491	1.940	0.83	169.84	1.229	208.726		0.88	1	
24.606	8	Sand to Silty Sand	225.874	3.566	1.467		1.467	1.92	0.8249	0.94	0.490	1.920	0.82	186.32	1.208	225.129		0.87	1	
24.934	8	Sand to Silty Sand	261.833	4.192	1.487		1.487	1.88	0.81876	0.94	0.490	1.880	0.82	214.38	1.171	250.945		0.86	1	
25.262	9	Sand	288.73	4.167	1.507		1.507	1.82	0.81271	0.94	0.489	1.820	0.81	234.65	1.122	263.166		0.85	1	
25.591	10	Gravelly Sand to Sand	312.716	4.979	1.528		1.528	1.84	0.80645	0.94	0.489	1.840	0.81	252.19	1.137	286.748		0.84	1	
25.919	8	Sand to Silty Sand	281.003	4.995	1.548		1.548	1.91	0.80058	0.94	0.488	1.910	0.80	224.97	1.198	269.601		0.84	1	
26.247	8	Sand to Silty Sand	233.117	3.966	1.568		1.568	1.95	0.7948	0.94	0.487	1.950	0.79	185.28	1.240	229.723		0.85	1	
26.575	8	Sand to Silty Sand	241.801	4.03	1.588		1.588	1.94	0.7891	0.94	0.487	1.940	0.79	190.80	1.229	234.496		0.85	1	
26.903	8	Sand to Silty Sand	268.991	4.642	1.608		1.608	1.92	0.78348	0.93	0.486	1.920	0.78	210.75	1.208	254.641		0.84	1	
27.231	8	Sand to Silty Sand	258.42	5.145	1.628		1.628	1.98	0.77793	0.93	0.485	1.980	0.78	201.03	1.275	256.265		0.84	1	
27.559	8	Sand to Silty Sand	229.126	4.517	1.647		1.647	2.02	0.77274	0.93	0.485	2.020	0.77	177.06	1.327	234.955		0.84	1	
27.887	8	Sand to Silty Sand	218.157	3.443	1.667		1.667	1.96	0.76735	0.93	0.484	1.960	0.77	167.40	1.251	209.439		0.84	1	
28.215	9	Sand	225.229	2.949	1.688		1.688	1.9	0.76177	0.93	0.483	1.900	0.76	171.57	1.189	203.974		0.84	1	
28.543	9	Sand	240.379	3.145	1.708		1.708	1.88	0.75653	0.93	0.482	1.880	0.76	181.85	1.171	212.874		0.83	1	
28.871	9	Sand	254.353	3.505	1.728		1.728	1.89	0.75137	0.93	0.482	1.890	0.75	191.11	1.180	225.430		0.82	1	
29.199	9	Sand	274.471	3.714	1.749		1.749	1.86	0.74602	0.92	0.481	1.860	0.75	204.76	1.153	236.158		0.81	1	
29.528	9	Sand	303.756	3.778	1.769		1.769	1.81	0.74099	0.92	0.480	1.810	0.74	225.08	1.114	250.742		0.80	1	
29.856	9	Sand	313.028	3.631	1.789		1.789	1.78	0.73603	0.92	0.479	1.780	0.74	230.40	1.092	251.675		0.79	1	
30.184	9	Sand	317.02	4.182	1.81		1.81	1.82	0.7309	0.92	0.478	1.820	0.73	231.71	1.122	259.865		0.79	1	
30.512	9	Sand	320.926	4.546	1.83		1.83	1.84	0.72607	0.92	0.477	1.840	0.73	233.02	1.137	264.946		0.79	1	

LIQUEFACTION POTENTIAL ANALYSIS (per Youd & Idriss, 2001)

PROJECT NAME	***WILLOW ROAD EXTENSION AT ROUTE 101***	*FAULT INFO*		*FAULT M_w =* 6.5
PROJECT NO.	***203125.EXT***	*SANTA MARIA RIVER - FOXEN CANYON FAULT*		*MSF =* 1.44
CPT NO.	***CPT-2***	*a_{max} (g)=*	0.8	
				DESIGN GW DEPTH= 18

			CPT RESULT INPUT							*CSR*		*$CRR_{7.5}$*						*F.S.=(CRR $_{7.5}$/CSR)*MSF*K $_\sigma$*K $_\alpha$*		
Depth (ft)		Soil Behavior Type	qc (tsf)	fs (tsf)	σ_v (tsf)	u (tsf)	σ_v' (tsf)	Ic*	C_N*	γ_d	CSR	Ic	C_Q	q_{c1N}	K_C	$(q_{c1N})_{cs}$	$CRR_{7.5}$	Kσ	Kα	F.S.
30.84	9	Sand	333.288	4.177	1.85		1.85	1.8	0.72131	0.92	0.476	1.800	0.72	240.40	1.107	266.046		0.78	1	
31.168	9	Sand	345.205	4.242	1.871		1.871	1.78	0.71638	0.91	0.476	1.780	0.72	247.30	1.092	270.134		0.78	1	
31.496	9	Sand	321.456	3.869	1.891		1.891	1.8	0.71174	0.91	0.475	1.800	0.71	228.79	1.107	253.197		0.78	1	
31.824	9	Sand	250.751	3.29	1.912		1.912	1.91	0.70694	0.91	0.474	1.910	0.71	177.27	1.198	212.437		0.80	1	
32.152	9	Sand	217.237	2.648	1.932		1.932	1.93	0.70243	0.91	0.473	1.930	0.70	152.59	1.218	185.929		0.81	1	
32.48	9	Sand	205.917	2.21	1.952		1.952	1.92	0.69797	0.91	0.472	1.920	0.70	143.72	1.208	173.658		0.81	1	
32.808	9	Sand	180.68	1.753	1.973		1.973	1.94	0.69335	0.90	0.471	1.940	0.69	125.27	1.229	153.961	0.42	0.82	1	0.89
33.136	9	Sand	168.431	1.27	1.993		1.993	1.9	0.68901	0.90	0.470	1.900	0.69	116.05	1.189	137.965	0.32	0.82	1	0.69
33.465	9	Sand	179.912	2.051	2.013		2.013	1.99	0.68472	0.90	0.468	1.990	0.68	123.19	1.287	158.564	0.45	0.82	1	0.96
33.793	9	Sand	244.702	3.427	2.034		2.034	1.95	0.68027	0.90	0.467	1.950	0.68	166.46	1.240	206.392		0.79	1	
34.121	8	Sand to Silty Sand	358.269	6.1	2.054		2.054	1.9	0.67609	0.90	0.466	1.900	0.68	242.22	1.189	287.964		0.75	1	
34.449	9	Sand	431.26	7.07	2.074		2.074	1.84	0.67196	0.89	0.465	1.840	0.67	289.79	1.137	329.500		0.75	1	
34.777	9	Sand	401.605	5.133	2.094		2.094	1.78	0.66788	0.89	0.464	1.780	0.67	268.22	1.092	292.993		0.74	1	
35.105	9	Sand	335.535	3.762	2.115		2.115	1.8	0.66365	0.89	0.463	1.800	0.66	222.68	1.107	246.428		0.74	1	
35.433	9	Sand	300.22	3.343	2.135		2.135	1.84	0.65967	0.89	0.462	1.840	0.66	198.05	1.137	225.185		0.76	1	
35.761	9	Sand	314.185	3.451	2.155		2.155	1.82	0.65574	0.89	0.460	1.820	0.66	206.02	1.122	231.057		0.75	1	
36.089	9	Sand	321.333	4.368	2.176		2.176	1.88	0.65166	0.88	0.459	1.880	0.65	209.40	1.171	245.117		0.74	1	
36.417	8	Sand to Silty Sand	270.404	4.88	2.196		2.196	2.03	0.64782	0.88	0.458	2.030	0.65	175.17	1.341	234.944		0.77	1	
36.745	10	Gravelly Sand to Sand	211.615	2.933	2.216		2.216	2.02	0.64403	0.88	0.456	2.020	0.64	136.29	1.327	180.853		0.79	1	
37.073	9	Sand	198.305	1.046	2.237		2.237	1.8	0.64009	0.88	0.455	1.800	0.64	126.93	1.107	140.472	0.34	0.79	1	0.74
37.402	9	Sand	182.557	1.282	2.257		2.257	1.9	0.63639	0.87	0.454	1.900	0.64	116.18	1.189	138.117	0.33	0.80	1	0.72
37.73	9	Sand	172.262	1.224	2.278		2.278	1.93	0.63255	0.87	0.452	1.930	0.63	108.96	1.218	132.769	0.30	0.80	1	0.66
38.058	8	Sand to Silty Sand	77.655	0.705	2.297		2.297	2.29	0.62911	0.87	0.451	2.290	0.63	48.85	1.917	93.655	0.16	0.85	1	0.35
38.386	7	Silty Sand to Sandy Silt	31.248	0.321	2.317		2.317	2.69	0.62553	0.86	0.450							0.85	1	
38.714	7	Silty Sand to Sandy Silt	26.963	0.227	2.336		2.336	2.72	0.62217	0.86	0.448							0.84	1	
39.042	7	Silty Sand to Sandy Silt	26.527	0.228	2.355		2.355	2.73	0.61885	0.86	0.447							0.84	1	
39.37	6	Sandy Silt to Clayey Silt	25.617	0.334	2.374		2.374	2.83	0.61556	0.86	0.445							0.84	1	
39.698	6	Sandy Silt to Clayey Silt	28.214	0.595	2.393		2.393	2.9	0.6123	0.85	0.444							0.84	1	
40.026	6	Sandy Silt to Clayey Silt	32.281	0.878	2.412		2.412	2.91	0.60908	0.85	0.442							0.84	1	
40.354	5	Clayey Silt to Silty Clay	32.86	0.979	2.431		2.431	2.93	0.60589	0.85	0.441							0.84	1	
40.682	5	Clayey Silt to Silty Clay	33.315	0.997	2.449		2.449	2.93	0.6029	0.84	0.439							0.84	1	
41.011	5	Clayey Silt to Silty Clay	31.343	1.012	2.468		2.468	2.98	0.59978	0.84	0.438							0.83	1	
41.339	5	Clayey Silt to Silty Clay	30.623	0.941	2.487		2.487	2.98	0.59669	0.84	0.436							0.83	1	
41.667	5	Clayey Silt to Silty Clay	31.011	0.937	2.506		2.506	2.97	0.59363	0.84	0.435							0.83	1	
41.995	5	Clayey Silt to Silty Clay	31.58	0.963	2.525		2.525	2.97	0.5906	0.83	0.433							0.83	1	
42.323	5	Clayey Silt to Silty Clay	31.855	0.951	2.543		2.543	2.96	0.58776	0.83	0.431							0.83	1	
42.651	5	Clayey Silt to Silty Clay	32.443	0.988	2.562		2.562	2.96	0.5848	0.83	0.430							0.83	1	
42.979	5	Clayey Silt to Silty Clay	33.485	1.022	2.581		2.581	2.96	0.58186	0.82	0.428							0.83	1	
43.307	6	Sandy Silt to Clayey Silt	35.031	1.006	2.6		2.6	2.93	0.57895	0.82	0.427							0.83	1	
43.635	6	Sandy Silt to Clayey Silt	37.951	1.057	2.619		2.619	2.89	0.57607	0.82	0.425							0.82	1	
43.963	6	Sandy Silt to Clayey Silt	42.236	1.14	2.637		2.637	2.84	0.57336	0.81	0.423							0.82	1	
44.291	6	Sandy Silt to Clayey Silt	45.886	1.341	2.656		2.656	2.83	0.57054	0.81	0.422							0.82	1	
44.619	6	Sandy Silt to Clayey Silt	50.768	1.494	2.675		2.675	2.8	0.56774	0.81	0.420							0.82	1	
44.948	6	Sandy Silt to Clayey Silt	53.072	1.563	2.694		2.694	2.79	0.56497	0.80	0.418							0.82	1	
45.276	6	Sandy Silt to Clayey Silt	50.882	1.506	2.713		2.713	2.8	0.56223	0.80	0.416							0.82	1	
45.604	6	Sandy Silt to Clayey Silt	48.427	1.42	2.731		2.731	2.82	0.55965	0.80	0.415							0.82	1	
45.932	6	Sandy Silt to Clayey Silt	44.312	1.35	2.75		2.75	2.87	0.55696	0.79	0.413							0.82	1	
46.26	6	Sandy Silt to Clayey Silt	42.511	1.222	2.769		2.769	2.87	0.5543	0.79	0.411							0.82	1	
46.588	6	Sandy Silt to Clayey Silt	42.103	1.222	2.788		2.788	2.88	0.55165	0.79	0.410							0.81	1	
46.916	6	Sandy Silt to Clayey Silt	42.303	1.145	2.806		2.806	2.87	0.54918	0.78	0.408							0.81	1	
47.244	6	Sandy Silt to Clayey Silt	43.051	1.12	2.825		2.825	2.85	0.54658	0.78	0.406							0.81	1	
47.572	6	Sandy Silt to Clayey Silt	41.487	1.274	2.844		2.844	2.91	0.54402	0.78	0.404							0.81	1	
47.9	6	Sandy Silt to Clayey Silt	40.757	1.237	2.863		2.863	2.92	0.54147	0.77	0.403							0.81	1	
48.228	6	Sandy Silt to Clayey Silt	43.886	1.253	2.882		2.882	2.88	0.53895	0.77	0.401							0.81	1	
48.556	6	Sandy Silt to Clayey Silt	46.408	1.343	2.9		2.9	2.86	0.53659	0.77	0.399							0.81	1	
48.885	6	Sandy Silt to Clayey Silt	48.038	1.319	2.919		2.919	2.84	0.53411	0.76	0.397							0.81	1	
49.213	6	Sandy Silt to Clayey Silt	48.72	1.346	2.938		2.938	2.83	0.53166	0.76	0.396							0.81	1	
49.541	6	Sandy Silt to Clayey Silt	50.873	1.475	2.957		2.957	2.83	0.52923	0.76	0.394							0.81	1	
49.869	6	Sandy Silt to Clayey Silt	57.926	1.724	2.976		2.976	2.79	0.52682	0.75	0.392							0.80	1	
50.197	6	Sandy Silt to Clayey Silt	58.116	1.835	2.994	0.006	2.989	2.81	0.52519	0.75	0.391							0.80	1	
50.525	6	Sandy Silt to Clayey Silt	53.414	1.679	3.013	0.016	2.997	2.84	0.52418	0.75	0.391							0.80	1	
50.853	6	Sandy Silt to Clayey Silt	50.276	1.494	3.032	0.026	3.006	2.85	0.52306	0.74	0.390							0.80	1	
51.181	6	Sandy Silt to Clayey Silt	48.067	1.449	3.051	0.036	3.014	2.87	0.52207	0.74	0.390							0.80	1	
51.509	6	Sandy Silt to Clayey Silt	47.043	1.403	3.07	0.047	3.023	2.88	0.52096	0.74	0.389							0.80	1	
51.837	6	Sandy Silt to Clayey Silt	46.881	1.371	3.088	0.057	3.032	2.88	0.51985	0.73	0.389							0.80	1	
52.165	6	Sandy Silt to Clayey Silt	47.536	1.3	3.107	0.067	3.04	2.85	0.51887	0.73	0.388							0.80	1	
52.493	6	Sandy Silt to Clayey Silt	49.119	1.333	3.126	0.077	3.049	2.84	0.51777	0.73	0.388							0.80	1	
52.822	6	Sandy Silt to Clayey Silt	51.271	1.431	3.145	0.088	3.057	2.83	0.5168	0.72	0.388							0.80	1	
53.15	6	Sandy Silt to Clayey Silt	52.513	1.544	3.164	0.098	3.066	2.84	0.51571	0.72	0.387							0.80	1	
53.478	6	Sandy Silt to Clayey Silt	51.138	1.54	3.182	0.108	3.074	2.86	0.51474	0.72	0.386							0.80	1	
53.806	6	Sandy Silt to Clayey Silt	51.66	1.516	3.201	0.118	3.083	2.85	0.51366	0.71	0.386							0.80	1	
54.134	6	Sandy Silt to Clayey Silt	57.585	1.95	3.22	0.129	3.091	2.84	0.5127	0.71	0.385							0.80	1	
54.462	6	Sandy Silt to Clayey Silt	59.007	2.043	3.239	0.139	3.1	2.84	0.51163	0.71	0.385							0.80	1	
54.79	6	Sandy Silt to Clayey Silt	53.793	1.776	3.258	0.149	3.109	2.87	0.51056	0.71	0.384							0.80	1	
55.118	6	Sandy Silt to Clayey Silt	54.03	1.783	3.276	0.159	3.117	2.87	0.50961	0.70	0.384							0.80	1	
55.446	6	Sandy Silt to Clayey Silt	54.068	1.834	3.295	0.17	3.126	2.87	0.50855	0.70	0.383							0.80	1	
55.774	5	Clayey Silt to Silty Clay	53.565	1.844	3.314	0.18	3.134	2.88	0.50761	0.70	0.383							0.80	1	
56.102	5	Clayey Silt to Silty Clay	52.835	1.815	3.333	0.19	3.143	2.89	0.50656	0.69	0.382							0.80	1	
56.43	5	Clayey Silt to Silty Clay	69.834	2.916	3.352	0.2	3.151	2.84	0.50563	0.69	0.382							0.79	1	
56.759	11	Sitff Fine-Grained	163.463	6.972	3.373	0.21	3.163	2.56	0.50424	0.69	0.381	2.560	0.50	82.42	3.091	254.738		0.79	1	
57.087	11	Sitff Fine-Grained	174.48	9.312	3.394	0.221	3.174	2.62	0.50297	0.68	0.380							0.79	1	
57.415	11	Sitff Fine-Grained	149.29	8.519	3.416	0.231	3.185	2.69	0.50171	0.68	0.380							0.79	1	
57.743	11	Sitff Fine-Grained	177.334	8.709	3.437	0.241	3.196	2.59	0.50045	0.68	0.379	2.590	0.50	88.75	3.266	289.853		0.79	1	
58.071	11	Sitff Fine-Grained	200.532	10.737	3.459	0.251	3.207	2.58	0.49921	0.68	0.379	2.580	0.50	100.11	3.206	320.987		0.79	1	
58.399	11	Sitff Fine-Grained	141.943	10.059	3.48	0.262	3.218	2.77	0.49796	0.67	0.378							0.79	1	
58.727	11	Sitff Fine-Grained	99.053	6.658	3.501	0.272	3.23	2.87	0.49661	0.67	0.378							0.79	1	
59.055	11	Sitff Fine-Grained	83.381	4.737	3.523	0.282	3.241	2.88	0.49538	0.67	0.377							0.79	1	
59.383	11	Sitff Fine-Grained	65.7	3.396	3.544	0.292	3.252	2.93	0.49416	0.66	0.376							0.79	1	
59.711	7	Silty Sand to Sandy Silt	80.537	1.99	3.564	0.303	3.261	2.66	0.49316	0.66	0.376							0.79	1	

APPENDIX C-6

PICTURES OF PAVEMENT CORING

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD/RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION, COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.: 203125.10	PLATE NO.:

CORE-4, RTE 101,
SB (Outside Lane)

CORE-3, RTE 101,
SB (Outside Lane)

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

WILLOW ROAD/RTE 101 INTERCHANGE & WILLOW ROAD EXTENSION, COUNTY OF SAN LUIS OBISPO, CALIFORNIA

JOB NO.: 203125.10	PLATE NO.:

APPENDIX D

NORCAL GEOPHYSICAL CONSULTANTS, INC.

March 27, 2007

Mr. Parry Chan
Civil Engineer
Parikh Geotechnical Consultants, Inc.
356 S. Milpitas Blvd.
Milpitas, CA 95035

Subject: NIPOMO CREEK BRIDGE
GEOPHYSICAL SURVEY
ELECTRICAL RESISTIVITY PROFILING
NIPOMO, CA
NORCAL JOB NUMBER 07-426.08

Attention: Mr. Chan

Gentlemen:

This report presents the findings of a surface geophysical survey performed by NORCAL Geophysical Consultants for the subject project. The survey was part of an on-going geotechnical site evaluation being performed by Parikh Consultants, Inc. for the construction of an interchange and road extension from US Route 101 north of the city Nipomo, California. The field survey was conducted on March 5, 2007 by NORCAL geophysicist William J. Henrich and geophysical technician Ken McGuire.

1.0 SITE DESCRIPTION

The proposed interchange and road extension project is located approximately one mile northwest of the city of Nipomo (see Plate 1, Location Map). Geologically, the site is situated on a series of gently sloping coalescing alluvial fans that originate from the southwest flank of the Sierra Madre Mountains. The alluvial fans are underlain by geologically recent unconsolidated alluvial deposits of clay, silt, sand and gravel. Bedrock may consist of sandstone belonging to the Obispo Formation. The site is drained by the northwest -southeast trending Nipomo Creek. On the northwest side of Nipomo Creek, the topography becomes hilly and was noted in the field to consist of very sandy alluvium possibly sand dune deposits.

321A BLODGETT STREET • COTATI, CA 94931 • TELEPHONE (707) 796-7170 • FAX (707) 796-7175
www.norcalgeophysical.com

2.0 PURPOSE

In the vicinity of Nipomo, the potentially active Wilmar Avenue Fault generally trends parallel to US Route 101. This fault may transect the site that is less than 500 feet northeast of US Route 101. The road extension project calls for a bridge to span across Nipomo Creek. Therefore, the surface electrical resistivity profiling was conducted to investigate for possible subsurface lateral lithologic or structural variations that may be associated with recent or older faulting at this bridge site.

3.0 SCOPE OF WORK

Our scope of work consisted of acquiring two electrical resistivity profiles oriented perpendicular to the trend of Nipomo Creek and to the extent constrained by vegetation, flanking the bridge site. These profiles will be analyzed and interpreted as resistivity models of the subsurface and described and interpreted in a written report.

4.0 METHODOLOGY

The electrical resistivity of the subsurface is measured using a galvanic resistivity method. This consists of transmitting electrical current into the earth through pairs of grounded metal electrodes, and measuring the resulting potential drop across the second pair of grounded metal electrodes. There are a variety of electrode arrangements (arrays) that can be used. The dipole-dipole electrode configuration was used in this survey because it provides information on both the depth and lateral extent of subsurface electrical properties.

5.0 DATA ACQUISITION

Apparent resistivity data was acquired with an automatic multi-electrode system manufactured by Advanced Geosciences Incorporated (AGI, Austin, Texas). The AGI system consists of an electrode switching box, acquisition console and four interconnecting cables capable of addressing 56 stainless steel electrodes. The 56 electrodes were laid out in a co-linear array and planted in the ground with the distance between each electrode set at a constant spacing. Both resistivity profiles contained a electrode spacing of 10 feet.

Data acquisition is controlled by programmed commands whereby one electrode pair (dipole) is energized by electric current and an adjacent electrode pair measures the resulting voltage drop. This measurement cycle takes 2 seconds. The instrument advances to the next cycle but moves the voltage measuring dipole down the array by turning the appropriate electrode switches on and off. Subsequent readings are then taken by incrementally increasing the distance between dipoles up to six times the initial electrode separation. More readings are taken by systematically increasing dipole lengths which are taken out to another six times the dipole separation out to the end of the array. All total, 691 electrical resistivity measurements were collected below a 56 electrode array.

We collected two resistivity profiles labeled NIPO-1 and 2. The locations of these electrical resistivity profiles is shown on Plate 1. The profile alignment (southwest - northeast) was chosen to intercept the trends of suspected geologic contacts and lateral discontinuities potentially associated with faulting.

6.0 DATA ANALYSIS

Upon completion of a dipole-dipole survey, apparent resistivity data are downloaded from the AGI console to a lap-top computer using the computer program STINGDMP. The data are inverted to true resistivity versus depth and distance models using the computer modeling program EARTH-IMAGER 2D. Both programs were written by AGI. We have incorporated the true terrain elevations into the resistivity models. The data generated by the EARTH-IMAGER 2D program are then gridded and contoured using the computer program Surfer 8.0 by Golden Software to produce final 2-D resistivity models.
A critical reduction procedure which we used in our presentation of the 2-D resistivity models was that we optimized the color scale within each resistivity model to enhance subsurface features. The result was that fine features possibly related to alluvial bedding and folding could be compared on both models.

7.0 PRESENTATION AND INTERPRETATION

The results of the resistivity modeling are shown as subsurface electrical resistivity profiles on Plate 2. In general, analysis of the electrical resistivity ER profiles showed that the local subsurface resistivity distribution ranged from 2 to over 1000 ohm-meters. However, we reduced the resistivity range to 2 to 100 ohm-m (see Resistivity Scale below each resistivity profile) to enhance resistivity variations of the alluvium which typically lie in this range. These resistivities are represented as a contour map which was in filled with a color spectrum. The purple-blue shades represent the lowest values of the local resistivity spectrum; the red-yellow shades represent the highest resistivity values. Based on the distribution of subsurface resistivity, inferences as to the configuration of geologic layers or bodies can be made and depending on the magnitude of resistivity and other subsurface information, a general interpretation of the underlying lithology.

In general, ER Profiles NIPO-1 and 2 show complex distributions of resistivity highs (red) on the southwest and lows (blues) on the northeast. Based on resistivity magnitudes and considering geologic information reported in Boring B-13 (see NIPO-1, Station 345) we have annotated the profiles with a very basic geologic interpretation. We have subdivided the geologic units into dune, alluvial clay, silt, sand and gravel deposits and bedrock. The subsurface configuration of these geologic units is shown on each profile.

In comparing the two profiles, a major, common subsurface feature appears as a near vertical lateral resistivity change approximately 50 feet west of the existing stream channel. This vertical boundary appears to separate primarily high resistivity zone interpreted as bedrock on the southwest from low resistivity zone interpreted as alluvium on the northeast given the limited geologic information available. This discontinuity can be explained by the presence of an interpreted near vertical fault boundary. This fault trend is northwest coincident with the course of Nipomo Creek and parallel to US Route 101.

Our results show a subsurface structure that is highly suggestive of a fault. However, even such a very generalized depiction of the subsurface will require a subsequent program of trenching and drilling to validate our geophysical interpretation.

8.0 LIMITATIONS

The scope of NORCAL's services for this project consisted of using geophysical techniques to measure and map the extent of subsurface physical properties. The accuracy of our findings is subject to specific site conditions and limitations inherent to the techniques used. We performed our services in a manner consistent with the level of skill ordinarily exercised by members of the profession currently employing similar methods. No warranty, with respect to the performance of services or products delivered under this agreement, expressed or implied, is made by NORCAL.

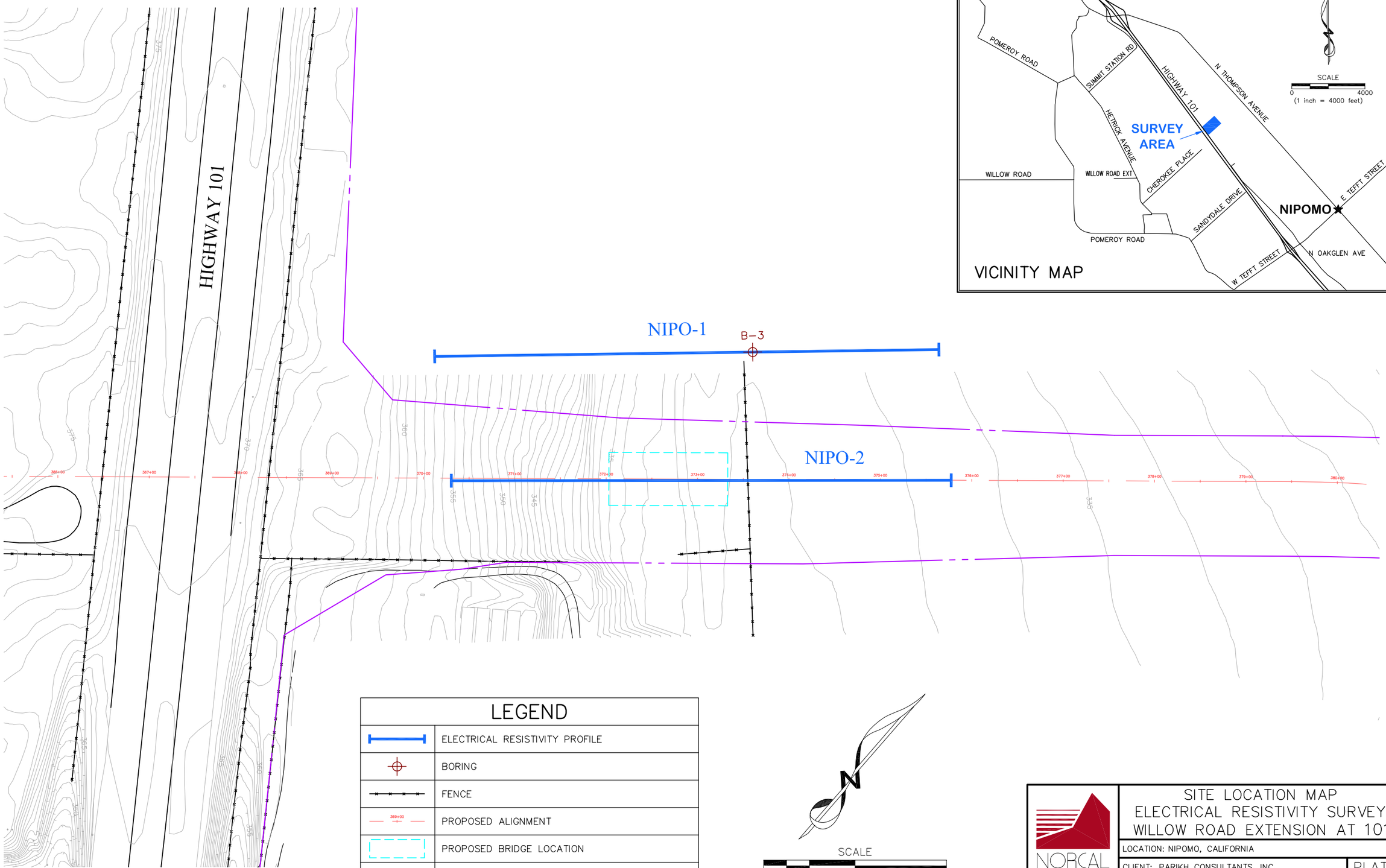
We appreciate the opportunity to provide our services to Parikh Geotechnical Consultants, Inc. for this project. If you have any questions, or require additional geophysical services, please do not hesitate to call.

Yours very truly,

NORCAL Geophysical Consultants, Inc.

William J. Henrich
Geophysicist PG-893

Enclosures: Plates 1 and 2



NORCAL

SITE LOCATION MAP
ELECTRICAL RESISTIVITY SURVEY
WILLOW ROAD EXTENSION AT 101

LOCATION: NIPOMO, CALIFORNIA

CLIENT: PARIKH CONSULTANTS, INC.

NORCAL GEOPHYSICAL CONSULTANTS INC.

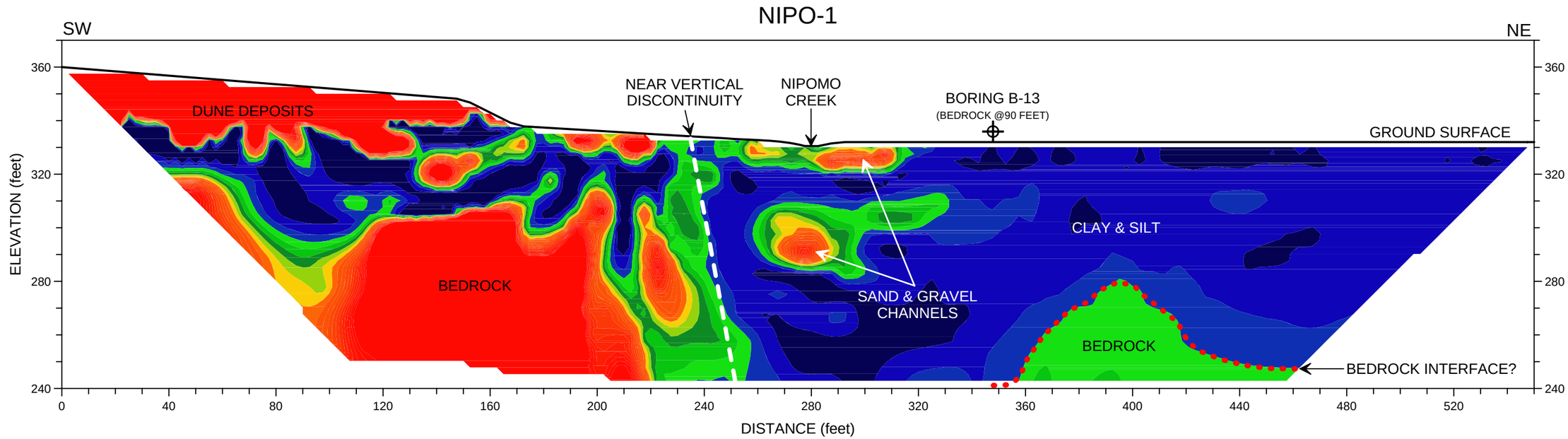
JOB #: 07-426.08

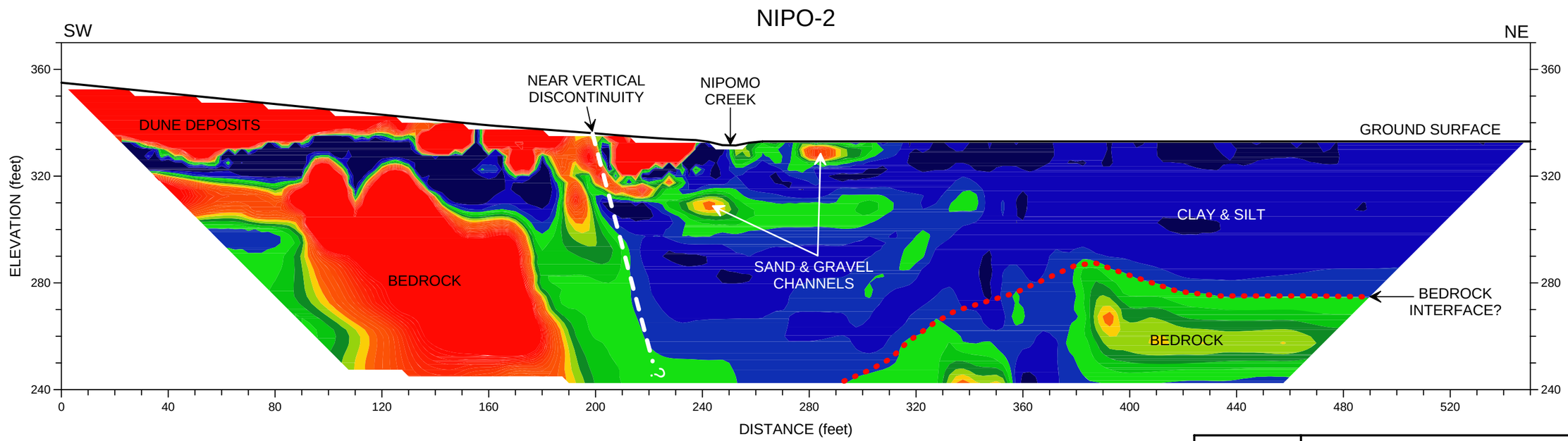
DATE: MAR. 2007

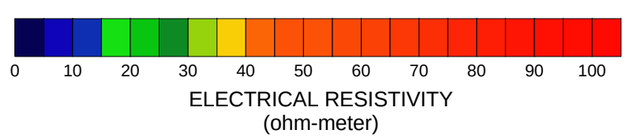
DRAWN BY: G.RANDALL

APPROVED BY: WJH

PLATE 1







SCALE: 1 INCH = 40 FEET

NORCAL

ELECTRICAL RESITIVITY PROFILES
NIPO-1 & NIPO-2
WILLOW ROAD EXTENTIONS AT 101

LOCATION: NIPOMO, CALIFORNIA

CLIENT: PARIKH CONSULTANTS, INC.

JOB #: 07-426.08

NORCAL GEOPHYSICAL CONSULTANTS INC.

DATE: MAR. 2007

DRAWN BY: G.RANDALL

APPROVED BY: WJH

PLATE 2

APPENDIX E

DESIGN COMMENT REVIEW AND RESPONSE

Project Title: Willow Road	Submittal: 65% Comments	Location: San Luis Obispo
By: SLO County	Date of Response: 09.11.09	CODE: A-Will Comply; B-Consultant to Evaluate; C-Will Not Incorporate; D-City/Caltrans to Evaluate

Comment By	Item No.	Drawing/ Page No.	Review Comment	Design Response
Storm Water	237	Materials report & typical sections	The composition of the existing pavement needs to be determined. Without this information the suitability of the proposed section cannot be determined.	We performed four pavement coring on Route 101 lanes. The data indicated 5" to 6" Asphalt Concrete (AC) over approx. 8" of Portland Cement Concrete. (PCC). See Section 9 of the updated GDMR (1-15-2010) and core pictures in Appendix C-6. The existing AC layer includes 1" to 1.5" of OGFC overlay.
Storm Water	238	Materials report & typical section	Use Class 2 AB not Class 3. Substantial justification needed for Class 3 usage.	Will use Class 2 AB.
Storm Water	239	Materials report & typical section	The TI for the ramps needs to be increased to 10.0. There is no way this could be considered a light duty ramp.	We have used TI = 10 for the ramps.
Storm Water	240	Typical sections	An thin overlay is needed over the project limits to seal cold joints, maintain safety by covering changed delineation, and providea professional appearance.	The designer will address the comment.
Storm Water	241	Materials report & typical sections	The ramps need to utilize a subbase, LCB section for long term maintainability.	We have added LCB for the section for long term maintainability.
Storm Water	242	Materials report	The investigation and sampling for structural section design is unacceptable. The ramps will be constructed on major cuts and fills, none of which were explored or sampled.	We have drilled two additional borings (A-09-112A & A-09-114A) to 30 ft depth for the ramps in December 2009. The data confirmed similar sandy material revealed in the 2007exploration. The southwest quadrant of proposed I/C is not accessible (existing fenced mobile home park).
Storm Water	243	Materials report	The report does not conform to the current Logging Manual. Revise.	The Log of Test Boring Sheets have been revised in accordance with Caltrans 2007 Logging Manual.
Storm Water	244	Materials report & typical sections	Due to investigation problems and lack of knowledge concerning the existing pavement, any structural sections proposed will be considered approximations only.	Refer to Item No. 237 (four cores were performed on existing pavement).

DESIGN COMMENT REVIEW AND RESPONSE

Project Title: Willow Road	Submittal: 65% Comments	Location: San Luis Obispo
By: SLO County	Date of Response: 09.11.09	CODE: A-Will Comply; B-Consultant to Evaluate; C-Will Not Incorporate; D-City/Caltrans to Evaluate

Comment By	Item No.	Drawing/ Page No.	Review Comment	Design Response
Storm Water	245	Comments 237-244	Our comments from the 30% review do not appear to have been addressed. The corrections will cause design revisions to the structural sections, ie. edge drains, deeper sections, change in pavement types.	Inadvertently, we did not receive 30% comments before.
Storm Water	246	Drainage	Where concrete backfill is used, it should be only brought up to the bottom of the HMA layer of the existing or proposed section.	The designer will address the comment.
Storm Water	247	Drainage	The consideration of corrosion from surface materials is missing. It does not appear any samples were investigated from the existing drainages.	We have obtained a near-surface sample (HA-ED-1) near the existing RCB (Sta. 346+90 approx. "U" Line, as shown on the Site Plan 2B) for corrosion study. Other samples were collected at shallow depths of the borings (Section 8.5 of GDMR 1-15-2010).
Storm Water	248	Drainage	The method used of estimating culvert service life is out of date. The consultant was made aware of this last year. Please revise.	We have performed analysis using AltPipe Program based on information provided by the designer. The AltPipe output is attached in Appendix C-4 of the report.

30% PS&E REVIEW COMMENT SHEET

EA: 05-474500
CO-Rte-PM SLO-101-PM 5.8/6.9
PROJECT NAME SLO-101-Willow IC
REVIEWED BY: G. Johnson
DATE: 02/27__/2009
UNIT: Materials Engineering
PHONE: 805-549-3158

Comment # ▼	Page/Sheet No ▼	Section	Comment
1		Materials report & typical sections	The composition of the existing pavement needs to be determined. Without this information the suitability of the proposed section cannot be determined.
2		Materials report & typical section	Use Class 2 AB not Class 3. Substantial justification needed for Class 3 usage.
3		Materials report & typical section	The TI for the ramps needs to be increased to 10.0. There is no way this could be considered a light duty ramp.
4		**Typical sections**	An thin overlay is needed over the project limits to seal cold joints, maintain safety by covering changed delineation, and provide a professional appearance.
5		Materials report & typical sections	The ramps need to utilize a subbase, LCB section for long term maintainability.
6		Materials report	**The investigation and sampling for structural section design is unacceptable. The ramps will be constructed on major cuts and fills, none of which were explored or sampled.**
7		Materials report	**The report does not conform to the current Logging Manual. Revise.**
8		Materials report & typical sections	**Due to investigation problems and lack of knowledge concerning the existing pavement, any structural sections proposed will be considered approximations only.**

* RESPONSES FOR 30% COMMENT ARE INCORPORATED IN THE 65% COMMENT/RESPONESE FORM (SEPT. 2009)

65% PS&E REVIEW COMMENT SHEET

EA: 05-474500
CO-Rte-PM SLO-101-PM 5.8/6.9 *PROJECT NAME* SLO-101-Willow IC
REVIEWED BY: G. Johnson *DUE:* 10/26/2009
UNIT: Materials Engineering *PHONE:* 805-549-3158

Comment # ▼	Page/Sheet No ▼ ▼	Section	Comment
			Our comments from the 30% review do not appear to have been addressed. The corrections will cause design revisions to the structural sections, ie. edge drains, deeper sections, change in pavement types.
		Drainage	Where concrete backfill is used, it should be only brought up to the bottom of the HMA layer of the existing or proposed section.
		Drainage	The consideration of corrosion from surface materials is missing. It does not appear any samples were investigated from the existing drainages.
		Drainage	The method used of estimating culvert service life is out of date. The consultant was made aware of this last year. Please revise.

PARIKH
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Geotechnical ■
Environmental ■
Materials Testing ■
Construction Inspection ■

Rajappan & Meyer Consulting Engineers, Inc.
1038 Leigh Avenue, Suite 100
San Jose, CA 95126

April 22, 2010
Job No.: 203125.GDR

Attn.: Mr. Keith Meyer

Sub: Amendment Letter for Pavement Sections
Route 101/Willow Road Interchange and Willow Road Extension
San Luis Obispo County, CA 05-SLO-101 PM 5.8/6.9 EA 474500

Ref: Geotechnical Design & Materials Report for Route 101/Willow Road Interchange and Willow Road Extension, San Luis Obispo County, CA, dated January 15, 2010

Dear Mr. Meyer:

Per the latest comments (4/22/2010) from Caltrans Dist. 5 (Materials), we have re-evaluated the pavement sections for mainline widening and ramp with the use of LCB as base layer and Aggregate Subbase (Class 1 AS). We have verified the sections indicated in the comment letter and concur with the design. The amended Page 27 of the report, calculations and Caltrans comments are attached with this letter. The recommended pavement sections are as follows:

Mainline – 0.55' HMA(A), 0.55' LCB, 0.70' AS (Class 1)
Ramp - 0.50' HMA(A), 0.50' LCB, 0.55' AS (Class 1)

Please be advised that we are performing a professional service and that our conclusions and recommendations are professional opinions only. All work done and all recommendations made are in accordance with generally accepted Geotechnical engineering principles and practices. No warranty, expressed or implied, of merchantability or fitness, is made or intended in connection with our work.

Very truly yours,
PARIKH CONSULTANTS, INC.

Y. David Wang, Ph.D., P.E., C52911
Senior Engineer

Gary Parikh, P.E., G.E., 666
Project Manager

REGISTERED PROFESSIONAL ENGINEER
GAURANG R. PARIKH
No. 666
EXP. 12-31-11
GEOTECHNICAL
STATE OF CALIFORNIA

Attachments: Amended Page, Calculations & Caltrans Comments (4/22/10)

AMENDMENT LETTER-ROUTE 101/WILLOW RD (S:\203125 WILLOW.GD1}

Structural Sections

Based on the Traffic Indices provided by the designer, the recommended typical structural pavement sections for 20-year design life are shown in Tables 9A & 9B below.

TABLE 9A: SUMMARY OF PAVEMENT STRUCTURAL SECTIONS (CALTRANS R/W)

Location	Composite Pavement Sections	Full Depth Section
Route 101 Widening (TI=13.5)	0.55' HMA (A) 0.55' LCB 0.70' AS (Class 1)	1.30' HMA
Ramps (TI=10.0)	0.50' HMA (A) 0.50' LCB 0.55' AS (Class 1)	0.75' HMA
Temporary Route 101 for Construction Duration (design for TI = 8.5)	0.40' HMA (A) 0.80' AB (Class 2)	0.80' HMA

TABLE 9B: SUMMARY OF PAVEMENT STRUCTURAL SECTIONS (COUNTY'S R/W)

Location	Composite Pavement Sections	Full Depth Section
Willow Road Extension & Frontage Road – West of Sta. 371+50 "A" Line (TI =9.5)	0.20' RHMA-G 0.30' HMA 0.85' AB (Class 2 or 3)	0.90' HMA
Willow Road Extension – East of Sta. 371+50 "A" Line (TI =9.5)	0.20' RHMA-G 0.30' HMA 0.85' AB (Class 2 or 3) Over 4' select fill (min. R = 40)	0.90' HMA Over 4' select fill (min. R = 40)

Hot Mix Asphalt (Asphalt Concrete), Aggregate Bases (Class 2, AB) and Aggregate Subbase (Class 1, AS) should conform to the Caltrans Standard Specifications in Section 39 and 26 respectively. RHMA-G is the gap-graded rubberized asphalt. It is our understanding that the County prefers to use rubberized asphalt on Willow Road extension for better noise control. Per discussion with the designer and comment from the County, the upper 0.20' of HMA is replaced with RHMA-G. Due to native sandy soil conditions, open-graded rubberized asphalt is not desirable. Pavement subgrade and structural sections should be prepared and compacted in accordance with the project specifications and Caltrans standard.

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

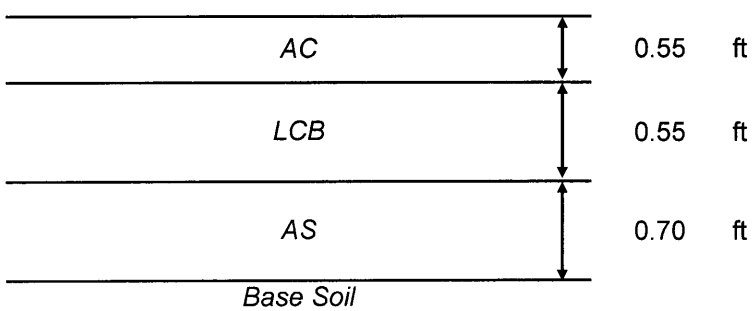
PROJECT NAME: *Route 101/Willow Rd I/C (Mainline Widening)*
PROJECT NO.: *203125.GDR*

Design Case: AC over LCB over AS (Class 1 w/ R = 60)

Design TI=	***13.5***
R_{BS}=	***40***
R_{AB}=	78
R_{AS}=	60

$GE_{TOTAL} = 0.0032*TI*(100-R_{BS}) =$		2.59	
$GE_{AC+LCB} = 0.0032*TI*(100-R_{AS}) =$		1.73	
$GE_{AC} = 0.4*GE_{AC+LCB} =$		0.69	
=>	GE'_{AC} =	0.89	(add 0.2 ft safety factor)
	AC thickness =	0.57	ft
=>	AC Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f,\ AC}$=	1.56	
	GE_{AC}=	0.86	
$GE_{LCB} = (GE_{AC+LCB})-GE_{AC} =$		0.87	
=>	GE_{AC+AB}=	1.07	(add 0.2 ft safety factor)
	$G_{f,\ LCB}$=	1.90	
	LCB thickness=	0.56	
=>	LCB Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	GE_{LCB}=	1.05	
$GE_{AS} = GE_{TOTAL}-GE_{LCB}-GE_{AC} =$		0.69	
=>	AS Thickness=	**0.70**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

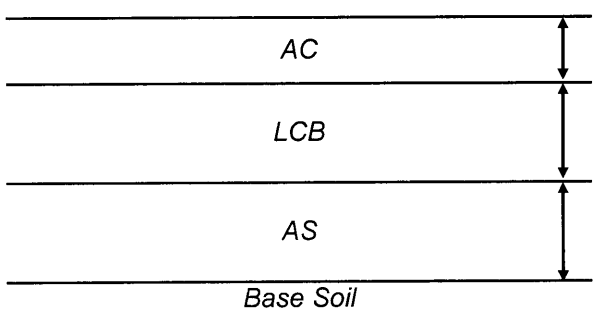
PROJECT NAME: *Route 101/Willow Rd I/C (Ramp)*
PROJECT NO.: *203125.GDR*

Design Case: AC over LCB over AS (Class 1 w/ R = 60)

Design TI=	***10***
R_{BS}=	***40***
R_{AB}=	78
R_{AS}=	60

$GE_{TOTAL} = 0.0032*TI*(100-R_{BS}) =$		1.92	
$GE_{AC+LCB} = 0.0032*TI*(100-R_{AS}) =$		1.28	
$GE_{AC} = 0.4*GE_{AC+LCB} =$		0.51	
=>	GE'_{AC} =	0.71	(add 0.2 ft safety factor)
	AC thickness =	0.40	ft
=>	AC Thickness=	**0.50**	ft (round up to the nearest 0.05 ft)
	$G_{f,\,AC}$=	1.79	
	GE_{AC}=	0.90	
$GE_{LCB} = (GE_{AC+LCB})-GE_{AC} =$		0.38	
=>	GE_{AC+AB}=	0.58	(add 0.2 ft safety factor)
	$G_{f,\,LCB}$=	1.90	
	LCB thickness=	0.31	
=>	LCB Thickness=	**0.50**	ft (round up to the nearest 0.05 ft)
	GE_{LCB}=	0.95	
$GE_{AS} = GE_{TOTAL}-GE_{LCB}-GE_{AC} =$		0.07	
=>	AS Thickness=	**0.10**	ft (round up to the nearest 0.05 ft)
		(Caltran Dist. 5 Material uses 0.55' AS Class 1 - ok)	

Design Section:



0.50	ft	
0.50	ft	
0.55	ft	(Use 0.55' per Caltrans Dist. 5 Materials)

2nd Submittal of 65% PS&E
REVIEW COMMENT SHEET

EA: 05-474500
CO-Rte-PM SLO-101-PM 5.8/6.9 *PROJECT NAME* SLO-101-Willow IC
REVIEWED BY: Doug J. Heumann *DATE:* 4/22/2010
UNIT: PM *PHONE:* 805-549-3788

Comment # ▼	Page/Sheet No ▼ ▼	Section	Comment
			SEE BELOW

REVIEWED BY: G. Johnson *DATE:* 4/22/10
UNIT: Materials Engineering *PHONE:* 805-549-3158

Comment # ▼	Page/Sheet No ▼ ▼	Section	Comment
1		Materials report and typical sections	There appears to be confusion concerning usage of and my comments about LCB. In an effort to expedite resolution, we suggest the following structural sections: Mainline – 0.55' HMA, 0.55' LCB, 0.70' ASB CL1 Ramps – 0.50' HMA, 0.50' LCB, 0.55' ASB CL1
2		X-1 thru 4	Change the OGFC overlay thickness to 0.10'. 0.20' is beyond the appropriate application of OGFC.
3		X-1 thru 4	Carry the OGFC overlay onto the new permanent ML structural sections by a foot.
4		X-1, 4	Please clarify the purpose of the 0.55' plane and replace areas.
5		X-, SC-	The new structural sections need to be constructed below adjacent OGFC layers to prevent ponding, early failure, and safety issues.
6		X-, SC-	OGFC placement should be called out to occur after mainline and ramp work is complete. Maybe in Stage 4?
7		X-1 thru 4	OGFC cannot be placed on existing OGFC. The existing must be removed prior to overlay placement.

REVIEWED BY: Kristen Inkrott *DUE:* 4/22/2010
UNIT: Hydraulics *PHONE:* 805-549-3679

Comment # ▼	Page/Sheet No ▼ ▼	Section	Comment
8	D-2	Drainage Plans	DS#3a and DS#3c do not meet the design water spread criteria. The ramp will be flooded during a 25-year storm event. Re-design the system so the criteria listed in HDM, Topic 831.3 is met.
9	D-2, D-4	" "	The culverts at DS#8 and DS#12 will not meet the criteria listed in HDM, Topic 821.3, *Selection of Design Flood.* Increase the diameter