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GEOTECHNICAL INVESTIGATION

Terminal Reservoir Renovation

500 Block of East Mountain Drive

Montecito, California

CLIENT
Montecito Water District
Attn: Adam Kanold
583 San Ysidro Road
Santa Barbara, CA 93108

June 14, 2021
Lab No: 135048-2
File No: 21-15481-2

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of a preliminary foundation investigation performed near the 500 block of East Mountain Drive in the Montecito area of Santa Barbara, California. Existing at the site is a reservoir for the Montecito Water District known as the Terminal Reservoir. The reservoir is built into the side of a slope with an earth fill on the south side supporting the south wall of the reservoir, while the north wall is supported on the cut excavation. It is proposed to modify the existing reservoir by excavating the bottom of the reservoir to a deeper elevation to increase the capacity.

SCOPE OF WORK

It is the purpose of this investigation to classify the soil disclosed by the exploratory borings and excavations by observation and tests on selected samples. In addition, this study includes laboratory tests to evaluate soil strength, the effect of moisture variation on the soil-bearing capacity, compressibility, liquefaction, and expansiveness. Based upon this information, we will provide grading and foundation recommendations for the proposed modifications.

The scope of this investigation does not include the analysis of geologic structures and their associated features, such as faults, fractures, bedding planes, strike and dip angles, ancient landslides, potential for earth movement in undisturbed or natural soil formations sloped or level, or other sources of potential instability which relate to the geologic conditions, as these items should be addressed by a qualified Engineering Geologist.

This exploration was conducted in accordance with presently accepted geotechnical engineering procedures currently applied in the local community in order to provide the appropriate geotechnical design characteristics of the foundations soils and of the proposed fill soils in order to properly evaluate the proposed structure with respect to differential settlement based upon the anticipated soil characteristics at the time of construction.

LIMITATIONS

This Laboratory's basic assumption is that the soil borings presented herein are representative of the entire footprint of the proposed development, however, no warranty is implied. If, during the course of construction, soil conditions are encountered which vary from those presented herein, please contact this Laboratory immediately so appropriate field modifications may be expeditiously proposed.

It is your responsibility to contact our office, providing at least 48 hours of notice for grading or footing excavation observations and testing. The observation of excavations during the construction phase represents an opportunity by our firm to either confirm soil conditions estimated by the exploratory borings or to discover soil conditions which have not been

addressed. When such undisclosed conditions are encountered, opinions and recommendations addressing these conditions will be rendered at that time.

FIELD INVESTIGATION

The subsurface soil conditions were explored by two truck-mounted auger borings, which were drilled to depths of up to 30 feet. The locations of the borings were selected as appropriate and representative. Representative, relatively "undisturbed" tube soil samples were obtained during the drilling operation by the Modified California sampler method. Laboratory tests and analysis of representative soil samples, obtained during the drilling operation, were performed to estimate the engineering properties and determine the soil classification. The locations of the borings are shown on Plate 1; these locations are approximate and have not been located by surveyed measurements. The boring log data is presented in Appendix A, "Field Investigation", while the results of the laboratory tests are provided in Appendix B, "Laboratory Tests".

SOIL CONDITIONS

1. No groundwater was encountered in the exploratory borings, which extended to depths of up to 30 feet. It should be recognized that water table elevations, even seasonal perched water tables, might fluctuate with time, being dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. Therefore, water level observations at the time of the field investigation may vary from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

2. The soil profile along the south side of the dam consists of an approximate 10-foot layer of fill soil. The fill is underlain by the sandstone rock of the Cold Water Formation.

3. The surface soils were found to have a very low potential for expansion.

4. The soil profile at this site is judged to be stiff soil corresponding to a Site Class C as specified in ASCE 7-16. This estimate is based on the borings, which encountered the geologic formation known as the Cold Water Formation, which is widely regarded as a Type C soil profile since the Standard Penetration Resistance typically results in blow counts greater than 50.

5. The potential for liquefaction is considered to be very low.

CORROSION POTENTIAL

Two (2) soil samples were obtained for corrosion testing. One sample was obtained from Boring No. 1 at the depth of 15 feet and the other from Boring No. 3 at a depth of 10 feet. The samples were evaluated for resistivity, chlorides, sulfates, and pH. The results are

presented in Appendix B. We recommend that the utility designer review the test data by consulting a licensed corrosion engineer to assess the relative impact and corrosion potential of buried materials. The results of the sulfate analyses indicate negligible sulfate exposure toward concrete. Type II cement can be used for concrete, unless other environmental or operating conditions indicate a more severe sulfate exposure. The results of the resistivity and chloride analyses indicate that corrosively toward ferrous metals is mild for the tested soil samples.

CONCLUSIONS AND RECOMMENDATIONS

It is the opinion of this Laboratory the proposed construction is feasible from a soil-engineering perspective provided the recommendations contained in this soil engineering report are incorporated into the design and implemented during construction.

Based upon the soil profile depicted by the exploratory borings, it appears the entire bottom of the reservoir is resting on the undisturbed Cold Water Formation. The proposal to extend the reservoir depth to a deeper elevation appears feasible and, therefore, the following recommendations are provided:

TEMPORARY AND PERMANENT CUT SLOPES

Permanent cut slopes in the Cold Water sandstone exist at this site and are nearly vertical. New cut excavations may be modeled after the existing cut slopes when excavated into similar hard sandstone conditions. Temporary cut slopes in the filled earth embankment shall be limited to a 45° angle (1 H to 1V).

FOUNDATIONS

The proposed foundations for the reservoir modifications may be for permanent retaining walls and for temporary shoring. The corresponding allowable soil bearing value may be assumed to be 2,500 psf with a one-third increase when considering wind or seismic forces when founded on the undisturbed native soil of the Cold Water Formation estimated to be 10-feet deep below the level grade surrounding the reservoir. Lateral earth pressures may be assumed an active soil pressure equivalent to a fluid (EFP) whose weight is 60 pcf for all backfill angles of up to 27 degrees maximum for compacted soil. The same value may be assumed for cut excavations in the native soil formation and no surcharge increase is required for native or cut slopes of any steep angle due to the geologic stability of the Cold Water Formation. The EFP value does not include surcharge loads nor hydrostatic lateral forces where drainage is not provided.

RESISTANCE TO LATERAL LOADS

Resistance to lateral loading can be provided by sliding friction acting on the base of spread footings combined with passive pressure acting on the sides of the foundation. A coefficient of 0.35 for resistance to lateral forces bearing in compacted fill or cut original ground

may be assumed. For resistance to lateral load, we recommend using a value of 400 pcf, equivalent fluid weight, for passive resistance acting on the sides of foundations, with concrete placed neat against compacted materials or cut original ground. Passive resistance should not be used for the upper one foot of soil that is not constrained at the ground surface by slab on grade or pavement. A one-third increase in passive value can be used when considering short-term wind or seismic loads.

SETTLEMENT

It is the intent of the recommendations contained in this report to achieve angular distortions[1] of approximately 1/480. A total settlement of approximately 1 inch or less is anticipated for foundations supported on the undisturbed native soil.

CONSTRUCTION OBSERVATION

The owner or his agent shall request the Project Geotechnical Engineer to observe all excavations prior to placement of compacted soil, gravel backfill, or rebar and concrete.

PLAN REVIEW

We request the grading and foundation plans be submitted to our office for a general review to verify substantial compliance to the recommendations contained in this report.

CLOSURE

The recommendations contained herein are for the sole use of our client and are based upon this Laboratory's understanding of the project which has been described herein. If the project scope, location, or conceptual design is subsequently altered, this Laboratory shall be requested to modify, as necessary, the recommendations contained herein as is appropriate for the new development concept. If the recommendations of this report are not implemented within one year, we recommend an update and review of the contents of this report be performed by this Laboratory.

The recommendations contained herein are based upon the assumption that Pacific Materials Laboratory shall be requested to perform the testing and observation services which will be required during the grading and foundation operations in order to verify that the actual soil conditions encountered and the construction procedures are consistent with the recommendations contained herein. If this service is performed by others, only the technical correctness of the actual analytical soil tests described here is attested to by this Laboratory.

[1] Angular distortion is the ratio of the vertical differential settlement divided by the horizontal distance over which the vertical differential is measured.

Thank you for the opportunity of providing this service. If you have any questions regarding this matter, please do not hesitate to call.

Respectfully submitted,

PACIFIC MATERIALS LABORATORY, INC.

Ronald J. Pike
Geotechnical Engineer, G. E. 2291

RJP:mpm

cc: Karl Meier
Email: kmeier@WoodRodgers.com
Montecito Water District, Attn: Adam Kanold
Email: akanold@montecitowater.com

LEGEND

B-1 – BORING LOCATION

SITE PLAN

Terminal Reservoir Renovation
500 Block of East Mountain Drive
Montecito, California

Pacific Materials Laboratory, Inc.

Scale: none	Plate 1 Lab No: 135048-2 File No: 15481-2 June 14, 2021

APPENDIX A

FIELD INVESTIGATION

June 14, 2021

Lab No: 135048-2

File No: 21-15481-2

June 14, 2021

-A.1-

Lab No: 135048-2
File No: 21-15481-2

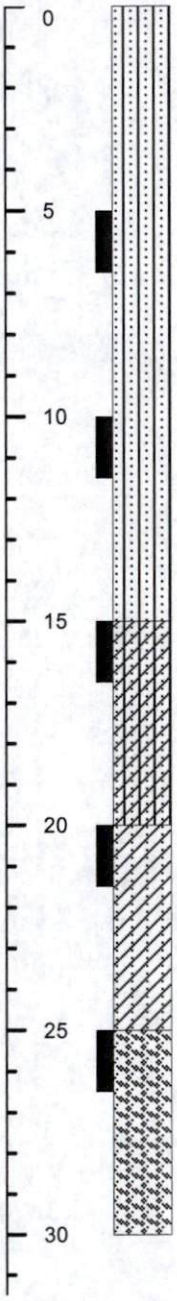
BORING LOG DATA

BORING NO. B-1

Field Technician: ZP

Date Drilled: 05/04/21

Blow Counts	Moisture Content (%)	Depth (ft)	Soil Log	Soil Description
		0		Brown silty SAND
38	9.6	5		
30	13.6	10		
6	12.2	15		Brown Clayey silty SAND
14	10.4	20		Clayey SAND
>50	10.3	25		SANDSTONE strata
>50	9.1	30		Auger Rejection from Hard Sandstone



LEGEND

■ - Modified California Sample

June 14, 2021

Lab No: 135048-2
File No: 21-15481-2

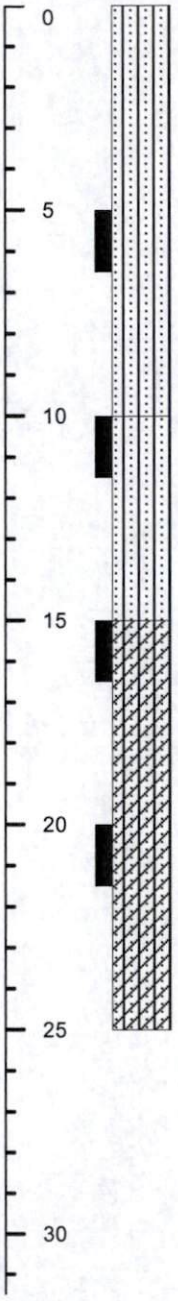
BORING LOG DATA

BORING NO. B-2

Field Technician: ZP

Date Drilled: 05/04/21

Blow Counts	Moisture Content (%)	Depth (ft)	Soil Log	Soil Description
		0		Brown silty SAND
>50	4.8	5		
>50	5.3	10		Black silty SAND
>50	5.4	15		Clayey silty SAND
>50	6.4	20		
>50	6.6	25		Auger Rejection from Hard Sandstone
		30		



LEGEND

■ - Modified California Sample

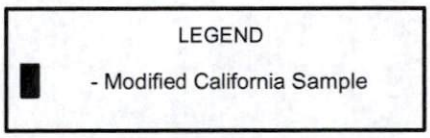
Lab No: 135048-2
File No: 21-15481-2

BORING LOG DATA

BORING NO. B-3

Field Technician: ZP Date Drilled: 05/04/21

Blow Counts	Moisture Content (%)	Depth (ft)	Soil Log	Soil Description
		0		Brown silty SAND
21	6.8	5		
21	11.3	10		Light brown CLAY
>50	8.9	15		Clayey silty SAND
>50	5.4	20		
>50	3.9	25		Auger Rejection from Hard Sandstone
		30		



June 14, 2021

Lab No: 135048-2
File No: 21-15481-2

BORING LOG DATA

BORING NO. B-4

Field Technician: ZP

Date Drilled: 05/04/21

Blow Counts	Moisture Content (%)	Depth (ft)	Soil Log	Soil Description
		0		Light brown SANDSTONE
>50	3.6	5		
>50	4.5	10		Tan brown SANDSTONE
>50	6.4	15		Auger Rejection from Hard Sandstone
		20		
		25		
		30		

LEGEND

■ - Modified California Sample

Pacific Materials Laboratory of Santa Barbara, Inc.

APPENDIX B

LABORATORY TESTS

June 14, 2021

Lab No: 135048-2

File No: 21-15481-2

MECHANICAL ANALYSES (Values in Percent Passing ASTM D 422)

SIEVE SIZE	B-1 @ 20'	B-3 @ 10'
1/2 Inch	86.7	95.4
3/8 Inch	86.3	92.9
No. 4	86.0	92.2
No. 8	85.5	91.1
No. 16	85.1	90.1
No. 30	83.3	87.3
No. 50	70.1	71.4
No. 100	46.4	47.3
No. 200	35.9	36.6

SAND-SILT-CLAY (By Hydrometer ASTM D 422)

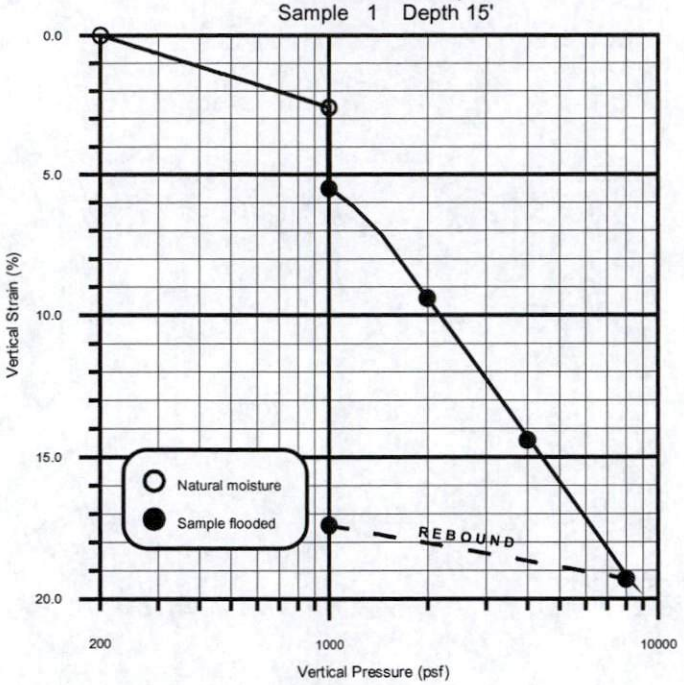
SAMPLE LOCATION	DEPTH (ft.)	SAND %	SILT %	CLAY %	SOIL DESCRIPTION
B-1	20	56	16	28	Clayey SAND
B-3	10	72	12	16	SAND

ATTERBERG LIMITS (ASTM D 4318)

SAMPLE LOCATION	DEPTH (ft.)	SOIL TYPE	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX
B-1	20	CL	24	21	3
B-3	10	CL	25	21	4

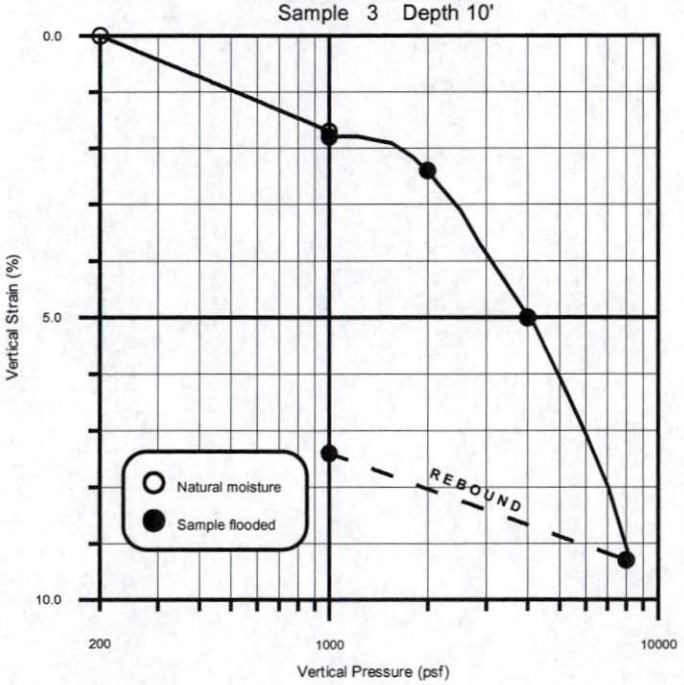
Consolidation Test Data

'Undisturbed' Sample
Sample 1 Depth 15'



Consolidation Test Data

'Undisturbed' Sample
Sample 3 Depth 10'

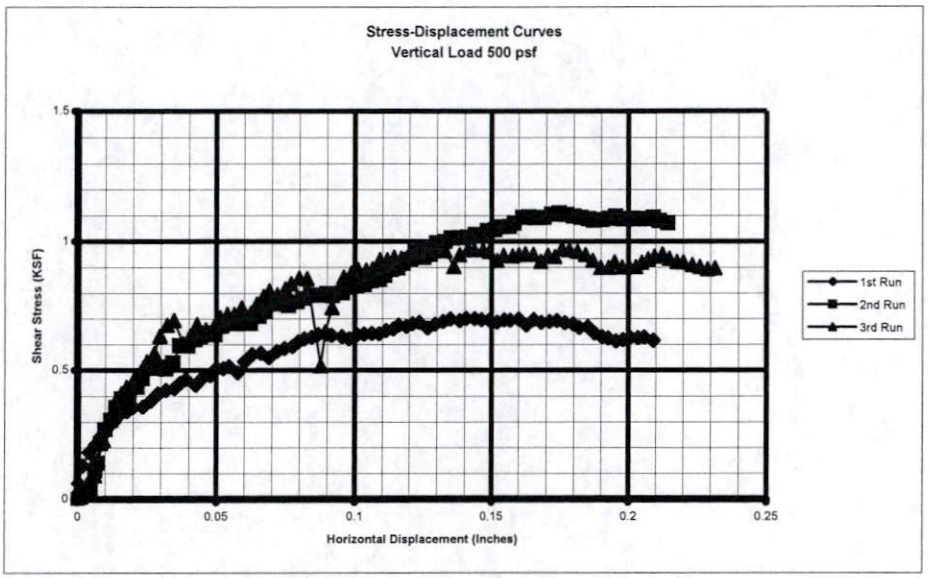


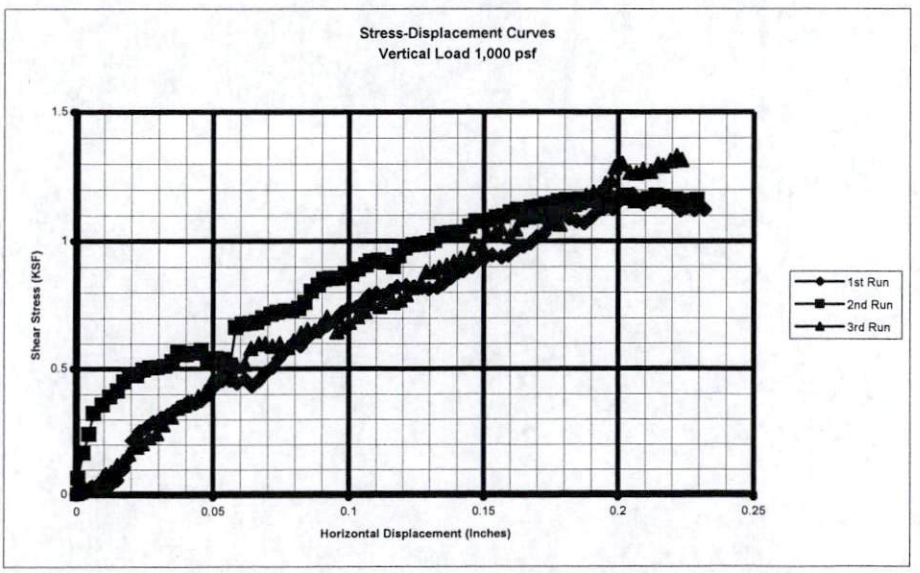
DIRECT SHEAR TESTS (ASTM D 3080)

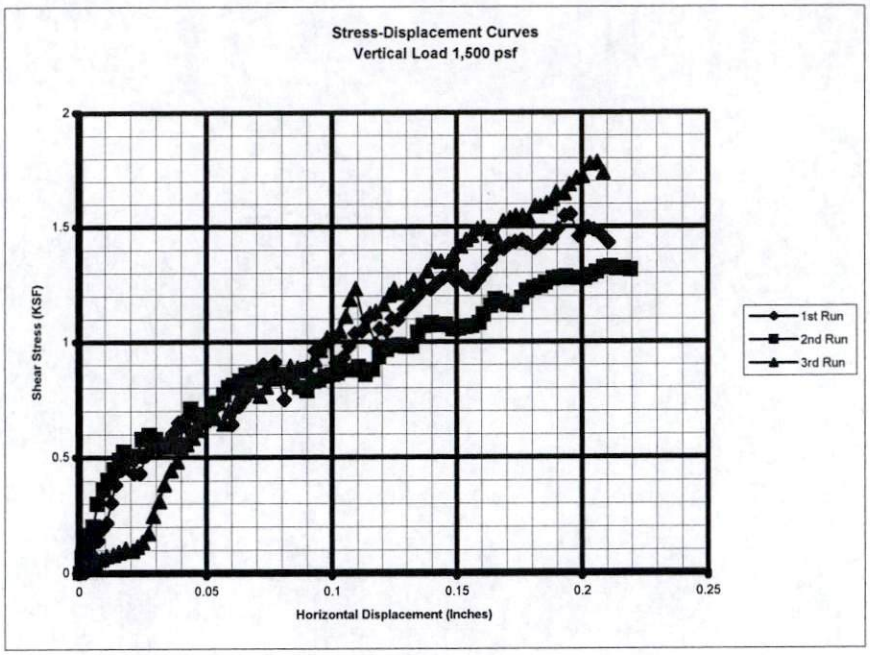
Two direct shear tests were performed on representative "undisturbed" soil samples which were 2.365 inches in diameter and 1 inch thick. The tests were performed under flooded conditions. The results are tabulated below:

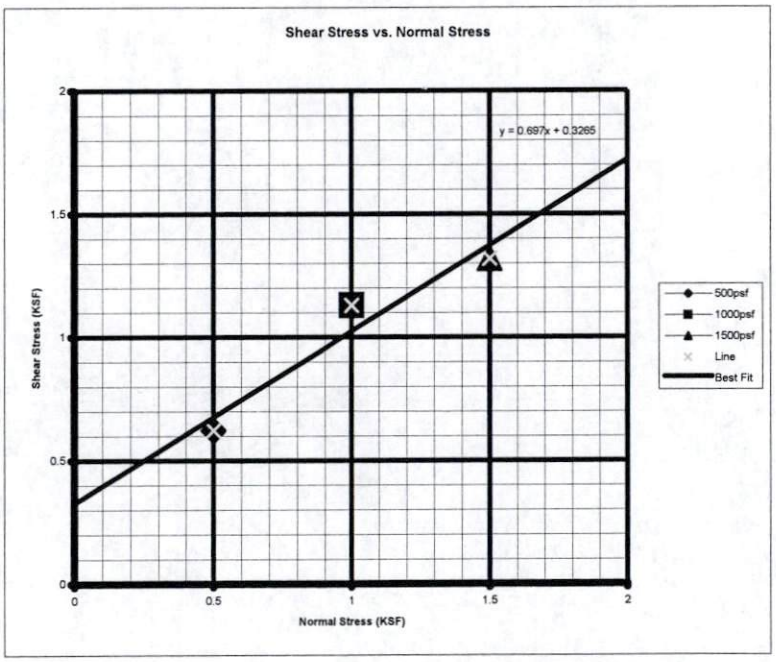
SAMPLE LOCATION	DEPTH (ft.)	INTERNAL ANGLE OF FRICTION (degrees)	COHESION (psf)
B-1	20	35	330
B-3	10	31	490

B-1

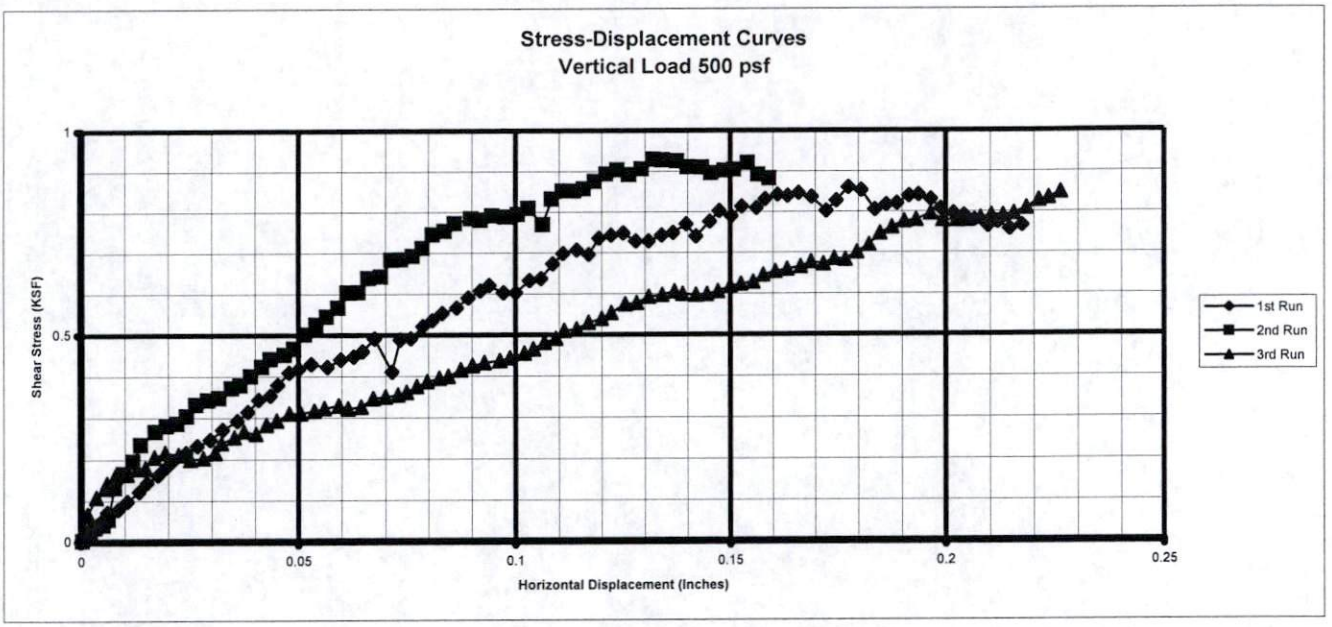


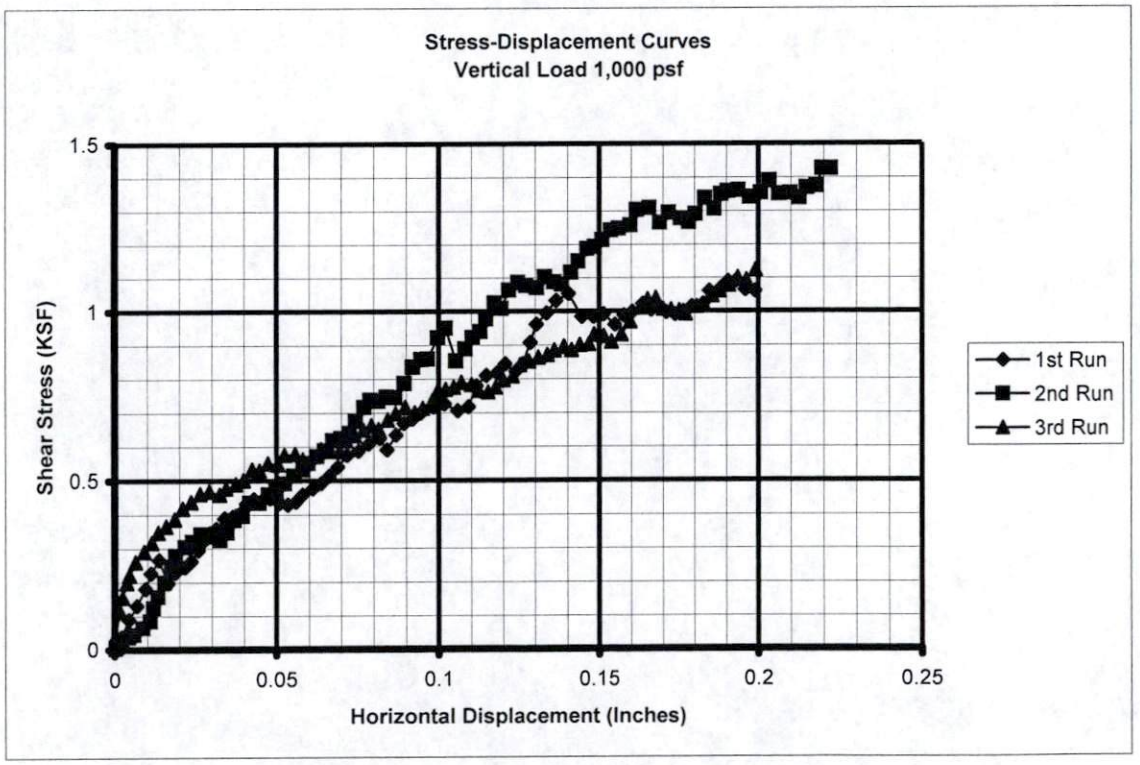


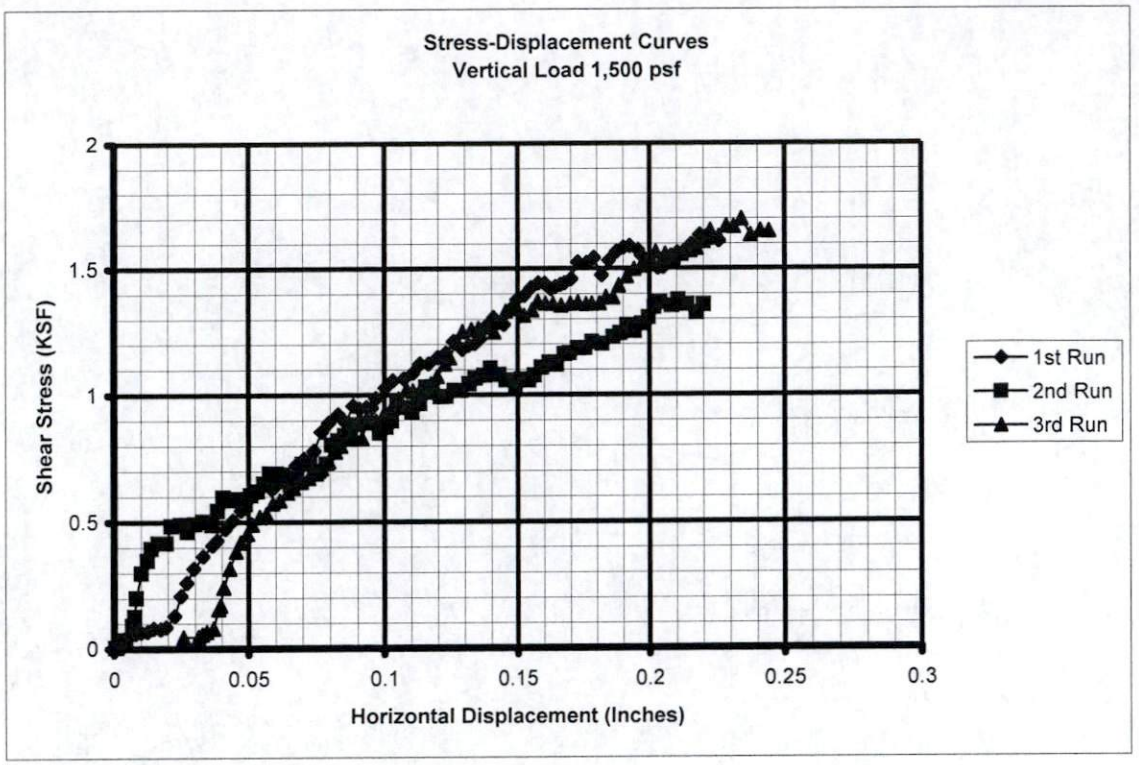

Stress-Displacement Curves
Vertical Load 1,500 psf
Shear Stress (KSF)
Horizontal Displacement (Inches)
0
0.05
0.1
0.15
0.2
0.25
0.5
1
1.5
2
1st Run
2nd Run
3rd Run

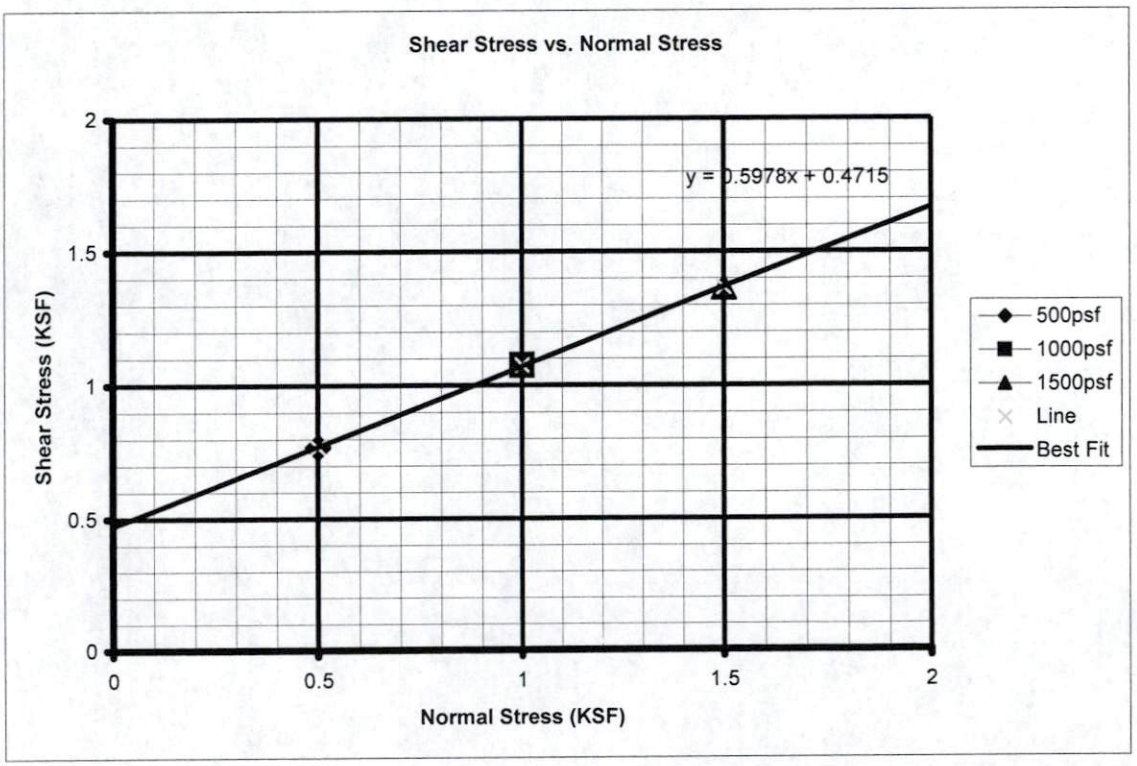

Shear Stress vs. Normal Stress
y = 0.697x + 0.3265
Shear Stress (KSF)
Normal Stress (KSF)
0
0.5
1
1.5
2
500psf
1000psf
1500psf
Line
Best Fit

B-3


Stress-Displacement Curves
Vertical Load 500 psf
Shear Stress (KSF)
1
0.5
0
0
0.05
0.1
0.15
0.2
0.25
Horizontal Displacement (Inches)
1st Run
2nd Run
3rd Run


Stress-Displacement Curves
Vertical Load 1,000 psf
Shear Stress (KSF)
1.5
1
0.5
0
0
0.05
0.1
0.15
0.2
0.25
Horizontal Displacement (Inches)
1st Run
2nd Run
3rd Run


Stress-Displacement Curves
Vertical Load 1,500 psf
Shear Stress (KSF)
2
1.5
1
0.5
0
0
0.05
0.1
0.15
0.2
0.25
0.3
Horizontal Displacement (Inches)
1st Run
2nd Run
3rd Run


Shear Stress vs. Normal Stress
y = 0.5978x + 0.4715
Shear Stress (KSF)
2
1.5
1
0.5
0
0
0.5
1
1.5
2
Normal Stress (KSF)
500psf
1000psf
1500psf
Line
Best Fit

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Prepared for: Pacific Materials Lab Santa Barbara, Inc.
P.O. Box 96
Goleta, CA 93116
Attn: Ron Pike

Report Date: June 3, 2021
Laboratory Number: 210853
Project Name: Terminal Reservoir
Sampled by: Ron Pike

Enclosed are the analysis results for samples received May 26, 2021 with the Chain of Custody document. The samples were received in good condition, at 23.5°C, and they were identified and assigned the laboratory ID numbers listed below:

SAMPLE DESCRIPTION	CAS LAB NUMBER ID
Terminal Reservoir 3/10	210853-01
Terminal Reservoir 1/15	210853-02

By my signature below, I certify that the results contained in this laboratory report comply with applicable standards for certification by the California Department of Public Health's Environmental Laboratories Accreditation Program (ELAP), both technically and for completeness, and that, based on my inquiry of the person or persons directly responsible for performing the analyses, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete.

Marcos Ramirez-Laboratory Director

If you have any further questions or concerns, please contact me at your convenience.
This report consists of 3 pages excluding the cover letter and the Chain of Custody.

CERTIFICATE OF ANALYSIS

Client: Pacific Materials
CAS LAB NO: 210853-01
Sample ID: Terminal Reservoir 3/10
Analyst: GP

Date Sampled: 05/13/21
Date Received: 05/26/21
Sample Matrix: Soil

WET CHEMISTRY SUMMARY

COMPOUND	RESULTS	UNITS	DF	PQL	METHOD	ANALYZED
pH (Corrosivity)	7.2	S.U.	1	---	9045	05/28/21
Resistivity*	15000	Ohms-cm	1	---	SM 120.1M	05/28/21
Chloride	16	mg/Kg	1	0.3	300.0M	05/28/21
Sulfate	80	mg/Kg	1	0.3	300.0M	05/28/21

*Sample was extracted using a 1:3 ratio of soil and DI water.

DF: Dilution Factor
PQL: Practical Quantitation Limit
BQL: Below Quantitation Limit
mg/Kg: Milligrams/Kilograms(ppm)

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CERTIFICATE OF ANALYSIS

Client: Pacific Materials
CAS LAB NO: 210853-02
Sample ID: Terminal Reservoir 1/15
Analyst: GP

Date Sampled: 05/13/21
Date Received: 05/26/21
Sample Matrix: Soil

WET CHEMISTRY SUMMARY

COMPOUND	RESULTS	UNITS	DF	PQL	METHOD	ANALYZED
pH (Corrosivity)	8.7	S.U.	1	---	9045	05/28/21
Resistivity*	15000	Ohms-cm	1	---	SM 120.1M	05/28/21
Chloride	9.0	mg/Kg	1	0.3	300.0M	05/28/21
Sulfate	63	mg/Kg	1	0.3	300.0M	05/28/21

*Sample was extracted using a 1:3 ratio of soil and DI water.

DF: Dilution Factor
PQL: Practical Quantitation Limit
BQL: Below Quantitation Limit
mg/Kg: Milligrams/Kilograms(ppm)

Quality Control Report

Client:	Pacific Materials	Date Sampled:	05/13/21
Sample ID:		Date Received:	05/26/21
CAS LAB NO:	210853	Date Analyzed:	05/28/21
Sample Matrix:	SOIL	Analyst:	GP

Sample Name	Qualifier	Sample Result	QC Result	Unit	Spike Level	%REC	Control Limits
Chloride (by EPA 300)							
Method Blank			BQL	mg/L			
Lab Control Sample			29.59	mg/L	30	99	90-110
210855-01 Matrix Spike		1.36	30.68	mg/L	30	98	80-120
210855-01 Matrix Spike Duplicate		1.36	30.58	mg/L	30	97	80-120
Sulfate (by EPA 300)							
Method Blank			BQL	mg/L			
Lab Control Sample			29.63	mg/L	30	99	90-110
210855-01 Matrix Spike		22.82	52.06	mg/L	30	97	80-120
210855-01 Matrix Spike Duplicate		22.82	51.83	mg/L	30	97	80-120

*ALL QC SAMPLES ARE PREPARED IN LIQUID PHASE

mg/L: Milligrams/Liter(ppm)

%Rec: Percent Recovered

BQL: Below Practical Quantitation Limit