Mathilda Avenue Landscaping Project
FRP S19247

SUPPLEMENTAL PROJECT INFORMATON HANDOUT

4. FINAL GEOTECHNICAL DESIGN AND MATERIALS REPORT

Santa Clara Valley Transportation Authority

GEOTECHNICAL DESIGN AND MATERIALS REPORT
MATHILDA AVENUE IMPROVEMENTS
AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA
04-SCL-237-PM 2.7/3.3; 04-SCL-101-PM 45.2/45.8
EA 04-4H2901; PROJECT ID: 0413000204

For

Sunnyvale

Caltrans

PARIKH CONSULTANTS, INC.
2360 Qume Drive, Suite A
San Jose, CA 95131

January 8, 2018

Job No. 2014-129-PSE

PARIKH
Practicing in the Geosciences

Geotechnical ■
Environmental ■
Materials Testing ■
Construction Inspection ■

WMH Corporation
50 West San Fernando Street, Suite 950
San Jose, CA 95113

Job No.: 2014-129-PSE
January 8, 2018

Attn: Mr. Tim Lee

Sub: GEOTECHNICAL DESIGN & MATERIALS REPORT
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

Dear Mr. Lee:

Transmitted herewith is the Geotechnical Design & Materials Report for the subject project. 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.

Very truly yours,
PARIKH CONSULTANTS, INC.

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

Attachment: Geotechnical Design & Materials Report

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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____

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GEOTECHNICAL DESIGN AND MATERIALS REPORT
MATHILDA AVENUE IMPROVEMENTS
AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA
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EA 04-4H2901; PROJECT ID: 0413000204

1.0 INTRODUCTION

This report presents the results of the geotechnical engineering investigation for the proposed "Mathilda Avenue Improvements at SR 237 and US 101 Project" (Project) to be constructed in the City of Sunnyvale, California. The work was performed in general accordance with the scope of work outlined in our proposal to WMH Corporation (Designer). The general location of the Project site is shown on the Project Location Map - Plate No. 1.

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 proposed Project. This report also establishes a geotechnical baseline to be used in assessing the existence and scope of changed site conditions, if any.

The scope of work performed for this investigation included a review of readily available soils and geologic literature pertaining to the site including Caltrans as-built log of test borings (LOTBs), site reconnaissance, drilling exploratory soil borings, 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.

In addition, the scope of work included a pavement deflection test along Mathilda Avenue and portion of West Moffett Park Drive, which was conducted by Pavement Engineering, Inc. (PEI) from Redding, California. The pavement rehabilitation recommendations are provided in a deflection analysis report under a separate cover (see Appendix F).

The report is intended for use by the design engineer, construction personnel, bidders and contractors for information and reference purposes only, and should not be used directly as specifications.

2.0 EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

The following are general descriptions of the existing facilities within the Project limits:

Mathilda Avenue

Within the Project area, Mathilda Avenue is a six-lane divided local roadway. Mathilda Avenue serves as the main access to the residential communities on the east side of Mathilda Avenue and is the only access to the landlocked area contained within the US 101/SR 237/Mathilda triangle via Ross Drive.

SR 237

SR 237 is an east-west freeway starting at SR 82 (El Camino Real) in the City of Mountain View and ending approximately 11 miles east at I-680 in the City of Milpitas. Within the Project area, SR 237 provides two (2) mixed-flow lanes in each direction. On eastbound SR 237, a High Occupancy Vehicle (HOV) lane is provided east of Mathilda Avenue and becomes an HOV/Express Lane from east of Zanker Road to the eastbound SR 237/ northbound I-880 direct connector ramp. On westbound SR 237, there is an HOV/Express Lane beginning at the southbound I-880/ westbound SR 237 direct connector ramp that becomes an HOV lane from North First Street to just east of Fair Oaks Avenue. Within the Project area, auxiliary lanes are provided in each direction between US 101 and Mathilda Avenue on SR 237. There is also an auxiliary lane on westbound SR 237 between Fair Oaks Avenue and Mathilda Avenue.

The SR 237/Mathilda Avenue Interchange is a full ‘tight’ diamond interchange that accommodates all ramp movements with access to and from eastbound and westbound SR 237. All ramp termini are signalized. The westbound SR 237 on-ramp has existing ramp metering equipment installed, however there is no existing ramp metering equipment installed for the eastbound SR 237 on-ramp.

US 101

Within the Project area, US 101 provides three mixed-flow lanes plus one HOV lane in each direction, while an auxiliary lane is also provided in the southbound direction between SR 237 and Mathilda Avenue.

The Moffett Park Drive/US 101 northbound on-ramp is a one-lane on-ramp located along Moffett Park Drive to the west of the Mathilda Avenue/Moffett Park Drive intersection. This on-ramp merges with the westbound SR 237 off-ramp that connects to northbound US 101. The ramp terminus is signalized, and the on-ramp is not metered.

The US 101/Mathilda Avenue Interchange is a partial cloverleaf interchange with access to all but two movements: southbound Mathilda Avenue to northbound US 101 and southbound US 101 to northbound Mathilda Avenue. None of the ramp termini are signalized; however all of the on-ramps are metered.

Major Structures

Major structures in the Project area and close proximity include the following:

- Mathilda Avenue Overcrossing (at US 101), Bridge Number 37-0177.
- Route 237/101 Separation (west of the Project site), Bridge Number 37-0178.
- North Mathilda Avenue Undercrossing (at SR 237), Bridge Number 37-0179.
- South Borregas Avenue Pedestrian Overcrossing (at US 101 east of the Project site), Bridge Number 37-0663.
- North Borregas Avenue Pedestrian Overcrossing (at SR 237 east of the Project site), Bridge Number 37-0664.

Existing Pavement Sections

Table 2.1 summarizes the as-built pavement sections within the improvement area based on the Typical Sections contained on the *As-built Roadway Plans* listed in Section 3.0.

TABLE 2.1 - SUMMARY OF EXISTING PAVEMENT SECTIONS

Roadway	Location	Pavement Sections (ft)	Approx. Total Thickness (ft)	Year of Construction
Mathilda Ave. at US 101 and SR 237 Interchanges	Loops, ramps and speed change lanes	0.25 AC 0.33 CTB (Cl A) 0.33 CTB (Cl B) 0.50 AS (Cl 2)	1.40	1960
SR 237	EB, WB	0.33 AC 0.33 CTB (Cl A) 0.33 CTB (Cl B) 0.67 AS (Cl 2)	1.65	1960
US 101	NB, SB	Main lanes 0.75 PCC 0.33 CTB (Cl A) 1.00 AS (Cl 2) Shoulders 0.25 AC 0.67 AB (Cl 2) 1.00 to 1.33 AS (Cl 2)	2.10 1.92 to 2.25	1960
Mathilda Ave.	NB, SB	0.33 AC 0.33 CTB (Cl A) 0.33 CTB (Cl B) 0.50 AS (Cl 2)	1.50	1960
Mathilda Ave.	"M1" 45+07.11 to 66+20	Widening on both sides 1.35 AC (A)	1.35	1991
Moffett Park Drive	"L6" 29+99.07 to 34+35.41, "L6" 37+10 to 43+84.51	Widening on left 0.90 AC (A)	0.90	1991
Mathilda Ave. OC at US 101, PM 45.1	Loop on-ramps	Existing 0.33 AC 0.67 AB 0.67 AS Widening on right 1.20 AC (A)	1.67 1.20	1996
Mathilda Ave.	M1 58+52.75 to 59+02.65	Widening median on both sides 1.33 AC (A)	1.33	1999

Roadway	Location	Pavement Sections (ft)	Approx. Total Thickness (ft)	Year of Construction
Mathilda Ave.	M1 11+24 to 22+14	Widening both median and outside of road in both directions 1.33 AC (A)	1.33	1999
Moffett Park Drive	MP 95+75 to 124+51.08	Widening and new pavement 1.33 AC (A)	1.33	1999
Moffett Park Drive on-ramp	97+00 to 104+45	0.25 AC (A) 0.50 AB (Cl B) 0.75 AS (Cl 1)	1.50	1999
SR 237 on-ramp	16+00 to 22+45	0.25 AC (A) 0.50 AB (Cl B) 0.75 AS (Cl 1)	1.50	1999
Mathilda Ave. OC at US 101, Route 101 PM 45.4/45.9	SB off-ramp onto SB Mathilda Ave. NB off-ramp onto NB Mathilda Ave. NB loop off-ramp onto SB Mathilda Ave. NB loop on-ramp from NB Mathilda Ave.	Existing 0.33 AC (A) 0.67 AB 0.50 AS Widening on right 1.00 AC (A)	1.50 1.00	2000

These sections are based on the available as-built records and may not include all pavement rehabilitation or other maintenance related modifications that have occurred over time. Therefore, it should be used as a reference only and not for construction cost estimates or bidding purposes.

Proposed Improvements

The California Department of Transportation (Caltrans), in cooperation with the Santa Clara Valley Transportation Authority (VTA) and the City of Sunnyvale, is proposing the Project to improve Mathilda Avenue from Almanor Avenue/Ahwanee Avenue to Innovation Way, including on- and off-ramp improvements at the State Route (SR) 237/Mathilda Avenue and U.S. Highway 101 (US 101)/Mathilda Avenue interchanges. On SR 237, the Project limits are from 0.3 miles east of the US 101/SR 237 interchange (post mile [PM] 2.7) to 0.3 miles east of the Mathilda Avenue undercrossing (PM 3.3). On US 101, the Project limits are from 0.5 miles south of the Mathilda Avenue overcrossing

(PM 45.2) to 0.3 miles south of the SR 237/US 101 interchange (PM 45.8). The total length of the Project on Mathilda Avenue is approximately one (1) mile.

The primary purpose of the Project is to improve traffic operations on Mathilda Avenue through the US 101 and SR 237 interchanges. The Project will include reconfiguration of the US 101 and SR 237 interchanges with Mathilda Avenue. This includes modification to on- and off-ramps; removal, addition, and signalization of intersections, and provision of new left-turn lanes. In addition, the Project would require modification and construction of bicycle and pedestrian facilities, utilities, drainage, street lighting, ramp metering, signage, and light rail crossing facilities as described. The Project will include the following design features:

- Moffett Park Drive between Bordeaux Drive and Mathilda Avenue would be removed and replaced with a Class I bikeway (as described below). Vehicular traffic would be shifted north to Bordeaux Drive and Innovation Way to access Mathilda Avenue. Innovation Way has been extended from Mathilda Avenue to Bordeaux Drive as part of the Moffett Place development project. Moffett Park Drive eastbound/westbound north of Mathilda Avenue would remain.
- The westbound SR 237 off-ramp would be realigned and widened to terminate opposite Moffett Park Drive (on the west side of Mathilda Avenue). The existing signalized intersections on Mathilda Avenue at the SR 237 westbound off-ramp and Moffett Park Drive would be removed.
- The reconfigured westbound SR 237 off-ramp/Moffett Park Drive intersection would be signalized. The westbound SR 237 on-ramp would be modified to intersect with Mathilda Avenue just south of the new signalized intersection. Mathilda Avenue northbound traffic bound for westbound SR 237 would make a U-turn movement at the new signalized intersection to access the on-ramp.
- Provide three continuous through lanes in each direction on Mathilda Avenue.
- Remove northbound US 101 loop off-ramp and shift traffic to northbound US 101 diagonal off-ramp.

- Realign and widen northbound US 101 ramps and signalize ramp intersection with Mathilda Avenue, and construct left-turn lane on southbound Mathilda Avenue to access northbound US 101 loop on-ramp.
- Realign southbound US 101 off-ramp and loop on-ramp and signalize ramp intersection with Mathilda Avenue.
- Modify Mathilda Avenue/Ross Drive signal intersection.
- Modify westbound SR 237 ramps to provide a diamond configuration.
- Pavement Rehabilitation on Mathilda Avenue

An Environmental Impact Report (EIR) to satisfy the requirements of the California Environmental Quality Act (CEQA) was approved on January 10, 2017. Cooperative Agreement 04-2567 between Caltrans and VTA was executed on May 7, 2015 to provide IQA for the PA&ED, PS&E and Right of Way phases. Caltrans is the partnering agency and VTA and the City of Sunnyvale are the sponsoring, funding, and implementation agencies for the PA&ED, PS&E, R/W and constructions phases of the project. The Project is included in the VTP 2040 highway program and will be locally funded.

The proposed improvements include new overhead sign structures, sound wall replacement, new pavement sections for Mathilda Avenue widening, US 101 off-ramp modification, and pavement rehabilitation on Mathilda Avenue which require geotechnical engineering investigation and recommendations. Other minor improvements will follow appropriate Caltrans and City standards and no specific geotechnical engineering services are required. The recommendations presented in this report are based on the above information. Any major deviation should be reported to this office for consideration. The layout of proposed improvements is included in Appendix A.

3.0 PERTINENT REPORTS AND INVESTIGATION

The following documents and literatures relevant to the Project were reviewed. The list shows the years quoted from the Caltrans as-built LOTBs when the field exploration was conducted. Parikh Consultants, Inc. (PARIKH) previously performed visual evaluation of the existing pavement conditions at the site in December 2014, and provided a geotechnical memorandum titled “Mathilda

Avenue Improvements at SR 237 and US 101, Sunnyvale, California, Preliminary Pavement Condition Evaluation" in January 2015 (see Appendix E).

As-Built Log of Test Borings

- Caltrans, 1957, As-built LOTB, Mathilda Avenue OC (Br. No. 37-0177).
- Caltrans, 1957, As-built LOTB, Route 237/101 Separation (Br. No. 37-0178).
- Caltrans, 1957, As-built LOTB, North Mathilda Avenue UC (Br. No. 37-0179).
- Caltrans, 2005, As-built LOTB, South Borregas Avenue POC (Br. No. 37-0663).
- Caltrans, 2005, As-built LOTB, North Borregas Avenue POC (Br. No. 37-0664).

As-Built Roadway Plans

- Caltrans, 1960, As-built Plans, State Highway in Santa Clara County, on Bayshore Highway between 0.3 mile North of Charleston Road in Mountain View and Guadalupe River near San Jose including Mountain View-Alviso Road between Baysore Highway and 0.2 mile east of Borregas Avenue.
- Caltrans, 1996, As-built Plans, State Highway in Santa Clara County, in San Jose, Santa Clara, Mountain View, Sunnyvale and Palo Alto at Various Locations from 0.2 mile South of Guadalupe River Bridge to Embarcadero Road Overcrossing.
- Caltrans, 2000, As-built Plans, State Highway in Santa Clara County, in San Jose and Sunnyvale at Various Locations from 0.5 km South of De La Cruz Boulevard Overcrossing to 0.4 km North of Mathilda Avenue Overcrossing.
- City of Sunnyvale Department of Public Works, 1991, As-built Plans, Mathilda Avenue Widening at Route 237, in Santa Clara County in Sunnyvale at North Mathilda Avenue Undercrossing.
- Santa Clara County Transportation Authority, 1999, As-built Plans, Tasman Corridor Project, Castro Street to Lockheed Way.

Others

- Baseline Environmental Consulting, 2015, Preliminary Geological Assessment for the Mathilda Avenue Improvements at SR 237 and US 101 Project.
- Baseline Environmental Consulting, 2015, Initial Site Assessment for the Mathilda Avenue Improvements at SR 237 and US 101 Project.
- Baseline Environmental Consulting, 2017, Preliminary Site Assessment for the Mathilda Avenue Improvements at SR 237 and US 101 Project.
- Parikh Consultants, Inc., 2005, Geotechnical Engineering Investigation, South Borregas Avenue POC at Hwy 101, City of Sunnyvale, California (Br. No. 37-0663).
- Parikh Consultants, Inc., 2005, Geotechnical Engineering Investigation, North Borregas Avenue POC at SR 237, City of Sunnyvale, California (Br. No. 37-0664).
- Parikh Consultants, Inc., 2015, Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, California, Preliminary Pavement Condition Evaluation.
- Parikh Consultants, Inc., 2017, Preliminary Geotechnical Design and Materials Report, Mathilda Avenue Improvements at SR 237 and US 101 Project.
- WRECO, 2016, Water Quality Assessment Report for the Mathilda Avenue Improvements at SR 237 and US 101 Project, City of Sunnyvale, California.

4.0 PHYSICAL SETTING

4.1 Climate

The Project site is characterized with moderate climatic conditions, which consist of mild winters, warmer summers, small daily and seasonal temperature ranges and mild humidity. Based on the statistical information obtained from the website of the Western Regional Climate Center, for an available record period from 1953 to 2015 at Palo Alto station (No. 046646), the average temperature in the project vicinity ranges from a minimum of 38.2°F in December to a maximum of 78.4°F in July and August, with an annual average total precipitation of about 15.2 inches. Most of the rainfall is recorded in February with an average total monthly precipitation of 3.15 inches. July is the month with the least rainfall precipitation of 0.02 inches. Freezing weather may occur, but it is generally not necessary to design for freeze-thaw conditions for the area.

4.2 Topography and Drainage

The Project site is located within the Santa Clara Valley groundwater basin with Diablo Range on the east and Santa Cruz Mountains on the west. The area generally drains northeast toward the San Francisco Bay. Based on a Project drainage profile, the ground surface elevations within the Project area ranges between approximately Elevation 50 feet and 20 feet (NAD83). Grade differences may vary due to roadway crossing and structure approach embankments. Surface drainage is collected in the local storm drain systems. In general, hills or valleys in the region do not directly influence the Project site.

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

The Project will not modify the existing overcrossing or undercrossing structures, except the Mathilda Avenue OC where bridge railings will be replaced. Sunnyvale West Channel is a flood protection channel that crosses to the west side of Mathilda Avenue at Innovation Way, then aligns north-south to cross SR 237 and US 101. San Francisco Public Utilities Commission (SFPUC) B.D.P.L. aqueducts (72- and 90-inch diameter) cross Mathilda Avenue between US 101 and Ross Drive, and US 101 just east of the Sunnyvale West Channel crossing. No structure is proposed on top of the channel and aqueducts.

4.4 Regional Geology and Seismicity

The Project site is in the southern portion of the San Francisco Bay area in the Coast Range geomorphic province of northern California. The Coast Range forms a nearly continuous topographic barrier between the California coastline and the San Joaquin Valley. In general, the Coast Range in this region is a double chain of mountains running north-northwest. Between the two chains of mountain lies the basin of San Francisco Bay, including the valleys at the end of the Bay, Petaluma on the north and Santa Clara on the south. Three prominent geologic blocks dominate the San Francisco Bay Area: the Santa Cruz Mountains (western block), the San Francisco Bay (central block), and the East Bay Hills/Diablo Range (eastern block).

The Santa Clara Valley is part of a fault-bounded valley which includes San Francisco Bay. It is believed that this trough formed in Pliocene Epoch and has been subjected to extensive deposition during the Pleistocene time. This deposition has resulted in filling the trough with marine and alluvial sediments derived from the adjoining hills. Normal processes associated the development of streams, alluvial fans, flood plains and deltas, along with the multiple cycles of erosion and deposition due to sea level changes have resulted in a very complex sedimentary sequence. The deposits within the general area may be characterized by irregular bedding, interfingering of fine and coarse grained materials, stream braiding and lenses. Individual deposits could be highly variable in both thickness and lateral extent.

The regional seismic context is an important consideration because the forces that affect the Project area are regional in nature: that is, they are generated off-site, outside the immediate area, or outside the Santa Clara County. However, the effects of these forces must be accommodated within the limits of the Project, in compliance with regulations and guidelines established by the State and County.

Santa Clara County and the Bay Area are in one of the most active seismic regions in the United States. Each year, low- and moderate-magnitude earthquakes occurring within or near the Bay Area are felt by residents. Since the mid-nineteenth century, hundreds of earthquakes have been felt in Contra Costa County. In 1868, the Hayward Fault ruptured the ground surface, producing several feet of right lateral displacement at the ground surface and causing an earthquake that damaged many structures in the Bay region. The Loma Prieta Earthquake of October 17, 1989, originated within the San Andreas Fault Zone and caused severe damage throughout much of the Bay Area. The major fault zones of the San Andreas Fault System (including the Hayward and Calaveras faults) have been the source of other earthquakes, and are expected to be the source of future earthquakes.

4.5 Soil Survey Mapping

Based on a Soil Map of Santa Clara County from the Web Soil Survey of the United States Department of Agriculture (USDA), the entire Project area is underlain by soils with a map unit name “Urbanland-Hangerone complex (map unit symbol: 145)” having 0 to 2 percent slopes, and roadway fill. A USDA Soil Map covering the Project area is attached as Plate No. 2. Since the Project site is in a developed urban area, the soil components may have been altered from those shown in the USDA soil map.

5.0 FIELD EXPLORATION

5.1 Drilling and Sampling

A total of 15 borings were drilled for the Project from March 27 to April 6, 2017. The borings were drilled with a truck- or track-mounted drill rig using hollow-stem augers or rotary wash drilling method. The boring information is tabulated in Table 5.1. The approximate boring locations are shown on the Site Plan - Plate No. 3. The relatively shallow borings (about 5 feet deep) are to collect bulk subgrade soil samples for pavement design. The relatively deep borings (depths ranging from approximately 25.5 to 41.5 feet) are for structure design.

TABLE 5.1- SUMMARY OF BORING INFORMATION

Boring No.	Approx. Station (ft)	Approx. Offset (ft)	Approx. Ground Elev. (ft)	Approx. Boring Depth (ft)	Date Drilled
B-1	28+00	“M1” 30 Rt.	38	5	3/27/2017
B-2	35+30	“M1” 50 Rt.	35	5	3/27/2017
R-17-003	45+80	“M1” 53 Rt.	31	30.5	4/6/2017
B-4	54+90	“M1” 85 Rt.	24	5	4/6/2017
B-5	63+50	“M1” 53 Rt.	22	5	3/28/2017
R-17-006	70+00	“M1” 32 Lt.	20	31.5	3/28/2017
B-7	66+05	“M1” 33 Lt.	20	5	3/28/2017
B-8	60+00	“M1” 105 Lt.	24	5	3/28/2017
R-17-009	50+85	“M1” 53 Lt.	30	41.5	3/27/2017

Boring No.	Approx. Station (ft)	Approx. Offset (ft)	Approx. Ground Elev. (ft)	Approx. Boring Depth (ft)	Date Drilled
R-17-010	47+00	"M1" 48 Lt.	35	41.5	3/27/2017
R-17-011	38+45	"M1" 68 Lt.	38	36.5	4/4/2017
B-12	31+45	"M1" 62 Lt.	36	5	3/27/2017
R-17-013	395+00	"C" 81 Lt.	31	41.5	3/28/2017
R-17-014	382+60	"C" 76 Lt.	32	35.5	4/6/2017
R-17-015	76+35	"SW1" 6 Rt.	31	25.5	4/6/2017

Selected soil samples were obtained with either a 2.5-inch I.D. Modified California (MC) or 1.4-inch I.D. Standard Penetration Test (SPT) sampler at various depths. The field investigation was conducted under the supervision of the field engineer who logged the test borings and prepared the samples for subsequent laboratory testing and evaluation. After visual examination, the samples were sealed and transported to PARIKH laboratory for further evaluation and testing.

5.2 Geologic Mapping

The Project site is mostly underlain by Quaternary sediments and roadway fill (see Section 7.1 "Site Geology"). Site specific geologic mapping was not performed for this 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

The exploratory borings mostly encountered clayey surficial deposits. Drilling conditions using hollow-stem augers and rotary wash drilling method were considered appropriate for this site.

6.0 GEOTECHNICAL TESTING

6.1 In-Situ Testing

Blow counts were recorded during soil sampling in the field. The blow counts combining with laboratory tests such as unconfined compression test are used to develop soil shear strengths for soil bearing capacity estimation. Soil samples were obtained during drilling by driving a MC or SPT sampler into subsurface soils under the impact of a 140-lb hammer falling through 30 inches. The blow counts required to drive the sampler for the last 12 inches are presented on the LOTBs in Appendix B. The drilling subcontractor was Geo-Ex Subsurface Exploration from Dixon, California. Based on a hammer energy calibration information provided, the hammer energy ratios of the drill rigs (CME 75 and CME 45) used are approximately 70% and 75%, respectively. Using a method suggested by Daniel, Howie and Sy (2003), when correlating standard penetration data, the blow counts for the Modified California Sampler may be converted to equivalent Standard Penetration Test blow counts by multiplying a conversion factor of 0.6.

6.2 Laboratory Testing

Laboratory tests were performed in accordance with California test methods on selected soil samples. The types of laboratory tests performed included the following:

- Moisture Content (CT 226)
- Atterberg Limits (CT 204)
- Grain Size Distribution (CT 202)
- Consolidation (CT 219)

- Unconfined Compression (CT 221)
- Corrosion (CT 643, 417 and 422)
- R-value (CT 301)

The corrosion tests were performed by Sunland Analytical in Rancho Cordova, California. The laboratory test results are contained in Appendix C.

7.0 GEOTECHNICAL CONDITIONS

7.1 Site Geology

Geologic features pertaining to the Project site were evaluated by referencing to the Geologic Map of the Palo Alto and Mountain View Quadrangles, Alameda, San Mateo & Santa Clara Counties, California, by Dibblee, T. W., and Minch, J. A. (ed.) (2007). Based on the map, different Holocene age units are present beneath the project site and its vicinity. A Geologic Map covering the general project area is shown on Plate No. 4. Descriptions of the main geologic units are as follows:

Qac - Silty clay and organic clay, fossiliferous; represents intra-fan areas.

Qya - Alluvial sand, fine-grained, silt, and clay; where differentiated represents distal alluvial fan deposits at outer edge of fan areas.

7.1.1 Lithology

The Project site is generally underlain by native materials and roadway fills. No bedrocks are mapped at the site.

7.1.2 Structure

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

7.1.3 Existing Slope Stability

The majority of the Project site is relatively flat with asphalt pavement surface and concrete sidewalks. The existing embankments within the Project limits generally have ± 2H:1V (horizontal to vertical) or flatter slopes. Embankment heights are approximately 20 feet at the Mathilda Avenue overcrossing (US 101) and undercrossing (SR 237) structures. Existing embankments are landscaped and appear to be in relatively stable condition.

7.2 Subsurface Soil Conditions

As-Built Subsurface Soil Information

The Caltrans as-built LOTBs and previous geotechnical engineering investigation reports for the structures within the Project site and in close proximity were reviewed. In general, the subsurface profiles encountered in the previous borings are mostly composed of younger alluvium clayey and silty materials interbedded with granular soils, which are, in general, consistent with the geologic materials shown in the Geologic Map of the site. Tables 7.1 presents general description of the subsurface soil conditions as shown in the as-built LOTBs. The as-built LOTBs are contained in Appendix B.

TABLE 7.1 - SUMMARY OF AS-BUILT SUBSURFACE SOIL CONDITIONS

Structure and Year of Field Exploration	Boring No. and Approx. Ground Surface Elev.[1] (ft)	Subsurface Soil Conditions[2] (Summarized from the As-built Boring Logs)
Mathilda Avenue OC, Br. No. 37-0177 (1957)	B-1, 34.4 B-2, 34.0 B-3, 33.4 B-4, 33.5 B-5, 34.3	Borings B-1 and B-2 were drilled to depths of approximately 100 and 115 feet below ground surface (bgs). The borings encountered predominately medium stiff to stiff silty and clayey soils with isolated medium dense sand and gravel. B-3, B-4, and B-5 were cone penetration borings advanced using a No. 2 McKiernan-Terry air hammer. The soil description is not available.

Structure and Year of Field Exploration	Boring No. and Approx. Ground Surface Elev.[1] (ft)	Subsurface Soil Conditions[2] (Summarized from the As-built Boring Logs)
Route 237/101 Separation, Br. No. 37-0178 (1957)	B-1, 38.3 B-2, 40.5 B-3, 40.3 B-4, 35.2 B-5, 36.4 B-6, 38.7 B-7, 37.3	Borings B-1 and B-2 were drilled to approximately 100 feet deep bgs and encountered predominately interbedded silty sand, poorly-graded sand, poorly-graded grave, silty clay, clayey silt, and sandy silt. The apparent densities of granular soils vary mostly from medium dense to very dense. The consistencies of the silty and clayey soils vary mostly from medium stiff to very stiff. Borings B-3 through B-7 were cone penetration borings advanced using a No. 2 McKiernan-Terry air hammer. The soil description is not available.
North Mathilda Avenue UC, Br. No. 37-0179 (1957)	B-1, 25.4 B-2, 24.3 B-3, 25.8 B-4, 24.3 B-5, 24.1 B-6, 24.4 B-7, 24.8 B-8, 24.8	Borings B-3 and B-6 encountered mostly silt, clayey silt, sandy silt and silty clay, interbedded with silty sand, poorly-graded sand and poorly-graded gravel to the maximum depths drilled, approximately 110 and 120 feet. The consistencies of the silty and clayey soils vary mostly from soft (between about 15 to 25 feet deep) to very stiff. The apparent densities of sandy soils are mostly medium dense and dense. The rest of the borings were cone penetration borings advanced using a No. 2 McKiernan-Terry air hammer. The soil description is not available.
South Borregas Avenue POC, Br. No. 37-0663 (2005)	B-5, 31.1 B-6, 30.5 B-7, 31.1 B-8, 30.5	Four borings were drilled to depths from approximately 64 to 103 feet bgs. The borings encountered about 3 to 4 feet of fill underlain by primarily clayey soils with isolated layers of clayey sand, poorly-graded sand with silt, poorly-graded sand with clay, well-graded sand with silt and gravel, and silty sand with gravel. The consistencies of the clayey soils vary from medium stiff to hard with consistency increasing with depth. The sandy soils are generally medium dense and dense. Fat clay about 4 to 10 feet thick was encountered below the fill in Borings B-6, B-7 and B-8, and also at deeper elevation in Boring B-6.
North Borregas Avenue POC, Br. No. 37-0664 (2005)	B-1, 17.4 B-2, 15.7 B-3, 18.7 B-4, 19.7	Four borings were drilled to depths from approximately 62 to 103.5 feet bgs. The borings encountered predominately clayey soils with isolated layers of well-graded sand with silt and gravel, silty sand with gravel, silty sand, and clayey sand. The consistencies of the clayey soils vary from medium stiff to hard with consistency increasing with depth. The sandy soils are generally medium dense and dense. Fill of 3.5 to 5 feet thick was encountered in the top in Borings B-2 and B-3. Fat clay about 5 feet thick was encountered below the fill in Boring B-3, and also encountered at deeper locations in Borings B-2 and B-3.

1. Elevations are assumed to be based on NGVD29 datum for 1957 LOTBs and NAVD88 datum for 2005 LOTBs.
2. The summaries generally follow the soil classification and description shown on the as-built LOTBs.

Subsurface Soil Conditions of Recent Borings

The subsurface profile encountered in the 2017 exploratory borings consisted of mostly clayey soils with isolated layers of sandy materials (<= 5 feet thick), except Boring R-17-015 in which about 9 feet thick of saturated, very loose to loose sand layer was encountered at depths from 13 to 22 feet. The consistencies of the clay mostly vary from soft to very stiff, and the apparent densities of the sand vary mostly from loose to medium dense. The findings revealed in the recent soil borings are in general consistent with the as-built LOTB information.

The LOTBs presented in Appendix B 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 logs. The abrupt stratum changes shown on these logs may be gradual and relatively minor changes in soil types within a stratum may not be noted on the logs due to field limitations.

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. Variations in subsurface soil conditions, if encountered, generally require additional geotechnical investigation to further evaluate subsurface soil conditions. Supplemental funds should be included in the Engineers Cost Estimate to accommodate any additional geotechnical investigation that may be required during construction.

7.3 Water

7.3.1 Surface Water

The grade at the Project site gently slopes down toward the north. The surface water/drainage generally follows the ground topography and is collected in the local storm drainage system.

7.3.1.1 Scour

No open water course is located within the Project limits.

7.3.1.2 Erosion

Erosion is an action of surface processes such as water, wind, or gravity that remove particles of soil or rock from one location to another location. The rate of soil erosion from rain and storm water is a function of the slope, vegetative cover, and soil properties. Based on the Soil Map of Santa Clara County from the Web Soil Survey of USDA (2016), the entire Project area is underlain by soils with a map unit named "Urbanland-Hangerone complex (map unit symbol: 145)."

The potential hazard of soil loss from unpaved roads and trails is based on soil erodibility factor K, slope, and content of rock fragments. The hazard is described as "slight," "moderate," or "severe." A rating of "slight" indicates that little or no erosion is likely; "moderate" indicates that some erosion is likely, that the roads or trails may require occasional maintenance, and that simple erosion-control measures are needed; and "severe" indicates that significant erosion is expected, that the roads or trails require frequent maintenance, and that costly erosion-control measures are needed. It should be noted that, for areas previously experienced grading, construction, excavation or fill, the erodibility is expected to have been changed significantly. Generally, for paved roads and trails, erosion hazard may be considered slight. For unpaved areas, the erosion hazard may be considered moderate or severe.

Baseline Environmental Consulting (BASELINE, 2015), in a Preliminary Geological Assessment report for the Project, states that soils with erodibility factors between about 0.25 and 0.4 are moderately susceptible to water erosion and K factors greater than 0.4 are highly susceptible to water erosion. The mapped soil "Urbanland-Hangerone complex" at the Project site has a soil erodibility factor (k) of about 0.37 (BASELINE, 2015), indicating moderate susceptibility to water erosion.

The existing embankment slopes have established landscaping to help control erosion. It is recommended that construction of the proposed Project be undertaken during the dry season or winterization measures be implemented. Newly graded slopes should be treated with erosion control measures. Uncontrolled runoff could wash away soils, block the storm drains, and damage the stability of embankments, pavement, and structure foundations.

Best management practices (BMP) such as temporary silt fence, temporary ESA fence, fiber rolls, temporary soil stabilizer, temporary erosion control, temporary construction entrances/exits, temporary construction road, temporary concrete washouts, temporary stockpile covers, and temporary drain inlet protection may be used on this Project. The existing vegetated surfaces will be preserved or re-landscaped with plants, soils, mulch or blankets. Implementation of surface drainage and slope treatment is important and should be incorporated in the Project plans. Landscaping should be planned to protect any new slopes and should be in accordance with "Erosion Control" of the Caltrans Standard Specifications and Caltrans Best Management Practices.

7.3.2 Groundwater

Groundwater was encountered at depths approximately from 8.5 to 13 feet deep (Elev. 10 to 25 feet) in 8 relatively deep borings during drilling (2017). The as-built LOTBs show that the groundwater level varied from approximately 8 to 18 feet deep (elevations from approximately 11 to 25 feet) during previous drilling. It appears that the groundwater encountered in the recent and previous borings are in general consistent with each other. Groundwater may vary with passage of time due to seasonal groundwater level fluctuation, surface and subsurface flows, ground surface run-off, and other factors that may not be present at the time of investigation. The groundwater levels encountered in the previous and recent borings are presented in Tables 7.2 and 7.3, respectively.

TABLE 7.2 - SUMMARY OF PREVIOUS GROUNDWATER LEVEL (as-built LOTBs)

Structure and Year of Field Exploration	Boring No. and Approx. Ground Surface Elev.[1] (ft)	Approx. Groundwater Depth (ft)	Approx. Groundwater Elev.[1] (ft)
Mathilda Avenue OC, Br. No. 37-0177 (1957)	B-3, 33.4	18.2	15.2
Route 237/101 Separation, Br. No. 37-0178 (1957)	B-4, 35.2 B-6, 38.7	10.0 18.0	25.2 20.7

Structure and Year of Field Exploration	Boring No. and Approx. Ground Surface Elev.[1] (ft)	Approx. Groundwater Depth (ft)	Approx. Groundwater Elev.[1] (ft)
North Mathilda Avenue UC, Br. No. 37-0179 (1957)	B-1, 25.4 B-4, 24.3 B-5, 24.1 B-7, 24.8	13.0 12.9 13.0 13.3	12.4 11.4 11.1 11.5
South Borregas Avenue POC, Br. No. 37-0663 (2005)	B-8, 30.5	8.0	22.5

1. Elevations are assumed to be based on NGVD29 datum for 1957 LOTBs and NAVD88 datum for 2005 LOTBs.

TABLE 7.3 - SUMMARY OF RECENT GROUNDWATER LEVEL (2017)

Boring No.	Approx. Ground Surface Elev.[1] (ft)	Approx. Groundwater Depth (ft)	Approx. Groundwater Elev.[1] (ft)	Date of Measurement
R-17-003	31	8.5	22.5	4/6/2017
R-17-006	20	10	10	3/28/2017
R-17-009	30	11	19	3/27/2017
R-17-010	35	12	23	3/27/2017
R-17-011	38	13	25	4/4/2017
R-17-013	31	12	19	3/28/2017
R-17-014	32	9	23	4/6/2017
R-17-015	31	8.5	22.5	4/6/2017

1. Elevations are assumed to be based on NAVD88 datum.

Groundwater elevation could significantly vary in the event of a ‘normal’ rainfall period or following an El Nino event. Also groundwater may take time to recharge or react to such changes and therefore seasonal fluctuations or the extreme conditions as noted above may or may not affect the groundwater immediately following such event. Therefore, it is all the more important to not rely on such transient measurements of groundwater level for the design and construction of any underground improvements. Instead, it is recommended to make conservative assumptions in establishing groundwater depths for design and construction of this Project.

7.4 Project Site Seismicity

7.4.1 Ground Motions

The Project site is located in a seismically active part of northern California. Many faults exist in the region. These faults are capable of producing earthquakes and may cause strong ground shaking at the site. The Caltrans Fault Database (V2b, 2012) and Acceleration Response Spectrum (ARS) Online (V2, 2012) contain known active faults (if there is evidence of surface displacement in the past 700,000 years) in the State. Table 7.4 summarizes active faults in the close vicinity of the Project site with use of the Caltrans ARS Online (V2, 2012) and with the middle of Mathilda Avenue as a reference point. The maximum moment magnitudes represent the largest earthquake that a fault is capable of generating and is related to the seismic moment. The attached Caltrans ARS Online Map, Plate No. 5, shows the location of the fault system relative to the Project site.

TABLE 7.4 - CALTRANS ARS ONLINE DATA

Fault Name	Fault ID	Max. Moment Magnitude (M_{max})	Fault Type	Approx. Distance R_{rup}/R_x (miles)
San Andreas (Peninsula) 2011 CFM	134	8.0	SS	9.68/9.68
Silver Creek	148	6.9	SS	4.56/4.56
Hayward (Southern extension)	149	6.7	SS	8.16/8.16
Cascade fault	153	6.7	R	3.94/3.94
Monte Vista-Shannon	154	6.4	R	5.35/5.34

R_{rup} = Closest distance to fault rupture plane
R_x = Horizontal distance to the fault trace or surface projection of the top of rupture plane
SS = Strike-slip fault
R = Reverse fault

7.4.2 Ground Rupture

The Project site is not within the State designated Alquist-Priolo Earthquake Fault Zones. Based on the Caltrans ARS Online report (V2, 2012), no mapped evidence of active or potentially active faulting was found for the site. The closest fault is Cascade fault that lies at approximately 3.94 miles southwest of the Project site. Therefore, the potential for surface fault rupture at the Project site appears to be low. The impact of the earthquake is considered to be minimal with regard to the roadway widening project. Roadway maintenance should be expected if pavement distress or damage occurred after seismic events.

8.0 GEOTECHNICAL ANALYSIS AND DESIGN

8.1 Dynamic Analysis

8.1.1 Parameter Selection

No major structures are proposed for this Project. A design acceleration response spectrum (ARS) for structures is not required for roadway widening. However, the Caltrans ARS online tool (2012) was used to estimate the peak ground acceleration (PGA). Based on the soil boring data, an average shear wave velocity for the upper 100 feet of soils (V_{30}) at the Project site was estimated to be 200 m/s according to the guidelines presented in Caltrans Methodology for Developing Design Response Spectrum for Use in Seismic Design Recommendations (2012). The PGA at the Project site was estimated to be approximately 0.58g. The estimated earthquake magnitude at zero period is 6.6. The above seismic parameters represent a hazardous level of 5 percent in 50 years probability of exceedance (or 975 year return period). Caltrans standard plans for retaining walls and bridge standard detail sheets ("XS" sheets) for a sound wall supported on retaining wall are applicable to sites with a ground peak acceleration of 0.6g and less. The Caltrans bridge standard detail sheets are applicable for a sound wall supported on retaining wall for this Project.

8.1.2 Analysis

Modification of the northbound and southbound US 101 ramps to Mathilda Avenue requires new embankment fill up to 10 feet in height. Global slope stabilities were analyzed using the Slope/W V8 program by Geo-Slope International (2007) with Spencer method. The Spencer method satisfies both moment and force equilibriums. The embankment slopes with drained (static) and undrained (pseudo-static) soil conditions were evaluated based on the subsurface profiles encountered in Borings R-17-003 and R-17-011 drilled in the embankment fill areas. Per Caltrans Guidelines for Structure Foundation Reports (2009), a seismic factor equal to one third of the horizontal peak acceleration and not exceeding 0.2g shall be used for pseudo-static slope stability analysis. The site with a pseudo-static factor of safety equal to or greater than 1.1 shall be considered to have adequate stability. A seismic coefficient of 0.2g, equal to 1/3 PGA (PGA=0.58g at the Project site), was adopted for the pseudo-static slope stability analysis. The analysis produced factors of safety greater than 1.5 under both static and pseudo-static conditions, which suggests that the embankment slope stability would be acceptable during the service and seismic events. The computer printouts of the slope stability analysis are attached in Appendix D.

8.1.3 Liquefaction Potential

Liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. Submerged cohesionless sands and silts of low relative density are the type of soils, which usually are susceptible to liquefaction. The susceptibility increases with decreasing relative density (reflected by the number of blows to drive a sampler), and decreasing fines contents. According to the AASHTO Bridge Design Specifications (BDS, 2012), sandy or silty soils with corrected SPT blow counts equal to or less than 25 is susceptible to liquefaction. Clays are generally not susceptible to liquefaction.

The liquefaction potential for the Project was evaluated on relatively deep soil borings (25.5 to 41.5 feet deep) according to the procedure proposed by Youd, et al. (2001). The sandy soils encountered in Borings R-17-003 (approximately from 13 to 18 feet deep), R-17-013 (approximately from 22.5 to 25.5 feet deep), and R-17-015 (approximately from 13 to 22 feet deep) appear to be potentially liquefiable. The estimated post-liquefaction settlement is about 1 to 3 inches within the boring depths drilled. Potentially liquefiable soils were generally not encountered in other borings drilled for the Project. The liquefaction analysis results are provided in Appendix D.

The Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California (Witter et al., 2006), were referred to in evaluation of the liquefaction potential at the Project site. According to these maps, the liquefaction susceptibility is classified as “high” for the Latest Holocene alluvial fan deposits and “very high” for the Modern stream channel deposit. The liquefaction susceptibility is classified as “very low” to “low” for the Early Quaternary deposits and Late Pleistocene deposits, and “moderate” for the Late Pleistocene deposits and Holocene deposits. It appears that the Project site is situated in a zone having moderate liquefaction susceptibility. A Liquefaction Susceptibility Map, part of the publication pertinent to the site, is attached on Plate No. 6.

In our opinion, liquefaction potential exists only at isolated locations at the Project site. Since no major structures are planned for this Project (except a sound wall replacement and two overhead sign structures), localized post-liquefaction settlement should have minor impact to the Project. For a roadway widening project, there is no need to implement a mitigation program and the aerial type of settlement can be repaired in a routine maintenance program, if necessary. The soil liquefaction impact on the sound wall and overhead sign structures should be minor. The sound wall and overhead sigh structures can be repaired if damaged during a seismic event.

8.2 Cut and Excavation

No major unsupported cuts and excavations are planned for the Project.

8.2.1 Stability

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

8.2.2 Rippability

The proposed excavations are anticipated to be in native soils or roadway fills. Rippability does not appear to be a concern for construction.

8.2.3 Grading Factor

Fills may be imported from outside borrow sources. The source of borrow is unknown at the time of report preparation. Usually, the volume of imported borrow will shrink after compaction at the job site. Based on previous experience, for preliminary estimate, a grading factor of 0.9 may be assumed for import materials. The on-site materials, if tested to meet the criteria of imported borrow, can be treated as imported borrow.

8.3 Embankments

The proposed US 101 off-ramp modification requires embankment fill not exceeding 10 feet high. Borings R-17-003 and R-17-011 were drilled at the northeast and southwest quadrants of the Mathilda Avenue and US 101 intersection, respectively, where the embankment fill is required. Boring R-17-015 was also drilled close to the new fill area northeast of the Mathilda Avenue and US 101 intersection. Settlement due to the new fill is estimated to be about 2 to 3 inches in the upper about 25.5 to 36.5 feet thick of soils (maximum depths drilled). Most settlement is in the over-consolidation range and should occur during fill placement. Less than about 0.5 inches of settlement is in the normally-consolidated range and should occur after the fill placement is completed, which is considered to be tolerable to roadway pavement and structures. The impact of fill settlement on the embankment should be insignificant. The settlement estimation as well as the time required for normal consolidation stabilization of soils are contained in Appendix D.

The Caltrans Highway Design Manual (HDM 2015), Topic 304 “Side Slope”, provides information regarding the embankment slope gradient. In our opinion, the fill slopes should not be steeper than 2H:1V. Slopes up to 1.5H:1V may be workable if they are protected by asphalt or concrete paving. It should be noted that local irregularities such as loose layers and pockets and seepage might require flatter slopes. Proper drainage and erosion control measures are important to maintain the overall stability of the slopes. Regular slope maintenance is important and should be planned. Landscaping should be planned to protect the new slopes.

The embankment fill should be placed in accordance with the guidelines provided in the Caltrans Standard Specifications and Highway Design Manual. Fills to be placed on existing slopes should be keyed and benched into the slope. For the fill to be placed on existing slopes (not behind a retaining wall), it is recommended that the fill to be placed on the slopes be over-built and cut back to the proposed grade to improve compaction of the slope face. Appropriate drainage should be provided for the embankments.

8.4 Earth Retaining System

The originally proposed retaining wall northwest of the Mathilda Avenue and US 101 intersection is eliminated and instead, a standard concrete barrier Type 60C is proposed with grading behind the barrier. Refer to Caltrans standard plan A76A (2015) for subgrade preparation underneath the barrier. A portion of existing sound wall replacement will be supported on retaining walls, which is discussed in a separate foundation report.

8.5 Culverts

8.5.1 Corrosion Investigation

Uncoated subsurface steel and concrete structures are susceptible to corrosion based on the moisture content, texture, acidity, electrical conductivity, and sulfate and sodium content of the soil. The corrosion investigation was performed on selected soil samples in general accordance with the provisions of California Test Methods 643, 417 and 422. Table 8.1 presents a summary of the corrosion test results.

TABLE 8.1 - CORROSION TEST RESULTS

Boring No.	Depth (ft)	pH	Minimum Resistivity (ohms-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
R-17-006	6	7.80	1,980	135.6	80.5
R-17-009	11	7.69	1,260	9.8	45.5
R-17-013	3	7.33	860	3.3	10.1

Boring No.	Depth (ft)	pH	Minimum Resistivity (ohms-cm)	Chloride Content (ppm)	Sulfate Content (ppm)
R-17-014	10	7.59	1,500	11.4	52.3

Caltrans defines a corrosive area in terms of the resistivity, pH, and soluble salt content of the soil and/or water. For structural elements, the Caltrans Corrosion Guidelines (2015) considers a site to be corrosive for foundation if one or more of the following conditions exist for the representative soil samples taken at the site:

- Chloride concentration is greater than or equal to 500 ppm
- Sulfate concentration is greater than or equal to 2,000 ppm
- pH is 5.5 or less

Based on the test results, the on-site subsurface materials are considered non-corrosive. The guidelines presented in the California Amendments to the AASHTO BDS (2012), Section 5.12.3, for the minimum cement factor and cover thickness may be used for the substructures.

8.5.2 Culverts

For selection of pipe material for culvert and storm drain applications, it is our understanding that the AltPipe computer program is used by Caltrans to assist designers. The AltPipe program is a web-based tool (*http://dap1.dot.ca.gov/design/altpipev7/*). The computations performed by AltPipe are based on the procedures and California Test Methods described in Chapter 850 of the Caltrans HDM (2015). The AltPipe program is intended for use during the final design. In addition to soil corrosivity data, required input data includes abrasion level, 2 to 5 year storm flow velocity, and height of cover, which should be determined while finalizing the drainage design. The AltPipe analysis results are provided in Appendix G.

8.6 Minor Structure Foundations

8.6.1 Overhead Sign Structures

Two single post type overhead sign structures are proposed. The sign structures will be supported on CIDH concrete piles using Caltrans standard plans. The information of sign structures and foundation recommendations are presented in Table 8.2. The CIDH concrete piles for overhead sign structures are subject to vertical loads, lateral loads, bending moments, and torsion moments. Analysis was performed for behavior of the piles based on the loads provided by the Design Team (Table 8.3) and subsurface soil conditions. The calculations show that the pile capacities developed from the friction resistance are adequate for vertical and torsional load demands.

TABLE 8.2 - SIGN STRUCTURE FOUNDATION RECOMMENDATIONS

Sign Structure	Approximate Location	Post Type	Pile Dia. (in)	Pile Cut-off Elev. (ft)	Pile Depth (ft)	Reference Standard Plans	Reference Soil Boring
OS2-2 (Lightweight OH Sign)	75.27 Rt “M1” 48+50	NPS 14 “t” = ¾”	36	31.0	16	S48, S49	R-17-003 R-17-010
OS4-1 (Lightweight OH Sign)	43.96 Lt “M1” 70+31	NPS 14 “t” = ¾”	36	18.5	16	S48, S49	R-17-006

TABLE 8.3 – LOADS AT TOP OF PILE

	Load	OS2-2 OS4-1
DL only	Vertical (kips)	5.9
	Moment (k-ft)	31.0
DL + LL	Vertical (kips)	--
	Moment (k-ft)	--
DL + Wind	Vertical (kips)	5.9
	Shear (kips)	3.9
	Torsional Moment (k-ft)	46.4

	Load	OS2-2 OS4-1
	Resultant Moment (k-ft)	77.0

The lateral pile capacity was analyzed using the LPILE V6.0 computer program. The geotechnical soil parameters in Tables 8.4, and 8.5 were adopted for the LPILE analysis. Both *p*-multiplier and *y*-multiplier were taken as 1.0. The LPILE analysis results show that the top pile deflections are less than 0.25 inches that are considered acceptable. The subsurface conditions were thus adequate for the use of Caltrans standard foundation for the two sign structures. The pile capacity calculations and LPILE analysis computer printouts for the two sign structures are included in Appendix D.

TABLE 8.4 – LPILE PARAMETERS FOR OS2-2 (Boring R-17-003)

Approx. Elevation (ft)	Generalized Soil Profile	LPILE Soil Type	Soil Strength	K (pci)	E_{50} (in/in)	Effective Unit Wt. (pcf)
31 to 23	Lean Clay	Stiff Clay w/o Free Water (Reese)	C = 1,400 psf	N/A	Default	125
23 to 18	Lean Clay	Soft Clay (Matlock)	C = 500 psf	N/A	Default	62
18 to 13	Silty Sand	Sand (Reese)	$\phi = 28°$	Default	N/A	62
13 to 0.5	Lean Clay	Mod. Stiff Clay w/o Free Water	C = 700 psf	N/A	Default	62

TABLE 8.5 – LPILE PARAMETERS FOR OS4-1 (Boring R-17-006)

Approx. Elevation (ft)	Generalized Soil Profile	LPILE Soil Type	Soil Strength	K (pci)	E_{50} (in/in)	Effective Unit Wt. (pcf)
20 to 12	Lean Clay	Stiff Clay w/o Free Water (Reese)	C = 1,500 psf	N/A	Default	125
12 to 2	Lean Clay	Stiff Clay w/o Free Water (Reese)	C = 1,500 psf	N/A	Default	62
2 to -4	Lean Clay	Mod. Stiff Clay w/o Free Water	C = 700 psf	N/A	Default	62

Approx. Elevation (ft)	Generalized Soil Profile	LPILE Soil Type	Soil Strength	K (pci)	E_{50} (in/in)	Effective Unit Wt. (pcf)
-4 to -11.5	Lean Clay	Mod. Stiff Clay w/o Free Water	C = 850 psf	N/A	Default	62

8.6.2 Sound Wall

A portion of existing sound wall would be replaced with a sound wall supported on retaining wall (Type 5SWB), retaining wall (Type 7SW), or concrete barrier (Type 736SV on cast-in-drilled-hole (CIDH) concrete piles) to accommodate realignment and widening of the northbound US 101 off-ramp to Mathilda Avenue. Caltrans bridge standard detail sheets will be used for special design of the sound wall. The design of sound wall is discussed in a foundation report under a separate cover.

8.6.3 CIDH Piling

Refer to Section 12.7 for construction of CIDH concrete piles. Entering into CIDH holes for excavation or inspection is not anticipated for this Project. The overhead sign structure locations can be classified as “potentially gassy” according to Tunnel Safety Orders specified in Section 110.12 of the Caltrans HDM (2015). It is advisable that proper Cal-OSHA or other regulating procedures be followed for notice of the classification and any special orders, rules, special conditions, or regulation to be used at the job site.

8.6.4 Other Minor Structures

Other minor structures for this Project may include traffic signal and lighting systems and minor drainage structures. The foundation design of these minor structures should be according to Caltrans or City standard plans. No geotechnical investigation is required.

9.0 STRUCTURAL PAVEMENT

9.1 Laboratory Tests on Subgrade Material

The bulk soil samples collected along Mathilda Avenue at the pavement subgrade level were screened in the laboratory, and three representative samples were tested for R-values. The tests result in R-values of 14 (B-2), 18 (B-6) and 28 (B-8). The subgrade soils appear to be mostly lean to fat clayey materials with moderately to highly expansive potential. In consideration of subgrade soil variation and uncertainty, an R-value of 10 is recommended for pavement design.

9.2 Recommended Structural Pavement Sections

Design Designation

In accordance with Caltrans HDM (2015) Topic 103, US 101 at the proposed northbound deceleration lane to the new Mathilda Avenue off-ramp has the following design designation:

ADT (2020) = 80,650 (one way)
ADT (2040) = 87,200 (one way)
DHV = 16,180 (2040)
ESAL = 14,279,060 (20 year)
D=50%
T=3.9%
V=70mph
TI_{20} = 12.5

Climate Region = Central Coast

It is our understanding that flexible pavement sections with HMA surface will be used for this Project. According to the Caltrans HDM (2015), the top portion of HMA surface layer (maximum 0.20 feet) can be replaced with a same thickness of Rubberized HMA (gap-graded). An R-value of 10 is adopted for pavement design of the on-site soil. The pavement sections should be designed not only to satisfy the structural adequacy but also thick enough to overcome soil expansive pressure. Based on the expansion pressure test results during the R-value test (B-2), the minimum covering thickness should be 2.10 feet. The design includes a layer of subgrade enhancement geotextile (SEG) Class B1 between the subgrade and base or subbase rocks if the pavement sections are supported on the on-site soil. If pavement sections are supported on a minimum of 4 feet of imported fill with a minimum of R-value of 15, no SEG is required. Tables 9.1, 9.2 and 9.3 provide recommended new HMA pavement sections. The calculations of structural pavement sections are attached in Appendix D.

New Ramps

TABLE 9.1 - FLEXIBLE PAVEMENT SECTIONS (20 year design life)

<table>
<tr><th rowspan="3">Design Life (yr)</th><th rowspan="3">TI</th><th rowspan="3">Assumed R-value</th><th colspan="7">Structural Pavement Sections (ft)</th></tr>
<tr><th colspan="2">Option 1[1]</th><th colspan="2">Option 2[1]</th><th colspan="3">Option 3[1]</th></tr>
<tr><th>Full-Depth HMA[2]</th><th>AS[4]</th><th>HMA[2]</th><th>AB</th><th>HMA[2]</th><th>AB</th><th>AS</th></tr>
<tr><td rowspan="2">20</td><td rowspan="2">10</td><td>10 (on-site soil)</td><td>1.25</td><td>1.0</td><td>0.55</td><td>1.75</td><td>0.55</td><td>0.75</td><td>1.10</td></tr>
<tr><td>15 (import fill)[3]</td><td>1.20</td><td>--</td><td>0.55</td><td>1.60</td><td>0.55</td><td>0.75</td><td>0.90</td></tr>
</table>

HMA: Hot Mix Asphalt (Type A)
AB: Aggregate Base (Class 2) with R-value equal to 78
AS: Aggregate Subbase (Class 2) with R-value equal to 50

1. The design includes a layer of subgrade enhancement geotextile (Class B1) between subgrade and AB or AS if the pavement sections are supported on the on-site soil.
2. The top portion of HMA can be substituted by Rubberized Hot Mix Asphalt, Gap-graded (RHMA-G) to the maximum equal thickness of 0.20 feet if rubberized HMA is preferred.
3. The import fill underneath the design pavement sections must be a minimum of 4 feet thick.
4. The AS is required to overcome the expansive soil pressure and to facilitate construction.

NB 101 / Mathilda Ave. Off-Ramp Auxiliary Lane

TABLE 9.2 - FLEXIBLE PAVEMENT SECTIONS (20 year design life)

Design Life (yr)	TI	Assumed R-Value	Structural Pavement Sections (ft)						
			Option 1[1]		Option 2[1]		Option 3[1]		
			Full-Depth HMA[2]	AS[4]	HMA[2]	AB	HMA[2]	AB	AS
20	12.5	10 (on-site soil)	1.60	1.0	0.65	2.30	0.65	1.00	1.40
		15 (import fill)[3]	1.55	--	0.65	2.10	0.65	1.00	1.20

HMA: Hot Mix Asphalt (Type A)
AB: Aggregate Base (Class 2) with R-value equal to 78
AS: Aggregate Subbase (Class 2) with R-value equal to 50

1. The design includes a layer of subgrade enhancement geotextile (Class B1) between subgrade and AB or AS if the pavement sections are supported on the on-site soil.
2. The top portion of HMA can be substituted by Rubberized Hot Mix Asphalt, Gap-graded (RHMA-G) to the maximum equal thickness of 0.20 feet if rubberized HMA is preferred.
3. The import fill underneath the design pavement sections must be a minimum of 4 feet thick.
4. The AS is required to overcome the expansive soil pressure and to facilitate construction

Mathilda Avenue and Moffett Park Drive

TABLE 9.3 - FLEXIBLE PAVEMENT SECTIONS (20 year design life)

Design Life (yr)	TI	Assumed R-Value	Structural Pavement Sections (ft)						
			Option 1[1]		Option 2[1]		Option 3[1]		
			Full-Depth HMA[2]	AS[4]	HMA[2]	AB	HMA[2]	AB	AS
20	11.5	10 (on-site soil)	1.50	1.0	0.60	2.10	0.60	0.95	1.25
		15 (import fill)[3]	1.40	--	0.60	1.90	0.60	0.95	1.05

HMA: Hot Mix Asphalt (Type A)
AB: Aggregate Base (Class 2) with R-value equal to 78
AS: Aggregate Subbase (Class 2) with R-value equal to 50

1. The design includes a layer of subgrade enhancement geotextile (Class B1) between subgrade and AB or AS if the pavement sections are supported on the on-site soil.
2. The top portion of HMA can be substituted by Rubberized Hot Mix Asphalt, Gap-graded (RHMA-G) to the maximum equal thickness of 0.20 feet if rubberized HMA is preferred.
3. The import fill underneath the design pavement sections must be a minimum of 4 feet thick.
4. The AS is required to overcome the expansive soil pressure and to facilitate construction.

It is our understanding that at some locations, a deep lift section is desirable to accommodate staging, traffic control, and constructability. While at the other locations due to utility concerns the sections would need to be thinner. In addition, "Rapid Strength Concrete Base (RSCB) with final HMA lift is planned for sliver widening and narrow median areas. Based on our discussions with the VTA, City and Designer, additional pavement sections are provided in Table 9.4. Please note the recommendations in Table 9.4 are not regular design but to accommodate the construction needs.

TABLE 9.4 - ADDITIONAL PAVEMENT SECTIONS OPTIONS (CITY'S R/W)

Design Life (yr)	TI	Assumed R-Value	Structural Pavement Sections (ft)						
			Option 4	Option 5			Option 6		
			Full-Depth HMA	HMA	AB	SEG	HMA	RSCB	SEG
20	11.5	10 (on-site soil)	2.50	1.50	0.33	B1	0.60	1.25	B1

HMA: Hot Mix Asphalt (Type A)
AB: Aggregate Base (Class 2) with R-value equal to 78
RSCB: Rapid Strength Concrete Base
SEG: Subgrade Enhancement Geotextile Class B1

Subgrade pumping maybe encountered during earthwork construction depending on the weather, moisture condition of the subsurface soils, and surface drainage conditions. Equipment mobility may also be difficult if the subgrade is wet. In which case, the subgrade soils may require reworking, aeration, or over-excavation and replacing with SEG and AS (minimum 12 inches) to facilitate earthwork construction.

9.3 Existing Pavement Rehabilitation

The Project will rehabilitate Mathilda Avenue, as well as a portion of Moffett Park Drive (West) between Mathilda Avenue and Innovation Way. Some locations will need inlay and others overlay with paving fabric to maintain the existing grade. Any pavement rehabilitation under SR 237 would need inlay because of vertical clearance issues.

Engineering procedures for flexible pavement and roadway rehabilitation are discussed in the Caltrans HDM (2015) Topic 635. Rehabilitation strategies include overlay, mill and overlay, and remove and replace. If entire HMA surfacing and any portion of the base are to be removed, remove and replace should be conducted. Caltrans recommends that if the removal depth is more than 1 foot, the pavement sections be designed as new or reconstructed.

A pavement deflection test was conducted by PEI on December 27 and 28, 2016 to determine the existing pavement structural adequacy. The test was conducted in each through travel lane in accordance with California Test Method 356 with Dynaflect method. HMA surfacing thicknesses are calculated based on the deflection measurements and Traffic Index, and adjusted for reflective crack retardation and ride quality if necessary. The current overlay design procedure is for a 10 year period. Adjustment is needed for a 20-year service life, in which the new HMA layer is expected to be thicker (generally 125-130 percent more). Alternative HMA overlay materials such as RHMA-G may be used to reduce the overlay thickness required (with limitation). The existing failed section showing cracks and severe deterioration would require a total dig-out and replacement with a full depth section before an overlay is applied. In general, if repair work area exceeds about 40 to 50 percent of the total area it is not considered to be cost effective for overlay. The areas that require a total dig-out should be confirmed prior to construction. A deflection analysis report discussing pavement structural evaluation and rehabilitation recommendations is prepared by PEI under a separate cover. Please refer to the PEI report contained in Appendix F for rehabilitation options.

PARIKH previously performed visual evaluation on the existing pavement conditions at the Project site and summarized the observations in a geotechnical memorandum in January 2015. The PARIKH memorandum is provided in Appendix E for reference.

10.0 MATERIAL SOURCES

There are several commercial sources of asphalt, concrete, and aggregate products in the area. Table 10.1 lists some of available commercial suppliers in the area.

TABLE 10.1 - SOURCES OF IMPORTED BORROW

Source	Location	Approx. Haul Distance (one way, mile)
Granite Construction, Co.	3800 Bassett Street, Santa Clara, CA 95054	5
Graniterock	11711 Berryessa Road, San Jose, CA 95133	8.5
Reed & Graham, Inc.	690 Sunol Street, San Jose, CA 95126	11

11.0 MATERIAL DISPOSAL

It appears that majority of fill sections will require imported borrow materials. Surplus of cutting materials can generally be hauled away and disposed to regular disposal sites. Any material generated during construction that is considered unsuitable as roadway subgrade, backfill, or topsoil should be properly disposed of offsite. Prior to excavating, materials should be tested for contamination in accordance with the recommendations of the environmental report. Disposal of aerially deposited lead (ADL) and other contaminated material (if any) is beyond the scope of this report.

Refer to the Final Preliminary Site Investigation report prepared by BASELINE, dated May 2017 for any potential hazardous waste materials located within the Project limits (including disposal of ADL, lead paint materials, asbestos materials, etc.) and proposed measures for hazardous materials management and disposal.

12.0 CONSTRUCTION CONSIDERATIONS

12.1 Construction Advisories

These sections are written primarily for the engineer responsible for 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 this office primarily addresses design issues and was not planned specifically to identify construction issues.

The Project site is the existing city streets and highway ramps. Therefore, traffic control and construction staging is required to maintain traffic flow during construction. There are numerous utility lines at the site. The contractor should verify the utility lines, be aware of the existing conditions and plan the construction activities accordingly. It is possible that unknown old buried utilities or abandoned structures, concrete rubble, etc. are located at the site that require special equipment and additional efforts to remove them.

The borings encountered mostly clayey materials with sandy layers and roadway fill near the existing ground surface. In our opinion, conventional equipment maybe used to excavate the on-site subsurface materials. Localized subgrade pumping may be encountered during earthwork construction depending on the weather, subsurface moisture, and surface drainage conditions. Equipment mobility may also be difficult if the subgrade is wet. In such a case, the subgrade soils may require reworking, aeration, or over-excavation and replacing with dry granular fill to facilitate earthwork construction.

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 OSHA and other applicable municipal and State regulatory agencies.

12.2 Construction Consideration that Influence Specifications

All grading and compaction operations should be performed in accordance with the project specifications and the current Caltrans Standard Specifications. A geotechnical engineer or the Resident Engineer should observe all excavated areas during grading and perform moisture and density tests on prepared subgrade and compacted fill material.

Areas to receive fill should be clean of vegetation, shrubs, trees, and their roots. Zones of soft, organic or saturated soils could be encountered during site grading. Loose materials will be left after the removal of large trees. Where such conditions are encountered, deeper excavation may be required to expose firm soils. Deeper excavation may also be required in areas of demolition of existing structures.

Any fill materials imported to the Project site should be non-expansive, relatively granular material having a plasticity index of less than 15 and a minimum sand equivalent (SE) of 10. The maximum particle size of fill material should not be greater than 4 inches in largest dimension. It should also be non-corrosive, free of deleterious material and should be reviewed by the Geotechnical Engineer. In addition, imported fill within 4 feet of pavement subgrade should have a minimum R-value of 15.

The contractor should verify the existing utility line conditions, and these locations should not be used for stockpiling of borrow materials. Any utility conflicts with proposed construction should also be reviewed prior to construction. There may be excavations that are proposed near existing utility lines. Contractor should take precautions to protect the utilities from damage caused by such excavations.

12.3 Waiting Period

As discussed in Section 8.3, the proposed US 101 off-ramp modification requires embankment fill not exceeding 10 feet in height. Most settlement would occur during fill placement and less than about 0.5 inches of settlement would occur after the fill placement is completed in the normally consolidated range. Based on our previous experience with Caltrans projects, a standard waiting period of 30 days prior to foundation and pavement construction is recommended. The waiting period serves as a contingency for the estimated consolidation settlement within the over-consolidated range.

12.4 Working Platform

Soft and loose, saturated native soil deposits may be encountered at the bottom of excavation. In such case, working conditions at the bottom of excavation may become difficult; equipment used at the bottom of the excavation may lose mobility, etc. The contractor should take adequate measures to minimize the disturbance of the sensitive deposits at the excavation subgrade. The contractor may minimize the disturbance of sensitive deposits or mitigate existing soft ground conditions by constructing a working platform at the bottom of the excavation. The working platform may be installed by 1) over excavating about 2 feet below the planned subgrade; 2) placing a stabilizing subgrade enhancement geotextile at the bottom of the resulting excavation; 3) backfilling with 2-inch crushed rock, compacted AB, or other such approved bridging material. The contractor may use other methods of subgrade stabilization. The contractor's proposed method should be reviewed by the geotechnical engineer.

12.5 Construction Dewatering

Groundwater may rise up to above the footing excavation. Groundwater may cause instability of excavation walls and bottom (piping, erosion, blow-outs, etc.) and difficult working conditions. For excavation below the groundwater table, construction dewatering will be required. The contractor should evaluate the subsurface conditions before selecting a dewatering method, which may include shoring, sumps or tremie slabs. Groundwater should be lowered to at least 2 feet below the bottom of excavation to prevent wet soil condition. Designing dewatering system should be the contractor's responsibility. Design dewatering system should be the contractor's responsibility. The Caltrans Standard Specifications (2015), Section 19-3.03B(5), provides guidelines for water control and foundation treatment.

All dewatering systems should be properly designed to prevent pumping soil fines with the discharge water. The contractor should sample and test the groundwater for soil fines content from the discharge, as needed. If soil fines are pumped, the contractor should revise their dewatering operations. Otherwise, failure of shoring, partial instability of trench bottom resulting in intolerable ground settlement / movement of existing utilities and unsafe working conditions may occur. The contractor should provide discharge sampling locations for each pump. The contractor is encouraged to perform their own investigation, test program, etc. prior to construction in order to satisfy their design requirements for an effective dewatering program. Contractor should confirm the design groundwater level (for shoring) prior to actual construction.

12.6 Temporary Excavation and Shoring

Excavation will be required for installation of foundations. According to OSHA Safety Standards, temporary excavations with personnel working within the excavations should be sloped or shored if the excavations are deeper than 5 feet. All excavations for the Project should be made and supported in accordance with OSHA standards. For excavations up to 20 feet deep in homogenous soils, OSHA guidelines state that the maximum allowable slope should be 1H:1V for clayey soils and 1.5H:1V for sandy soils. It should be noted that the slope ratio recommended by OSHA is for temporary, unsurcharged slopes and properly dewatered conditions. Traffic and surcharge loads should be set back at least 15 feet from the top of the excavations unless they are accounted for in the design. Flatter trench slopes may be required if seepage is encountered during construction or if exposed soils conditions differ from those encountered by test borings. The excavation should be closely monitored during construction to detect any evidence of instability, soil creep, settlement, etc. Appropriate mitigation measures should be implemented to correct such situations that may cause or lead to future damage to facilities, utilities and other improvements.

A shoring system may be necessary for the excavation. The selection, design and performance of shoring system should be the responsibility of the contractor. The contractor should have the shoring system designed and signed by a registered civil engineer in California. The shoring system should be designed to be relatively rigid and with as many supports or struts as necessary to prevent excessive straining and deformation of the supported soils. Trench boxes/shields are not recommended since they are primarily for protection of workers from cave-ins and similar incidents and do not provide support to the excavations.

12.7 Construction of CIDH Concrete Piles

Caltrans standard specifications (2015) Section 49-3 "Cast-in-Place Concrete Piling" should be referred to for construction of CIDH concrete piles. The contractor should carefully examine the subsurface conditions and make their own interpretation and perform independent study on the constructability of the piles.

Due to presence of granular material and groundwater, raveling or caving is expected, which may require additional drilling and cleaning effort and may increase the concrete volume for the piles. The use of temporary steel casing and/or slurry displacement method should be anticipated at all times to maintain the integrity of the piles. It is prudent to make the contractor aware of these conditions so that they take appropriate steps to comply with the standards and maintain the integrity of the CIDH concrete piles. Mitigation and repair procedures for CIDH anomaly should be anticipated. All pile excavations should be observed by a geotechnical engineer prior to the placement of reinforcement and concrete so that if conditions differ from those anticipated, appropriate recommendations can be made.

Vertical inspection pipes for acceptance testing should be provided in all CIDH piles that are 24 inches in diameter or larger, except when the holes are dry or when the holes are dewatered without use of temporary casing to control groundwater. The acceptance test should include Gamma-Gamma Logging and may also include cross-hole sonic logging. Gamma-Gamma Logging should be performed in accordance with California Test Method 233 Standard (CT 233) to check the integrity of CIDH concrete piles. CT 233 defines pile rejection criteria based on the statistical principles of mean and three standard deviations to analyze the homogeneity of a pile. Anomalies detected should be evaluated by the Designer for their significance and potential impact on design and to see if mitigation plans are required. Details of the acceptance testing and Gamma-Gamma Logging are contained in Caltrans specifications and CT 233.

12.8 Construction Monitoring and Instrumentation

In general, the construction subject of monitoring and instrumentation was considered and was determined to be not significant for the Project. However, contractors may need to monitor their excavations that are in near proximity to existing utilities or other improvements.

12.9 Hazardous Waste Considerations

No hazardous waste was observed during the filed investigation. Refer to the Preliminary Site Investigation report (BASELINE, 2017) for any potential hazardous waste materials located within the project limits (including disposal of ADL, lead paint materials, asbestos materials, etc.) and proposed measures for hazardous materials management and disposal.

12.10 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 conditions only at the locations drilled. Because of the variability from place to place within soils in general, and the nature of geologic depositions, subsurface soil conditions could change between the explored 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.

13.0 RECOMMENDATIONS AND SPECIFICATIONS

13.1 Summary of Recommendations

If the Designer has questions or concerns regarding 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. These services may be provided under a separate authorization, as necessary. A concise summary of the geotechnical recommendations is presented below:

- Peak ground acceleration = 0.58g;
- Mean earthquake moment magnitude at zero period = 6.6;
- Soil boring data indicate that the subsurface soils consist of predominantly clayey soils with isolated sandy layers;
- Groundwater was encountered at depths of approximately from 8.5 to 13 feet (Elev. 10 to 25 feet) during drilling (2017);
- Soil liquefaction potential is considered to have minor impact on the Project;
- Caltrans standard plans can be used for design and construction of overhead sign structures;
- Normally consolidated settlement after the embankment fill placement is completed is about 0.5 inches that is considered to be tolerable; and
- The structural pavement sections for the Project include flexible pavement sections (Section 9).

13.2 Recommended Material Specifications

Unless otherwise stated, all materials specifications should conform to the Caltrans Standard Specifications (2015), including but not limited to the following: Earthwork, Structure Backfill, Pervious Backfill Material, Geotextile, Thermoplastic Pipes, Concrete, bond breaker, Hot Mix Asphalt, Aggregate Base, Aggregate Subbase, and Lean Concrete Base, etc.

14.0 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. An Initial Site Assessment report has been prepared by others.

Unanticipated soil conditions are commonly encountered and cannot be fully determined by taking soil samples and excavating test borings. Differing soil conditions may require that supplemental funds be made for the construction phase to perform additional investigation if required.

This report has been prepared for the proposed Project 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 ensure that the recommendations are implemented during construction.

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.

Respectfully submitted,
PARIKH CONSULTANTS, INC.

Peter

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Project Manager

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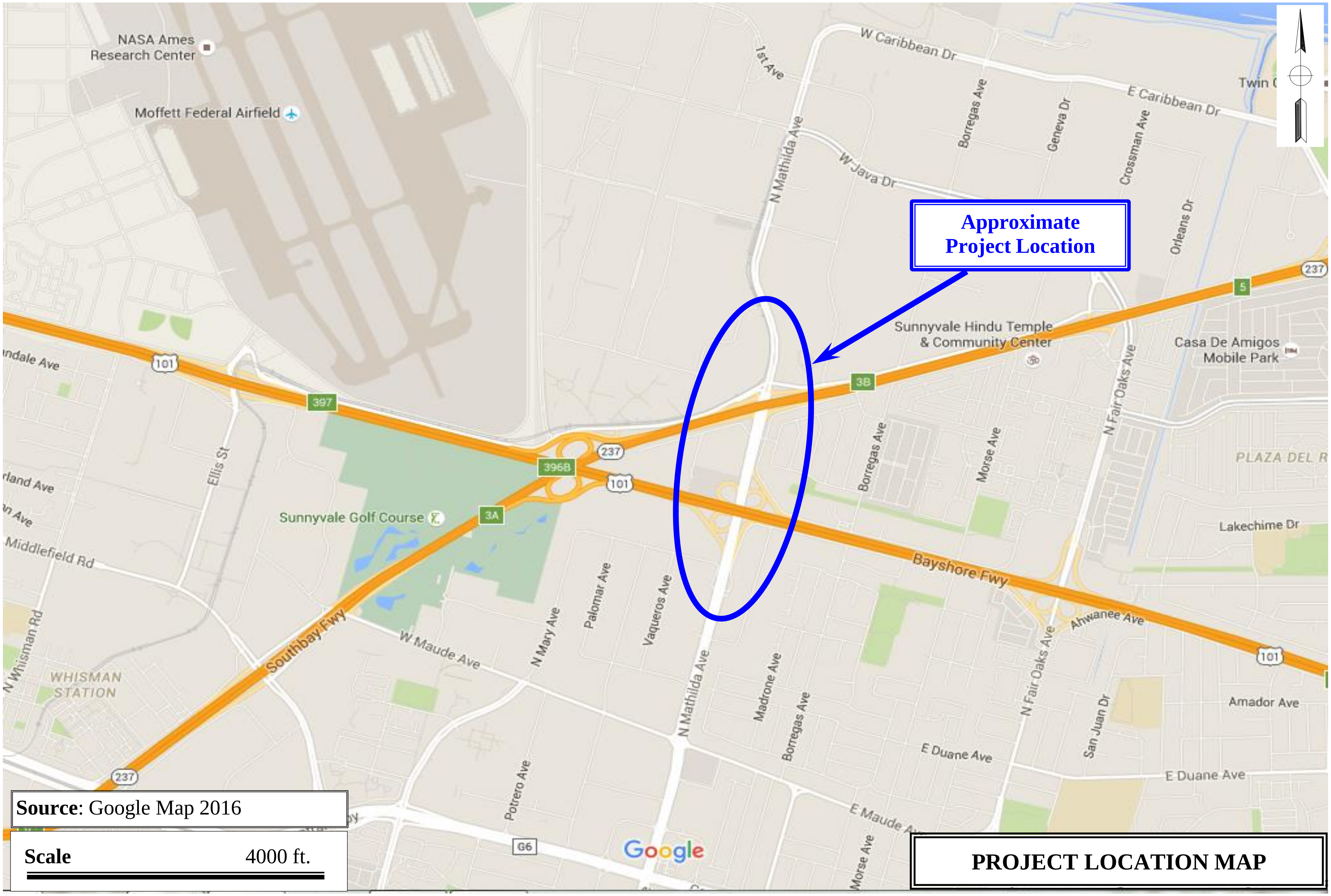

PARIKH Practicing in the Geosciences	MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 SUNNYVALE, CALIFORNIA	
	JOB NO.: 2014-129-PSE	PLATE NO.: 1

Source:
Web Soil Survey, Natural Resources Conservation Service, USDA
http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx
Santa Clara Area, California, Western Part

145
Urbanland-Hangerone complex, 0 to 2 percent slopes, drained

USDA SOIL MAP

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 **SUNNYVALE, CALIFORNIA**	
JOB NO.: 2014-129-PSE	**PLATE NO.: 2**

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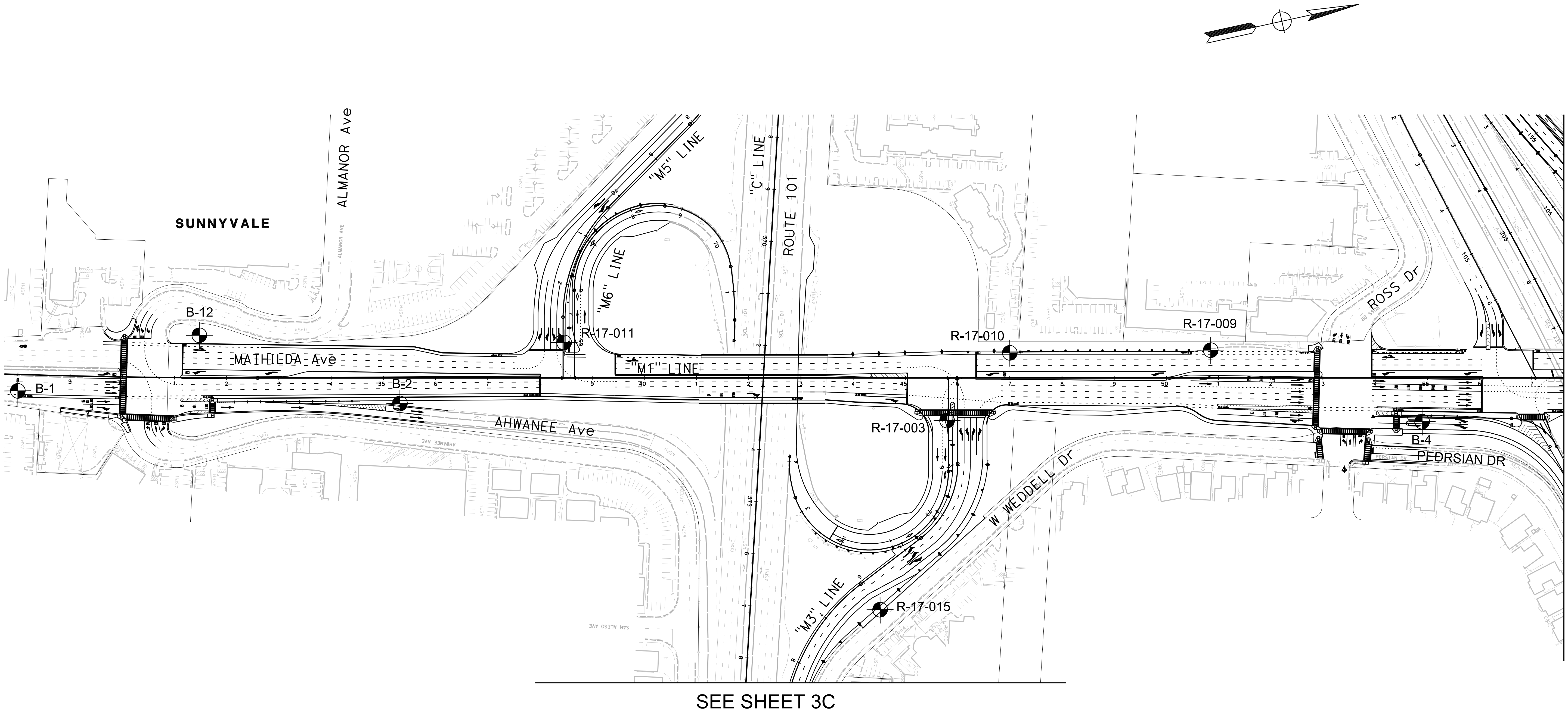

SITE PLAN

LEGEND

R-17-003

Approx. Boring Location Drilled By Parikh Consultants, Inc.

SCALE: 1 inch = 200 feet

Note: All units are in feet unless otherwise specified

Reference Map was provided by WMH Corporation , Inc.

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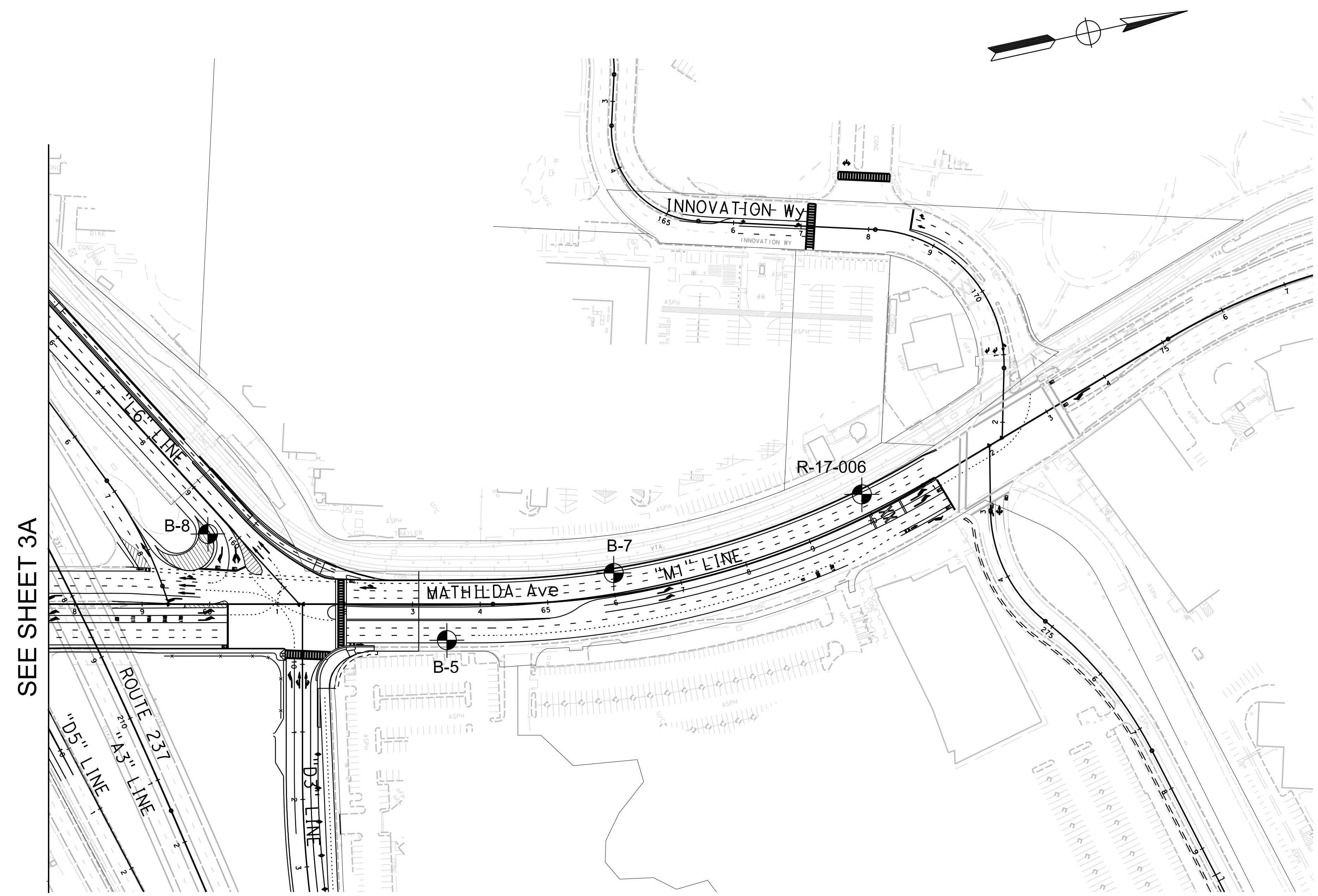
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101	
SUNNYVALE , CALIFORNIA	
PROJECT NO.: 2014-129-PSE	PLATE NO: 3A



SITE PLAN

LEGEND

R-17-006

Approx. Boring Location Drilled By Parikh Consultants, Inc.

SCALE: 1 inch = 200 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by WMH Corporation , Inc.

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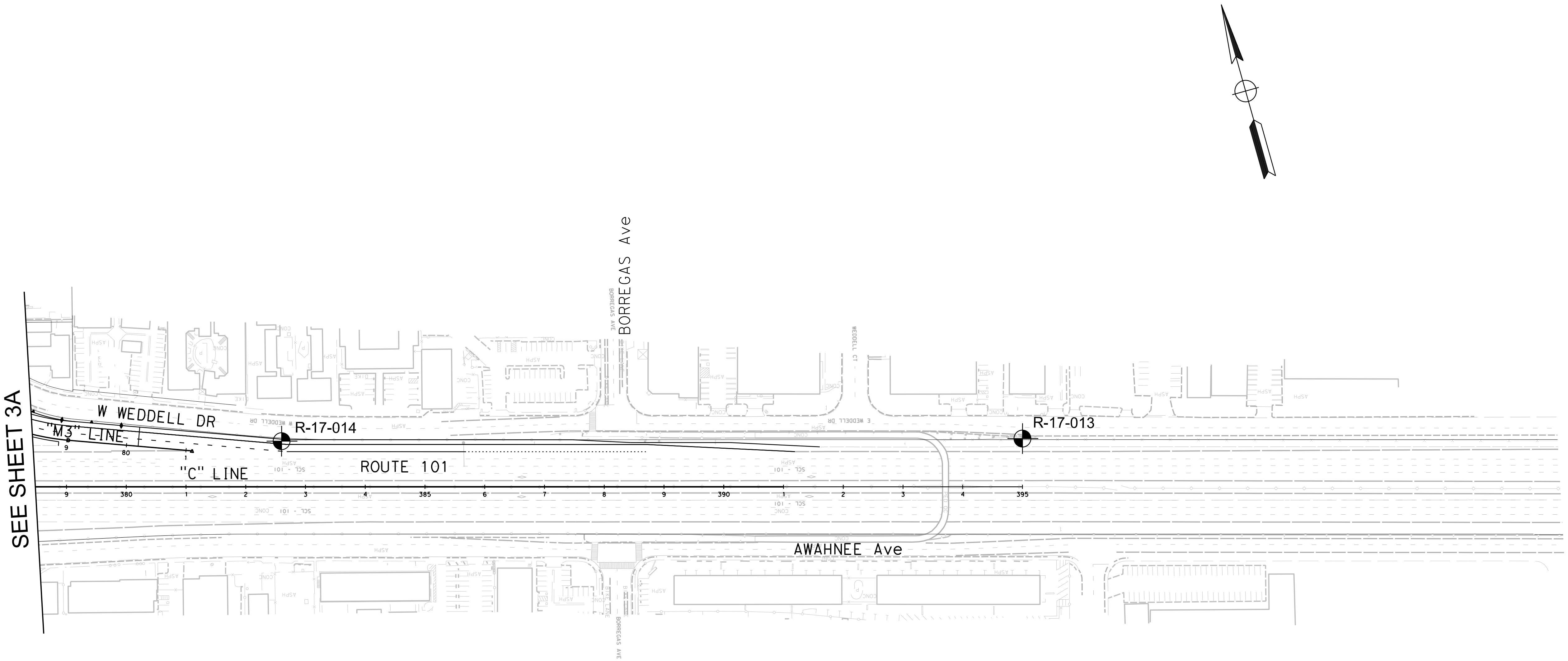
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

SUNNYVALE , CALIFORNIA

PROJECT NO.: 2014-129-PSE | PLATE NO: 3B



SITE PLAN

LEGEND

R-17-013
Approx. Boring Location Drilled By Parikh Consultants, Inc.

SCALE: 1 inch = 200 feet

Note: All units are in feet unless otherwise specified
Reference Map was provided by WMH Corporation , Inc.

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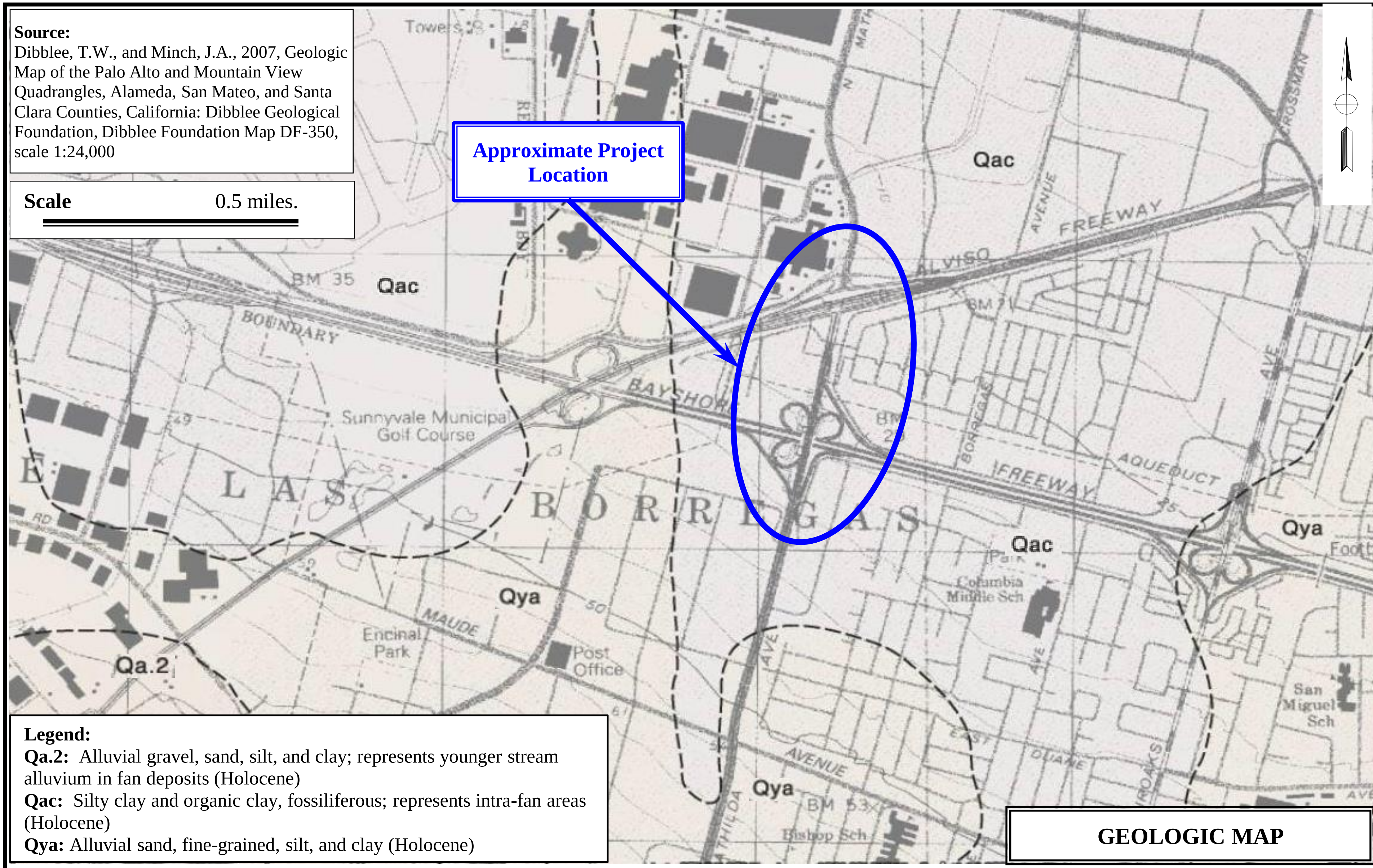
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

SUNNYVALE , CALIFORNIA

PROJECT NO.: 2014-129-PSE | PLATE NO: 3C

Source:
Dibblee, T.W., and Minch, J.A., 2007, Geologic Map of the Palo Alto and Mountain View Quadrangles, Alameda, San Mateo, and Santa Clara Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-350, scale 1:24,000

Scale 0.5 miles.



Legend:
Qa.2: Alluvial gravel, sand, silt, and clay; represents younger stream alluvium in fan deposits (Holocene)
Qac: Silty clay and organic clay, fossiliferous; represents intra-fan areas (Holocene)
Qya: Alluvial sand, fine-grained, silt, and clay (Holocene)

GEOLOGIC MAP

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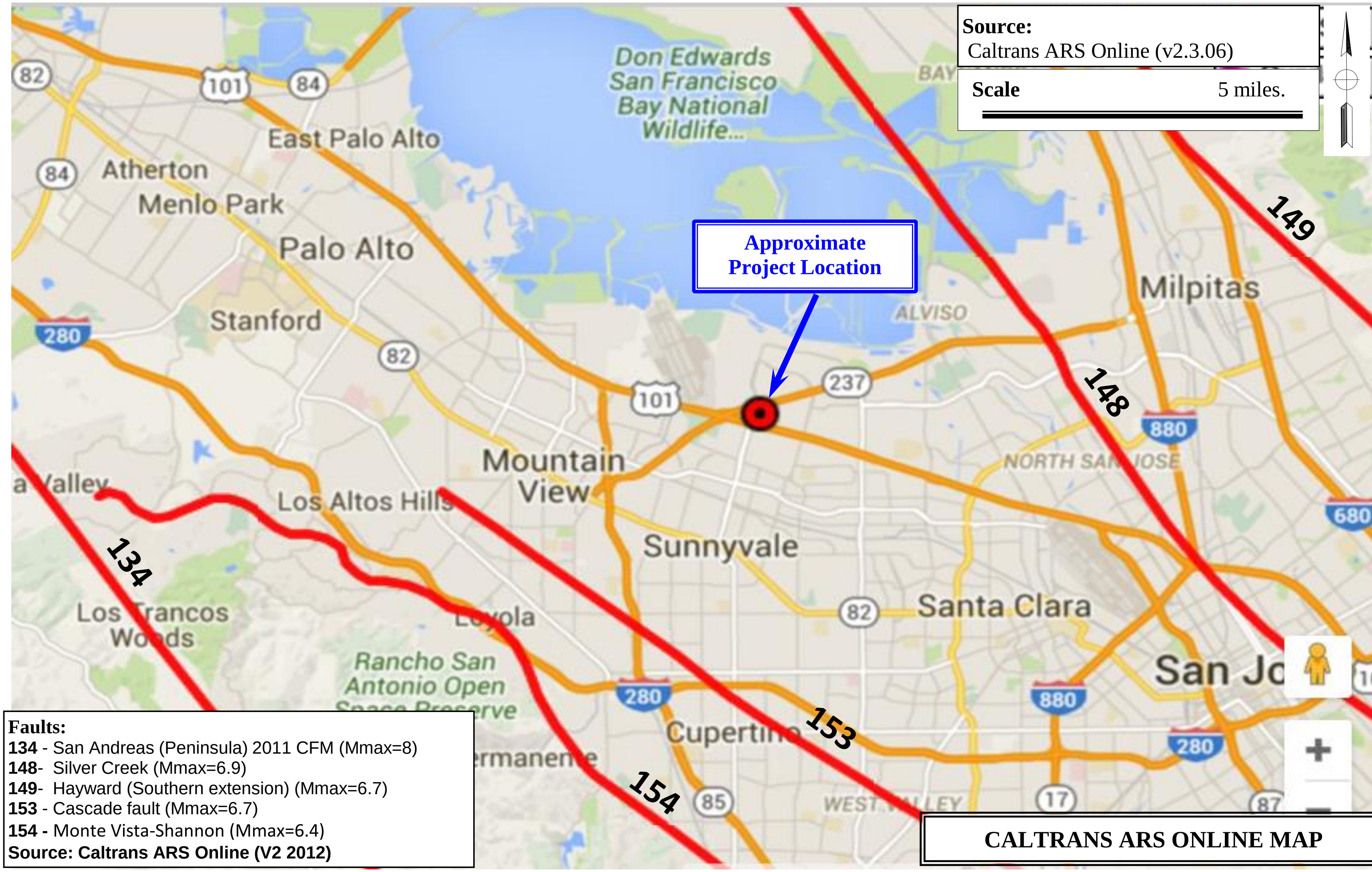
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

JOB NO.: 2014-129-PSE	**PLATE NO.: 4**



CALTRANS ARS ONLINE MAP

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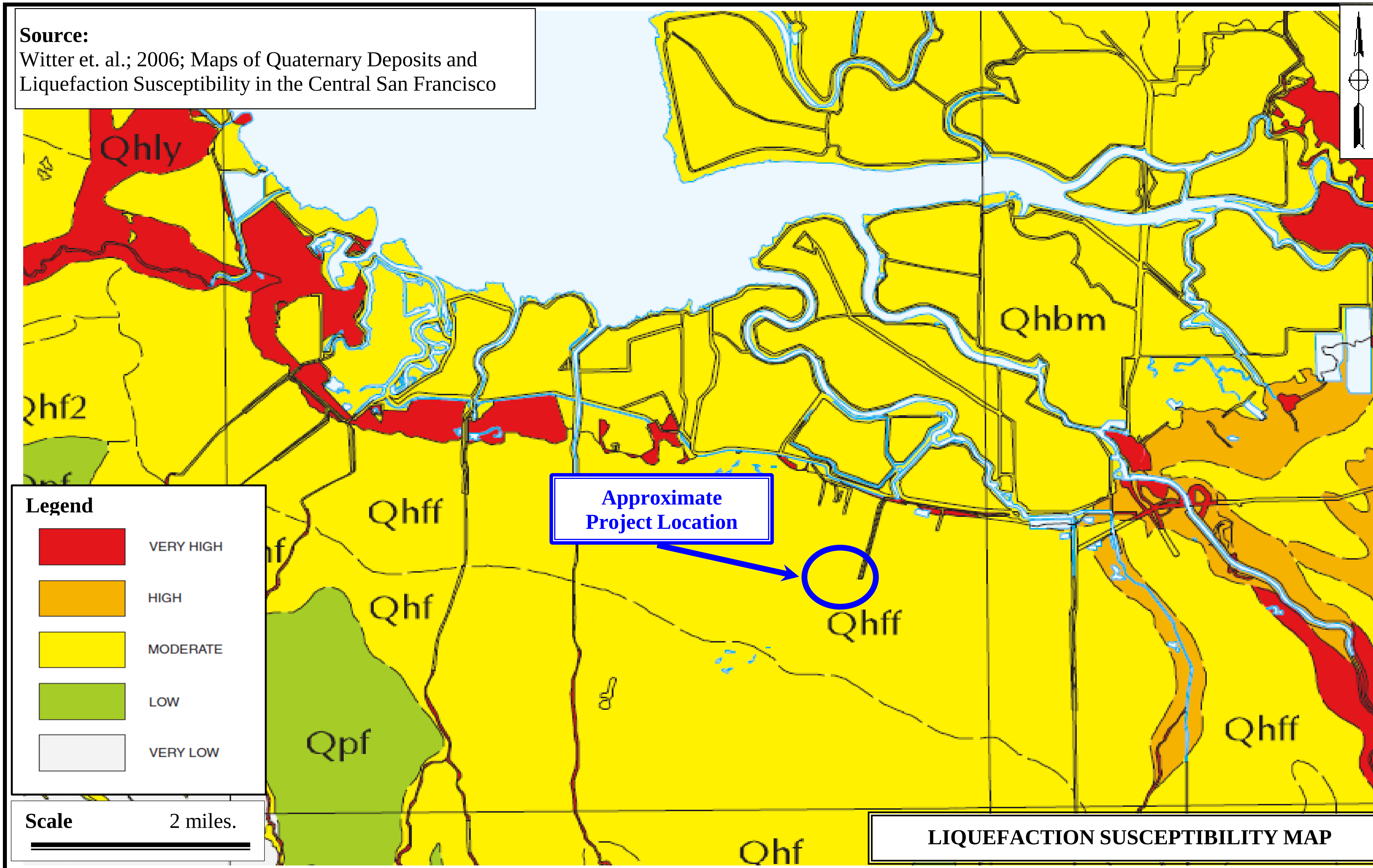
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT
SUNNYVALE, CALIFORNIA

JOB NO.: 2014-129-PSE

PLATE NO.: 5

Source:
Witter et. al.; 2006; Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco



Legend

	VERY HIGH
	HIGH
	MODERATE
	LOW
	VERY LOW

Scale 2 miles.

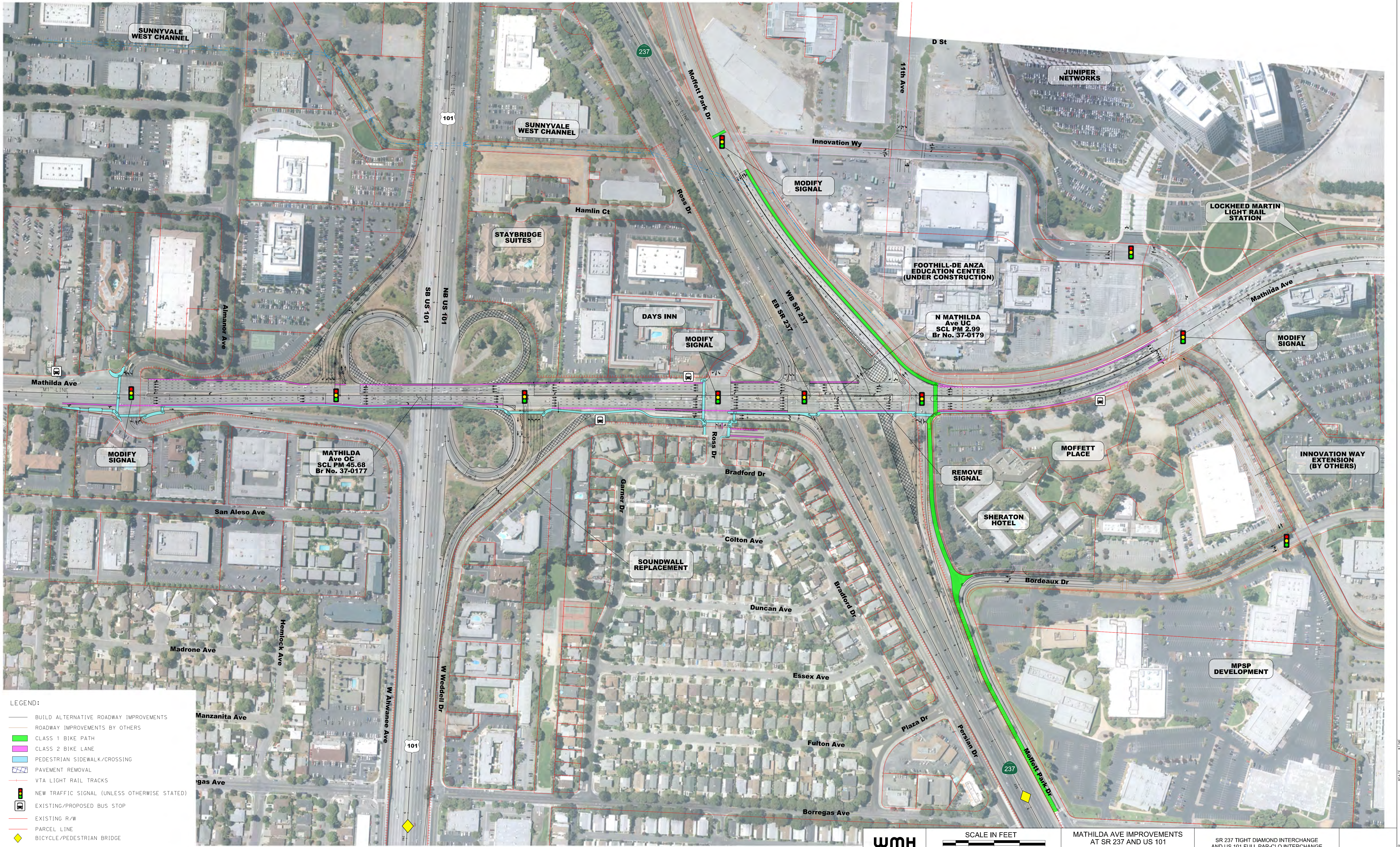
LIQUEFACTION SUSCEPTIBILITY MAP

PARIKH
Practicing in the Geosciences

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

JOB NO.: 2014-129-PSE | **PLATE NO.: 6**

APPENDIX A



WMH	SCALE IN FEET 100 50 0 100 200 300	MATHILDA AVE IMPROVEMENTS AT SR 237 AND US 101 SCL 237 - PM 2.7/3.3 SCL 101 - PM 45.2/45.8	SR 237 TIGHT DIAMOND INTERCHANGE AND US 101 FULL PAR-CLO INTERCHANGE	OCT 2016

APPENDIX B

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SCL	237, 101	2.7/3.3 45.2/45.8		

REGISTERED CIVIL ENGINEER DATE

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San Jose, CA 95134

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

NOTES:

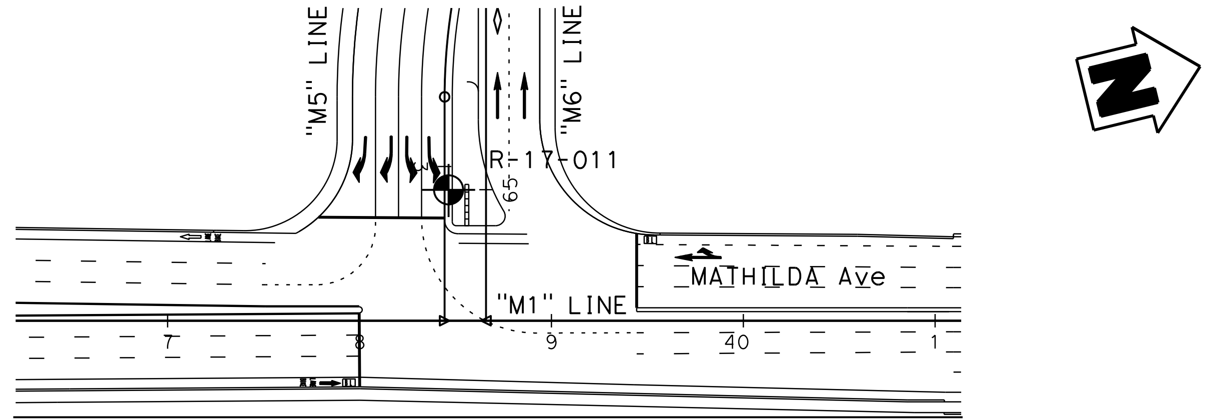
Standard Penetration Test Sampler: I.D. = 1.4"; O.D. = 2" Modified California Sampler: I.D. = 2.5"; O.D. = 3" Hammer Assembly: A 140 lb hammer with a 30" drop (Automatic Hammer)

This LOTB sheet was prepared in accordance with the Caltrans Soil & Rock, Logging, Classification, and Presentation Manual (2010)

See Caltrans 2015 Standard Plans A10F, A10G and A10H for Soil and Rock Legend.

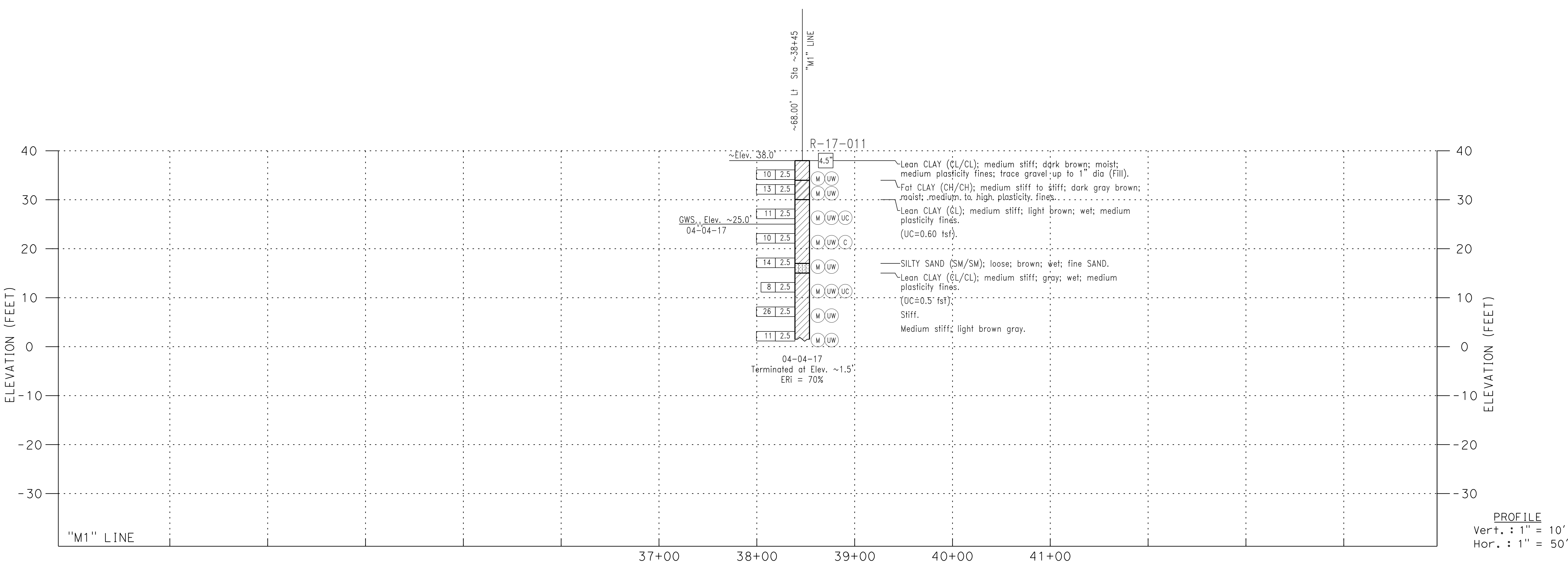
All dimensions are in feet unless otherwise shown

Base map was provided by WMH.



PLAN

SCALE: 1"=50'



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

DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG	L. S. Bhangoo & V. SANTOS FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	PETER WEI	DATE: MARCH TO APRIL 2017

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PETER WEI
PROJECT ENGINEER

BRIDGE NO.

POST MILES

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

LOG OF TEST BORINGS 1 OF 5

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0000
PROJECT NUMBER & PHASE: 0413000204
CONTRACT NO.: S13089

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

FILE => LOTB.dgn

USERNAME => ogouthier DATE PLOTTED => 7/14/2017 TIME PLOTTED => 9:03:11 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
04	SCL	237, 101	2.7/3.3 45.2/45.8		

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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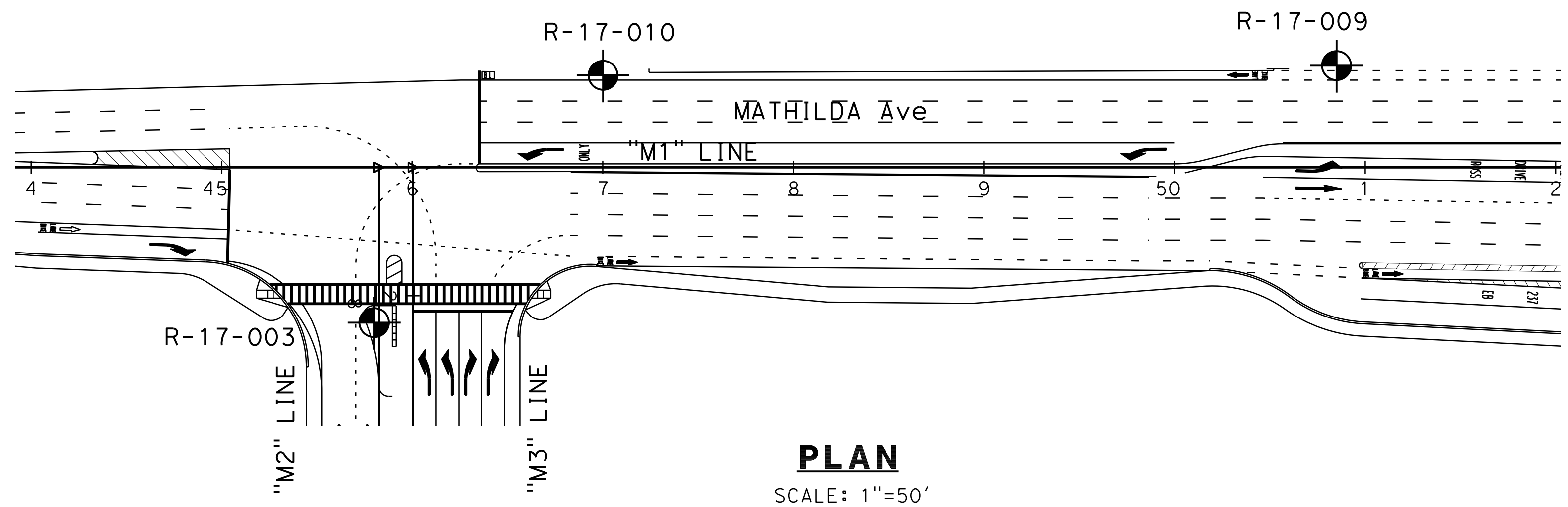
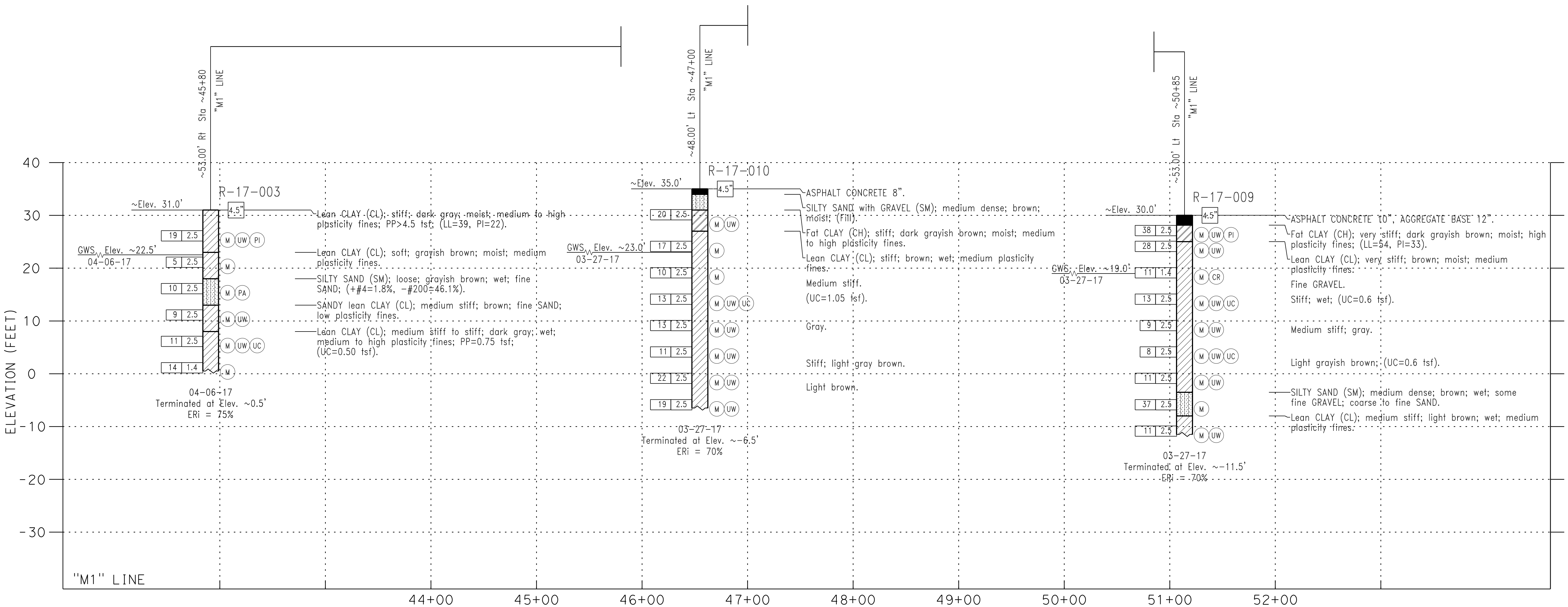


PLAN

SCALE: 1"=50'



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

DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG
SIGN OFF DATE	CHECKED BY	PETER WEI

L. S. Bhangoo & V. SANTOS
FIELD INVESTIGATION BY:
DATE: MARCH TO APRIL 2017

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PETER WEI
PROJECT ENGINEER

BRIDGE NO.
POST MILES

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

LOG OF TEST BORINGS 2 OF 5

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0000
PROJECT NUMBER & PHASE: 0413000204
CONTRACT NO.: S13089

DISREGARD PRINTS BEARING EARLIER REVISION DATES

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04	SCL	237, 101	2.7/3.3 45.2/45.8		

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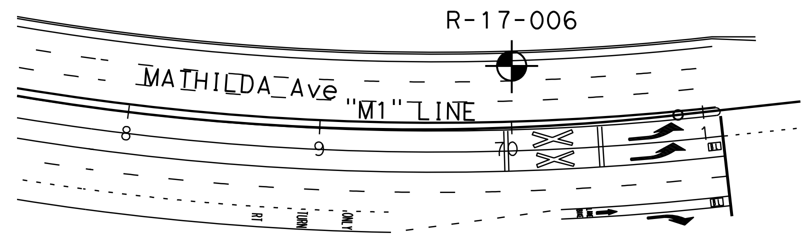
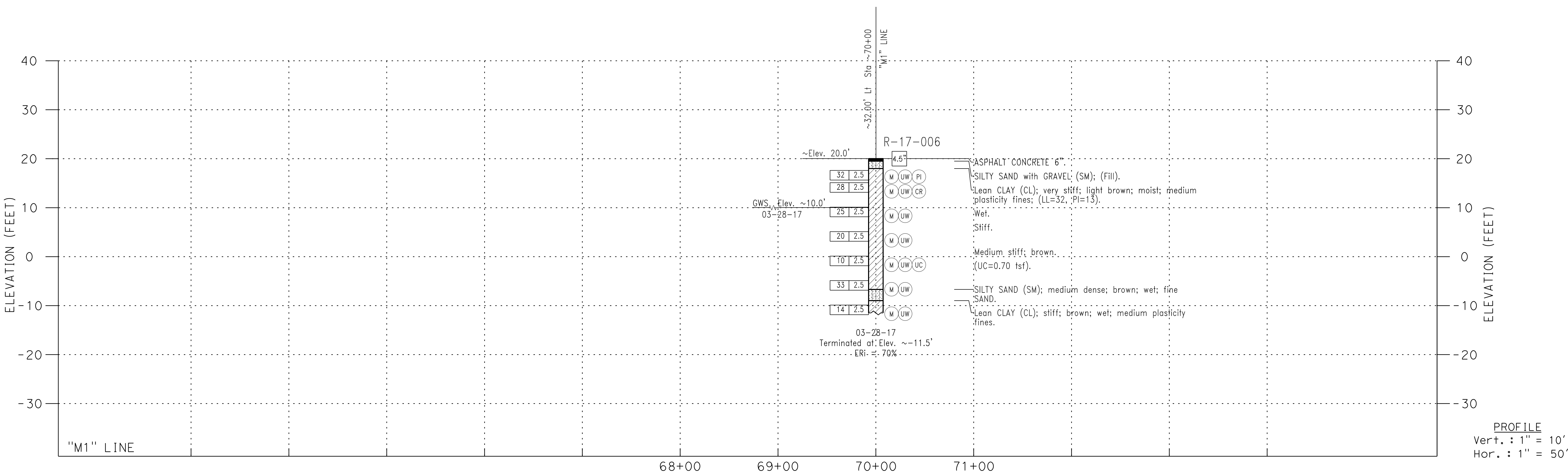


PLAN

SCALE: 1"=50'



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

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SIGN OFF DATE	CHECKED BY: PETER WEI	FIELD INVESTIGATION BY: DATE: MARCH TO APRIL 2017	PETER WEI PROJECT ENGINEER

BRIDGE NO. POST MILES

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

LOG OF TEST BORINGS 3 OF 5

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0000
PROJECT NUMBER & PHASE: 0413000204 CONTRACT NO.: S13089

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

FILE => LOTB.dgn

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SCL	237, 101	2.7/3.3 45.2/45.8		

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PLANS APPROVAL DATE

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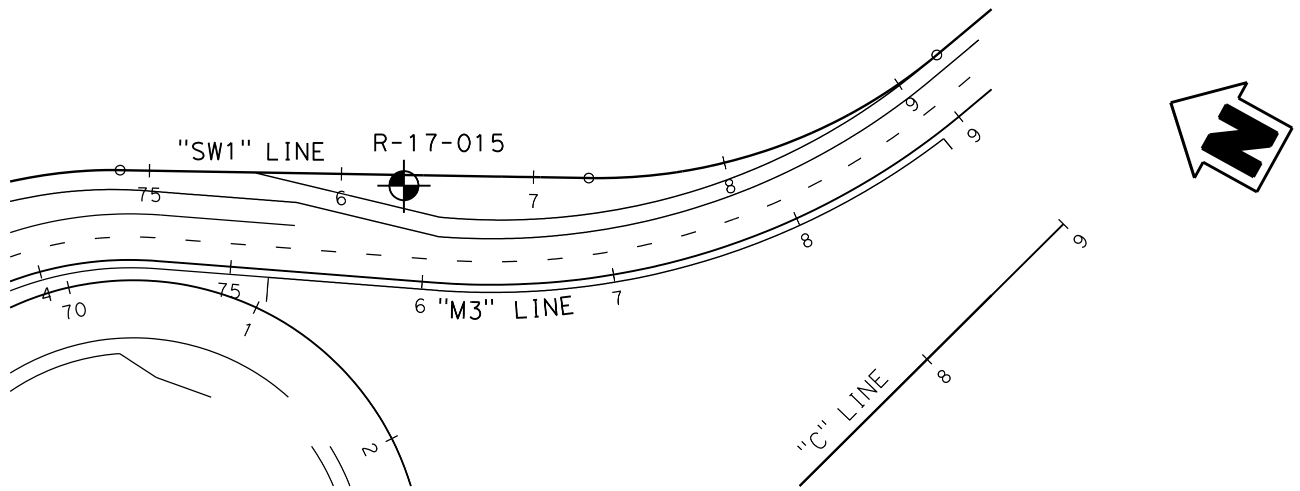
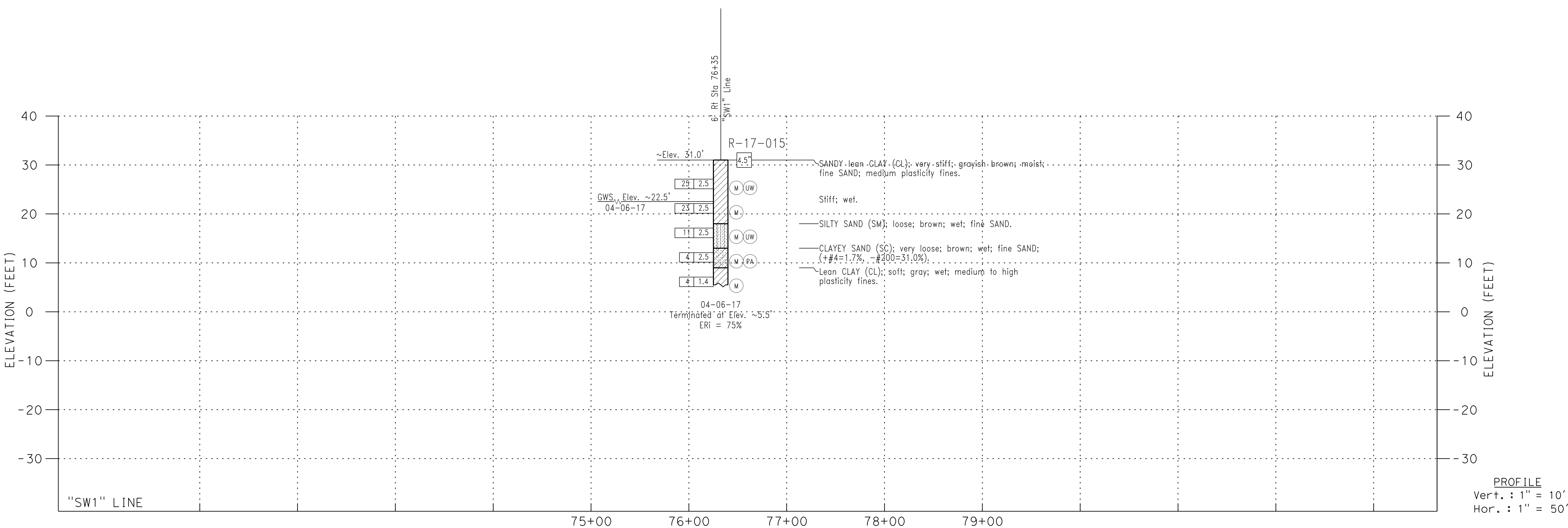


PLAN

SCALE: 1"=50'



DESIGN OVERSIGHT	DRAWN BY	KIM OUYANG	L. S. Bhangoo & V. SANTOS FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	PETER WEI	DATE: MARCH TO APRIL 2017

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

PETER WEI
PROJECT ENGINEER

BRIDGE NO.

POST MILES

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

LOG OF TEST BORINGS 4 OF 5

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0000
PROJECT NUMBER & PHASE: 0413000204
CONTRACT NO.: S13089

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES SHEET OF

FILE => LOTB.dgn

USERNAME => ogouthier DATE PLOTTED => 7/14/2017 TIME PLOTTED => 9:25:36 AM

NOTES:

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All dimensions are in feet unless otherwise shown

Base map was provided by WMH.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
04	SCL	237, 101	2.7/3.3 45.2/45.8		

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San Jose, CA 95134

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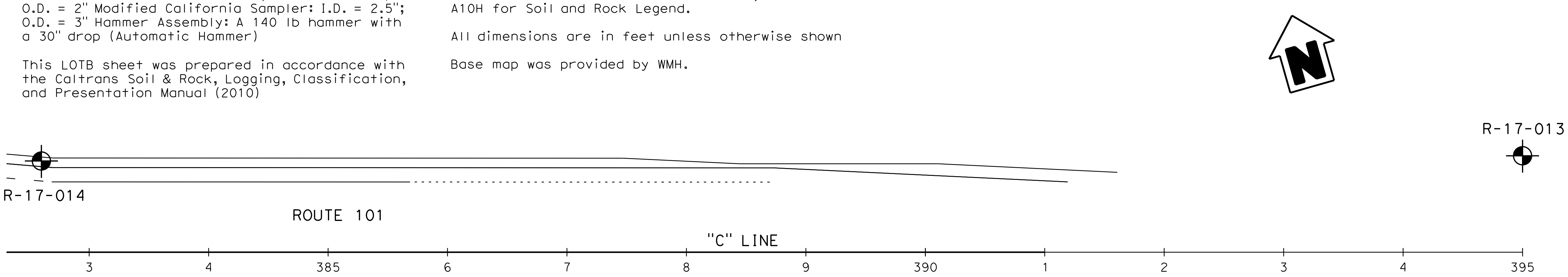
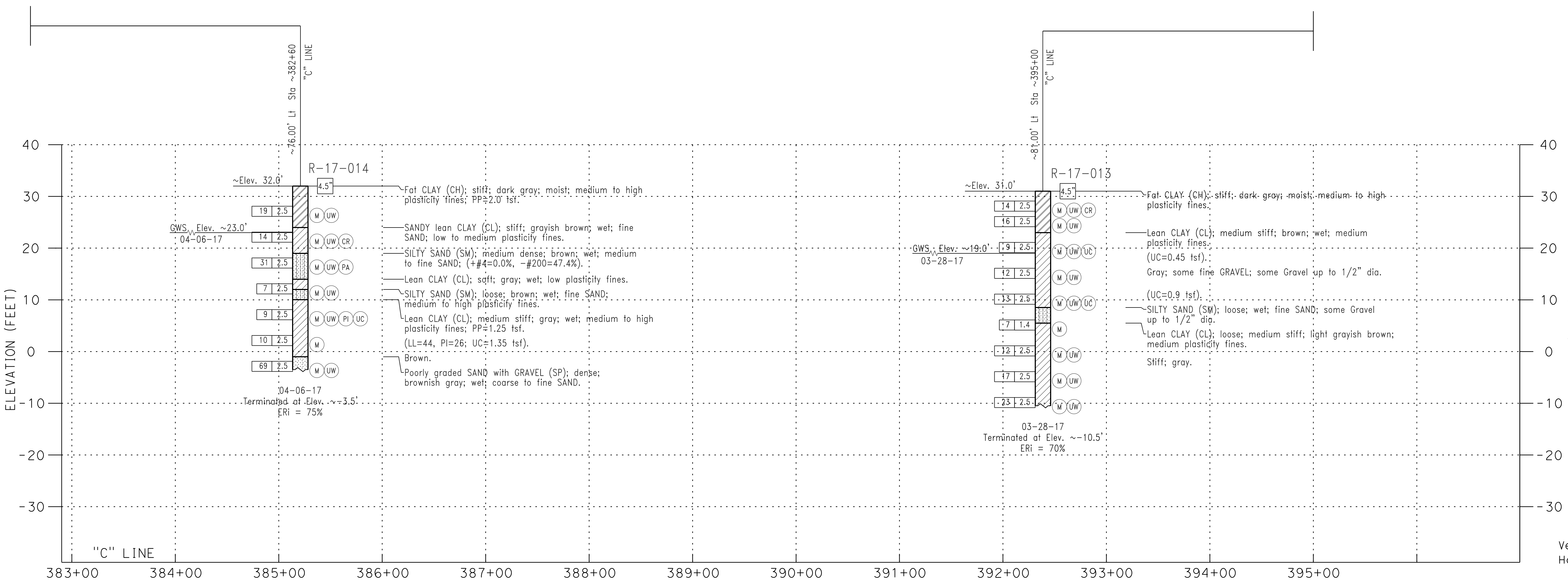
2360 QUME DRIVE, SUITE A
SAN JOSE, CA 95131



PLAN

SCALE: 1"=50'



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

DESIGN OVERSIGHT	DRAWN BY: KIM OUYANG	L. S. Bhangoo & V. SANTOS FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
SIGN OFF DATE	CHECKED BY: PETER WEI	DATE: MARCH TO APRIL 2017	

PETER WEI
PROJECT ENGINEER

BRIDGE NO.

POST MILES

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101

LOG OF TEST BORINGS 5 OF 5

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0000
PROJECT NUMBER & PHASE: 0413000204
CONTRACT NO.: S13089

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES | SHEET | OF

FILE => LOTB.dgn

USERNAME => ogouthier DATE PLOTTED => 7/14/2017 TIME PLOTTED => 9:27:44 AM

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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
4	SCL	237/101	237-PM 2.7/3.3; 101-PM 45.2/45.8		

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REGISTERED CIVIL ENGINEER 2/29/2016 DATE

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT

LOG OF TEST BORINGS

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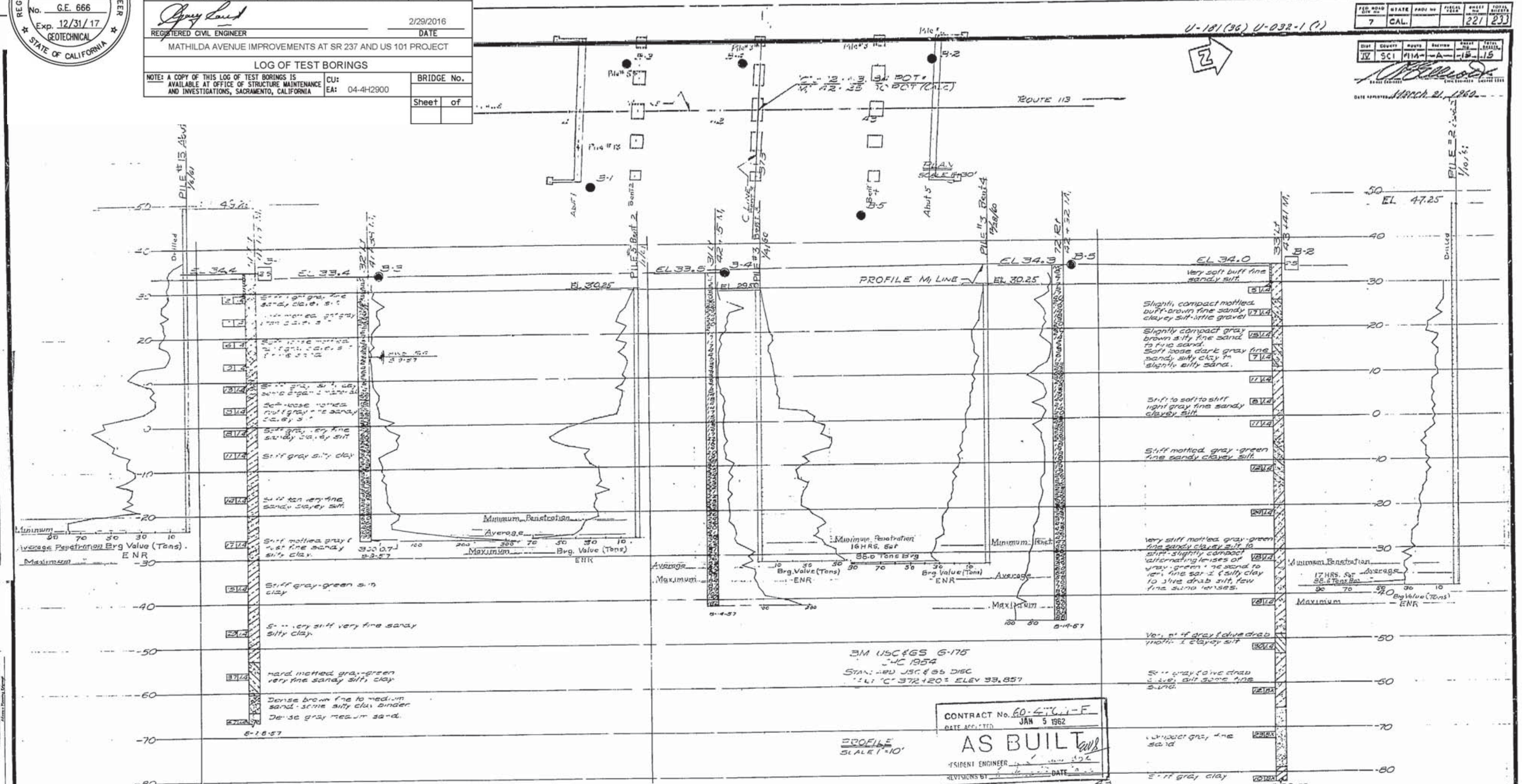
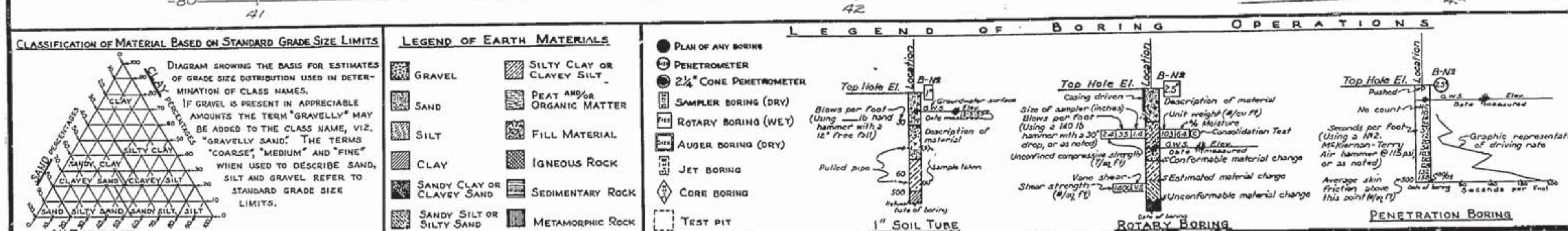
CU:
EA: 04-4H2900

BRIDGE No.

Sheet of

AS BUILT PLANS
Contract No. 60-4TC71
Date Completed
Document No. 40002469





NOTES

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

~~ROUTE 114/68 SEPARATION~~

LOG OF TEST BORINGS

SCALE AS NOTED | BRIDGE 37-177 | FILE | DRAWING C-5674-14

PREL. DRAWING No. P-5674 40 62

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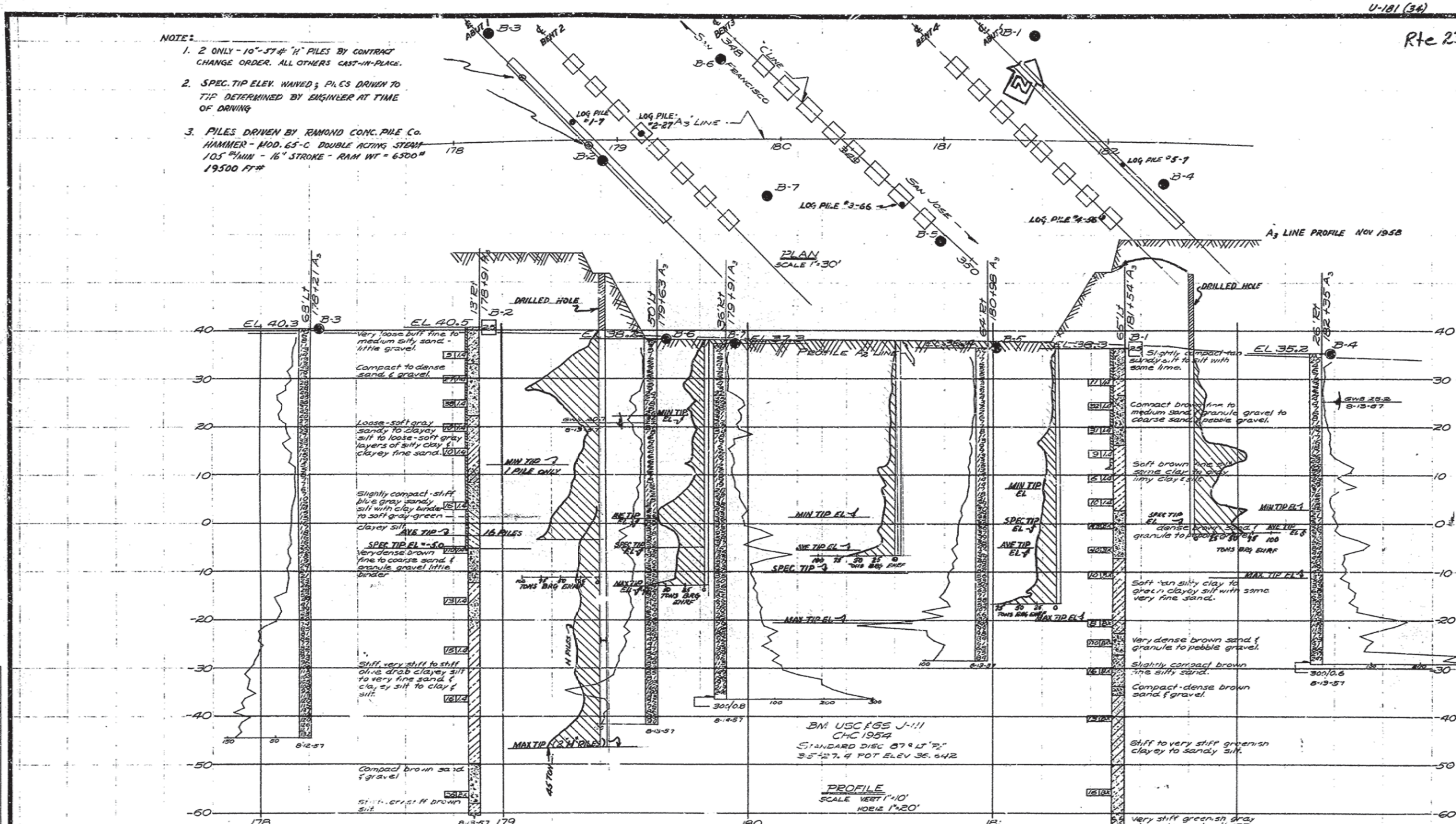
DATE SIGNATURE TITLE



U-181 (34)

Rte 237

JUNE 9 1958

AS BUILT

CORRECTIONS BY E. STRANBERG
CONTRACT NO. 59-4TC32
DATE 5-14-59 DEC 13 1973

AS BUILT
CONTRACT No. 59-4TC32-F
DATE ACCEPTED 7-10-59

BRIDGE DEPARTMENT

Classification of Material Based on Standard Grade Size Limits

Diagram showing the basis for estimates of grade size distribution used in determination of class names.
If gravel is present in appreciable amounts the term "gravelly" may be added to the class name, viz. "gravelly sand." The terms "coarse", "medium" and "fine" when used to describe sand, silt and gravel refer to standard grade size limits.

Legend of Earth Materials

Gravel · Sand · Silt · Clay · Sandy Clay or Clayey Sand · Sandy Silt or Silty Sand · Silty Clay or Clayey Silt · Peat and/or Organic Matter · Fill Material · Igneous Rock · Sedimentary Rock · Metamorphic Rock

Legend of Boring Operations

Plan of any boring · Penetrometer · 2½" Cone Penetrometer · Sampler boring (dry) · Rotary boring (wet) · Auger boring (dry) · Jet boring · Core boring · Test pit

1" Soil Tube · Rotary Boring · Penetration Boring

NOTES

The contractor's attention is directed to Section 2, Article (c) of the Standard Specifications and to the Special Provisions accompanying this set of plans.

Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

ROUTE 237/101 SEPARATION

LOG OF TEST BORINGS

SCALE AS SHOWN | BRIDGE 37-178 | FILE E-37 | DRAWING B-5675-14

PREL. DRAWING NO. P-5675

67

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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
4	SCL	237/101	237-PM 2.7/3.3; 101-PM 45.2/45.8		

REGISTERED CIVIL ENGINEER — DATE 2/29/2016

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT

LOG OF TEST BORINGS

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CU:
EA: 04-4H2900

BRIDGE No.

Sheet | of

REGISTERED PROFESSIONAL ENGINEER
GARY PARIKH
No. G.E. 666
Exp. 12/31/17
GEOTECHNICAL
STATE OF CALIFORNIA

AS BUILT PLANS
Contract No. 59-4TC32
Date Completed
Document No. 40002153

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DATE 1-28-80 — SUPERVISOR OF MICROFILM SERVICES

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM

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REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/17 GEOTECHNICAL STATE OF CALIFORNIA

REGISTERED CIVIL ENGINEER — DATE 2/29/2016

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

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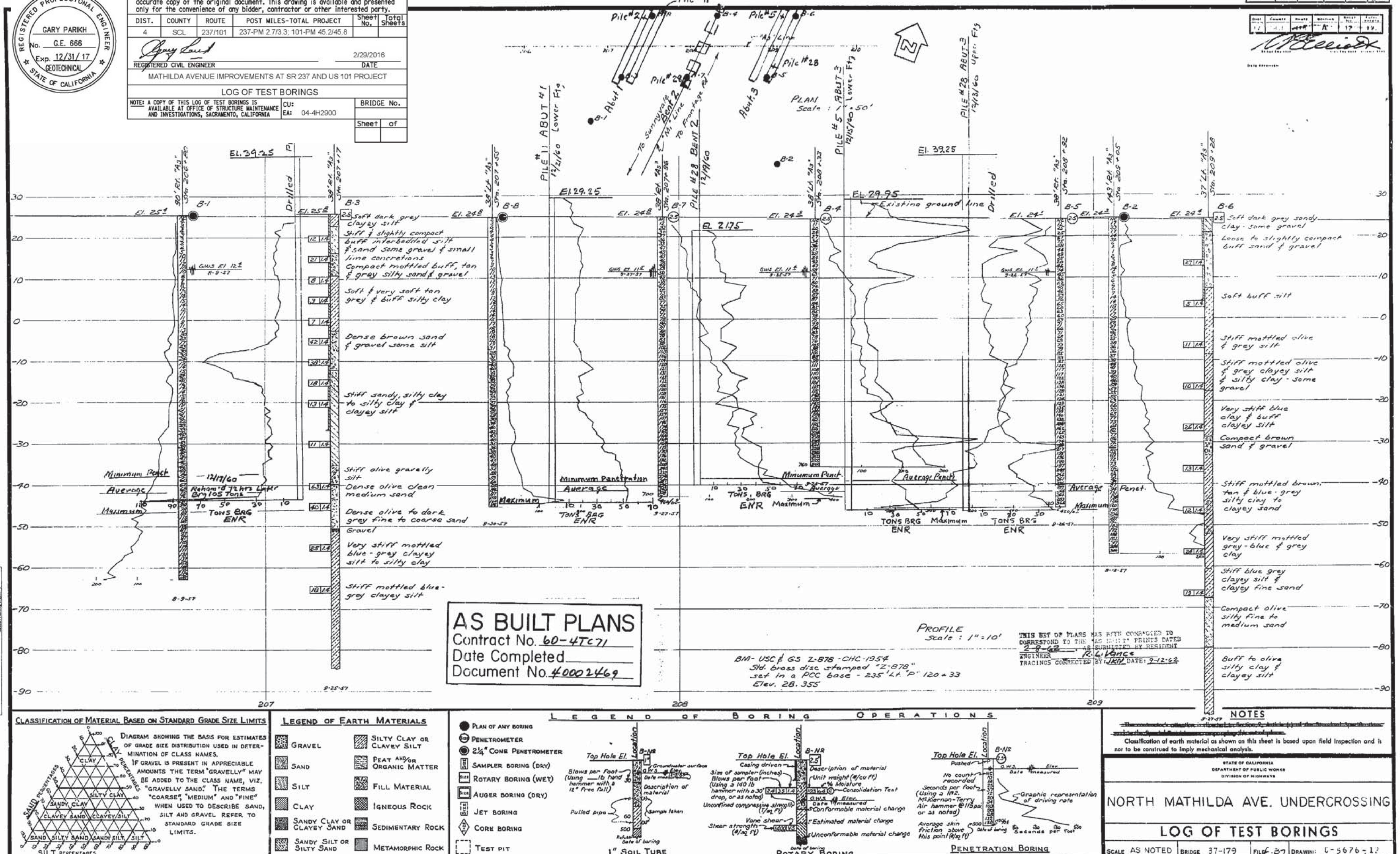
EA: 04-4H2900

BRIDGE No.

Sheet of



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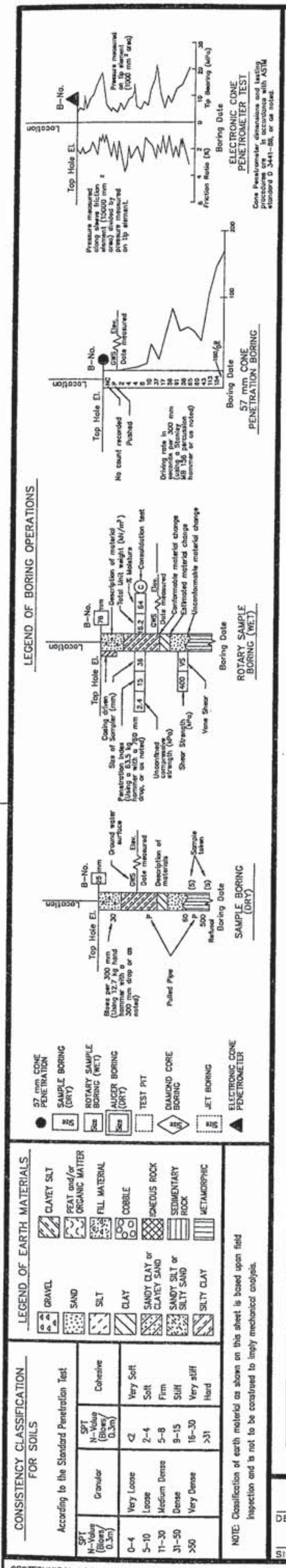
DATE / / SIGNATURE /TITLE



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DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
4	SCL	237/101	237-PM 2.7/3.3; 101-PM 45.2/45.8		
REGISTERED CIVIL ENGINEER				DATE 2/29/2016	
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT					
LOG OF TEST BORINGS					
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA			CU: / EA: 04-4H2900	BRIDGE No.	
				Sheet	of

REGISTERED PROFESSIONAL ENGINEER
GARY PARIKH
No. G.E. 666
Exp. 12/31/17
GEOTECHNICAL
STATE OF CALIFORNIA

SITE PLAN FOR BORING LOCATIONS)

Caltrans Metric

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SCL	101	72.4 (45.0)		

08-16-06
GEOTECHNICAL PROFESSIONAL

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Exp. 12-31-07
GEOTECHNICAL
STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD
MILPITAS CA 95035

ELEVATION (meters): 9, 6, 3, 0, −3, −6, −9, −12, −15, −18, −21, −24

05-B-5

Elev. 9.5 m± — Sta 20+... 7.6m± Lt.

							127 mm: 64mm ASPHALT CONCRETE over 178mm AGGREGATE BASE
							SILTY SAND WITH GRAVEL (SM), loose, yellowish brown, moist
	20	64	1	–	6		LEAN CLAY WITH SAND (CL), very stiff, gray, moist
	30	64	2	19.3	25		--very stiff
77	12	64	3	19.7	27	AL UC	--firm, yellowish brown, medium plasticity (LL=37, PI=15)
	32	64	4	20.2	27	SA	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, yellowish brown, wet (+#4=0%, −#200=9%)
	9	64	5	19.8	28		LEAN CLAY WITH SAND (CL), firm, gray, wet
	19	64	6	20.8	22		--stiff
50	14	64	7	20.1	24	UC	--stiff
	20	64	8	20.6	23		--stiff
	21	64	9	21.9	19		--stiff
							CLAYEY SAND (SC), yellowish brown, wet
67	16	64	10	21.7	17	UC	LEAN CLAY WITH SAND (CL), stiff, yellowish brown, wet
	18	64	11	21.9	18		SANDY LEAN CLAY (CL), stiff, gray, wet, trace pockets of clayey sand
	32	64	12	21.1	21		--very stiff
	25	64	13	20.5	23		LEAN CLAY WITH SAND (CL), very stiff, yellowish brown, wet

07-06-05
Groundwater was not measured due to Rotary wash drilling method

05-B-6

Elev. 9.3 m± — Sta 21+29 7.6m±Lt. BRIDGE ℄

							127 mm: 76mm ASPHALT CONCRETE
	29	64	1	20.1	8		GRAVELLY LEAN CLAY WITH SAND (CL), very stiff, dry, brown, medium plasticity (FILL)
	32	64	2	17.3	36		GRAVELLY FAT CLAY (CH), very stiff, black, moist, gravel up to 95mm
	20	64	3	20.4	20	CA AL	LEAN CLAY (CL), stiff, light gray, moist, trace nodules up to 13mm (LL=34, PI=18)
	29	64	4	19.6	22		POORLY-GRADED SAND WITH CLAY (SP-SC), medium dense, brownish gray, moist, fine to medium grained (−#200=11%)
140	15	64	5	20.1	22	AL UC	LEAN CLAY (CL), stiff, dark gray, moist, medium plasticity (LL=34, PI=17)
	50/102	64	6	19.4	12		CLAYEY SAND (SC), very dense, gray, moist
	22	64	7	20.2	26		SANDY LEAN CLAY (CL), stiff, gray, moist, low to medium plasticity
	35	64	8	20.3	21		SILTY CLAY (CL-ML), very stiff, mottled brown and gray, moist, low plasticity, trace fine grained sand
	44	64	9	21.7	18		LEAN CLAY WITH SAND (CL), very stiff, gray, moist, low to medium plasticity, fine grained sand
	29	64	10	20.7	22		--very stiff, mottled gray and brown, trace fibers
	62	64	11	20.8	20		--hard
	89/292	64	12	21.5	17		SANDY SILT (ML), hard, mottled gray and brown, moist, low plasticity, fine grained sand
	42	64	13	19.8	23		LEAN CLAY (CL), hard, brown, moist, medium plasticity, trace sand and nodules
	29	35	14	18.2	37		FAT CLAY (CH), very stiff, dark gray, moist, high plasticity
	52	64	15	20.2	23		SILTY CLAY WITH SAND (CL-ML), hard, olive brown, moist, low plasticity
	43	64	16	20.0	24		LEAN CLAY (CL), very stiff, olive brown, moist, medium plasticity, trace sand and nodules
	89/279	64	17	20.3	18		SANDY LEAN CLAY (CL), hard, mottled gray and brown, moist, low plasticity

07-11-05
Groundwater was not measured due to Rotary wash drilling method

05-B-7

Elev. 9.5 m± — Sta 22+24 3.8m± Rt. BRIDGE ℄

							127 mm: 102mm ASPHALT CONCRETE over 51mm AGGREGATE BASE
							SILTY SAND WITH GRAVEL (SM), medium dense, yellowish brown, moist
	52	64	1	22.1	12		
	45	64	2	19.9	28		FAT CLAY (CH), very stiff, gray, moist, trace sand and gravel (Disturbed sample)
	28	64	3	19.6	29	AL	--very stiff, high plasticity (LL=52, PI=28)
	44	64	4	21.3	17		SILTY SAND WITH GRAVEL (SM), medium dense, yellowish brown, wet
62	12	64	5	19.6	25	UC	LEAN CLAY WITH SAND (CL), firm, gray, wet
	48	64	6	20.1	25		--very stiff, light gray
	75/280	64	7	21.8	13		SILTY SAND WITH GRAVEL (SM), very dense, yellowish brown, wet
	60	64	8	20.3	21		LEAN CLAY WITH SAND (CL), hard, yellowish brown, wet
96	16	64	9	21.1	18	UC	--firm, light yellowish brown
72	23	64	10	20.2	22	UC	--stiff
	55	64	11	20.3	21		--hard
	36	64	12	20.7	22	AL	--very stiff, low plasticity (LL=28, PI=9)
	60	64	13	20.1	23		--hard
	40	64	14	19.6	30		--very stiff
	46	64	15	20.6	21		--very stiff
							SILTY SAND WITH GRAVEL (SM), gray, wet
	49	64	16	20.1	26		LEAN CLAY WITH SAND (CL), hard, gray, wet
	50/127	64	17	18.8	34		--hard, very dense Silty sand at the bottom of sample

07-07-05
Groundwater was not measured due to Rotary was drilling method

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

PROFILE

Vert. 1 : 100
Hor. 1 : 500

Note:
Standard Penetration Test sampler: I.D. = 35mm; O.D. = 50mm
Modified California Sampler: I.D. = 64mm; O.D. = 76mm
Hammer Assembly: A 63.5 kg hammer with a 762 mm drop (Rope and Pulley)

20+00 BRIDGE ℄ 20+50 21+00 21+50 22+00 22+50

DESIGN OVERSIGHT	DRAWN BY	SYAMALA PAMPATI	R. LIARD/ L. BHANGOO	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK WANG PROJECT ENGINEER	BRIDGE NO. 37-0663	SOUTH BORREGAS AVE POC
SIGN OFF DATE	CHECKED BY	FRANK WANG	FIELD INVESTIGATION BY: DATE: 07-05			KILOMETER POST 72.4	LOG OF TEST BORINGS 2 OF 3

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 8/21/04)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU 04
EA 44120

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 1-19-06 04-03-06 08-16-06

SHEET OF

FILE => $REQUEST

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

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SCL	101	72.4 (45.0)		

Caltrans Metric

GEOTECHNICAL PROFESSIONAL 08-16-06

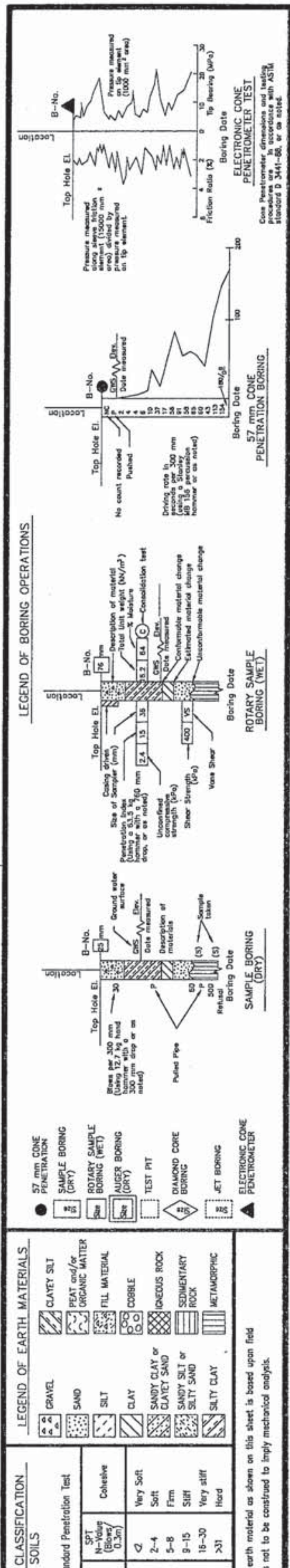
PLANS APPROVAL DATE

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

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12-31-07 GEOTECHNICAL STATE OF CALIFORNIA

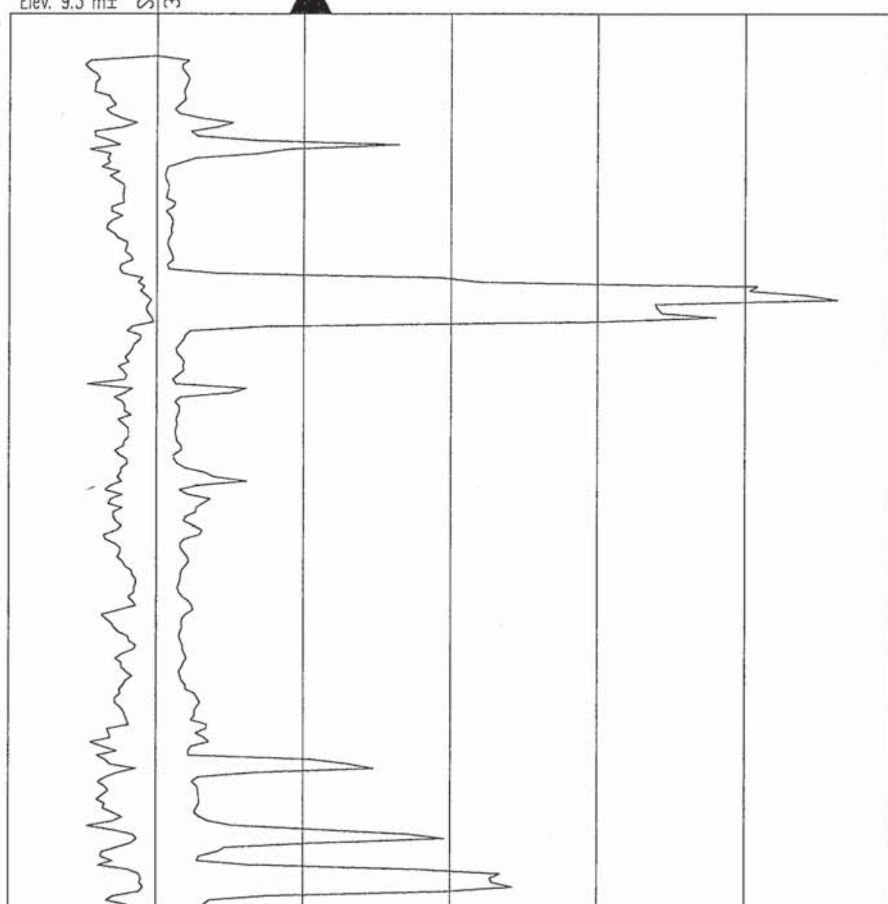
PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD
MILPITAS CA 95035

(SEE SITE PLAN FOR BORING LOCATIONS)



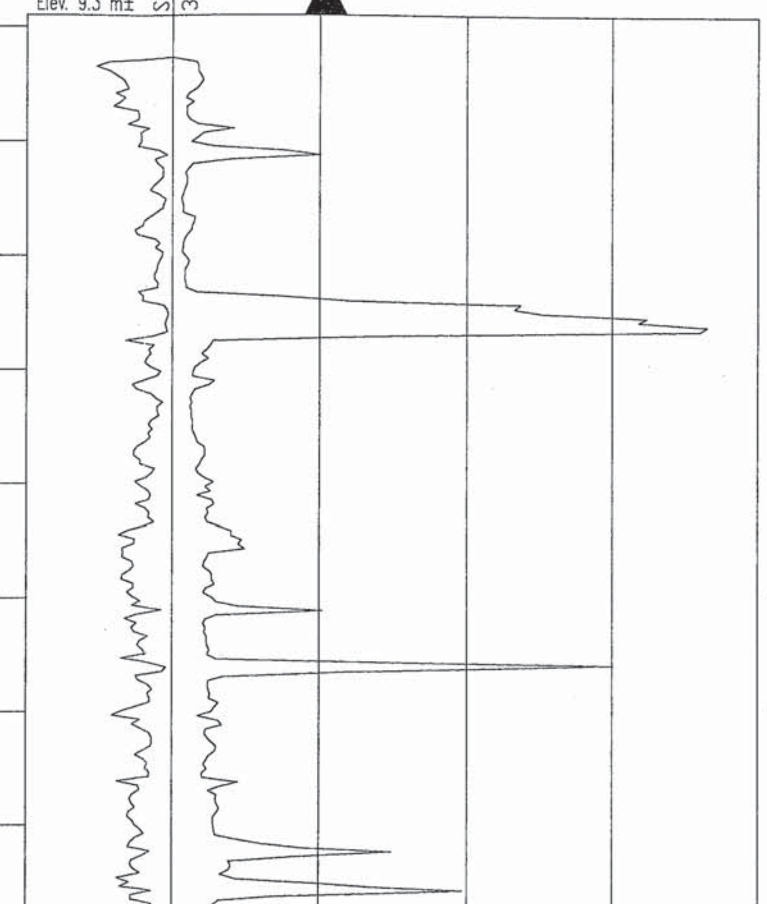
05-CPT-2

Elev. 9.3 m± Sta 22+54 3.8m± Rt. BRIDGE ℄



05-CPT-1

Elev. 9.3 m± Sta 22+84 3.8m± Rt. BRIDGE ℄



05-B-8

Elev. 9.3 m± Sta 23+09 3.8m± Rt. BRIDGE ℄

GWS Elev. = 6.86 m± 7-7-05

							Description
	127 mm						152mm ASPHALT CONCRETE over a Geotextile Fabric
							GRAVELLY LEAN CLAY WITH SAND (CL), reddish brown, dry (FILL)
	24	64	1	19.0	27	CA	FAT CLAY (CH), stiff, black, moist, high plasticity
	26	64	2	19.5	24	AL	--very stiff, brownish gray, trace nodules of sand (LL=56, PI=34)
124	12	64	3	19.5	25	UC	LEAN CLAY (CL), firm, mottled gray and brown, moist, medium plasticity, trace nodules
	29	64	4	20.7	14	SA	POORLY-GRADED SAND WITH SILT (SP-SM), medium dense, grayish brown, moist, fine to coarse grained (+#4=9%, -#200=7%)
	7	64	5	19.4	25		SILTY CLAY (CL-ML), firm, gray, wet, low plasticity
	11	64	6	19.0	30		LEAN CLAY (CL), firm, gray, moist, medium plasticity, trace nodules
62	12	64	7	20.6	22	UC	SANDY LEAN CLAY (CL), firm, gray, moist, medium plasticity, fine to coarse grained
	38	64	8	20.6	20		SANDY SILT (ML), very stiff, brown, moist, nonplastic, fine grained sand
	36	64	9	20.0	11	SA	WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), medium dense, brownish gray, wet, fine to coarse grained (+#4=15%, -#200=5%)
	12	64	10	19.9	23		SILTY CLAY (CL-ML), firm, brown, moist, low plasticity, trace sand and gravel
	22	64	11	20.0	22		--stiff, mottled brown and gray, moist, low plasticity, trace nodules
	33	64	12	19.4	26		LEAN CLAY (CL), very stiff, mottled gray and brown, moist, medium plasticity, trace nodules and sand
	52	64	13	20.4	22		--hard, mottled dark brown and gray

07-07-05

ELEVATION (meters): 9, 6, 3, 0, -3, -6, -9, -12, -15, -18, -21, -24

PROFILE

Vert. 1 : 100
Hor. 1 : 250

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

BRIDGE ℄ 22+50 22+75 23+00 23+75

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/17 GEOTECHNICAL STATE OF CALIFORNIA

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	POST MILES-TOTAL PROJECT	Sheet No.	Total Sheets
4	SCL	237/101	237-PM 2.7/3.3; 101-PM 45.2/45.8		

REGISTERED CIVIL ENGINEER — DATE 2/29/2016

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT

LOG OF TEST BORINGS

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU:
EA: 04-4H2900

BRIDGE No.

Sheet of

Note:
Standard Penetration Test sampler: I.D. = 35mm; O.D. = 50mm
Modified California Sampler: I.D. = 64mm; O.D. = 76mm
Hammer Assembly: A 63.5 kg hammer with a 762 mm drop (Rope and Pulley)

DESIGN OVERSIGHT	DRAWN BY	SYAMALA PAMPATI	R. LIARD/ L. BHANGOO FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	FRANK WANG PROJECT ENGINEER	BRIDGE NO. 37-0663 KILOMETER POST 72.4	SOUTH BORREGAS AVE POC
SIGN OFF DATE	CHECKED BY	FRANK WANG	DATE: 07-05				LOG OF TEST BORINGS 3 OF 3

GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 6/21/04)

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

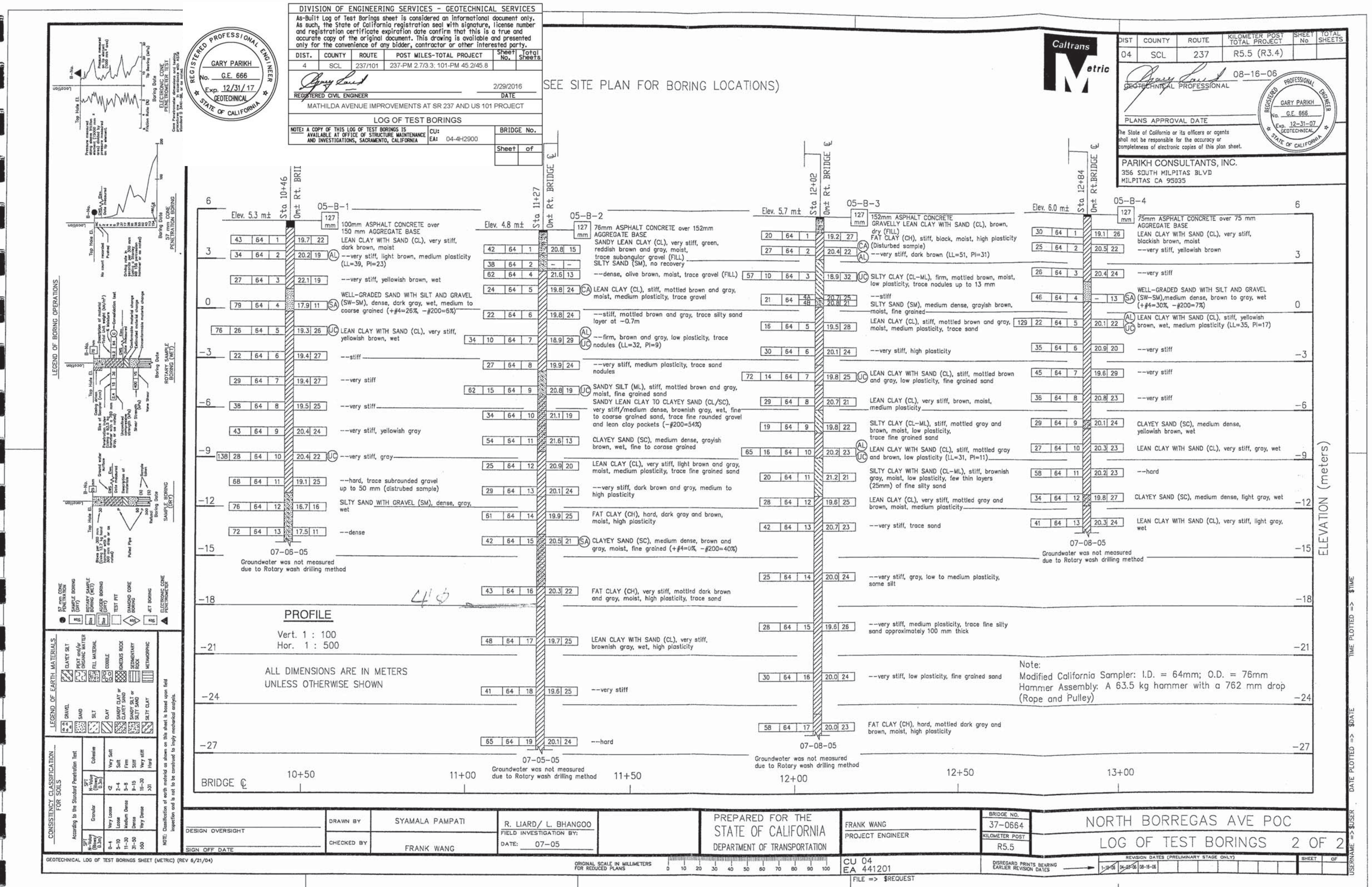
CU 04
EA 44120

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES (PRELIMINARY STAGE ONLY) 1-18-06 04-03-06 08-16-06

SHEET OF

FILE => $REQUEST

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



DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES
As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.
DIST. 4 COUNTY SCL ROUTE 237/101 POST MILES-TOTAL PROJECT 237-PM 2.7/3.3; 101-PM 45.2/45.8
REGISTERED CIVIL ENGINEER 2/29/2016 DATE
MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101 PROJECT
LOG OF TEST BORINGS
NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA
CU: EA: 04-4H2900
BRIDGE No. Sheet of
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/17 GEOTECHNICAL STATE OF CALIFORNIA
(SEE SITE PLAN FOR BORING LOCATIONS)
Caltrans Metric
DIST 04 COUNTY SCL ROUTE 237 KILOMETER POST TOTAL PROJECT R5.5 (R3.4)
08-16-06
GEOTECHNICAL PROFESSIONAL
PLANS APPROVAL DATE
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.
REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12-31-07 GEOTECHNICAL STATE OF CALIFORNIA
PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD
MILPITAS CA 95035
05-B-1 Elev. 5.3 m± Sta 10+46 0m± Rt. BRIDGE ℄
127 mm 100mm ASPHALT CONCRETE over 150 mm AGGREGATE BASE
LEAN CLAY WITH SAND (CL), very stiff, dark brown, moist
--very stiff, light brown, medium plasticity (LL=39, PI=23)
--very stiff, yellowish brown, wet
WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), dense, dark gray, wet, medium to coarse grained (+#4=26%, -#200=6%)
LEAN CLAY WITH SAND (CL), very stiff, yellowish brown, wet
--stiff
--very stiff
--very stiff
--very stiff, yellowish gray
--very stiff, gray
--hard, trace subrounded gravel up to 50 mm (distrubed sample)
SILTY SAND WITH GRAVEL (SM), dense, gray, wet
--dense
07-06-05
Groundwater was not measured due to Rotary wash drilling method
05-B-2 Elev. 4.8 m± Sta 11+27 0m± Rt. BRIDGE ℄
127 mm 76mm ASPHALT CONCRETE over 152mm AGGREGATE BASE
SANDY LEAN CLAY (CL), very stiff, green, reddish brown and gray, moist, trace subangular gravel (FILL)
SILTY SAND (SM), no recovery
--dense, olive brown, moist, trace gravel (FILL)
LEAN CLAY (CL), stiff, mottled brown and gray, moist, medium plasticity, trace gravel
--stiff, mottled brown and gray, trace silty sand layer at -0.7m
--firm, brown and gray, low plasticity, trace nodules (LL=32, PI=9)
--very stiff, medium plasticity, trace sand nodules
SANDY SILT (ML), stiff, mottled brown and gray, moist, fine grained sand
SANDY LEAN CLAY TO CLAYEY SAND (CL/SC), very stiff/medium dense, brownish gray, wet, fine to coarse grained sand, trace fine rounded gravel and lean clay pockets (-#200=54%)
CLAYEY SAND (SC), medium dense, grayish brown, wet, fine to corase grained
LEAN CLAY (CL), very stiff, light brown and gray, moist, medium plasticity, trace fine grained sand
--very stiff, dark brown and gray, medium to high plasticity
FAT CLAY (CH), hard, dark gray and brown, moist, high plasticity
CLAYEY SAND (SC), medium dense, brown and gray, moist, fine grained (+#4=0%, -#200=40%)
FAT CLAY (CH), very stiff, mottled dark brown and gray, moist, high plasticity, trace sand
LEAN CLAY WITH SAND (CL), very stiff, brownish gray, wet, high plasticity
--very stiff
--hard
07-05-05
Groundwater was not measured due to Rotary wash drilling method
05-B-3 Elev. 5.7 m± Sta 12+02 0m± Rt. BRIDGE ℄
127 mm 152mm ASPHALT CONCRETE
GRAVELLY LEAN CLAY WITH SAND (CL), brown, dry (FILL)
FAT CLAY (CH), stiff, black, moist, high plasticity (Disturbed sample)
--very stiff, dark brown (LL=51, PI=31)
SILTY CLAY (CL-ML), firm, mottled brown, moist, low plasticity, trace nodules up to 13 mm
--stiff
SILTY SAND (SM), medium dense, grayish brown, moist, fine grained
LEAN CLAY (CL), stiff, mottled brown and gray, moist, medium plasticity, trace sand
--very stiff, high plasticity
LEAN CLAY WITH SAND (CL), stiff, mottled brown and gray, low plasticity, fine grained sand
LEAN CLAY (CL), very stiff, brown, moist, medium plasticity
SILTY CLAY (CL-ML), stiff, mottled gray and brown, moist, low plasticity, trace fine grained sand
LEAN CLAY WITH SAND (CL), stiff, mottled gray and brown, low plasticity (LL=31, PI=11)
SILTY CLAY WITH SAND (CL-ML), stiff, brownish gray, moist, low plasticity, few thin layers (25mm) of fine silty sand
LEAN CLAY (CL), very stiff, mottled gray and brown, moist, medium plasticity
--very stiff, trace sand
--very stiff, gray, low to medium plasticity, some silt
--very stiff, medium plasticity, trace fine silty sand approximately 100 mm thick
--very stiff, low plasticity, fine grained sand
FAT CLAY (CH), hard, mottled dark gray and brown, moist, high plasticity
07-08-05
Groundwater was not measured due to Rotary wash drilling method
05-B-4 Elev. 6.0 m± Sta 12+84 0m± Rt.BRIDGE ℄
127 mm 75mm ASPHALT CONCRETE over 75 mm AGGREGATE BASE
LEAN CLAY WITH SAND (CL), very stiff, blackish brown, moist
--very stiff, yellowish brown
--very stiff
WELL-GRADED SAND WITH SILT AND GRAVEL (SW-SM), medium dense, brown to gray, wet (+#4=30%, -#200=7%)
LEAN CLAY WITH SAND (CL), stiff, yellowish brown, wet, medium plasticity (LL=35, PI=17)
--very stiff
--very stiff
--very stiff
CLAYEY SAND (SC), medium dense, yellowish brown, wet
LEAN CLAY WITH SAND (CL), very stiff, gray, wet
--hard
CLAYEY SAND (SC), medium dense, light gray, wet
LEAN CLAY WITH SAND (CL), very stiff, light gray, wet
07-08-05
Groundwater was not measured due to Rotary wash drilling method
PROFILE
Vert. 1 : 100
Hor. 1 : 500
ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN
Note:
Modified California Sampler: I.D. = 64mm; O.D. = 76mm
Hammer Assembly: A 63.5 kg hammer with a 762 mm drop (Rope and Pulley)
ELEVATION (meters)
BRIDGE ℄ 10+50 11+00 11+50 12+00 12+50 13+00
LEGEND OF BORING OPERATIONS
LEGEND OF EARTH MATERIALS
CONSISTENCY CLASSIFICATION FOR SOILS
NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.
DESIGN OVERSIGHT
SIGN OFF DATE
DRAWN BY SYAMALA PAMPATI
CHECKED BY FRANK WANG
R. LIARD/ L. BHANGOO FIELD INVESTIGATION BY:
DATE: 07-05
PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
FRANK WANG PROJECT ENGINEER
BRIDGE NO. 37-0664
KILOMETER POST R5.5
NORTH BORREGAS AVE POC
LOG OF TEST BORINGS 2 OF 2
GEOTECHNICAL LOG OF TEST BORINGS SHEET (METRIC) (REV 6/21/04)
ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS
CU 04
EA 441201
DISREGARD PRINTS BEARING EARLIER REVISION DATES
FILE => $REQUEST

APPENDIX C

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" in Appendix B.

Moisture-Density
The natural moisture contents and dry unit weights were determined for selected undisturbed samples of the soils in general accordance with CT 226. This information was used to classify and correlate the soils. The results are presented in the summary table on Plates C-2A and C-2B.

Atterberg Limits
Atterberg Limits (CT 204) were determined on 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. The tests results are presented on Plate C-3, "Plasticity Chart".

Grain Size Classification
Grain size classification tests (CT 202) were performed on selected samples of granular soil to aid in the classification. The results are presented on Plate C-4, "Grain Size Distribution Curves".

Unconfined Compression Tests
Strength tests were performed on selected undisturbed samples in general accordance with CT 221. The results are presented on Plates C-5A through C-5J.

Consolidation Test
One dimension consolidation test (CT 219) was performed on selected sample of clayey soil to aid in estimating settlement under approach fill. The results are presented on Plate C-6.

Corrosion Tests
Corrosion tests were performed on selected samples to determine the corrosion potential of the soils, according to CT 643, 417 and 422. The tests were performed by Sunland Analytical. The test results are presented on Plates C-7A through C-7D.

R-value Test
R-value test was performed on representative bulk sample for pavement design. The test was performed according to CT 301. The test results are presented on Plates C-8A, C-8B, and C-8C.

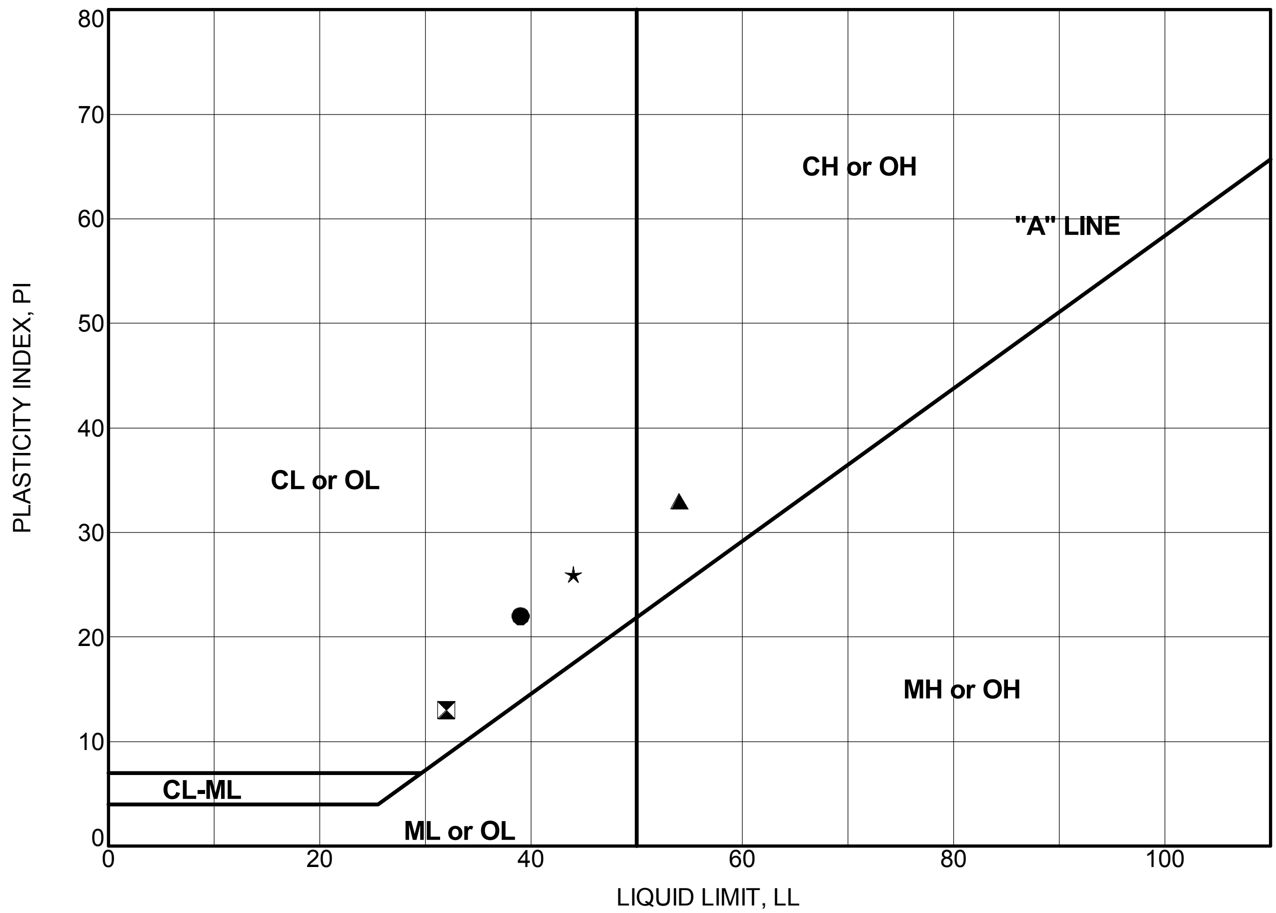
Borehole	Sample Number	Depth	Classi-fication	Water Content	Dry Density	Liquid Limit	Plastic Limit	Plasticity Index	% > Sieve 4	% < Sieve 200	Shear Strength (tsf)
R-17-003	1	5.0	CL	18.0	115.2	39	17	22			
R-17-003	2	10.0	CL	18.9	-						
R-17-003	3	15.0	SM	20.1	-				1.8	46.1	
R-17-003	4	20.0	CL	26.4	99.6						
R-17-003	5	25.0	CL	26.3	98.3						UC = 0.25
R-17-003	6	30.0	CL	25.7	-						
R-17-006	1	3.0	CL	19.8	101.9	32	19	13			
R-17-006	2	6.0	CL	15.8	110.0						
R-17-006	3	11.0	CL	23.2	102.8						
R-17-006	4	16.0	CL	32.6	91.6						
R-17-006	5	21.0	CL	19.5	107.5						UC = 0.35
R-17-006	6	26.0	CL	16.8	116.1						
R-17-006	7	31.0	CL	23.5	105.3						
R-17-009	1	3.0	CH	15.1	109.9	54	21	33			
R-17-009	2	6.0	CL	18.9	105.8						
R-17-009	3	11.0	CL	23.6	-						
R-17-009	4	16.0	CL	25.9	96.9						UC = 0.3
R-17-009	5	21.0	CL	28.9	93.8						
R-17-009	6	26.0	CL	34.8	90.4						UC = 0.3
R-17-009	7	31.0	CL	30.1	93.7						
R-17-009	8	36.0	SM	8.7	-						
R-17-009	9	41.0	CL	26.8	96.7						
R-17-010	1	6.0	CH	24.5	102.0						
R-17-010	2	11.0	CL	18.6	-						
R-17-010	3	16.0	CL	20.9	-						
R-17-010	4	21.0	CL	21.7	106.2						UC = 0.5
R-17-010	5	26.0	CL	28.2	92.2						
R-17-010	6	31.0	CL	28.9	94.8						
R-17-010	7	36.0	CL	20.7	112.5						
R-17-010	8	41.0	CL	24.1	91.2						
R-17-011	1	3.0	CL	17.6	107.1						
R-17-011	2	6.0	CH	28.8	94.7						
R-17-011	3	11.0	CL	29.7	92.9						UC = 0.3
R-17-011	4	16.0	CL	30.4	90.9						
R-17-011	5	21.0	SM	23.1	104.5						
R-17-011	6	26.0	CL	21.7	106.4						UC = 0.25
R-17-011	7	31.0	CL	26.6	99.1						
R-17-011	8	36.0	CL	31.2	94.1						
R-17-013	1	3.0	CH	30.8	83.3						
R-17-013	2	6.0	CH	26.1	96.6						
R-17-013	3	11.0	CL	22.3	102.9						UC = 0.2
R-17-013	4	16.0	CL	28.5	94.0						
R-17-013	5	21.0	CL	20.0	106.1						UC = 0.45

PARIKH
Practicing in the Geosciences

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

JOB NO: 2014-129-PSE | **PLATE NO: C-2A**

Borehole	Sample Number	Depth	Classi-fication	Water Content	Dry Density	Liquid Limit	Plastic Limit	Plasticity Index	% > Sieve 4	% < Sieve 200	Shear Strength (tsf)
R-17-013	6	26.0	CL	19.3	-						
R-17-013	7	31.0	CL	24.1	103.0						
R-17-013	8	36.0	CL	21.6	103.1						
R-17-013	9	41.0	CL	20.8	103.0						
R-17-014	1	5.0	CH	30.1	98.8						
R-17-014	2	10.0	CL	20.6	98.7						
R-17-014	3	15.0	SM	24.2	99.6				0.0	47.4	
R-17-014	4	20.0	SM	30.0	103.9						
R-17-014	5	25.0	CL	26.4	97.7	44	18	26			UC = 0.7
R-17-014	6	30.0	CL	21.6	-						
R-17-014	7	35.0	SP	11.1	144.0						
R-17-015	1	5.0	CL	70.2	113.1						
R-17-015	2	10.0	CL	21.1	-						
R-17-015	3	15.0	SM	17.8	114.8						
R-17-015	4	20.0	SC	29.3	-				1.7	31.0	
R-17-015	5	25.0	CL	24.5	-						



PLASTICITY CHART

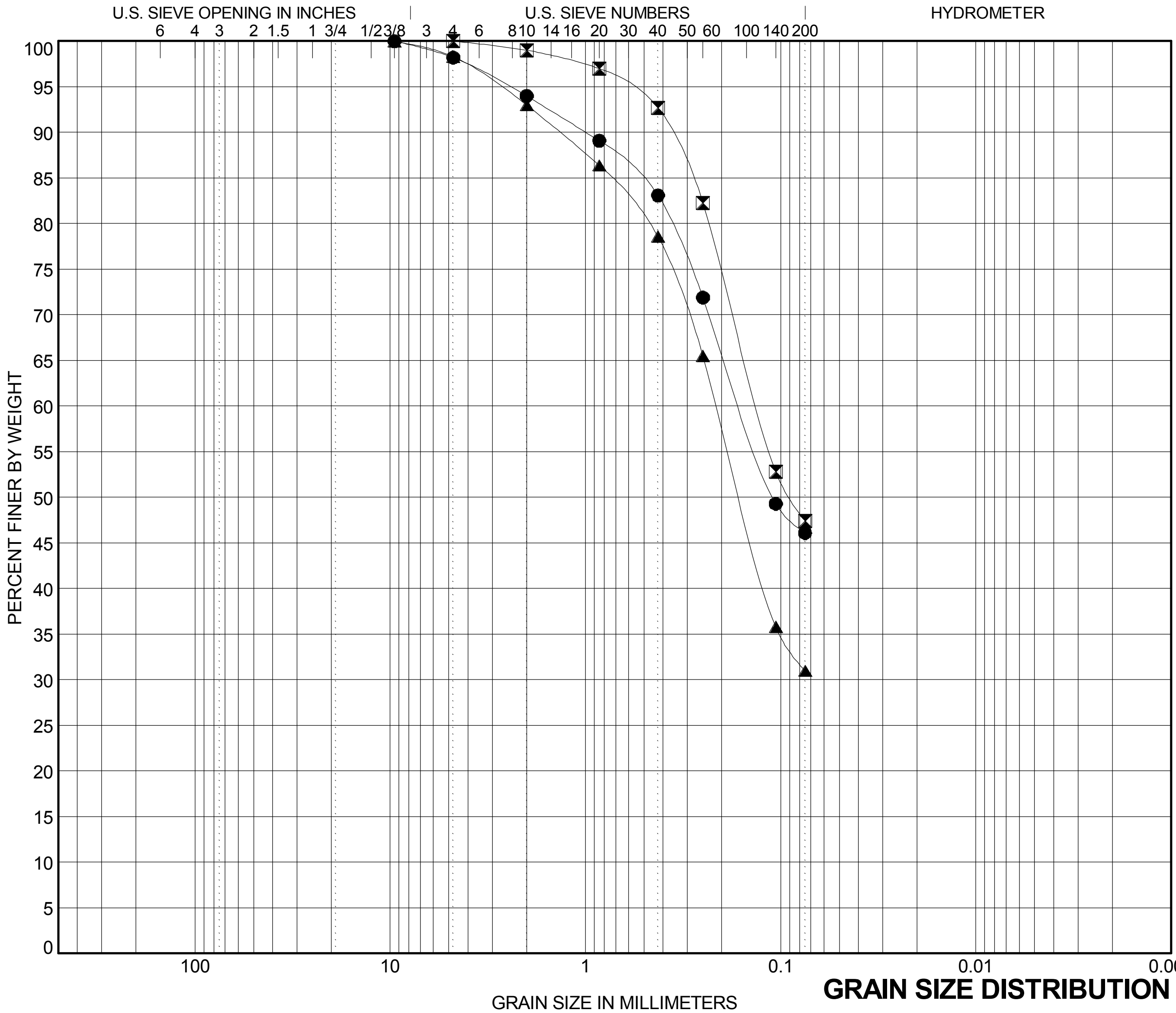
Boring Number	Sample Number	Depth (feet)	Test Symbol	Moisture Content (%)	LL	PL	PI	Description
R-17-003		5.0	●		39	17	22	Lean CLAY
R-17-006		3.0	⧗		32	19	13	Lean CLAY
R-17-009		3.0	▲		54	21	33	Fat CLAY
R-17-014		25.0	★		44	18	26	Lean CLAY

PARIKH
Practicing in the Geosciences

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

JOB NO: 2014-129-PSE

PLATE NO: C-3



GRAIN SIZE DISTRIBUTION

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	BORING	SAMPLE #	DEPTH	Classification	LL	PL	PI	Cc	Cu
●	**R-17-003**	**3**	**15.0**	**SILTY SAND**					
⧗	**R-17-014**	**3**	**15.0**	**SILTY SAND**					
▲	**R-17-015**	**4**	**20.0**	**CLAYEY SAND**					

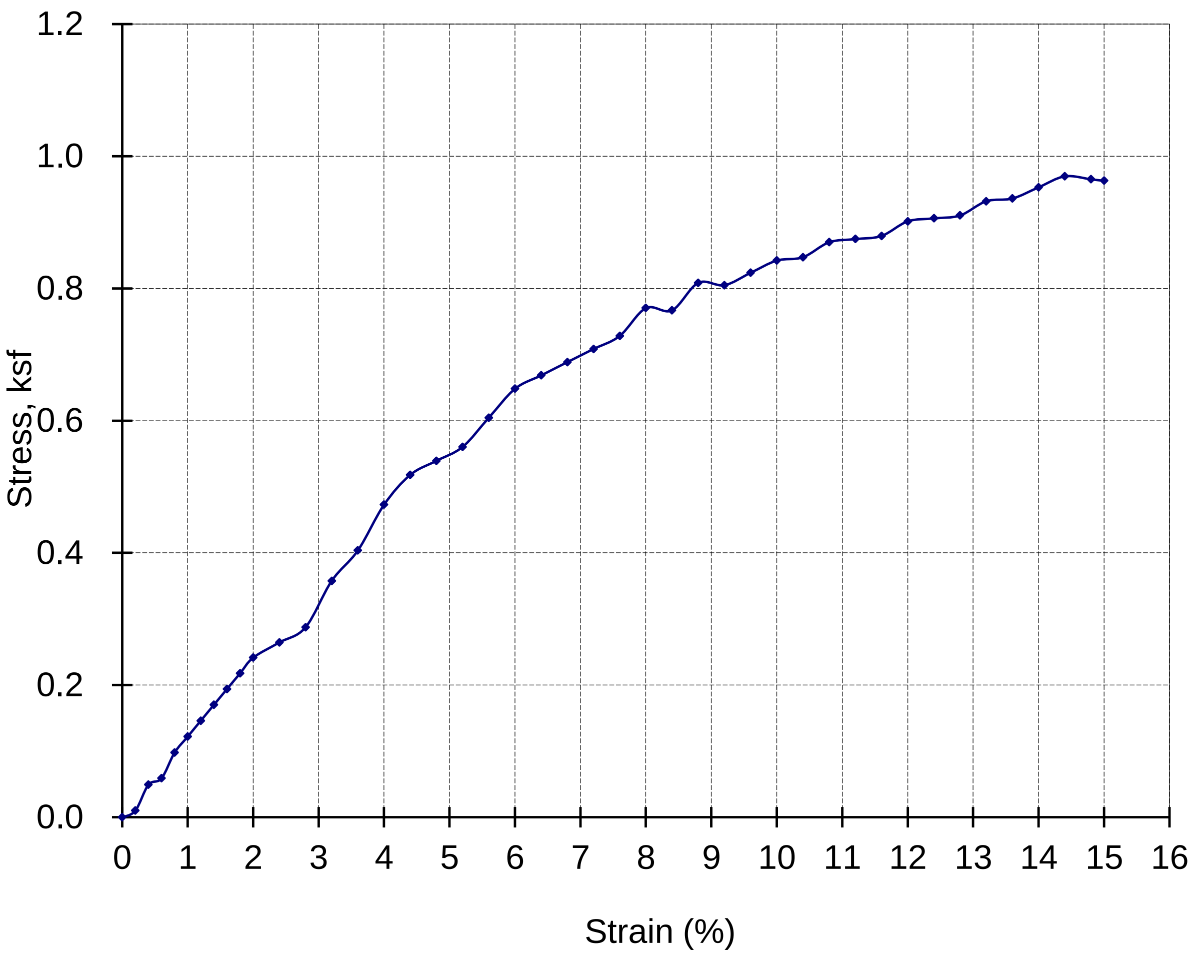
	BORING	SAMPLE #	DEPTH	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**R-17-003**	**3**	**15.0**	**9.5**	**0.159**			**1.8**	**52.1**	**46.1**	
⧗	**R-17-014**	**3**	**15.0**	**4.75**	**0.131**			**0.0**	**52.6**	**47.4**	
▲	**R-17-015**	**4**	**20.0**	**9.5**	**0.213**			**1.7**	**67.3**	**31.0**	

PARIKH
Practicing in the Geosciences

MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101
SUNNYVALE, CALIFORNIA

JOB NO: 2014-129-PSE | **PLATE NO: C-4**

UNCONFINED COMPRESSION TEST



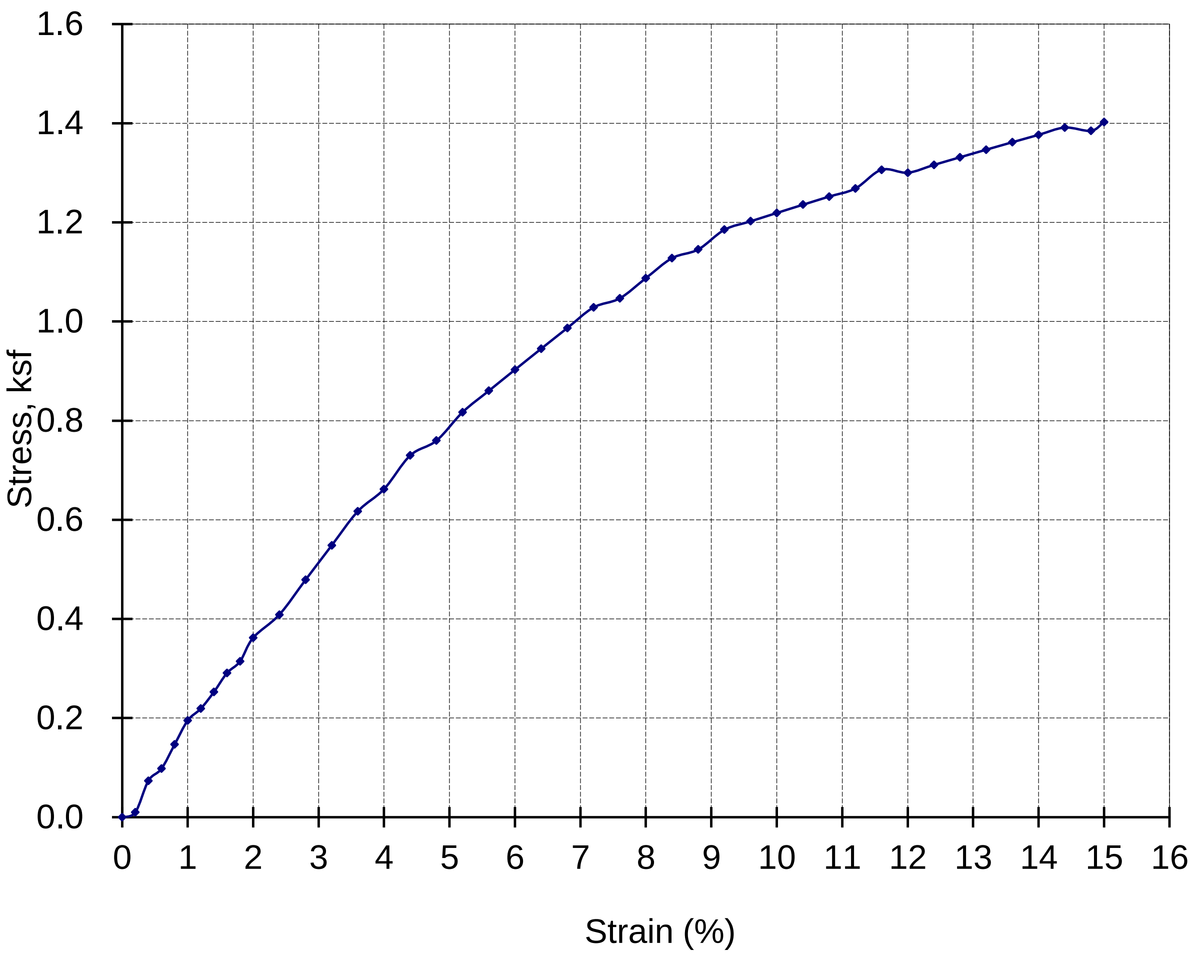
Boring No.: R-17-003

Sample No. : 6 **Maximum Strength (ksf):** 0.96

Depth (feet): 25 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

UNCONFINED COMPRESSION TEST



Boring No.: R-17-006

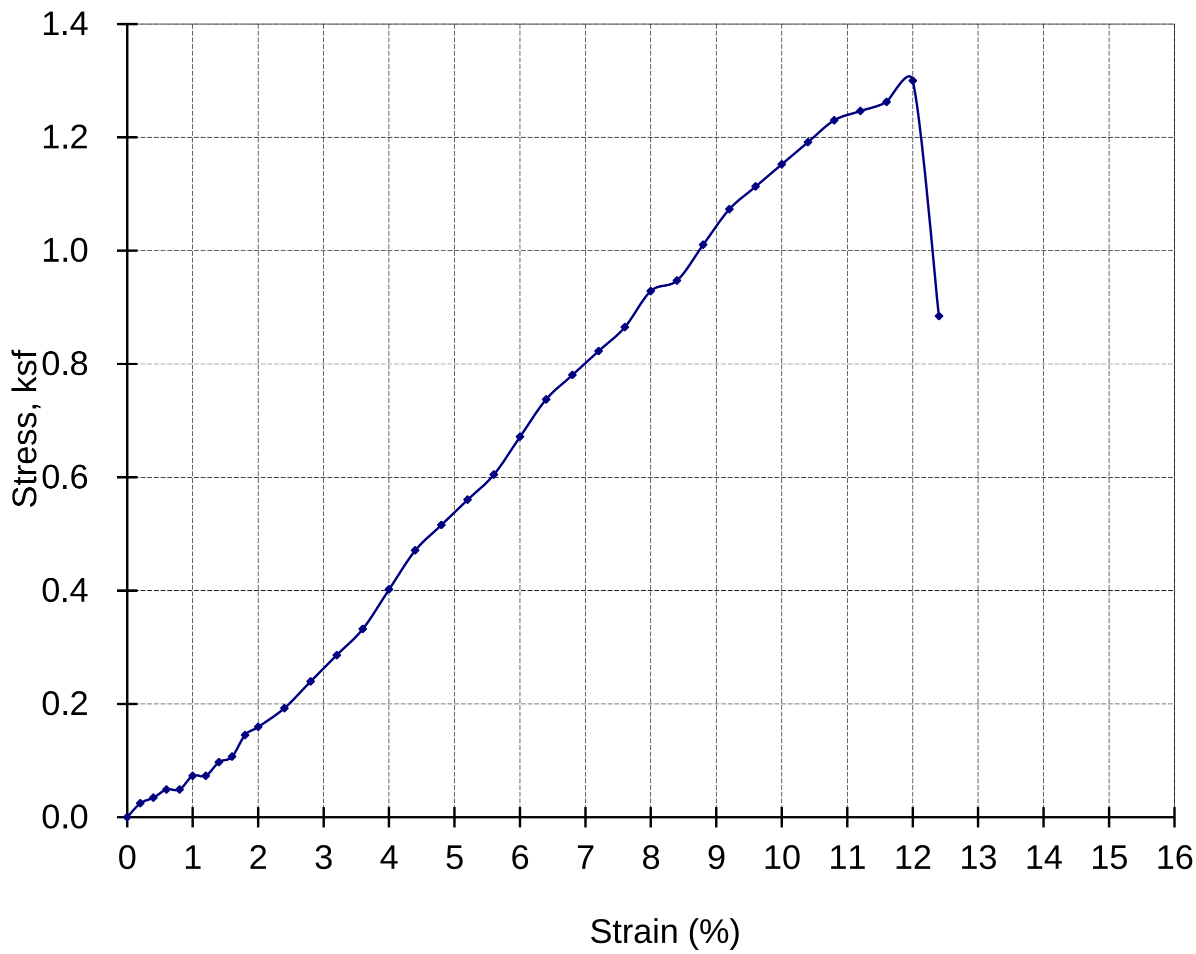
Sample No. : 5 **Maximum Strength (ksf):** 1.40

Depth (feet): 21 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**
	JOB NO.: 2014-129-PSE **PLATE NO.:** C-5B

UNCONFINED COMPRESSION TEST



Boring No.: R-17-009

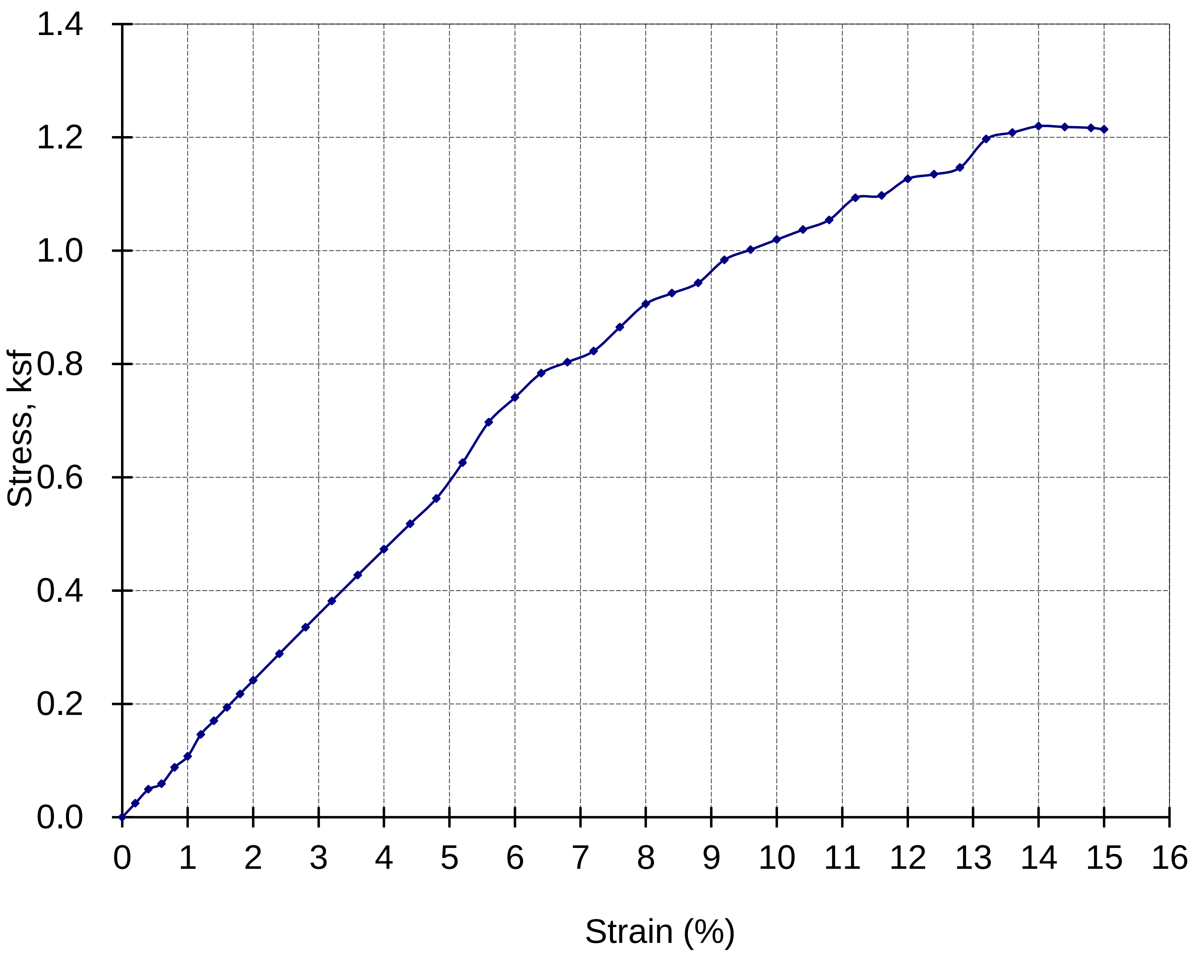
Sample No. : 4 **Maximum Strength (ksf):** 1.30

Depth (feet): 16 **Strain @ Failure (%):** 12.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**
JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5C

UNCONFINED COMPRESSION TEST



Boring No.: R-17-009

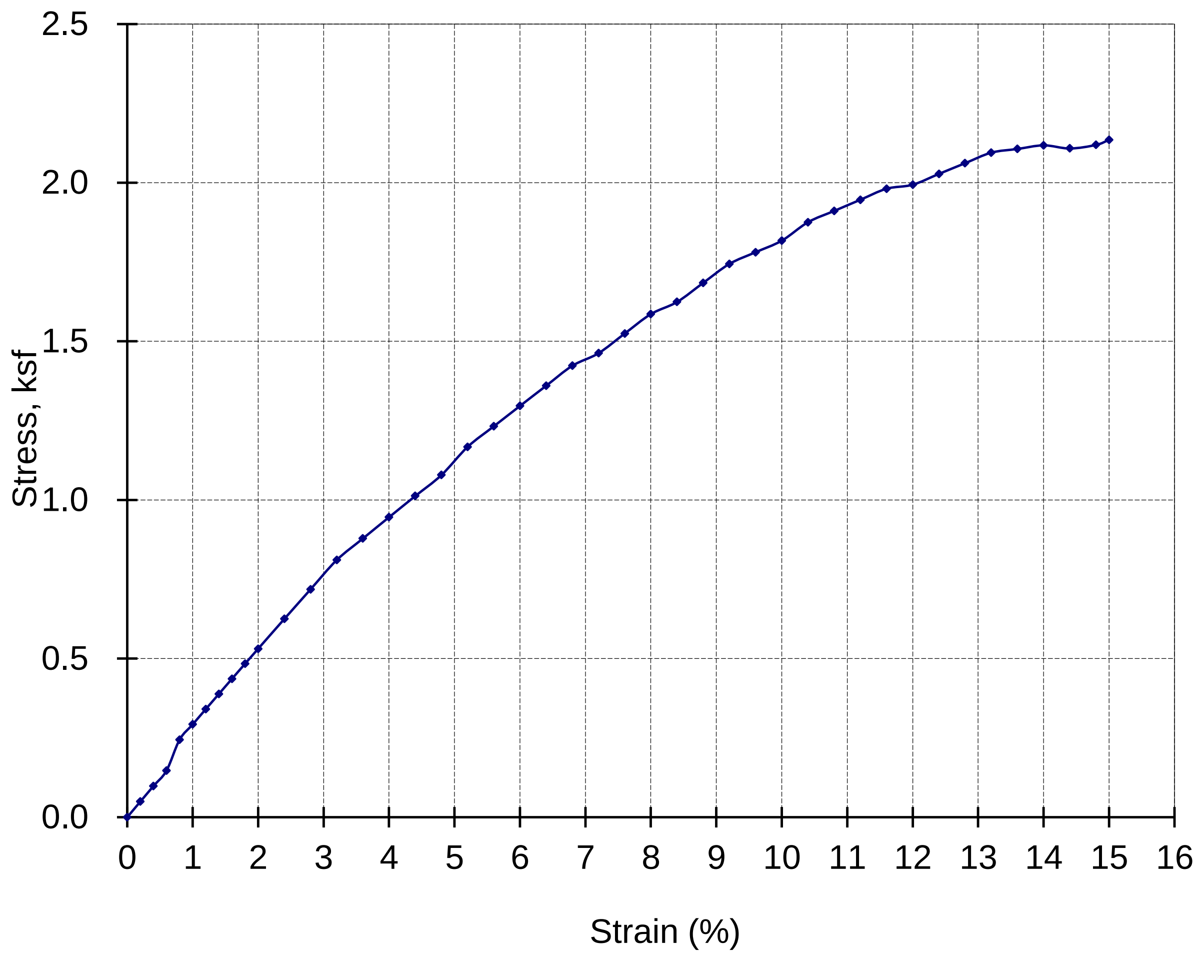
Sample No. : 6 **Maximum Strength (ksf):** 1.20

Depth (feet): 26 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**	
	JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5D

UNCONFINED COMPRESSION TEST



Boring No.: R-17-010

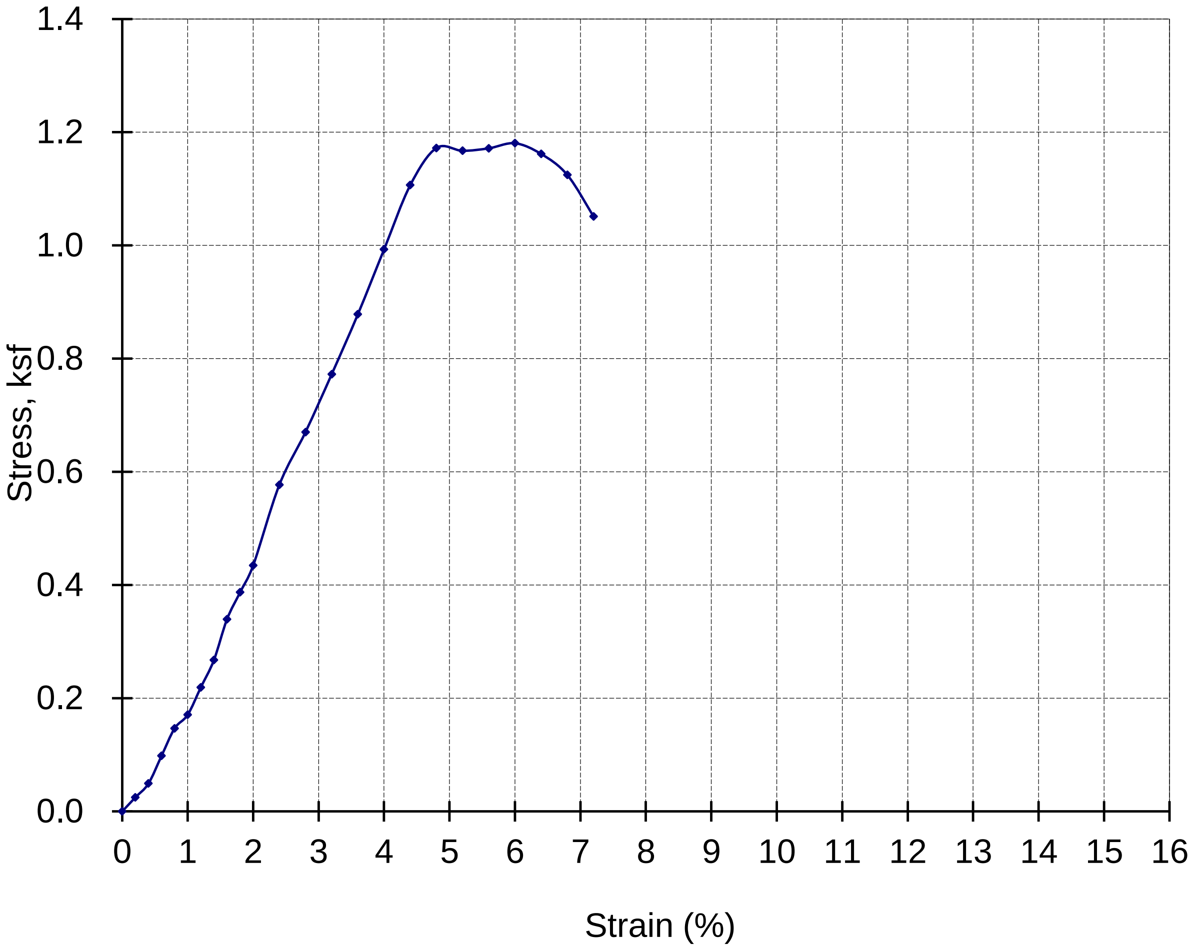
Sample No. : 4 **Maximum Strength (ksf):** 2.10

Depth (feet): 21 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**	
	JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5E

UNCONFINED COMPRESSION TEST



Boring No.: R-17-011

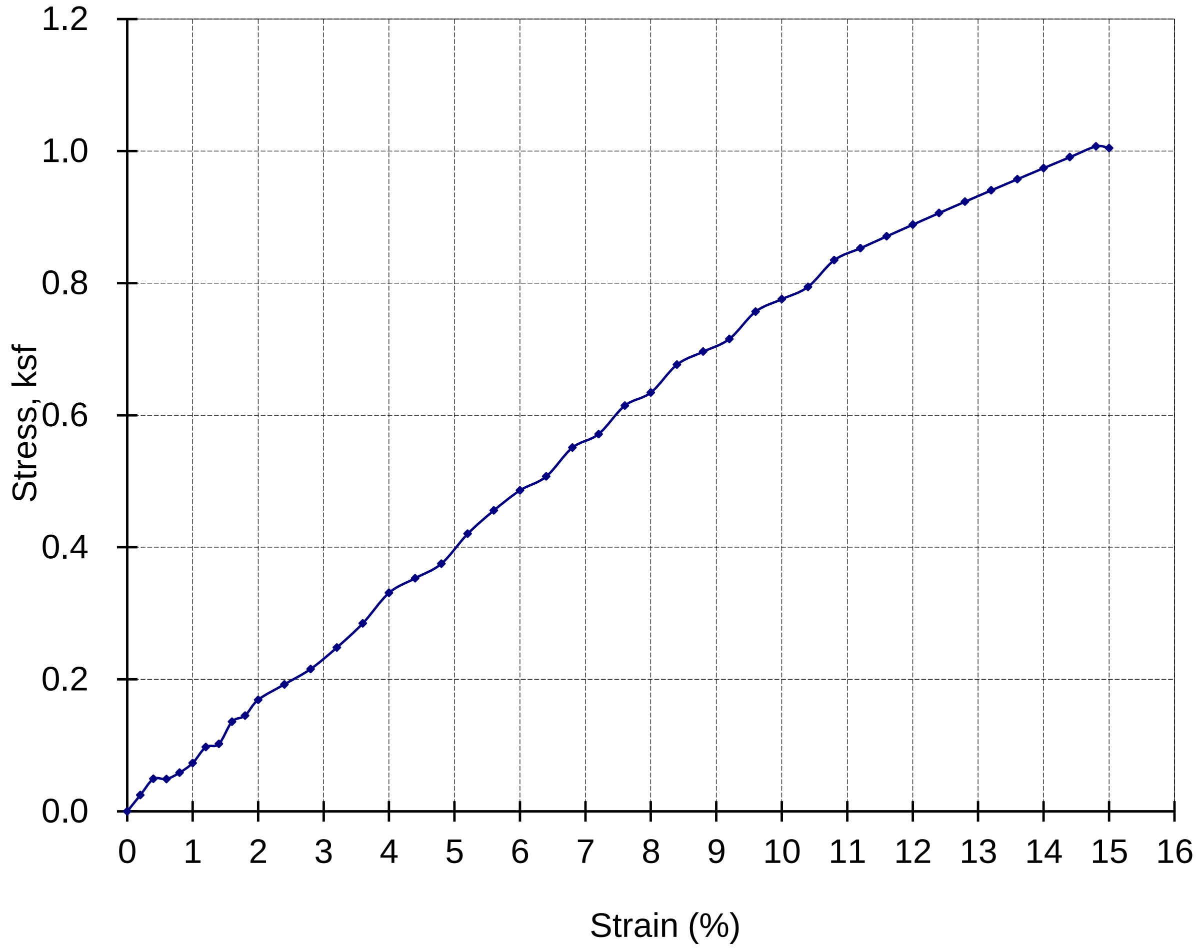
Sample No. : 3 **Maximum Strength (ksf):** 1.20

Depth (feet): 11 **Strain @ Failure (%):** 6.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**	
	JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5F

UNCONFINED COMPRESSION TEST



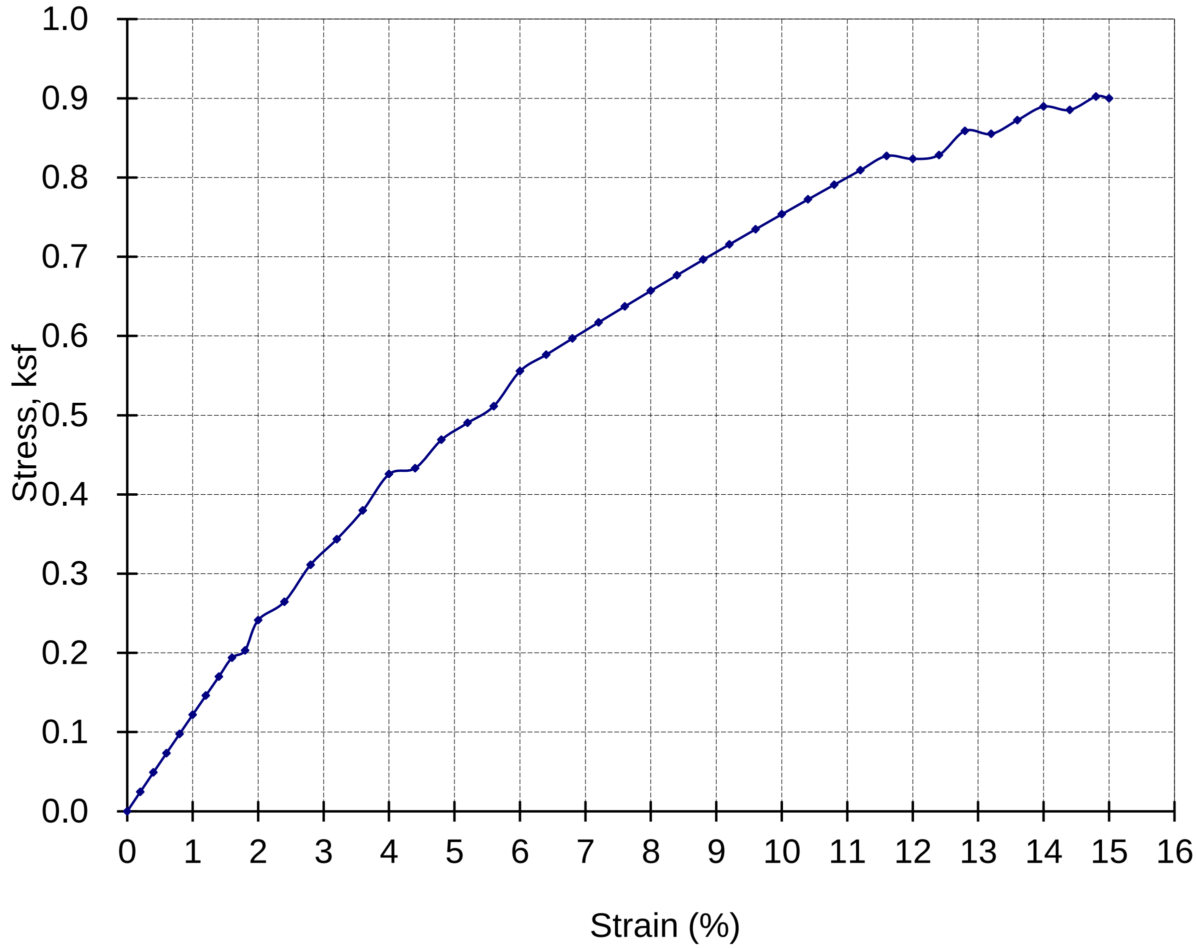
Boring No.: R-17-011

Sample No. : 6 **Maximum Strength (ksf):** 1.00

Depth (feet): 26 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

UNCONFINED COMPRESSION TEST



Boring No.: R-17-013

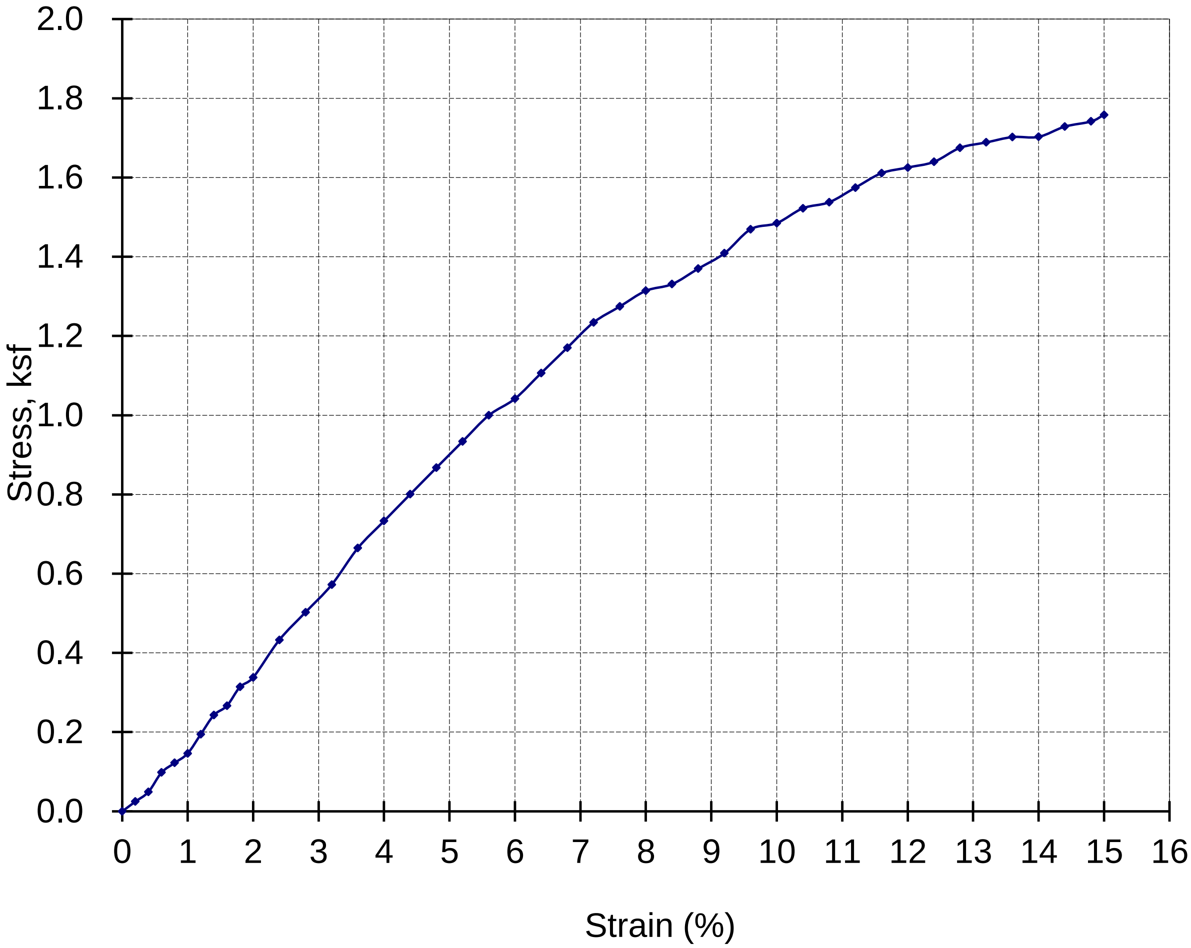
Sample No. : 3 **Maximum Strength (ksf):** 0.90

Depth (feet): 11 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, soft

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**	
	JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5H

UNCONFINED COMPRESSION TEST



Boring No.: R-17-013

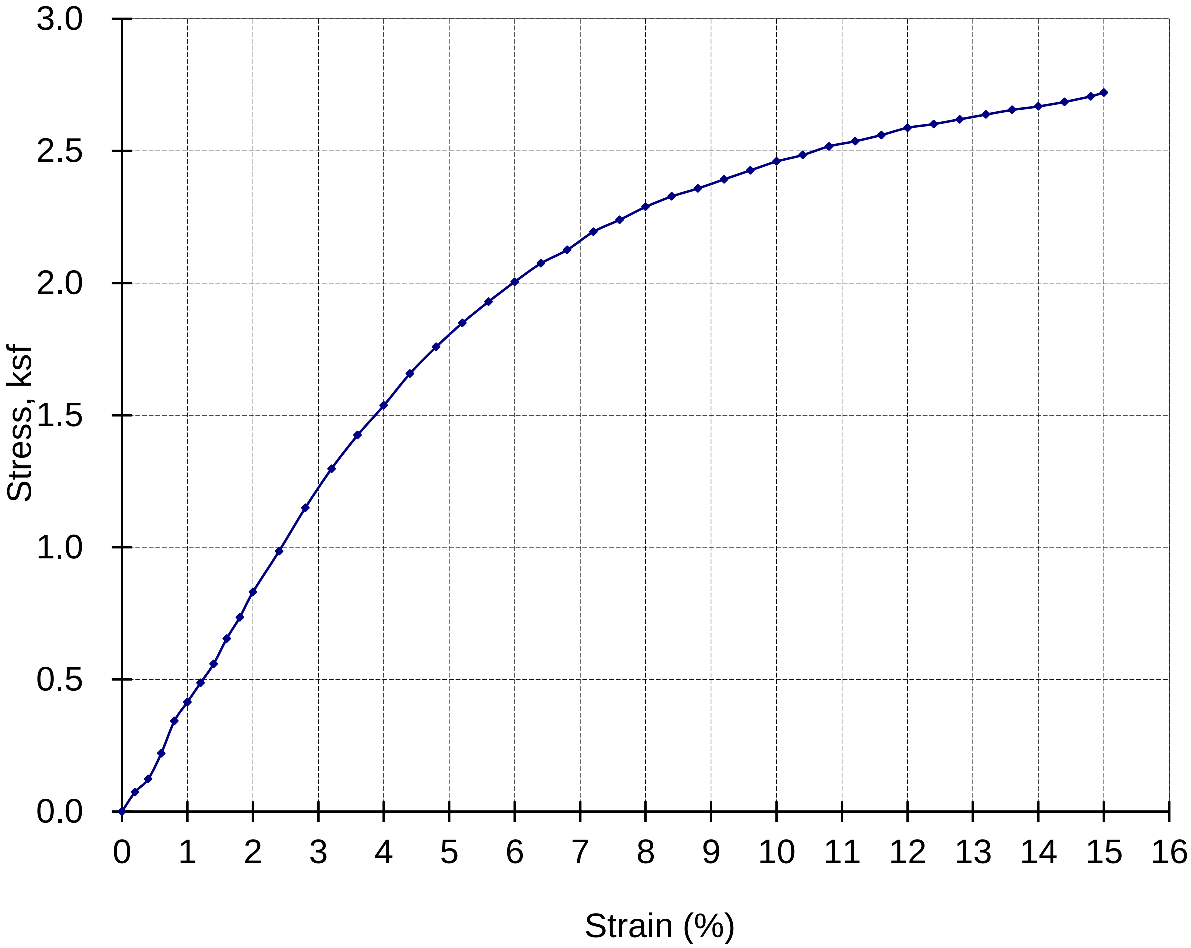
Sample No. : 5 **Maximum Strength (ksf):** 1.80

Depth (feet): 21 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, medium stiff

PARIKH CONSULTANTS, INC. **GEOTECHNICAL CONSULTANTS** **MATERIALS TESTING**	**MATHILDA AVENUE IMPROVEMENTS AT SR 237 AND US 101** **SUNNYVALE, CALIFORNIA**	
	JOB NO.: 2014-129-PSE	**PLATE NO.:** C-5l

UNCONFINED COMPRESSION TEST



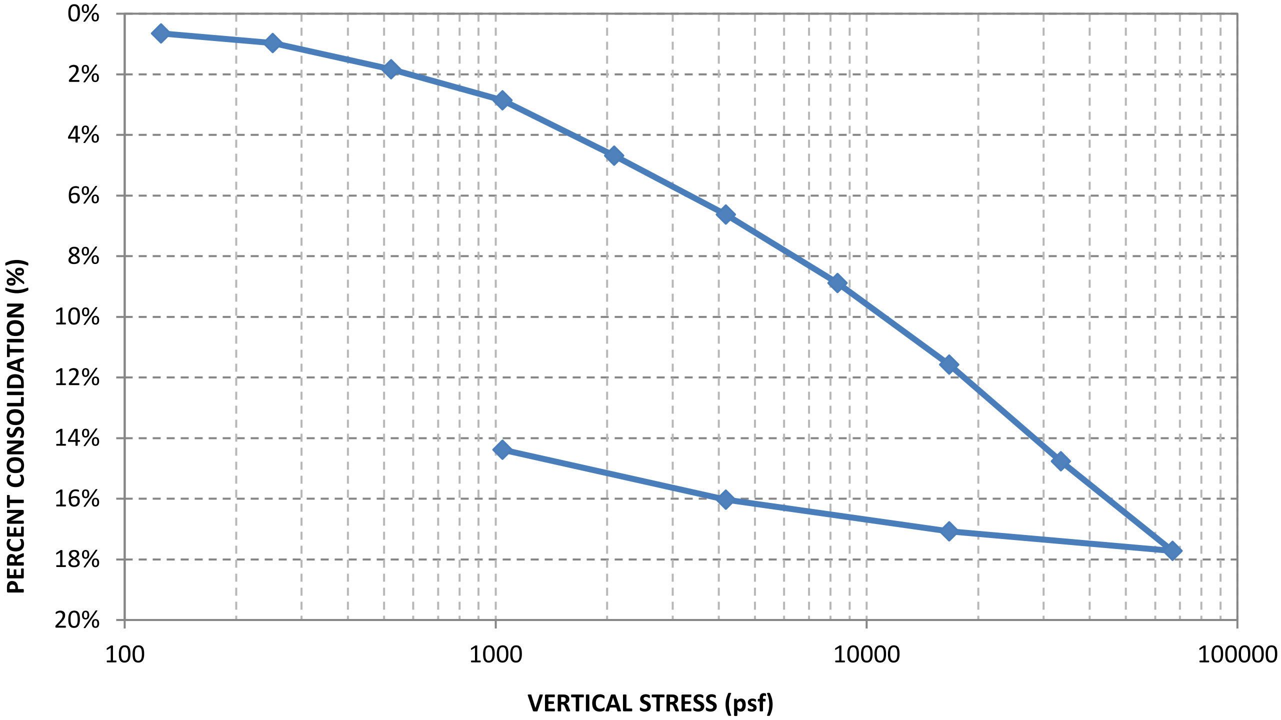
Boring No.: R-17-014

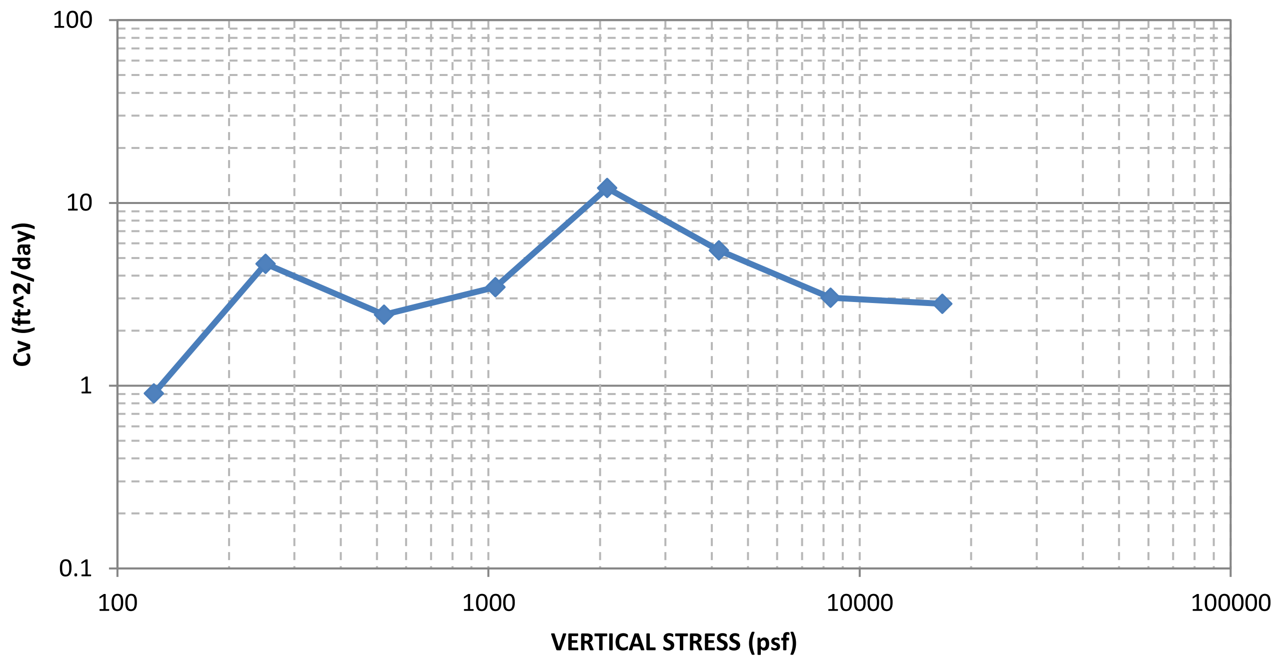
Sample No. : 5 **Maximum Strength (ksf):** 2.70

Depth (feet): 25 **Strain @ Failure (%):** 15.00

Material Description:
Lean Clay, stiff

CONSOLIDATION TEST RESULT





	Moisture Content (%)	Bulk Density (psf)	Dry Density (psf)
Initial	30.6	113.53	86.91
Final	21.9	131.03	107.53

Boring No.	R-17-011
Sample No.	4
Depth (ft)	16
Soil Description:	LEAN CLAY, light brown

PARIKH CONSULTANTS, INC.
GEOTECHNICAL CONSULTANTS
MATERIALS TESTING

MATHILDA AVENUE IMPROVEMENTS
AT SR 237 AND US 101
SANNYVALE, CALIFORNIA

JOB NO.: 2014-129-PSE | **PLATE NO.: C-6**

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 04/19/2017
Date Submitted 04/14/2017

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite 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 : 2014-129-065 Site ID : R-17-006 2@6FT
Thank you for your business.

* For future reference to this analysis please use SUN # 74009-154368.

EVALUATION FOR SOIL CORROSION

Soil pH	7.80	
Minimum Resistivity	1.98	ohm-cm (x1000)
Chloride	135.6 ppm	00.01356 %
Sulfate	80.5 ppm	00.00805 %

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

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 04/19/2017
Date Submitted 04/14/2017

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite 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 : 2014-129-065 Site ID : R-17-009 3@11FT
Thank you for your business.

* For future reference to this analysis please use SUN # 74009-154367.

EVALUATION FOR SOIL CORROSION

Soil pH	7.69	
Minimum Resistivity	1.26 ohm-cm (x1000)	
Chloride	9.8 ppm	00.00098 %
Sulfate	45.5 ppm	00.00455 %

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

Sunland Analytical

11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 04/19/2017
Date Submitted 04/14/2017

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite 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 : 2014-129-065 Site ID : R-17-013 1@3FT
Thank you for your business.

* For future reference to this analysis please use SUN # 74009-154369.

EVALUATION FOR SOIL CORROSION

Soil pH	7.33	
Minimum Resistivity	0.86 ohm-cm (x1000)	
Chloride	3.3 ppm	00.00033 %
Sulfate	10.1 ppm	00.00101 %

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

Sunland Analytical
11419 Sunrise Gold Circle, #10
Rancho Cordova, CA 95742
(916) 852-8557

Date Reported 04/19/2017
Date Submitted 04/14/2017

To: Nasir Ahmad
Parikh Consultants, Inc.
2360 Qume Dr. Suite 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 : 2014-129-065 Site ID : R-17-014 2@10FT
Thank you for your business.

* For future reference to this analysis please use SUN # 74010-154370.

EVALUATION FOR SOIL CORROSION

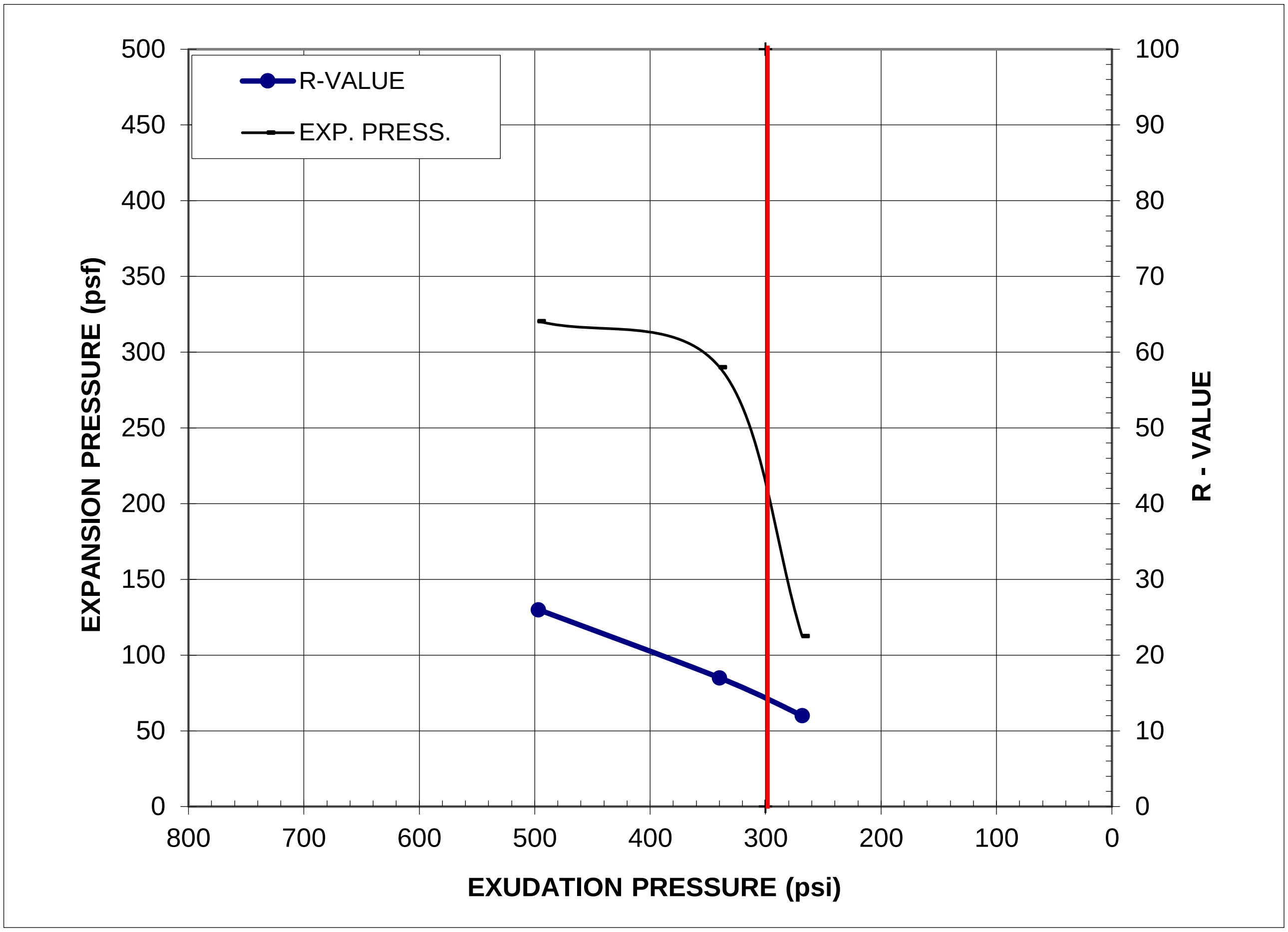
Soil pH	7.59		
Minimum Resistivity	1.50	ohm-cm (x1000)	
Chloride	11.4 ppm	00.00114	%
Sulfate	52.3 ppm	00.00523	%

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

R-VALUE REPORT

Parikh Consultants, Inc. **ASTM D2844 or CTM 301** (408) 452-9000

Project Name:	Mathilda Ave Improvements at SR 237 and US 101	Date:	3/31/2017
Client:	WMH	Project #:	2014-129-PSE
Sample #:	B-2 Depth: 0'-5'	Lab #:	M985
Location / Source:	Onsite / Native	Sample Date:	
Material :	Silty lean clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	268.43	339.94	496.8
Expansion Pressure, psf	112.58	290.11	320.4
R-Value	12	17	26
Moisture Content at Test, %	27.5	25.4	24.3
Dry Density at Test, pcf	98.2	100.2	112.9

R-Value @ 300 psi Exudation Pressure = 14

Expansion Pressure @300 psi Exudation, psf = **210**

Minimum R-Value Requirement:

Comments:

Report By: Nasir Ahmad

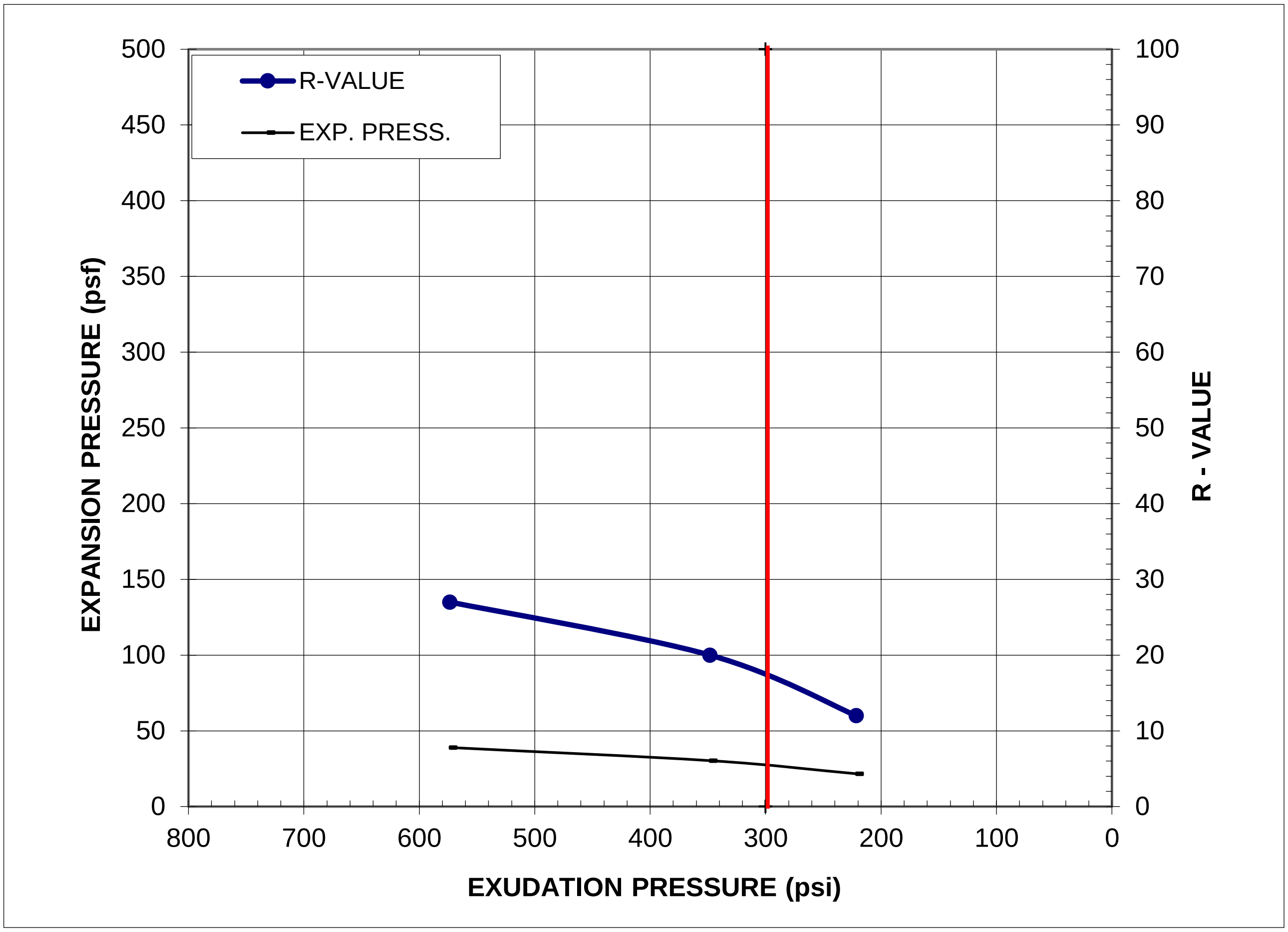
PLATE NO.: C-8A

RVALUE with calcs pdp

R-VALUE REPORT

Parikh Consultants, Inc. **ASTM D2844 or CTM 301** (408) 452-9000

Project Name:	Mathilda Ave Improvements at SR 237 and US 101	Date:	4/11/2017
Client:	WMH	Project #:	2014-129-PSE
Sample #:	B-6 Depth: 0'-5'	Lab #:	M985
Location / Source:	Onsite / Native	Sample Date:	
Material :	Sandy lean clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	221.61	348.3	573.52
Expansion Pressure, psf	21.65	30.31	38.97
R-Value	12	20	27
Moisture Content at Test, %	15.9	14.1	13.1
Dry Density at Test, pcf	117.8	122.6	122.9

R-Value @ 300 psi Exudation Pressure = 18

Expansion Pressure @300 psi Exudation, psf = **25**

Minimum R-Value Requirement:

Comments:

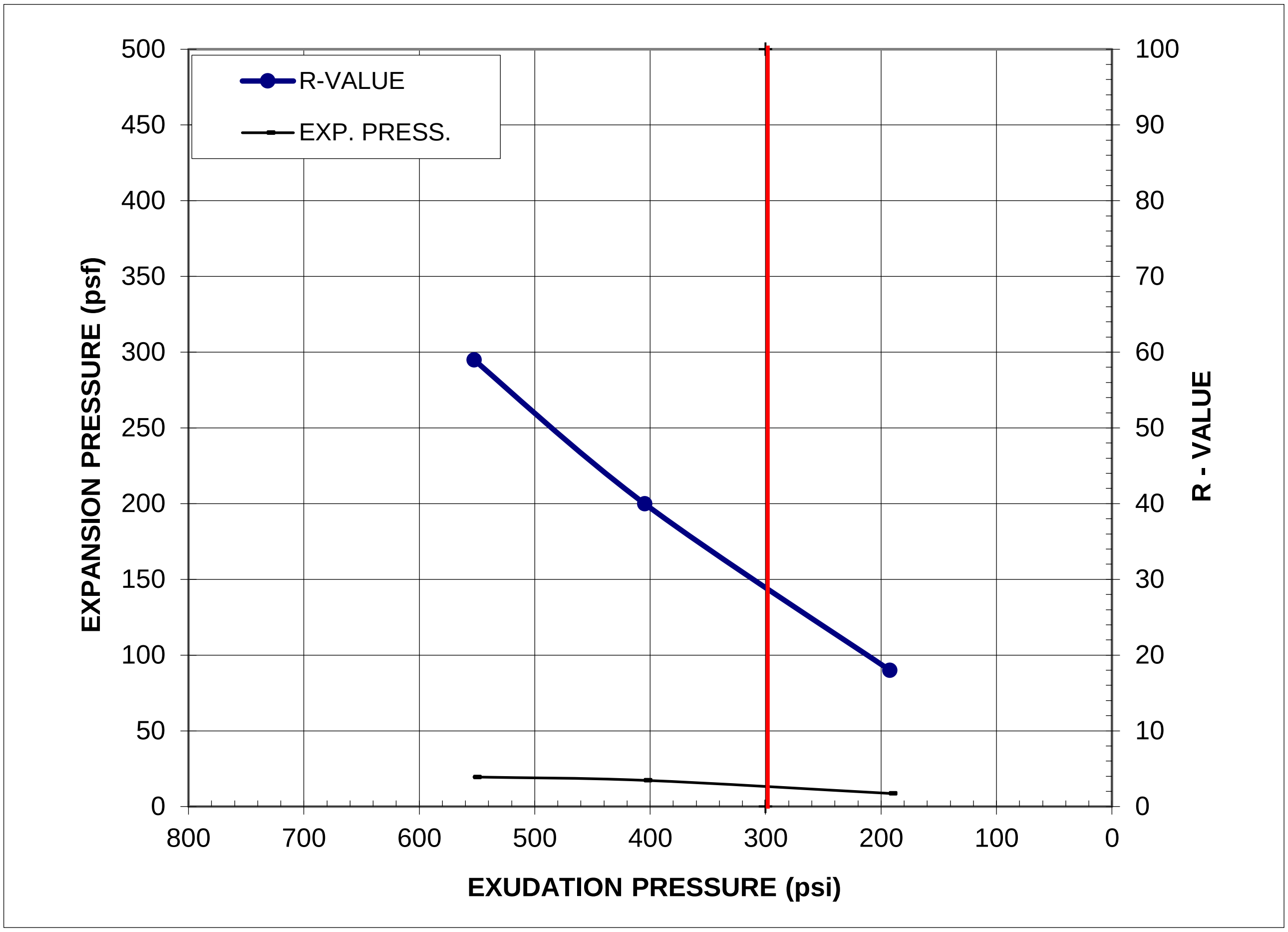
Report By: Nasir Ahmad

PLATE NO.: C-8B

R-VALUE REPORT

Parikh Consultants, Inc. | **ASTM D2844 or CTM 301** | (408) 452-9000

Project Name:	Mathilda Ave Improvements at SR 237 and US 101	Date:	4/11/2017
Client:	WMH	Project #:	2014-129-PSE
Sample #:	B-8 Depth: 0'-5'	Lab #:	M985
Location / Source:	Onsite / Native	Sample Date:	
Material :	Sandy lean clay, brown	Sampled By:	



Specimen No.	A	B	C
Exudation Pressure, psi	192.4	404.9	552.7
Expansion Pressure, psf	8.66	17.3	19.5
R-Value	18	40	59
Moisture Content at Test, %	9.6	7.8	7.4
Dry Density at Test, pcf	128.2	133.3	135.0

R-Value @ 300 psi Exudation Pressure = 28

Expansion Pressure @300 psi Exudation, psf = **15**

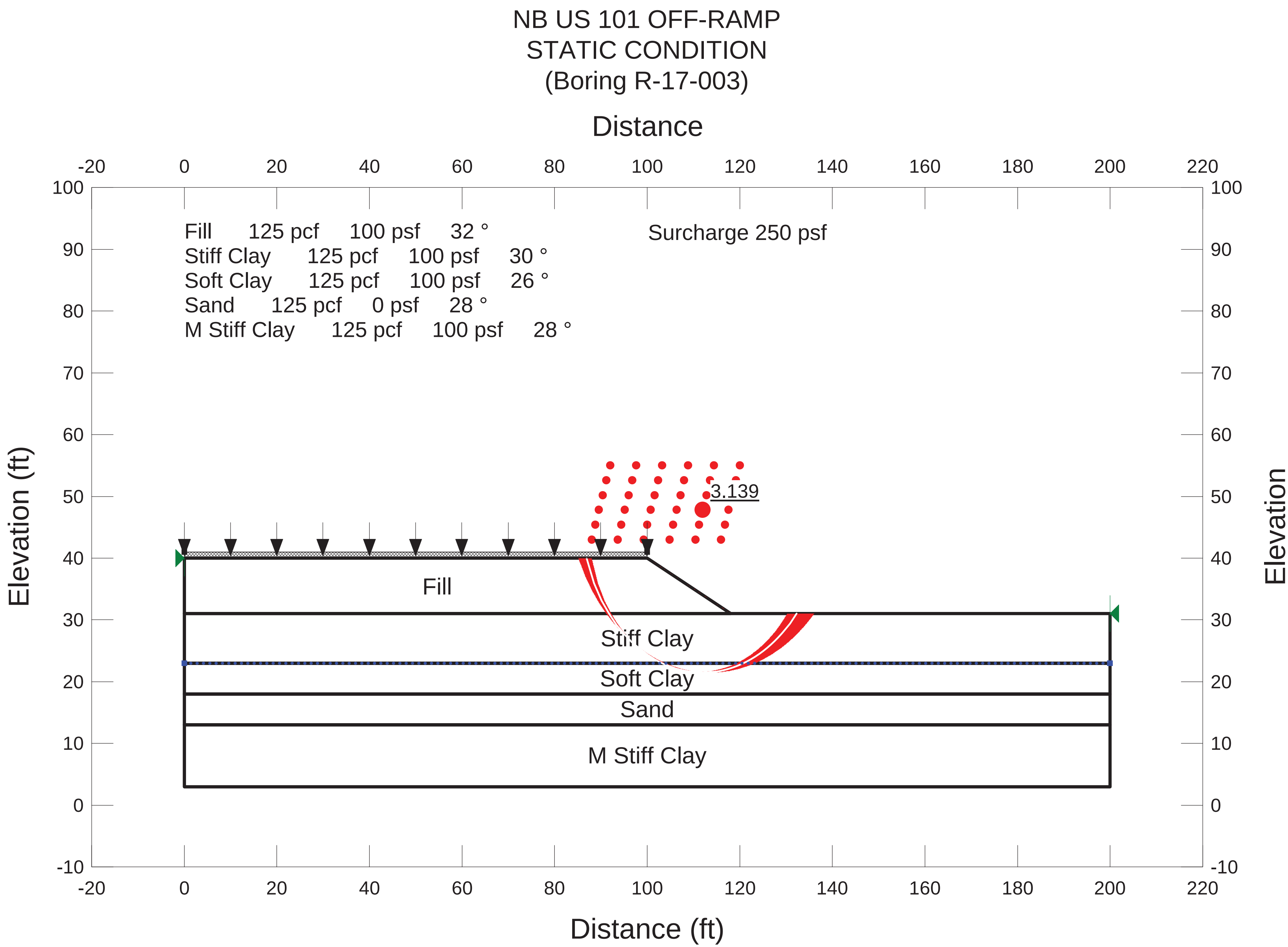
Minimum R-Value Requirement:

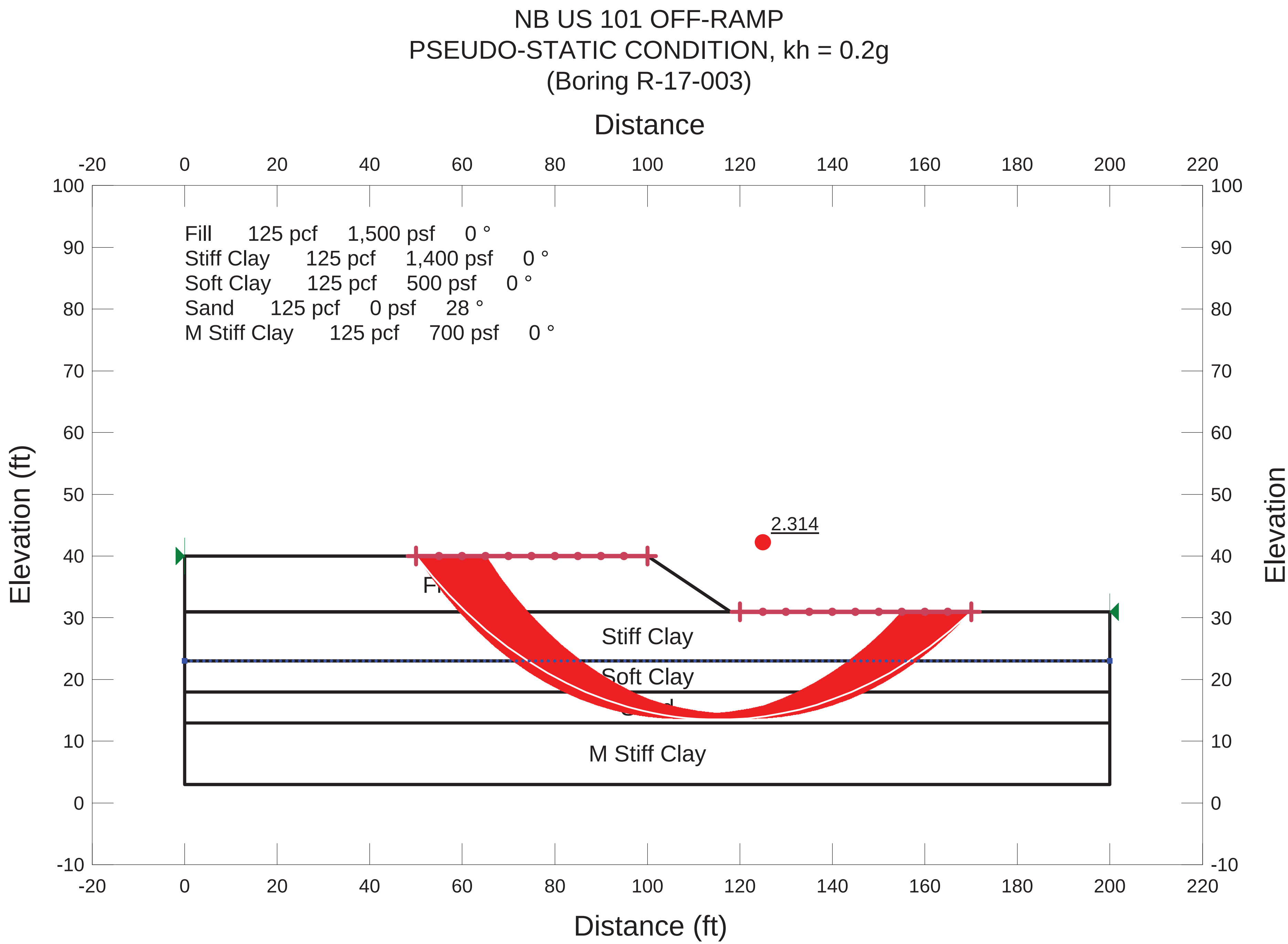
Comments:

Report By: Nasir Ahmad

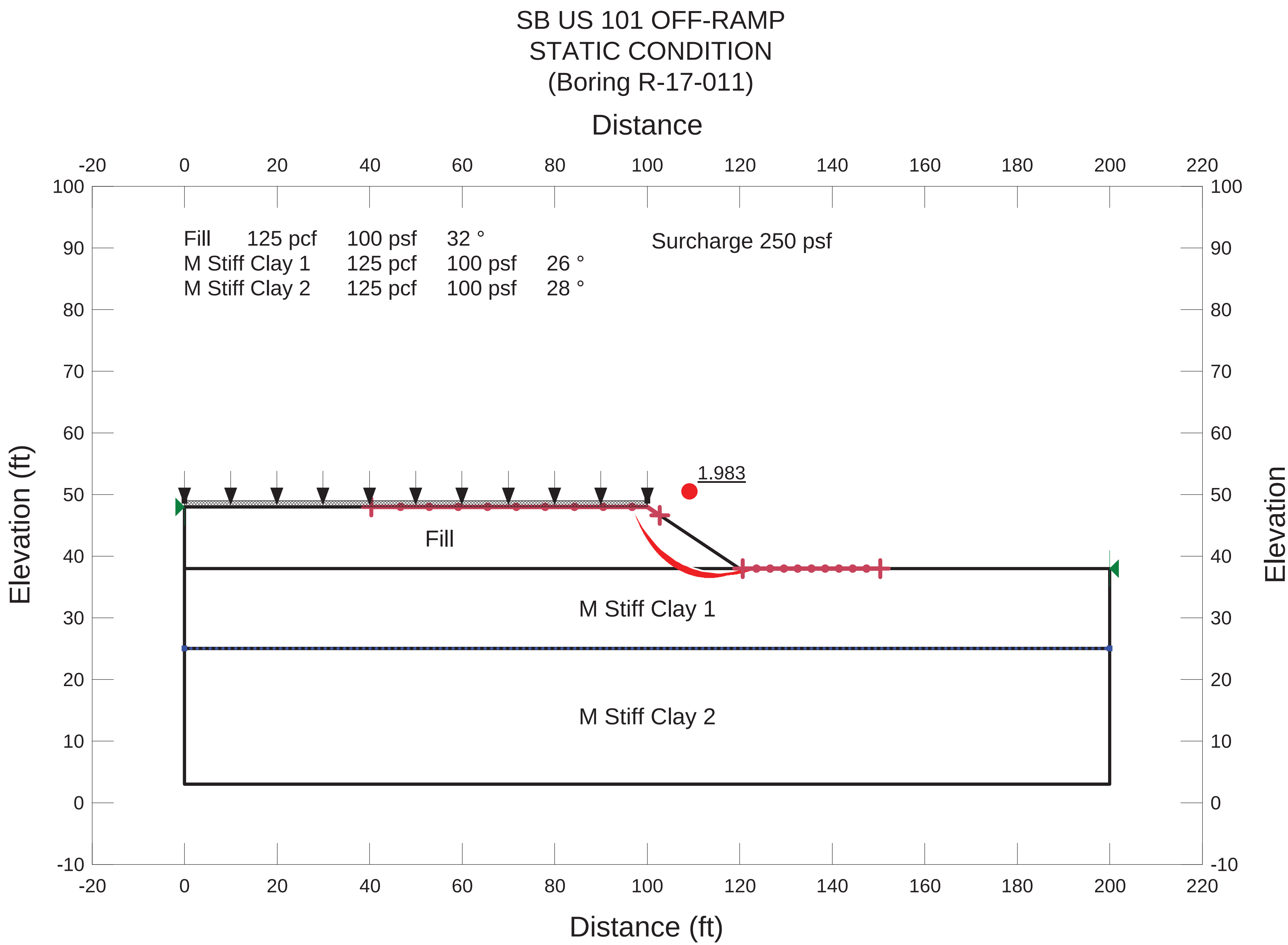
PLATE NO.: C-8C

APPENDIX D


NB US 101 OFF-RAMP
STATIC CONDITION
(Boring R-17-003)
Distance
Fill 125 pcf 100 psf 32 °
Stiff Clay 125 pcf 100 psf 30 °
Soft Clay 125 pcf 100 psf 26 °
Sand 125 pcf 0 psf 28 °
M Stiff Clay 125 pcf 100 psf 28 °
Surcharge 250 psf
3.139
Fill
Stiff Clay
Soft Clay
Sand
M Stiff Clay
Elevation (ft)
Elevation
Distance (ft)

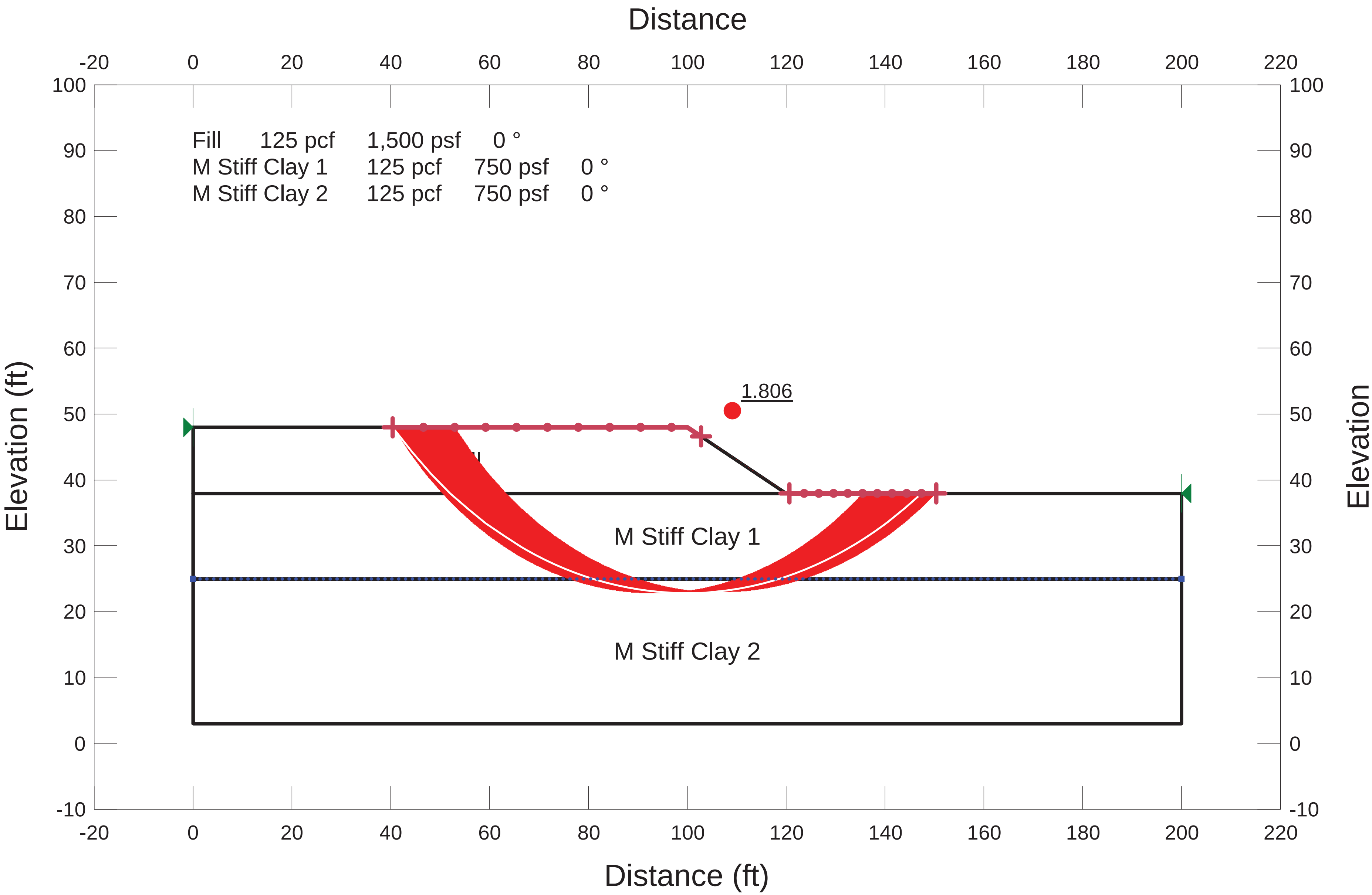


NB US 101 OFF-RAMP
PSEUDO-STATIC CONDITION, kh = 0.2g
(Boring R-17-003)
Distance
Fill 125 pcf 1,500 psf 0 °
Stiff Clay 125 pcf 1,400 psf 0 °
Soft Clay 125 pcf 500 psf 0 °
Sand 125 pcf 0 psf 28 °
M Stiff Clay 125 pcf 700 psf 0 °
2.314
Stiff Clay
Soft Clay
M Stiff Clay
Elevation (ft)
Elevation
Distance (ft)



SB US 101 OFF-RAMP
STATIC CONDITION
(Boring R-17-011)
Distance
Fill 125 pcf 100 psf 32 °
M Stiff Clay 1 125 pcf 100 psf 26 °
M Stiff Clay 2 125 pcf 100 psf 28 °
Surcharge 250 psf
1.983
Fill
M Stiff Clay 1
M Stiff Clay 2
Elevation (ft)
Elevation
Distance (ft)

SB US 101 OFF-RAMP
PSEUDO-STATIC CONDITION, kh = 0.2g
(Boring R-17-011)



LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-003**	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 75%	
GW DEPTH (ft)=	9		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR)				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	$K\sigma$	$K\alpha$	F.S.	Volumetric Strain (%)
1	5	2	19	MC	625	625	0.99		12.4	1.3	0.75	1.0	1.0	11.6	1.45	16.8				1.00	1		
2	10	2	5	MC	1250	1156	0.98		3.3	1.3	0.80	1.0	1.0	3.3	1.24	4.0				1.00	1		
3	15	1	10	MC	1875	1469	0.97	0.47	6.5	1.3	0.85	1.0	1.0	6.9	1.14	7.9	46%	14.4	0.15	1.00	1	0.46	2
4	20	2	9	MC	2500	1781	0.96		5.9	1.3	0.95	1.0	1.0	6.9	1.05	7.3				1.00	1		
5	25	2	11	MC	3125	2094	0.94		7.2	1.3	0.95	1.0	1.0	8.5	0.98	8.3				0.99	1		
6	30	2	14	SPT	3750	2406	0.92		14.0	1.3	1.00	1.2	1.0	21.0	0.92	19.2				0.94	1		
7																							

Total Liquefaction Settlement (in.)= 1.2

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

   where α and β = coefficients determined from the following relationships

   for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

   for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

   for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-006**	2. CLAYS AND PLASTIC SILTS	a_{max} *(g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 70%	
GW DEPTH (ft)=	10		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE (CRR 7.5)*											*S.=(CRR 7.5/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	2	2	32	MC	250	250	1.00		20.8	1.2	0.75	1.0	1.0	18.2	1.66	30.2				1.00	1		
2	5	2	28	MC	625	625	0.99		18.2	1.2	0.75	1.0	1.0	15.9	1.45	23.2				1.00	1		
3	10	2	25	MC	1250	1250	0.98		16.3	1.2	0.80	1.0	1.0	15.2	1.21	18.3				1.00	1		
4	15	2	20	MC	1875	1563	0.97		13.0	1.2	0.85	1.0	1.0	12.9	1.11	14.3				1.00	1		
5	20	2	10	MC	2500	1875	0.96		6.5	1.2	0.95	1.0	1.0	7.2	1.03	7.4				1.00	1		
6	25	2	33	MC	3125	2188	0.94		21.5	1.2	0.95	1.0	1.0	23.8	0.96	22.8				0.97	1		
7	30	2	14	MC	3750	2500	0.92		9.1	1.2	1.00	1.0	1.0	10.6	0.90	9.5				0.94	1		

Total Liquefaction Settlement (in.)= 0.0

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

where α and β = coefficients determined from the following relationships

for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*		*FAULT INFO*	
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS			
BORING NO.	**R-17-009**	2. CLAYS AND PLASTIC SILTS		*a_{max} (g)=*	0.58
				FAULT M_w =	6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =*	70%		
GW DEPTH (ft)=	11			*MSF =*	1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampl er Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	$K\sigma$	$K\alpha$	F.S.	Volumetric Strain (%)
1	2	2	38	MC	250	250	1.00		24.7	1.2	0.75	1.0	1.0	21.6	1.66	35.9				1.00	1		
2	5	2	28	MC	625	625	0.99		18.2	1.2	0.75	1.0	1.0	15.9	1.45	23.2				1.00	1		
3	10	2	11	SPT	1250	1250	0.98		11.0	1.2	0.80	1.2	1.0	12.3	1.21	14.9				1.00	1		
4	15	2	13	MC	1875	1625	0.97		8.5	1.2	0.85	1.0	1.0	8.4	1.09	9.2				1.00	1		
5	20	2	9	MC	2500	1938	0.96		5.9	1.2	0.95	1.0	1.0	6.5	1.01	6.6				1.00	1		
6	25	2	8	MC	3125	2250	0.94		5.2	1.2	0.95	1.0	1.0	5.8	0.95	5.5				0.97	1		
7	30	2	11	MC	3750	2563	0.92		7.2	1.2	1.00	1.0	1.0	8.3	0.89	7.4				0.94	1		
8	35	1	37	MC	4375	2875	0.89	0.51	24.1	1.2	1.00	1.0	1.0	28.1	0.83	23.4	15%	27.0	0.34	0.87	1	0.80	
9	40	2	11	MC	5000	3188	0.85		7.2	1.2	1.00	1.0	1.0	8.3	0.79	6.6				0.89	1		

Total Liquefaction Settlement (in.)= 0.0

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

where α and β = coefficients determined from the following relationships

for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-010**	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 70%	
GW DEPTH (ft)=	12		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR)				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	2	1	20	MC	250	250	1.00	0.38	13.0	1.2	0.75	1.0	1.0	11.4	1.66	18.9		18.9	0.20	1.00	1		
2	5	2	20	MC	625	625	0.99		13.0	1.2	0.75	1.0	1.0	11.4	1.45	16.5				1.00	1		
3	10	2	17	SPT	1250	1250	0.98		17.0	1.2	0.80	1.2	1.0	19.0	1.21	23.0				1.00	1		
4	15	2	10	MC	1875	1688	0.97		6.5	1.2	0.85	1.0	1.0	6.4	1.08	6.9				1.00	1		
5	20	2	13	MC	2500	2000	0.96		8.5	1.2	0.95	1.0	1.0	9.4	1.00	9.4				1.00	1		
6	25	2	13	MC	3125	2313	0.94		8.5	1.2	0.95	1.0	1.0	9.4	0.93	8.7				0.96	1		
7	30	2	11	MC	3750	2625	0.92		7.2	1.2	1.00	1.0	1.0	8.3	0.88	7.3				0.93	1		
8	35	2	22	MC	4375	2938	0.89		14.3	1.2	1.00	1.0	1.0	16.7	0.82	13.8				0.88	1		
9	40	2	19	MC	5000	3250	0.85		12.4	1.2	1.00	1.0	1.0	14.4	0.78	11.2				0.86	1		

Total Liquefaction Settlement (in.)= 0.0

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\,(N_1)_{60}$

   where α and β = coefficients determined from the following relationships

   for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

   for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

   for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-011**	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 70%	
GW DEPTH (ft)=	13		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	2	2	10	MC	250	250	1.00		6.5	1.2	0.75	1.0	1.0	5.7	1.66	9.4				1.00	1		
2	5	2	13	MC	625	625	0.99		8.5	1.2	0.75	1.0	1.0	7.4	1.45	10.8				1.00	1		
3	10	2	11	SPT	1250	1250	0.98		11.0	1.2	0.80	1.2	1.0	12.3	1.21	14.9				1.00	1		
4	15	2	10	MC	1875	1750	0.97		6.5	1.2	0.85	1.0	1.0	6.4	1.06	6.8				1.00	1		
5	20	2	14	MC	2500	2063	0.96		9.1	1.2	0.95	1.0	1.0	10.1	0.99	9.9				0.99	1		
6	25	2	8	MC	3125	2375	0.94		5.2	1.2	0.95	1.0	1.0	5.8	0.92	5.3				0.96	1		
7	30	2	26	MC	3750	2688	0.92		16.9	1.2	1.00	1.0	1.0	19.7	0.86	17.1				0.90	1		
8	35	2	11	MC	4375	3000	0.89		7.2	1.2	1.00	1.0	1.0	8.3	0.81	6.8				0.90	1		

Total Liquefaction Settlement (in.)= 0.0

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

   where α and β = coefficients determined from the following relationships

   for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

   for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

   for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*	
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS		
BORING NO.	**R-17-013**	2. CLAYS AND PLASTIC SILTS	a_{max} *(g)=*	0.58
			FAULT M_w *=*	6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 75%		
GW DEPTH (ft)=	12		*MSF =*	1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	2	2	14	MC	250	250	1.00		9.1	1.3	0.75	1.0	1.0	8.5	1.66	14.2				1.00	1		
2	5	2	16	MC	625	625	0.99		10.4	1.3	0.75	1.0	1.0	9.8	1.45	14.2				1.00	1		
3	10	2	9	MC	1250	1250	0.98		5.9	1.3	0.80	1.0	1.0	5.9	1.21	7.1				1.00	1		
4	15	2	12	MC	1875	1688	0.97		7.8	1.3	0.85	1.0	1.0	8.3	1.08	8.9				1.00	1		
5	20	2	13	MC	2500	2000	0.96		8.5	1.3	0.95	1.0	1.0	10.0	1.00	10.0				1.00	1		
6	25	1	7	SPT	3125	2313	0.94	0.48	7.0	1.3	0.95	1.2	1.0	10.0	0.93	9.3	15%	12.3	0.13	0.96	1	0.37	2.2
7	30	2	12	MC	3750	2625	0.92		7.8	1.3	1.00	1.0	1.0	9.8	0.88	8.5				0.93	1		
8	35	2	17	MC	4375	2938	0.89		11.1	1.3	1.00	1.0	1.0	13.8	0.82	11.4				0.89	1		
9	40	2	23	MC	5000	3250	0.85		15.0	1.3	1.00	1.0	1.0	18.7	0.78	14.6				0.86	1		

Total Liquefaction Settlement (in.)= 0.8

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

where α and β = coefficients determined from the following relationships

for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-014**	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 75%	
GW DEPTH (ft)=	9		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	5	2	19	MC	625	625	0.99		12.4	1.3	0.75	1.0	1.0	11.6	1.45	16.8				1.00	1		
2	10	2	14	MC	1250	1188	0.98		9.1	1.3	0.80	1.0	1.0	9.1	1.23	11.2				1.00	1		
3	15	1	31	MC	1875	1500	0.97	0.46	20.2	1.3	0.85	1.0	1.0	21.4	1.13	24.2	47%	34.0		1.00	1		
4	20	2	7	MC	2500	1813	0.96		4.6	1.3	0.95	1.0	1.0	5.4	1.04	5.6				1.00	1		
5	25	2	9	MC	3125	2125	0.94		5.9	1.3	0.95	1.0	1.0	6.9	0.97	6.8				0.99	1		
6	30	2	10	SPT	3750	2438	0.92		10.0	1.3	1.00	1.2	1.0	15.0	0.91	13.6				0.94	1		
7	35	2	69	MC	4375	2750	0.89		44.9	1.3	1.00	1.0	1.0	56.1	0.85	47.9				0.88	1		

Total Liquefaction Settlement (in.)= 0.0

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

   where α and β = coefficients determined from the following relationships

   for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

   for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

   for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

LIQUEFACTION POTENTIAL ANALYSIS

PROJECT NAME	**Mathilda Avenue Improvements**	*SOIL GROUPS*	*FAULT INFO*
PROJECT NO.	**2014-129-PSE**	1. GRAVELS, SANDS AND NONPLASTIC SILTS	
BORING NO.	**R-17-015**	2. CLAYS AND PLASTIC SILTS	*a_{max} (g)=* 0.58
			FAULT M_w = 6.6
BOREHOLE DIA (in)	5	*HAMMER ENERGY =* 75%	
GW DEPTH (ft)=	9		*MSF =* 1.39

					CYCLIC STRESS RATIO (CSR				*LIQUEFACTION RESISTANCE ($CRR_{7.5}$)*											*S.=($CRR_{7.5}$/CSR)*MSF*K σ*K*			
Sample No	Depth (ft)	Soil Type	Blow Count	Sampler Type	σ_v (psf)	σ_v' (psf)	γ_d	CSR	SPT-$N_{eq.}$	C_E	C_R	C_S	C_B	N_{60}	C_N	$(N_1)_{60}$	F.C.	$(N_1)_{60, CS}$	$CRR_{7.5}$	Kσ	Kα	F.S.	Volumetric Strain (%)
1	2	2	25	MC	250	250	1.00		16.3	1.3	0.75	1.0	1.0	15.2	1.66	25.3				1.00	1		
2	5	2	23	MC	625	625	0.99		15.0	1.3	0.75	1.0	1.0	14.0	1.45	20.4				1.00	1		
3	10	1	11	MC	1250	1156	0.98	0.40	7.2	1.3	0.80	1.0	1.0	7.2	1.24	8.8	15%	11.8	0.13	1.00	1	0.45	2.4
4	15	1	4	MC	1875	1469	0.97	0.47	2.6	1.3	0.85	1.0	1.0	2.8	1.14	3.1	31%	8.4	0.10	1.00	1	0.30	2.9
5	20	2	4	SPT	2500	1781	0.96		4.0	1.3	0.95	1.2	1.0	5.7	1.05	6.0				1.00	1		
6																							

Total Liquefaction Settlement (in.)= 3.2

1. The correction factors C_E (Energy Ratio), C_B (Borehole Diameter), C_R (Rod Length) and C_S (Sampling Method-liner) are per Youd et al. (2001).
2. For correction of overburden, $C_N = 2.2/(1.2 + \sigma_v'/P_a)$ with a maximum value of 1.7 per Kayen et al. (1992) as cited in Youd et al. (2001).
3. The influence of Fines Contents are expressed by the following correction: $(N_1)_{60cs} = \alpha + \beta\ (N_1)_{60}$

   where α and β = coefficients determined from the following relationships

   for FC $\leq$ 5% $\alpha = 0$, $\beta = 1.0$

   for 5% < FC < 35% $\alpha = \exp(1.76-(190/FC^2))$, $\beta = (0.99+(FC^{1.5}/1000))$

   for FC $\geq$ 35% $\alpha = 5.0$, $\beta = 1.2$

Reference: Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER Workshops on Evaluation of Liquefaction Resistance of Soils, Youd, et al., ASCE Journal of Geotechnical and Geoenvironmental Engineering, October 2001, Vol. 127 No. 10

SETTLEMENT ANALYSIS

PROJECT NAME **Mathilda Avenue Improvements**
PROJECT NO. **2014-129-PSE**
BORING NO. **R-17-003**

Embankment H (ft)=	10	*Contact Pressure (psf)=*	1250	*Contact Area, B (ft)=*	100	*Cr/Cc=*	20.0%
Unit Weight (pcf)=	125	*GW Level (ft)=*	8.5	*Contact Area, L (ft)=*	200	*Ei*	75%
				Plain Strain? (Y/N)=	n		

GROUPS
1. GRAVELS AND SANDS
2. CLAYS AND SILTS

Soil Type	Depth From	Depth To	BLOW COUNT	SAMPLER TYPE	AVG SPT-N	γ_T (pcf)	γ' (pcf)	ω	σ_v' (psf)	$\Delta\sigma_v'$ (psf)	Su (psf)	Pp (psf)	$Cr/1+e_0$	$Cc/1+e_0$	Settlements (in) OC	NC	SAND	Sum
2	0	4	10	MC	8	125.0	125.0	18.0%	250	1213.4	975	3900	0.0240	0.1202	0.885			0.885
2	4	8	19	MC	15	135.9	135.9	18.0%	772	1144.9	1853	7410	0.0240	0.1202	0.456			0.456
2	8	13	5	MC	4	125.0	62.6	19.0%	1200	1074.8	488	1950	0.0245	0.1227	0.310	0.493		0.803
1	13	18	10	MC	8	125.0	62.6	20.1%	1513	1004.4							0.320	
2	18	23	9	MC	7	125.8	63.4	26.4%	1828	940.9	878	3510	0.0282	0.1411	0.305			0.305
2	23	28	11	MC	9	124.2	61.8	26.3%	2141	883.4	1073	4290	0.0282	0.1409	0.254			0.254
2	28	30.5	14	SPT	18	125.0	62.6	25.7%	2374	843.7	2100	8400	0.0279	0.1394	0.110			0.110
														Estimated Settlement (in)=	*2.32*	*0.49*	*0.32*	***3.13***

SETTLEMENT ANALYSIS

PROJECT NAME **Mathilda Avenue Improvements**
PROJECT NO. **2014-129-PSE**
BORING NO. **R-17-011**

Embankment H (ft)=	10	*Contact Pressure (psf)=*	1250	*Contact Area, B (ft)=*	100	*Cr/Cc=*	20.0%	***GROUPS*** 1. GRAVELS AND SANDS	
Unit Weight (pcf)=	125	*GW Level (ft)=*	13	*Contact Area, L (ft)=*	200	*Ei*	70%	2. CLAYS AND SILTS	
				Plain Strain? (Y/N)=	n				

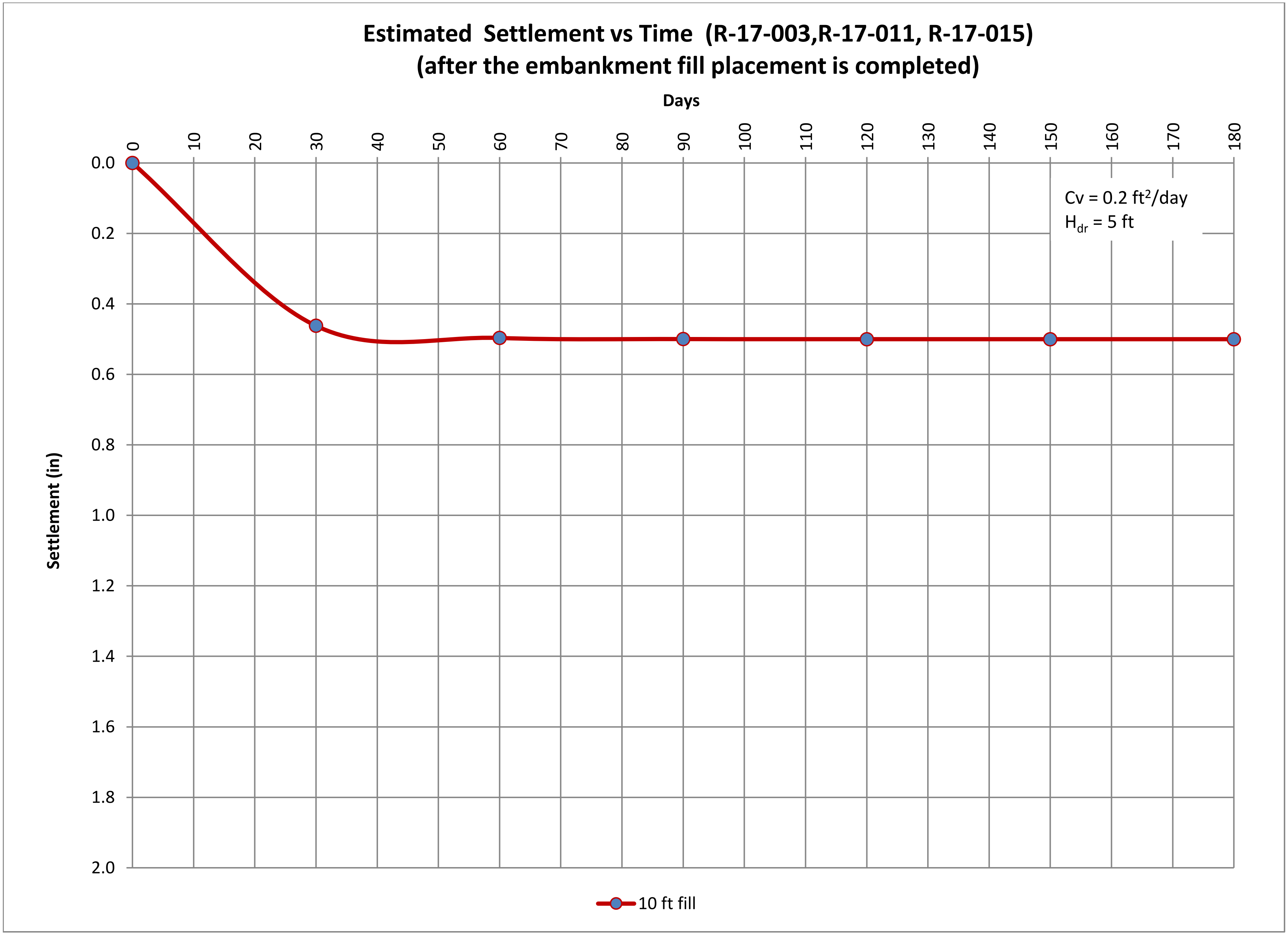
Soil Type	Depth From	Depth To	BLOW COUNT	SAMPLER TYPE	AVG SPT-N	γ_T (pcf)	γ' (pcf)	ω	σ_v' (psf)	$\Delta\sigma_v'$ (psf)	Su (psf)	Pp (psf)	$Cr/1+e_0$	$Cc/1+e_0$	Settlements (in) OC	NC	SAND	Sum
2	0	4	10	MC	8	126.0	126.0	17.6%	252	1213.4	910	3640	0.0238	0.1192	0.875			0.875
2	4	8	13	MC	10	122.0	122.0	28.8%	748	1144.9	1183	4732	0.0294	0.1471	0.569			0.569
2	8	13	11	MC	8	120.5	120.5	29.7%	1293	1074.8	1001	4004	0.0299	0.1493	0.471			0.471
2	13	18	10	MC	8	118.5	56.1	30.4%	1735	1004.4	910	3640	0.0302	0.1510	0.359			0.359
2	18	23	14	MC	11	128.7	66.3	23.1%	2041	940.9	1274	5096	0.0266	0.1329	0.263			0.263
2	23	28	8	MC	6	129.4	67.0	21.7%	2374	883.4	728	2912	0.0259	0.1294	0.138	0.378		0.516
2	28	33	26	MC	20	125.4	63.0	26.6%	2699	831.1	2366	9464	0.0283	0.1416	0.198			0.198
2	33	37	11	MC	8	123.4	61.0	31.2%	2979	788.0	1001	4004	0.0306	0.1530	0.150			0.150
														Estimated Settlement (in)=	*3.02*	*0.38*	*0.00*	***3.40***

SETTLEMENT ANALYSIS

PROJECT NAME **Mathilda Avenue Improvements**
PROJECT NO. **2014-129-PSE**
BORING NO. **R-17-015**

Embankment H (ft)=	10	*Contact Pressure (psf)=*	1250	*Contact Area, B (ft)=*	100	*Cr/Cc=*	20.0%	***GROUPS***
Unit Weight (pcf)=	125	*GW Level (ft)=*	8.5	*Contact Area, L (ft)=*	200	*Ei*	75%	1. GRAVELS AND SANDS
				Plain Strain? (Y/N)=	n			2. CLAYS AND SILTS

Soil Type	Depth From	Depth To	BLOW COUNT	SAMPLER TYPE	AVG SPT-N	γ_T (pcf)	γ' (pcf)	ω	σ_v' (psf)	$\Delta\sigma_v'$ (psf)	Su (psf)	Pp (psf)	$Cr/1+e_0$	$Cc/1+e_0$	Settlements (in) OC	NC	SAND	Sum
2	0	3	10	MC	8	125.0	125.0	20.0%	188	1222.4	975	3900	0.0250	0.1252	0.790			0.790
2	3	8	25	MC	20	135.9	135.9	20.2%	715	1153.1	2438	9750	0.0251	0.1257	0.629			0.629
2	8	13	23	MC	19	125.0	62.6	21.1%	1211	1074.8	2243	8970	0.0256	0.1279	0.423			0.423
1	13	18	11	MC	9	135.3	72.9	17.8%	1550	1004.4							0.304	
1	18	23	4	MC	3	125.0	62.6	29.3%	1889	940.9							0.329	
2	23	25.5	4	SPT	5	125.0	62.6	24.5%	2123	897.2	600	2400	0.0273	0.1364	0.044	0.409		0.452
														Estimated Settlement (in)=	*1.89*	*0.41*	*0.63*	***2.93***


Estimated Settlement vs Time (R-17-003,R-17-011, R-17-015)
(after the embankment fill placement is completed)
Days
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Settlement (in)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Cv = 0.2 ft²/day
Hdr = 5 ft
10 ft fill

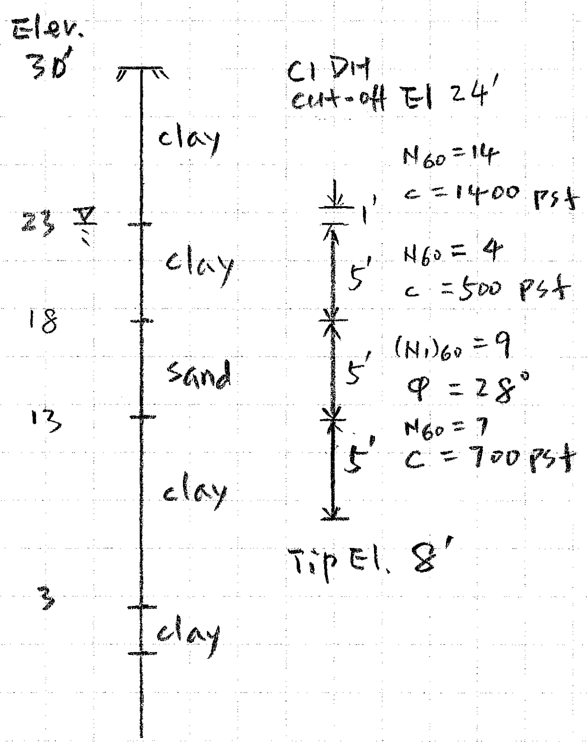
OH OSZ-2, Sta. 71.07 Rt "M1" 48+50 (FNBT)

Standard Plan: S49 Post Type NPS = 14, "t" = 3/4"

Design $\phi = 3'$, $L = 16'$ CIDH Ped $L = 6'6''$

Boring R-17-003, Ref. FHWA-NHI-016, May 2010

$\gamma = 125$ pcf, $\gamma' = 62$ pcf



N.T.S.

$\alpha = 0.55$ clay skin adhesion factor

$P_c = 0.55 \times (1.4 \times 1 + 0.5 \times 5 + 0.7 \times 5) \times 3. \times 3.14$
$\doteq 38$ kips

$\beta = 0.4$ sand skin friction coefficient

$\sigma_v' = 125 \times 7 + 62 \times 7.5 \doteq 1340$ psf
(from ground surface to mid sand layer)

$P_s = (0.4 \times 1.34) \times 5 \times 3 \times 3.14 \doteq 25$ kips

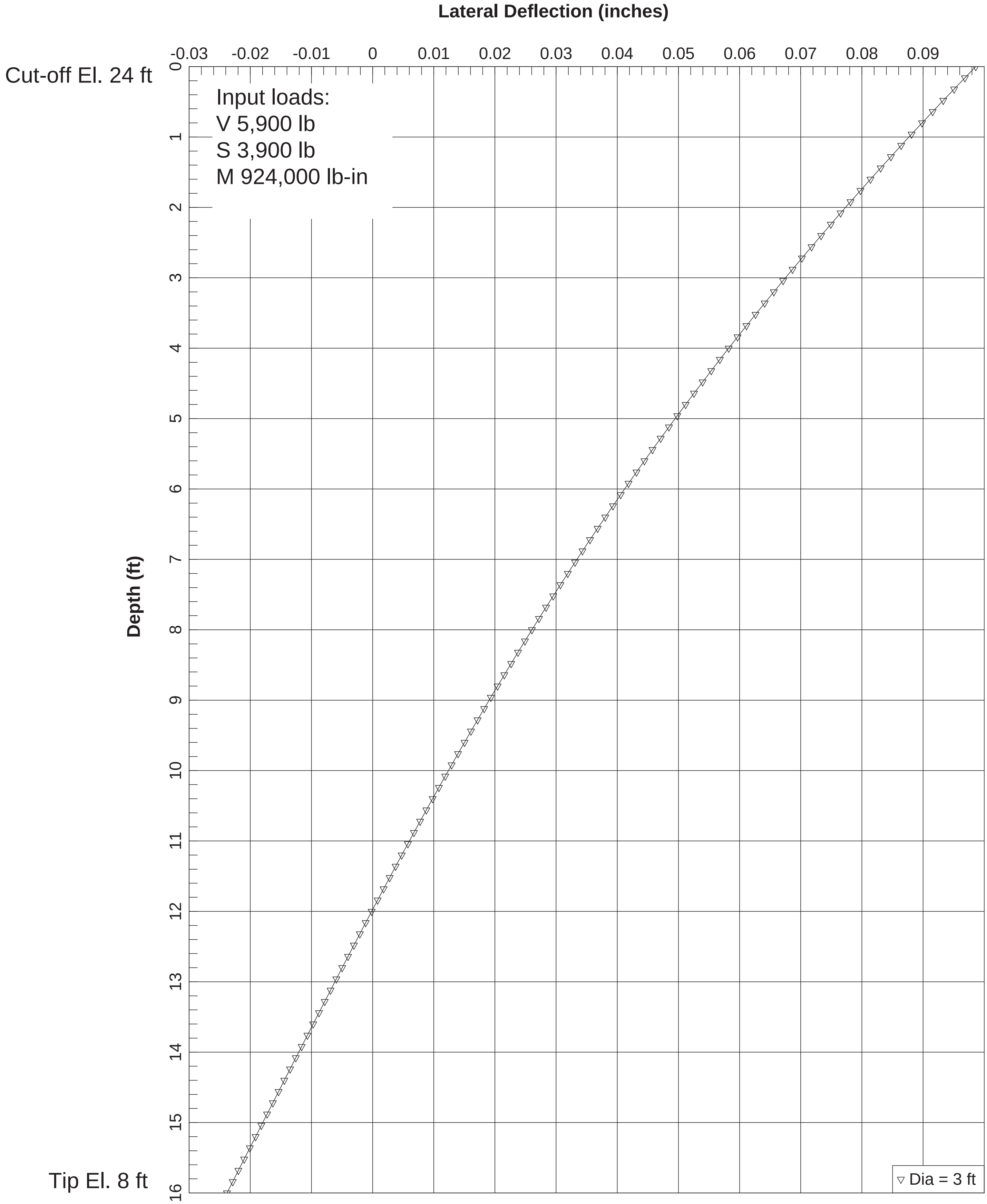
Axial capacity:

$P_u = 38 + 25 = 63$ kips > 59 kips ✓

Torsion capacity:

$M_T = 63 \times 3/2 \doteq 94.5$ k-ft > 46.4 k-ft ✓

Overhead Sign OS2-2
CIDH Pile Dia = 3 ft; Boring R-17-003



PARIKH
Practicing in the Geosciences

PROJECT NO. 2014-129-PSE
PROJECT NAME Mathilda Avenue
CALCULATED BY P.W. DATE 7-12-17
CHECKED BY ______ DATE ______
VERIFIED BY ______ DATE ______
BACK CHECKED BY ______ DATE ______

SUBJECT OH Sign Capacity

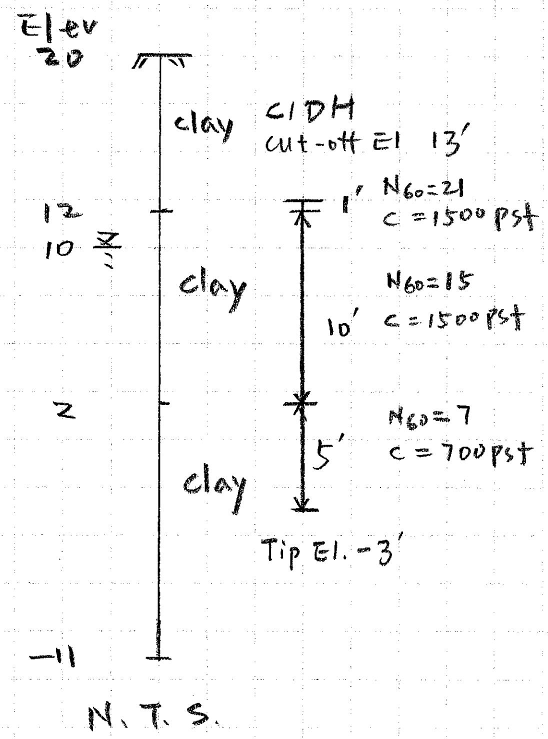
OH OS4-1 sta. 0.82 Lt "M1" 70+00 (FSBT)

Standard plan: S49, Post Type: NPS = 14, "t" = 3/4"

Design $d = 3'$, $L = 16'$ CIDH ped $L = 6'6"$

Boring R-17-006, Ref. FHWA-NHI-016, May 2010

$\gamma = 125$ pcf, $\gamma' = 62$ pcf



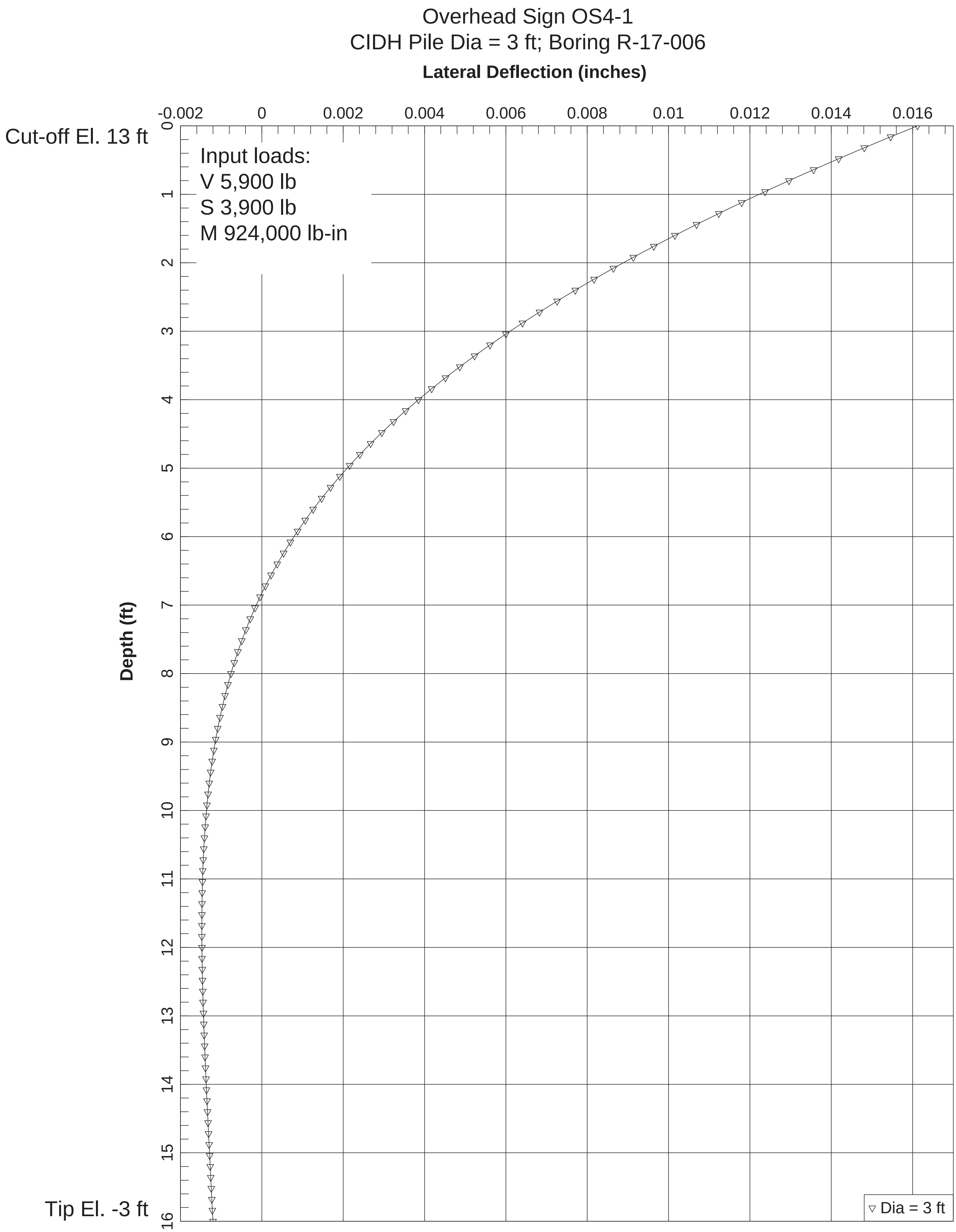
$\alpha = 0.55$ clay skin adhesion factor

$P_c = 0.55 \times (1.5\times1 + 1.5\times10 + 0.7\times5) \times 3 \times 3.14$

$\doteq 103$ kips > 5.9 kips ✓

Torsion capacity

$M_T = 103 \times 3/2 \doteq 154$ k-ft > 46.4 k-ft ✓



Overhead Sign OS4-1
CIDH Pile Dia = 3 ft; Boring R-17-006
Lateral Deflection (inches)
-0.002
0
0.002
0.004
0.006
0.008
0.01
0.012
0.014
0.016
Depth (ft)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Cut-off El. 13 ft
Tip El. -3 ft
Input loads:
V 5,900 lb
S 3,900 lb
M 924,000 lb-in
Dia = 3 ft

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

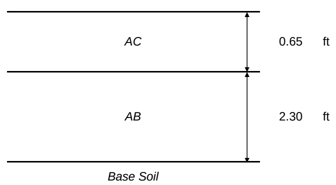
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB

Design TI=	***12.5***	input
R_{BS}=	***10***	input
R_{AB}=	78	

$GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =$		3.60	
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$		0.88	
=>	GE'_{AC} =	1.08	(add 0.2 ft safety factor)
	AC Thickness =	0.63	ft
=>	AC Thickness =	**0.65**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$ =	1.72	
	GE_{AC} =	1.11	
$GE_{AB} = GE_{AC+AB} - GE_{AC} =$		2.49	
	AB thickness=	2.26	ft
=>	AB Thickness=	**2.30**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	2.53	$G_{f, AB}$=1.1

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

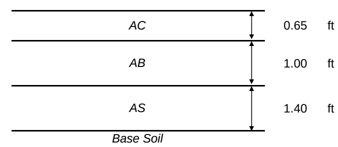
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB over AS

Design TI=	***12.5***	input
R_{BS}=	***10***	input
R_{AB}=	78	
R_{AS}=	50	check

$GE_{TOTAL} = 0..0032*TI*(100-R_{BS}) =$		3.60	
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$		0.88	
=>	GE'_{AC} =	1.08	(add 0.2 ft safety factor)
	AC thickness =	0.63	ft
=>	AC Thickness=	**0.65**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$=	1.72	
	GE_{AC}=	1.11	
$GE_{AB+AC} = 0.0032*TI*(100-R_{AS}) =$		2.00	
=>	GE_{AC+AB}=	2.20	(add 0.2 ft safety factor)
$GE_{AB} = GE_{AC+AB} - GE_{AC} =$		1.09	
=>	AB thickness=	0.99	
=>	AB Thickness=	**1.00**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	1.10	$G_{f, AB}$=1.1
$GE_{AS} = GE_{TOTAL} - GE_{AB} - GE_{AC} =$		1.39	
=>	AS Thickness=	**1.40**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

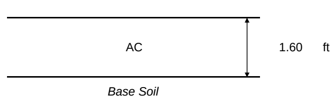
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: Full depth AC

Design TI=	***12.5***	input
R_{BS}=	***10***	input

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$		3.60	
=>	GE'_{AC}=	3.70	(add 0.1 ft safety factor)
=>	AC Thickness=	1.60	
=>	AC Thickness=	**1.60**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB

Design TI= ***12.5*** input
R_{BS}= ***15*** input
R_{AB}= 78

$GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =$ 3.40

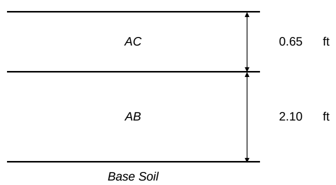
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$ 0.88
=> GE'_{AC} = 1.08 (add 0.2 ft safety factor)
AC Thickness = 0.63 ft

=> AC Thickness = **0.65** ft (round up to the nearest 0.05 ft)
$G_{f,\,AC}$ = 1.72
GE_{AC} = 1.11

$GE_{AB} = GE_{AC+AB} - GE_{AC} =$ 2.29
AB thickness= 2.08 ft

=> AB Thickness= **2.10** ft (round up to the nearest 0.05 ft)
GE_{AB}= 2.31 $G_{f,\,AB}$=1.1

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB over AS

Design TI= ***12.5*** input
R_{BS}= ***15*** input
R_{AB}= 78
R_{AS}= 50 check

$GE_{TOTAL} = 0..0032*TI*(100-R_{BS}) =$ 3.40

$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$ 0.88
=> GE'_{AC} = 1.08 (add 0.2 ft safety factor)
AC thickness = 0.63 ft

=> AC Thickness= **0.65** ft (round up to the nearest 0.05 ft)
$G_{f,\,AC}$= 1.72
GE_{AC}= 1.11

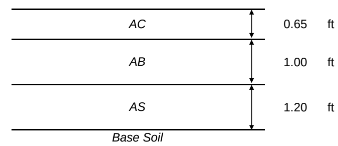
$GE_{AB+AC} = 0.0032*TI*(100-R_{AS}) =$ 2.00
=> GE_{AC+AB}= 2.20 (add 0.2 ft safety factor)

$GE_{AB} = GE_{AC+AB} - GE_{AC} =$ 1.09
=> AB thickness= 0.99

=> AB Thickness= **1.00** ft (round up to the nearest 0.05 ft)
GE_{AB}= 1.10 $G_{f,\,AB}$=1.1

$GE_{AS} = GE_{TOTAL} - GE_{AB} - GE_{AC} =$ 1.19
=> AS Thickness= **1.20** ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

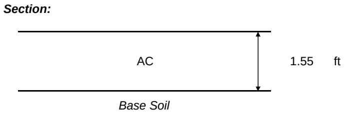
Design Case: Full depth AC

Design TI= ***12.5*** input
R_{BS}= ***15*** input

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$ 3.40
=> GE'_{AC}= 3.50 (add 0.1 ft safety factor)
=> AC Thickness= 1.53

=> AC Thickness= **1.55** ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

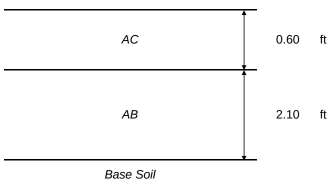
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB

Design TI=	***11.5***	input
R_{BS}=	***10***	input
R_{AB}=	78	

*GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =*		3.31	
*GE_{AC} = 0.0032*TI*(100-R_{AB}) =*		0.81	
=>	GE'_{AC} =	1.01	(add 0.2 ft safety factor)
	AC Thickness =	0.58	ft
=>	AC Thickness =	**0.60**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$ =	1.74	
	GE_{AC} =	1.04	
GE_{AB} = GE_{AC+AB} - GE_{AC} =		2.27	
	AB thickness=	2.06	ft
=>	AB Thickness=	**2.10**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	2.31	$G_{f, AB}$=1.1

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

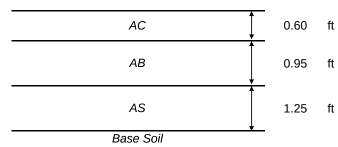
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB over AS

Design TI=	***11.5***	input
R_{BS}=	***10***	input
R_{AB}=	78	
R_{AS}=	50	check

*GE_{TOTAL} = 0..0032*TI*(100-R_{BS}) =*		3.31	
*GE_{AC} = 0.0032*TI*(100-R_{AB}) =*		0.81	
=>	GE'_{AC} =	1.01	(add 0.2 ft safety factor)
	AC thickness =	0.58	ft
=>	AC Thickness=	**0.60**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$=	1.74	
	GE_{AC}=	1.04	
*GE_{AB+AC} = 0.0032*TI*(100-R_{AS}) =*		1.84	
=>	GE_{AC+AB}=	2.04	(add 0.2 ft safety factor)
GE_{AB} = GE_{AC+AB}-GE_{AC} =		1.00	
=>	AB thickness=	0.90	
=>	AB Thickness=	**0.95**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	1.05	$G_{f, AB}$=1.1
GE_{AS} = GE_{TOTAL}-GE_{AB}-GE_{AC} =		1.22	
=>	AS Thickness=	**1.25**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

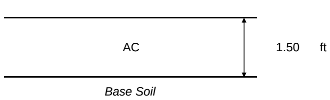
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: Full depth AC

Design TI=	***11.5***	input
R_{BS}=	***10***	input

*GE_{AC} = 0.0032*TI*(100-R_{BS}) =*		3.31	
=>	GE'_{AC}=	3.41	(add 0.1 ft safety factor)
=>	AC Thickness=	1.46	
=>	AC Thickness=	**1.50**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB

Design TI= ***11.5*** input
R_{BS}= ***15*** input
R_{AB}= 78

*GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =* 3.13

*GE_{AC} = 0.0032*TI*(100-R_{AB}) =* 0.81
=> GE'_{AC} = 1.01 (add 0.2 ft safety factor)
AC Thickness = 0.58 ft

=> AC Thickness = **0.60** ft (round up to the nearest 0.05 ft)
$G_{f, AC}$ = 1.74
GE_{AC} = 1.04

GE_{AB} = GE_{AC+AB} - GE_{AC} = 2.08
AB thickness= 1.89 ft

=> AB Thickness= **1.90** ft (round up to the nearest 0.05 ft)
GE_{AB}= 2.09 $G_{f, AB}$=1.1

Design Section:

AC	0.60	ft
AB	1.90	ft

Base Soil

PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB over AS

Design TI= ***11.5*** input
R_{BS}= ***15*** input
R_{AB}= 78
R_{AS}= 50 check

*GE_{TOTAL} = 0..0032*TI*(100-R_{BS}) =* 3.13

*GE_{AC} = 0.0032*TI*(100-R_{AB}) =* 0.81
=> GE'_{AC} = 1.01 (add 0.2 ft safety factor)
AC thickness = 0.58 ft

=> AC Thickness= **0.60** ft (round up to the nearest 0.05 ft)
$G_{f, AC}$= 1.74
GE_{AC}= 1.04

*GE_{AB+AC} = 0.0032*TI*(100-R_{AS}) =* 1.84
=> GE_{AC+AB}= 2.04 (add 0.2 ft safety factor)

GE_{AB} = GE_{AC+AB} -GE_{AC} = 1.00
=> AB thickness= 0.90

=> AB Thickness= **0.95** ft (round up to the nearest 0.05 ft)
GE_{AB}= 1.05 $G_{f, AB}$=1.1

GE_{AS} = GE_{TOTAL} -GE_{AB} -GE_{AC} = 1.04
=> AS Thickness= **1.05** ft (round up to the nearest 0.05 ft)

Design Section:

AC	0.60	ft
AB	0.95	ft
AS	1.05	ft

Base Soil

PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: Full depth AC

Design TI= ***11.5*** input
R_{BS}= ***15*** input

*GE_{AC} = 0.0032*TI*(100-R_{BS}) =* 3.13
=> GE'_{AC}= 3.23 (add 0.1 ft safety factor)
=> AC Thickness= 1.40

=> AC Thickness= **1.40** ft (round up to the nearest 0.05 ft)

Design Section:

AC	1.40	ft

Base Soil

PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB

Design TI=	***10***	input
R_{BS}=	***10***	input
R_{AB}=	78	

$GE_{AC+AB} = 0.0032*TI*(100-R_{BS}) =$		2.88	
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$		0.70	
=>	GE'_{AC} =	0.90	(add 0.2 ft safety factor)
	AC Thickness =	0.51	ft
=>	AC Thickness =	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$ =	1.81	
	GE_{AC} =	1.00	
$GE_{AB} = GE_{AC+AB} - GE_{AC} =$		1.88	
	AB thickness=	1.71	ft
=>	AB Thickness=	**1.75**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	1.93	$G_{f, AB}$=1.1

Design Section:

AC	0.55	ft
AB	1.75	ft
Base Soil		

PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: AC over AB over AS

Design TI=	***10***	input
R_{BS}=	***10***	input
R_{AB}=	78	
R_{AS}=	50	check

$GE_{TOTAL} = 0..0032*TI*(100-R_{BS}) =$		2.88	
$GE_{AC} = 0.0032*TI*(100-R_{AB}) =$		0.70	
=>	GE'_{AC} =	0.90	(add 0.2 ft safety factor)
	AC thickness =	0.51	ft
=>	AC Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f, AC}$=	1.81	
	GE_{AC}=	1.00	
$GE_{AB+AC} = 0.0032*TI*(100-R_{AS}) =$		1.60	
=>	GE_{AC+AB}=	1.80	(add 0.2 ft safety factor)
$GE_{AB} = GE_{AC+AB} - GE_{AC} =$		0.80	
=>	AB thickness=	0.73	
=>	AB Thickness=	**0.75**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	0.83	$G_{f, AB}$=1.1
$GE_{AS} = GE_{TOTAL} - GE_{AB} - GE_{AC} =$		1.06	
=>	AS Thickness=	**1.10**	ft (round up to the nearest 0.05 ft)

Design Section:

AC	0.55	ft
AB	0.75	ft
AS	1.10	ft
Base Soil		

PAVEMENT DESIGN
PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: Full depth AC

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

$GE_{AC} = 0.0032*TI*(100-R_{BS}) =$		2.88	
=>	GE'_{AC}=	2.98	(add 0.1 ft safety factor)
=>	AC Thickness=	1.25	
=>	AC Thickness=	**1.25**	ft (round up to the nearest 0.05 ft)

Design Section:

AC	1.25	ft
Base Soil		

PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

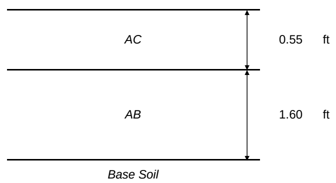
Design Case: AC over AB

Design TI=	***10***	input
R_{BS}=	***15***	input
R_{AB}=	78	

$GE_{AC+AB} = 0.0032*TI*(100-R_{BS})$ = 2.72

$GE_{AC} = 0.0032*TI*(100-R_{AB})$ =		0.70	
=>	GE'_{AC} =	0.90	(add 0.2 ft safety factor)
	AC Thickness =	0.51	ft
=>	AC Thickness =	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f,\,AC}$ =	1.81	
	GE_{AC} =	1.00	
$GE_{AB} = GE_{AC+AB} - GE_{AC}$ =		1.72	
	AB thickness=	1.57	ft
=>	AB Thickness=	**1.60**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	1.76	$G_{f,\,AB}$=1.1

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

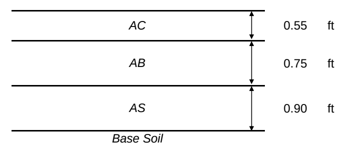
Design Case: AC over AB over AS

Design TI=	***10***	input
R_{BS}=	***15***	input
R_{AB}=	78	
R_{AS}=	50	check

$GE_{TOTAL} = 0..0032*TI*(100-R_{BS})$ = 2.72

$GE_{AC} = 0.0032*TI*(100-R_{AB})$ =		0.70	
=>	GE'_{AC} =	0.90	(add 0.2 ft safety factor)
	AC thickness =	0.51	ft
=>	AC Thickness=	**0.55**	ft (round up to the nearest 0.05 ft)
	$G_{f,\,AC}$=	1.81	
	GE_{AC}=	1.00	
$GE_{AB+AC} = 0.0032*TI*(100-R_{AS})$ =		1.60	
=>	GE_{AC+AB}=	1.80	(add 0.2 ft safety factor)
$GE_{AB} = GE_{AC+AB} - GE_{AC}$ =		0.80	
=>	AB thickness=	0.73	
=>	AB Thickness=	**0.75**	ft (round up to the nearest 0.05 ft)
	GE_{AB}=	0.83	$G_{f,\,AB}$=1.1
$GE_{AS} = GE_{TOTAL} - GE_{AB} - GE_{AC}$ =		0.90	
=>	AS Thickness=	**0.90**	ft (round up to the nearest 0.05 ft)

Design Section:



PAVEMENT DESIGN

PER HIGHWAY DESIGN MANUAL, CHAP. 600

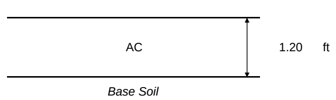
PROJECT NAME: *Mathilda Avenue Improvements at SR 237 and US 101*
PROJECT NO.: *2014-129-PSE*

Design Case: Full depth AC

Design TI=	***10***	input
R_{BS}=	***15***	input

$GE_{AC} = 0.0032*TI*(100-R_{BS})$ =		2.72	
=>	GE'_{AC}=	2.82	(add 0.1 ft safety factor)
=>	AC Thickness=	1.20	
=>	AC Thickness=	**1.20**	ft (round up to the nearest 0.05 ft)

Design Section:



APPENDIX E

PARIKH
Practicing in the Geosciences

MEMORANDUM

To: **WMH Corporation**
50 West San Fernando, Suite 950
San Jose, CA 95113

January 5, 2015
Job No. 2014-129-GEO

Attn: Mr. Tim Lee, P.E.

REGISTERED PROFESSIONAL ENGINEER GAURANG R. PARIKH No. 666 EXP. 12-31-15 GEOTECHNICAL STATE OF CALIFORNIA

From: Gary Parikh, P.E., G.E., 666

Subject: Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, California
Preliminary Pavement Condition Evaluation

Parikh Consultants Inc. (PCI) has visually evaluated the pavement condition of the Mathilda Avenue Improvements at SR 237 and US 101 (Project). The field review was performed on December 31, 2014. The existing pavement consists of Asphalt Concrete sections (Hot Mix Asphalt). For the purposes of this memorandum, Mathilda Avenue is considered to follow an east-west alignment. The Project extends from Innovation Way to the east to W. Ahwanee Avenue to the west in the City of Sunnyvale, Santa Clara County. Some of the ramps associated with the two interchanges are also planned to be modified. No mainline improvements for either US 101 or SR 237 are currently proposed.

1. The pavement conditions along the ramps at SR 237 and US 101 are reasonably good. It appears that most of the ramps have been resurfaced or slurry sealed ‘recently’. Based on study of aerial photographs it appears that SR 237 ramps were probably resurfaced in August of 2011. US 101 ramps look like were worked on much prior to 2010. No significant cracking or pavement distress was noted.
2. Within the project limits, pavement conditions along Mathilda Avenue vary significantly. The segment to the east of SR 237 that is generally beyond the Caltrans right-of-way is in reasonably good condition. There are quite a few utility patches due to activities related to various developments. These patches are showing cracking and obvious difference in ground elevations. In the event this roadway has to be upgraded, it should require grind and overlay with possible pavement enhancement fabric to retard reflective cracking.
3. The pavement condition beneath the SR 237 Undercrossing and the Caltrans ROW indicates significant wear and distress. There are various repairs and patches, transverse cracks and loss of binder. This indicates the age of the pavement. Grinding and overlay with some reconstruction should be required which should also include pavement reinforcement fabric to maintain uniformity and control reflective cracking.

4. Pavement conditions west of Ross Drive in the west bound direction shows significant distress conditions. This is visible in all three lanes till it reaches US 101 overcrossing. The inside lane shows indications of pavement fatigue represented by some depressions along the wheel lines and the outside two lanes have significant alligator and joint cracking. Relatively the condition of this segment is the worst within the project limits. In addition to grinding and overlay there are areas that should be reconstructed. Overlay thicknesses may also be significant since the need to control reflective cracking. It is possible that based on the repairs required this segment may qualify for a full reconstruction.
5. The segment west of US 101 is in reasonably good condition and limited wear is noted. Alligator cracks are not seen as noted on the east of the US 101. Some joint cracking is visible along the longitudinal direction. Limited overlay and or slurry seal might be enough to get this segment in a reasonable condition.
6. The east bound segment between US 101 Overcrossing and SR 237 has also some wear and the surface shows loss of asphalt binder and overall wear. Some joint cracking is visible along the longitudinal direction. Utility related patches or pavement repairs are visible which may be due its age.
7. Pavement condition between Ross Drive to SR 237 interchange is similar to the eastbound condition. This is apparently maintained by Caltrans and has its own repair and maintenance thresholds and schedule. This segment indicates significant wear and distress. There are various repairs and patches, longitudinal and transverse cracks and loss of binder. This indicates the age of the pavement. Grinding and overlay with some reconstruction should be required which should also include pavement reinforcement fabric to maintain uniformity and control reflective cracking.

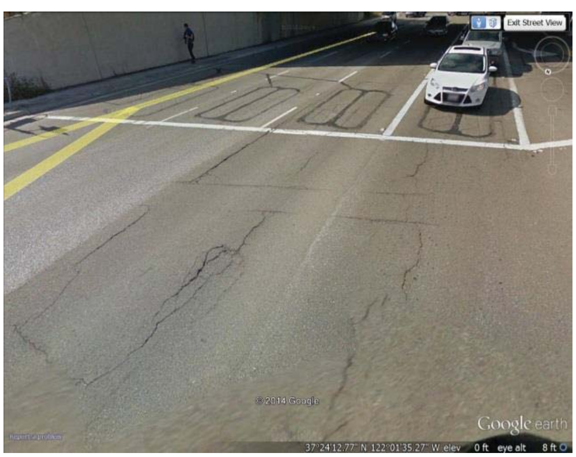
At all the intersections there are signal loops and sensors that would have to be repaired and or replaced in the event the pavement is repaired, overlaid and or reconstructed.

It is recommended that in the event an overlay option is considered a Deflection Test based (performance based) study be conducted. This should provide deflections of the existing pavement and the required overlay thickness to control reflective cracking using the proposed Traffic Index values. However in the event the Traffic Index has changed significantly the pavement may have to be reconstructed as the overlay requirements may be significant which would defeat the cost/benefit of the overlay work. Also the overlay requires the existing failed areas to be completely removed and replaced with full depth HMA. This should be considered in the cost analyses.

Attached are some pictures of the pavement conditions along selected locations.

Views looking towards west - WB Mathilda Ave. between SR 237 and Ross Drive

Views looking towards east - EB Mathilda Ave. between US 101 and Ross Drive



Views looking towards east - SR 237 IC (South-West side of Interchange)

PARIKH Practicing in the Geosciences	Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, CA	
	JOB NO.: 2014-129-GEO	Figure 1

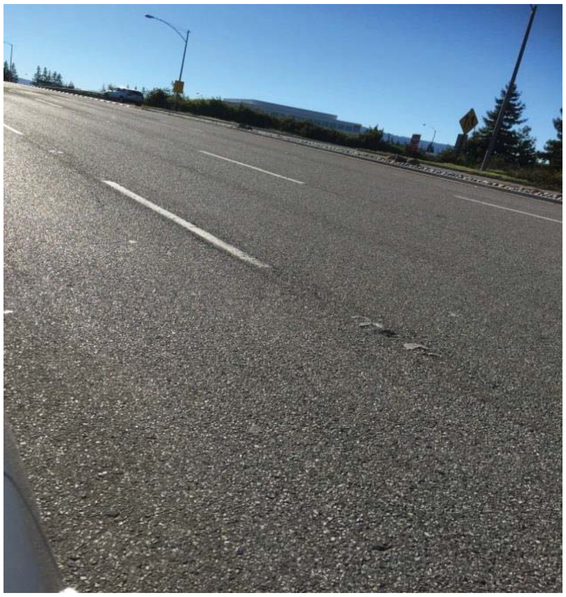
Views looking towards west - WB Mathilda Ave. between SR 237 and US 101

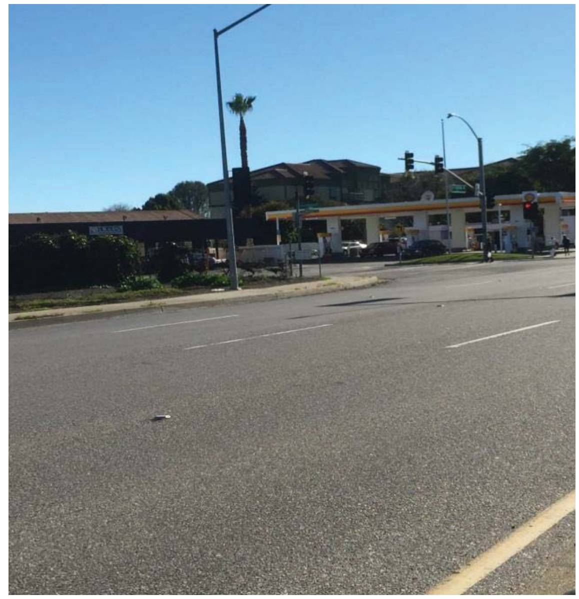
Views looking towards west - WB Mathilda Ave. between SR 237 and US 101

Views looking towards east - along WB Mathilda Ave. between SR 237 and US 101

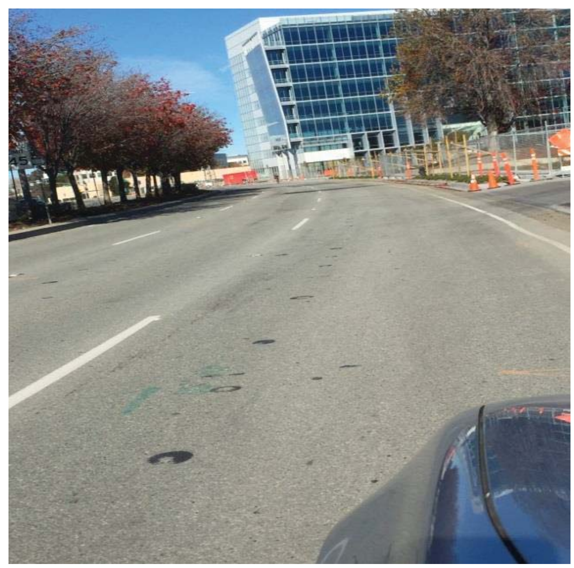
PARIKH
Practicing in the Geosciences

Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, CA		
JOB NO.: 2014-129-GEO	**Figure 2**	



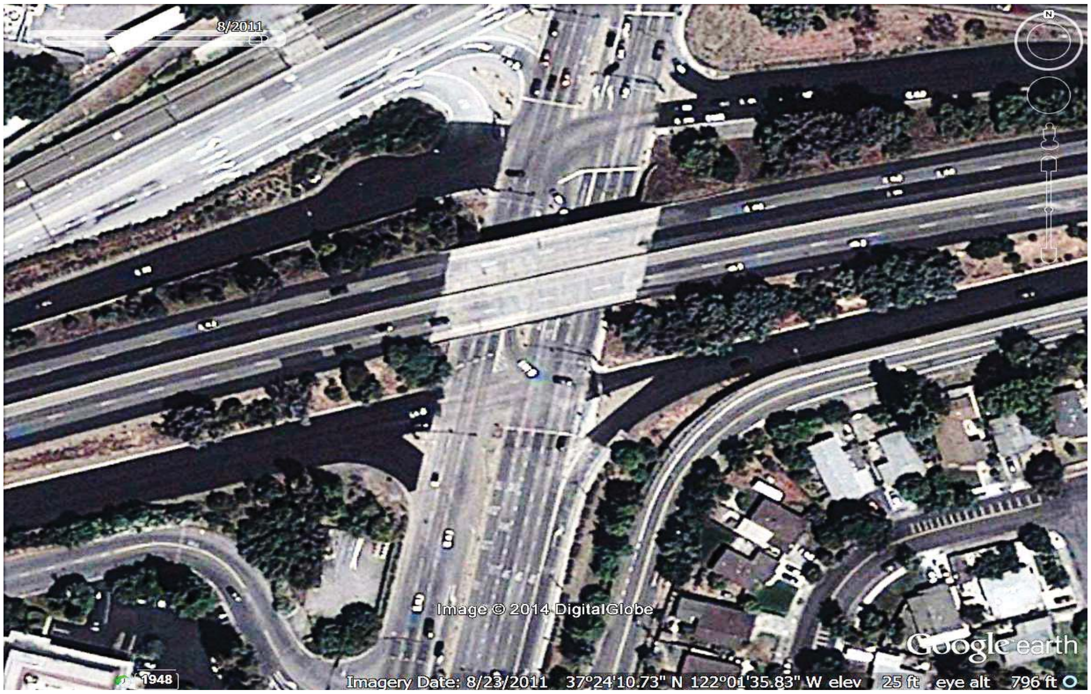


Views looking at EB Mathilda Ave. between US 101 and Ahwanee Drive

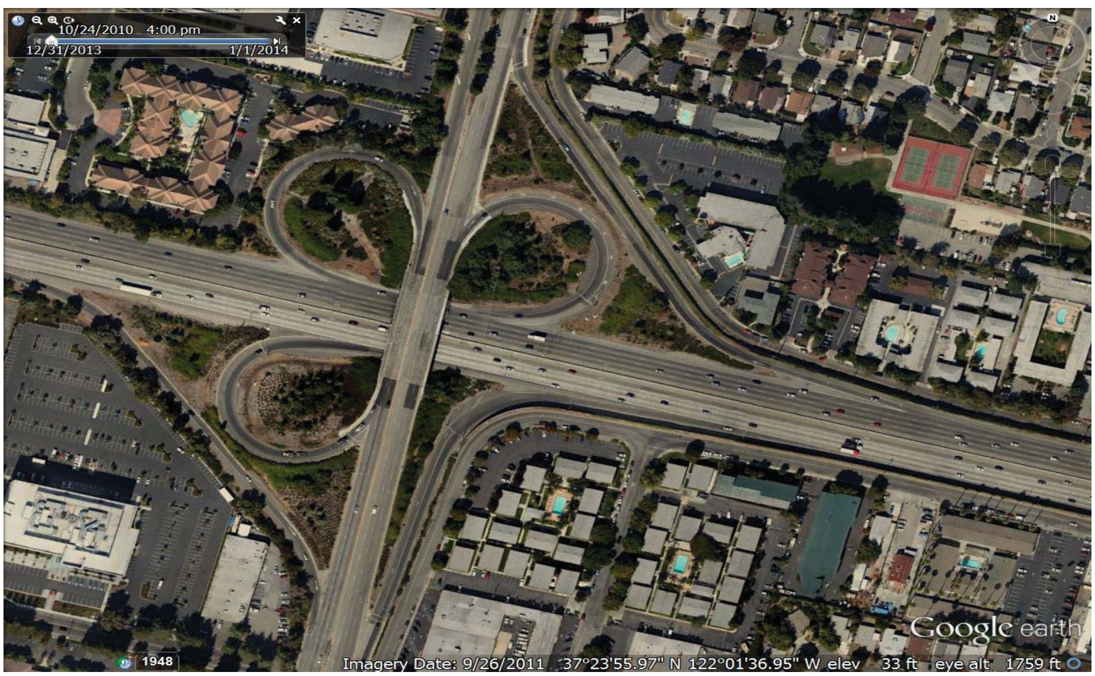


Views looking at EB Mathilda Ave. between SR 237 & Innovation Drive

PARIKH Practicing in the Geosciences	**Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, CA**	
	JOB NO.: 2014-129-GEO	**Figure 3**



Rte. 237 Ramps Overlaid in August 2011



Rte. 101 ramps overlaid/reconstructed prior to 2010

PARIKH Practicing in the Geosciences	**Mathilda Avenue Improvements at SR 237 and US 101, Sunnyvale, CA**	
	JOB NO.: 2014-129-GEO	**Figure 4**

APPENDIX F

DEFLECTION ANALYSIS
for
CITY OF SUNNYVALE
MATHILDA AVENUE & MOFFETT PARK DRIVE

Pavement Engineering Inc.

June 22, 2017 Project No. 160293-01

Mr. Gary Parikh
Parikh Consultants, Inc.
2360 Qume Drive, Suite A
San Jose, CA 95131

Subject: Deflection Analysis for the Mathilda Avenue Improvement Project

Dear Gary:

In accordance with your request, we have completed the pavement deflection analysis for the Mathilda Avenue Improvement Project for the City of Sunnyvale and are herein providing our findings and recommendations.

INTRODUCTION

The Mathilda Avenue Improvement Project consists of Mathilda Avenue from North of San Aleso Avenue to Innovation Way and Moffett Park Drive from Mathilda Avenue to Innovation Way.

The field work for our analysis consisted of deflection testing using our Dynaflect pavement deflection testing device in general accordance with CTM 356; coring to measure the existing structural section; sampling the native soil to determine R-value; and a visual condition survey. This work was performed by Brett Long and Alex Long of PEI's laboratory staff. Visual evaluations were performed by Bill Long.

We have summarized our analysis on the deflection summary sheets for Mathilda Avenue & Moffett Park Drive in the City of Sunnyvale in this report. Included on the summary sheets are the coring data for existing pavement thickness, visual condition survey, deflection test results analysis and recommendations.

ANALYSIS

The rehabilitation alternatives have been designed using structural requirements from the deflection analysis contained in CTM 356, reflective cracking criteria and the visual condition survey. Reflection cracking requirements are determined as a minimum of one-half the bonded layer section per current Caltrans recommendations for reflective cracking. Engineering judgment and experience has been used in applying these criteria to the individual street segments.

The rehabilitation alternatives evaluated in this analysis include HMA and RHMA overlays; milling and replacement with HMA; and Cold In-place Recycling (CIR).

OVERLAYS

The recommended overlays must meet both the requirements of the structural requirement from the deflection analysis and reflective cracking requirements. The minimum recommended overlay thickness is 1-3/4 inches to ensure that the HMA can be properly compacted.

For HMA overlays, typically a 1/2-inch HMA leveling course is recommended if pavement fabric is placed. The leveling course provides a uniform surface and fills cracks to insure the fabric is bonded properly to the overlay.

PEI also recommends placing a 1/2-inch leveling course under RHMA overlays. The leveling course helps provide a uniform surface for placing the RHMA to insure the thickness of the RHMA overlay. Minimum thickness for RHMA overlays is critical for compaction.

MILLING AND REPLACEMENT

Milling and replacement is generally recommended when overlay requirements for reflective cracking exceed 3-1/2 inches, but are structurally adequate by deflection. Overlays which exceed 3-1/2 inches are not usually feasible due to geometric constraints such as curb and gutter.

Mill and replacement alternatives allow for resurfacing the pavement to match the existing profile. This alternative can also reduce the lift thickness to meet reflective cracking requirements if the pavement is structurally adequate. The expected pavement life for milling and replacing is similar to an overlay. Milling and replacement is a green alternative also, because asphalt suppliers use the removed asphalt in Rap mixes.

COLD IN-PLACE RECYCLING (CIR)

CIR is an option when pavements are structurally adequate. It can be especially useful when pavements are thick (greater than 6 inches). CIR helps reduce crack history in thicker pavement and provides a green approach by using existing materials. CIR consists of either an emulsion process or a foaming process. The cold foam process can include mixing aggregate base with the asphalt.

PROJECT ANALYSIS

PEI is providing multiple alternatives for rehabilitating the pavements. The estimated design life of each recommended alternative is provided in the following table:

Proposed Treatment	Expected Service Life
HMA and RHMA Overlays	7-12 years
Milling and Replacement	8-12 years
Cold In-place Recycling (CIR)	8-12 years

Each alternative should be evaluated by the design engineer for cost, constructability and impact on the public during construction.

The Deflection Summary Sheets following this report provide the coring data, deflection data, visual condition evaluations and recommended repair strategies. Following the summary sheets are the deflection data print outs.

MATERIALS AND CONSTRUCTION

HMA recommended for leveling courses less than 1 inch should be constructed using 3/8 inch maximum HMA or #4 mix. The leveling course should be rolled and compacted with an 8 to 12 ton pneumatic-tire roller.

HMA with thicknesses of 1 to 2 inches should be constructed using 1/2-inch maximum HMA. HMA layer thicknesses greater than 2 inches can be constructed with either 1/2- or 3/4-inch maximum HMA.

RHMA should be constructed with 3/8 inches maximum aggregate for overlays less than 2 inches and 1/2-inch maximum size aggregate for overlays greater than or equal to 2 inches.

All HMA and RHMA work should be placed in accordance with Caltrans 2010 Section 39 using the standard process.

LIMITATIONS

This report has been prepared based on the indicated field testing and application of our knowledge of pavement technology. The repair strategies in this report are based upon industry standards.

Our professional services were performed, findings obtained, and recommendations prepared in accordance with generally accepted engineering principles and practices. No warranty is either expressed or implied.

SUMMARY

We performed deflection testing for the subject project and have provided recommendations and repair strategies for resurfacing the pavement of Mathilda Avenue and Moffett Park Drive in City of Sunnyvale.

If you have any questions, please do not hesitate to give me a call at (530) 224-4535.

Very truly yours,
PAVEMENT ENGINEERING INC.

William J. Long, P.E.
Senior Principal Engineer

Attachments: Mathilda Avenue - Innovation Way to Moffett Park Drive
Mathilda Avenue - Moffett Park Drive to Highway 101
Mathilda Avenue - Highway 101 to San Aleso Avenue
Moffett Park Drive - Mathilda Avenue to Innovation Way

pc: C File
160293-01

REGISTERED PROFESSIONAL ENGINEER
WILLIAM J. LONG
No. C047552
Exp. 12-31-17
CIVIL
STATE OF CALIFORNIA

MATHILDA AVENUE

Innovation Way to Moffett Park Drive

CORING LOG

Core No.	Lane & Direction	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)
9	SB3	300 Feet from Innovation Way	5-1/2	Y	0
10	SB2	315 Feet from Innovation Way	6-3/4	Y	0
11	SB3	750 Feet from Innovation Way	7	Y	0
12	SB2	800 Feet from Innovation Way	6-3/4	Y	0
13	SB1	850 Feet from Innovation Way	8-1/2	---	0
14	NB2	300 Feet from Moffett Park Drive	7	Y	0
15	NB1	400 Feet from Moffett Park Drive	5-1/2	---	0
16	NB1	550 Feet from Moffett Park Drive	6-1/2	---	0
17	NB2	650 Feet from Moffett Park Drive	8-1/2	Y	0
18	NB3	800 Feet from Moffett Park Drive	12	Y	0
19	SB1	350 Feet from Innovation Way	7	Y	7
20	NB3	150 Feet from Moffett Park Drive	12-3/4	Y	0

STRUCTURAL REQUIREMENTS
(by Deflection Analysis)

Direction/Lane	Traffic Index (TI)	Tolerable	80th Percentile	HMA Overlay Requirement (Inches)
NB1	11.5	10.00	8.79	0
NB2	11.5	10.00	12.09	1/2
NB3	11.5	10.00	7.06	0
SB1	11.5	10.00	12.32	3/4
SB2	11.5	10.00	11.74	1/2
SB3	11.5	10.00	14.13	1-1/2

REFLECTIVE CRACKING REQUIREMENTS

Direction/Lane	HMA Overlay Requirement (Inches)*	Pavement Fabric Required (Yes or No)
NB1	2	Yes
NB2	2-3/4	Yes
NB3	5-1/4	Yes
SB1	2-3/4	Yes
SB2	2-1/4	Yes
SB3	2-1/4	Yes

**Required overlay by reflective cracking is half the existing AC thickness – if pavement fabric is used then this criteria can be reduced by 1-1/4 inch with at least a minimum overlay requirement of 1-3/4 inches.*

VISUAL CONDITIONS

The southbound #1 and #2 lanes of Mathilda Ave. from Innovation Way to Moffett Park Dr. exhibit slight shrinkage cracking and small areas of moderate to severe alligator cracking. The southbound #3 lane appears to be a part of a widening project and is in good condition. Previous pavement repairs have been performed.

The northbound lanes of Mathilda Ave. from Moffett Park Dr. to Innovation Way are in generally good condition, exhibiting no distresses with the exception of the northbound #1 lane, which exhibits moderate to severe raveling as it approaches Innovation Way.

ANALYSIS

Mathilda Ave. from Innovation Way to Moffett Park Dr. is structurally deficient by up to 1-1/2 inches in the southbound lanes. Only the #2 lane in the northbound direction shows a slight structural deficiency. Because the northbound lanes are generally in good condition, rehabilitation alternatives could be limited to the southbound lanes only.

RECOMMENDATIONS

Crack Fill & Slurry Seal

The northbound lanes, overall, are in good condition, with the exception of the #3 lane, which is structurally deficient by 1/2 inch. We recommend applying a crack seal and Type II slurry to the roadway. The slurry seal does not address the structural deficiency of the northbound #3 lane, however, there is currently no cracking.

Overlay

HMA

We recommend removing and replacing base failures to a depth of 6 inches, placing a 3/4 inch HMA leveling course, pavement fabric and a 2 inch HMA overlay.

RHMA

We recommend removing and replacing pavement base failures to a depth of 6 inches, placing a 1/2 inch HMA leveling course and a 1-3/4 inch RHMA overlay.

These recommendations can also be applied to both the southbound and northbound lanes to maintain a consistent road condition. The overlay does not meet reflective cracking criteria of the northbound #3 lane, but there is currently no cracking in this lane.

The overlay options will eliminate the curb reveal at the median.

Milling and Replacement

HMA

We recommend milling off 3 inches of the existing pavement structure, 4 inch digouts of base failures, placing a 1 inch HMA leveling course and a 2 inch HMA overlay. RHMA can be used in place of HMA for the surface course. RHMA is a better inhibitor of reflective cracking.

This option can be applied to both the northbound and southbound lanes.

Cold In-Place Recycling (CIR)

We recommend cold in-place recycling to a depth of 3 inches and placing a 2 inch RHMA overlay.

This option can be applied to both the northbound and southbound lanes.

As previously discussed in the report, rehabilitation alternatives may have different anticipated service lives. The design engineer should evaluate each alternative based on cost, constructability and impact on the public.

PAVEMENT ENGINEERING INCORPORATED

Redding	Petaluma	San Luis Obispo
(530) 224-4535	(707) 769-5330	(805) 781-2265

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.54
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	5.85	7.87	9.94	1.10

Road Surface

Thickness	Traffic Index
0.54	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	8.79	9.27	0.00	0.00

HMA Overlay
0.00

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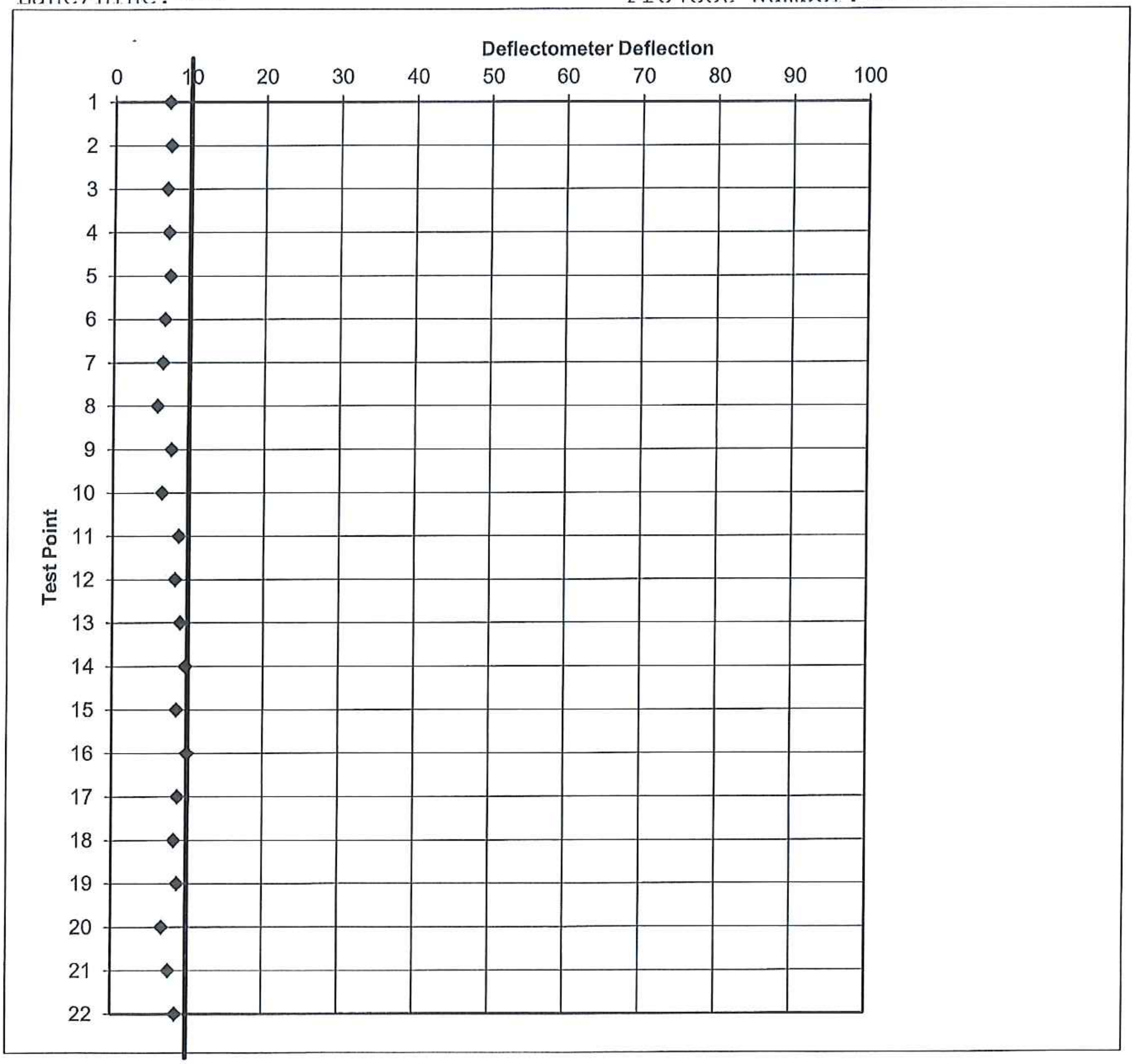
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.54
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.71
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	5.63	9.27	15.83	3.36

Road Surface

Thickness	Traffic Index
0.71	11.50

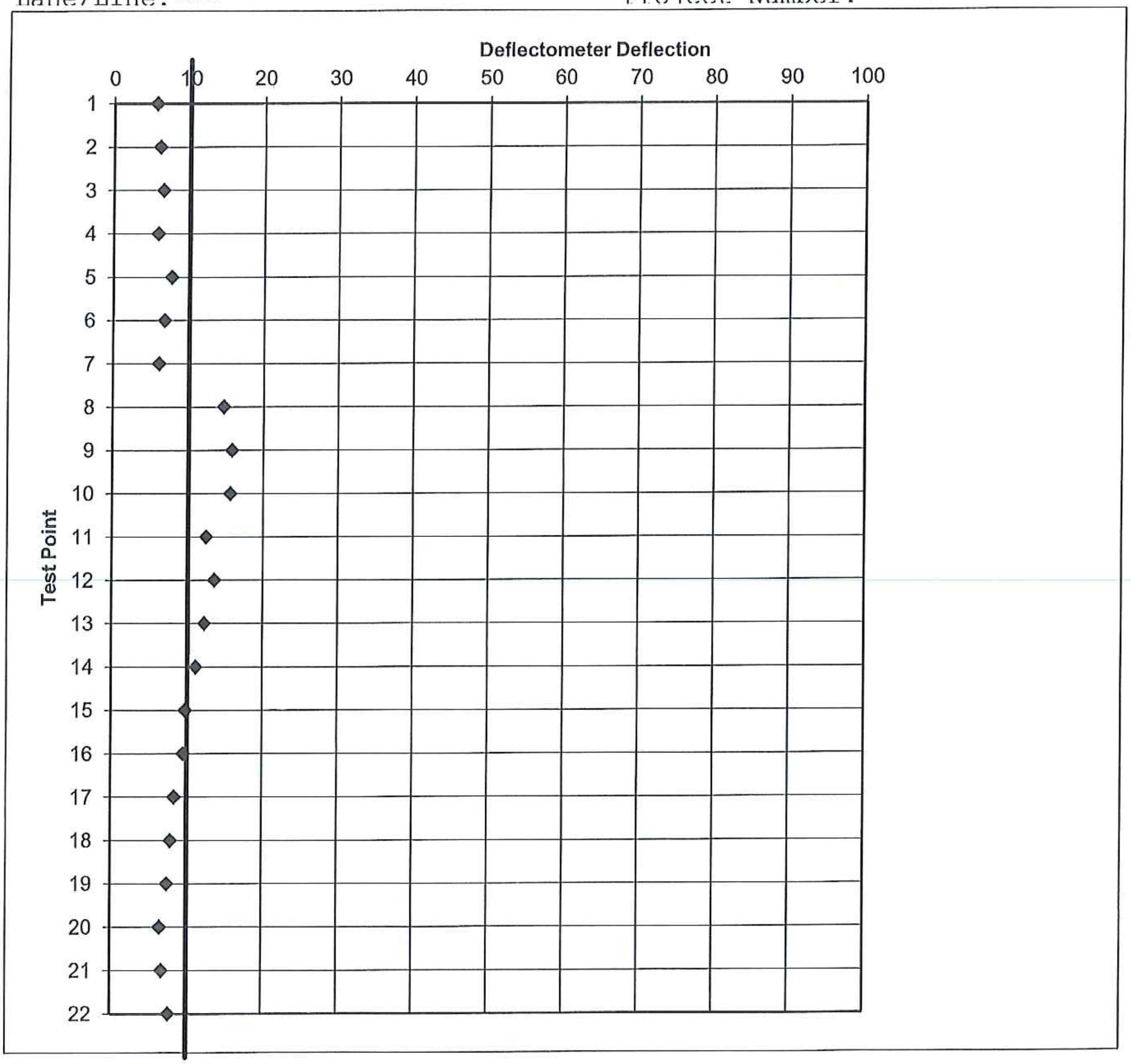
Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	12.09	13.57	17.29	0.08

HMA Overlay
0.04

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.71
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	1.06
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	4.94	6.24	8.12	0.97

Road Surface

Thickness	Traffic Index
1.06	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	7.06	7.49	0.00	0.00

HMA Overlay
0.00

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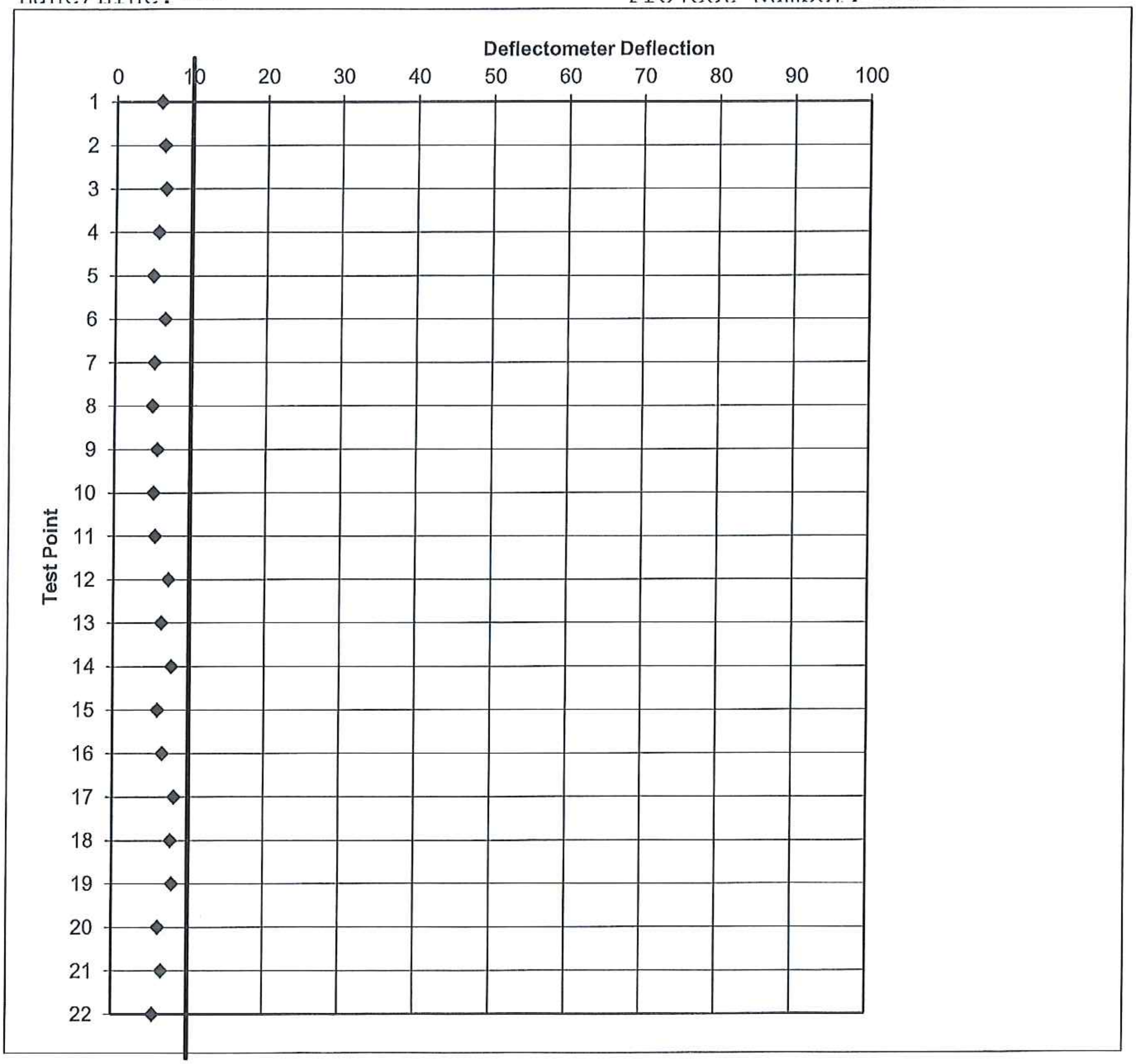
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	1.06
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.71
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	6.53	10.52	15.38	2.14

Road Surface

Thickness	Traffic Index
0.71	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	12.32	13.26	18.84	0.10

HMA Overlay
0.05

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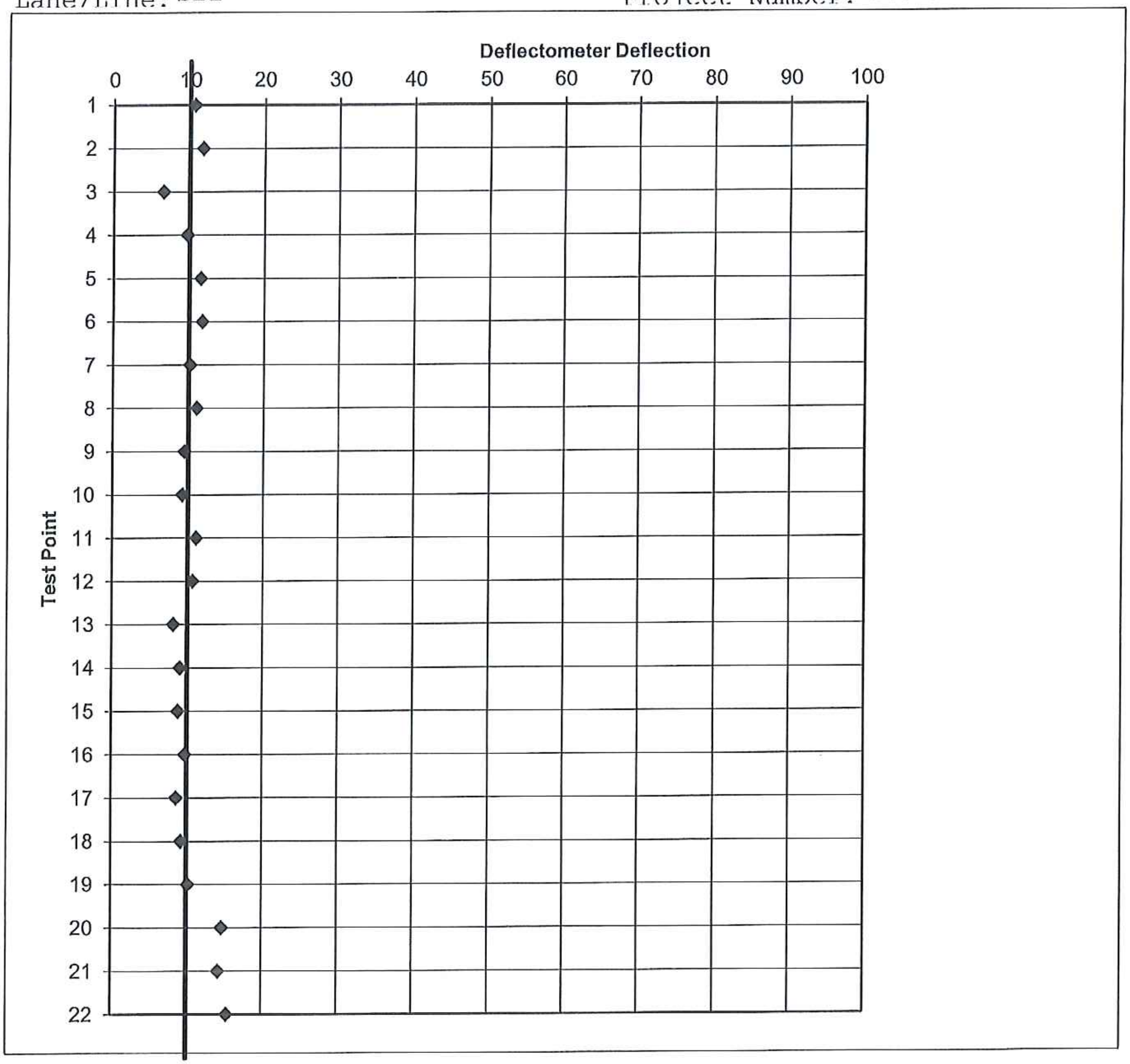
San Luis Obispo (805) 781-2265

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.71
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.56
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	5.17	9.73	16.51	2.39

Road Surface

Thickness	Traffic Index
0.56	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	11.74	12.79	14.79	0.07

HMA Overlay
0.04

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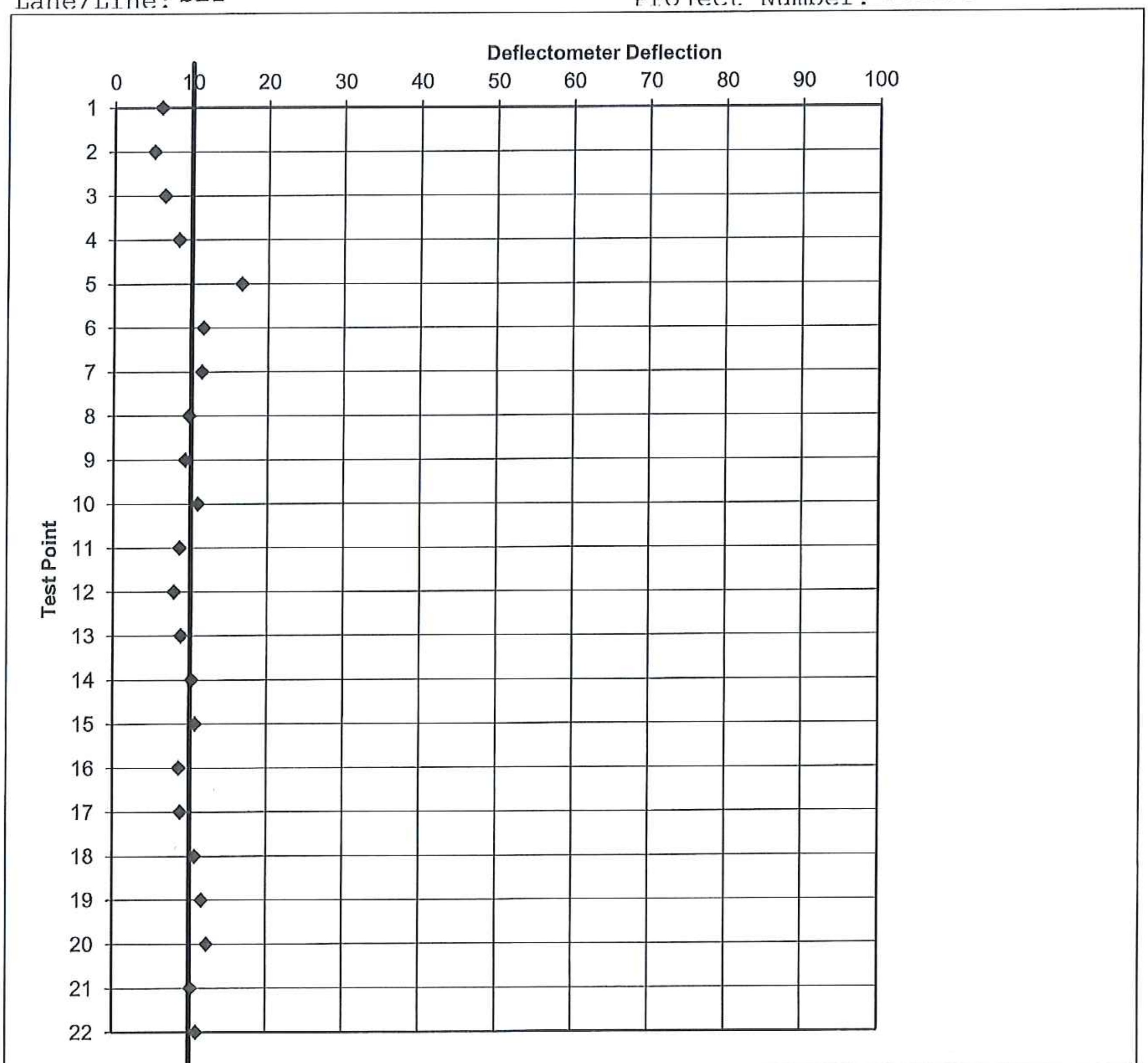
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.56
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	8.12	11.85	16.97	2.71

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	14.13	15.32	29.23	0.23

HMA Overlay
0.12

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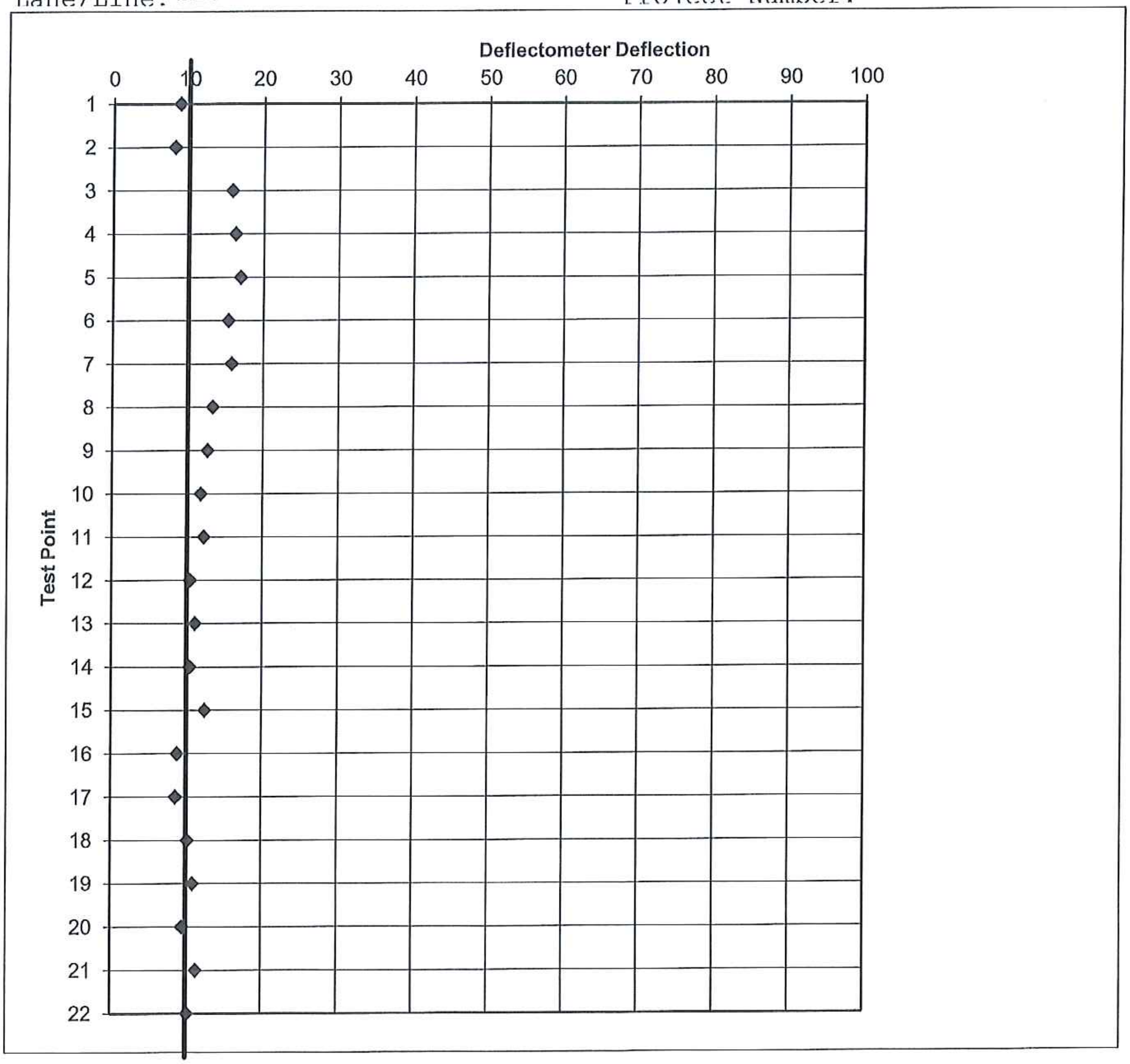
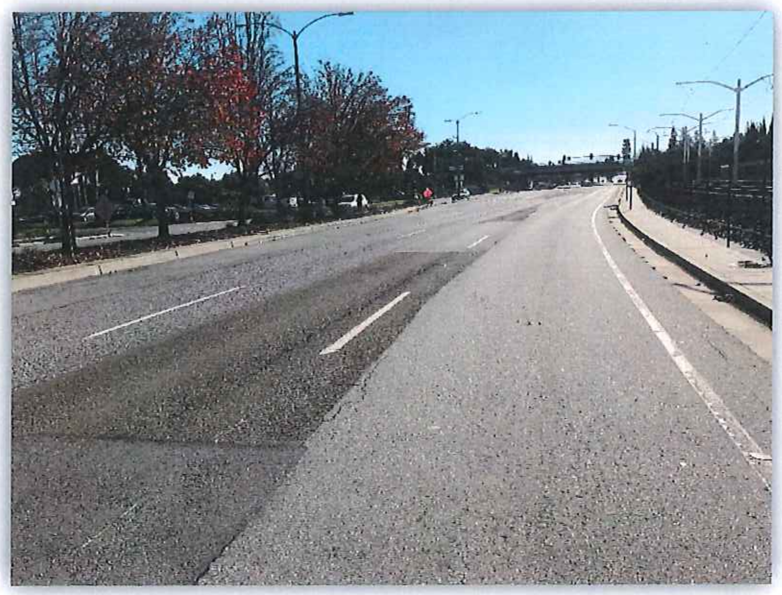
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Innovation Way	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	SB3	Project Number:	160293



Mathilda Avenue
Innovation Way to Moffett Park Drive

MATHILDA AVENUE – INNOVATION WAY TO MOFFETT PARK DRIVE
NEAR INNOVATION WAY (SB)



MATHILDA AVENUE – INNOVATION WAY TO MOFFETT PARK DRIVE
NEAR MOFFETT PARK DRIVE (SB)

<u>MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY</u>
NEAR MOFFETT PARK DRIVE (NB)

<u>MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY</u>
NEAR INNOVATION WAY (NB)

MATHILDA AVENUE
Moffett Park Drive to Highway 101

CORING LOG

Core No.	Lane & Direction	Location	HMA Layer (Inches)	AB Layer (Inches)	LTB/ CTB
21	SB3	625 Feet from Moffett Park Dr.	6-1/2	10	0
22	SB1	1,250 Feet from Moffett Park Dr.	7	9	0
23	NB1	200 Feet from Bridge Deck	14-1/2	3	0
24	NB5	1,500 Feet from Bridge Deck	18-1/2	3	0
25	NB4	210 Feet from Bridge Deck	20	0	0
26	NB3	240 Feet from Bridge Deck	7	0	1
27	NB2	520 Feet from Bridge Deck	11	0	5
28	NB5	700 Feet from Bridge Deck	14	0	0
29	NB4	830 Feet from Bridge Deck	6	0	0
30	NB3	1,180 Feet from Bridge Deck	5-1/2	0	0
31	NB2	1,240 Feet from Bridge Deck	5-1/2	0	0
32	NB1	1,680 Feet from Bridge Deck	6-1/2	0	0
33	SB2	510 Feet from Moffett Park Dr.	8	0	0
34	SB1	850 Feet from Moffett Park Dr.	6	0	2
35	SB3	1,020 Feet from Moffett Park Dr.	4-1/2	0	0
36	SB2	1,400 Feet from Moffett Park Dr.	6	0	1

STRUCTURAL REQUIREMENTS
(by Deflection Analysis)

Direction/Lane	Traffic Index (TI)	Tolerable	80th Percentile	HMA Overlay Requirement (Inches)
NB1	11.5	10.00	10.78	1/4
NB2	11.5	10.00	10.54	1/4
NB3	11.5	10.00	12.63	3/4
NB4	11.5	10.00	10.50	1/4
NB5	11.5	10.00	11.98	1/2
SB1	11.5	10.00	10.19	1/4
SB2	11.5	10.00	10.33	1/4
SB3	11.5	10.00	18.83	3-3/4

REFLECTIVE CRACKING REQUIREMENTS

Direction/Lane	HMA Overlay Requirement (Inches)*	Pavement Fabric Required (Yes or No)
NB1	2-1/4	Yes
NB2	2-1/4	Yes
NB3	2-1/4	Yes
NB4	2-1/4	Yes
NB5	8	Yes
SB1	2-1/4	Yes
SB2	2-3/4	Yes
SB3	2	Yes

**Required overlay by reflective cracking is half the existing AC thickness – if pavement fabric is used then this criteria can be reduced by 1-1/4 inch with at least a minimum overlay requirement of 1-3/4 inches.*

VISUAL CONDITIONS

The southbound lanes exhibit slight to moderate block shrinkage cracking and some alligator cracking and moderate to severe raveling with significant loss of aggregate of several locations particularly at joints. Some areas of alligator cracking have progressed to base failure. The base failures are more prevalent in the #3 lane. Previous maintenance includes pavement repairs and small areas of thin maintenance overlays. Some areas of disbonding have occurred.

The pavement in the northbound lanes also exhibit block shrinkage cracking, moderate to severe raveling and areas of alligator cracking. The base failure is mainly in the northbound #4 and #5 lanes. The raveling is less severe in the northbound lanes than the southbound lanes.

ANALYSIS

Mathilda Ave. from Moffett Park Dr. to Highway 101 is slightly structurally deficient by between 1/4 and 3/4 inch of HMA. The exceptions are the southbound #3 lane, which is structurally deficient by 3-3/4 inches of HMA and the northbound #5 lane that requires 8 inches of HMA to meet reflective cracking criteria. The southbound #3 and northbound #5 lanes will require partial reconstruction as part of any rehabilitation alternative.

RECOMMENDATIONS

Overlay

HMA

We recommend removing and replacing pavement base failures to a depth of 6 inches, milling off and replacing with 5 inches of HMA in the southbound #3 lane, and 4 inches of HMA in the northbound #5 lane. A 3/4 inch HMA leveling course, pavement fabric and a 2 inch HMA overlay should be placed across all lanes.

RHMA

We recommend removing and replacing pavement base failures to a depth of 6 inches, milling off and replacing 5 inches of HMA in the southbound #3 lane and placing 3 inches of HMA in the northbound #5 lane. A 1/2 inch HMA leveling course, pavement fabric and a 1-3/4 inch RHMA overlay should be placed across all lanes.

The overlay options will eliminate the curb reveal at the median.

Milling and Replacement

We recommend milling off 2-1/2 inches of existing asphalt concrete, 4 inch digouts of base failures, placing a 1/2 inch HMA leveling course and a 2 inch RHMA overlay. The exception is the southbound #3 lane, which will require removing 5 inches of existing asphalt beyond the 2-1/2 inches of milled pavement and replacement with 5 inches of new HMA placed in 2 lifts.

Cold In-Place Recycling (CIR)

We recommend milling off 2 inches of the existing pavement, cold in-place recycling to a depth of 3 inches and placing a 2 inch RHMA overlay. The exception is the southbound #3 lane, which requires removal of an additional 5 inches of the existing pavement and placing 5 inches of new HMA placed in two lifts prior to placing the 2 inch RHMA overlay.

As previously discussed in the report, rehabilitation alternatives may have different anticipated service lives. The design engineer should evaluate each alternative based on cost, constructability and impact on the public.

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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	4.94	8.31	20.60	2.94

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.78	12.07	7.20	0.02

HMA Overlay
0.01

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01/04/17

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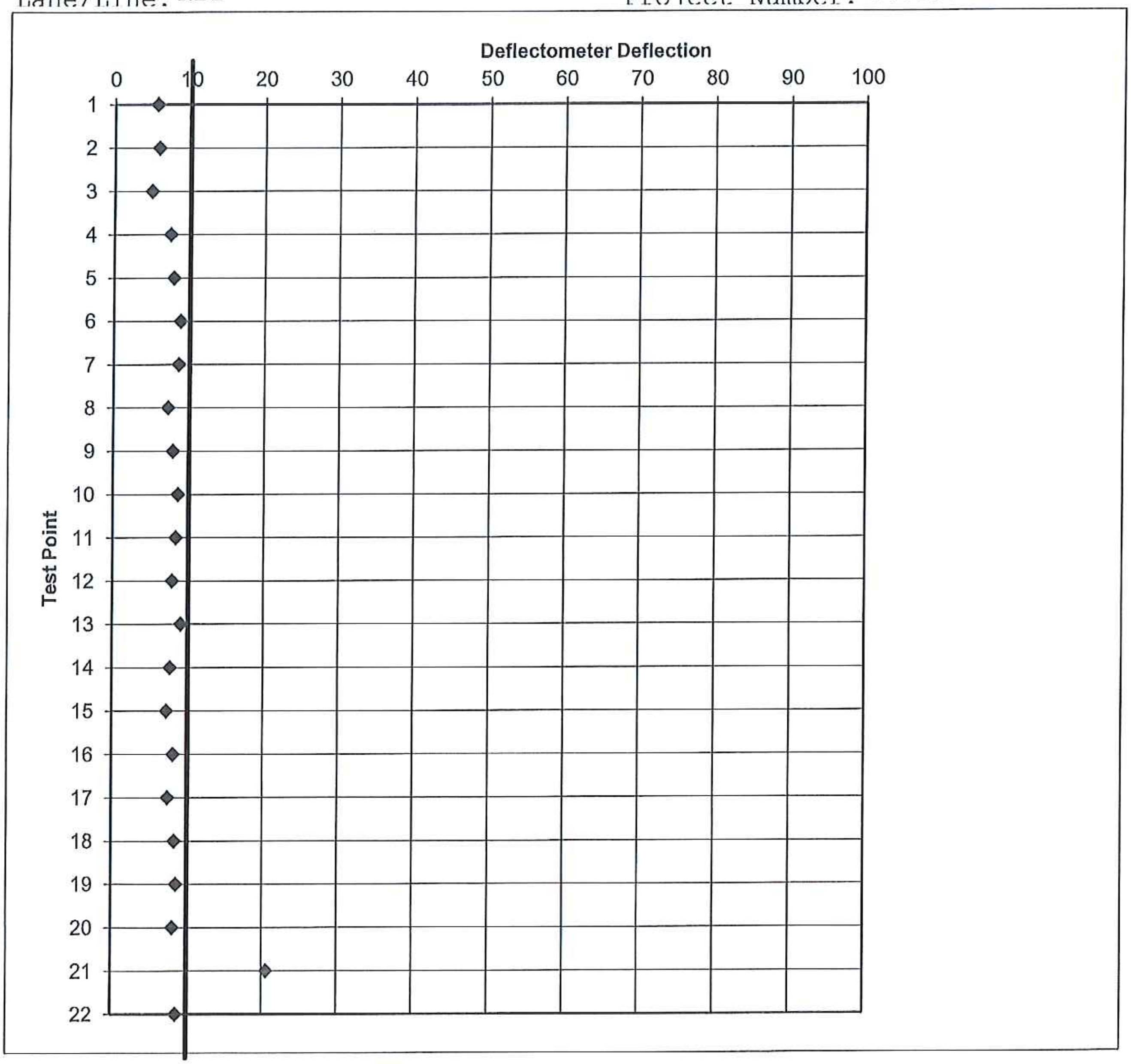
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.81	8.27	13.57	2.71

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.54	11.73	5.11	0.02

HMA Overlay
0.01

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Parikh Consultants

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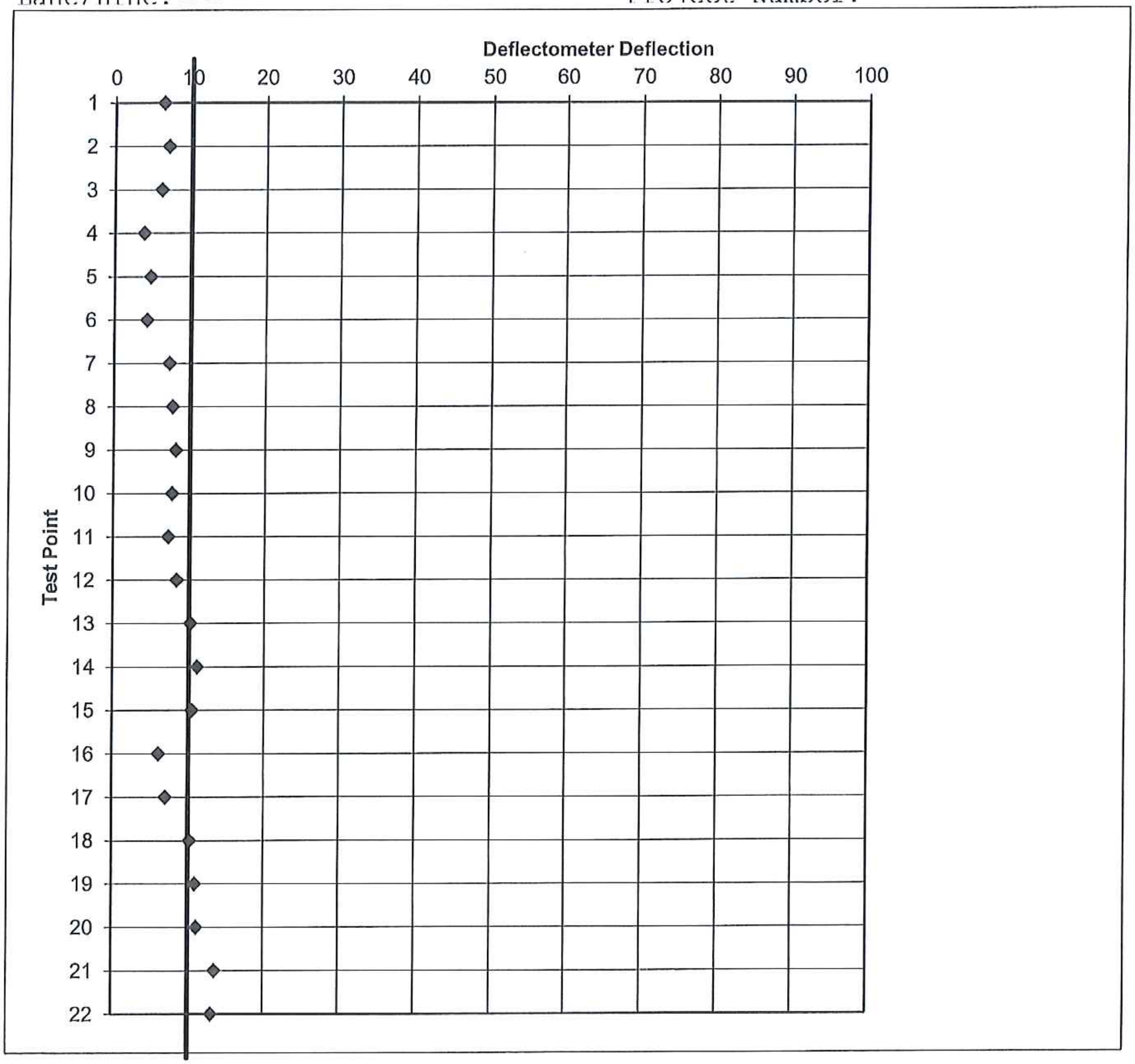
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	4.72	9.02	21.96	4.29

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	12.63	14.52	20.79	0.12

HMA Overlay
0.06

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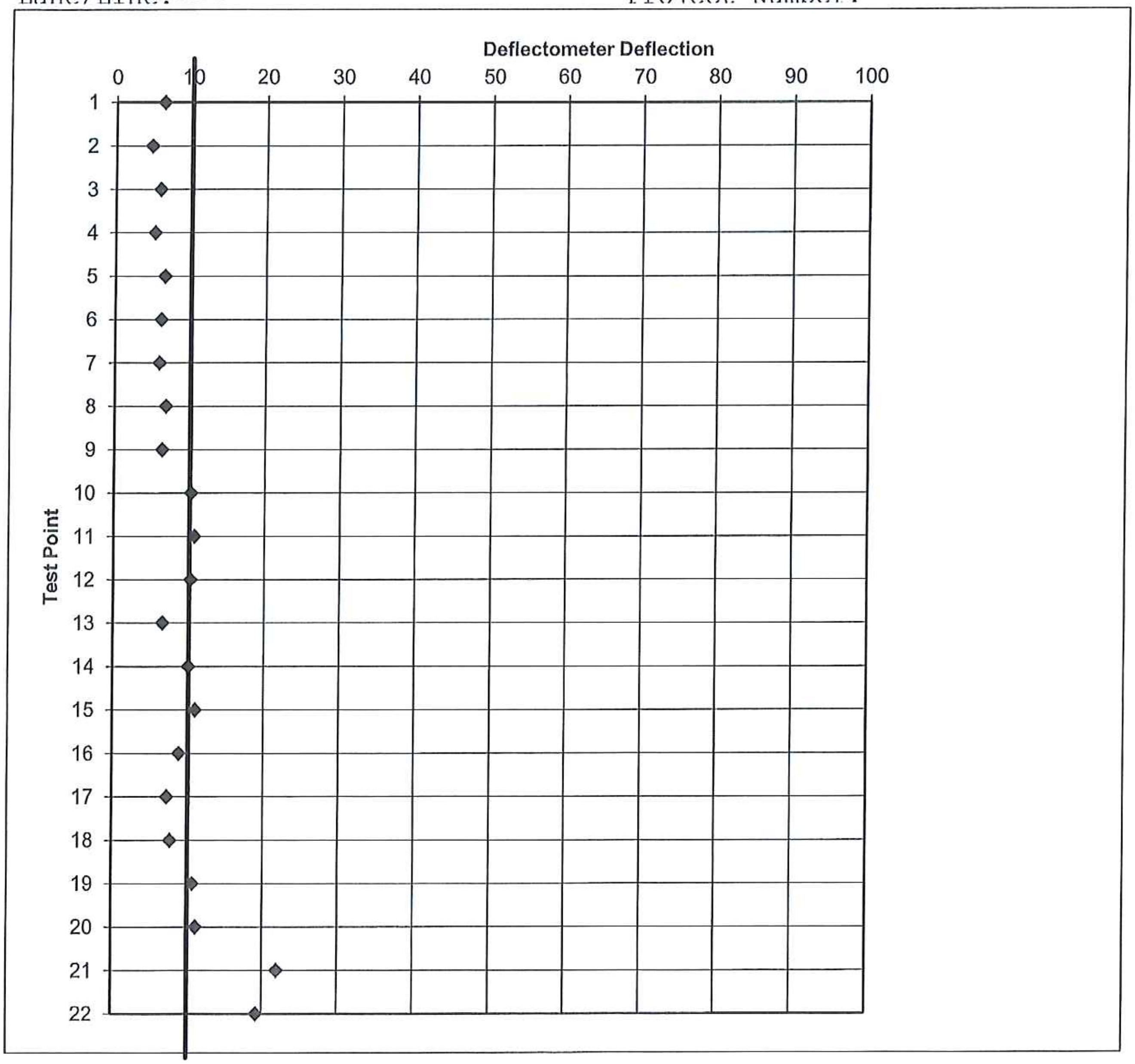
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB4	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.36	7.81	12.89	3.20

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.50	11.91	4.74	0.02

HMA Overlay
0.01

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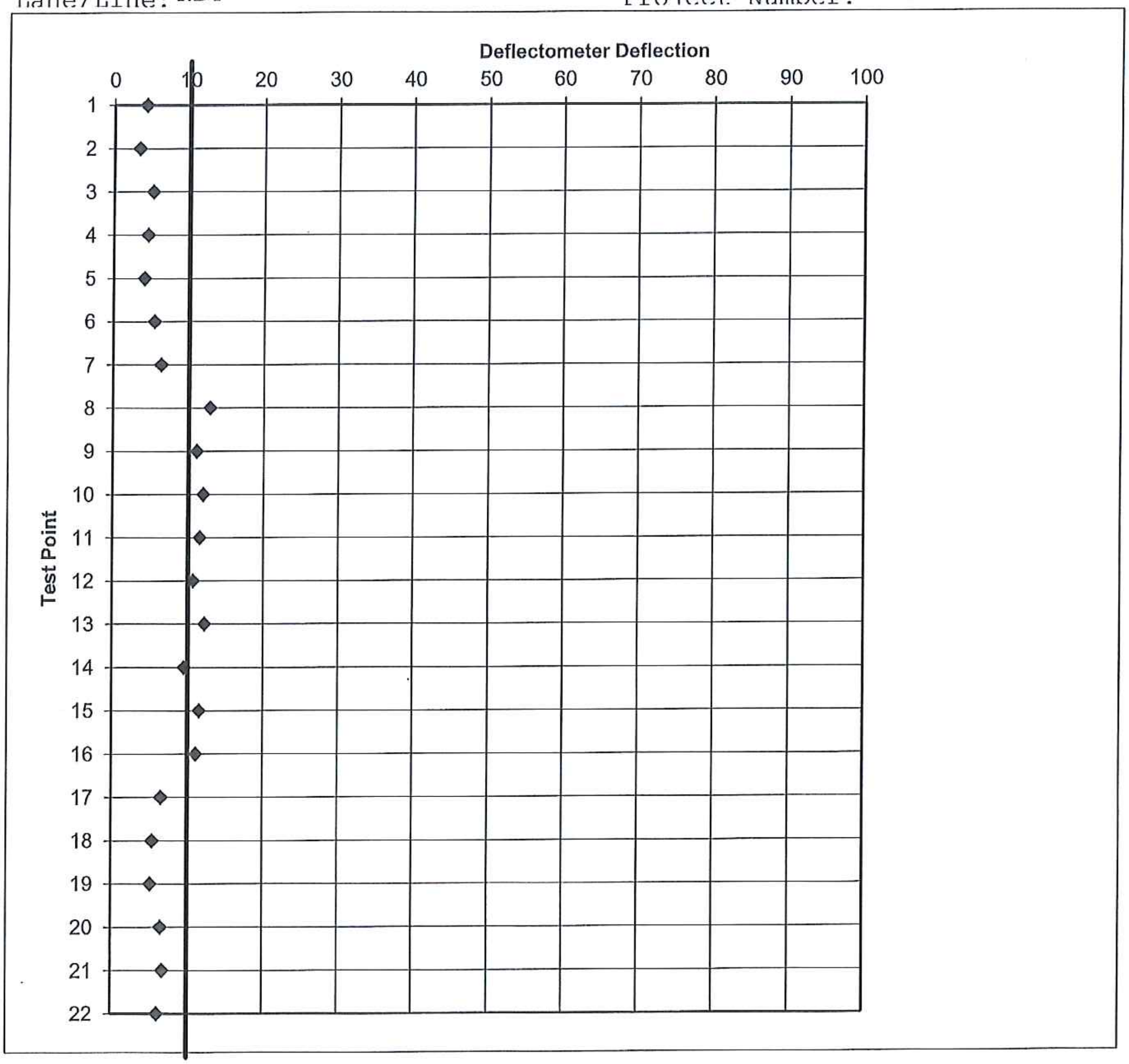
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.58
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB4	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	1.54
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB5	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.13	7.92	27.18	4.82

Road Surface

Thickness	Traffic Index
1.54	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	11.98	14.10	16.50	0.08

HMA Overlay
0.04

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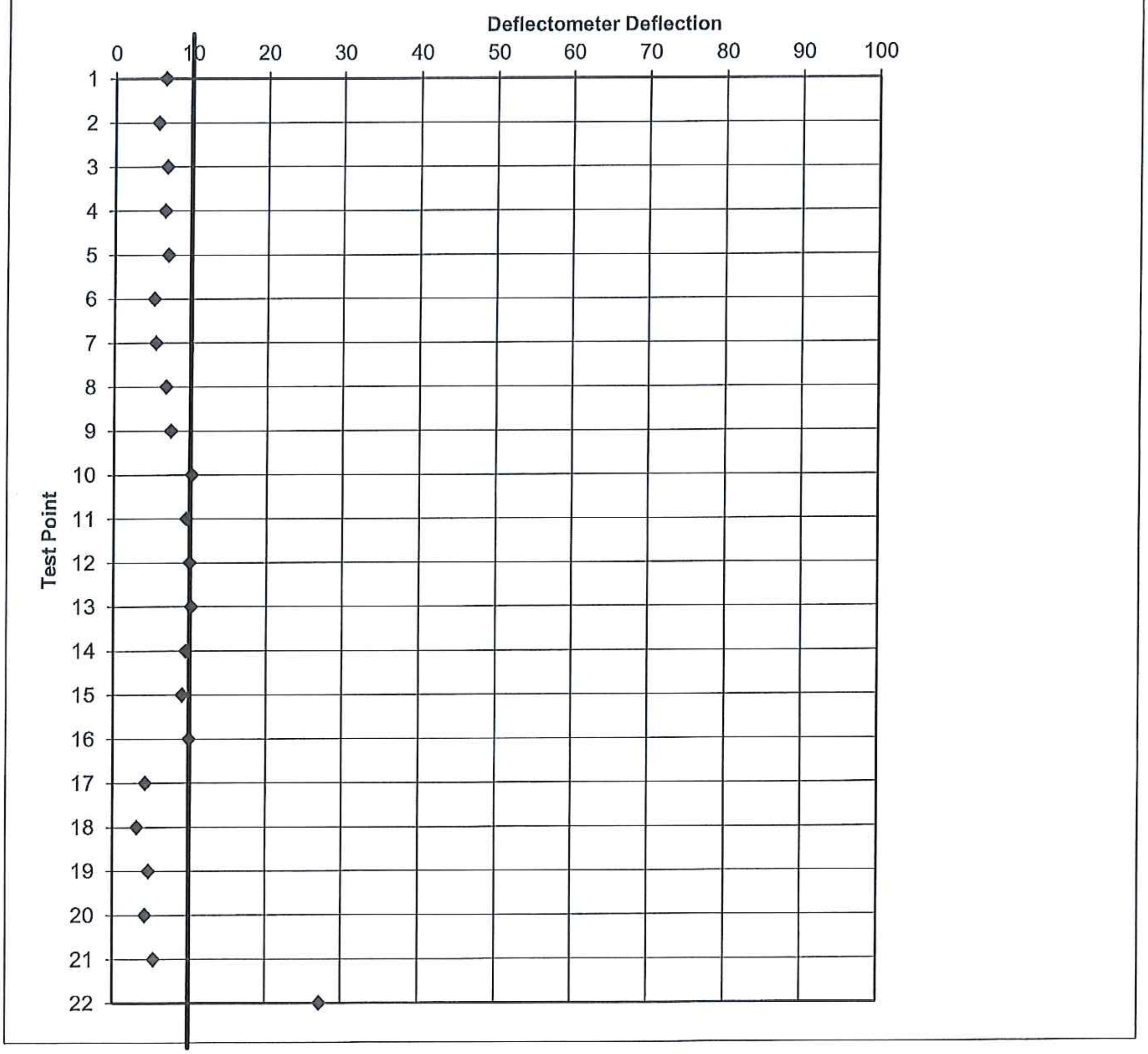
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	1.54
To:	Moffett Park Drive	Traffic Index:	11.50
Lane/Line:	NB5	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.58
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	6.08	8.55	14.93	1.94

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.19	11.04	1.83	0.01

HMA Overlay
0.01

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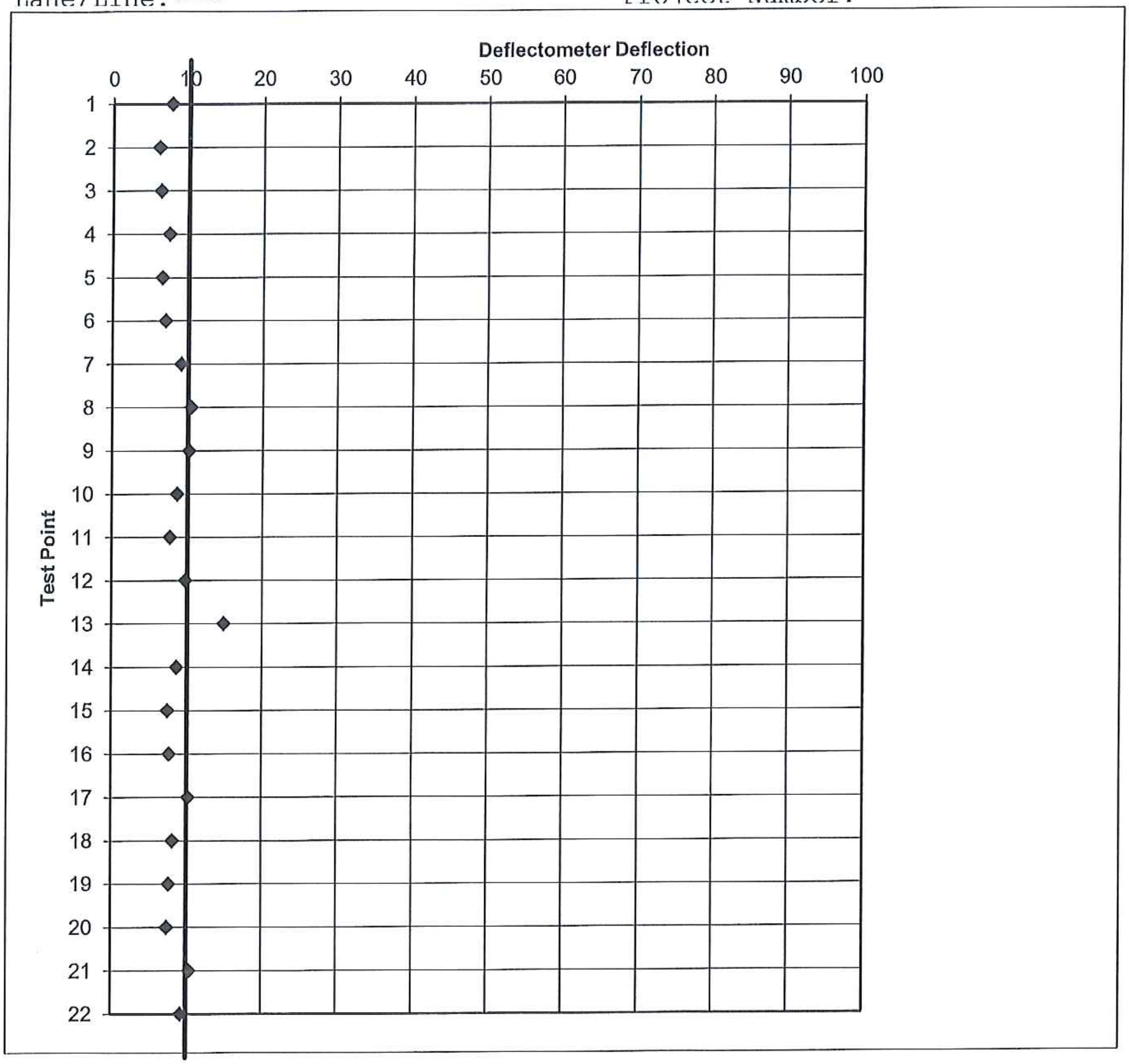
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.58
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	1.77	8.37	11.30	2.34

Road Surface

Thickness	Traffic Index
0.66	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.33	11.36	3.23	0.01

HMA Overlay
0.01

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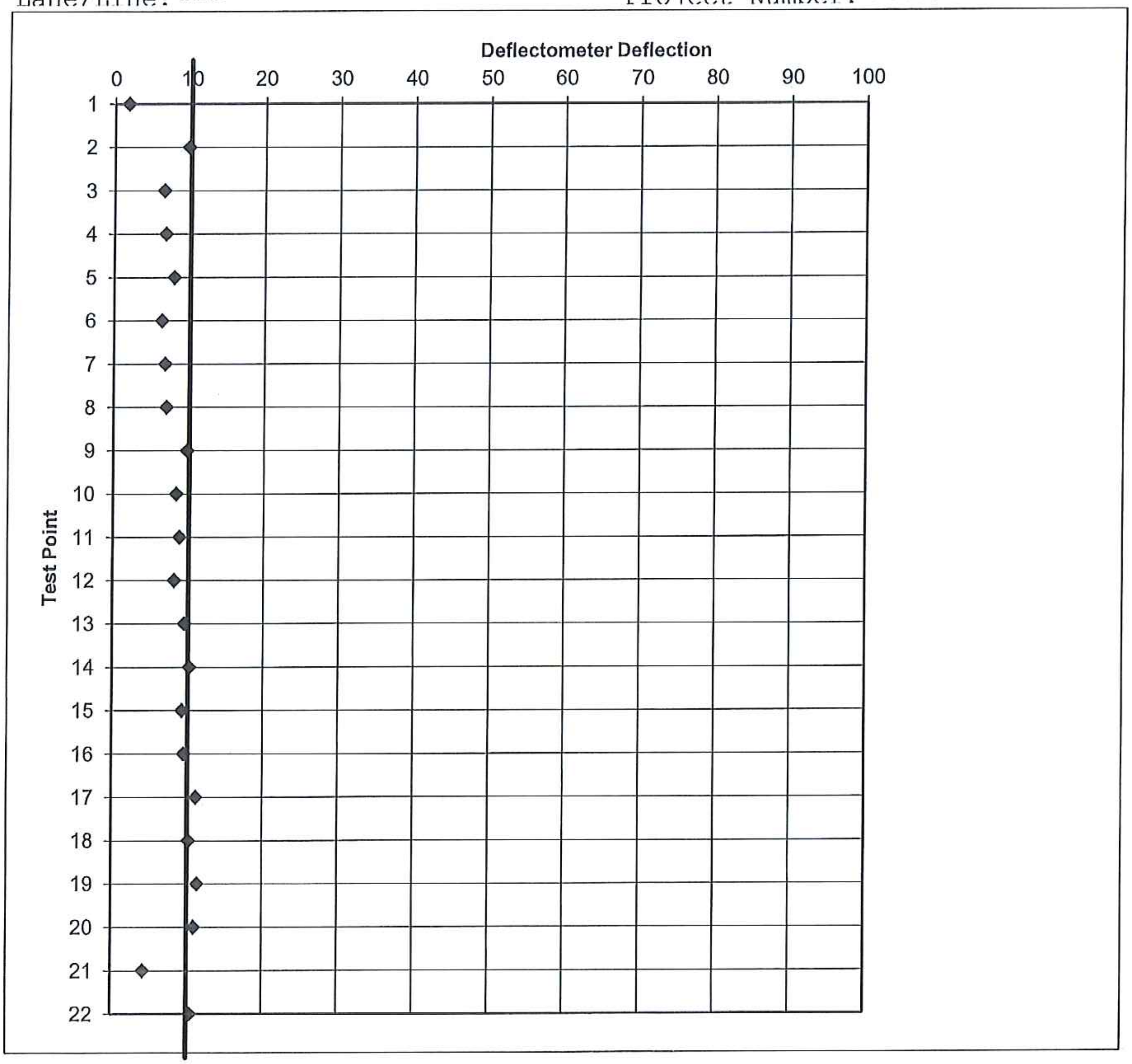
01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293



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Road:	Mathilda Avenue	Survey Date:	
From:	Moffett Park Drive	Thickness:	0.54
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	SB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
17	3.36	12.48	24.91	7.55

Road Surface

Thickness	Traffic Index
0.54	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	18.83	22.15	46.88	0.57

HMA Overlay
0.30

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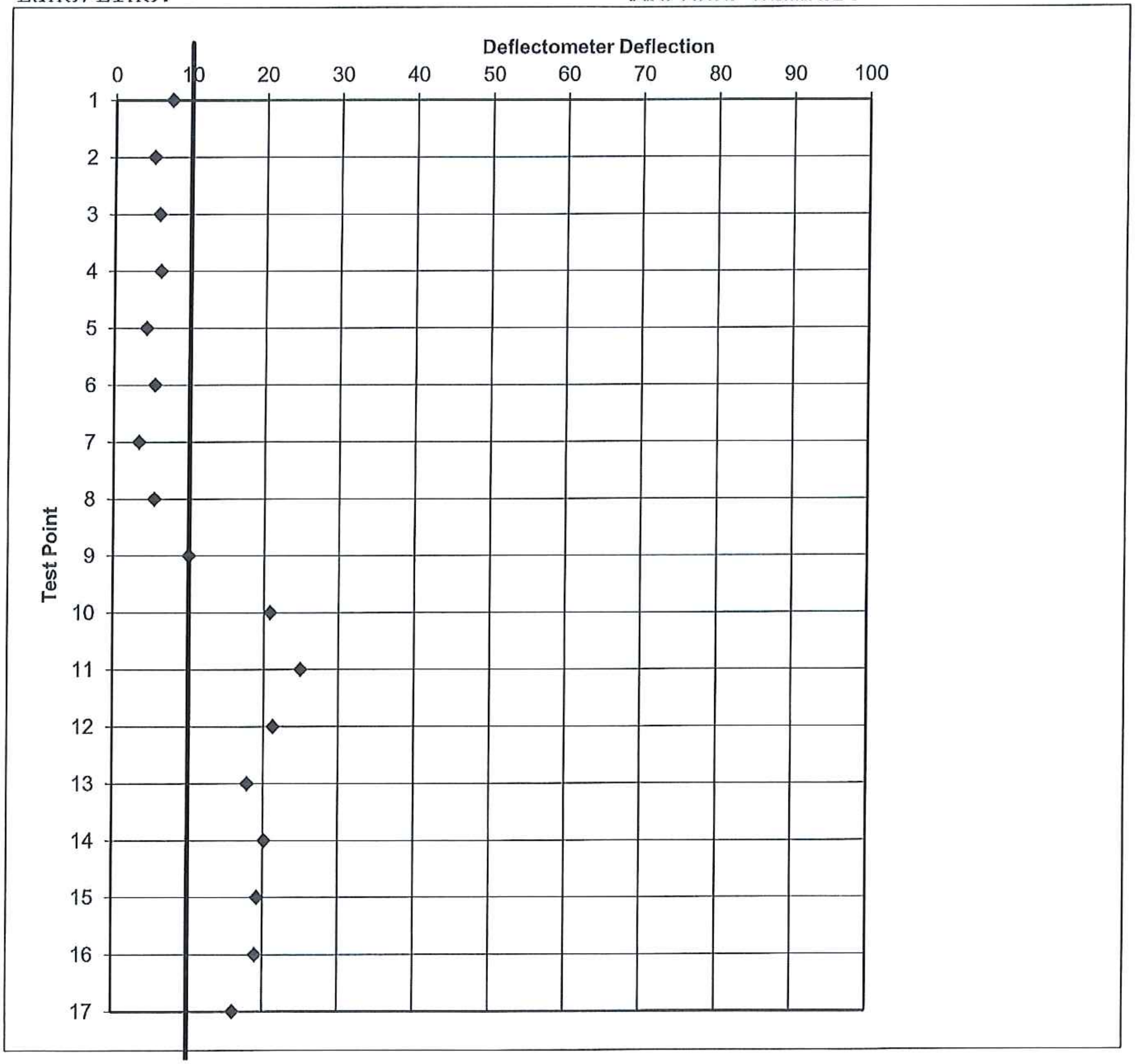
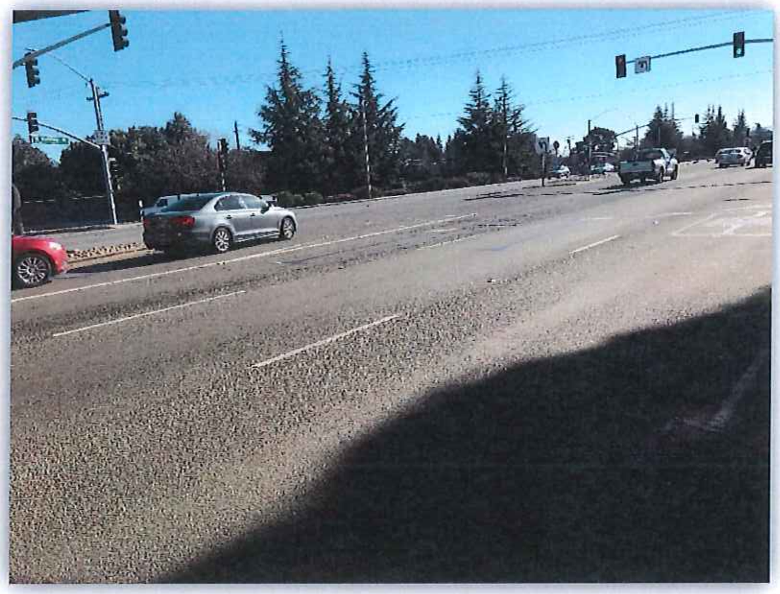
Parikh Consultants

Road: Mathilda Avenue
From: Moffett Park Drive
To: Highway 101 Bridge Deck
Lane/Line: SB3

Survey Date:
Thickness: 0.54
Traffic Index: 11.50
Project Number: 160293

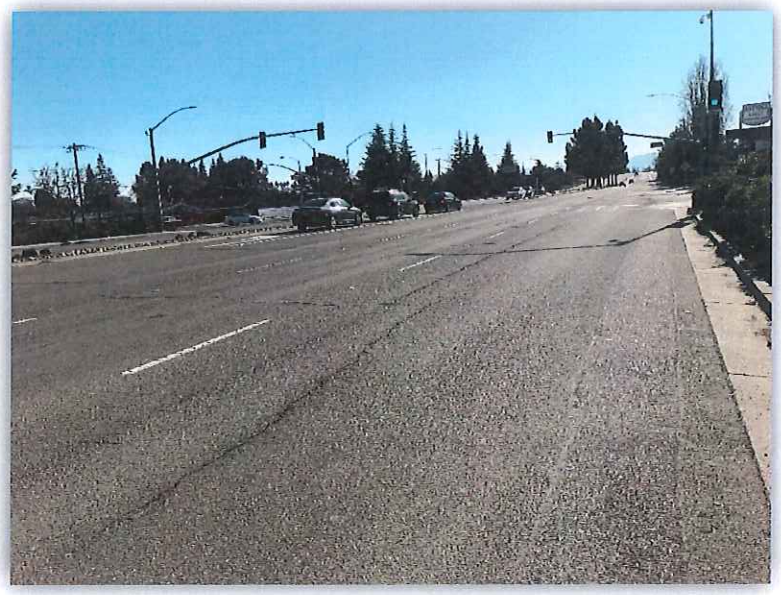


Mathilda Avenue
Moffett Park Drive to Highway 101



MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101

NEAR HIGHWAY 237 (SB)



MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101

NEAR ROSS ROAD (SB)

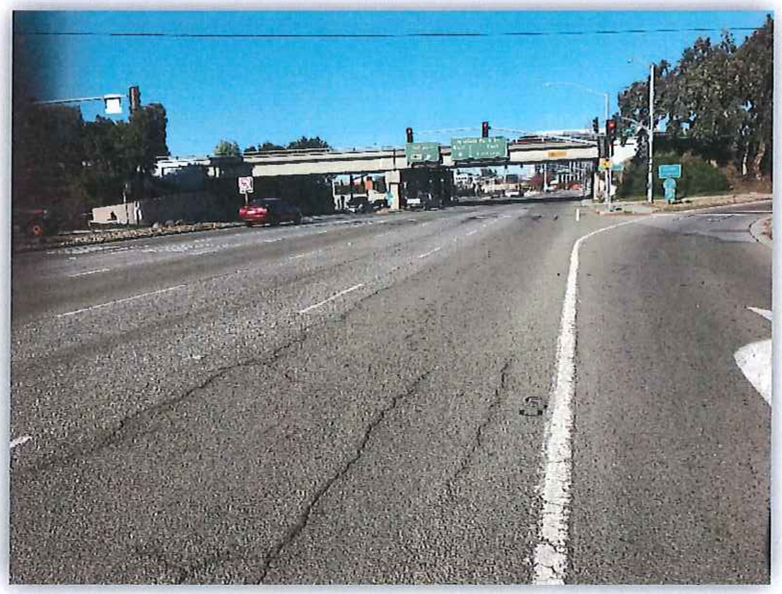
MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101

SOUTH OF ROSS ROAD INTERSECTION (SB)

MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101

NEAR HIGHWAY 101 (NB)

MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101
NEAR ROSS ROAD (NB)



MATHILDA AVENUE – MOFFETT PARK DRIVE TO HIGHWAY 101
NEAR HIGHWAY 237 (NB)

MATHILDA AVENUE

Highway 101 to San Aleso Avenue

CORING LOG

Core No.	Lane & Direction	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)	LTB/ CTB
37	SB3	530 Feet from Bridge Deck	6-1/4	Y	9	0
38	SB1	1,500 Feet from Bridge Deck	18-1/2	Y	2	0
39	NB3	315 Feet from San Aleso Ave.	7	Y	5	0
40	NB1	1,450 Feet from San Aleso Ave.	18-1/2	Y	0	0
41	NB2	430 Feet from San Aleso Ave.	10	---	0	0
42	NB1	530 Feet from San Aleso Ave.	8	---	0	0
43	NB4	880 Feet from San Aleso Ave.	9	---	0	0
44	NB3	1,130 Feet from San Aleso Ave.	7	---	0	7
45	NB2	1,320 Feet from San Aleso Ave.	7-1/2	---	0	0
46	NB4	1,600 Feet from San Aleso Ave.	6-1/2	---	0	3
47	SB1	130 Feet from Bridge Deck	6-3/4	Y	0	0
48	SB2	500 Feet from Bridge Deck	7	Y	0	3-1/2
49	SB4	880 Feet from Bridge Deck	10	Y	0	0
50	SB3	1,230 Feet from Bridge Deck	5-1/2	---	0	0
51	SB2	1,400 Feet from Bridge Deck	9-1/2	Y	0	0
52	SB4	1,650 Feet from Bridge Deck	7	Y	0	0

STRUCTURAL REQUIREMENTS
(by Deflection Analysis)

Direction/Lane	Traffic Index (TI)	Tolerable	80th Percentile	HMA Overlay Requirement (Inches)
NB1	11.5	10.00	7.29	0
NB2	11.5	10.00	8.99	0
NB3	11.5	10.00	13.31	1-1/4
NB4	11.5	10.00	13.12	1
SB1	11.5	10.00	10.48	1/4
SB2	11.5	10.00	9.97	0
SB3	11.5	11.00	15.33	1-1/2
SB4	11.5	10.00	13.70	1-1/2

REFLECTIVE CRACKING REQUIREMENTS

Direction/Lane	HMA Overlay Requirement (Inches)*	Pavement Fabric Required (Yes or No)
NB1	2-3/4	Yes
NB2	3-1/4	Yes
NB3	2-1/4	Yes
NB4	2-3/4	Yes
SB1	2-3/4	Yes
SB2	2-3/4	Yes
SB3	1-1/2	Yes
SB4	2-3/4	Yes

**Required overlay by reflective cracking is half the existing AC thickness – if pavement fabric is used then this criteria can be reduced by 1-1/4 inch with at least a minimum overlay requirement of 1-3/4 inches.*

VISUAL CONDITIONS

The existing pavement exhibits slight to moderate block shrinkage cracking, slight to moderate raveling and areas of alligator cracking. Some areas of alligator cracking have progressed to base failure.

ANALYSIS

The pavements are generally structurally adequate in the #1 and #2 lanes in both directions. The pavement is structurally deficient by 1 to 1-1/2 inches of HMA in the northbound and southbound #3 and #4 lanes. Reflective cracking criteria controls the overlay requirement.

RECOMMENDATIONS

Overlay

HMA

We recommend removing and replacing pavement base failures to a depth of 6 inches, placing a 1 inch HMA leveling course, pavement fabric and a 2 inch HMA overlay.

RHMA

We recommend removing and replacing pavement base failures to a depth of 6 inches, placing a 1/2 inch HMA leveling course and a 2 inch RHMA overlay.

The overlay options will eliminate the curb reveal at the median.

Milling and Replacement

We recommend milling off 3 inches, placing a 1 inch HMA leveling course and placing 2 inches of new HMA. RHMA can be used in place of HMA for the overlay.

Cold In-Place Recycling (CIR)

We recommend milling off 2-1/2 inches of the existing pavement, cold in-place recycling to a depth of 3 inches and placing a 2-1/2 inch RHMA overlay.

As previously discussed in the report, rehabilitation alternatives may have different anticipated service lives. The design engineer should evaluate each alternative based on cost, constructability and impact on the public.

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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.58	6.20	7.44	1.30

Road Surface

Thickness	Traffic Index
0.66	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	7.29	7.86	0.00	0.00

HMA Overlay
0.00

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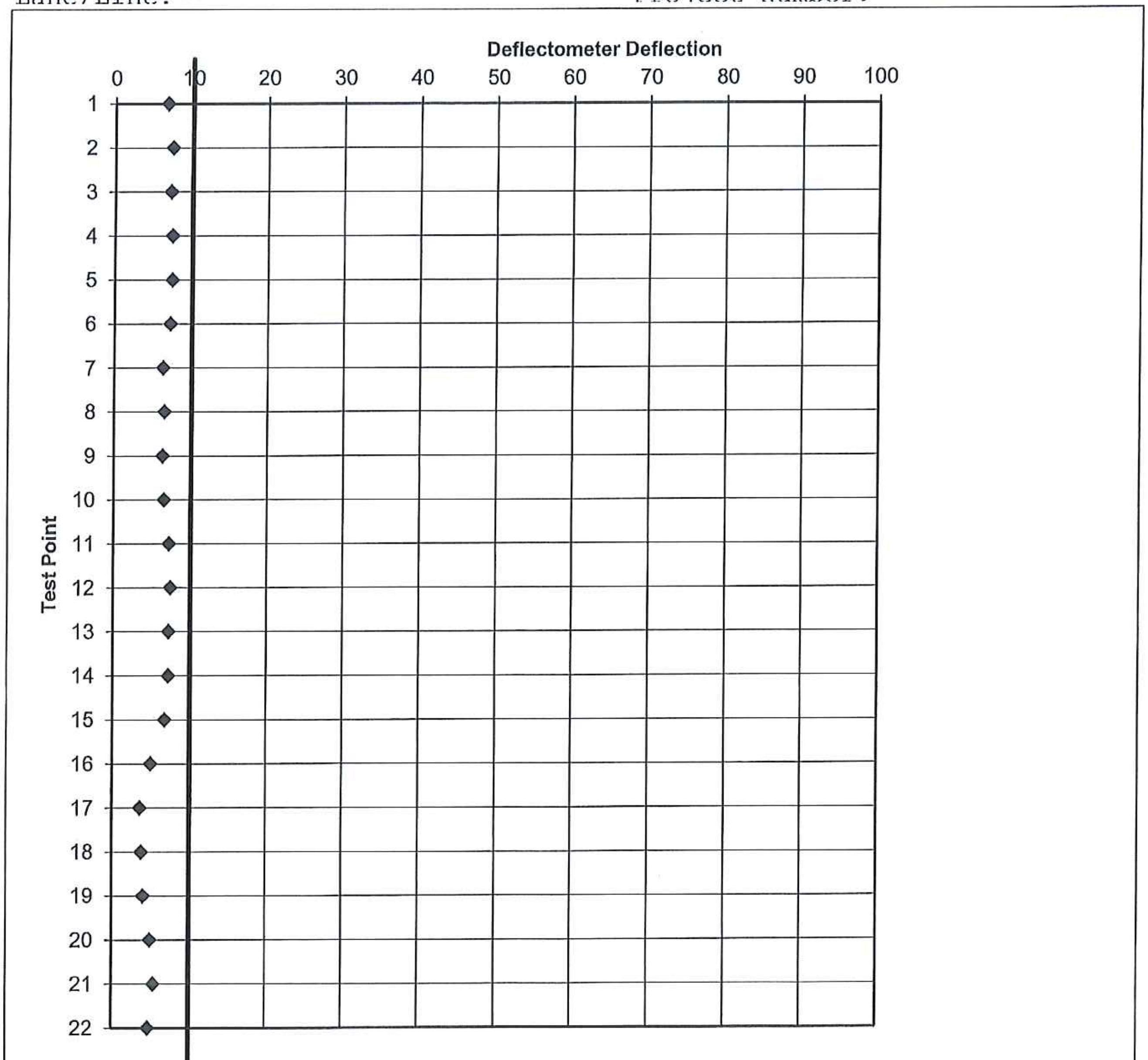
01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB1	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.75
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	5.63	7.83	11.75	1.37

Road Surface

Thickness	Traffic Index
0.75	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	8.99	9.59	0.00	0.00

HMA Overlay
0.00

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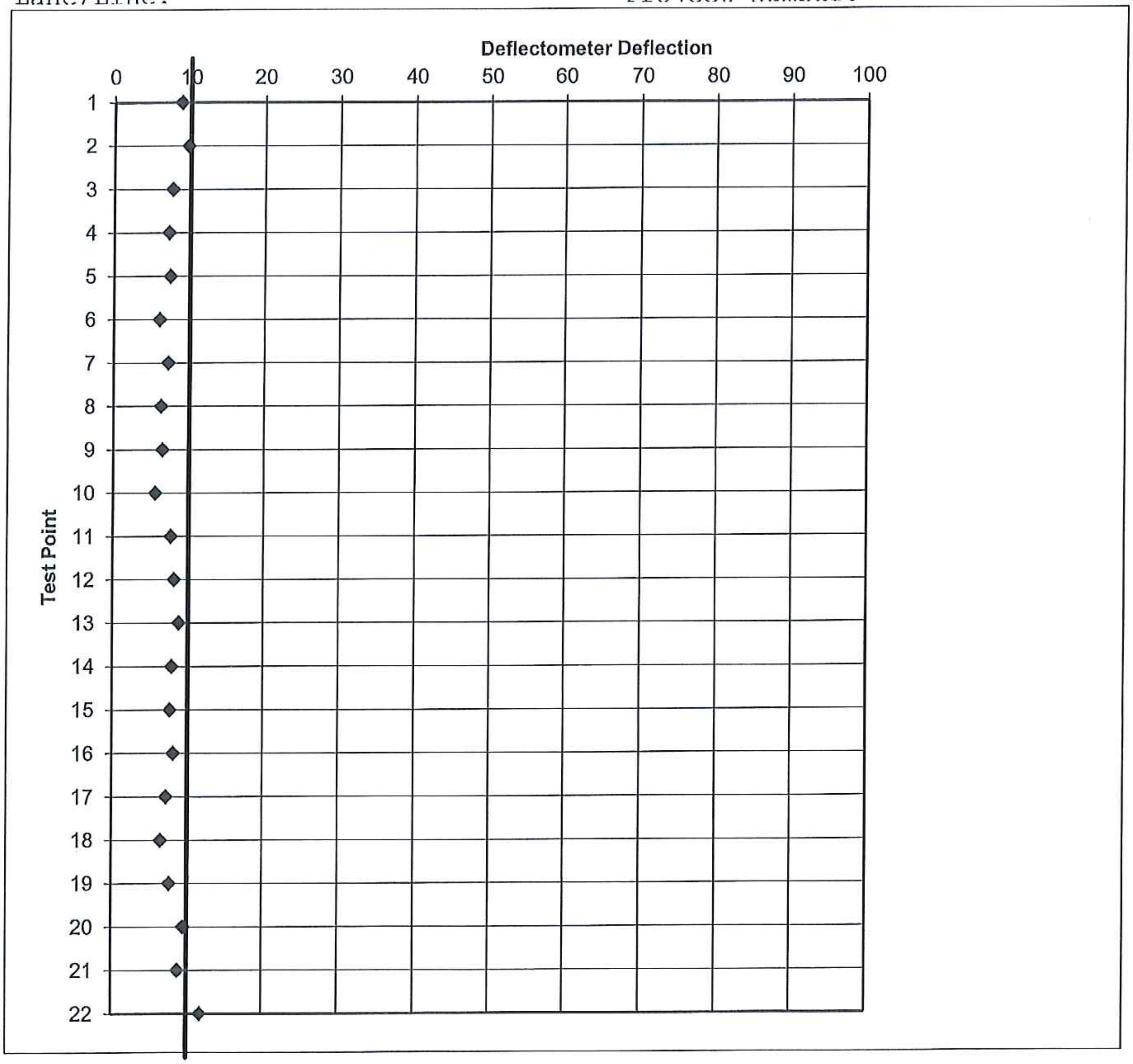
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.75
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB2	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.58
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	4.72	9.94	18.10	4.02

Road Surface

Thickness	Traffic Index
0.58	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	13.31	15.08	24.88	0.17

HMA Overlay
0.09

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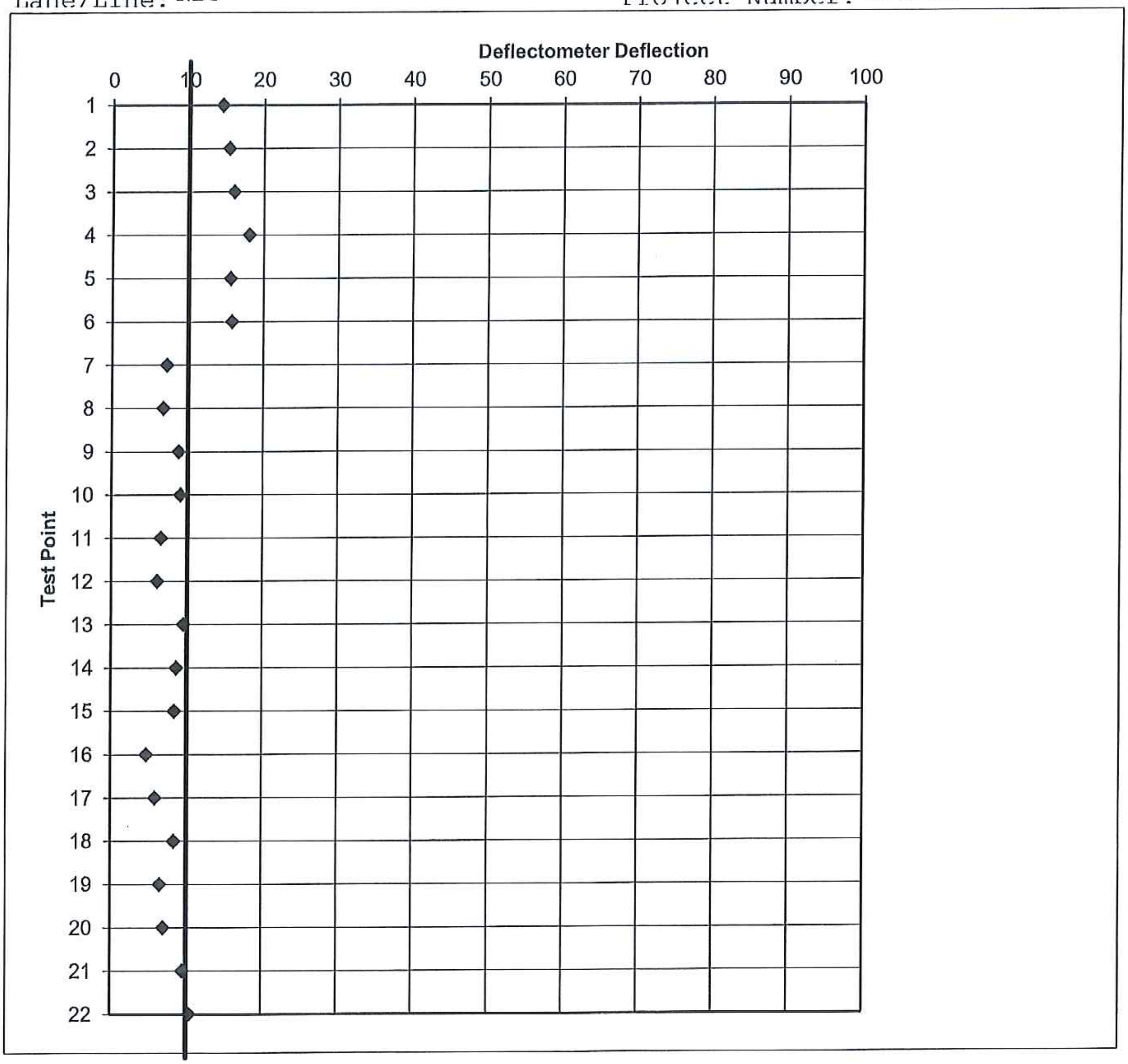
Road:	Mathilda Avenue	Survey Date:	
From:	San Aleso Avenue	Thickness:	0.58
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB3	Project Number:	160293



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Road:	Mathilda Avenue	Survey Date:	
From:	250 ft South of Ahwanee Aven	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB4	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	8.12	11.09	16.06	2.42

Road Surface

Thickness	Traffic Index
0.66	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	13.12	14.18	23.78	0.16

HMA Overlay
0.08

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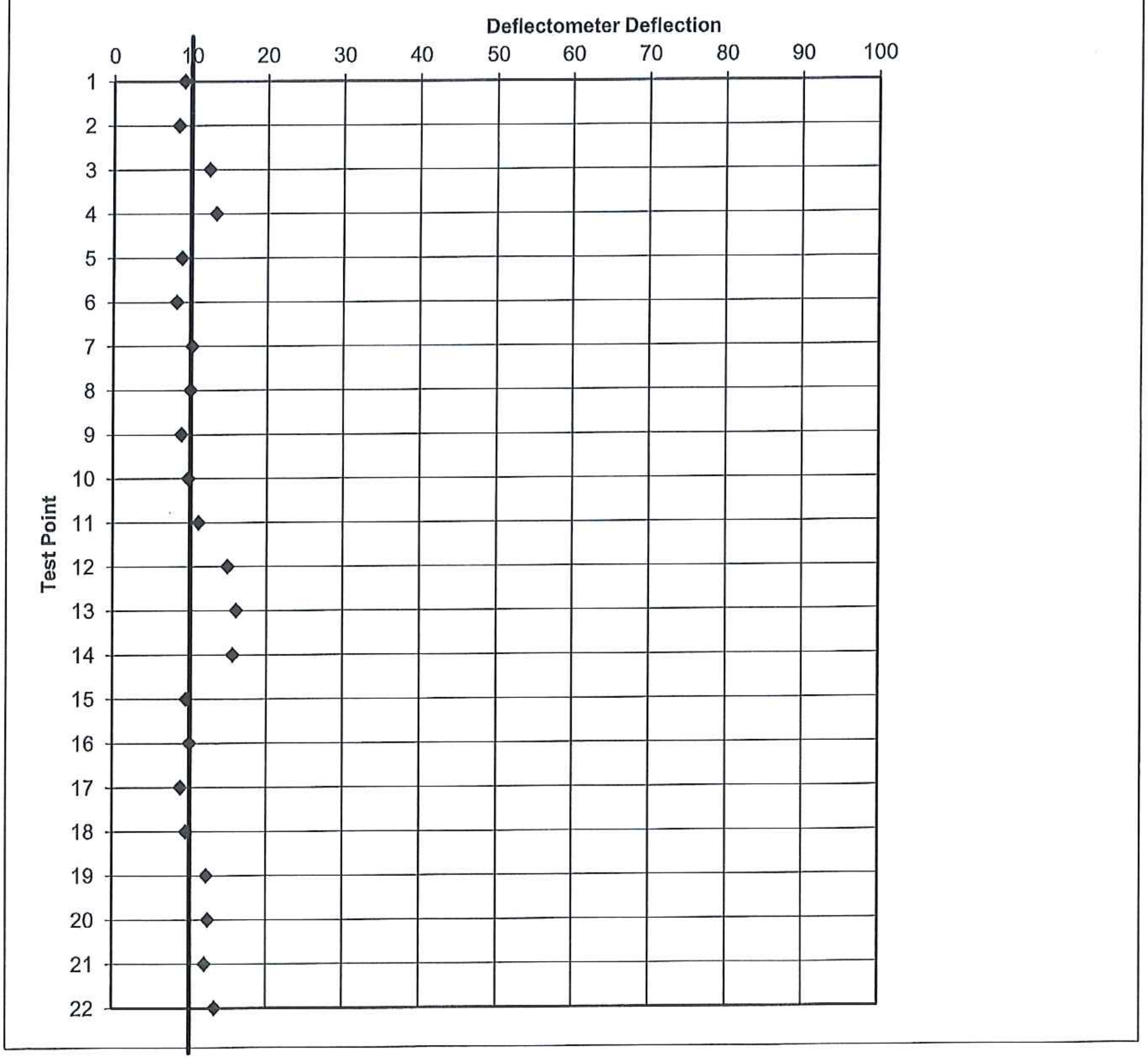
01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	250 ft South of Ahwanee Aven	Thickness:	0.66
To:	Highway 101 Bridge Deck	Traffic Index:	11.50
Lane/Line:	NB4	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	6.53	8.94	14.93	1.84

Road Surface

Thickness	Traffic Index
0.66	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	10.48	11.29	4.59	0.01

HMA Overlay
0.01

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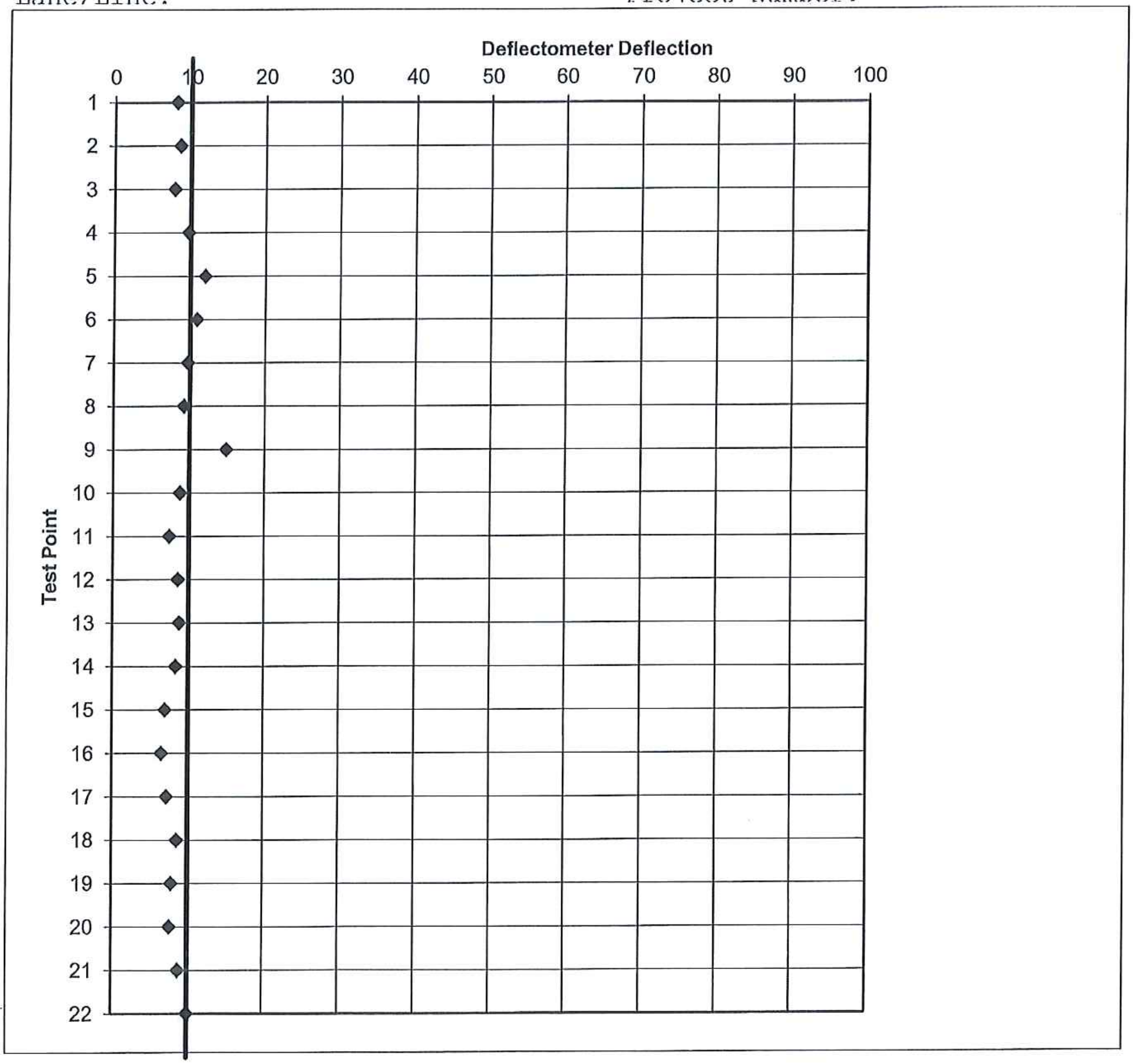
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB1	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	5.85	8.58	11.30	1.65

Road Surface

Thickness	Traffic Index
0.66	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	9.97	10.69	0.00	0.00

HMA Overlay
0.00

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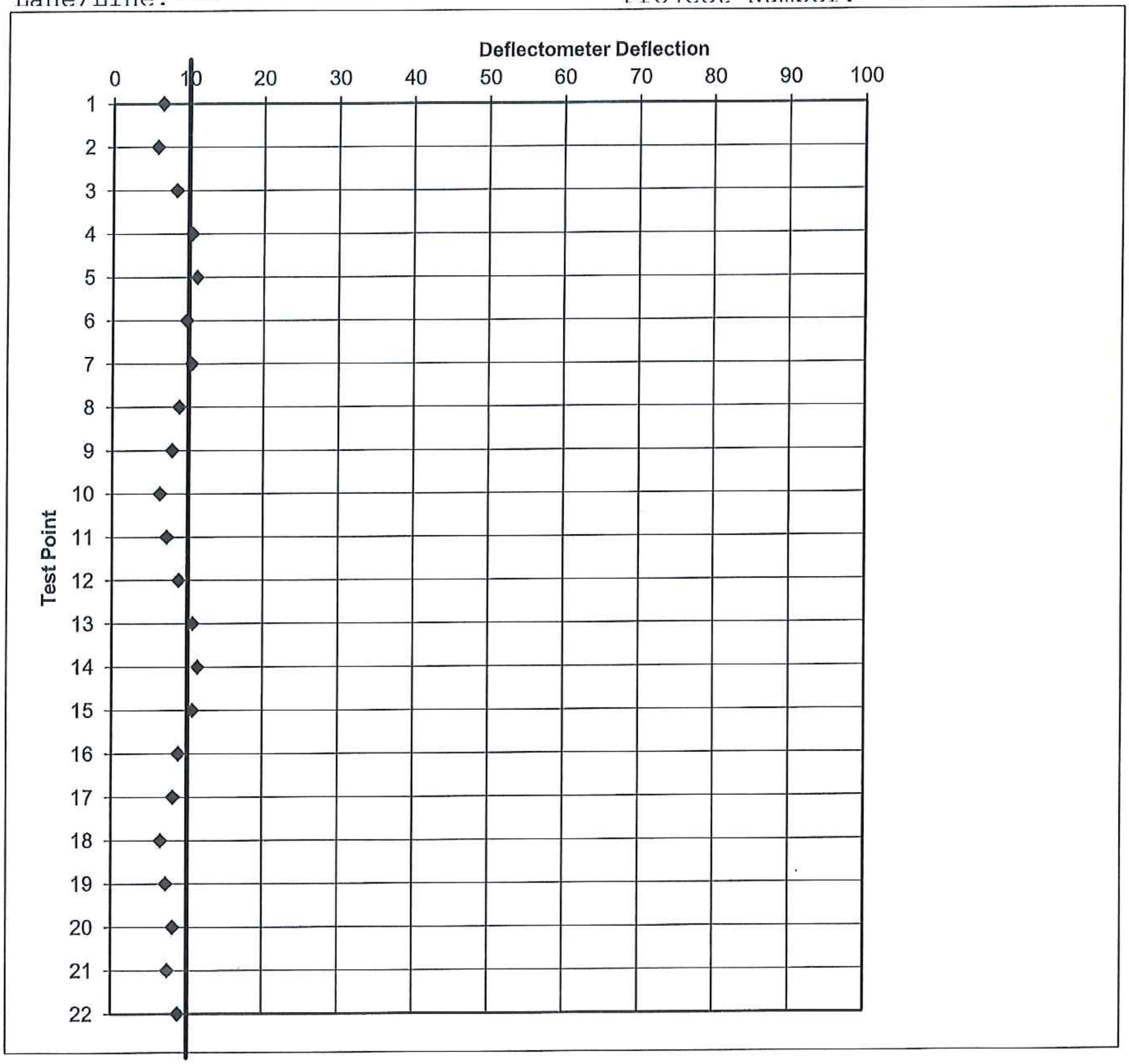
Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB2	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.46
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB3	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	7.89	12.48	17.88	3.39

Road Surface

Thickness	Traffic Index
0.46	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
11.00	15.33	16.82	28.24	0.22

HMA Overlay
0.12

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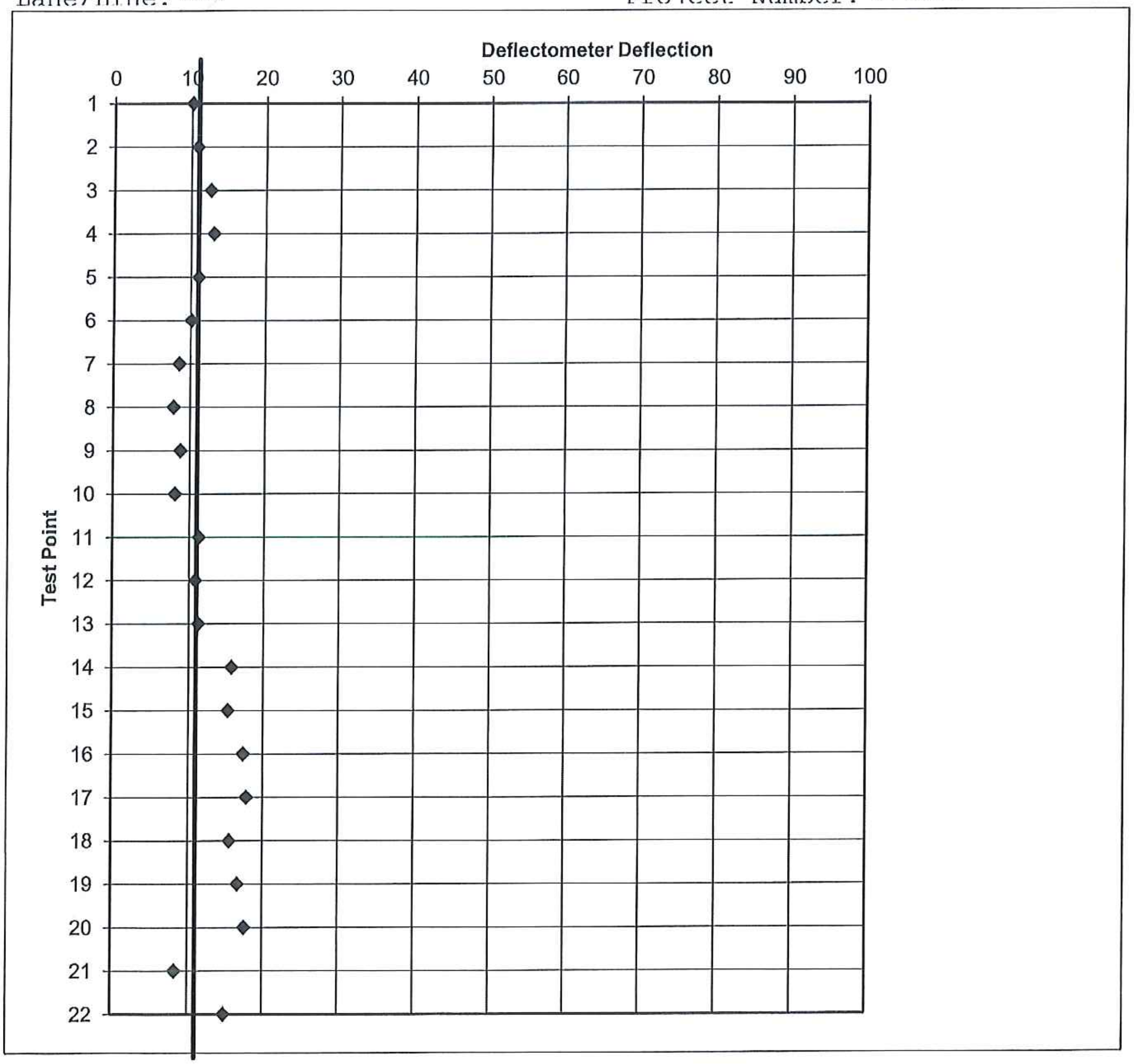
Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Bridge Deck	Thickness:	0.46
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB3	Project Number:	160293



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Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Ramp	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB4	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	6.76	11.73	15.38	2.35

Road Surface

Thickness	Traffic Index
0.66	11.50

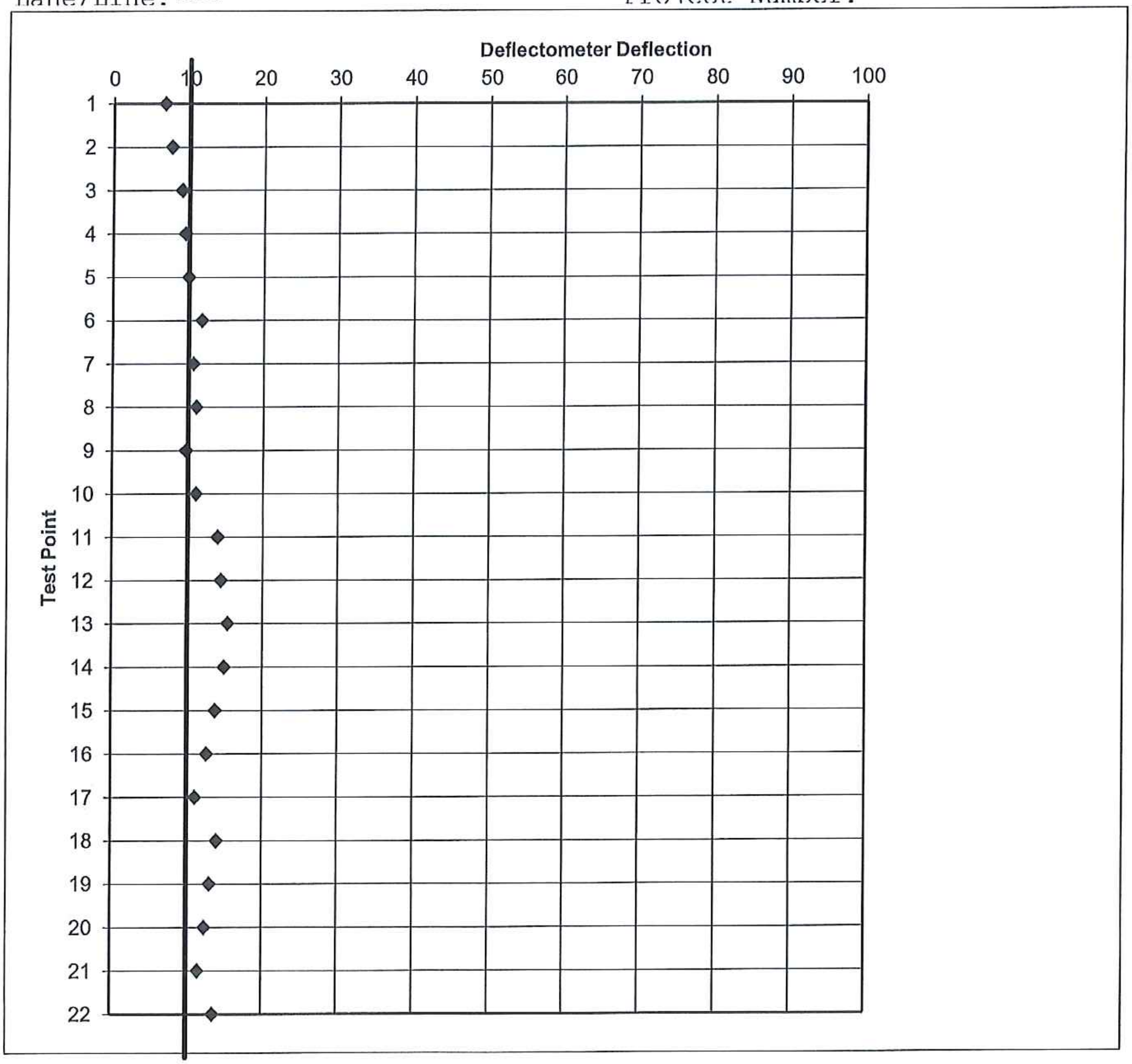
Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	13.70	14.74	27.03	0.20

HMA Overlay
0.11

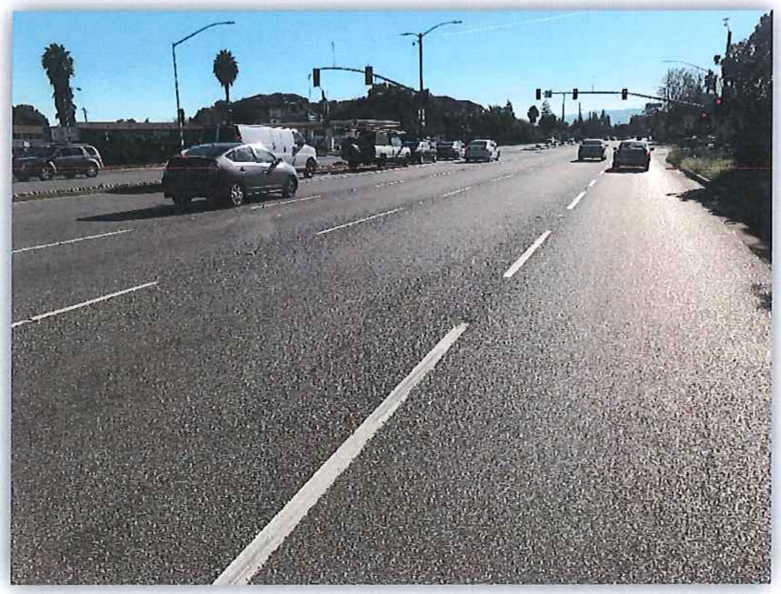
Parikh Consultants

Road:	Mathilda Avenue	Survey Date:	
From:	Highway 101 Ramp	Thickness:	0.66
To:	San Aleso Avenue	Traffic Index:	11.50
Lane/Line:	SB4	Project Number:	160293



Mathilda Avenue
Highway 101 to San Aleso Avenue

MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE
NEAR HIGHWAY 101 (SB)



MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE
NEAR ALMANOR AVENUE INTERSECTION (SB)

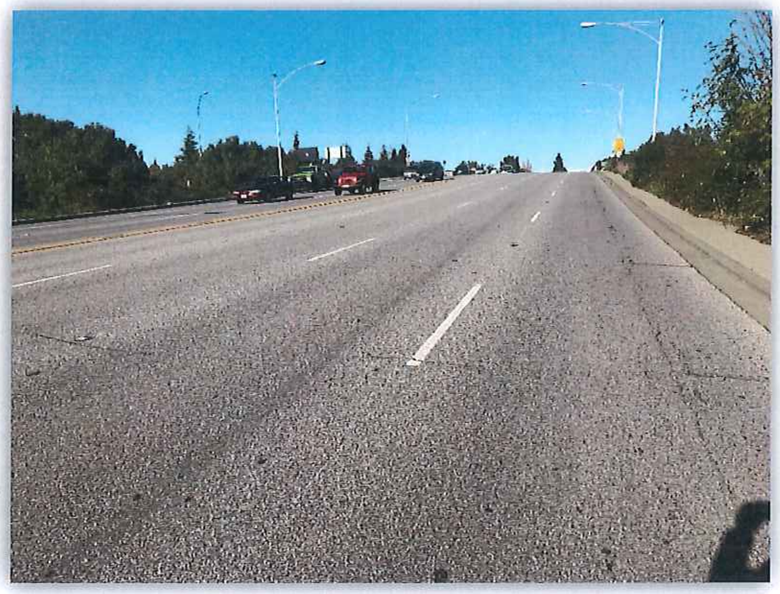
MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE

NORTH OF SAN ALESO AVENUE (SB)

MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE

NORTH OF SAN ALESO AVENUE (NB)

<u>MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE</u>
NEAR EASTBOUND ON-RAMP TO HIGHWAY 101 (NB)



<u>MATHILDA AVENUE – HIGHWAY 101 TO SAN ALESO AVENUE</u>
NEAR HIGHWAY 101 (NB)

MOFFETT PARK DRIVE

Mathilda Avenue to Innovation Way

CORING LOG

Core No.	Lane & Direction	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)
1	EB2	400 Feet from Innovation Way	16-1/2	---	0
2	WB2	400 Feet from Mathilda Ave.	14-1/2	---	2-1/2
3	WB1	600 Feet from Mathilda Ave.	14	Y	0
4	WB2	800 Feet from Mathilda Ave.	10-1/2	Y	0
5	WB1	1,000 Feet from Mathilda Ave.	10	Y	0
6	EB1	250 Feet from Innovation Way	18-1/2	---	0
7	EB2	650 Feet from Innovation Way	15-1/2	---	0
8	EB1	850 Feet from Innovation Way	17-1/2	---	0

STRUCTURAL REQUIREMENTS

(by Deflection Analysis)

Direction/Lane	Traffic Index (TI)	Tolerable	80th Percentile	HMA Overlay Requirement (Inches)
EB1	11.5	10.00	7.64	0
EB2	11.5	10.00	4.78	0
WB1	11.5	10.00	5.01	0
WB2	11.5	10.00	7.58	0

REFLECTIVE CRACKING REQUIREMENTS

Direction/Lane	HMA Overlay Requirement (Inches)*	Pavement Fabric Required (Yes or No)
EB1	8	Yes
EB2	7	Yes
WB1	5-3/4	Yes
WB2	6	Yes

**Required overlay by reflective cracking is half the existing AC thickness – if pavement fabric is used then this criteria can be reduced by 1-1/4 inch with at least a minimum overlay requirement of 1-3/4 inches.*

VISUAL CONDITIONS

The existing pavement exhibits areas of flushing and bleeding with minor rutting, slight shrinkage cracking, slight raveling and some shrinkage cracking around utilities. Previous maintenance includes pavement repairs.

ANALYSIS

The pavement in this section is structurally adequate. Reflective cracking criteria controls the rehabilitation requirements, but there is little to no cracking to retard.

RECOMMENDATIONS

Maintenance

We recommend removing areas of bleeding and rutting to a depth of 4 inches, cracking sealing and placing a Type II slurry seal.

Overlay

Not recommended due because of the flushing/bleeding and rutting occurring in the existing pavement.

Milling and Replacement

We recommend milling and replacing to a depth of 3-1/2 inches, placing 1 inch HMA leveling course and a 2-1/2 inch RHMA overlay. This alternative will remove the pavement at the surface that is bleeding. It should reduce the potential of future bleeding and rutting.

This option can be applied to both the northbound and southbound lanes.

Cold In-Place Recycling (CIR)

We recommend milling off 2-1/2 inches of the existing pavement, cold in-place recycling to a depth of 3 inches and placing a 2-1/2 inch RHMA overlay.

This option can be applied to both the northbound and southbound lanes.

As previously discussed in the report, rehabilitation alternatives may have different anticipated service lives. The design engineer should evaluate each alternative based on cost, constructability and impact on the public.

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5702 Marsh Drive, Unit T · Pacheco, CA · 94553 · Tel. (925) 872-3472
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01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Mathilda Avenue	Thickness:	1.54
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	EB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.58	6.16	11.75	1.76

Road Surface

Thickness	Traffic Index
1.54	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	7.64	8.42	0.00	0.00

HMA Overlay
0.00

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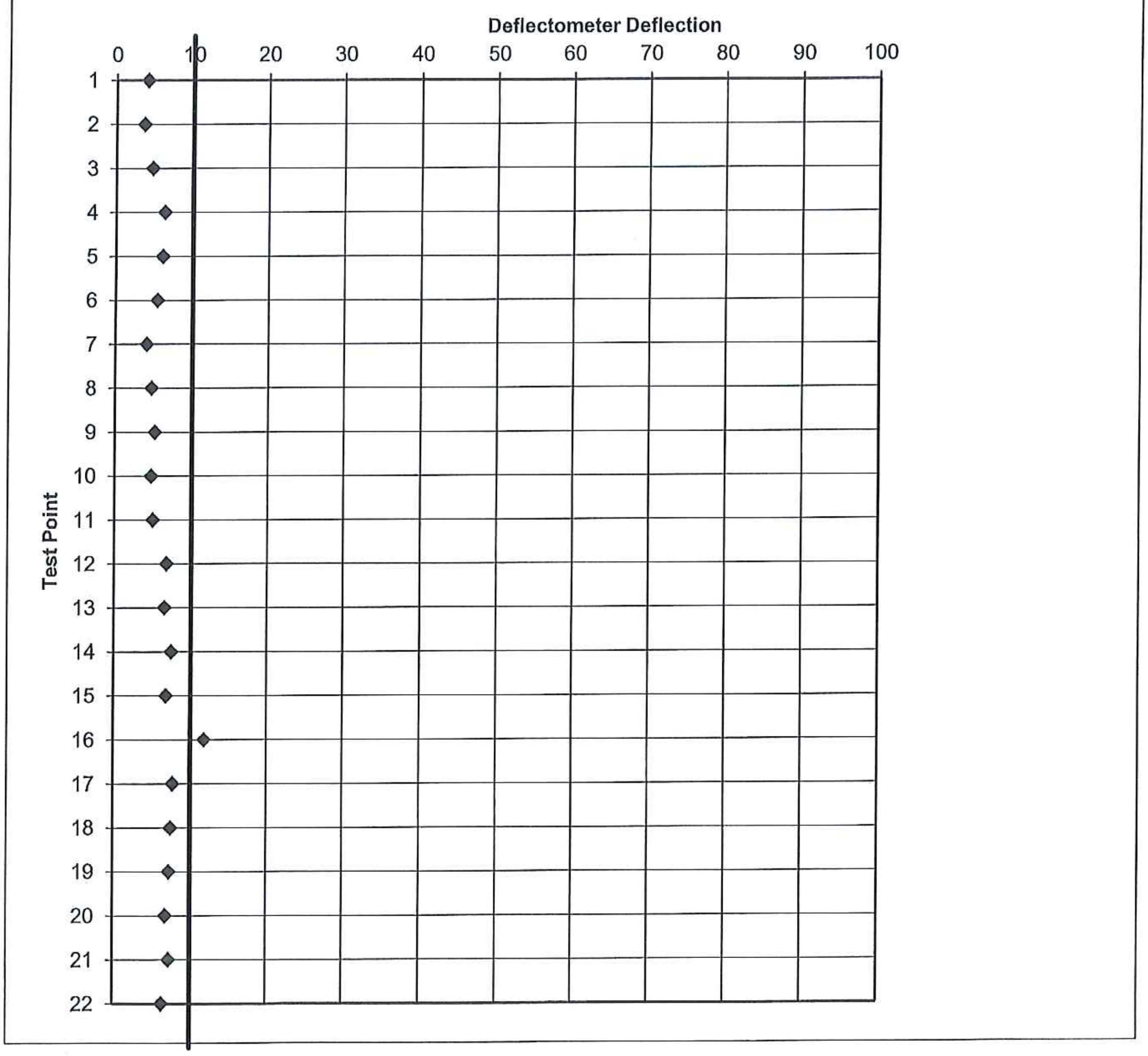
Redding (530) 224-4535 | Petaluma (707) 769-5330 | San Luis Obispo (805) 781-2265

01/04/17

Parikh Consultants

Road: Moffett Park Drive
From: Mathilda Avenue
To: Innovation Way
Lane/Line: EB1

Survey Date:
Thickness: 1.54
Traffic Index: 11.50
Project Number: 160293



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01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Mathilda Avenue	Thickness:	1.38
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	EB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	2.22	3.94	5.40	0.99

Road Surface

Thickness	Traffic Index
1.38	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	4.78	5.21	0.00	0.00

HMA Overlay
0.00

PAVEMENT ENGINEERING INCORPORATED

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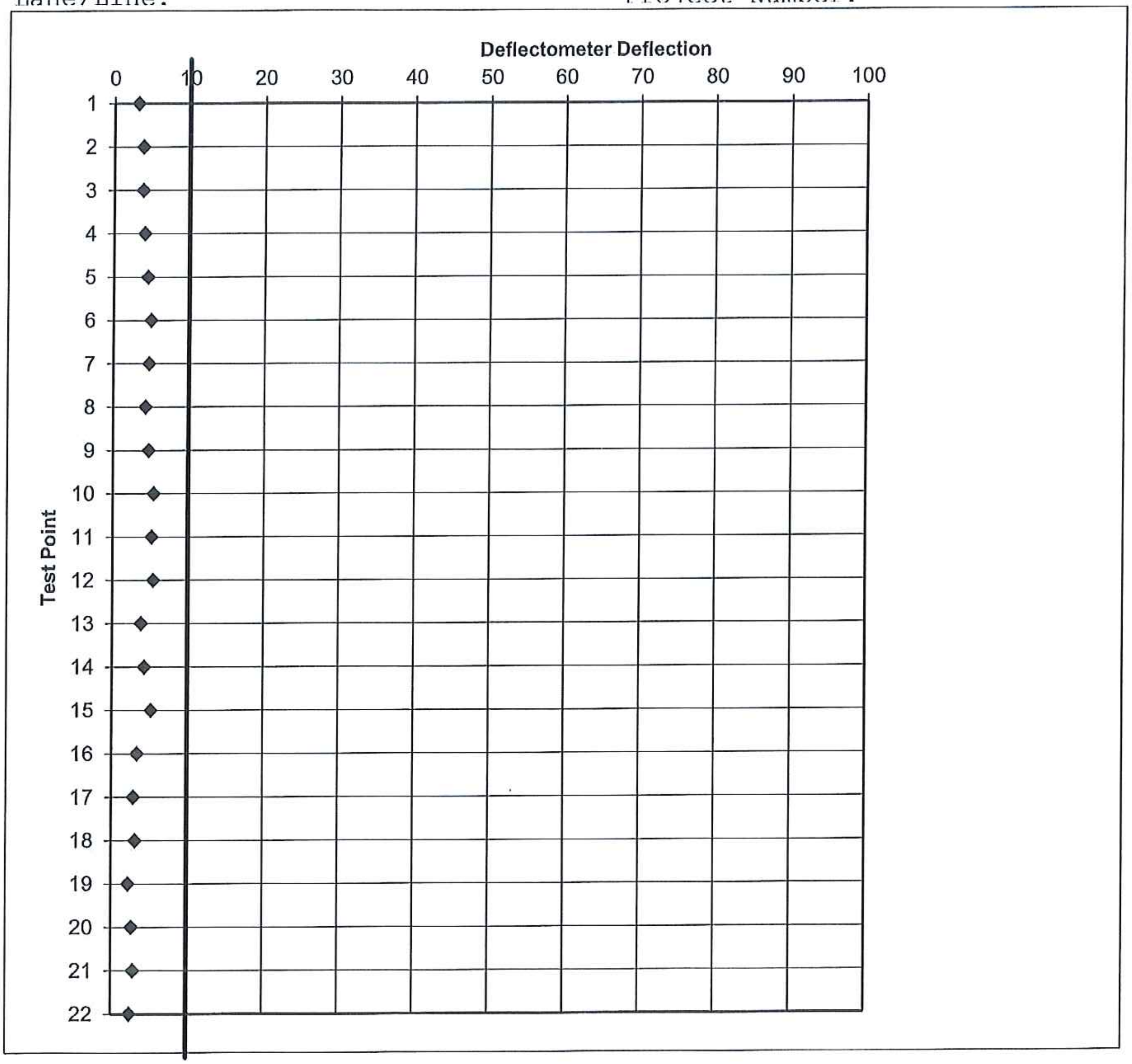
01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Mathilda Avenue	Thickness:	1.38
To:	Innovation Way	Traffic Index:	11.50
Lane/Line:	EB2	Project Number:	160293



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01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Innovation Way	Thickness:	1.16
To:	Mathilda Avenue	Traffic Index:	11.50
Lane/Line:	WB1	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.58	4.46	6.31	0.65

Road Surface

Thickness	Traffic Index
1.16	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	5.01	5.29	0.00	0.00

HMA Overlay
0.00

PAVEMENT ENGINEERING INCORPORATED

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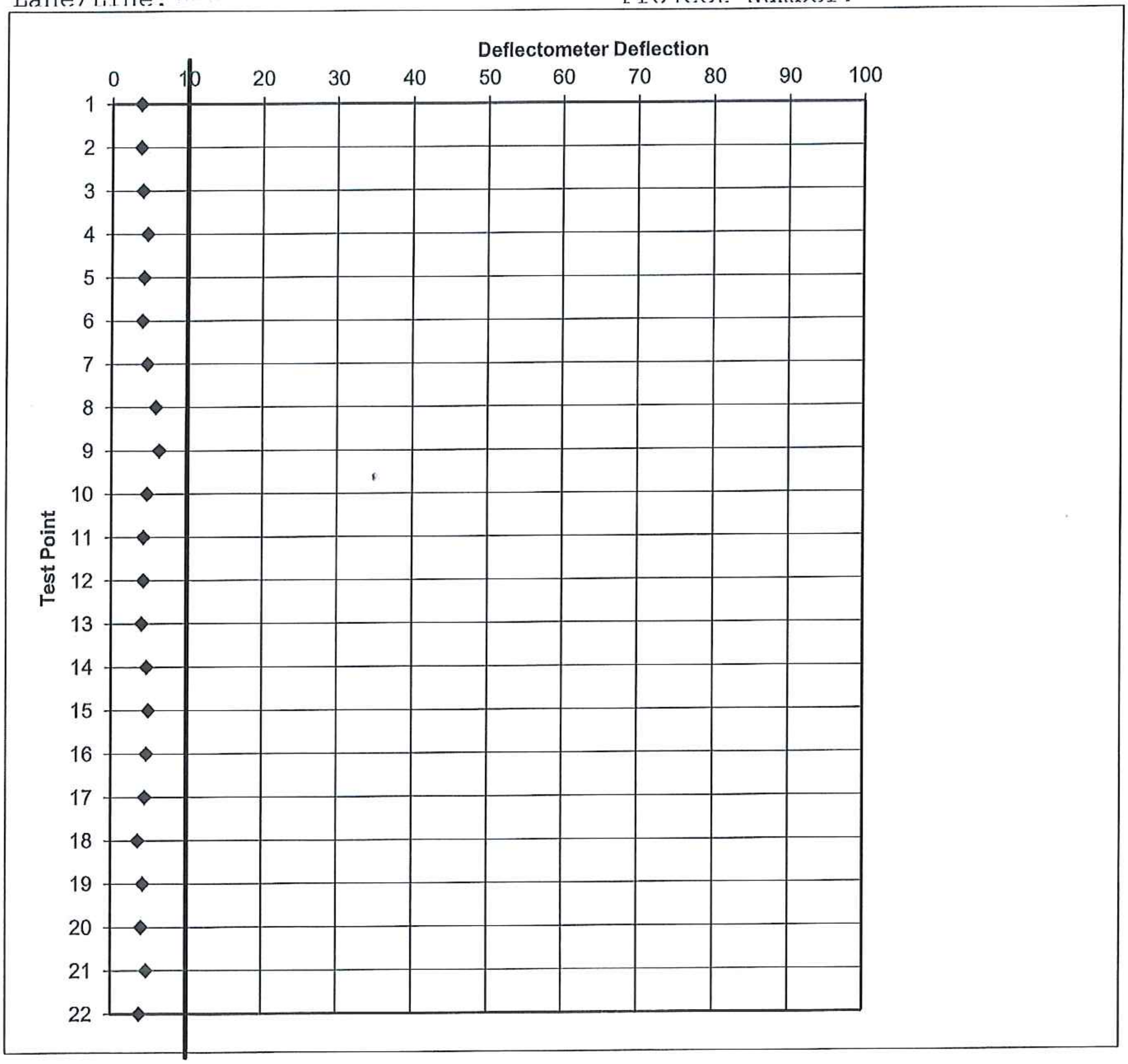
Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Innovation Way	Thickness:	1.16
To:	Mathilda Avenue	Traffic Index:	11.50
Lane/Line:	WB1	Project Number:	160293



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Redding	Petaluma	San Luis Obispo
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01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Innovation Way	Thickness:	1.21
To:	Mathilda Avenue	Traffic Index:	11.50
Lane/Line:	WB2	Project Number:	160293

Deflection Data Analysis

Deflection Readings (Equivalent Deflectometer Units)

No. of Tests	Low	Mean	High	Std. Dev.
22	3.81	6.30	8.80	1.53

Road Surface

Thickness	Traffic Index
1.21	11.50

Structural Design

Tolerable	80th Percentile	90th Percentile	% Reduction	GE Deficient
10.00	7.58	8.25	0.00	0.00

HMA Overlay
0.00

PAVEMENT ENGINEERING INCORPORATED

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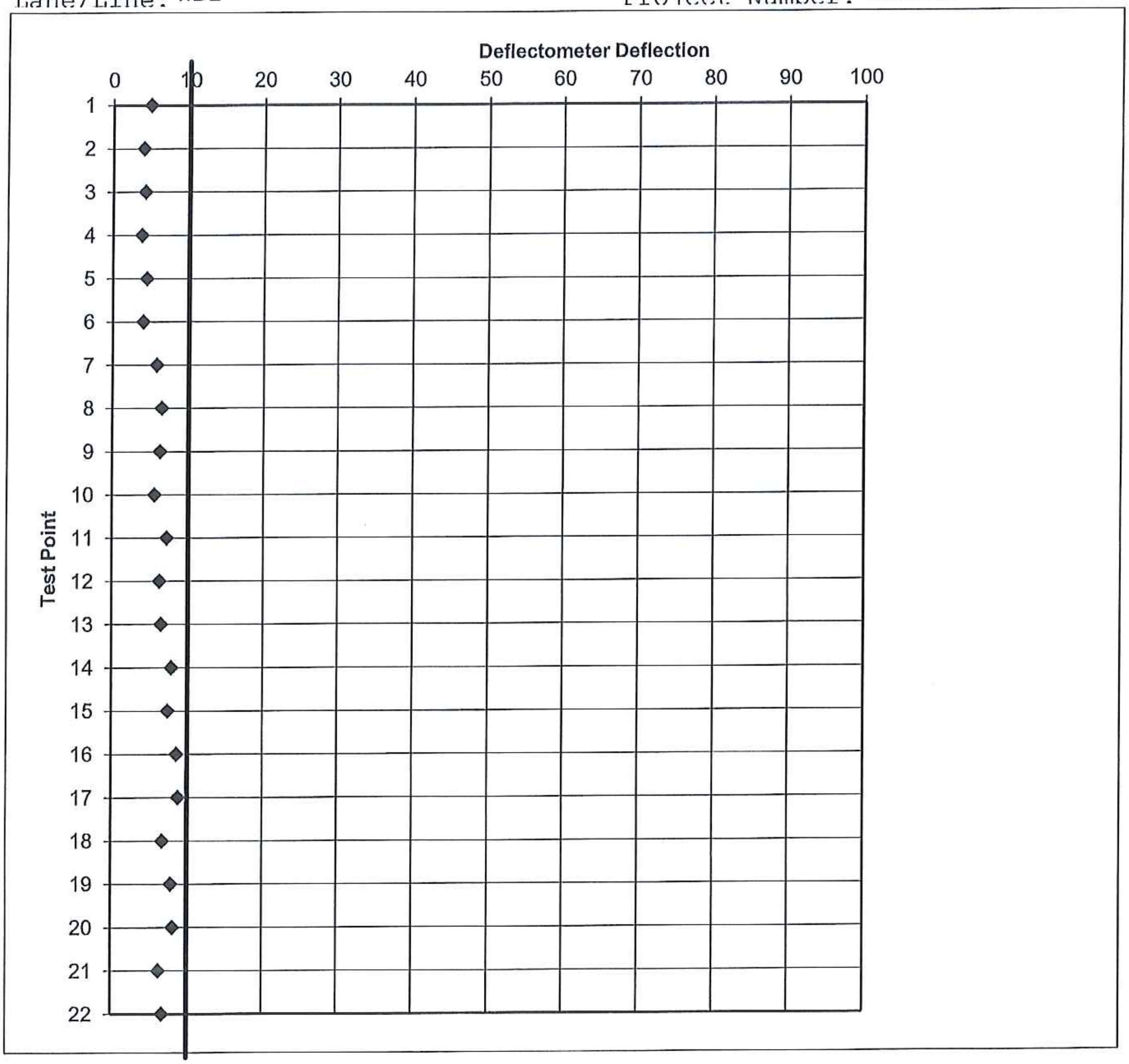
01/04/17

Parikh Consultants

Road:	Moffett Park Drive	Survey Date:	
From:	Innovation Way	Thickness:	1.21
To:	Mathilda Avenue	Traffic Index:	11.50
Lane/Line:	WB2	Project Number:	160293



Moffett Park Drive
Mathilda Avenue to Innovation Way

MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY
NEAR MATHILDA AVENUE INTERSECTION (WB)

MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY
FROM MATHILDA AVENUE (WB)

MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY

FROM MATHILDA AVENUE (WB)

MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY

NEAR INNOVTION WAY (EB)

MOFFETT PARK DRIVE – FROM MATHILDA AVENUE TO INNOVATION WAY

NEAR MATHILDA AVENUE (EB)

Moffett Park Drive

Innovation Way to Mathilda Avenue

CORES

Core No.	Lane & Direction	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)
1	EB2	400 Feet from Innovation Way	16-1/2	----	0
2	WB2	400 Feet from Mathilda Avenue	14-1/2	---	2-1/2
3	WB1	600 Feet from Mathilda Avenue	14	Y	0
4	WB2	800 Feet from Mathilda Avenue	10-1/2	Y	0
5	WB1	1,000 Feet from Mathilda Avenue	10	Y	0
6	EB1	250 Feet from Innovation Way	18-1/2	---	0
7	EB2	650 Feet from Innovation Way	15-1/2	---	0
8	EB1	850 Feet from Innovation Way	17-1/2	---	0

Mathilda Avenue

Innovation Way to Moffett Park Drive

CORES

Core No.	Lane & Direction	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)
9	SB3	300 Feet from Innovation Way	5-1/2	Y	0
10	SB2	315 Feet from Innovation Way	6-3/4	Y	0
11	SB3	750 Feet from Innovation Way	7	Y	0
12	SB2	800 Feet from Innovation Way	6-3/4	Y	0
13	SB1	850 Feet from Innovation Way	8-1/2	---	0
14	NB2	300 Feet from Moffett Park Drive	7	Y	0
15	NB1	400 Feet from Moffett Park Drive	5-1/2	---	0
16	NB1	550 Feet from Moffett Park Drive	6-1/2	---	0
17	NB2	650 Feet from Moffett Park Drive	8-1/2	Y	0
18	NB3	800 Feet from Moffett Park Drive	12	Y	0
19	SB1	350 Feet from Innovation Way	7	Y	7
20	NB3	150 Feet from Moffett Park Drive	12-3/4	Y	0

Mathilda Avenue

HWY 101 Bridge Deck to Moffett Park Drive

CORES

Core No.	Lane & Dir	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)	LTB/ CTB
21	SB3	625 Feet from Moffett Park Drive	6-1/2	---	10	0
22	SB1	1,250 Feet from Moffett Park Drive	7	---	9	0
23	NB1	200 Feet from Bridge Deck	14-1/2	---	3	0
24	NB5	1,500 Feet from Bridge Deck	18-1/2	---	3	0
25	NB4	210 Feet from Bridge Deck	20	---	0	0
26	NB3	240 Feet from Bridge Deck	7	---	0	1
27	NB2	520 Feet from Bridge Deck	11	---	0	5
28	NB5	700 Feet from Bridge Deck	14	---	0	0
29	NB4	830 Feet from Bridge Deck	6	---	0	0
30	NB3	1,180 Feet from Bridge Deck	5-1/2	---	0	0
31	NB2	1,240 Feet from Bridge Deck	5-1/2	---	0	0
32	NB1	1,680 Feet from Bridge Deck	6-1/2	---	0	0
33	SB2	510 Feet from Moffett Park Drive	8	---	0	0
34	SB1	850 Feet from Moffett Park Drive	6	---	0	2
35	SB3	1,020 Feet from Moffett Park Drive	4-1/2	---	0	0
36	SB2	1,400 Feet from Moffett Park Drive	6	---	0	1

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5702 Marsh Drive, Unit T · Pacheco, CA · 94553 · Tel. (925) 872-3472
3820 Cypress Drive, Suite 3 · Petaluma, CA · 94954-5613 · Tel. (707) 769-5330 · Fax (707) 769-5333

Boring Log
City of Sunnyvale

Project No. 160281-01

Mathilda Avenue

HWY 101 Bridge Deck to San Aleso Avenue

CORES

Core No.	Lane & Dir	Location	HMA Layer (Inches)	Fabric Present	AB Layer (Inches)	LTB/ CTB
37	SB3	530 Feet from Bridge Deck	6-1/4	Y	9	0
38	SB1	1,500 Feet from Bridge Deck	18-1/2	Y	2	0
39	NB3	315 Feet from San Aleso Avenue	7	Y	5	0
40	NB1	1,450 Feet from San Aleso Avenue	18-1/2	Y	0	0
41	NB2	430 Feet from San Aleso Avenue	10	---	0	0
42	NB1	530 Feet from San Aleso Avenue	8	---	0	0
43	NB4	880 Feet from San Aleso Avenue	9	---	0	0
44	NB3	1,130 Feet from San Aleso Avenue	7	---	0	7
45	NB2	1,320 Feet from San Aleso Avenue	7-1/2	---	0	0
46	NB4	1,600 Feet from San Aleso Avenue	6-1/2	---	0	3
47	SB1	130 Feet from Bridge Deck	6-3/4	Y	0	0
48	SB2	500 Feet from Bridge Deck	7	Y	0	3-1/2
49	SB4	880 Feet from Bridge Deck	10	Y	0	0
50	SB3	1,230 Feet from Bridge Deck	5-1/2	---	0	0
51	SB2	1,400 Feet from Bridge Deck	9-1/2	Y	0	0
52	SB4	1,650 Feet from Bridge Deck	7	Y	0	0

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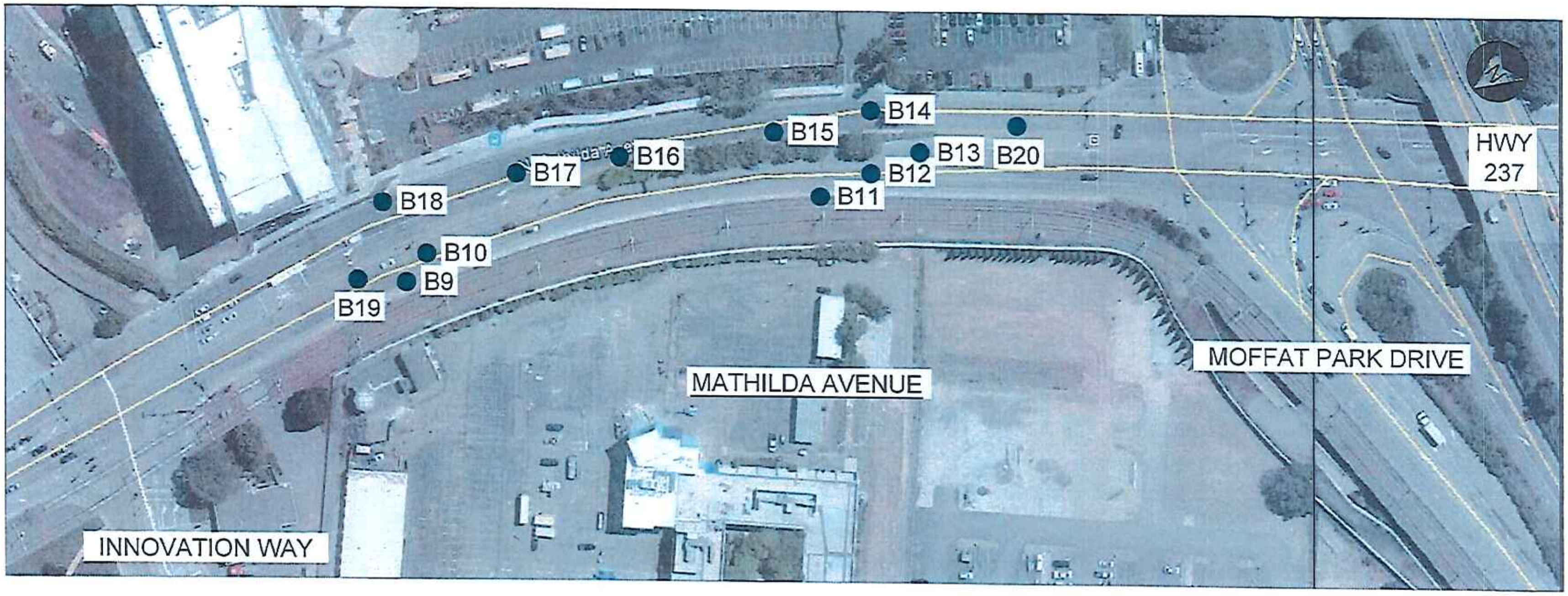


MATCHLINE A-A

MATCHLINE A-A

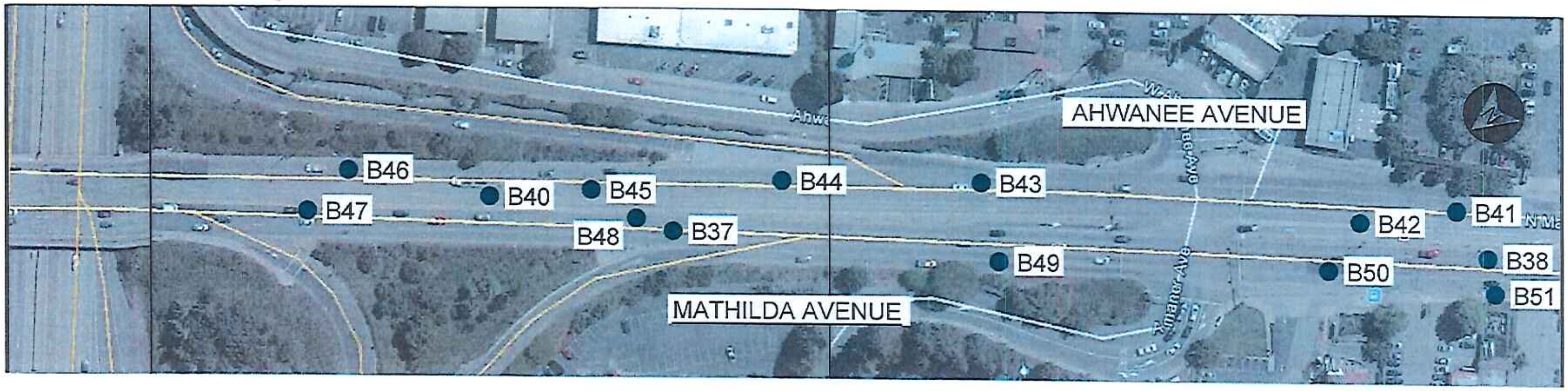
MATCHLINE B-B

● CORE LOCATION

MATHILDA AVENUE
FROM INNOVATION WAY TO SAN ALESO AVENUE

CITY OF SUNNYVALE
DATE: JAN. 2017
SHEET 1 OF 3

MATCHLINE B-B



MATCHLINE C-C

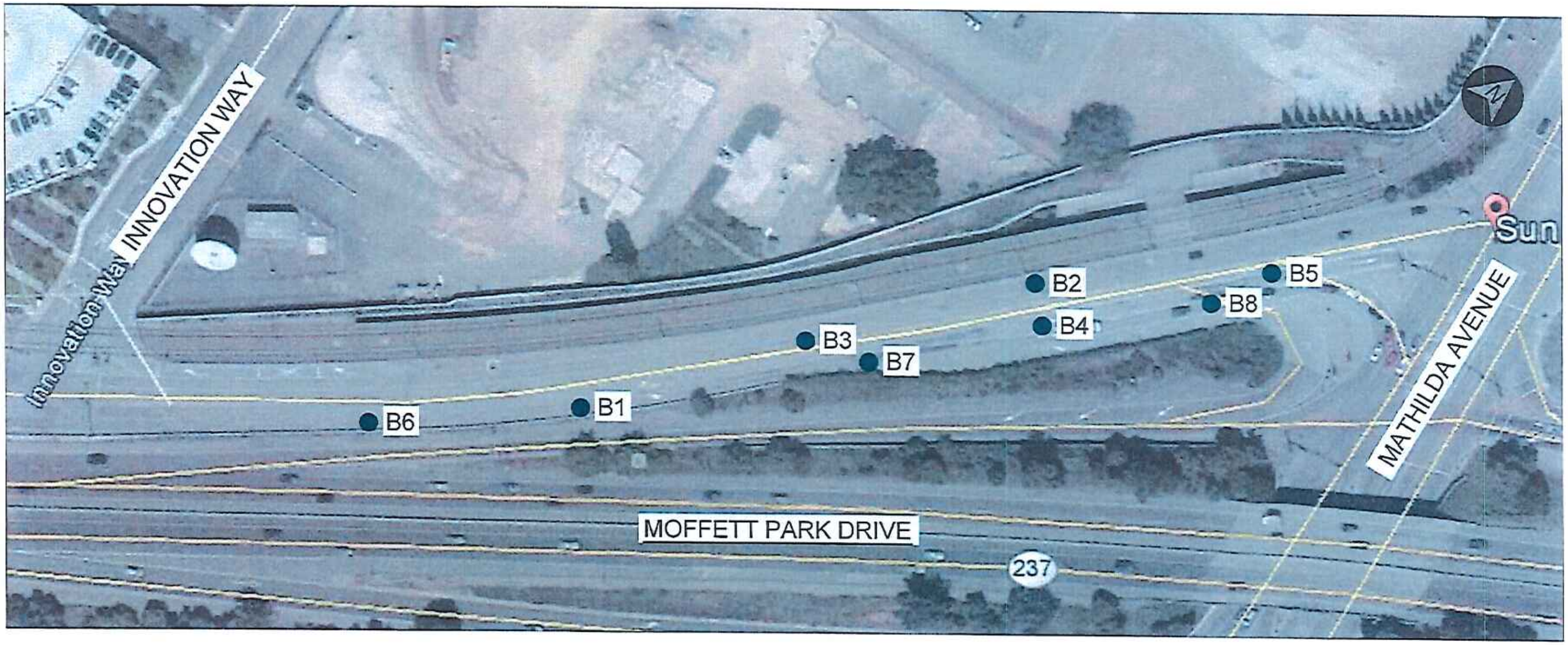
MATCHLINE C-C

● CORE LOCATION

MATHILDA AVENUE

FROM INNOVATION WAY TO SAN ALESO AVENUE

CITY OF SUNNYVALE
DATE: JAN. 2017
SHEET 2 OF 3



● CORE LOCATION

MOFFETT PARK DRIVE

FROM MATHILDA AVENUE TO INNOVATION WAY

CITY OF SUNNYVALE
DATE: JAN. 2017
SHEET 3 OF 3

Core Sample Photos

Moffett Park Drive & Mathilda Avenue


CORE #1
Moffett Park Drive
400 ft from Innovation Way


CORE #2
Moffett Park Drive
400 ft from Mathilda Avenue


CORE #3
Moffett Park Drive
600 ft from Mathilda Avenue


CORE #4
Moffett Park Drive
800 ft from Mathilda Avenue


CORE #5
Moffett Park Drive
1,000 ft from Mathilda Avenue


CORE #6
Moffett Park Drive
250 ft from Innovation Way


CORE #7
Moffett Park Drive
650 ft from Innovation Way


CORE #8
Moffett Park Drive
850 ft from Innovation Way


CORE #9
Mathilda Avenue
300 ft from Innovation Way


CORE #10
Mathilda Avenue
315 ft from Innovation Way


CORE #11
Mathilda Avenue
750 ft from Innovation Way
16'
DEWALT


CORE #12
Mathilda Avenue
800 ft from Innovation Way
16'
DEWALT


CORE #13
Mathilda Avenue
850 ft from Innovation Way


CORE #14
Mathilda Avenue
300 ft from Moffett Park Drive


CORE #15
Mathilda Avenue
400 ft from Moffett Park Drive
DEWALT
16'


CORE #16
Mathilda Avenue
550 ft from Moffett Park Drive
DEWALT
16'


CORE #17
Mathilda Avenue
650 ft from Moffett Park Drive


CORE #18
Mathilda Avenue
800 ft from Moffett Park Drive


CORE #19
Mathilda Avenue
350 ft from Innovation Way


CORE #20
Mathilda Avenue
150 ft from Moffett Park Drive


CORE #21
Mathilda Avenue
625 ft from Moffett Park Drive


CORE #22
Mathilda Avenue
1,250 ft from Moffett Park Drive


CORE #23
Mathilda Avenue
1,500 ft from Bridge Deck


CORE #24
Mathilda Avenue
200 ft from Bridge Deck


CORE #25
Mathilda Avenue
210 ft from Bridge Deck


CORE #26
Mathilda Avenue
290 ft from Bridge Deck


CORE #27
Mathilda Avenue
520 ft from Bridge Deck


CORE #28
Mathilda Avenue
700 ft from Bridge Deck


CORE #29
Mathilda Avenue
830 ft from Bridge Deck
DEWALT
16'


CORE #30
Mathilda Avenue
1,180 ft from Bridge Deck
DEWALT
16'


CORE #31
Mathilda Avenue
1,240 ft from Bridge Deck
DEWALT
16'


CORE #32
Mathilda Avenue
1,680 ft from Bridge Deck
DEWALT
16'


CORE #33
Mathilda Avenue
510 ft from Moffett Park Drive
DEWALT
16'


CORE #34
Mathilda Avenue
850 ft from Moffett Park Drive
DEWALT
16'


CORE #35
Mathilda Avenue
1,020 ft from Moffett Park Drive
2 3 4
16'
DEWALT


CORE #36
Mathilda Avenue
1,400 ft from Moffett Park Drive
2 3 4 5
16'
DEWALT

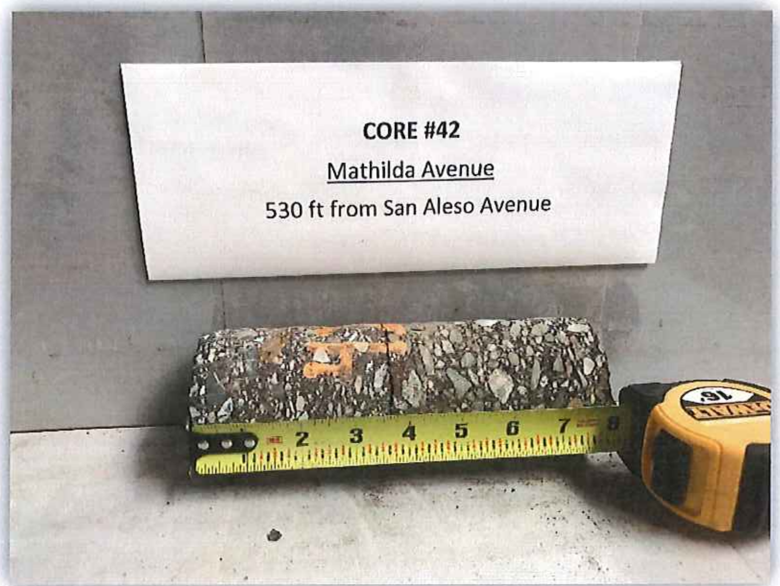

CORE #37
Mathilda Avenue
530 ft from Bridge Deck
DEWALT
16'


CORE #38
Mathilda Avenue
1,500 ft from Bridge Deck


CORE #39
Mathilda Avenue
315 ft from San Aleso Avenue


CORE #40
Mathilda Avenue
1,450 ft from San Aleso Avenue


CORE #41
Mathilda Avenue
430 ft from San Aleso Avenue


CORE #42
Mathilda Avenue
530 ft from San Aleso Avenue


CORE #43
Mathilda Avenue
880 ft from San Aleso Avenue


CORE #44
Mathilda Avenue
1,130 ft from San Aleso Avenue


CORE #45
Mathilda Avenue
1,320 ft from San Aleso Avenue


CORE #46
Mathilda Avenue
1,600 ft from San Aleso Avenue


CORE #47
Mathilda Avenue
130 ft from Bridge Deck


CORE #48
Mathilda Avenue
500 ft from Bridge Deck


CORE #49
Mathilda Avenue
880 ft from Bridge Deck


CORE #50
Mathilda Avenue
1,230 ft from Bridge Deck


CORE #51
Mathilda Avenue
1,400 ft from Bridge Deck


CORE #52
Mathilda Avenue
1,650 ft from Bridge Deck

APPENDIX G

AltPipe

Project EA: **04-4H29001**
Project Engineer:
Location: **SCI-237-2.7/3.3, SCI-101-45.2/45.8**
Description: **Interchange and roadway improvements**

Steel Pipes

	DSN/U	B-6	B-9	B-13	B-14
	Pipe Diameter (in)	12	12	12	12
Pipe Type	Coat	Minimum Thickness (in)			
Corrugated Steel Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	GAL	0.079			
	AL2	0.052			0.052
	BC	0.064	0.079		0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.052	0.052	0.052	0.052

Aluminum Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	12	12	12	12
Pipe Type	Minimum Thickness (in)			
Corrugated Aluminum Pipe Annular Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060
Corrugated Aluminum Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060

Plastic Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	12	12	12	12
Pipe Type	Availability			
PVC Corrugated	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	12	12	12	12
Steel Cover (in)	0.75	0.75	0.75	0.75
Sacks of Cement	5	5	5	5
Percentage Water	11.1	11.1	11.1	11.1

Other Information

DSN/U	B-6	B-9	B-13	B-14

Soil pH	7.8	7.69	7.33	7.59
Minimum Soil Resistivity (ohm-cm)	1980	1260	860	1500
Sulfate Concentration (ppm)	80.5	45.5	10.1	52.3
Chloride Concentration (ppm)	135.6	9.8	3.3	11.4
Abrasion Level	1	1	1	1
2–5 Year Flow Velocity (ft/sec)	10	10	10	10
Design Service Life (years)	50	50	50	50
Height of Cover (ft)	10	10	10	10

AltPipe

Project EA: **04-4H29001**
Project Engineer:
Location: **SCI-237-2.7/3.3, SCI-101-45.2/45.8**
Description: **Interchange and roadway improvements**

Steel Pipes

	DSN/U	B-6	B-9	B-13	B-14
	Pipe Diameter (in)	15	15	15	15
Pipe Type	Coat	Minimum Thickness (in)			
Corrugated Steel Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	GAL	0.079			
	AL2	0.052			0.052
	BC	0.064	0.079		0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.052	0.052	0.052	0.052

Aluminum Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	15	15	15	15
Pipe Type	Minimum Thickness (in)			
Corrugated Aluminum Pipe Annular Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060
Corrugated Aluminum Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060

Plastic Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	15	15	15	15
Pipe Type	Availability			
PVC Corrugated	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	15	15	15	15
Steel Cover (in)	0.75	0.75	0.75	0.75
Sacks of Cement	5	5	5	5
Percentage Water	11.1	11.1	11.1	11.1

Other Information

DSN/U	B-6	B-9	B-13	B-14

Soil pH	7.8	7.69	7.33	7.59
Minimum Soil Resistivity (ohm-cm)	1980	1260	860	1500
Sulfate Concentration (ppm)	80.5	45.5	10.1	52.3
Chloride Concentration (ppm)	135.6	9.8	3.3	11.4
Abrasion Level	1	1	1	1
2–5 Year Flow Velocity (ft/sec)	10	10	10	10
Design Service Life (years)	50	50	50	50
Height of Cover (ft)	10	10	10	10

AltPipe

Project EA: **04-4H29001**
Project Engineer:
Location: **SCI-237-2.7/3.3, SCI-101-45.2/45.8**
Description: **Interchange and roadway improvements**

Steel Pipes

	DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
	Pipe Diameter (in)	**18**	**18**	**18**	**18**
Pipe Type	**Coat**	**Minimum Thickness (in)**			
Corrugated Steel Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	GAL	0.079	0.109	0.109	0.109
	AL2	0.052			0.052
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.052	0.052	0.052	0.052
Corrugated Steel Pipe 2 2/3" x 1/2" Annular Corrugations	AL2	0.064			0.064
	BC	0.064			
	BCI	0.064	0.064		0.064
	PS	0.064	0.064	0.064	0.064

Aluminum Pipes

DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
Pipe Diameter (in)	**18**	**18**	**18**	**18**
Pipe Type	**Minimum Thickness (in)**			
Corrugated Aluminum Pipe Annular Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060
Corrugated Aluminum Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060

Plastic Pipes

DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
Pipe Diameter (in)	**18**	**18**	**18**	**18**
Pipe Type	**Availability**			
PVC Corrugated	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
Pipe Diameter (in)	**18**	**18**	**18**	**18**
Steel Cover (in)	0.75	0.75	0.75	0.75
Sacks of Cement	5	5	5	5

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**18**	**18**	**18**	**18**
Percentage Water	11.1	11.1	11.1	11.1

Other Information

DSN/U	B-6	B-9	B-13	B-14
Soil pH	7.8	7.69	7.33	7.59
Minimum Soil Resistivity (ohm-cm)	1980	1260	860	1500
Sulfate Concentration (ppm)	80.5	45.5	10.1	52.3
Chloride Concentration (ppm)	135.6	9.8	3.3	11.4
Abrasion Level	1	1	1	1
2–5 Year Flow Velocity (ft/sec)	10	10	10	10
Design Service Life (years)	50	50	50	50
Height of Cover (ft)	10	10	10	10

AltPipe

Project EA: **04-4H29001**
Project Engineer:
Location: **SCI-237-2.7/3.3, SCI-101-45.2/45.8**
Description: **Interchange and roadway improvements**

Steel Pipes

	DSN/U	B-6	B-9	B-13	B-14
	Pipe Diameter (in)	24	24	24	24
Pipe Type	Coat	Minimum Thickness (in)			
Corrugated Steel Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	GAL	0.079	0.109	0.109	0.109
	AL2	0.052			0.052
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.052	0.052	0.052	0.052
Corrugated Steel Pipe 2 2/3" x 1/2" Annular Corrugations	GAL	0.079			
	AL2	0.064			0.064
	BC	0.064	0.079		0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 1" Ribs at 11 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 1" Ribs at 8 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 3/4" Ribs at 7 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064

Aluminum Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	24	24	24	24
Pipe Type	Minimum Thickness (in)			

Corrugated Aluminum Pipe Annular Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060
Corrugated Aluminum Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	0.060			0.060
Aluminum Spiral Rib Pipe 3/4" x 1" Ribs at 11 1/2" Pitch	0.060			0.060
Aluminum Spiral Rib Pipe 3/4" x 3/4" Ribs at 7 1/2" Pitch	0.060			0.060

Plastic Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**24**	**24**	**24**	**24**
Pipe Type	**Availability**			
PVC Corrugated	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**24**	**24**	**24**	**24**
Steel Cover (in)	1	1	1	1
Sacks of Cement	5	5	5	5
Percentage Water	11.1	11.1	11.1	11.1

Other Information

DSN/U	B-6	B-9	B-13	B-14
Soil pH	7.8	7.69	7.33	7.59
Minimum Soil Resistivity (ohm-cm)	1980	1260	860	1500
Sulfate Concentration (ppm)	80.5	45.5	10.1	52.3
Chloride Concentration (ppm)	135.6	9.8	3.3	11.4
Abrasion Level	1	1	1	1
2–5 Year Flow Velocity (ft/sec)	10	10	10	10
Design Service Life (years)	50	50	50	50
Height of Cover (ft)	10	10	10	10

AltPipe

Project EA: **04-4H29001**
Project Engineer:
Location: **SCI-237-2.7/3.3, SCI-101-45.2/45.8**
Description: **Interchange and roadway improvements**

Steel Pipes

	DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
	Pipe Diameter (in)	**30**	**30**	**30**	**30**
Pipe Type	**Coat**	**Minimum Thickness (in)**			
Corrugated Steel Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	GAL	0.079	0.138	0.138	0.138
	AL2	0.052			0.052
	BC	0.064	0.079	0.138	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.052	0.052	0.052	0.052
Corrugated Steel Pipe 2 2/3" x 1/2" Annular Corrugations	GAL	0.079			
	AL2	0.064			0.064
	BC	0.064	0.079		0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 1" Ribs at 11 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 1" Ribs at 8 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
Steel Spiral Rib Pipe 3/4" x 3/4" Ribs at 7 1/2" Pitch	GAL	0.079	0.109	0.109	0.109
	AL2	0.064			0.064
	BC	0.064	0.079	0.109	0.079
	BCI	0.064	0.064	0.079	0.064
	PS	0.064	0.064	0.064	0.064
	CSS	0.064	0.064	0.064	0.064

Aluminum Pipes

DSN/U	**B-6**	**B-9**	**B-13**	**B-14**
Pipe Diameter (in)	**30**	**30**	**30**	**30**

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**30**	**30**	**30**	**30**
Pipe Type	**Minimum Thickness (in)**			
Corrugated Aluminum Pipe Annular Corrugations 2 2/3" x 1/2" Corrugations	0.075			0.075
Corrugated Aluminum Pipe Annular Corrugations 3" x 1" Corrugations	0.060			0.060
Corrugated Aluminum Pipe Helical Corrugations 2 2/3" x 1/2" Corrugations	0.075			0.075
Corrugated Aluminum Pipe Helical Corrugations 3" x 1" Corrugations	0.060			0.060
Aluminum Spiral Rib Pipe 3/4" x 1" Ribs at 11 1/2" Pitch	0.060			0.060
Aluminum Spiral Rib Pipe 3/4" x 3/4" Ribs at 7 1/2" Pitch	0.060			0.060

Pipe Type Minimum Thickness (in)

Plastic Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**30**	**30**	**30**	**30**
Pipe Type	**Availability**			
PVC Corrugated	Allowable	Allowable	Allowable	Allowable
HDPE Corrugated - Type S	Allowable	Allowable	Allowable	Allowable

Reinforced Concrete Pipes

DSN/U	B-6	B-9	B-13	B-14
Pipe Diameter (in)	**30**	**30**	**30**	**30**
Steel Cover (in)	1	1	1	1
Sacks of Cement	5	5	5	5
Percentage Water	11.1	11.1	11.1	11.1

Other Information

DSN/U	B-6	B-9	B-13	B-14
Soil pH	7.8	7.69	7.33	7.59
Minimum Soil Resistivity (ohm-cm)	1980	1260	860	1500
Sulfate Concentration (ppm)	80.5	45.5	10.1	52.3
Chloride Concentration (ppm)	135.6	9.8	3.3	11.4
Abrasion Level	1	1	1	1
2–5 Year Flow Velocity (ft/sec)	10	10	10	10
Design Service Life (years)	50	50	50	50
Height of Cover (ft)	10	10	10	10