FOR CONTRACT NO.: 10-0G8004

ADDITIONAL INFORMATION HANDOUT

MATERIALS INFORMATION

1. Geotechnical Design Report for Route 12 Highway Improvement
dated January 31, 2002

2. Supplemental Recommendations to Geotechnical Design Report
dated September 7, 2009

3. Foundation Report
dated December 17, 2012

Dist-Co-Rte-PM: 10-SJ-12-0.1/R4.4

ADDED PER ADDENDUM NO. 1 DATED JUNE 3, 2013

Geotechnical Design Report

For

Route 12 Highway Improvement

Passing Lanes and Shoulder Widening
Embankment Fills
From Mokleumne River Bridge to Potato Slough Bridge

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
EA: 10-0A8400

Prepared for:

District 10
Central Region – Project Development
Design Branch I

By:

Division of Engineering Services
Geotechnical Services
Geotechnical Design – North

January 31, 2002

State of California

Business, Transportation and Housing Agency

Memorandum

To: MR. PAUL ELLIOTT
Central Region, Branch I
Project Development Division

Date: January 25, 2002

File No.: 10-SJ-12-0.1/4.2
KP 0.2/6.8 (PM 0.1/4.2)
10-0A8400

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

Subject: Geotechnical Design Report

Introduction

This report presents the results of our geotechnical study performed for the proposed addition of passing lanes on State Highway 12 at KP 0.2 to 6.8 (PM 0.1 to 4.2), located in San Joaquin County, California. The proposed project consists of widening the existing roadway embankment to provide passing lanes for traffic heading both eastbound and westbound as well as widening of the shoulders.

The purpose of this report is to document subsurface conditions, present results of testing, provide analyses of anticipated site conditions, and to recommend design and construction criteria for the project. This report also establishes an idealized subsurface stratigraphy and associated geotechnical parameters for use as a baseline for assessing the existence and scope of changed site conditions.

Conclusions and recommendations presented in this report are based on our subsurface exploration and laboratory testing programs as well as a review of existing documentation. Variation between anticipated and actual subsurface soil conditions may be found in localized areas during construction. This Office should be contacted for review and supplemental recommendations if significant variations in subsurface conditions are encountered during construction.

This report is intended for use by the project design engineers, construction personnel, potential bidders, and selected contractors or subcontractors.

If you have any questions or comments, please call Jeff Fippin at (916) 227-6980, Michael Engelmann at (916) 227-7153 or Craig Hannenian at (916) 227-7237.

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Michael J Engelmann

MICHAEL ENGELMANN
Transportation Engineer - Civil
Geotechnical Design - North

Attachments

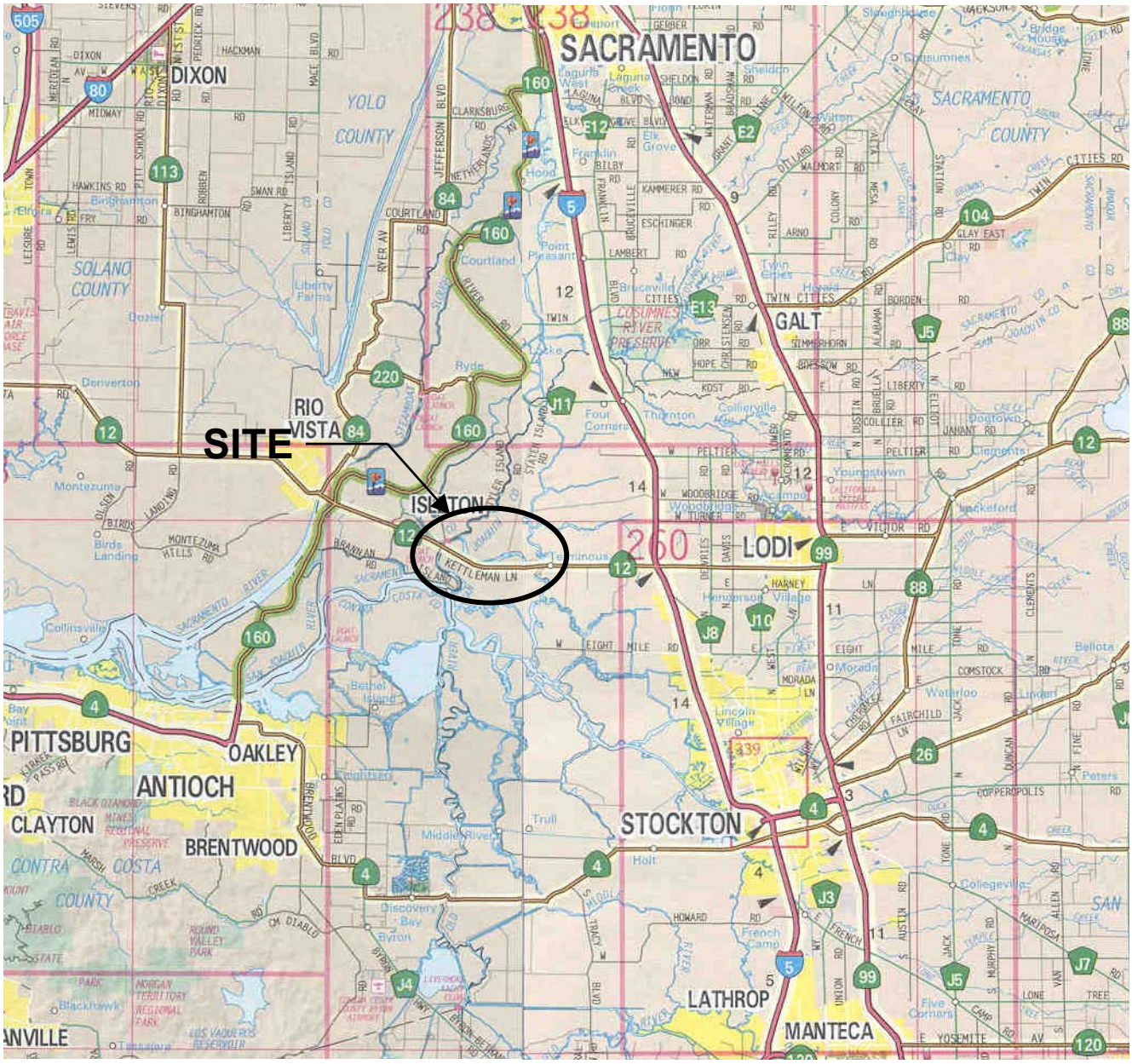
c: RBibbens-GDN
AAbbai-Dist 10
GDN.02

1 INTRODUCTION

The Office of Geotechnical Design – North, has completed a geotechnical investigation into improvements along Route 12 on Bouldin Island in San Joaquin County between Mokelumne River Bridge and Potato Slough Bridge. The project covered by this report proposes to widen the existing fill embankment to provide passing lanes for both eastbound and westbound traffic as well as widening the shoulders. The project covers a distance of approximately 6600 meters. A vicinity map (Figure No. 1) showing the project location is attached.

The site is underlain by a significant amount of compressible soil. The existing embankment has historically experienced significant settlement damage. This report presents several remediation alternatives that should minimize the amount of settlement damage the new roadway sections will be subjected to.

This report includes a review of published data including California Department of Mines and Geology (CDMG) publications, a review of laboratory data and reports for projects in the area, a site reconnaissance, subsurface exploration, and analyses.



APPROXIMATE SCALE:

0 3.75 7.5 11.25 15.00 18.75 miles

0 10.0 20.0 30.0 40.0 km

Base Map Reference:
California Road Atlas & Driver's Guide, Thomas Bros. Maps, 2000.

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Division of Engineering Services
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Geotechnical Design Branch - North

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VICINITY MAP

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

Figure No. 1

2 EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

2.1 Project Background/Existing Facilities

Route 12 in San Joaquin County connects I-80 and I-5, and is the principal connector between Fairfield, Rio Vista and the Central Valley. The project section of highway traverses Bouldin Island between the South Fork of the Mokelumne River and Potato Slough. The Delta Wetlands Company owns the Island. Currently, the land adjacent to the highway is used as agricultural. Eventually, the island could be flooded for water storage or to create wetlands mitigation habitat. At the project location, Highway 12 consists of a 2-lane highway, which is built on fill. It is paved with asphalt concrete and aligned in a general east/west direction. This section of highway is located between the Mokelumne River Bridge and the Potato Slough Bridge. The fill ranges in height with a maximum height of approximately 3.5 meters with side slopes typically 1:1.5 (V:H) or steeper. Three culverts cross underneath the highway along the project. These culverts are at Station 14+95, Station 26+30, and Station 49+33. The culverts at Stations 26+30 and 49+33 are both 915-mm diameter welded steel pipe culverts. At this time, we are not sure of the exact dimensions of the culvert at Station 14+95, and we are not sure of the foundation details for any of the culverts. There are drainage ditches at various locations on each side of the roadway, which are used for agricultural and dewatering purposes.

2.2 Proposed Improvements

The project proposes improvements to the highway by the addition of two new lanes for the eastbound traffic between the Mokelumne River Bridge and the Potato Slough Bridge. The existing two lanes will then solely be used for the westbound traffic. Addition of approximately 3.2 meters of fill to the south side of the existing embankment will be used to facilitate construction of the eastbound lanes. Additionally, the shoulders will be widened to a standard 2.4 meters width. This report addresses the geotechnical considerations for the construction of the aforementioned improvements on Highway 12 between Mokelumne River Bridge and the Potato Slough Bridge located in the San Joaquin Delta.

3 PHYSICAL SETTING

The physical setting of the project site and the surrounding area was reviewed to provide climate, topography and drainage, man-made and natural features, geology and seismicity characteristics to aid in project design and construction. The following is a discussion of our above review:

3.1 Climate

Monthly average temperatures and precipitation near the project site are presented in Tables 1 and 2. This data was obtained from data published by the Western Regional Climate Center for 1948-2000. The recording station used is located in Lodi, which is located approximately 21 km east of the project site at a comparable elevation.

Table 1 – Lodi Average Monthly Rainfall (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean (mm)	91	76	69	33	13	3	3	3	8	23	58	71	450
Mean (in)	3.6	3.0	2.7	1.3	0.5	0.1	0.1	0.1	0.3	0.9	2.3	2.8	17.6

Table 2 – Lodi Temperatures

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean (°C)	7.5	10.2	12.1	14.9	18.2	21.2	23.1	22.6	21.0	16.9	11.4	7.4	15.6
Mean (°F)	45.5	50.4	53.8	58.9	64.7	70.1	73.6	72.6	69.8	62.5	52.5	45.4	60
Max (°C)	12.2	16.1	18.9	22.8	26.7	30.4	32.9	32.3	30.6	25.7	18.0	12.4	23.3
Max (°F)	54	60.9	66	73	80.1	86.8	91.3	90.2	87	78.2	64.4	54.4	73.9
Min (°C)	2.8	4.3	5.3	7.1	9.6	11.9	13.2	12.7	11.4	8.2	4.8	2.5	7.8
Min (°F)	37	39.7	41.6	44.7	49.2	53.4	55.8	54.9	52.6	46.7	40.6	36.5	46.1

As can be seen in the tables, the average rainfall for a calendar year is about 450 mm (17.6 in). The majority of this precipitation (over 90 percent) falls between October and April. The average annual air temperature is approximately 15.6^{o} C (60.0^{o} F) with the highest average daily maximum of 32.9^{o} C (91.3^{o} F) in July and the lowest average daily minimum of 2.5^{o} C (36.5^{o} F) in December.

3.2 Topography

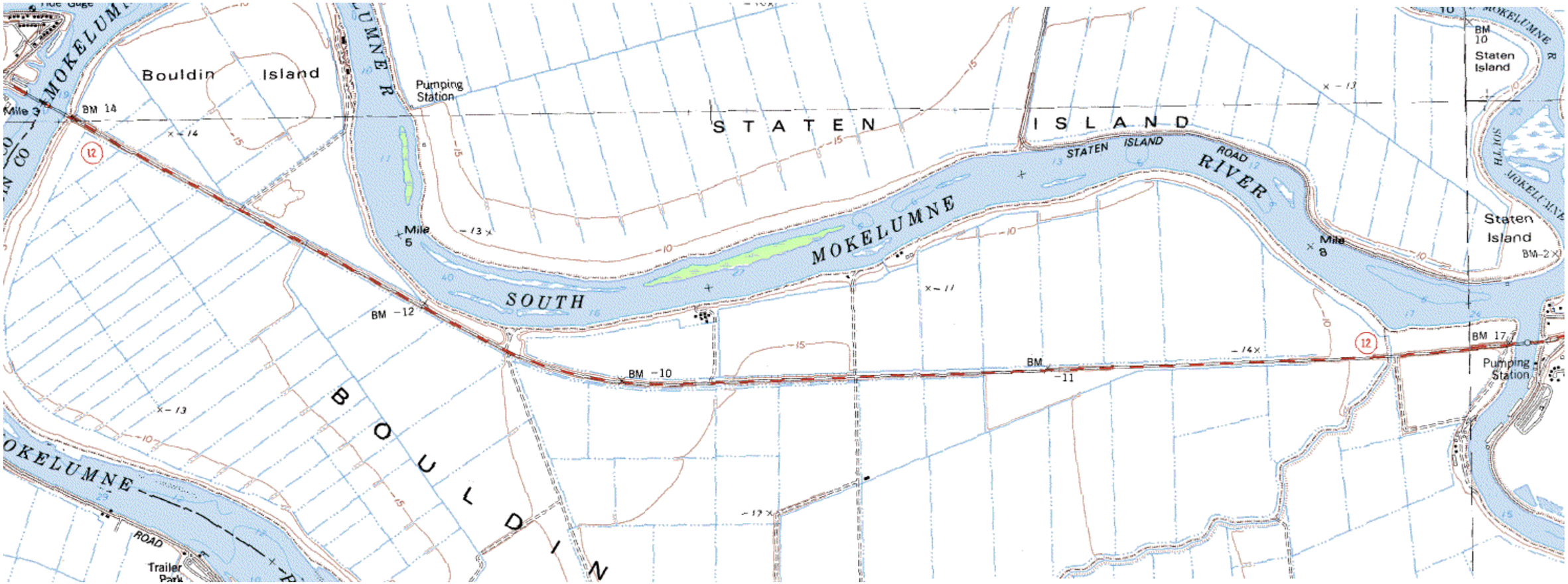
According to the Bouldin Island and Terminous CA 7.5-Minute Quadrangle dated 1978, the site is relatively flat. Highway 12 and both the Mokelumne River Bridge and the Potato Slough Bridge can be seen on the attached topographic map (Figure 2). Agricultural land occupies the area to the north and the south of the project location. The site elevation varies between -4.6 to -3.0 meters (-15 to -10 feet) below mean sea level.

3.3 Regional Geology and Seismicity

Information regarding the regional geology can be found on the Geologic Map of the Sacramento Quadrangle, published by CDMG dated 1987. According to this map, the entire site is located in intertidal deposits, which consist mostly of peaty mud, labeled as Qi. This soil is composed of soft mud and peat that were deposited in marshes, swamps, and adjacent waterways. This formation was deposited primarily in the Quaternary Period of the Cenozoic Era. This formation is a relatively young deposit that has been formed over the last 1.6 million years. A portion of the Geologic Map of the Sacramento Quadrangle showing the regional geology can be found on Figure 3.

We reviewed the State of California, Air Resources Board (ARB) Map of California Showing Principal Asbestos Deposits, undated. According to the map, the site is not in an area of naturally occurring asbestos.

We reviewed the Caltrans California Seismic Hazard Map dated 1996. The map indicates that the controlling fault for the site is the Coast Ranges-Sierran Block fault, located about 32 km (20 miles) west of the site. The maximum credible earthquake of this fault is Mw=7.00, and the corresponding peak horizontal bedrock acceleration at this site is estimated to be 0.3g.



Base Map Reference:
Bouldin Island and Terminous, California 7.5-Minute Quadrangle, dated 1978
All elevations are in feet

APPROXIMATE SCALE:

0 0.25 0.50 0.75 1.0 miles

0 0.5 1.0 1.5 kilometers

N

Caltrans

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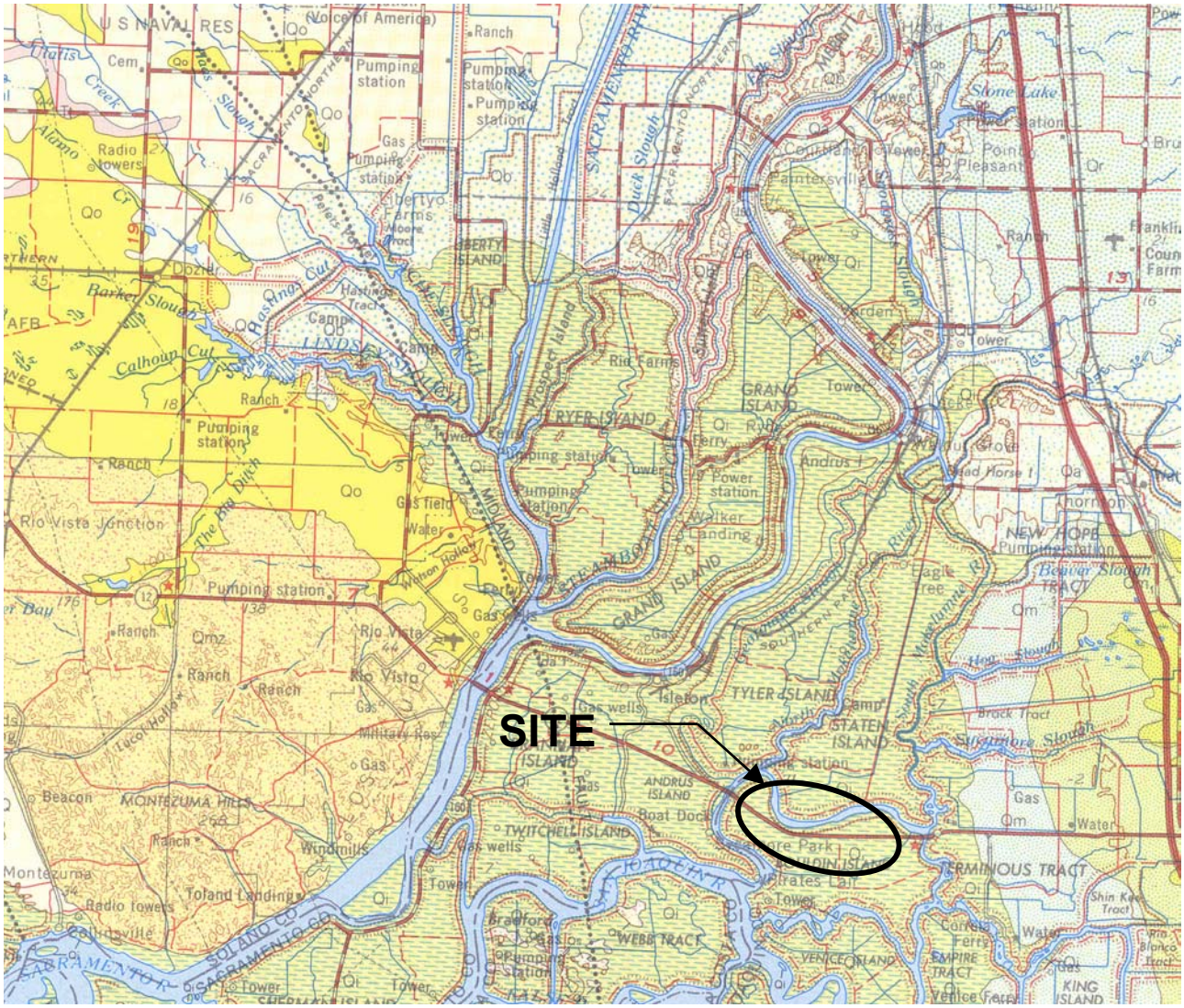
TOPOGRAPHIC MAP

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

Figure No. 2



Base Map Reference:
Geologic Map of the Sacramento Quadrangle, 1981, California Mines and Geology

APPROXIMATE SCALE:

0 3.75 7.5 11.25 15.00 18.75 miles

0 10.0 20.0 30.0 40.0 km

N

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GEOLOGY MAP

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GEOTECHNICAL DESIGN REPORT

Figure No. 3

4 EXPLORATION PROGRAM

4.1 Site Visits

Personnel from this office performed the preliminary site visit for this report on March 6, 2001. Subsequent site visits were conducted with members of the District 10 Design team as well as representatives of the local Maintenance office. At these meetings, the existing conditions at the site were noted, and the proposed improvements were discussed.

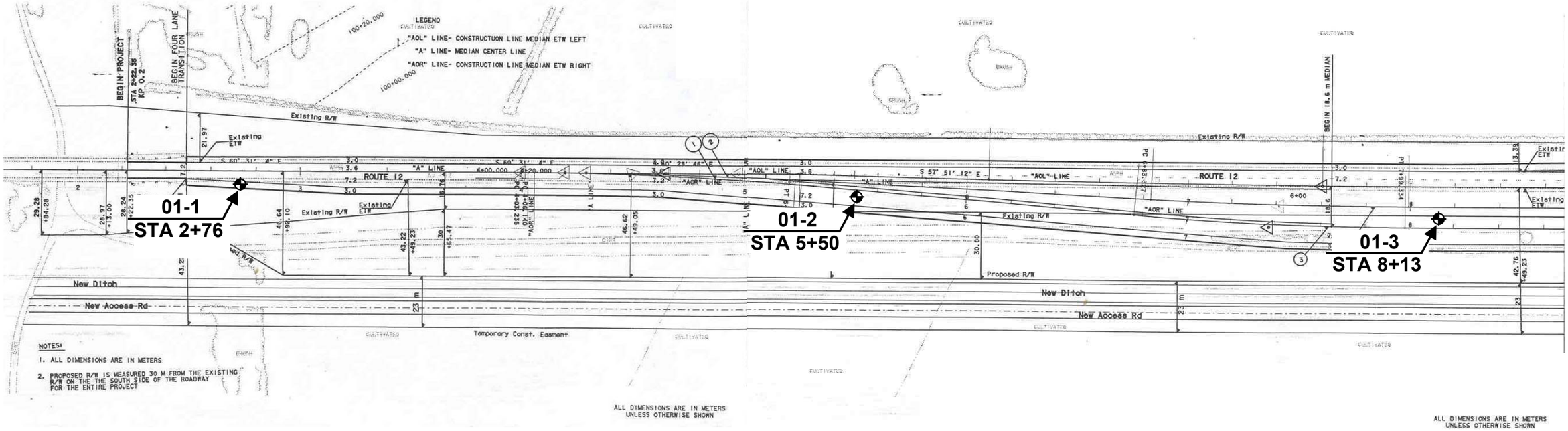
The existing Route 12 is located on an embankment with a maximum height of approximately 3.2 meters and an average height of approximately 2.5 meters. The side slopes of the embankment are approximately 1:2 (V:H) and are mostly vegetated with grasses. The roadway shows signs of extreme distress likely due to settlement of the embankment.

Damage observed during our site visit includes cracking and sinking of the highway as it crosses several culverts, cracking and collapse of the highway along the fog line at several locations, and occasional longitudinal cracking near the centerline of the roadway. Damage is visible nearly continuously along the entire project length, however, the most significant damage to the highway begins at the culvert near Station 57+00 and continues to be evident traveling westward through approximately Station 29+00. Several large undulations along the highway are evidence of differential settlements along this stretch of highway.

According to Mr. Steve Stolp of District 10 Maintenance, this stretch of Highway 12 presents an ongoing maintenance challenge as damage similar to that observed has continued to occur since the highway was originally constructed. Maintenance has attempted to remedy the problems through several methods including dig-outs and overlays. As recently as 1996, a major rehabilitation of the highway was performed, this project included grinding of at least 3 inches of AC followed by overlaying the roadway with a leveling course including a geosynthetic material. According to Mr. Stolp, the rehabilitation project also included select dig-out sections where the entire roadway was removed over a short section and the material beneath was removed to a depth of 18 inches with a backhoe. The dig-out work consisted of recompacting the removed material and replacement of the roadway structural section. Also according to Mr. Stolp, the shoulders were widened to 2.4 meters. However, these sliver fills have eroded, and the shoulder widths are approximately the same as prior to the rehabilitation work.

4.2 Subsurface Investigation Program

In support of the design for the proposed highway widening, a subsurface exploration program was performed between May 1 and May 11, 2001 by personnel from this Office. Nineteen borings were drilled to a depth ranging between 13.7 to 18.7 meters below the existing ground surface. Figures 4 through 11 show the approximate locations of the borings.



APPROXIMATE SCALE: 1:1000

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APPROXIMATE BORING LOCATIONS

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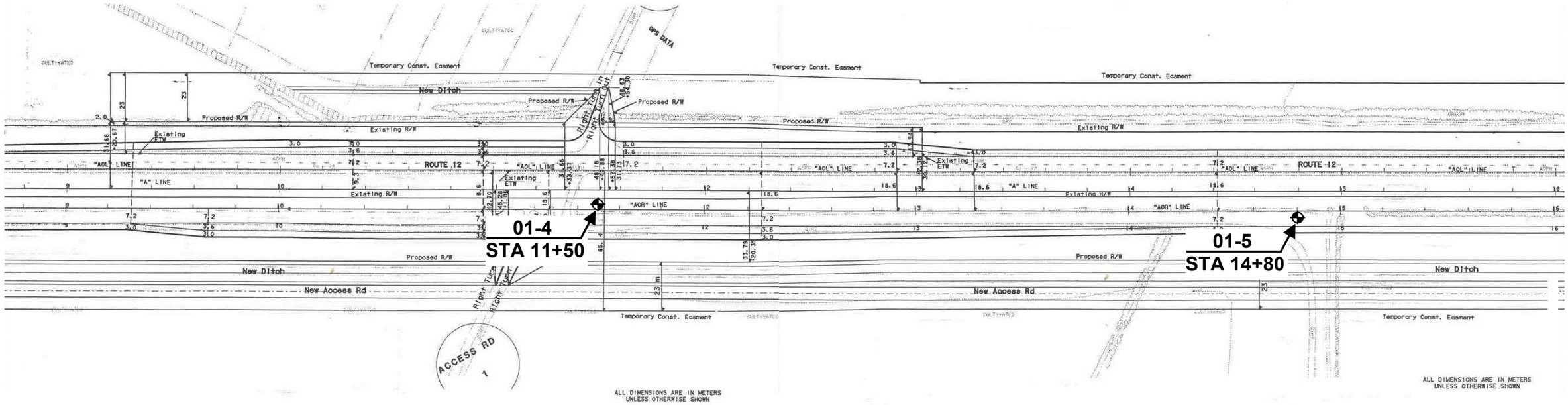
Figure No. 4



APPROXIMATE SCALE: 1:1000

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APPROXIMATE BORING LOCATIONS

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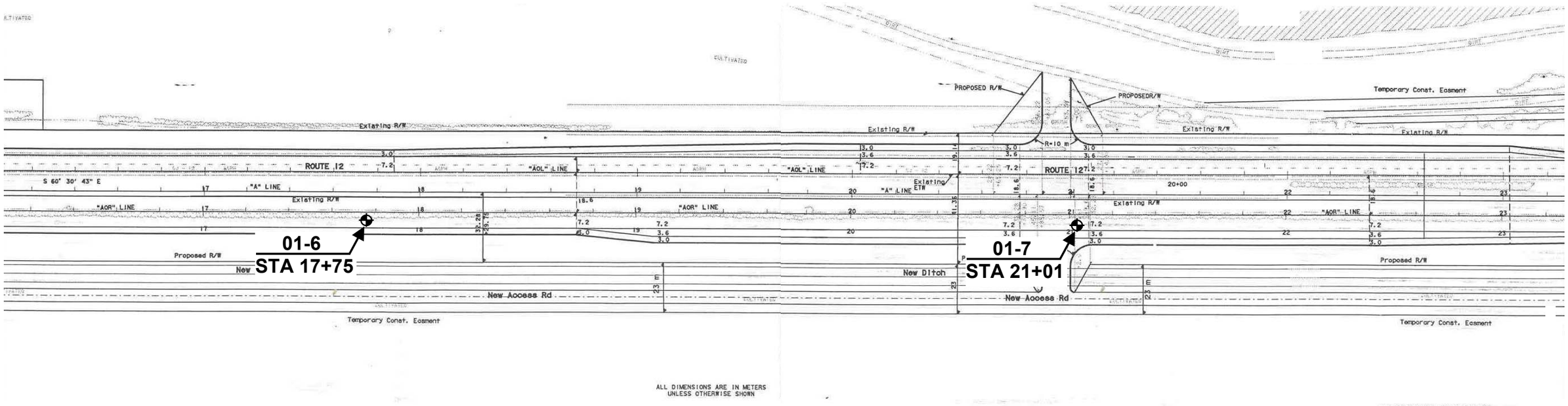
Figure No. 5



APPROXIMATE SCALE: 1:1000

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APPROXIMATE BORING LOCATIONS

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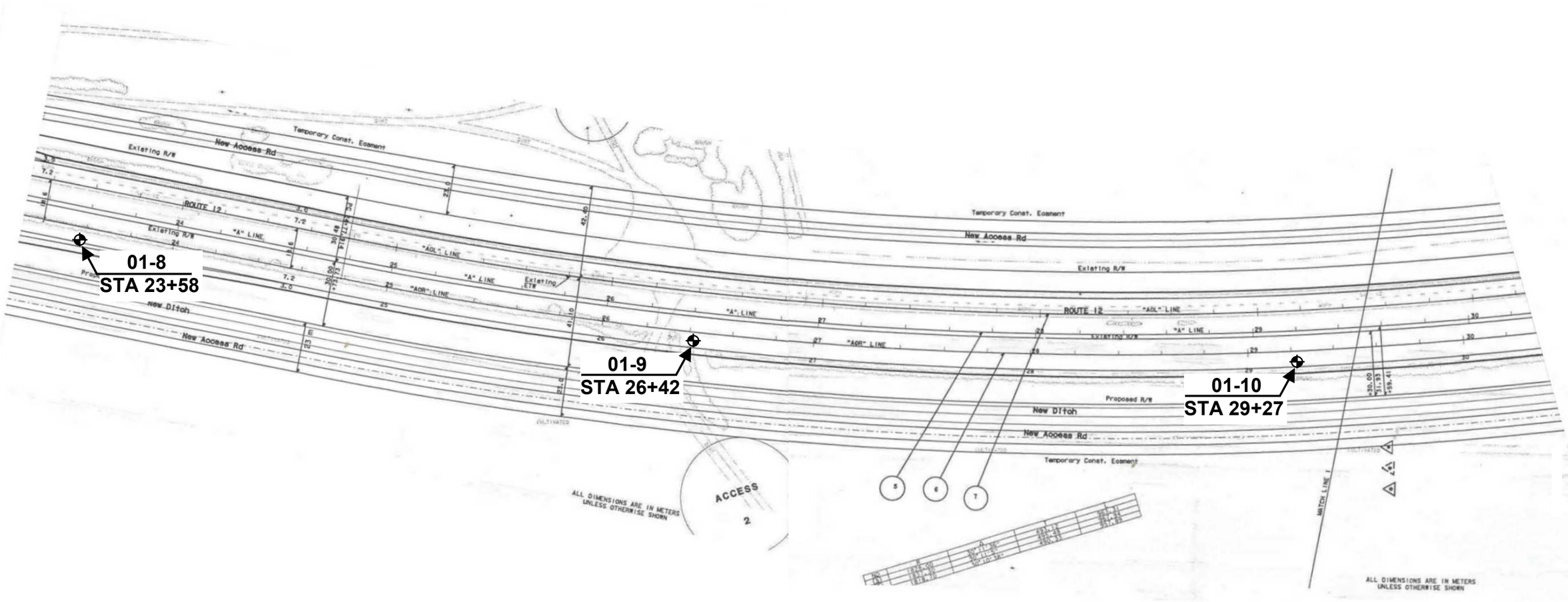
Figure No. 6



APPROXIMATE SCALE: 1:1000

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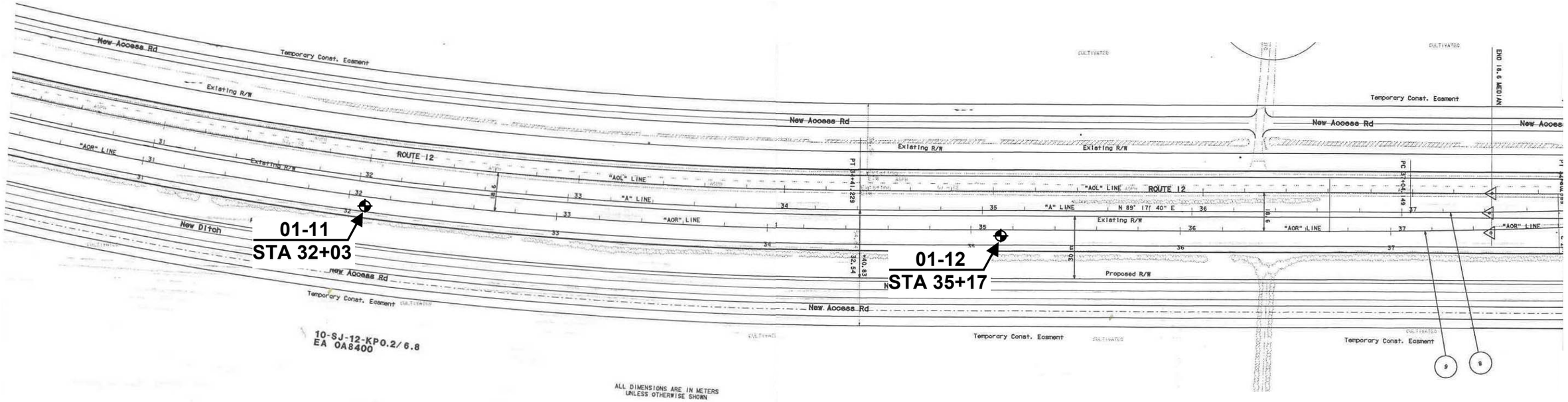
DEPARTMENT OF TRANSPORTATION Division of Engineering Services Geotechnical Services Geotechnical Design - North	EA: 10-0A8400 Date: January 2002	**APPROXIMATE BORING LOCATIONS**
	10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2) **GEOTECHNICAL DESIGN REPORT**	Figure No. 7



APPROXIMATE SCALE: 1:1000

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Geotechnical Services
Geotechnical Design - North

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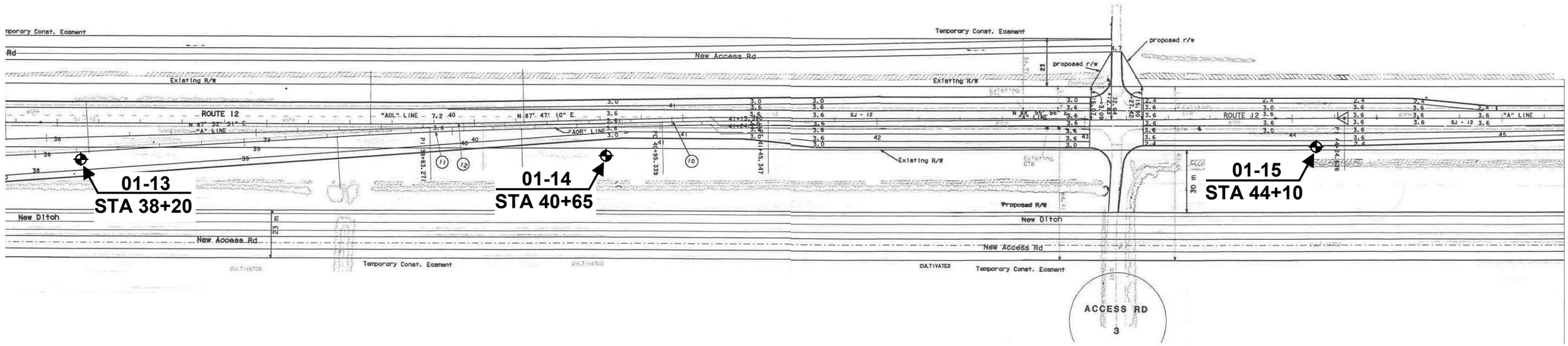
APPROXIMATE BORING LOCATIONS

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

Figure No. 8



APPROXIMATE SCALE: 1:1000

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APPROXIMATE BORING LOCATIONS

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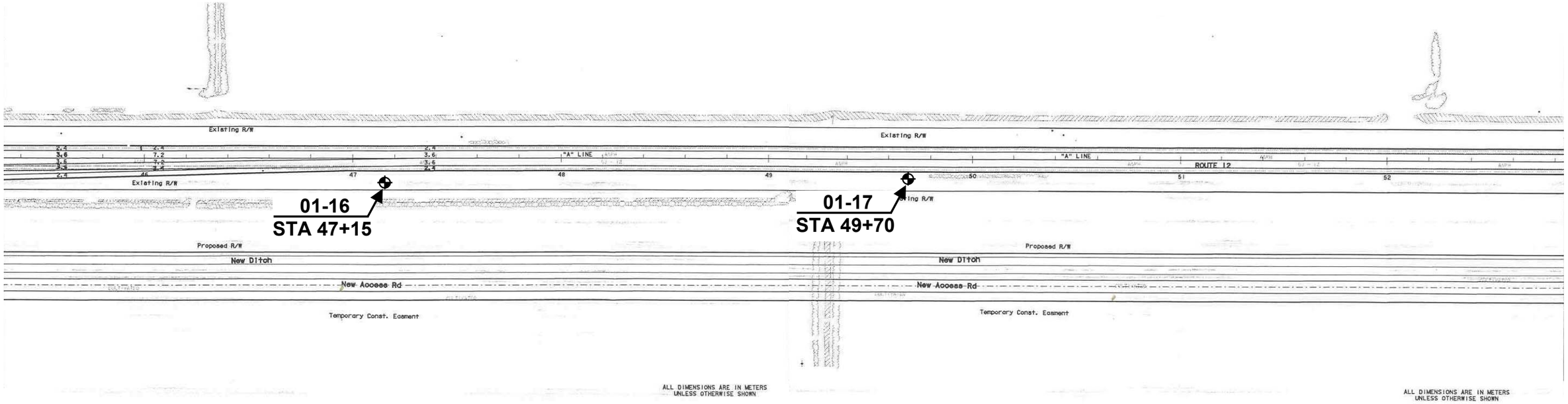
Figure No. 9



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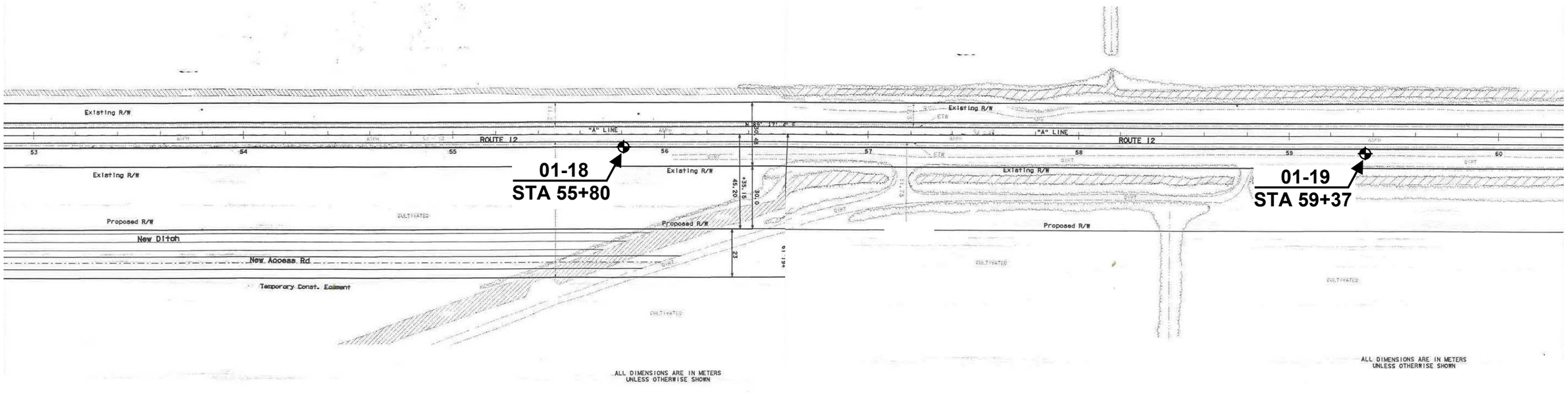
APPROXIMATE BORING LOCATIONS

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

Figure No. 10



APPROXIMATE SCALE: 1:1000

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Geotechnical Design - North

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APPROXIMATE BORING LOCATIONS

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GEOTECHNICAL DESIGN REPORT

Figure No. 11

The borings were drilled using a truck-mounted Christensen CS 2000 and a trailer-mounted Mobile B-47 drill rig. The borings were advanced using a 10.8-cm (4¼-inch) diameter finger bit and a 7.6-cm (3-inch) diameter drag bit. In some cases, a punch core was installed inside the finger bit to help in the continuous classification of the subsurface soils.

Disturbed samples of soil were taken using both a 50.8-mm (2-inch) ID modified California sampler and a 38.1-mm (1.5-inch) ID split-barrel sampler. The samplers were driven 457 mm (18 inches) into the material at the bottom of the hole with a 63.5 kg (140 lb) hammer dropped 762 mm (30 inches). When the modified California sampler was used, the brass liners containing the sample were removed and sealed to preserve the natural moisture. Samples from the split-barrel sampler were placed in plastic bags and sealed. Relatively undisturbed samples were taken within the clay and peat layers by pushing a thin-walled (Shelby) 60-mm (2.4-inch) ID tube. The Shelby tubes were pushed with the drill rig kelly bar and sealed upon recovery from the borings. All samples were transported to our laboratory in Sacramento, California. Logs of the exploratory borings were prepared based on soil classifications made in the field and on laboratory test results performed on select samples. Results of the laboratory tests are presented at the corresponding sample locations in the boring logs (as shown in Plates A-1 through A-40 in Appendix A).

5 GEOTECHNICAL TESTING

5.1 In-Situ Testing

In situ testing was performed utilizing a RocTest Model M-100 Vane Shear device. Testing was performed in accordance with ASTM D2573-72, "Standard Test Method for Field Vane Shear Testing in Cohesive Soil" and procedures developed by the Department. Undisturbed measurements of the undrained shear strength (s_u) as well as the shear strength after remolding (s_{ur}) were taken. Additional in-situ testing consisted of recording blow counts for the driven samplers, which were used to correlate to approximate strength and consistency values for the soils tested.

5.2 Laboratory Testing

Laboratory tests were performed on select samples obtained during the subsurface investigation program. The following tests were performed:

- Unconfined Compressive Testing: California Test Method 221
- Consolidation Testing: California Test Method 219
- Corrosivity determination: California Test Method 643
- Organic Content determination: ASTM Test Method D2974
- Unit Weight and Moisture Content determination: California Test Method 223
- Specific Gravity: California Test Methods 206, 207, and 208
- Mechanical Analysis: California Test Method 202
- Plasticity Index determination: California Test Method 204

Tables summarizing the laboratory testing results are included in Appendix A.

5.3 Instrumentation

Borings 01-10 and 01-19 were converted to piezometers by installing a 50.8-mm (2-inch) diameter slotted PVC pipe and backfilling the annulus with coarse sand. The level of water in the slotted pipe was measured at various times in order to determine the subsurface water pressures. As shown on the appropriate Logs of Test Borings, the groundwater was recorded at 0.9 meters to 1.5 meters below the ground surface.

6 GEOTECHNICAL CONDITIONS

6.1 Subsurface Conditions

Sampling of the subsurface soils revealed that relatively similar foundation soils exist across the limits of the site. Based on our field exploration program, we have idealized the subsurface conditions to be represented by four soil types. Figure 12 shows the idealized subsurface stratigraphy developed for this project. In general, the site is underlain by a soft strata of peat, and then by either a soft or a firm clay (except approximately between Station 28+00 to Station 31+50 where no clay was encountered), and finally, combinations of silt and sand.

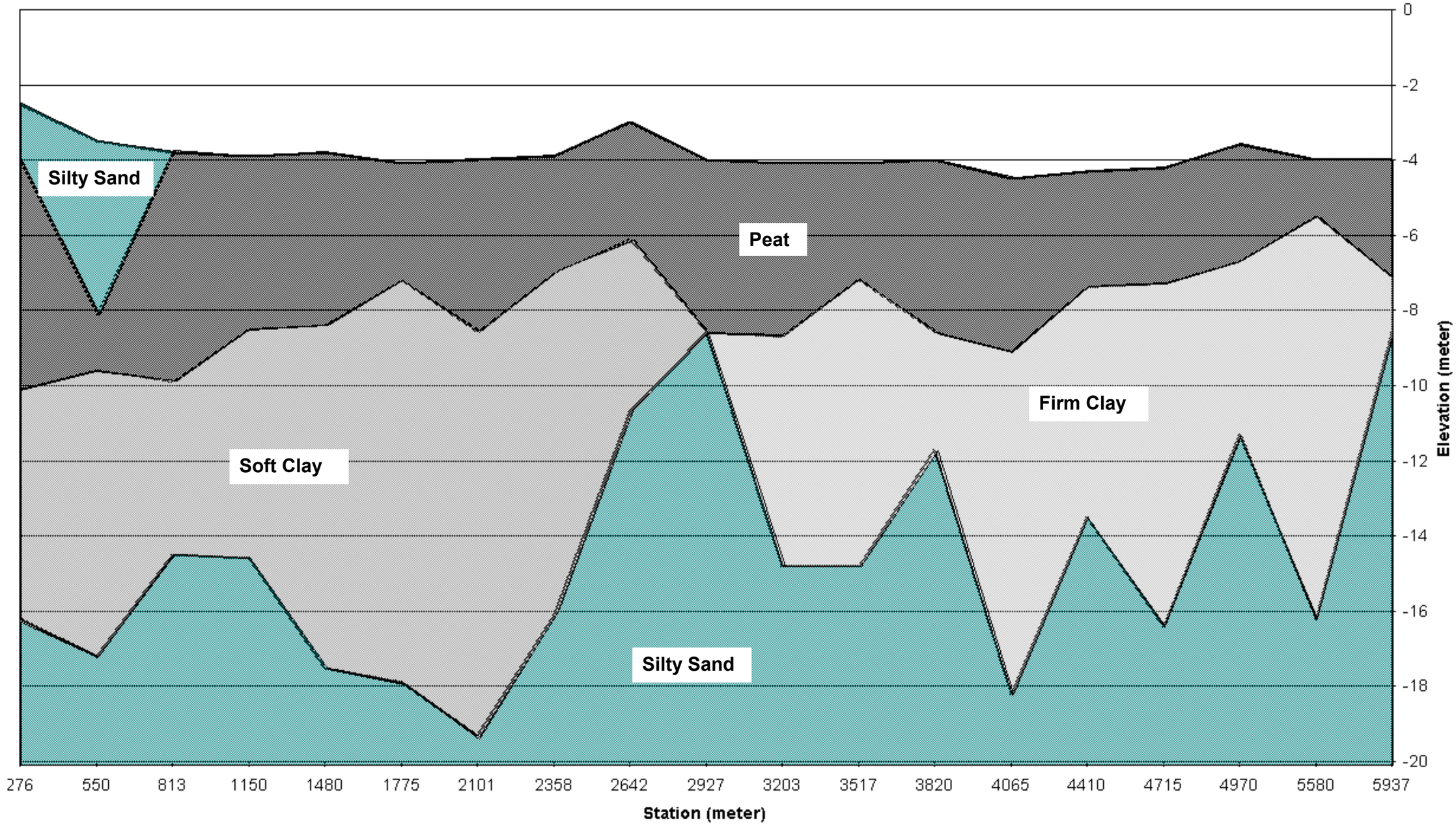
6.2 Peat

In general, the existing surface soil along the project length is hardened, desiccated topsoil composed primarily of sandy, silty clay heavy in organics. The topsoil typically extends approximately 0.15 meters below the ground surface. Below the topsoil is a layer of black, clayey peat. This peat is typically very soft to soft. The thickness of the peat ranges from 1.5 to 6.1 meters.

This soil layer has an extremely high natural water content (w_n) and void ratio (e_0) and is composed primarily of decomposed organic materials. It is anticipated that this material will compress considerably under the proposed embankment loads. In fact, the deformation of this layer under vertical loads is expected to involve two separate, but interlinked time effects associated with primary consolidation and secondary creep.

Laboratory tests were performed on the peat to determine index properties such as water contents, organic contents, and plasticity indices. These index properties were used in conjunction with published correlations and laboratory data from nearby projects to develop strength and compressibility parameters for the peat. The compression index C_c was approximated using the relationship $C_c = 0.0115 \times w_n$ (as Published by Azzouz, Krizk, and Crotis, 1976) where w_n is the in-place water content of the peat. The coefficient of secondary compression, C_α, was approximated using the relationship $C_c/C_\alpha = 0.075$, as published by Mesri, Stark, Ajlouni and Chen, 1997. Conservative value of undrained shear strength, s_u, in-place unit weight, γ, and in-place void ratio, e_0, were selected for the peat through review of lab data for nearby projects, values from vane shear testing, and published ranges. The following parameters were developed to model the peat in design calculations:

$C_c = 4.5$
$C_\alpha = 0.35$
$_\gamma = 10.5$ kN/m^3
$e_0 = 7.6$
$s_u = 10$ kPa



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Geotechnical Design - North

EA: 10-0A8400

Date: January 2002

IDEALIZED SUBSURFACE PROFILE

10-SJ-12 KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

Figure No. 12

6.3 Clays

Underlying the peat layer, silty clay was encountered. The thickness of clay generally ranges from 3.0 to 10.7 meters. While the clay has a similar color and similar texture across the site, the consistency varies such that we divided the clay deposit into two soil types; a soft clay layer and a firm clay layer. It is assumed that the soft clay layer underlies the site from the western end of the project to Station 26+40 while the firm clay ranges from Station 32+00 to the eastern end of the project. It is assumed that between Station 26+40 and 32+00, the deposit transitions from the soft clay to the firm clay.

The clay underlying this site is considered to have a relatively high compressibility. The majority of compression is anticipated to come in the form of primary consolidation. Unlike the peat, the clay has an extremely tight soil matrix meaning that the time for primary consolidation to occur in the clay will be much greater than in the peat. Secondary compression of the material is expected to be relatively small.

The soil parameters used to model the clay in analyses were developed primarily based on the results of our vane shear testing in combination with laboratory testing of selected samples. The following parameters were developed for the two types of clay:

<u>Soft Clay</u>
$C_c/(1+e_0) = 0.16$
$C_r/(1+e_0) = 0.02$
$\gamma = 17.5$ kN/m^3
$s_u = 20$ kPa
$s_u/p = 0.25$

<u>Firm Clay</u>
$C_c/(1+e_0) = 0.1$
$C_r/(1+e_0) = 0.02$
$\gamma = 19$ kN/m^3
$s_u = 45$ kPa

6.4 Sand

Underlying the clays was a layer of medium dense to dense, coarse grained, silty sand. This sand layer was occasionally intermixed with lenses of sandy silt. All of the borings were terminated within this stratum. Blow counts, and laboratory results were used to select soil parameters for modeling the sand layer. The following parameters were developed for the sand:

$\gamma = 19$ kg/m^3
$\phi = 35°$
$E = 19$ MN/m^2

7 DRAINAGE CONSIDERATIONS

7.1 Surface Water

The land adjacent to Route 12 within the limits specified in this report is relatively flat. The existing ground surface ranges from –2 meters to –4.5 meters. The land appears to be a natural flood plain that has been reclaimed for agricultural use by construction of the levees which surround the island.

Paralleling the highway are ditches. These ditches are filled with water year round. The water from these ditches is used by the landowner for agricultural purposes.

7.2 Groundwater

Groundwater was measured between 0.9 and 1.5 meters below the ground surface. Since the site is so close to the Mokelumne River and Potato Slough, it is likely that the groundwater fluctuates with the level of water in these adjacent bodies of water.

8 GEOTECHNICAL ANALYSES

8.1 Settlement - Primary and Secondary Consolidation

A key design issue for the project is the consolidation of the underlying soils. Both the peat and clay underlying the site will undergo significant consolidation under the design embankment loading. The consolidation of the underlying foundation soils will be composed of two mechanisms. The first mechanism of consolidation, primary consolidation, is essentially the rearrangement of soil particles as pore water is squeezed out of the soil matrix by vertical stress. The amount of primary consolidation is dependent on the soil compressibility, the thickness of the compressible layer, and the amount of vertical load placed on the soil. The time over which primary consolidation occurs is related to how easily pore water can drain from the soil matrix. As previously discussed, both the peat and clay layers are anticipated to experience significant primary consolidation under the proposed embankment loading. Because of the difference in the composition of the two soil types, the time for the clay to fully consolidate is expected to be dramatically larger than for the peat.

A second mechanism for settlement of the foundation soil is secondary consolidation. Secondary consolidation is composed of creep, which is the continuing deformation of normally consolidated soil under constant vertical stress, and decomposition of organic matter. Settlement due to secondary consolidation is a slower continuation of settlement that follows primary consolidation. In the peat layer, secondary consolidation is expected to be significant and can be as large as primary consolidation. In the clay layers secondary settlement should be minimal. Since secondary consolidation is time dependent, we have calculated the secondary consolidation of the peat assuming a 30-year design life for the new embankment. Secondary consolidation of the subsurface soils will continue after the assumed design life, however the rate of secondary consolidation decreases exponentially with time so after 30 years, the expected additional secondary settlement should be minimal.

According to cross sections provided by District 10 Design, the thickness of new fill will range from 1 to 3.2 meters. The soil parameters previously discussed were used to approximate the amount of settlement expected for the new embankment loading assuming that no settlement mitigation program is adopted. The settlements we anticipate would result from fill placement without settlement mitigation are very large and would result in very high maintenance costs that would continue for the lifetime of the roadway. Total settlements between 0.6 and 3 meters were calculated for various stations along the project. As with the existing roadway, large differential settlements are expected at the culvert crossings. Larger settlements are anticipated at the locations underlain by the soft clay deposits than those sites underlain by the firm clay.

The added stresses from the new embankment fill will cause significant settlement of the existing embankment fill. Settlements between 0.3 and 0.7 meters were calculated beneath the existing embankment fill. These settlements are expected along the fog line adjacent to the new fill. Further from the new fill, the magnitude of settlement drops

significantly, such that the anticipated settlement at the existing centerline of the highway is expected to be less than 0.1 meters.

The amount of expected settlement at a given location, and the time required to achieve that settlement, is primarily dependent on the thickness of each soil layer. The primary settlement of the peat is expected to be completed in a matter of months, however, in the clay layers, the time to completion of 90 percent of the primary consolidation is expected to take up to 3.5 years.

For the various settlement remediation alternatives presented later in this report, similar analyses were performed to evaluate the effectiveness of each potential solution.

8.2 Slope Stability

Another important key to the successful construction and operation of the widened highway is the stability of the new embankment fill. The underlying peat and clay layers have relatively low strengths meaning that the expected stability of fills placed on them is very low. Because of the extremely low shear strengths, if the embankment were constructed rapidly to the final design grade, the embankment would likely fail. However, the foundation materials gain strength as they consolidate. Therefore, if the rate of embankment construction is controlled, the stability of the embankment can be maintained. The cross section at Station 8+15 was selected as the most critical stability condition for assuring acceptable temporary and long-term factors of safety. In evaluating the stability of the new embankment, the selected minimum acceptable design factors of safety for construction and permanent conditions were 1.2 and 1.5, respectively.

Slope stability analyses were performed to model the stability of the new embankments during construction as well as after completion of fill placement. A limit equilibrium procedure was performed using Spencer's procedure of slices (Spencer, 1967). The analysis results presented in this report were obtained using the computer software SLOPE/W (GeoSlope International, Ltd., 1998). SLOPE/W is a general-purpose computer program that allows the user to perform two-dimensional slope stability computations using a variety of methods, including Spencer's procedure. Circular failure surfaces were used with various searches to obtain the critical failure surfaces.

The analysis procedures presented in this section were used to evaluate the allowable rate of construction and long term stability of the various remediation alternatives presented later in this report. Sample stability results are shown in Appendix C.

9 GEOTECHNICAL RECOMMENDATIONS

9.1 General

This section presents geotechnical design alternatives for the proposed widening of Route 12. Associated analyses were described in Section 8 of this report. As previously discussed, large amounts of settlement are anticipated. Additionally, the existing low-strength subsurface soils present a stability issue during construction. Without mitigating these two concerns, the roadway placed on the new embankment will have an unacceptable level of performance and require continuous maintenance for its service life.

The mitigation methods considered utilize combinations of wick drains, controlled fill rates, surcharge loading, lightweight fill, and/or deep soil mixing. The following geotechnical design alternatives, which are further detailed in the following report sections, are presented for your consideration:

- Alternative 1: simply constructing the embankment to the planned final elevation utilizing conventional fill.

- Alternative 2: constructing the embankment to the final elevation with lightweight fill to reduce the total settlements.

- Alternative 3: installing wick drains and surcharging the foundation with additional fill.

- Alternative 4: similar to Alternative 3 as it includes wick drains and surcharging, however it also includes replacing the surcharge fill with lightweight fill to obtain better long-term performance through reduced settlements.

- Alternative 5: a combination of Alternatives 3 and 4 in that wick drains and surcharging with conventional fill are utilized, but the settlement is monitored during construction, and lightweight fill is used to improve performance at select areas. This alternative is this Office's preferred design alternative.

- Alternative 6: improving the foundation soils with soil mixing and conventional fill placement.

Because of variabilities in the thickness of embankment as well as in the subsurface conditions, the settlement behavior will vary significantly along the 6.6 kilometers of this project. Table 3 presents a summary of our approximation of the typical settlement behavior for each of the six alternatives. For comparison purposes, the table lists behavior expected to be typical along the project length. In localized areas, settlements will be larger as well as smaller than those listed in the table.

Table 3: Comparative Summary of Geotechnical Alternatives

Alt	Wick Drains	Fill Height (m)	Construction Time + Settlement Period (mo)	Ultimate Settlement	Settlement During Settlement Period	Thickness of Fill to be Removed	Thickness of Lightweight Fill	Remaining Settlement over next 30 yr
1	No	5	36	3	2.5	0	N/A	1
2	No	3.5	6	2	1.5	0	N/A	0.75
3	Yes	7.0	12	3.5	3	2	N/A	0.4
4	Yes	7.0	12	3.5	3	4.5	2.5	0.1
5**	Yes	7.0	12	3.5	3	2-4.5	0-1	0.1
6	No	2.5	18	minimal	minimal	minimal	N/A	minimal

** Recommended alternative

Geotechnical instrumentation devices should be installed in order to monitor the performance of the selected alternative. These devices will be used as a tool to evaluate the stability of the embankment fill during construction, and to indicate whether any modifications to construction rates and/or surcharging times are warranted. Section 10 presents our recommended instrumentation program.

9.2 Alternative 1

Alternative 1 consists of simply building the embankment fill to the design subgrade elevations and placing the structural section. Rates and magnitude of settlement are not mitigated with this alternative. We estimate that total settlements ranging from 0.6 to 3 meters will occur along the new embankment over a design life of 30 years for the design thickness of fill.

The low strengths of the foundation soils necessitate that the rate of fill placement be controlled to avoid bearing failures within the native material. In order to maintain acceptable short and long-term factors of safety, the amount of fill that can initially be placed on the site must be limited to a thickness of 2 meters. Prior to placing the remaining fill, a waiting period of approximately ten months will be required to allow the underlying clay to consolidate and strengthen. However, we expect up to 1 meter of consolidation to occur during that ten-month wait period which would necessitate yet even more fill placement to achieve final grade. Ultimately, we expect that an average of 5 meters of fill will be required, placed over approximately 3 years of construction time to achieve final grade. Up to 6.5 meters of fill will likely be required in localized areas.

We expect up to 1 m of post-construction settlement to occur over the remainder of the assumed design lifetime of the roadway. Additional weight placed upon the embankment in the form of overlays for leveling or maintenance will initiate further settlement on the order of 0.5 meter for each meter of fill added. Significant differential settlements would occur at the locations of the three culverts.

Placement of fill in this manner is expected to result in significant settlement-related damage to the existing roadway. We estimate that a maximum of 0.5 meter of settlement will occur at the existing edge of pavement. At the existing centerline, less than 0.1 meter of settlement is expected. This settlement will occur at roughly the same rate as the settlement of the new embankment. The anticipated differential settlement would likely necessitate placement of AC leveling overlays to keep highway operation safe.

This Office does not recommend this alternative because of the lengthy construction time and the undesirable long-term performance level. Maintenance costs for this alternative will be extremely high. If this alternative is selected, this Office should be contacted in order to modify the recommendations following in this report.

9.3 Alternative 2

Alternative 2 consists of constructing the embankment using lightweight fill in lieu of conventional fill. For this alternative, we have performed our analyses assuming the use of a lightweight fill with a weight equal to one half of conventional fill. The reduction in weight means that less total settlement is expected and that controlled fill rates need not be used. However, the amounts of settlement we expect are still large, ranging from 0.4 to 2 meters. We expect 50 percent of the settlement to occur in the first year after construction and that it will take up to 8 years for 90 percent of the consolidation to occur.

As with Alternative 1, additional fill will need to be placed in order to compensate for the settlement that occurs. Assuming that lightweight material is utilized, the anticipated total thickness of fill required to achieve the desired grade is expected to average approximately 3.5 meters. If the fill placed to maintain the design grade consists of conventional fill or AC leveling overlays, significantly larger settlements will occur and a total fill thickness approaching those of Alternative 1 should be expected.

We expect that the existing roadway will experience similar settlement-related damage as expected with Alternative 1, only to a lesser extent. We expect approximately 0.3 m of differential settlement to occur during construction, which will likely necessitate AC leveling operations. As with Alternative 1, overlays placed for leveling and routine maintenance will result in approximately 0.5 meter of settlement for each meter of overlay placed. We anticipate that the culverts will experience differential settlements resulting in damage to the roadway.

The advantage of placing lightweight fill in lieu of conventional fill is that construction of the embankment can proceed without interruption. Long-term performance of the lightweight embankment is expected to be similar to the conventional fill. However, lightweight fill costs significantly more than conventional fill. As such, this Office does not recommend this alternative because the long-term performance level is expected to be inadequate for the cost of construction. Maintenance costs for this alternative are expected to be similar to that expected for Alternative 1. If this alternative were selected,

this Office should be contacted in order to modify the recommendations following in this report.

9.4 Alternative 3

Alternative 3 consists of surcharging the foundation by placing additional fill and accelerating the consolidation with wick drains. Wick drains are prefabricated drains, which are installed vertically through saturated compressible soils to facilitate accelerated drainage of pore water. The accelerated drainage will result in accelerated primary consolidation, which ultimately allows faster construction rates with improved results. The use of wick drains will minimize post-construction settlement-related damage to the structural section. For this project, the wick drains should be installed to the bottom of the clay layers as depicted on our idealized subsurface profile (Figure 12). The optimum spacing of the wick drains is an equilateral triangle with 1.5-meter spacing. This spacing will allow for the primary consolidation rate of the clay to be similar to the anticipated rate of the peat, and allow for a reasonable construction rate.

Surcharge loading will assist in further speeding up the consolidation of the foundation soils. As discussed by Mesri, Stark, Ajlouni, and Chen (1997) and others, surcharging also allows for a reduction in the secondary consolidation of the peat. Surcharging will consist of building the embankment under controlled construction rates to a thickness of seven meters and leaving the surcharge until nearly all of the primary consolidation of the foundation has occurred, approximately six months. After most of the primary consolidation is complete, the fill will be removed to subgrade elevation and, after a rebound period of 2 weeks, the roadway structural section will be constructed. Figure 13 shows a typical section view of the staging of construction for this alternative.

The rate of embankment construction will need to be controlled in order to maintain embankment stability during construction. Fill should be placed following installation of the wick drains, fabrics and permeable layer. The initial 2 meters of fill thickness should be stable regardless of the rate of construction. After placement of the first 2 meters of fill thickness, the embankment should be constructed at a maximum rate of 0.3 meters vertically in any seven calendar days until the required thickness is placed. An instrumentation program, described later in this report, will be used to verify that the embankment is constructed to the correct fill thickness and that stability is maintained through construction.

Based on our settlement analyses, the majority of primary consolidation will occur in approximately 4 months after completion of fill placement to the full surcharge thickness. Because of the variation in thickness and compressibility characteristics of the underlying soils, the settlements occurring during construction and surcharging are expected to range from 1 m to a maximum of 4 meters along the length of the project.

We estimate that during the construction and surcharging of the new embankment, a maximum of 0.5 meters of settlement is expected to occur at the existing edge of pavement. At the existing centerline, less than 0.1 meters of settlement is expected. This

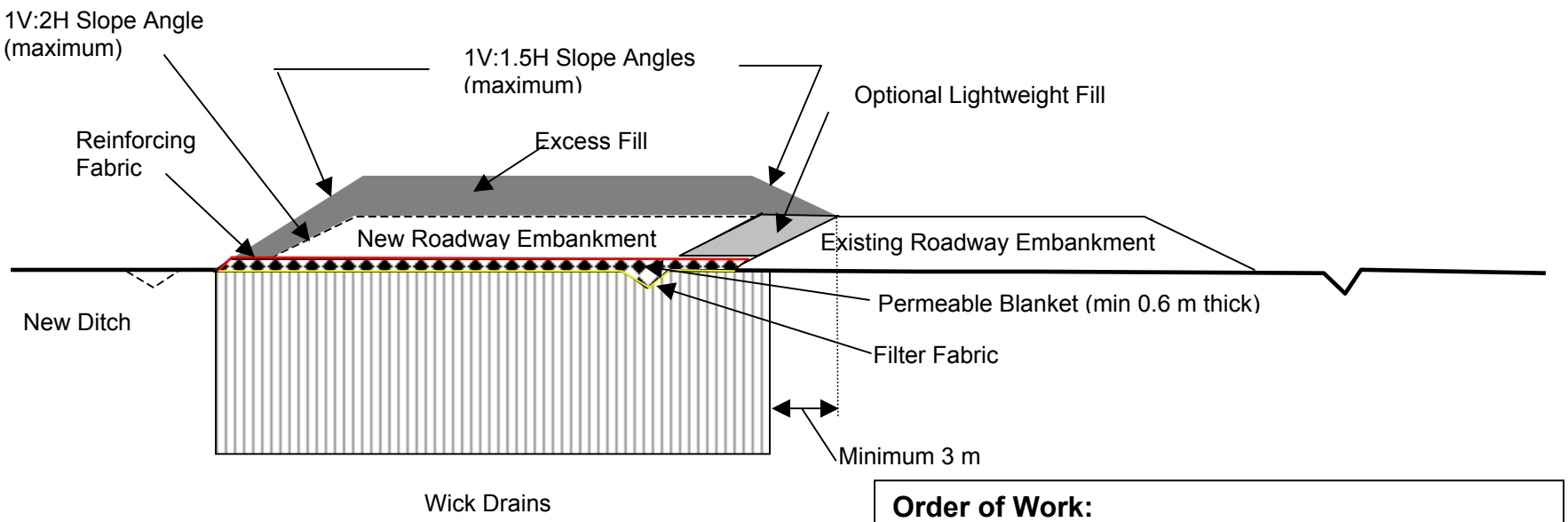
differential settlement would likely necessitate that at least one AC leveling overlay be placed to maintain the existing traveled way. In order to minimize this anticipated damage, lightweight fill could be placed in the wedge between the slope of the existing embankment and the new fill prism as shown in Figure 15. This lightweight fill would reduce the anticipated settlement damage to the existing roadway, however, not eliminate it, so AC leveling might still be necessary although to a lesser extent. We anticipate that the lightweight wedge would reduce settlements of the existing roadway by up to 50 percent.

At the culvert locations, special considerations are required to avoid the significant damage from differential settlement that the existing roadway has experienced. Prior to placement of the surcharge fill, the existing culverts should be extended with flexible plastic piping beyond the footprint of the fill in order to keep them operational during surcharging. The wick drains and surcharge fill should be placed in the same manor as the rest of the project. After the completion of the settlement period, the entire fill section should be removed to grade on either side of each culvert. The width of the excavation should be a minimum of 30 meters and the side slopes of the fill towards the excavation should be no steeper than 1:3 (V:H) to control differential settlements. The culverts should then be extended permanently. While differential settlements between the existing culvert and new extension will be minimized by this treatment, we do anticipate some amount of differential settlement to occur between the two. To compensate for this differential settlement, we recommend that a flexible connector be used to connect the two. The connection should be able to accommodate a differential settlement of 0.1 meters. The excavation around the culvert should be backfilled with lightweight fill.

The settlement mitigation proposed for this alternative will account for the majority of the settlement occurring prior to placement of the new roadway. However, settlement due to secondary consolidation will still occur long after project completion. We approximate settlement due to secondary consolidation will be up to 0.4 meters at the worst sections of the project. Approximately 50 percent of this secondary consolidation will occur in the first 2 years after construction is completed. A further drawback to this alternative is that much of the site will only be slightly overconsolidated; meaning that, as road rehabilitation and overlay work is performed in the future, additional weight added to the roadway could result in relatively large settlements which would, in turn, damage the roadway. After time, as normal roadway maintenance is performed, sections of the new highway lanes could be in much the same condition as the current lanes. If this alternative were to chosen, we recommend that the weight of future overlays be offset by removal of an equal amount of AC by grinding.

9.5 **Alternative 4**

Alternative 4 includes the same wick drain treatment and initial embankment surcharging recommendations as included in Alternative 3. This alternative differs from Alternative 3 in that it utilizes lightweight fill along the entire length of project to achieve a larger amount of net surcharging than Alternative 3. The recommended spacing of the wick



Order of Work:

1. Place filter fabric, 600 mm thick permeable drainage blanket.
2. Install wick drains to bottom of clay layer (expected maximum depth of installation 14 m) with equilateral triangular spacing of 1.5 m on center.
3. Install instrumentation.
4. Place high strength reinforcing fabric.
5. Place 1.4 m thickness of fill.
6. Place fill at max rate of 0.3 m of fill per week up to max height of 7 m.
7. Wait approximately 6 months for primary consolidation.
8. Remove excess fill down to roadway subgrade.
9. Construct new structural section.

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Schematic of Alternative 3

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Figure No. 13

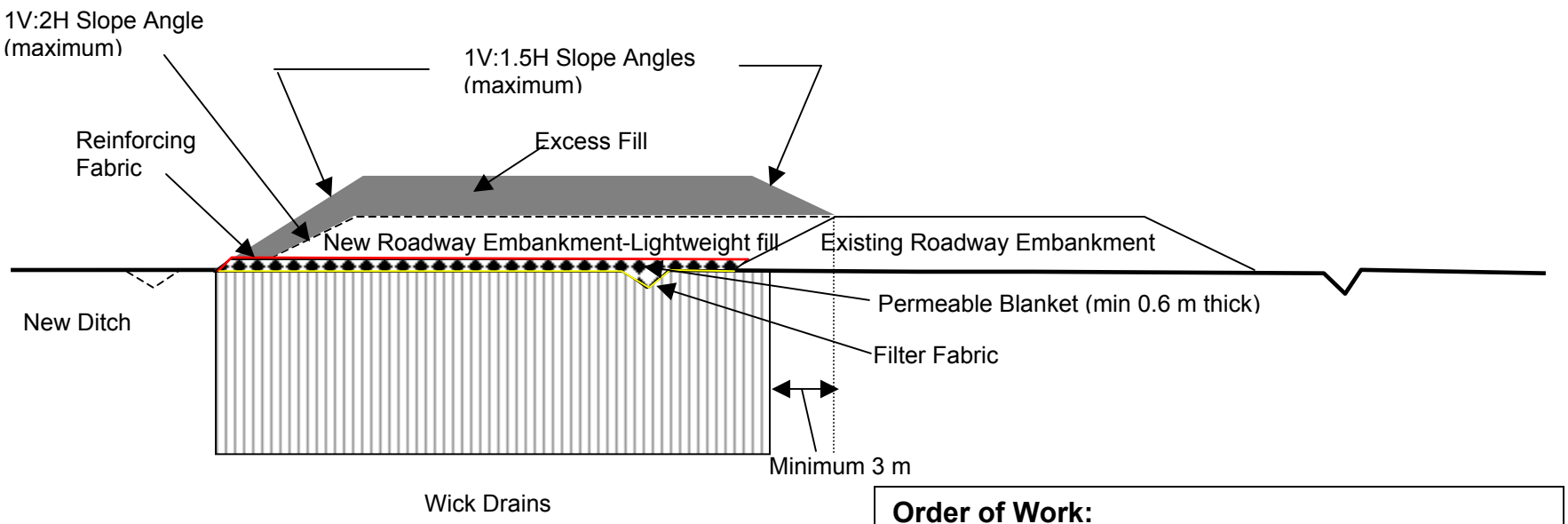
drains is the same (1.5 meters), as is the allowable fill thickness (7 meters) and rate for the initial construction of the embankment. After waiting primary consolidation to essentially complete, the fill will be removed to the original grade elevation and a new embankment would be constructed using lightweight fill. We estimate that approximately 3.5 to 5 meters of the 7 meters of fill placed would actually be removed, as the remainder of the fill would have settled to an elevation below original grade. The culverts should be treated in much the same way as with Alternative 3. Figure 16 shows a representation of the staging of work at a typical section.

The proposed instrumentation and monitoring program is the same for both Alternatives 3 and 4. The primary consolidation occurring during construction and surcharging periods would be the same as with Alternative 3. Placement of lightweight fill could be begun immediately after the fill is removed to original ground. The rate of construction of the lightweight fill would not need to be controlled. A short wait period (approximately 2 weeks) should be allowed between construction of the lightweight fill embankment and placement of the structural section to account for any reloading settlement.

While the removal of the entire original fill and replacement with lightweight fill makes this alternative significantly more expensive than Alternative 1, it has significant advantages in expected performance level of the new embankment. A much larger amount of overconsolidation will be achieved using the methods of Alternative 4. This will result in significantly smaller amounts of secondary consolidation over the lifetime of the highway. We anticipate less than 0.1 m of settlement after construction of the structural section. Furthermore, future maintenance should be minor when compared with the anticipated maintenance required if Alternative 3 were selected.

9.6 Alternative 5

The fifth alternative presented combines aspects of both Alternatives 3 and 4. While we anticipate that the methods presented in Alternative 3 will produce satisfactory roadway performance over the majority of the embankment length, we believe that less than desirable results may exist in limited areas. Alternative 5 proposes additional improvements to those areas that would otherwise under perform. Additional improvement to those areas would consist of removal and replacement of select amounts of conventional fill with lightweight fill. Using this methodology, we would achieve a minimum net surcharge for the entire project length, thereby minimizing differential settlements and related maintenance costs. Based on our analyses, we believe that a minimum of 1.5 meters of effective surcharge is required to obtain a desirable level of long-term performance. In order to assure that this minimum level of effective surcharge is obtained, those areas that have experienced a settlement greater than 3 meters upon completion of the settlement period should have further improvement. For those areas, we recommend that 2 meters of lightweight fill replace each meter of fill that settles in excess of 3 meters. The instrumentation program discussed later in this report has been developed in order to efficiently identify those areas of concern and allow for implementation of this strategy. Table 4 presents an estimation of locations and



Order of Work:

1. Place filter fabric, 600 mm thick permeable drainage blanket.
2. Install wick drains to bottom of clay layer (expected maximum depth of installation 14 m) with equilateral triangular spacing of 1 m on center.
3. Install instrumentation.
4. Place high strength reinforcing fabric.
5. Place 1.4 m thickness of fill.
6. Place fill at max rate of 0.3 m of fill per week up to max thickness of 7 m.
7. Wait approximately 6 months for primary consolidation.
8. Remove excess fill down to original ground.
9. Place lightweight aggregate to subgrade level.
10. Construct new structural section.

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Schematic of Alternative 4

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Figure No. 14

quantities of lightweight fill placement. We caution that actual settlements could vary from those predicted resulting in changes to the limits and quantities of lightweight fill placement.

Table 4: Recommended Placement of Lightweight Fill

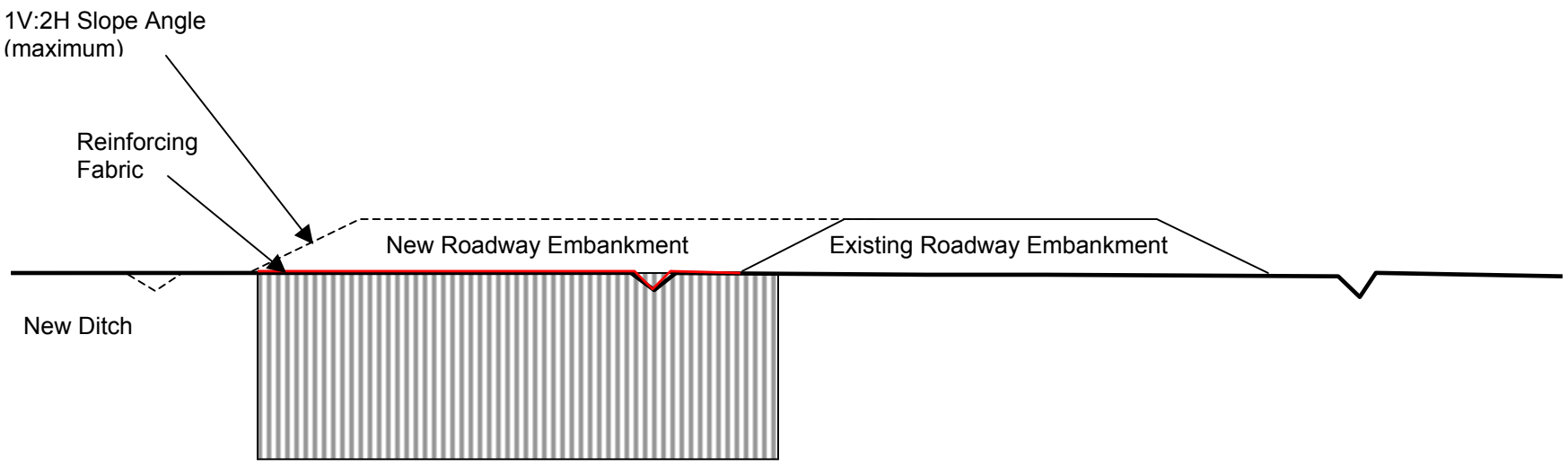
Station Limits	Anticipated Settlement	Required Fill Removal	Thickness of Lightweight Fill
6+50–10+00	4 m	2.5 m	2 m
10+00–23+50	3.5 m	2 m	1 m

Settlements during construction and surcharging would be the same as Alternatives 3 and 4. We anticipate that the post construction settlements would be less than 0.1 meter, and differential settlements would be minimal. Settlements resulting from regular maintenance overlays should also be minimal. We anticipate the same damage to the existing highway as with Alternatives 3 and 4, and as with those alternatives, we expect virtually all the damage to occur during the construction and surcharge periods. Lightweight fill placed in a wedge along the slope of the existing embankment should be considered as a method of mitigating this anticipated damage.

9.7 Alternative 6

The sixth and final alternative consists of deep mixing below the entire embankment fill. Deep mixing consists of improving the foundation soils by mixing them with binders. This methodology would increase the in situ strengths and decrease the compressibility of the foundation soils without surcharging, excavation or removal. Using the deep mixing alternative, the settlement under the new and existing embankment fills will be minimal. This alternative would allow for construction of the embankment without the rate of construction being controlled.

In deep mixing, cementatious materials are mixed with the in place soils to create columns of strengthened soil. Materials used as mixing agents are typically cement and lime. Mixing is obtained with specially designed equipment equipped with paddles and augers. As the paddles and augers are drilled into the subsurface, the binder is injected into the soil and mixed to create columns of treated soil. Since the soil columns are dramatically stiffer than the surrounding soil, they will carry a majority of the applied load from the new embankment to the bearing layers. The need for wick drains or surcharge loading is not required for this alternative. The expected final roadway product should be similar to what Alternative 5 will achieve. The settlement below the existing highway due to added embankment load should be minimal, as the strengthened soil-cement columns distribute stresses to the sand layer. The construction period for this alternative will be similar to that of the other two alternatives as construction rates are not controlled and surcharging is not required, however, the time required to perform the deep mixing is considerable. Figure 17 shows a typical section view of the planned mixing program for Alternative 6.



Order of Work:

1. Perform deep mixing through peat and clay layers (maximum depth of mixing approximately 14 m).
2. Allow curing time for columns to gain full design stiffness.
3. Place fill to subgrade level.
4. Construct new structural section.

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Schematic of Alternative 6

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Figure No. 15

Advantages of using deep mixing are that far less fill will be required for the site meaning that truck traffic related to importing and exporting the fill will be significantly reduced. In addition, the deep mixing alternative will limit settlement to the existing embankment, thereby eliminating the need for AC leveling overlays during construction. We anticipate that worker exposure to traffic would be minimized if this alternative were selected.

The disadvantages to this alternative are that deep mixing is still considered an emerging technology locally, and only a limited number of specialty contractors perform this work. Because only a limited number of contractors perform deep mixing locally, costs of this method are much higher than conventional methods. Based on our estimates and cost estimates performed by District 10 Design staff, the cost of soil mixing alternative is roughly 5 times the cost of Alternative 3 and 2.5 to 3 times the cost of Alternative 4. A significant amount of spoils are created by the mixing procedures. Approximately 30 percent of the volume of the treated columns will be spoil material. Because the spoil will be intermixed with deleterious material and fines it is not suitable as construction fill material for this project and must be off hauled.

9.8 Embankment Fill

All permanent embankments should be sloped at 1:2 (V:H). Temporary embankments can be constructed to 1:1.5 (V:H) slopes. If either Alternative 3, 4 or 5 is selected, a nonwoven geotextile filter fabric, a permeable drainage blanket, wick drains, geotechnical instrumentation, and high strength geotextile reinforcement fabric should be placed prior to placement of the fill. The drainage blanket should have a minimum thickness of 0.6 m. The wick drains, as previously described, should be installed vertically through the drainage blanket and extend to the elevation of the top of the dense silty sand. The geotextile filter and reinforcement fabrics should meet the requirements in the attached special provisions in Appendix C. If either Alternative 4 or 5 is selected, after removal of the surcharge load, another high strength geotextile reinforcement should be placed prior to adding the lightweight fill. If Alternative 6 is selected, only the high strength geotextile reinforcement will be required below the fill embankment.

We recommend the lightweight fill consist of rotary kiln expanded shale of the extruded type, or a processed, naturally occurring volcanic fill. The maximum calculated saturated surface dry unit weight should be no more than 960 kg/m^3. Other material properties and construction requirements are presented in Appendix C. Other lightweight fill materials are available such as expanded polystyrene (EPS), foamed concrete, shredded tires and wood fiber. Each of these materials requires special considerations, especially if they could become submerged, which we understand is a possibility at this site. EPS and foamed concrete are extremely light materials and as such are subject to buoyant forces if placed below the water table. Additionally, EPS dissolves if subjected to petroleum products necessitating special encapsulation considerations to protect the product. Shredded tires have ignition problems and it is believed that they also leach heavy metals. To prevent leaching, shredded tire fills are nearly always kept above the water table. Wood fiber fill needs to be completely separated from water, as the leachate is acidic as well as potentially contaminated with toxins. Wood fiber will degrade if subjected to wet

dry cycles. Given the specifics of this project, we recommend that these products not be considered. However, if one of these alternative lightweight fill products is selected, this Office should be contacted to provide specific recommendations suited to that fill product.

Cross sections provided by District 10 Design staff shows widening of the existing fill embankment by placing a sliver fill, approximately 1 m wide, along the northern side of the highway. It is our understanding that the relatively recent roadway rehabilitation project included widening of the existing shoulders with a similar sliver fill. This new fill has either slumped off or settled so much that it no longer exists. In general, sliver fills in soft ground conditions do not have very good long-term performance. In order to achieve the same ultimate embankment width, this fill could be added to the south side of the highway along the sections where the new embankment will be placed. This would essentially require the same amount of fill, but eliminate many of the problems associated with sliver fills. This would likely require restriping of the highway and possibly acquisition of additional right of way, however, the ultimate product would be improved.

In lieu of performing all widening on the south side of the highway, the widening of the shoulders could be achieved using a similar approach to the rest of the fill. In addition to wick drains, surcharging and use of lightweight fill, we recommend that the fills be built by overbuilding the fill and then cutting back after consolidation to the final slope face. Overbuilding the fill slope will allow for better compaction of the final slope face, and work to limit erosion. We recommend that any fill placed should have a minimum overbuild width of 3 meters. This means that overbuilding would waste a significant amount of lightweight fill. Additionally, since the surcharge loading is expected to cause large settlements to the existing roadway, construction on both sides of the highway will result in damage to both existing lanes of roadway.

9.9 Construction Considerations

The proposed construction requires thoughtful planning and execution of the work by the contractor. In this regard, the contractor should be required to submit a comprehensive, detailed work plan. We recommend that the plan be submitted to this Office as well as the project Resident Engineer for approval.

Regular monitoring of the instrumentation is key, as it will allow regulation of the construction rate for staged filling placement. If the rate of construction is too fast and pore pressures are not allowed to significantly dissipate prior to placement of the next layer of fill, failure of the foundation soil may result. Failure of the fill extending into the foundation soil should be avoided, as the shear strengths will be dramatically decreased after a failure requiring expensive remedial measures and/or extensive project delays.

9.10 Future Maintenance

Since the foundation soils underlying the newly widened embankment will have a relatively low overconsolidation, the addition of weight to the embankment should be minimized to limit settlements. Over the lifetime of the new highway lanes, regular

maintenance will require AC pavement overlays. To minimize addition of weight to the embankment by adding AC layers, we recommend that the existing AC be ground down to the same thickness as the proposed lift of AC prior to placement.

9.11 Proposed Roadway Rehabilitation Project

This Office has recently prepared a Preliminary Geotechnical Report, dated June 5, 2001 for a proposed project to rehabilitate the existing highway lanes along this stretch of Route 12. The subject project and the proposed rehabilitation project overlap significantly. The rehabilitation work proposed consists of placing an AC blanket, widening shoulders, performing localized dig-outs, and installing rumble strips. Because of the anticipated damage to the existing roadway, we recommend that the proposed rehabilitation work be performed after the subject project is completed.

10 GEOTECHNICAL INSTRUMENTATION

10.1 General

This section of the report presents geotechnical instrumentation recommendations related to the preferred geotechnical design alternative (Alternative 5) presented earlier in this report. If a different alternative is selected, an appropriate program will be developed for that alternative. We recommend that the contract documents specify that furnishing and installation of the instrumentation be the responsibility of the Contractor. Furthermore we recommend that the payment be made by Force Account methods so that this Office can make modifications as necessary in the field to reflect conditions encountered. Once operational, we anticipate the monitoring efforts will be shared between the Resident Engineer and this Office.

We recommend that four main geotechnical instrumentation stations be located along the project at the following stations: 10+50, 18+00, 33+00, 55+50. Each station should include the following instruments:

- Vibrating wire piezometers (3) installed at various depths to obtain and monitor the increase and subsequent dissipation of excess pore water pressure associated with the placement of fill and subsequent consolidation of the clay layer.

- Fluid settlement gage installed to measure the settlement resulting from consolidation of the underlying foundation soil.

- Slope Inclinometer installed at the toe of the surcharge fill slope to monitor lateral deformation if any occurs.

- Automated data acquisition unit to read and record outputs from the piezometer and fluid settlement gauges.

In addition, we recommend that additional fluid settlement gauges be installed every 250 meters along the project length. These gauges would be monitored manually. The close spacing of these instruments will allow for determination of how much of the site requires removal of the conventional fill and replacement with the lightweight material.

The monitoring proposed will be used to allow the safe placement of fill in stages with the rate controlled by actual rate of foundation soil consolidation and subsequent strength gain. Also, the completion of primary consolidation, which controls how quickly the surcharge fill can be removed, will be verified by settlement and pore pressure measurements. Fluid settlement gauges will additionally allow for verification of the thickness of fill placed for contractor progress payment.

Instrumentation should be installed after placement of the permeable drainage blanket and wick drains but prior to placement of fill. Wires for instrumentation should be placed

in a conduit, buried not less than 0.3 meter below the permeable layer, to protect them from damage during construction.

Due to the critical nature of the geotechnical monitoring proposed, the project specifications should explicitly indicate that the contractor during construction must carefully protect the measurement points/instrumentation. Any instrumentation equipment damaged by the contractor must be immediately replaced prior to work commencement unless the Resident Engineer authorizes work continuance in writing.

We recommend that supplemental funds be allocated for the purchase and installation of the geotechnical monitoring stations. This Office will provide equipment specifications and an estimate of cost for both the purchase and installation of such instrumentation to the District under separate cover.

Further discussion of the geotechnical monitoring program is provided in the following sections. Figure 18 provides a schematic of the instrumentation program recommended.

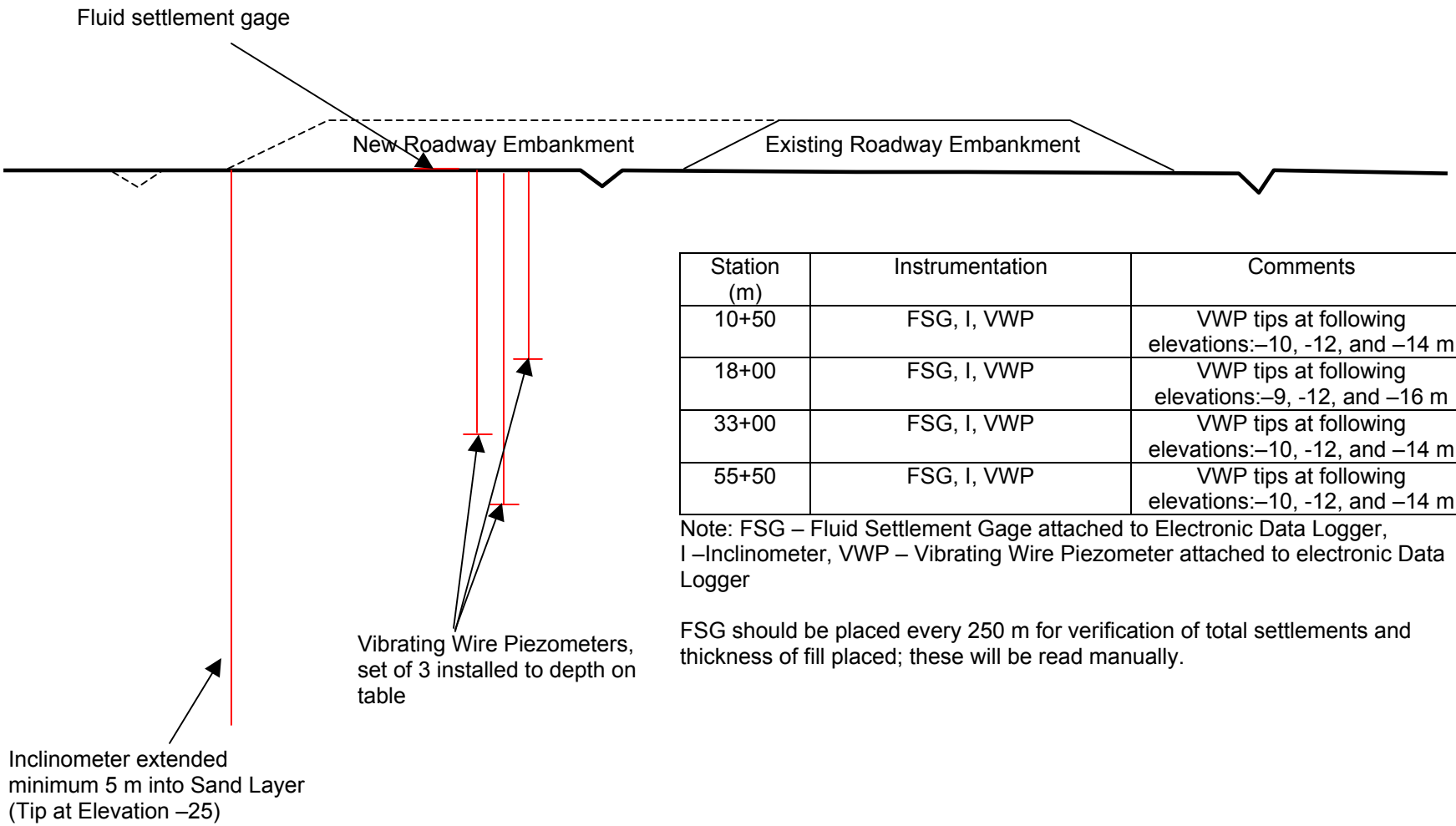
10.2 Pore Pressure Measurements

Vibrating wire piezometers should be installed below the fill to measure the pore pressure and track the changes as fill is added. Since individual piezometers measure pore pressure at a single point, the piezometers should be installed at a minimum of three depths at each location. In addition, some of the piezometer measurement points may be compromised by their proximity to wick drains. Therefore, a minimum of 4 piezometer locations is recommended. Each piezometer should be connected to an automated data acquisition unit.

10.3 Deformation Measurement

In order to measure settlements of the fill, a suite of fluid settlement gages connected to electronic data loggers will be used. These devices will be installed after placement of the gravel drainage blanket and wick drains but prior to placement of fill. Since large amounts of settlement are expected to occur relatively rapidly during construction, surface survey measurements made with control on hubs or stakes will not be reliable for controlling fill thicknesses and rates of filling. The settlement gages should be used to verify fill thicknesses.

The fluid settlement gages should be installed below the center of the fill at each of the same 5 locations where the piezometers are installed. This will allow for correlation between pore pressure dissipation and settlement. Since settlement gages should be used to verify whether removal and replacement with lightweight fill is required, fill thicknesses and filling rates, they should be more regularly spaced. We recommend that they be placed approximately every 250 meter along the project length. Once the fill is placed to full surcharge height, survey points along the fill surface may be established to monitor displacements provided a reliable datum is established.



Station (m)	Instrumentation	Comments
10+50	FSG, I, VWP	VWP tips at following elevations:–10, -12, and –14 m
18+00	FSG, I, VWP	VWP tips at following elevations:–9, -12, and –16 m
33+00	FSG, I, VWP	VWP tips at following elevations:–10, -12, and –14 m
55+50	FSG, I, VWP	VWP tips at following elevations:–10, -12, and –14 m

Note: FSG – Fluid Settlement Gage attached to Electronic Data Logger, I –Inclinometer, VWP – Vibrating Wire Piezometer attached to electronic Data Logger

FSG should be placed every 250 m for verification of total settlements and thickness of fill placed; these will be read manually.

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Geotechnical Services
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Date: January 2002

Schematic of Instrumentation

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Figure No. 16

In addition to the above, inclinometers are recommended along the southern toe of embankment. These inclinometers should be installed after placement of the drainage blanket and wick drains but prior to placement of fill. The inclinometers should extend through the peat and clay a minimum of 3 meters into the underlying silty sand layer. If all inclinometers are installed to approximately Elevation –25 meters, this minimum embedment into the sand should be accomplished. These inclinometers should be installed at the same 4 locations as the fluid settlement gages and the piezometers in order to correlate slope movement at the crest and toe of fill with settlement and pore pressures. The inclinometers will be read manually.

11 RECOMMENDATIONS AND SPECIFICATIONS

11.1 General Specifications

Based on the recommended geotechnical design alternative and subsurface conditions present, the special provision specifications for the proposed geotechnical design consist of the following elements:

- installation of wick drains through the peat and clay underlying the site to accelerate consolidation and allow stable staged construction;
- placement of two types of geotextile providing filtration, separation, and reinforcement functions;
- placement of lightweight aggregate fill;
- placement of surcharge fill; and
- placement of angular gravel drainage blanket.

The special provision specifications proposed will provide the technical design requirements for the various materials including installation procedures, if applicable. In addition, methods of measurement and payment are included for completeness. Suggested specifications for the above elements are provided in Appendix D.

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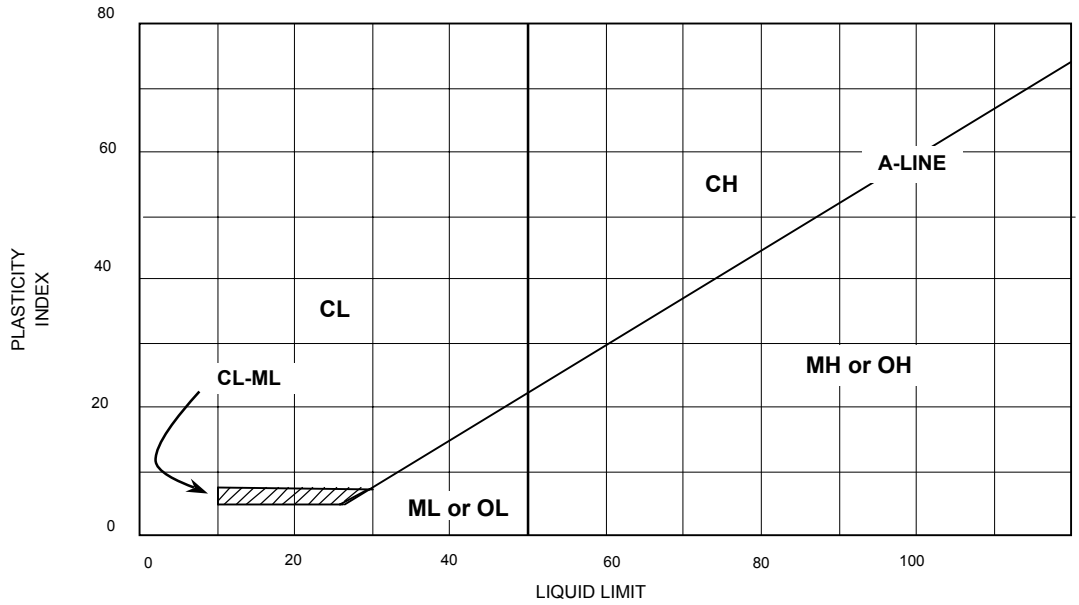
APPENDIX A : LOGS OF TEST BORINGS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISION			SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS Over 50% > #200 sieve	GRAVELS Over 50% > #4 sieve	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS Over 50% < #4 sieve	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	SILTY SANDS, POORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE-GRAINED SOILS Over 50% < #200 sieve	SILTS AND CLAYS Liquid limit < 50		ML	INORGANIC SILTS, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS Liquid limit > 50		MH	INORGANIC SILTS , MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

PLASTICITY CHART
(USED FOR CLASSIFICATION OF FINE-GRAINED SOILS)



SOIL GRAIN SIZE

U.S. STANDARD SIEVE	12"	3"	3/4"	4	10	40	200	
	BOULDERS	COBBLES	GRAVEL		SAND			SILT / CLAY
			COARSE	FINE	COARSE	MEDIUM	FINE	
SOIL GRAIN SIZE (in mm)	300	75	19	4.75	2.0	0.425	0.075	0.005

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EA: 10-0A8400	**SOIL CLASSIFICATION SYSTEM**
Date: Jun-01	
10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)	**PLATE NO.**
GEOTECHNICAL DESIGN REPORT	**A-1**

SAMPLING DATA

TYPE

25 mm (1") O.D. Caltrans One Inch Sampler (NT)	25 mm (1") O.D. Caltrans One Inch Sampler (LT)
51 mm (2") O.D. Standard Penetration Test Sampler (NT)	51 mm (2") O.D. Standard Penetration Test Sampler (LT)
64 mm (2.5") O.D. Modified California Sampler (NT)	64 mm (2.5") O.D. Modified California Sampler (LT)
76 mm (3") O.D. California Sampler (NT)	76 mm (3") O.D. California Sampler (LT)
Shelby Tube (NT)	Shelby Tube (LT)
NQ Size (2.0" ID) Core Barrel (NT)	NQ Size Core Barrel (LT)
HQ Size (2.5" ID) Core Barrel (NT)	HQ Size Core Barrel (LT)
Bulk Sample Collected from Cuttings (NT)	Bulk Sample Collected from Cuttings (LT)

Note: LT=lab testing performed on sample; NT= no lab testing performed on sample

DRIVING DATA

23	23 blows drove sampler 305mm, after initial 152mm of seating
68/203{8}	68 blows drove sampler 203mm {8"}, after initial 152mm of seating
*50/76{3}	50 blows drove sampler 76mm {3"} during seating interval
	(Note: To avoid damage to sampling tools, driving is limited to 50 blows per 152mm interval)
PUSH	Sampler pushed under static load
20@150	20 seconds time @ an average pressure of 150 psi to descend depth interval of 305 mm (1 ft)
	(Note: ## indicates no reading obtained)
NR	Indicates no recovery of material in sampler for entire drive

OTHER SYMBOLS

Water level encountered while drilling (Time/Date)

Water level measured in hole after drilling (Time/Date)

Seepage from sidewall noted

_?_._._?_ Strata boundary inferred without visual confirmation (i.e. no sample or boring cuttings retreval)

TESTING

CONS	Consolidation (Cal Test 219)	L_r	Recovery Ratio (rock cores only)
UU	Uncons. Undrained Triaxial (Cal Test 230)	RQD	Rock Quality Designation (%)
CU	Cons. Undrained Triaxial (Cal Test 230)	CP	Compaction Test (Cal Test 216)
DS	Cons. Drained Direct Shear (ASTM D3080)	PERM	Permeability (Cal Test 220))
UCC	Unconfined Compression (Cal Test 221)	COR	Corrosivity Testing (Cal Test 532/643)
LL	Liquid Limit-% (Cal Test 204)	GRAD	Gradation Analysis (Cal Tests 202/203)
PI	Plasticity Index (Cal Test 204)	EP	Expansion Pressure Test (Cal Test 354)
PP	Pocket Penetrometer	TORV	Pocket Torvane Test
S_u	Undrained Shear Strength: From UU, or one-half the unconfined compressive strength per UCC or PP; Intended as a guideline only and does not address clay content or draining charateristics of material.	60^O	Dip Angle

GENERAL NOTES

1. Logs represent general subsurface conditions observed at the point of exploration on the date indicated.
2. In general, USCS designations presented on logs were established by visual methods only; Therefore, actual designations (based on laboratory tests) may vary.
3. No warranty is provided as to the continuity of soil conditions between individual sample locations.
4. Lines separating strata on the logs represent approximate boundaries only; actual transitions may be gradual.

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-2.5 m**	LOG I.D. **Boring No. 01-1**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **2+76**	APPROX. DISTANCE FROM ROADWAY CL: **17.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Unconfined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SAND, coarse grained, gray to brown, loose, moist	SP		1	9					
	2.44	8		? ?									
				CLAYEY PEAT, medium to dark brown, very soft to soft, moist	Pt		2	1	357				
	3.66	12											
	4.88	16			Pt		3	0					
	6.10	20			Pt		4	4	431				
	7.32	24		? ?									
				SILTY CLAY w/ peat, gray to brown, very soft to soft, moist	CL		5	2					
	8.53	28											
				no peat	CL		6	PUSH	42.9	50	23	4.6	
	9.75	32											
	10.97	36			CL		7	PUSH					
	12.19	40											

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EA:	10-0A8400
Date:	June-01

LOG OF BORING NO. 01-1

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-3**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-2.5 m**	LOG I.D. **Boring No. 01-1 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **2+76**	APPROX. DISTANCE FROM ROADWAY CL: **17.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					CL		8	1	33.9		NP	2.8	
	13.41	44			CL		9	3					
	14.63	48		? ?									
	15.85	52		SILTY SAND, coarse grained, gray, loose to dense, moist	SM		10	PUSH					
	17.07	56			SM		11	22	22.9				
	18.29	60			SM		12	32					
	19.51	64		Bottom of Boring @ 18.75 m									
	20.73	68											
	21.95	72											
	23.16	76											

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Caltrans

EA:	10-0A8400
Date:	June-01

LOG OF BORING NO. 01-1

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-4**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-3.5 m**	LOG I.D. **Boring No. 01-2**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J. Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **5+50**	APPROX. DISTANCE FROM ROADWAY CL: **11.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY SAND w/ clay and peat lenses, blueish gray, loose to medium dense, moist	SM		1	14	18.9				vane shear test undisturbed ~1920 psf remolded not performed
	2.44	8											
					SM		2	1					
	3.66	12		? ?									vane shear test undisturbed ~1210 psf remolded ~260 psf
	4.88	16		CLAYEY PEAT, dark brown, very soft, moist	Pt		3	1					
	6.10	20		? ?									
				SILTY CLAY w/ peat, gray, very soft to stiff, moist	CL		4	PUSH					vane shear test undisturbed ~1180 psf remolded ~80 psf
	7.32	24											
				no peat, turning greenish gray	CL		5	PUSH	41.5	40	14	1.5	
	8.53	28											
					CL		6	PUSH					
	9.75	32											vane shear test undisturbed ~1070 psf remolded ~290 psf
	10.97	36			CL		7	PUSH	39	40	13		
	12.19	40											

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EA: 10-0A8400
Date: June-01

LOG OF BORING NO. 01-2

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-5**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-3.5 m**	LOG I.D. **Boring No. 01-2 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J. Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **5+50**	APPROX. DISTANCE FROM ROADWAY CL: **11.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					CL		8	PUSH					vane shear test undisturbed ~1580 psf remolded ~340 psf
	13.41	44		? ?									
				SILTY SAND, medium to coarse grained, gray, medium dense, moist	SM		9	22					
	14.63	48											
					SM		10	14					
	15.85	52											
	17.07	56			SM		11	17					
	18.29	60											no sample taken
				Bottom of Boring @ 18.75 m Installed 1" slotted PVC pipe to bottom of hole to monitor water table, at time of boring water was protruding from top of hole								
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

Caltrans

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EA: 10-0A8400
Date: June-01

LOG OF BORING NO. 01-2

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-6**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.8 m**	LOG I.D. **Boring No. 01-3**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **8+13**	APPROX. DISTANCE FROM ROADWAY CL: **13.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	1	400				
	2.44	8			Pt		2	0	499				
	3.66	12			Pt		3	PUSH					
	4.88	16											
	6.10	20		? ?	CL		4	PUSH					
	7.32	24		SILTY CLAY w/ trace peat, dark brown, very soft, moist	CL		5	PUSH	57.4	52	22		
	8.53	28											
	9.75	32			CL		6	2	36.1		NP		
	10.97	36		SILTY SAND, dark gray, loose, moist	SM		7	6					
	12.19	40		SANDY CLAY, dark gray, soft, moist ? ?	CL								

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.8 m**	LOG I.D. **Boring No. 01-3 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **8+13**	APPROX. DISTANCE FROM ROADWAY CL: **13.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY SAND, coarse grained, dark gray, medium dense, moist	SM		8	19	27.5				
	13.41	44			SM		9	22					
	14.63	48			SM		10	16	27.3				
	15.85	52			SM		11	20					
	17.07	56			SM		12	22					
	18.29	60		Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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PLATE NO. **A-8**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.9 m**	LOG I.D. **Boring No. 01-4**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **11+50**	APPROX. DISTANCE FROM ROADWAY CL: **14.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	1					
	2.44	8											
	3.66	12			Pt		2	0					
				? ?									
	4.88	16		SILTY CLAY, dark gray to black, very soft, moist	CL		3	PUSH					
	6.10	20			CL		4	PUSH					
	7.32	24			CL		5	PUSH					
	8.53	28			CL		6	PUSH	40.2	48	22	5.5	
	9.75	32		? ?									
	10.97	36		SILTY SAND, coarse grained, dark gray, loose to medium dense, moist	SM		7	10					
	12.19	40											

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LOG OF BORING NO. 01-4

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-9**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.9 m**	LOG I.D. **Boring No. 01-4 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **11+50**	APPROX. DISTANCE FROM ROADWAY CL: **14.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SM		8	12					
	13.41	44		? ?									
				SAND, coarse grained, light gray, medium dense, moist	SP		9	19					
	14.63	48		? ?									
				SILTY SAND, fine grained, light gray, medium dense, moist	SM		10	16					
	15.85	52											
	17.07	56		less silt, coarser grains	SM		11	41					
	18.29	60		more silt	SM		12	15					
	19.51	64		Bottom of Boring @ 18.75 m									
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.8 m**	LOG I.D. **Boring No. 01-5**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **14+80**	APPROX. DISTANCE FROM ROADWAY CL: **13.8 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY PEAT, dark brown to black, very soft, moist	Pt		1	1	426				
	2.44	8			Pt		2	1					
	3.66	12		? ?									
	4.88	16		SILTY CLAY, dark gray to black, very soft to very stiff, moist	CL		3	PUSH					
	6.10	20			CL		4	PUSH	45.3	36	6	2.2	
	7.32	24			CL		5	PUSH					
	8.53	28			CL		6	PUSH	45.8	44	16	2.2	
	9.75	32			CL		7	20					
	10.97	36											
	12.19	40											

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PLATE NO. **A-11**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.8 m**	LOG I.D. **Boring No. 01-5 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/8/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **14+80**	APPROX. DISTANCE FROM ROADWAY CL: **13.8 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					CL		8	PUSH	27.4	41	18	12.6	
	13.41	44		? ?									
				CLAYEY SAND, coarse grained, dark gray, medium dense, moist	SC		9	30					
	14.63	48		? ?									
	15.85	52		SILTY SAND, coarse grained, dark gray, medium dense, moist	SM		10	19	24.4				
				? ?									
	17.07	56		SILTY CLAY, dark gray, very stiff, moist	CL		11	26					
	18.29	60		? ?									
				SILTY SAND, dark gray, medium dense, moist	SM		12	30					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-6**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **17+75**	APPROX. DISTANCE FROM ROADWAY CL: **13.7 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	0	421				
	2.44	8		? ?	Pt		2	1					
	3.66	12		SILTY CLAY, dark gray, very soft to firm, moist									
	4.88	16			CL		3	1					
	6.10	20			CL		4	PUSH	42.5	36	7	2.9	
	7.32	24			CL		5	1					
	8.53	28			CL		6	PUSH	65.6	52	22	3.9	
	9.75	32			CL		7	3					
	10.97	36											
	12.19	40											

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PLATE NO. **A-13**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-6 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **17+75**	APPROX. DISTANCE FROM ROADWAY CL: **13.7 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					CL		8	PUSH	25.9	37	18	14.1	
	13.41	44		? ?									
				CLAYEY SAND, dark gray, medium dense, moist	SC		9	17					
	14.63	48		? ?									
	15.85	52		SILTY SAND, fine grained, dark gray, medium dense, moist	SM		10	29					
				? ?									
	17.07	56		CLAYEY SAND, fine grained, dark gray, very dense, moist	SC		11	65	24.2				
	18.29	60		? ?									
				SILTY CLAY, dark gray, firm, moist	CL		12	6					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-7**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **21+01**	APPROX. DISTANCE FROM ROADWAY CL: **15.4 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	PUSH					
	2.44	8											
					Pt		2	PUSH	302				
	3.66	12		? ?									
	4.88	16		SILTY CLAY w/ roots, gray, very soft to firm, moist	CL		3	PUSH					
	6.10	20			CL		4	PUSH	43.5	38	9	1.1	vane shear test undisturbed ~610 psf remolded ~200 psf
	7.32	24											
					CL		5	PUSH	50.1		NP	3.8	
	8.53	28											
					CL		6	PUSH					
	9.75	32											
	10.97	36			CL		7	PUSH	43.3	50	26	1.4	vane shear test undisturbed ~950 psf remolded ~320 psf
	12.19	40											

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PLATE NO. **A-15**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-7 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **21+01**	APPROX. DISTANCE FROM ROADWAY CL: **15.4 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				CLAYEY SAND, gray, medium dense, moist	SC		8	PUSH					
	13.41	44		SILTY CLAY, gray, very stiff, moist	CL		9	PUSH	34.4	54	36	4.6	vane shear test undisturbed ~1840 psf remolded not performed
	14.63	48		? ?									
	15.85	52		CLAYEY SAND, gray, loose to medium dense, moist	SC		10	5					
	17.07	56			SC		11	9	37.0				
	18.29	60		less clay	SC		12	21					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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PLATE NO. **A-16**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.9 m**	LOG I.D. **Boring No. 01-8**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **23+58**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	1	176				
	2.44	8		? ?									
				SILTY CLAY, dark gray, very soft to soft, moist	CL		2	1					
	3.66	12											
	4.88	16			CL		3	1					
	6.10	20			CL		4	PUSH	36.7	33	4	1.6	
	7.32	24		? ?									
				SILTY SAND, dark gray, loose, moist	SM		5	PUSH					
	8.53	28		? ?									
				SANDY CLAY, dark gray, firm to stiff, moist	CL		6	8					
	9.75	32											
	10.97	36			CL		7	13					
	12.19	40											

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PLATE NO. **A-17**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-3.9 m**	LOG I.D. **Boring No. 01-8 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **23+58**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY SAND, coarse grained, dark gray, loose, moist	SM		8	PUSH					
	13.41	44		? ?									
				SANDY CLAY, dark gray, stiff, moist	CL		9	11					
	14.63	48		? ?									
				CLAYEY FINE SAND, fine grained, dark gray, medium dense, moist	ML		10	19					
	15.85	52											
	17.07	56			ML		11	26	26.2				
	18.29	60			ML		12	13					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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PLATE NO. **A-18**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-2.1 m**	LOG I.D. **Boring No. 01-9**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **26+42**	APPROX. DISTANCE FROM ROADWAY CL: **17.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	0					
	2.44	8		? ?									
				CLAYEY SAND, fine grained, dark gray, loose, moist	SC		2	2					
	3.66	12		? ?									
	4.88	16		SILTY CLAY, dark gray, very stiff, moist	CL		3	24					
	6.10	20			CL		4	PUSH	23.5	56	31	21.5	
	7.32	24		? ?	CL		5	30					
	8.53	28		SILTY SAND, dark gray, medium dense to very dense, moist	SM		6	66	20.3				
	9.75	32											
	10.97	36			SM		7	42					
	12.19	40											

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PLATE NO. **A-19**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-2.1 m**	LOG I.D. **Boring No. 01-9 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **26+42**	APPROX. DISTANCE FROM ROADWAY CL: **17.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SM		8	38					
	13.41	44		? ?									
					SP		9	40	26.9				
	14.63	48											
					SP		10	34					
	15.85	52		Bottom of Boring @ 15.70 m									
	17.07	56											
	18.29	60											
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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Date:	June-01

LOG OF BORING NO. 01-9

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-20**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-10**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **29+27**	APPROX. DISTANCE FROM ROADWAY CL: **18.2 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	1	550				
	2.44	8											
	3.66	12		? ?	Pt		2	PUSH	477				
	4.88	16		CLAYEY SAND, gray, loose to medium dense, moist	SC		3	PUSH					
	6.10	20			SC		4	16					
	7.32	24		more clay	SC		5	30					
	8.53	28											
	9.75	32		less clay	SC		6	23	20.9				
	10.97	36			SC		7	23					
	12.19	40											

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LOG OF BORING NO. 01-10

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-21**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-10 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/9/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **29+27**	APPROX. DISTANCE FROM ROADWAY CL: **18.2 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SC		8	21					
	13.41	44			SC		9	23	21.3				
	14.63	48			SC		10	22					
	15.85	52		Bottom of Boring @ 15.70 m Installed 1" slotted PVC pipe to bottom of hole to monitor water table, at time of boring water was 0.91 m (3 ft) from top of hole									
	17.07	56											
	18.29	60											
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-22**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-11**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **32+03**	APPROX. DISTANCE FROM ROADWAY CL: **15.2 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	0	153				
	2.44	8			Pt		2	1					
	3.66	12			Pt		3	PUSH					
	4.88	16											
	6.10	20		? ? SILTY CLAY, blueish gray, stiff, moist	CL		4	16					
	7.32	24		trace sand	CL		5	18	37.6	37	5	4.0	
	8.53	28			CL		6	12					
	9.75	32		? ?									
	10.97	36		SILTY SAND, medium to coarse grained, gray, medium dense, moist	SM		7	PUSH					
	12.19	40											

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10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-23**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-11 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **32+03**	APPROX. DISTANCE FROM ROADWAY CL: **15.2 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SM		8	15					
	13.41	44		? ?									
					SP		9	26					
	14.63	48											
					SP		10	14					
	15.85	52		? ?									
	17.07	56		CLAYEY SILT, gray, loose, moist	ML		11	5					
	18.29	60		? ?									
				SAND, coarse grained, gray, loose, moist	SP		12	9					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-24**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-12**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **35+17**	APPROX. DISTANCE FROM ROADWAY CL: **16.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown, very soft, moist	Pt		1	PUSH					
	2.44	8		? ?									
				SANDY CLAY, gray, very soft to stiff, moist	CL		2	1					
	3.66	12											vane shear test undisturbed ~1940 psf remolded ~565 psf
	4.88	16		trace organics	CL		3	PUSH	27.5	26	6	2.4	
	6.10	20		trace claystone fragments	CL		4	16					
	7.32	24		? ?									
				CLAYEY SILT, light to medium brown, loose, moist	ML		5	9	30.9	32	12	4.8	
	8.53	28											vane shear test undisturbed ~1800 psf remolded not performed
				mottled w/ rust and dark brown	ML		6	8					
	9.75	32		? ?									
	10.97	36		SILTY SAND, fine grained, medium brown to gray, loose to medium dense, moist	SM		7	22					
	12.19	40											

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LOG OF BORING NO. 01-12

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-25**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.1 m**	LOG I.D. **Boring No. 01-12 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/10/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **35+17**	APPROX. DISTANCE FROM ROADWAY CL: **16.1 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SM		8	7					
	13.41	44			SM		9	15	35.0			3.1	
	14.63	48			SM		10	PUSH					
	15.85	52		? ?									
	17.07	56		SILTY CLAY, blueish gray, firm, moist	CL		11	PUSH					
	18.29	60			CL		12	7					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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LOG OF BORING NO. 01-12

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-26**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-13**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/7/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **38+20**	APPROX. DISTANCE FROM ROADWAY CL: **15.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	1	336				
	2.44	8			Pt		2	1					
	3.66	12		? ?									
	4.88	16		SILTY CLAY, greenish gray, stiff to hard, moist	CL		3	15					
	6.10	20		medium brown mottled w/ gray	CL		4	75	18.3		NP	6.0	
	7.32	24		? ?									
				SILTY SAND, light brown to light gray, medium dense, moist	SM		5	23					
	8.53	28			SM		6	15					
	9.75	32											
	10.97	36		CLAYEY SAND, medium brown to dark gray, medium dense, moist	SC		7	PUSH	20.8			3.0	
	12.19	40											

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-27**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-13 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/7/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **B. Barnes**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **38+20**	APPROX. DISTANCE FROM ROADWAY CL: **15.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				less clay	SC		8	17					
	13.41	44		? ?									
				SANDY SILT, greenish gray, medium dense, moist	ML		9	15					
	14.63	48											
				trace clay	ML		10	16	42.2				
	15.85	52		? ?									
	17.07	56		CLAY, dark gray, soft to firm, moist	CL		11	8					
	18.29	60		trace silt	CL		12	3					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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LOG OF BORING NO. 01-13

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-28**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.5 m**	LOG I.D. **Boring No. 01-14**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/3/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **40+65**	APPROX. DISTANCE FROM ROADWAY CL: **16.4 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	0	440				
	2.44	8			Pt		2	PUSH					
	3.66	12		? ?									
	4.88	16		SILTY SAND, greenish gray, medium dense, moist	SM		3	13					
	6.10	20		? ?									
				SANDY SILTY CLAY, greenish gray, firm to very stiff, moist	CL		4	15					
	7.32	24		medium brown mottled w/ rust	CL		5	14					
	8.53	28		medium brown mottled w/ rust	CL		6	PUSH	27.9	25	3	5.0	
	9.75	32											
	10.97	36		medium brown mottled w/ rust	SC		7	22	27.4	28	6	9.4	
	12.19	40											

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-29**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.5 m**	LOG I.D. **Boring No. 01-14 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/3/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **40+65**	APPROX. DISTANCE FROM ROADWAY CL: **16.4 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				greenish brown	CL		8	5					
	13.41	44		? ?									
				SILTY SAND, blueish gray, loose to medium dense, moist	SM		9	8					
	14.63	48			SM		10	15	38.7				
	15.85	52		? ?									
	17.07	56		SANDY SILTY CLAY, blueish gray, very soft, moist	CL								no sample taken rods filled w/ soil
	18.29	60			CL		11	PUSH					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-30**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.3 m**	LOG I.D. **Boring No. 01-15**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/11/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **44+10**	APPROX. DISTANCE FROM ROADWAY CL: **13.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SILTY CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	1	436				
	2.44	8		? ?									
				SANDY CLAY, gray, very soft to hard, moist	CL		2	1					
	3.66	12											
	4.88	16			CL		3	66	19.2				
	6.10	20		? ?									
				SANDY CLAYEY SILT, brown to gray, loose to dense, moist	ML		4	46					
	7.32	24											
				brown mottled w/ rust	ML		5	10					
	8.53	28		? ?									
				SILTY SAND w/ trace clay, rust brown, loose to medium dense, moist	SM		6	PUSH					
	9.75	32											
	10.97	36		gray	SM		7	20	28.3				
	12.19	40											

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.3 m**	LOG I.D. **Boring No. 01-15 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/11/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **44+10**	APPROX. DISTANCE FROM ROADWAY CL: **13.6 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY SANDY CLAY, medium brown to gray, soft to stiff, moist	CL		8	14					
	13.41	44		more sand, less silt	CL		9	PUSH					
	14.63	48		more silt, less sand	CL		10	16					
	15.85	52		no sand	CL		11	PUSH	58.2	64	36	5.9	
	17.07	56		no sand	CL		12	3					
	18.29	60		Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.2 m**	LOG I.D. **Boring No. 01-16**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/3/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **47+15**	APPROX. DISTANCE FROM ROADWAY CL: **15.5 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		CLAYEY PEAT, dark brown to black, very soft, moist	Pt		1	PUSH	323				
	2.44	8		? ?									
	3.66	12		SANDY SILTY CLAY, greenish gray, stiff to very stiff, moist	CL		2	15					
	4.88	16		no sand	CL		3	19					
	6.10	20		light brown mottled w/ dark brown	CL		4	14	32.5	43	18.0	11.3	
	7.32	24		medium brown	CL		5	PUSH	40.2	47	22		
	8.53	28		? ?									
	9.75	32		SILTY SAND, fine grained, medium brown, loose, moist	SM		6	9					
				? ?									
	10.97	36		SILTY CLAY, gray brown mottled w/ medium brown, stiff, moist	CL		7	10					
	12.19	40											

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.2 m**	LOG I.D. **Boring No. 01-16 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/3/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **47+15**	APPROX. DISTANCE FROM ROADWAY CL: **15.5 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
							8	10					
				SANDY SILT, greenish to bluish gray, loose moist	ML								
	13.41	44											
				trace clay	ML		9	6	42.3				
	14.63	48											
				more clay, less sand	ML		10	11					
	15.85	52											
				? ?									
	17.07	56		SILTY CLAY, greenish gray, soft, moist	CL		11	4					
	18.29	60					12	PUSH	52.0	45	17	4.6	
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-3.6 m**	LOG I.D. **Boring No. 01-17**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/1/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **49+70**	APPROX. DISTANCE FROM ROADWAY CL: **11.7 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4		SANDY PEAT, dark brown to black, very soft, moist	Pt		1	1					
	2.44	8		? ?									
	3.66	12		SANDY SILTY CLAY, greenish to bluish gray, firm to very stiff, moist	CL		2	6					
	4.88	16		less sand	CL		3	18	22.7	56	34	23.8	
	6.10	20		more silt, brown mottled w/ red brown	CL		4	8					
	7.32	24		? ?									
				SANDY SILT, medium brown, loose, moist	ML		5	PUSH					
	8.53	28		? ?									
				SILTY SAND, medium brown, medium dense, moist	SM		6	22					
	9.75	32											
	10.97	36		trace clay	SM		7	18	26.9				
	12.19	40											

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EA: 10-0A8400

Date: June-01

LOG OF BORING NO. 01-17

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-35**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-3.6 m**	LOG I.D. **Boring No. 01-17 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/1/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **49+70**	APPROX. DISTANCE FROM ROADWAY CL: **11.7 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				CLAYEY SANDY SILT, blueish gray, loose, moist	MH		8	9					
	13.41	44		less sand	MH		9	6					
	14.63	48		less sand	MH		10	8	37.6				
	15.85	52		less sand w/ trace organics	MH		11	4					
	17.07	56		more clay	MH		12	8					
	18.29	60		Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-18**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/1/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **55+80**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4					1	1					
				CLAYEY PEAT w/ trace sand and weathered sandstone fragments, dark brown to black,	Pt		2	PUSH					
	2.44	8		very soft, moist									
				? ?									
				CLAYEY FINE SAND, fine grained, gray, loose,	ML		3	7	18.2				
	3.66	12		moist									
				? ?									
	4.88	16		SILTY CLAY, gray, stiff to hard, moist	CH		4	16					
	6.10	20		gray mottled w/ brown	CH		5	12					
	7.32	24			CH		6	PUSH	28.3	26	3	2.0	
	8.53	28			CH		7	12					
	9.75	32											
	10.97	36		trace sand, blueish gray	CH		8	30	28.8	40	19	5.5	
	12.19	40											

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EA: 10-0A8400

Date: June-01

LOG OF BORING NO. 01-18

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-37**

DRILL RIG: **Mobile B-47**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-18 cont.**
BORING DIAMETER: **76 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/1/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J. Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **55+80**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY SAND w/ trace clay and roots, fine grained, blueish gray, dense, moist	SM		9	37					
	13.41	44		becomes coarser, less silt and clay	SM		10	18	29.9				
	14.63	48		? ?									
				SILTY CLAY w/ fine sand, blueish gray, stiff, moist	CL		11	17					
	15.85	52											
	17.07	56		less sand	CL		12	PUSH	50.3		NP	4.3	
	18.29	60		? ?									
				SILTY SAND, fine grained, blueish gray, dense, moist	SM		13	44					
				Bottom of Boring @ 18.75 m									
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-19**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/7/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **59+37**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
				SILTY CLAY heavy w/ ORGANICS, medium brown, soft, dry	OL								top soil
	1.22	4											
				CLAYEY PEAT, black, very soft to soft, moist	Pt		1	PUSH	530			0.5	vane shear test undisturbed ~630 psf remolded ~160 psf
	2.44	8		? ?									
				SILTY CLAY / CLAYEY SILT w/ some roots, blueish gray, soft to firm, moist	CL/ML		2	12					
	3.66	12		? ?									
	4.88	16		SILTY SAND, fine grained, blueish gray, medium dense to dense, moist	SM		3	46					
	6.10	20		? ?									
				SAND, coarse grained, blueish gray, medium dense, moist	SP		4	15					
	7.32	24											
				trace silt	SP		5	17					
	8.53	28											
				gray and brown	SP		6	15	18.9				
	9.75	32		? ?									
	10.97	36		SILTY SAND, gray, loose to medium dense, moist	SM		7	5					
	12.19	40											

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EA:	10-0A8400
Date:	June-01

LOG OF BORING NO. 01-19

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)

GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-39**

DRILL RIG: **CS 2000**	GROUND SURFACE ELEVATION: **-4.0 m**	LOG I.D. **Boring No. 01-19 cont.**
BORING DIAMETER: **108 mm**	DEPTH TO GROUND WATER: **N/A**	DATE PERFORMED: **5/7/01**
DRILLING METHOD: **Mud Rotary**	SAMPLING METHOD: **2" Standard Penetration Test; 2.5" Cal Mod Sampler; Shelby Tube; 63.5 kg (140#) dropped 762mm (30")**	LOGGED BY: **M. Engelmann/J. Fippin**
	APPROXIMATE BORING LOCATION (STA;KP;PM): **59+37**	APPROX. DISTANCE FROM ROADWAY CL: **14.9 m Right of Centerline**

ELEVATION (m)	DEPTH (m)	DEPTH (ft)	GRAPHIC LOG	GEOTECHNICAL DESCRIPTION	SOIL TYPE	SAMPLER	SAMPLE NO.	DRIVING DATA	WATER CONTENT %	Liquid Limit	Plasticity Index	Uncondined Compression psi (Cu)	ADDITIONAL COMMENTS AND TESTS
					SM		8	11	35.0				
	13.41	44			SM		9	19					
	14.63	48		Bottom of Boring @ 14.17 m									
	15.85	52											
	17.07	56											
	18.29	60											
	19.51	64											
	20.73	68											
	21.95	72											
	23.16	76											

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EA: 10-0A8400
Date: June-01

LOG OF BORING NO. 01-19

10-SJ-12; KP 0.2/6.8 (PM 0.1/4.2)
GEOTECHNICAL DESIGN REPORT

PLATE NO. **A-40**

APPENDIX B : LABORATORY TESTING

Sample Location				Percentage Passing Through SieveNo. or Particle Size Finer Than														Spec. Grav.	Atterb. Limits		In-Situ					Unconfined Comp Stnth	Consolidation Coefficients			
Boring No.	I.D. No.	Start (ft)	Depth (m)	1 1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200	5μ	1μ		LL	PI	Dry Density γ_d (pcf)	Moisture (%)	Organic (%)	Initial Void e_o	Final Void e	C_u (psi)	C_c	C_v	C_α	C_r
01-1	2	10	3.05																			356.7	54.5				4.10		0.31	
01-1	4	20	6.1																			431.1					4.96		0.37	
01-1	6A	30	9.14															2.71	50	23	76.7	42.9		1.20	1.01		0.32	2.28E-04		0.063
01-1	6B	30	9.14																		77.8	43.1				4.6				
01-1	8	40	12.2																	NP	90.8	33.9				2.8				
01-1	11	55	16.8						100	99	95	74	24	10	6	2	2					22.9								
01-2	1	5	1.52							100	98	87	40	17	12	4	3					18.9								
01-2	5A	25	7.62															2.67	40	14	79.2	41.5		1.11	0.84		0.27	4.45E-04		0.049
01-2	5B	25	7.62																		83.4	39.6				1.5				
01-2	7	35	10.7																40	13	82.5	39.4				2.4				
01-3	1	5	1.52																			400.0					4.60		0.35	
01-3	2	10	3.05																			499.4	62.3				5.74		0.43	
01-3	5	25	7.62																52	22		57.4								
01-3	6	30	9.14																	NP		36.1								
01-3	8	40	12.2								100	99	68	30	18	5	4					27.5								
01-3	10	50	15.2							100	99	95	65	11	4	3	3					27.3								
01-4	6A	30	9.14															2.73	48	22	79.0	40.2		1.16	0.90		0.36	5.90E-04		0.0607
01-4	6B	30	9.14																		85.3	36.3				5.5				
01-5	1	5	1.52																			425.5	54.9				4.89		0.37	
01-5	4	20	6.1																36	6	75.1	45.3				2.2				
01-5	6A	30	9.14															2.70	44	16	68.1	45.8		1.47	0.88		0.46	3.79E-04		0.055
01-5	6B	30	9.14																		67.0	56.6				2.2				
01-5	8	40	12.2																41	18	95.6	27.4				12.6				
01-5	10	50	15.2						100	99	95	75	35	22	14	7	5					24.4								
01-6	1	5	1.52																			421.1	44.3				4.84		0.36	
01-6	4	20	6.1																36	7	77.8	42.5				2.9				
01-6	6A	30	9.14															2.74	52	22	59.1	65.6		1.89	1.09		0.31	1.79E-04		0.066
01-6	6B	30	9.14																		76.8	44.1				3.9				
01-6	8	40	12.2																37	18	99.3	25.9				14.1				
01-6	11	55	16.8					100	99	98	97	96	89	53	35	9	6					24.2								

Peat Soft Clay Sand Firm Clay

Sample Location				Percentage Passing Through SieveNo. or Particle Size Finer Than														Spec. Grav.	Atterb. Limits		In-Situ					Unconfined Comp Stnth	Consolidation Coefficients			
Boring No.	I.D. No.	Start (ft)	Depth (m)	1 1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200	5μ	1μ		LL	PI	Dry Density γ_d (pcf)	Moisture (%)	Organic (%)	Initial Void e_o	Final Void e	C_u (psi)	C_c	C_v	C_α	C_r
01-7	2	10	3.05																			301.6	34.0				3.47		0.26	
01-7	4	20	6.1																38	9	78.5	43.5				1.1				
01-7	5A	25	7.62															2.53		NP	68.2	50.1		1.31	1.07		0.28	6.24E-04		0.015
01-7	5B	25	7.62																		79.7	42.4				3.8				
01-7	7	35	10.7																50	26	76.3	43.3				1.4				
01-7	9	45	13.7																54	36	88.0	34.4				4.6				
01-7	11	55	16.8					100	99	98	96	95	93	69	38	8	5					37.0								
01-8	1	5	1.52																			176.2	20.3				2.03		0.15	
01-8	4	20	6.1																33	4	85.7	36.7				1.6				
01-8	11	55	16.8									100	96	84	64	17	10					26.2								
01-9	4	20	6.1																56	31	102.9	23.5				21.5				
01-9	6	30	9.14					100	96	94	91	66	45	31	18	9	7					20.3								
01-9	9	45	13.7						100	98	95	74	23	5	3	2	2					26.9								
01-10	1	5	1.52																			549.7					6.32		0.47	
01-10	2	10	3.05																			476.8	45.3				5.48		0.41	
01-10	6	30	9.14							100	97	80	42	30	24	12	5					20.9								
01-10	9	45	13.7					100	99	96	82	57	26	9	6	5	1					21.3								
01-11	1	5	1.52																			152.8	19.2				1.76		0.13	
01-11	5	25	7.62																37	5	84.7	37.6				4.0				
01-11	9	45	13.7							100	97	76	21	5	4	3	1					24.3								
01-12	3A	15	4.57															2.76	26	6	88.8	27.5		0.94	0.73		0.23	1.36E-05		0.0332
01-12	3B	15	4.57																		96.8	27.5				2.4				
01-12	5	25	7.62																32	12	93.9	30.9				4.8				
01-12	9	45	13.7									100	99	97	31	9	4				87.5	35.0				3.1				
01-13	1	5	1.52																			335.7	47.3				3.86		0.29	
01-13	4	20	6.1																	NP	112.5	18.3				6.0				
01-13	7	35	10.7									100	99	42	20	8	4				99.4	20.8				3.0				
01-13	10	50	15.2									100	99	98	86	16	7					42.2								

Peat Soft Clay Sand Firm Clay

Sample Location				Percentage Passing Through SieveNo. or Particle Size Finer Than															Atterb. Limits		In-Situ						Unconfined Comp Stnth	Consolidation Coefficients			
Boring No.	I.D. No.	Start (ft)	Depth (m)	1 1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200	5μ	1μ	Spec. Grav.	LL	PI	Dry Density γ_d (pcf)	Moisture (%)	Organic (%)	Initial Void e_o	Final Void e	C_u (psi)	C_c	C_v	C_α	C_r
01-14	1	5	1.52																			439.5	48.0				5.05			
01-14	6A	30	9.14															2.75	25	3	90.9	22.9		0.89	0.79		0.11	4.50E-04		0.0318
01-14	6B	30	9.14																		96.4	27.9				5.0				
01-14	7	35	10.7																28	6	97.7	27.4				9.4				
01-14	10	50	15.2						100	99	98	98	95	41	12	7	3					38.7								
01-15	1	5	1.52																			436.3	46.4				5.02		0.38	
01-15	3	15	4.57																		109.9	19.2								
01-15	7	35	10.7								100	98	86	30	11	5	3					28.3								
01-15	11	55	16.8																64	36	65.1	58.2				5.9				
01-16	1	5	1.52																			322.6	31.1				3.71		0.28	
01-16	4	20	6.1																43	18	91.3	32.5				11.3				
01-16	5A	25	7.62															2.79	47	22	82.3	40.2		1.11	0.94		0.28	3.30E-04		0.0607
01-16	5B	25	7.62																			33.7								
01-16	9	45	13.7						100	99	99	98	98	92	75	14	6					42.3								
01-16	12A	60	18.3															2.71	45	17	69.0	51.4		1.45	1.21		0.65	1.20E-05		0.0565
01-16	12B	60	18.3																		70.2	52.0				4.6				
01-17	3	15	4.57																56	34	104.3	22.7				23.8				
01-17	7	35	10.7								100	98	93	66	36	7	4					26.9								
01-17	10	50	15.2							100	99	99	99	98	89	14	8					37.6								
01-18	3	10	3.05								100	99	88	63	55	13	7					18.2								
01-18	6A	25	7.62															2.77	26	3	91.0	28.3		0.90	0.77		0.19	1.60E-03		0.0333
01-18	6B	25	7.62																		96.0	26.4				2.0				
01-18	8	35	10.7																40	19	89.6	28.8				5.5				
01-18	10	45	13.7					100	99	95	91	89	80	17	9	4	1					29.9								
01-18	12	55	16.8																	NP	71.9	50.3				4.3				
01-19	1	5	1.52																		10.4	530.0				0.5	6.10		0.46	
01-19	6	30	9.14							100	99	47	16	7	3	2	1					18.9								
01-19	8	40	12.2							100	99	97	91	69	46	16	8					35.0								

Peat Soft Clay Sand Firm Clay

REPORT BY: Susan Hall,
Corrosion Technology Section

MATERIAL SOURCE: 10 - N/A - 12 - PM 0.12/4.23
SAMPLE OF: Clay & Silt
EA : 10-0AS400

SIC NUMBER	CORROSION NUMBER	SAMPLE FROM	LOCATION	DATE SAMPLED	SAMPLE DEPTH	pH	MINIMUM RESISTIVITY (ohm-cm)	SULFATE CONTENT (PPM or mg/kg)	CHLORIDE CONTENT (PPM or mg/kg)	YEARS TO PERFORATION 18 ga. GALV. STEEL CULVERT
C537762	01-0709	Sample 1	Hwy 12, 51 County	8/2/2001	0.0'-5.0'	5.9	2650	N/A	N/A	N/A
C537763	01-0710	Sample 2	Hwy 12, 55 County	8/2/2001	0.0'-5.0'	6.0	3250	N/A	N/A	N/A

Note: Caltrans currently defines a corrosive area as an area where the soil and/or water contains more than 500 ppm of chlorides, or more than 2000 ppm of sulfates, or has a minimum resistivity of less than 1000 ohm-centimeters, or has a pH of 5.5 or less.
With the exception of MSE Walls, chloride and sulfate tests (CTM 422 and CTM 417) are not required (N/A) if the minimum resistivity is greater than 1,000 ohm-cm.

APPENDIX C : STABILITY ANALYSES FOR STA 8+15

Comments: First stage - build to 2 m
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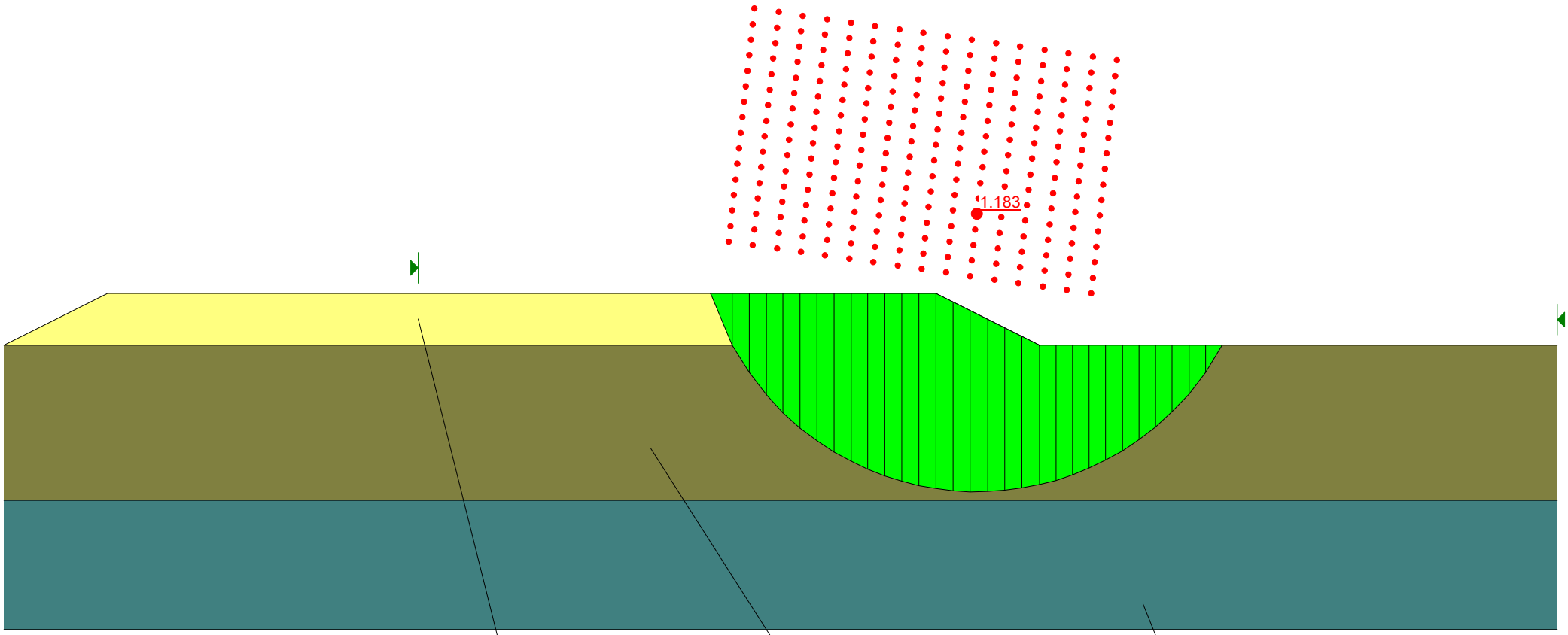
Last Saved Date: 8/21/01
Last Saved Time: 12:07:01 PM
Analysis Method: Spencer

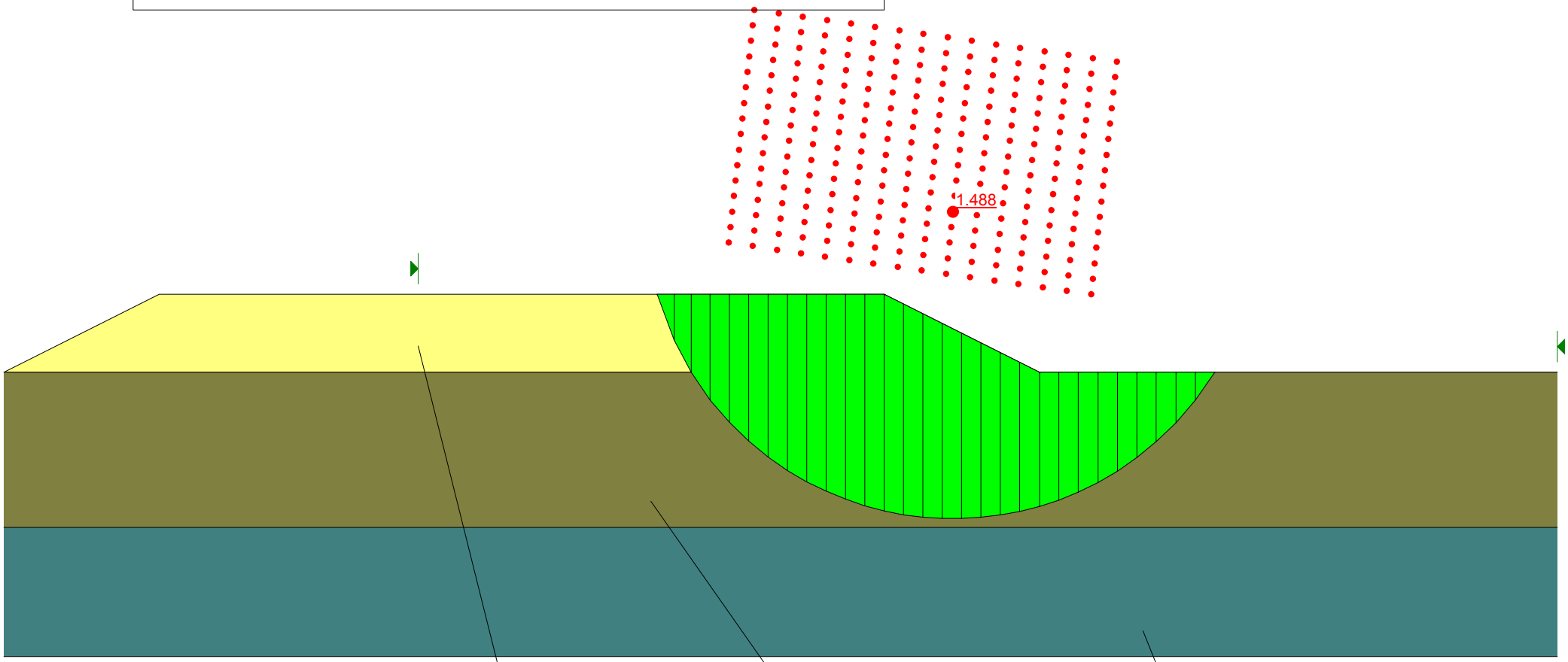


Fill
Unit Weight:23
Cohesion:0
Phi:32

Peat
Unit Weight:10.5
Cohesion:10
Phi:0

Soft Clay
Unit Weight:17.5
Cohesion:20
Phi:0

Comments: Controlled Rate of Construction - build to 3 m at 1 foot per week
File Name: 10sj12_run3m(8+15).slp
Last Saved Date: 8/21/01
Last Saved Time: 11:40:51 AM
Analysis Method: Spencer



Fill
Unit Weight:23
Cohesion:0
Phi:32

Peat
Unit Weight:10.5
Cohesion:19
Phi:0

Soft Clay
Unit Weight:17.5
Cohesion:29
Phi:0

Comments: Controlled Rate of Construction - build to 4 m at 1 foot per week
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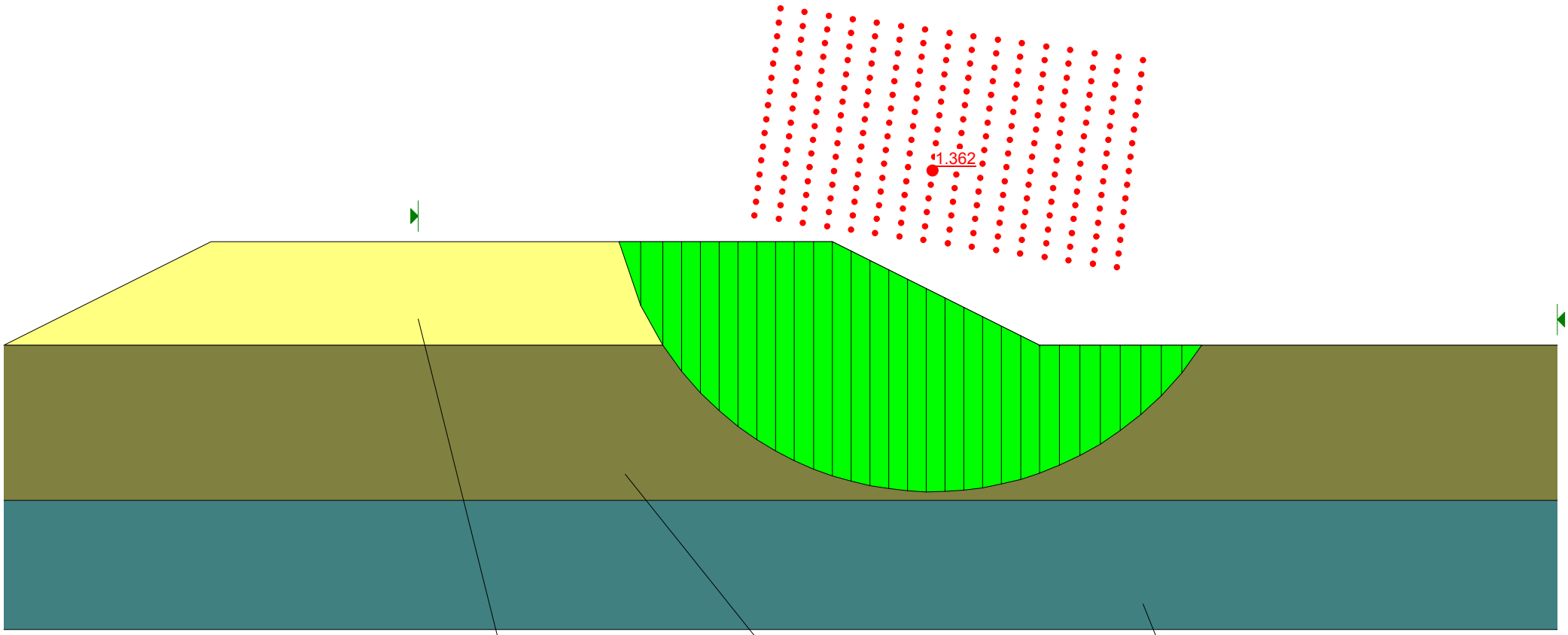
Last Saved Date: 8/21/01
Last Saved Time: 11:39:44 AM
Analysis Method: Spencer



Fill
Unit Weight:23
Cohesion:0
Phi:32

Peat
Unit Weight:10.5
Cohesion:23
Phi:0

Soft Clay
Unit Weight:17.5
Cohesion:33
Phi:0

Comments: Controlled Rate of Construction - build to 5 m at 1 foot per week
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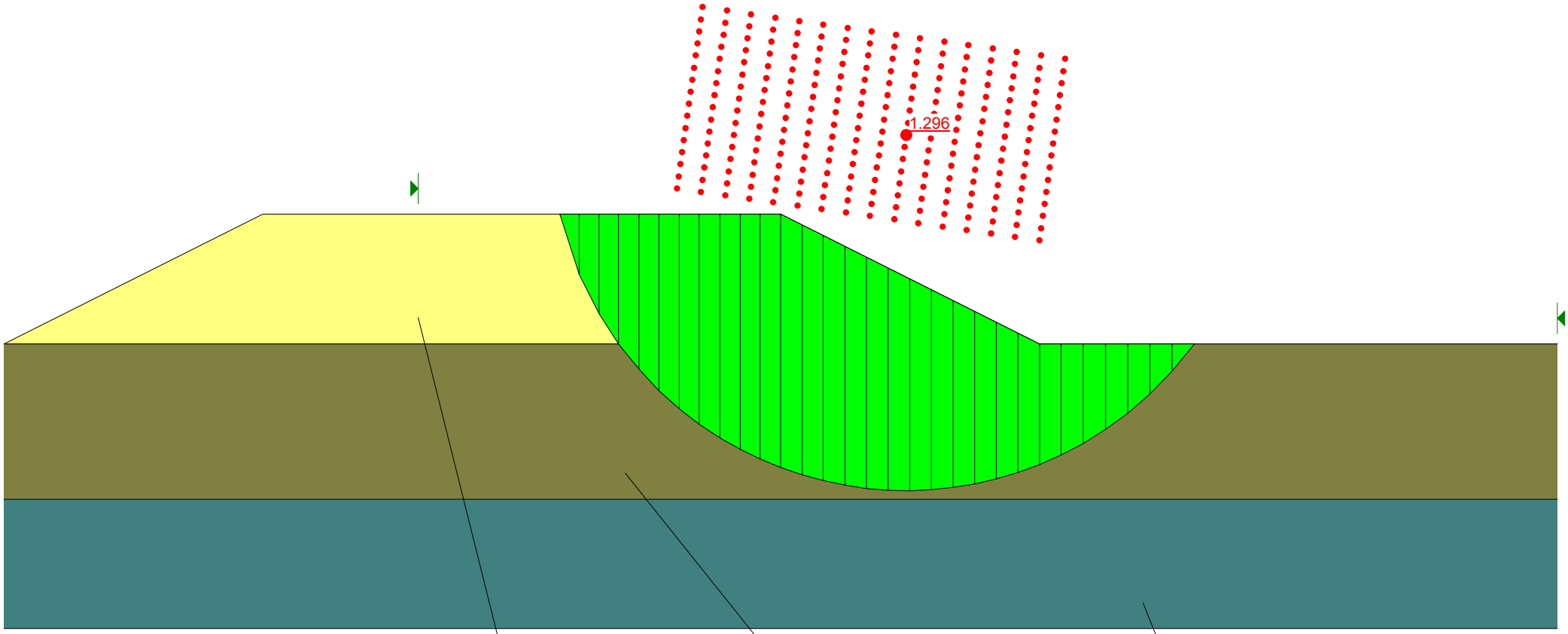
Last Saved Date: 8/21/01
Last Saved Time: 11:37:42 AM
Analysis Method: Spencer



Fill
Unit Weight:23
Cohesion:0
Phi:32

Peat
Unit Weight:10.5
Cohesion:27
Phi:0

Soft Clay
Unit Weight:17.5
Cohesion:37
Phi:0

Comments: Controlled Rate of Construction - build to 6 m at 1 foot per week
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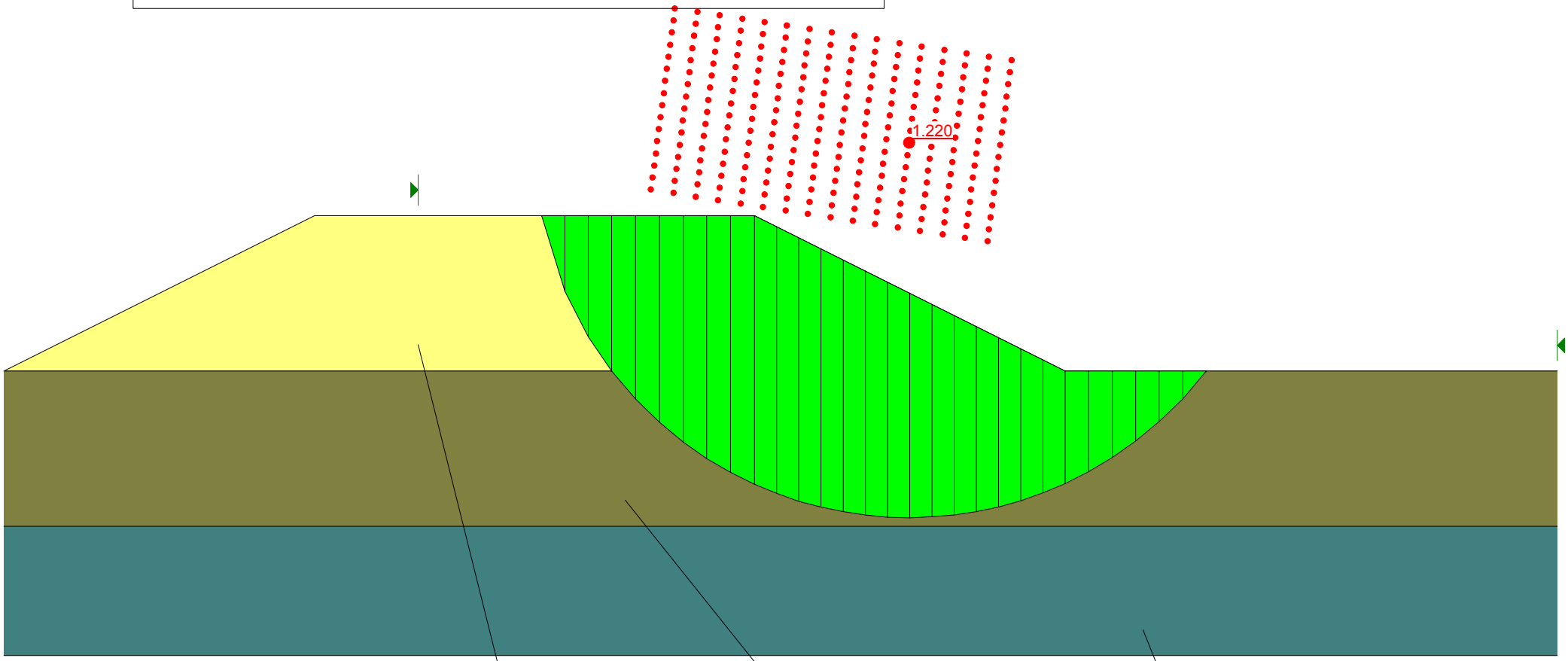
Last Saved Date: 8/21/01
Last Saved Time: 11:34:26 AM
Analysis Method: Spencer



Comments: Controlled Rate of Construction - build to 7 m at 1 foot per week
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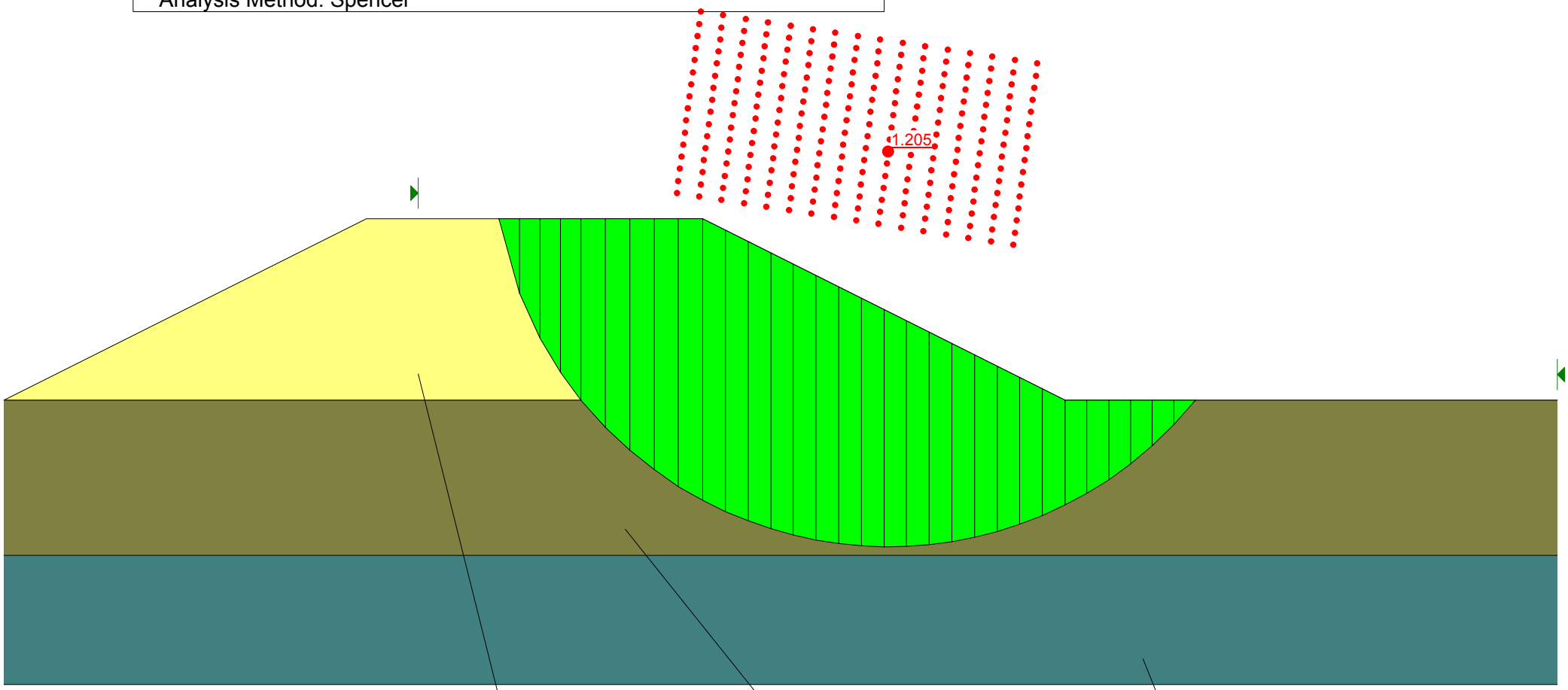
Last Saved Date: 8/21/01
Last Saved Time: 11:44:37 AM
Analysis Method: Spencer



Comments: Undrained Analysis after Surcharging and replacing with Lightweight Fill
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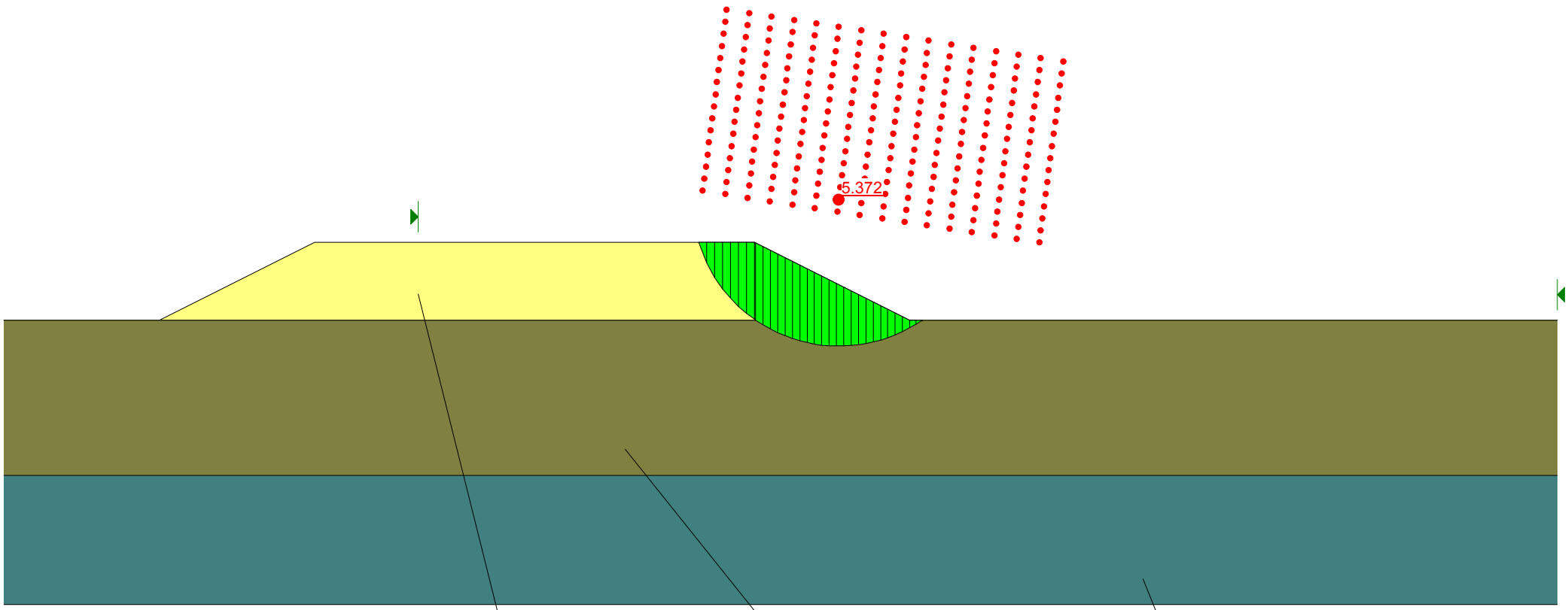
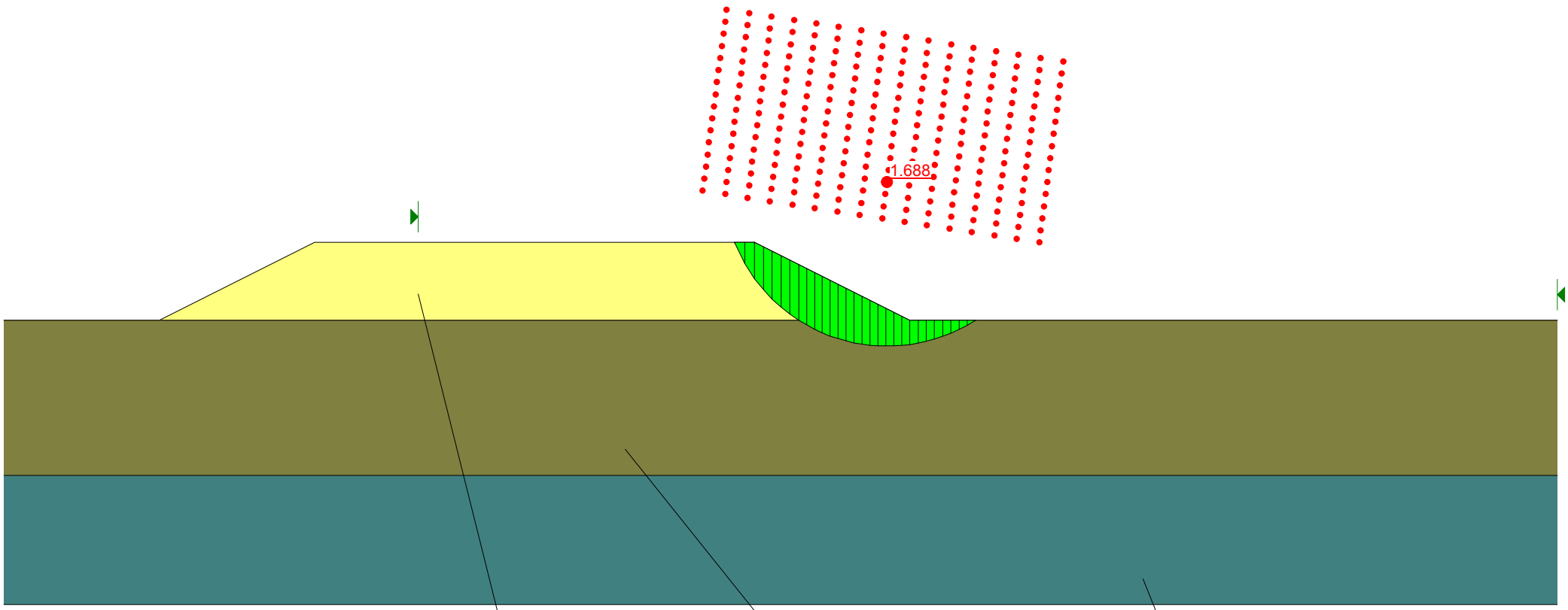
Last Saved Date: 8/21/01
Last Saved Time: 12:01:13 PM
Analysis Method: Spencer



Comments: Drained Analysis after Surcharging and replacing with Lightweight Fill
File Name: 10sj12_runxlightweight(8+15).slp
Last Saved Date: 8/21/01
Last Saved Time: 12:03:17 PM
Analysis Method: Spencer



APPENDIX D : RECOMMENDED SPECIAL PROVISIONS

10-1.__ IMPORTED BORROW (LIGHTWEIGHT AGGREGATE)

Imported borrow (lightweight aggregate) shall consist of furnishing, placing and compacting lightweight aggregate material at the locations and to the lines and grades designated on the plans or specified in the special provisions. Imported borrow (lightweight aggregate) shall conform to the requirements specified for embankment and structure backfill in Section 19, "Earthwork," of the Standard Specifications and these special provisions.

Lightweight aggregate material shall consist of a rotary kiln expanded shale aggregate of the extruded type or a processed, naturally-occurring volcanic aggregate.

Lightweight aggregate material shall be as specified in these special provisions.

Lightweight aggregate material, when deposited in place, shall conform to the following:

Grading Requirements

Sieve Sizes	Percentage Passing
37.5-mm	100
25-mm	95 - 100
19-mm	90 - 100
9.5-mm	15 - 85
75-μm	0 - 9

Grading will be determined in conformance with the requirements of California Test 202, except shaking in the sieves shall be limited to 5 minutes.

Quality Requirements

Test	Requirement
Resistance (R-Value)	50 min
Durability Index	35 min

Imported borrow (lightweight aggregate) shall have a maximum calculated saturated surface dry unit weight of 960 kg/m^3. The saturated surface dry unit weight shall be calculated by adjusting the dry loose unit weight, determined in conformance with the requirements of California Test Method 212, using test procedure (b) Compaction Method (by jigging), by the absorption of the coarse and fine fractions. The absorption shall be determined by California Test Methods 206 and 207, except that the samples shall be oven dry before soaking and shall be soaked for 24 hours plus or minus 30 minutes. To calculate the saturated surface dry unit weight: 1) multiply the percent coarse aggregate by the absorption of the coarse aggregate; 2) multiply the percent fine aggregate by the absorption of the fine aggregate; 3) add the two values from 1) and 2) and divide by 10000; 4) add one (1) to the result from 3) and multiply by the dry loose unit weight.

Imported borrow (lightweight aggregate) shall be placed and compacted to the designated dimensions as specified in Sections 19-1.03, "Grade Tolerance," and the requirements specified for embankment construction in Section 19-6, "Embankment Construction," of the Standard Specifications, except Section 19-5, "Compaction," of the Standard Specifications shall not apply.

Initial layers of imported borrow (lightweight aggregate) may be placed by end dumping from trucks, or by any other method approved by the Engineer.

Imported borrow (lightweight aggregate) shall be spread or placed in such manner that will prevent bulking of the material and minimize particle breakdown. Imported borrow (lightweight aggregate) shall be compacted in uniform layers of 0.2-m maximum thickness before compaction. Compaction shall be obtained by a minimum of 3 complete coverage passes using smooth drum steel roller compaction equipment imposing contact force of 5,360 kg per-meter-

width of the roller face. Track type equipment which imposes the equivalent contact pressure as that specified for steel drum rollers, as determined by the Engineer, may be used provided the 3 complete coverages of the tracks of the track type equipment are achieved. Sufficient moisture treatment shall be made to aid the compactive effort. Compaction using pneumatic-tired equipment or compaction within trenches or other limited-access areas, or compaction in areas of low confining pressure, shall be demonstrated by the Contractor and approved by the Engineer.

A test site using proposed lightweight aggregate material shall be constructed and compacted when alternative compaction equipment and methods of compaction (including use of pneumatic-tired equipment in trenches, in limited-access areas, and areas of low confining pressure) are proposed by the Contractor. The alternative compaction equipment and methods of compaction shall not be used until the alternative methods and equipment meet project and site conditions, as determined by the Engineer.

Quantities of imported borrow (lightweight aggregate) shall be paid for by the cubic meter calculated on the basis of the mass, measured in place in accordance with Section 9-1.01, "Measurement of Quantities," of the Standard Specifications divided by the 95 percent of the dry unit weight measured in accordance with California Test Method 212, using test procedure (b) Compaction Method (by jigging).

The contract price paid per cubic meter for imported borrow (lightweight aggregate) shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in constructing imported borrow (lightweight aggregate), complete in place (including constructing and removing any test sites required), as shown on the plans, as specified in these special provisions, and as directed by the Engineer.

10-1.__ GEOTEXTILE FILTER FABRIC

Geotextile filter fabric shall be furnished and installed for the installation of Class 3 permeable bedding material, prior to the placement for rock slope protection, and for Class 3 permeable material (blanket) for wick and vertical drains, as shown on the plans, in conformance with these specifications, and as directed by the Engineer.

Geotextile filter fabric shall be manufactured from polyester or polypropylene.

Geotextile filter fabric shall be nonwoven and shall conform to the following:
A.

Property	Value	ASTM Test Designation
Minimum Grab Tensile Strength	1.1 kN	D4632
Minimum Elongation at Break	50%	D4632
Maximum Apparent Opening Size	0.21 mm	D4751
Minimum Permittivity	0.5 sec-1	D4491

B. Geotextile rolls shall be furnished with suitable wrapping for protection against moisture, ultraviolet exposure and abrasion during shipping. Each roll shall be labeled or tagged to provide product identification sufficient for field identification as well as inventory and quality control purposes. Rolls shall be stored in a manner that protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.
C. The amount of geotextile placed shall be limited to that amount which can be covered with the specified material within 72 hours.
D. Installation sites shall be prepared by clearing, grubbing and excavation or filling to the design grades. The surface upon which the geotextile filter fabric is to be placed should be graded smooth and be free of debris and large depressions.
E. Geotextile fabric shall be handled and placed in accordance with the manufacturers recommendations and these specifications. The geotextile shall be laid transverse to the roadway alignment (i.e., geotextile roll or machine direction perpendicular to roadway centerline) and shall be placed loosely without folds. The ends of subsequent rolls and/or parallel rolls of geotextile should be overlapped a minimum of 300 mm prior to sewing. The fabric shall be stitched with a yarn of a contrasting color. The size and composition shall be as recommended by the fabric manufacturer. The stitches shall number 5 to 7 per 25 mm of seam. Lock type stitch shall be used.
F. Vehicles or equipment shall not be driven directly on the geotextile fabric. A minimum of 200 mm cover shall be maintained between the compaction equipment and the fabric.
G. The contractor shall patch holes in the geotextile as directed by the Engineer. Repairs shall be performed by placing a new piece of fabric over the damaged area that extends beyond the damaged area in all directions a minimum overlap of 300 mm and heat bonding in place. If damage is greater that one square meter the damaged section shall be cut out and shall be replaced with a new piece of geotextile filter fabric material, in according to the fabric overlap and stitches requirement, as directed by the Engineer. Damage to the geotextile fabric resulting from the Contractors vehicles, equipment or operations shall be repaired at the Contractors expense.

MEASUREMENT AND PAYMENT

Geotextile fabric will be measured by square meters computed from the payment lines shown on the plans, excluding seam overlaps.

The contract price paid per square meter for geotextile filter fabric shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing the fabric, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ PERMEABLE MATERIAL (BLANKET)

Permeable material blanket shall be constructed in conformance with the details shown on the plans and these special provisions.

Permeable material for permeable material blanket shall be Class 3 and shall conform to the provisions in Section 68-1.025, "Permeable Material," of the Standard Specifications, except as follows.

Class 3 permeable materials shall be free from organic material, clay balls or other deleterious substances.

Class 3 permeable material shall conform to the following:

A. Grading requirements

Sieve Sizes	Percentage Passing
37.5-mm	100
25-mm	88-100
19-mm	52-85
9.5-mm	15-38
4.75-mm	0-16
2.36-mm	0-6

B. Class 3 permeable material shall have a Durability Index of not less than 40.

C. At least 90 percent by mass of Class 3 permeable material shall be crushed particles as determined by California Test 205.

Geotextile reinforcement fabric woven and geotextile filter fabric nonwoven for use with permeable material blanket as shown on the plans, shall conform to "Engineering Fabrics," of these special provisions.

Permeable material (blanket) will be measured by the cubic meter. Quantities of permeable material to be paid for as permeable material (blanket) will be determined from the dimensions shown on the plans or such other dimensions as may be ordered in writing by the Engineer. Permeable material blanket constructed in excess of these dimensions will not be paid for.

The contract price paid per cubic meter for permeable material (blanket) shall include full compensation for furnishing all labor, materials (including filter fabric), tools, equipment, and incidentals, and for doing all the work involved in constructing a permeable material (blanket) and placing filter fabric, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ GEOTEXTILE REINFORCEMENT FABRIC

Geotextile reinforcement fabric shall be furnished and installed over Class 3 permeable material (blanket), prior to the placement of the embankment, as shown on the plans, in conformance with these specifications, and as directed by the Engineer.

Geotextile reinforcement fabric shall be manufactured from polyester or polypropylene.

Geotextile reinforcement fabric shall be woven and shall conform to the following:

A.

Property	Value	ASTM Test Designation
Minimum Grab Tensile Strength	1.4 kN	D4632
Elongation at Break	15-50%	D4632
Maximum Apparent Opening Size	0.6 mm	D4751
Minimum Permittivity	0.2 sec-1	D4491

B. Fabric rolls shall be furnished with suitable wrapping for protection against moisture, ultraviolet exposure and abrasion during shipping. Each roll shall be labeled or tagged to provide product identification sufficient for field identification as well as inventory and quality control purposes. Rolls shall be stored in a manner that protects them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

C. The amount of fabric placed shall be limited to that amount which can be covered with engineered fill material within 72 hours.

D. The subgrade surface upon which the fabric is to be placed shall be graded smooth and free of debris.

E. Fabric shall be handled and placed in accordance with the manufacturers recommendations and these specifications. The geotextile shall be laid transverse to the roadway alignment (i.e., geotextile roll or machine direction perpendicular to roadway centerline) and shall be placed loosely but with as few wrinkles and folds as is practicable. The ends of subsequent rolls and/or parallel rolls of geotextile should be overlapped a minimum of 300 mm prior to sewing. The fabric shall be stitched with a yarn of a contrasting color. The size and composition shall be as recommended by the fabric manufacturer. The stitches shall number 5 to 7 per 25 mm of seam. Lock type stitch shall be used. Vehicles or equipment shall not be driven directly on the fabric. The initial cover will comply with the plans and specifications but in no case will be less than 300 mm. Compaction of the initial cover shall be achieved by using overlapping passes of tracked equipment such that the initial cover has received one complete coverage of the tracks and will not require density testing. Sheepsfoot or other types of equipment employing a penetrating foot shall not be used to construct the initial cover. Placement and grading of the engineered fill materials shall proceed in the direction of construction.

F. The contractor shall patch rips or tears in the fabric as directed by the Engineer. Repairs shall be performed by placing a new piece of fabric over the damaged area that extends beyond the damaged area in all directions a minimum overlap of 300 mm and heat bonding in place. If damage is greater that one square meter, the damaged section shall be cut out and shall be replaced with a new piece of geotextile filter fabric material, in accordance to the fabric overlap and stitches requirement, as directed by the Engineer.

Damage to the fabric resulting from the Contractors vehicles, equipment or operations shall be repaired at the Contractors expense.

MEASUREMENT AND PAYMENT

Geotextile fabric will be measured by square meters computed from the payment lines shown on the plans, excluding seam overlaps.

The contract price paid per square meter for geotextile reinforcement fabric shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in furnishing and placing the fabric, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

10-1.__ DRAINAGE WICK

Drainage wicks shall be furnished and installed as shown on the plans, as specified in these special provisions, and as directed by the Engineer.

The Contractor's attention is directed to "Permeable Material" of these special provisions regarding the thickness of the initial placement of the permeable material.

Drainage wicks shall consist of fabricated vertical drain materials conforming to the following requirements:

A. Saturated test samples of the fabricated drainage wick 0.6-m long, or 0.6-m plus the length of splice if splices are being tested, when suspended vertically shall support a 23 kg mass for a period of 5 minutes without distress or separation.
B. Fabricated drainage wicks shall have the following flow capacity characteristics when test samples are tested in conformance with the test procedure and sequence set forth in these special provisions.

    1. The pressure required to produce and maintain a flow of 3.8 L per minute for a period of 10 minutes, through the sidewalls and out the unsealed end of test samples, shall not exceed 8 kPa when the samples are immersed in water only.
    2. The pressure required to produce and maintain a flow of 3.8 L per minute for a period of 10 minutes, through the sidewalls and out the unsealed end of test samples, shall not exceed 100 kPa when the samples are embedded in a glassbead-aggregate soil matrix.

The test procedure to be used in determining flow capacity characteristics of fabricated drainage wicks shall consist of placing a 350 mm long test sample of the drainage wick that has been sealed at one end in a test chamber, centered along its longitudinal axis, such that 300 mm of the sample is exposed to the flow within the chamber and such that the unsealed end of the sample extends out of the top of the chamber. Samples of spliced drainage wick shall be placed in the test chamber with 300 mm of the splice exposed to flow within the chamber or, if the splice is less than 300 mm long, the spliced portion of the sample shall be placed in the top portion of the chamber. The inside diameter of the test chamber shall be at least 20 mm greater than the width of the test sample. Water shall be introduced into the test chamber through an inlet centered in the bottom of the chamber. Pressure shall be measured with a strain gage pressure tap installed in the test chamber at approximately mid-depth. Water used in determining flow capacity characteristics shall be potable tap water. Each test sample of spliced and unspliced drainage wick shall first be tested for flow capacity when immersed in water only and then for flow capacity when embedded in a glassbead-aggregate soil matrix. The glassbead-aggregate soil matrix shall consist of inert glass beads and soil and shall conform to the following requirements:

A. Gradation:

Sieve Sizes	Percentage Passing
4.75 mm	100
2.36 mm	77
1.18 mm	63
600 μm	42
300 μm	19
150 μm	7
75 μm	3
53 μm	0

B. The material passing the 4.75 mm sieve and retained on the 300 μm sieve shall conform to the provisions in Section 90-2.02B, "Fine Aggregate" of the Standard Specifications. The material passing the 300 μm sieve and retained on the 53 μm sieve shall consist of inert glass beads.

C. The glass beads and soil shall be thoroughly mixed while damp, carefully installed around the test sample of drainage wick in the test chamber and compacted by rodding.

Splices in drainage wicks will be permitted provided the splices are fabricate in a workmanlike manner approved by the Engineer, and the spliced wicks conform to the provisions in these special provisions.

The Contractor shall submit for testing a sample of the unspliced drainage wick to be used and 3 samples of proposed splices to the Engineer at least 21 days prior to the installation of the drainage wicks. The sample of unspliced drainage wick shall be at least 3 m long. Samples of spliced drainage wick shall be long enough to include the splice plus 0.6 m of unspliced wick on either side of the splice. At the same time, the contractor shall submit full details of the sequence and method proposed for installation of the drainage wicks for the Engineer's review and approval. Approval by the Engineer of installation details and methods shall not relieve the Contractor of the responsibility to install drainage wicks in conformance with the plans and these special provisions.

Prior to installation of the drainage wicks, the contractor shall demonstrate that the proposed equipment and methods will produce satisfactory installation of approved drainage wicksin conformance with the plan and these special provisions. For this purpose, trial drainage wicks shall be installed at those locations designated by the Engineer. Payment for trial drainage wicks will be made at the contract price per meter for drainage wick. Payment will not be made for unsatisfactory installations of trial drainage wicks.

Drainage wicks shall be installed using a driving sleeve. The driving sleeve shall protect the drainage wick from tears, cuts, and abrasions during installation and shall be retracted after each drainage wick is installed. The cross-section of the driving sleeve shall be of a shape that will produce minimum disturbance of the soil surrounding the installed drainage wick and shall not exceed15,500 mm^2 in area. The tip of the driving sleeve shall cut through the filter fabric layer cleanly without tearing, gathering, folding or otherwise distressing or stressing the fabric.

Drainage wicks shall not be installed by jetting or impact methods.

Upon written request from the Contractor and when approved by the Engineer, augering or other methods may be used to loosen the soil and permeable material prior to installation of

drainage wicks provided the augering does not penetrate more than 0.3 m into the underlying compressible native soil and does not tear, gather, fold, or otherwise disturb or stress the filter fabric layer.

Equipment for installing drainage wicks shall be plumbed prior to installing each wick and shall not deviate from the vertical more than 30 mm in 3 m during installation of the wicks. Drainage wicks that are out of proper location more than 150 mm or are damaged or improperly installed will be rejected. Rejected drainage wicks may be removed or abandoned in place, at the Contractor's option, except that rejected wicks which interfere with installation of replacement wicks, or other acceptable wicks, shall be removed.

Drainage wick locations shall be marked on the ground by the contractor. The locations of the drainage wicks shall not vary by more than 150 mm from the locations shown on the plans.

Drainage wicks shall be installed from the working surface to the depth shown on the plans or designated by the Engineer.

The Contractor shall provide the Engineer with suitable means of determining the quantity of drainage wick installed at each location and shall provide suitable means for the Engineer to determine the depth of the wick at any given time.

Drainage wicks shall be cut off neatly at the ground line at the location shown on the plans.

Where obstructions are encountered which the drainage wick cannot be driven through, the Contractor shall abandon the drainage wick in place. At the direction of the Engineer, the Contractor shall install a new drainage wick within 500 mm of the obstructed drain. A maximum of two attempts shall be made, as directed by the Engineer, for each obstructed drainage wick.

Drainage wicks will be measured by the meter. The length of drainage wick to be paid for will be the length shown on the plans or designated by the Engineer. Drainage wick placed in excess of such lengths will not be paid for. Payment for abandoned drainage wicks will be made at the contract price per meter for drainage wick.

The contract price per meter for the drainage wick shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in installing drainage wicks, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

State of California
Department of Transportation

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: PAUL ELLIOT
Office of Design IV
Design Branch I

Attention: Rick Boyer
Project Engineer

Date: September 7, 2009
File: 10-SJ-12
PM 0.1/4.2
EA: 10-0G8001

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

Subject: Supplemental Recommendations to Geotechnical Design Report

Introduction

Per your request, we are providing supplemental recommendations to the Geotechnical Design Report (GDR) dated January 1, 2002 for proposed improvements to State Route 12 between PM 0.4 and 4.2, located in San Joaquin County, California. The recommendations in this report supercede the recommendations in 2002 GDR. All other recommendations in the 2002 GDR shall remain applicable.

Scope of Work

The original scope of the project was to rehabilitate the existing section of State Route 12 between PM 0.1 and 4.4. Several alternatives were reviewed during the PSSR phase and it was decided that the most feasible rehabilitation would be to construct a new roadway section to the south of the existing highway. This new section will have standard 12-foot travel lanes, 8-foot shoulders, and a concrete median barrier. The existing highway section will be removed after the new section is constructed.

Subsurface Conditions

In general, the subsurface material within the project limits consists of approximately 20 feet of clayey peat, underlain by approximately 30 feet of soft to firm clay, underlain by silty sand. The peat and clay soil types exhibit significant settlement potential and low shear strength. The proposed embankment widening ranges in height from 3 to 10 feet with the majority being 5 feet or less. It is anticipated that the fill will experience

between 5 and 10 feet of settlement. Without mitigation measures, settlement time will be on the order of 3 to 4 years.

Geotechnical Recommendations

The 2002 GDR proposed six design alternatives, which included use of wick drains, surcharge, lightweight fill, and deep soil mixing. Design has chosen to use wick drains and surcharge. One of the alternatives in the 2002 GDR proposed lightweight fill in lieu of standard fill. The use of lightweight fill in lieu of standard fill would help reduce the secondary settlement a small amount with a large additional cost. It is the opinion of this Office that lightweight fill would not be cost effective and therefore is not recommended.

The following is a discussion of the recommendations on the use of wick drains and surcharge. A visual illustration of the recommendations is shown on **Figure 1**.

It is questionable whether the near surface soils are of adequate strength to support the wick driving equipment. The contractor may need to construct a gravel working platform to support the equipment.

Wick drains should be installed beneath the footprint of the proposed fill embankments. During construction, K-rail will be placed along the fog line of Highway 12. The existing embankment should be cut with a 1:1 slope down from the K-rail to original ground. The wicks should then be installed and extend from the toe of the 1:1 slope to the edge of the proposed fill. Wicks should be placed in a triangular pattern at 5 foot spacing, and installed to a depth of 60 feet. Once the wicks are installed, a filter fabric should be placed followed by a 1 ft gravel layer and then a reinforcement fabric. The gravel layer should not be compacted.

The embankment and surcharge will then be constructed, and should extend 10 feet in height above the proposed embankment finished grade. The surcharge should begin at a point 3 feet from the K-rail to allow room for deformation of the existing roadway and should have a slope of 0.5:1 (H:V) using a Geosynthetic Reinfored Embankment (GRE). The surcharge should continue at a height of 10 feet to the outer edge of the proposed structural section and then slope down to original ground at 1.5:1 (H:V) or flatter. The embankment and surcharge should be compacted to 90%.

Settlement Waiting Period

The settlement waiting period will be approximately 9 months. Once the settlement period is complete, the surcharge may be removed and the structural section constructed.

Rate of Fill Placement

After the drainage blanket is applied, loading of the embankment should be restricted to allow time for dissipation of pore pressures, thereby increasing the shear strength of the foundation soil and reducing any chance of bearing capacity failure. Up to five feet of embankment fill may be placed without any restrictions; additional fill may be placed at a rate of 1 foot per week up to 10 feet and then one half foot per week to final height.

Geotechnical Instrumentation

This section of the report presents geotechnical instrumentation recommendations. We recommend that the contract documents specify that furnishing, installation and monitoring of the instrumentation be the responsibility of the Contractor. Once operational, we anticipate the interpretation of the monitoring data will be shared between the Resident Engineer and this Office. A visual illustration of the instrumentation is shown on **Figure 1**.

Table 1 summarizes the piezometer and settlement platform locations.

Table 1. Piezometer / Settlement Platform Locations

Piezometers			Settlement Platforms	
STA (ft)	Depths (ft)	Centerline Offset (ft)	STA (ft)	Centerline Offset (ft)
120+00	20, 25, 30	0.0	120+00	0.0
155+00	15, 25, 35	0.0	155+00	0.0
185+00	15, 20, 25	0.0	185+00	0.0
205+00	20, 25, 30	0.0	205+00	0.0
235+00	20, 25, 30	0.0	235+00	0.0
255+00	10, 20, 25	0.0	255+00	0.0
285+00	15, 20, 35	0.0	285+00	0.0

Each station should include the following instruments:

- Vibrating wire piezometers (3) installed within the clay layer at depths shown in Table 1 to obtain and monitor the increase and subsequent dissipation of excess pore water pressure associated with the placement of fill and subsequent consolidation of the clay layer.

- Fluid settlement gage installed to measure the settlement resulting from consolidation of the underlying foundation soil.

- Automated data acquisition unit to read and record outputs from the piezometer and fluid settlement gauges.

The monitoring proposed will be used to allow the safe placement of fill in stages with the rate controlled by actual rate of foundation soil consolidation and subsequent strength gain. Also, the completion of primary consolidation will be verified by settlement and pore pressure measurements. Fluid settlement gauges will additionally allow for verification of the thickness of fill placed for contractor progress payment.

Instrumentation should be installed after placement of the drainage layer and wick drains ~~but prior to placement of fill. Wires for instrumentation should be placed in a conduit,~~ buried not less than 0.3 meters, to protect them from damage during construction.

Due to the critical nature of the geotechnical monitoring proposed, the project specifications should explicitly indicate that the contractor during construction must carefully protect the measurement points/instrumentation. Any instrumentation equipment damaged by the contractor must be immediately replaced prior to work commencement unless the Resident Engineer authorizes work continuance in writing.

Secondary Settlement

The use of wick drains and surcharge is expected to reduce the secondary settlement considerably. However, secondary settlement is expected to be on the order of 6 to 8 inches over a period of about 50 years, mostly due to the decomposition of the organic peat material. The secondary settlement may pose maintenance challenges throughout the life of the road.

Project Information

Standard Special Provision S5-280, "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is an excerpt from SSP S5-280 disclosing information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to the addressee(s) of this report via electronic mail.

Data and information attached with the project plans are:

A. None

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

A. Supplemental GDR for EA 10-0G8001, dated 9/7/2009.

Data and Information available for inspection at the District Office:

A. None

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

A. None

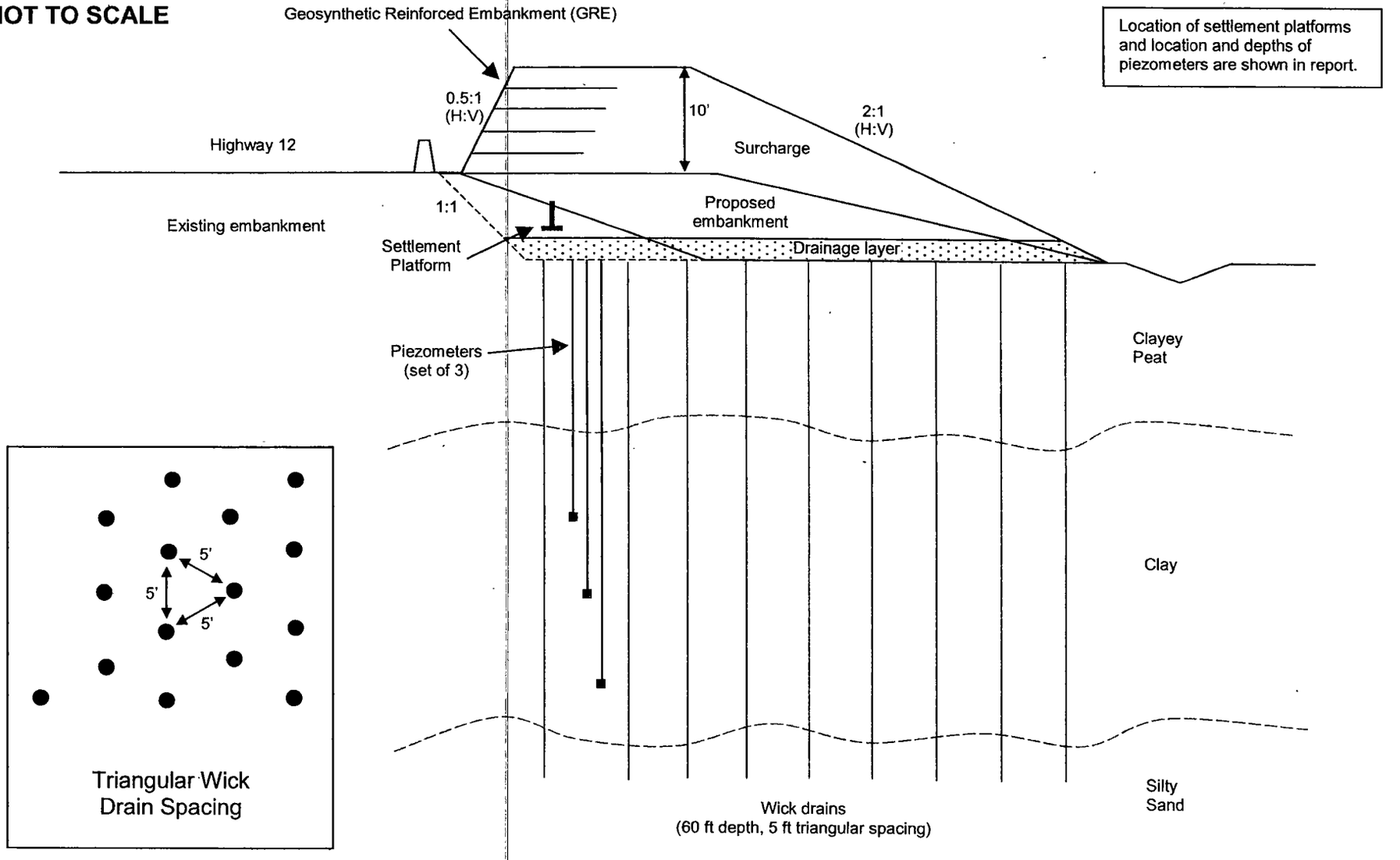
If you have any questions or comments, please contact Ben Barnes at (916) 227-1039.

Benjamin Barnes

BENJAMIN BARNES, P.E.
Transportation Engineer – Civil
Geotechnical Design – North

c: Qiang Huang
GDN File
GS File Room

NOT TO SCALE



CALTRANS
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - North

EA: 10-0G8001

Date: September 2009

WICK DRAIN LAYOUT AND EMBANKMENT INSTRUMENTATION

Figure 1

10-SJ-12 PM 0.1/4.2
SUPPLEMENTAL GEOTECHNICAL DESIGN REPORT

M e m o r a n d u m

Flex your power!
Be energy efficient!

To: MR. GARY JOE
Branch Chief, Branch 17
Office of Bridge Design Central
Structure Design
Division of Engineering Services

Attention: Rene Coria

Date: December 17, 2012

File: 10-SJ-12 PM 2.64
EA 10-0G8001
ID 1000000052
Bouldin Island
Retaining Walls

To: MR. NOMAR GUTIERREZ
Senior Design Engineer
Office of Design IV, Branch I
Project Development Central Region

Attention: Richard Boyer

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

Subject: Foundation Report

Introduction

The Office of Geotechnical Design North has prepared this Foundation Report (FR) to provide foundation recommendations for two retaining walls as part of the Bouldin Island rehabilitation/median barrier project on State Route (SR) 12 in San Joaquin County.

Scope of Work

The scope of our work for this FR includes review of the General Plan, Foundation Plan, evaluation of subsurface conditions based on the available geotechnical and geologic data, a field exploration program, and engineering and seismic analyses.

Project Description

The Bouldin Island rehabilitation/median barrier project covers a 4 mile segment of SR 12 on Bouldin Island from the Sacramento County line at the Mokelumne River Bridge (PM 0.1) to the Potato Slough Bridge (PM 4.4).

To improve a deteriorating roadway surface and driver safety, the project proposes to replace the existing two lane freeway with a new roadway section that includes 12 ft travel lanes in each direction, eight ft outside shoulders, five foot inside shoulders, and a concrete median barrier. Formerly served by an at-grade crossing, a bridge undercrossing will be installed at PM 2.64 (approximate STA 234+50) to maintain access between the properties to the north and south of SR 12. Due to right of way constraints, two Standard Plan Type 1 retaining walls are proposed along the southern edge of the east and west undercrossing approach fills. The walls will be approximately 500 feet in length with a design height ranging from 4 to 10 feet.

Field Investigation

For the Bouldin Island UC, the Office of Geotechnical Design North conducted a subsurface investigation in March 2011.

The subsurface investigation consisted of two rotary wash borings (No. R-11-001 and R-11-002) and two Cone Penetrometer Tests (CPT-11-001 and CPT-11-002). The borings were advanced using a self-casing wireline drilling method. The maximum depth reached by the borings and CPT was approximately 136.5 feet and 100.1 feet, respectively. Sampling was achieved in the borings utilizing a Standard Penetration Test (SPT) sampler. A summary of the borings and CPT is included in **Table 1**.

Table 1. Subsurface Exploration Summary for Bouldin Island UC

Boring / CPT No.	Completion Date	Drill Rig Type	Hammer Type	Hammer Efficiency (%)	Approx. Ground Surface Elevation (ft)	Boring Depth (ft)
R-11-001	3/8/2011	B-47	Safety	73	-12	136.5
R-11-002	3/9/2011	B-47	Safety	73	-12	111.5
CPT-11-101	1/7/2011	CPT	NA	NA	-12	104
CPT-11-102	1/7/2011	CPT	NA	NA	-12	105

For subsurface data and boring locations, please refer to the Log of Test Borings for Bouldin Island UC in the project plans.

Site Geology and Subsurface Conditions

Information regarding the regional geology can be found on the Geologic Map of the Sacramento Quadrangle, published by CDMG dated 1987. According to this map, the entire site is located in intertidal deposits, which consist mostly of peaty mud, labeled as Qi. This soil is composed of soft mud and peat that were deposited in marshes, swamps, and adjacent waterways.

The subsurface investigation indicates that the near surface soils consist of about 7 feet of very loose/soft peat underlain by about 5 feet of loose to very loose silty to clayey sand. Below these soils are layers of dense to very dense sand, silty sand, and clayey sand interbedded with layers of soft to very stiff clay, silty clay, and sandy clay and clayey silt to a depth of 97 feet. Below a depth of 97 feet, the soils consist of very dense sand and clayey sand and very stiff clay and clayey silt to the maximum depth explored of 136.5 feet.

Topography and Drainage

The topography of the project site is generally flat. The most prominent drainage feature is the Mokelumne River, which runs to the north of the site. The elevation at the proposed site of the retaining walls ranges from approximately -11.5 to -12.5 feet.

Ground Water

The groundwater depth was measured at a stabilized depth of 3 feet (approximate elevation -15 feet) in boring R-11-001 in March 2011.

Corrosion

For the roadway portion of this project, soil samples were tested for corrosion characteristics. The test results indicate that the soils within the project limits are non-corrosive.

Seismic Recommendations

Fault data was obtained from Caltrans ARS Online (v2.0) and Caltrans 2011 Fault Database. The nearest active fault to the site is the Great Valley fault 5 (Fault ID No. 24) with a Mmax of 6.5 and is located west of the proposed site. The rupture distance to the fault plane from the site is estimated to be about 12 miles. The fault is referred to as a reverse (R) fault with a dip angle of 15 degrees to the west.

Based on the log of test borings a V_{S30} (average shear wave velocity for the top 100 feet of soil column) was estimated using the SPT blow counts and the correlation formulas for both cohesive and granular soil. The estimated shear wave velocity is 700 feet per second.

Using the above shear wave velocity, the design Acceleration Response Spectrum, (ARS) curve is controlled by the USGS 5% probability of exceedance in 50 years (return period of 975 years). The spectral acceleration (SA) by the probabilistic method is higher than both the deterministic SA and the statewide minimum SA. The design ARS curve was obtained from "USGS 2008 Interactive Deaggregation (Beta)" web site. The estimated peak ground acceleration as shown on the ARS curve is 0.36g.

A liquefaction analysis indicates that the granular soil from elevation -29 to -34 feet in boring R-11-001 and from elevation -19 to -24 feet and -29 to -34 feet in boring R-11-002 have potential to liquefy during a seismic event. The ground surface elevation is approximately -12 feet.

The potential for surface rupture at the site due to fault movement is considered insignificant since there are no known faults projecting towards or passing directly through the project site.

Foundation Recommendations

Due to soft subsurface soils and the potential for excessive settlement, we recommend that the retaining walls be supported by Standard 14-inch Class 90 piles (Alternative “W”) with a pile tip elevation of -94 feet (pile cut-off elevation of -15 feet).

Settlement of the approach fills on the order of 3 to 4 feet is anticipated at the location of the proposed Standard Plan Type 1 retaining walls. To mitigate the settlement, wick

drains, surcharge and a settlement period are proposed. As the load produced by the embankment settlement may cause the wall to rotate, the fill embankment/surcharge must be constructed and the required settlement period completed before construction of the proposed Standard Plan Type 1 retaining walls may begin.

In order to effectively load the footing area, we recommend that a temporary Geosynthetic Reinforced Earth (GRE) wall be constructed along the layout line for each of the proposed Type 1 walls. The GRE walls should have a face slope of 0.5:1 (H:V) and extend horizontally for the entire length of the proposed Type 1 walls. The height of the GRE walls should vary to match the height of the proposed Type 1 walls. The slope above the GRE walls may be constructed at 2:1 (H:V). As with the embankment and surcharge, soil within the GRE walls must be compacted to 90%.

The temporary GRE walls must remain in place for the duration of the settlement period. Once the settlement period is complete, the GRE walls (and a portion of the embankment fill) may be removed and the Type 1 walls constructed.

Construction Considerations

1. Pile acceptance criteria for all driven piles shall be based on the Gates formula (Caltrans Standard Specifications Section 49-1.08).

2. The settlement waiting period must be completed before installation of the piles for the Type 1 walls may begin.

3. Ground water was encountered approximately 3 feet below the ground surface in boring R-11-001 in March 2011. Ground water may be encountered during excavation for the Type 1 walls.

4. All earthwork shall follow Section 19 of the Caltrans Standard Specifications.

Project Information

Standard Special Provision S5-280, "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is an excerpt from SSP S5-280 disclosing information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to the addressee(s) of this report via electronic mail.

Data and information attached with the project plans are:

A. None.

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

A. Foundation Report for Bouldin Island Retaining Walls, EA 10-0G8001, dated 12/17/2012.

Data and Information available for inspection at the District Office:

A. None.

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

A. None.

Disclaimer and Contact Information

The foundation recommendations included in this report are based on specific project information regarding structure type, location, and design loads provided by Structure Design. If any changes are made during final project design, OGDN should review the changes to determine if these foundation recommendations are still applicable. Any questions regarding this report should be directed to the attention of Ben Barnes at 916-227-1039.

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