INFORMATION HANDOUT

MATERIALS INFORMATION

PRELIMINARY FOUNDATION REPORT
W91/5 SEPARATION AND OVERHEAD
BR. 55-0293L
Dated November 18, 2008

PRELIMINARY FOUNDATION REPORT
MAGMP;OA AVENUE OFF-RAMP OVERHEAD
BR. 55-0472S
Dated November 18, 2008

PRELIMINARY FOUNDATION REPORT
E91-S5 CONNECTOR OVERHEAD
BR. 55-0503G
Dated November 18, 2008

FOUNDATION REPORT FOR STRUCTURES REHABILITATION
of retaining walls next to
BR 55-0293L, 55-0472S and 55-0503G
Dated July 11, 2009

REVISED FOUNDATION REPORT FOR STRUCTURES REHABILITATION
of retaining walls next to
BR 55-0293L, 55-0472S and 55-0503G
Dated July 11, 2009

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
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To: MR. Howard NG
Branch Chief
Bridge Design Branch 20

Date: November 18, 2008

File: 12-ORA-91/5-PM 3.56
EA: 12-0C9701
Bridge Rehabilitation (55-0293L)

Attn: **Sharareh Bikaee**

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design South 1
Branch B

Subject: Preliminary Foundation Report (PFR) for W91/5 Separation and Overhead structure (Br. 55-0293L)

Per your request received on October 28th, 2008, Geotechnical Design South 1 – Branch B has prepared this Preliminary Foundation Report (PFR) for the rehabilitation of the bridge: W91/5 Separation and Overhead structure (Br. 55-0293L). The purpose of this PFR is to provide preliminary foundation recommendation and identify additional investigations and studies.

1.0 INTRODUCTION

The subject bridge was built in 1970 on Route 91 in city of Fullerton, California at posted mile 3.56. It is a continuous 5 span cast-in-place (CIP) box girder (6 cells) bridge. The bridge is supported on driven pile foundations. The attached wingwalls are either supported by pile foundation or cantilevered from the abutments. The retaining walls by the wingwalls are supported either by pile foundations or by spread footings. According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The proposed bridge rehabilitation includes retaining wall repair, bridge rail upgrades, slab replacement, expansion joints repair, and etc.

2.0 SUMMARY OF THE SITE GEOLOGY AND SUBSURFACE CONDITIONS

2.1 Regional Geology

The project lies within the Peninsular Range Geomorphic Province. The Peninsular Ranges Province is characterized by northwest to southeast trending mountain ranges and faults, which are parallel to and related to the San Andreas Fault.

2.2 Site Geology

The site is located south of the Coyote Hills, in the Los Angeles Basin. The Los Angeles Basin is filled by deposits of alluvial sediment derived from the surrounding hills and mountains. The alluvial sediments are underlain by a thick sequence of primarily Neogene, marine sediments that overlie Mesozoic, crystalline, basement rocks at great depth.

Based on documented Logs of Test Borings (LOTBs), two field investigations were performed the site in 1956 and 1957, respectively, which included SPT borings and CPT soundings. Both of the investigations covered the sites of W91/5 Separation and Overhead structure (Br. 55-0293L), and Magnolia Avenue off-ramp Overhead (Br. 55-0472S). According to the LOTBs, the ground surface elevation of the site was approximately 90 feet, which was underlain by alluvial material that consisted of loose to medium dense sandy silt approximately to an elevation of 80 feet. Below elevation 80 feet was a layer of interbedded dense sandy silt/silty sand of approximately 40 feet, which was underlain by dense clean sand. Even though ground water was not encountered during 1956 field investigation, it was encountered at an elevation between 65 and 70 feet in 1957 field investigation. It should be advised that this data is old and ground water levels can fluctuate with change of season, climate, irrigation and so on.

3.0 PRELIMINARY SEISMIC STUDY

3.1 Grout Motion Study

The controlling fault for the subject bridge is Puente Hills Blind Thrust, which is not on the current Caltrans Seismic Hazard Map (1996), but is on the Caltrans new fault list to be considered in design. The Puente Hills Blind Thrust largely runs in an east-west direction. It starts from downtown Los Angeles (west) at depths between 2 and 9 miles and continues eastward, dipping under the San Gabriel Mountains. It is a reverse/thrust fault of MCE Moment Magnitude 7.3. The controlling fault is located 5.28 miles from this bridge. The peak ground acceleration (PGA) is 0.5g based on Sadigh et al. (1997) attenuation with assigned soil type D.

The standard and adjusted ARS curves of the bridge are included in Appendix A. The adjusted curve is obtained from standard curve with adjustment according to Caltrans SDC (2006) to account for near source and/or long period effect.

3.2 Liquefaction Evaluation

The bridge is located within liquefiable zone based on Seismic Hazard Zone Maps (California Geological Survey, 2008). Therefore, liquefaction potential exists for this bridge site and can be investigated further in a Foundation Report (FR).

3.3 Fault Rupture Study

The bridge is not located within California Geological Survey (CGS) Fault-Rupture Hazard Zones (Alquist-Priolo Earthquake Fault Zones). Therefore, the potential of surface rupture is considered low for this bridge.

4.0 SCOUR EVALUATION

Since there is no water channel for any of the bridge, the scour potential is considered low for this bridge.

5.0 CORROSION EVALUATION

No evidence of laboratory testing was found in the office files for these existing structures. The actual potential is unknown and should be verified before construction.

6.0 RETAINING WALL FOUNDATION AND MOVEMENT

According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The movement has been stable after the year of 2000 based on the bridge inspection reports dated between 2000 and 2006. Detailed information regarding the retaining wall foundations and measured movement are provided Table 1.

Table 1. Foundation Data and Movement of Retaining Walls of W91/5 Separation and Overhead

Retaining wall	Foundation Type	Horizontal movement (in)	Vertical movement (in)
Northeast	Spread footing	0	6
Northwest	Spread footing	See note (1)	6
Southeast	Pile foundation	0	0
Southwest	Spread footing	See note (1)	See note (1)

Note: (1) data unclear or not given in bridge inspection report

Summarily, the retaining walls on spread footing have experienced noticeable movement since they were built. The retaining walls on pile foundation do not appear to settle so far.

The southeast and northeast wingwalls are cantilevered from the abutments and have moved approximately outward 4 inches and inward 4inches from the retaining walls, respectively. The movements of other wingwalls are not given in bridge inspection reports

7.0 PRELIMINARY FOUNDATION RECOMMENDATIONS

The causes of vertical and horizontal movement of the retaining walls and wingwalls cannot be revealed until investigation has been performed. Therefore, no recommendation for the foundation can be made at the date of this PFR.

Geotechnical site exploration and laboratory testing are recommended to investigate the causes of the movement of these retaining walls and wingwalls. Foundation or rehabilitation recommendation then can be made accordingly.

If you have any questions, please call Jie Huang at (213) 620-2367 or Sam Sukiasian at (213) 620-2135.

Prepared by: Date: 11/18/08

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Supervised by: Date: 11/18/08

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11-18-08

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STATE OF CALIFORNIA

cc: OGDS1 – Los Angeles File
OGDS1 – SAC File (MS-5)
GS – SAC File (MS-5)

REFERENCES

1. Caltrans, Seismic Design Criteria, 2006.
2. Caltrans, Seismic Hazard Map, 1996.
3. California Geological Survey, Seismic Hazard Zone Maps, 2008.

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
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To: MR. Howard NG
Branch Chief
Bridge Design Branch 20

Date: November 18, 2008

File: 12-ORA-91/5-PM 3.64
EA: 12-0C9701
Bridge Rehabilitation (55-0472S)

Attn: **Sharareh Bikaee**

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design South 1
Branch B

Subject: Preliminary Foundation Report (PFR) for Magnolia Avenue off-ramp Overhead (55-0472S)

Per your request received on October 28th, 2008, Geotechnical Design South 1 – Branch B has prepared this Preliminary Foundation Report (PFR) for the rehabilitation of the bridge: Magnolia Avenue off-ramp Overhead (55-0472S). The purpose of this PFR is to provide preliminary foundation recommendation and identify additional investigations and studies.

1.0 INTRODUCTION

The subject bridge was built in 1970 on Route 91 in city of Fullerton, California at posted mile 3.64. It is a continuous 5 span reinforced concrete (RC) box girder (2 cells) bridge. The bridge is supported on driven pile foundations. The attached wingwalls are either supported by pile foundation or cantilevered from the abutments. The retaining walls by the wingwalls are supported either by pile foundations or by spread footings. According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The proposed bridge rehabilitation includes retaining wall repair, bridge rail upgrades, slab replacement, expansion joints repair, and etc.

2.0 SUMMARY OF THE SITE GEOLOGY AND SUBSURFACE CONDITIONS

2.1 Regional Geology

The project lies within the Peninsular Range Geomorphic Province. The Peninsular Ranges Province is characterized by northwest to southeast trending mountain ranges and faults, which are parallel to and related to the San Andreas Fault.

2.2 Site Geology

The site is located south of the Coyote Hills, in the Los Angeles Basin. The Los Angeles Basin is filled by deposits of alluvial sediment derived from the surrounding hills and mountains. The alluvial sediments are underlain by a thick sequence of primarily Neogene, marine sediments that overlie Mesozoic, crystalline, basement rocks at great depth.

Based on documented Logs of Test Borings (LOTBs), two field investigations were performed the site in 1956 and 1957, respectively, which included SPT borings and CPT soundings. Both of the investigations covered the sites of W91/5 Separation and Overhead structure (Br. 55-0293L), and Magnolia Avenue off-ramp Overhead (Br. 55-0472S). According to the LOTBs, the ground surface elevation of the site was approximately 90 feet, which was underlain by alluvial material that consisted of loose to medium dense sandy silt approximately to an elevation of 80 feet. Below elevation 80 feet was a layer of interbedded dense sandy silt/silty sand of approximately 40 feet, which was underlain by dense clean sand. Even though ground water was not encountered during 1956 field investigation, it was encountered at an elevation between 65 and 70 feet in 1957 field investigation. It should be advised that this data is old and ground water levels can fluctuate with change of season, climate, irrigation and so on.

3.0 PRELIMINARY SEISMIC STUDY

3.1 Grout Motion Study

The controlling fault for the subject bridge is Puente Hills Blind Thrust, which is not on the current Caltrans Seismic Hazard Map (1996), but is on the Caltrans new fault list to be considered in design. The Puente Hills Blind Thrust largely runs in an east-west direction. It starts from downtown Los Angeles (west) at depths between 2 and 9 miles and continues eastward, dipping under the San Gabriel Mountains. It is a reverse/thrust fault of MCE Moment Magnitude 7.3. The controlling fault is located 5.27 miles from this bridge. The peak ground acceleration (PGA) is 0.5g based on Sadigh et al. (1997) attenuation with assigned soil type D.

The standard and adjusted ARS curves of the bridge are included in Appendix A. The adjusted curve is obtained from standard curve with adjustment according to Caltrans SDC (2006) to account for near source and/or long period effect.

3.2 Liquefaction Evaluation

The bridge is located within liquefiable zone based on Seismic Hazard Zone Maps (California Geological Survey, 2008). Therefore, liquefaction potential exists for this bridge site and can be investigated further in a Foundation Report (FR).

3.3 Fault Rupture Study

The bridge is not located within California Geological Survey (CGS) Fault-Rupture Hazard Zones (Alquist-Priolo Earthquake Fault Zones). Therefore, the potential of surface rupture is considered low for this bridge.

4.0 SCOUR EVALUATION

Since there is no water channel for the bridge, the scour potential is considered low for this bridge.

5.0 CORROSION EVALUATION

No evidence of laboratory testing was found in the office files for these existing structures. The actual potential is unknown and should be verified in a Foundation Report (FR).

6.0 RETAINING WALL FOUNDATION AND MOVEMENT

According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The movement has been stable after the year of 2000 based on the bridge inspection reports dated between 2000 and 2006. Detailed information regarding the retaining wall foundations and measured movement are provided Table 1.

Table 1. Foundation Data and Movement of Retaining Walls of W91/5 Separation and Overhead

Retaining wall	Foundation Type	Horizontal movement (in)	Vertical movement (in)
Northeast	Spread footing	1 (out)	2.5 (down)
Northwest	Spread footing	0.5 (out)	4 (down)
Southeast	Pile foundation	0	0
Southwest	Spread footing	2.5 (out)	7 (down)

Summarily, the retaining walls on spread footing have experienced noticeable movement since they were built. The retaining walls on pile foundation do not appear to settle so far.

All wingwalls are cantilevered from the abutments. The movements of the wingwalls are not given in bridge inspection reports.

7.0 PRELIMINARY FOUNDATION RECOMMENDATIONS

The causes of vertical and horizontal movement of the retaining walls cannot be revealed until investigation has been performed. Therefore, no recommendation for the foundation can be made at the date of this PFR.

Geotechnical site exploration and laboratory testing are recommended to investigate the causes of the movement of these retaining walls. Foundation or rehabilitation recommendation then can be made accordingly.

If you have any questions, please call Jie Huang at (213) 620-2367 or Sam Sukiasian at (213) 620-2135.

Prepared by: Date: 11/18/08

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Supervised by: Date: 11/18/08

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cc: OGDS1 – Los Angeles File
OGDS1 – SAC File (MS-5)
GS – SAC File (MS-5)

REFERENCES

1. Caltrans, Seismic Design Criteria, 2006.
2. Caltrans, Seismic Hazard Map, 1996.
3. California Geological Survey, Seismic Hazard Zone Maps, 2008.

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
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To: MR. Howard NG
Branch Chief
Bridge Design Branch 20

Date: November 18, 2008

File: 12-ORA-91/5-PM 5.81
EA: 12-0C9701
Bridge Rehabilitation (55-0503G)

Attn: **Sharareh Bikaee**

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design South 1
Branch B

Subject: Preliminary Foundation Report (PFR) for E91-S5 Connector Overhead structure (55-0503G)

Per your request received on October 28th, 2008, Geotechnical Design South 1 – Branch B has prepared this Preliminary Foundation Report (PFR) for the rehabilitation of the bridge: E91-S5 Connector Overhead structure (55-0503G). The purpose of this PFR is to provide preliminary foundation recommendation and identify additional investigations and studies.

1.0 INTRODUCTION

The subject bridge was built in 1970 on Route 91 in city of Fullerton, California between posted mile 5.81. It is a continuous 4 span reinforced concrete box girder (4 cells) bridge. The bridge is supported on driven pile foundations. The attached wingwalls are either supported by pile foundation or cantilevered from the abutments. The retaining walls by the wingwalls are supported by spread footings. According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The proposed bridge rehabilitation includes retaining wall repair, bridge rail upgrades, slab replacement, expansion joints repair, and etc.

2.0 SUMMARY OF THE SITE GEOLOGY AND SUBSURFACE CONDITIONS

2.1 Regional Geology

The project lies within the Peninsular Range Geomorphic Province. The Peninsular Ranges Province is characterized by northwest to southeast trending mountain ranges and faults, which are parallel to and related to the San Andreas Fault.

2.2 Site Geology

The site is located south of the Coyote Hills, in the Los Angeles Basin. The Los Angeles Basin is filled by deposits of alluvial sediment derived from the surrounding hills and mountains. The alluvial sediments are underlain by a thick sequence of primarily Neogene, marine sediments that overlie Mesozoic, crystalline, basement rocks at great depth.

No filed field investigation was performed for E91-S5 Connector Overhead structure (Br. 55-0503G). The foundation recommendation of this bridge was made based on the field investigations for W91/5 Separation and Overhead structure (Br. 55-0293L), and Magnolia Avenue off-ramp Overhead (Br. 55-0472S).

Based on documented Logs of Test Borings (LOTBs), two field investigations were performed the site in 1956 and 1957, respectively, for W91/5 Separation and Overhead structure (Br. 55-0293L), and Magnolia Avenue off-ramp Overhead (Br. 55-0472S). Both of the investigations included SPT borings and CPT soundings. According to the LOTBs, the ground surface elevation of the site was approximately 90 feet, which was underlain by alluvial material that consisted of loose to medium dense sandy silt approximately to an elevation of 80 feet. Below elevation 80 feet was a layer of interbedded dense sandy silt/silty sand of approximately 40 feet, which was underlain by dense clean sand. Even though ground water was not encountered during 1956 field investigation, it was encountered at an elevation between 65 and 70 feet in 1957 field investigation. It should be advised that this data is old and ground water levels can fluctuate with change of season, climate, irrigation and so on.

3.0 PRELIMINARY SEISMIC STUDY

3.1 Grout Motion Study

The controlling fault for the subject bridge is Puente Hills Blind Thrust, which is not on the current Caltrans Seismic Hazard Map (1996), but is on the Caltrans new fault list to be considered in design. The Puente Hills Blind Thrust largely runs in an east-west direction. It starts from downtown Los Angeles (west) at depths between 2 and 9 miles and continues eastward, dipping under the San Gabriel Mountains. It is a reverse/thrust fault of MCE Moment Magnitude 7.3. The controlling fault is located 5.44 miles from this bridge. The peak ground acceleration (PGA) is 0.5g based on Sadigh et al. (1997) attenuation with assigned soil type D.

The standard and adjusted ARS curves of the bridge are included in Appendix A. The adjusted curve is obtained from standard curve with adjustment according to Caltrans SDC (2006) to account for near source and/or long period effect.

3.2 Liquefaction Evaluation

The bridge is located within liquefiable zone based on Seismic Hazard Zone Maps (California Geological Survey, 2008). Therefore, liquefaction potential exists for this bridge site and can be investigated further in a Foundation Report (FR).

3.3 Fault Rupture Study

The bridge is not located within California Geological Survey (CGS) Fault-Rupture Hazard Zones (Alquist-Priolo Earthquake Fault Zones). Therefore, the potential of surface rupture is considered low for this bridge.

4.0 SCOUR EVALUATION

Since there is no water channel for the bridge, the scour potential is considered low for this bridge.

5.0 CORROSION EVALUATION

No evidence of laboratory testing was found in the office files for these existing structures. The actual potential is unknown and should be verified in a Foundation Report (FR).

6.0 RETAINING WALL FOUNDATION AND MOVEMENT

According to the bridge inspection reports, the retaining walls of the bridge have been moving vertically and horizontally since they were built. The movement has been stable after the year of 2000 based on the bridge inspection reports dated between 2000 and 2006. Detailed information regarding the retaining wall foundations and measured movement are provided Table 1.

Table 1. Foundation Data and Movement of Retaining Walls of E91-S5 Connector Overhead

Retaining wall	Foundation Type	Horizontal movement (in)	Vertical movement (in)
Northeast*	Spread footing	N/A	N/A
Northwest	Spread footing	3 (out)	4 (down)
Southeast	Spread footing	0.5 (out)	4 (down)
Southwest	Spread footing	0	6 (down)

* This retaining wall was removed by 91&5 interchange expansion contract.

The northwest wingwall is on pile foundation. Other wingwalls are cantilevered from the abutments. The movements of the wingwalls are not given in bridge inspection reports.

7.0 PRELIMINARY FOUNDATION RECOMMENDATIONS

The causes of vertical and horizontal movement of the retaining walls cannot be revealed until an investigation has been performed. Therefore, no recommendation for the foundation can be made at the date of this PFR.

Geotechnical site exploration and laboratory testing are recommended to investigate the causes of the movement of these retaining walls. Foundation or rehabilitation recommendation then can be made accordingly.

If you have any questions, please call Jie Huang at (213) 620-2367 or Sam Sukiasian at (213) 620-2135.

Prepared by: Date: 11/18/08

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Supervised by: Date: 11/18/08

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cc: OGDS1 – Los Angeles File
OGDS1 – SAC File (MS-5)
GS – SAC File (MS-5)

REFERENCES

1. Caltrans, Seismic Design Criteria, 2006.
2. Caltrans, Seismic Hazard Map, 1996.
3. California Geological Survey, Seismic Hazard Zone Maps, 2008.

State of California

Business, Transportation and Housing Agency

Memorandum

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To: Mr. SON NGUYEN, Branch Chief
Design Branch E

Date: June 11, 2009

File: 12-ORA-91-PM 3.51/3.64
EA 12-0C9701
Structures Rehab of Retaining Walls next to three bridges (55-0293L, 55-0472S, and 55-0503G)

Attn: Mr. James Lai

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design South-1 Branch B

Subject: Foundation Report for Structures Rehabilitation of Retaining Walls next to Three Bridges (55-0293L, 55-0472S, and 55-0503G)

Per your request dated January 29, 2009, the Office of Geotechnical Design – South 1, Branch B has performed a site-specific geotechnical study to provide a Foundation Report (FR) for the above referenced project.

1.0 SITE CONDITIONS AND DISTRESS

Retaining wall and wingwall distresses were observed next to three bridges (55-0293L, 55-0472S, and 55-0503G at location W91/5, E91/S5 connector, and E91/Magnolia Offramp respectively). Their locations are shown in Figure 1. Caltrans D7 maintenance has been performing regular observation and investigation on these structures, and Bridge Inspection Reports for these locations were provided to us on 1/29/2009.

According to the Bridge Inspection Reports, the retaining walls at these locations have been moving vertically and/or horizontally since they were built in 1970s. Total vertical displacement 3.25 to 10 inches and horizontal displacement 0.5 to 4.5 inches were observed. It is worth noting that the retaining walls founded on spread footings have experienced noticeable movement since they were built; while retaining walls on pile foundation do not appear to settle so far.

For wingwalls, horizontal movement of 4 to 4.5 inches was observed at bridge 55-0293L Northeast and Southeast wingwalls. No vertical and/or horizontal movement was observed or reported for all other wingwalls. A summary of the settlement and horizontal movement of these retaining walls and wingwalls is given in Table 1.

Preliminary foundation reports for the subject project have been conducted by Geotechnical Design – South 1 Branch B and submitted to your office on 11/18/2008.

Table 1: Bridge Inspection Report Summary

Maintenance Inspection report			Ver. Disp.				Hor. Disp.				
Br. #	Type of str.	Inspection date	NW	NE	SW	SE	NW	NE	SW	SE	Notes
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	
55-0472S	Ret. Wall	10/28/2008	5.5	3.25	10	0	.5' out	1' out	2.5' out	0.5' out	Measured 10/28/08
55-0472S	Ret. Wall	10/3/2006	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	4/7/2004	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	14/2/2002	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	28/03/2000	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall**	4/8/1991	3.75	2.625	6.5		0	1' out	2.5' out	NA	
55-0472S	Ret. Wall**	12/29/1982	2.75	2.125	4.5	0					
55-0472S	Ret. Wall**	5/20/1980	2.75	2	3.5	ok					
55-0472S	Ret. Wall**	10/31/1978	1.625	1.75	2.875	0.125	0.125 out	0.1875 out	0.75 out	0.125 out	
55-0472S	Ret. Wall**	5/12/1977	1.25	1.5	2.25	normal					

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement.

Maintenance Inspection report			Ver. Disp.					Hor. Disp.					
Br. #	Type of str.	Inspection date	NW Abut. Joint	NW	NE	SW	SE	NW Abut. Joint	NW	NE	SW	SE	Notes
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	
55-0503G	Ret. Wall	10/28/2008	0.5	5.5	Removed	6	4	2 out	4	Removed	0	0.5 out	Measured 10/28/08
55-0503G	Ret. Wall	10/3/2006	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	4/7/2004	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	14/2/2002	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	28/3/2000	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
													From Previous insp. Rep.
55-0503G	Ret. Wall**	4/8/1991	.25 up	4	2.875	5.375	3.25	1.5 out	3 out	1.75 out		0.625 out	
55-0503G	Ret. Wall**	12/29/1982		0	2.25	4.75	2.625		1.125 out				
55-0503G	Ret. Wall**	5/27/1980		3	1.75	4.375	2.5						
55-0503G	Ret. Wall**	10/31/1979			1.875	4.25*	2.375*			1.5 out	0.1875 in	0.75 out	
55-0503G	NW Ret. Wall** (Outer)	10/31/1979		2.375					1.625 out				
55-0503G	NW Wing wall (Inner)	10/31/1979		0					.75 out				
55-0503G	Ret. Wall**	5/12/1977		normal	1.25	3.25	2.125						

*There are two settlement for SE (4.25" and 2.375"), and with considering the next reports , I think 4.25" is for SW and 2.375" is for SE.

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement.

Maintenance Inspection report			Ver. Disp.				Hor. Disp.			
Br. #	Type of str.	Inspection date	NW	NE	SW	SE	NW	NE	SW	SE
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
55-0293L	Ret. Wall	1/12/2009	4.5***	5***			.5 out***			
55-0293L	Ret. Wall	10/28/2008	6or4*	6		0	1 out			
55-0293L	Ret. Wall	10/3/2006	6or4*	6		0	1 out			
55-0293L	Ret. Wall	4/7/2004	6or4*	6		0	1 out			
55-0293L	Ret. Wall	14/2/2002	6or4*	6		0	1 out			
55-0293L	Ret. Wall	3/28/2000	6or4*	6		0	1 out			
55-0293L	Wing wall	1/12/2009						4.5 inward***		
55-0293L	Wing wall	10/28/2008						4 inward		4 out
55-0293L	Wing wall	10/3/2006						4 inward		4 out
55-0293L	Wing wall	4/7/2004						4 inward		4 out
55-0293L	Wing wall	14/2/2002						4 inward		4 out
55-0293L	Wing wall	3/28/2000						4 inward		4 out
55-0293L	Ret. Wall**	4/8/1991	2.625	3.75	1	0.5 up	0.5 out	2.875 out	1.125 out	1.125 out

* 6" per last paragraph pg.1 and 4" per 7th paragraph pg.2

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement. *** Per my last visit accompanying by James Lai from district 12 and Ben Phan from Maintenance (This report is provided By Sharareh Bikaee (SD - Diamond Bar Office))

2.0 GEOTECHNICAL SUBSURFACE INVESTIGATION

The subsurface exploration program conducted for the project consisted of four (4) soil borings and thirteen (13) Cone Penetrometer Tests (CPTs). The boring and CPT locations are shown in Figure 2-1 and 2-2, and summarized in Table 2. The borings were drilled to a depth from 46.5 feet to 51.5 feet from March 23 to April 2, 2009. A log of soil boring is shown in Appendix A. CPTs were terminated at a depth from 17 feet to 90 feet. The CPT test results are attached in Appendix B.

Table 2 – Summary of Soil Borings

Location No.	Br. No.	Location Name	Soil Boring Drilled	
			Bridge NW and SW (Abut #1)	Bridge NE and SE (Abut #6 or #5)
1	55-0293L	W91/5 Separation & Overhead	C4,C5,C6 and R-09-02	C1,C2,C3 and R-09-01
2	55-0472S	E91/Magnolia Ave Offramp Overhead	C11,C12,C13 and A-09-04	C10
3	55-0503G	E91/5S Connector Overhead	C7,C8,C9 and R-09-03	C10

A Caltrans-operated Mobile B-80 drill rig and an Acker MP-8 drill rig were used to drill the 4 soil borings. The rig was outfitted with hollow stem auger or rotary wash drilling equipment. The diameter of the boring was 8 inches. Samples were obtained from the borings by driving a 1.4-inch inside-diameter split-spoon sampler with a 140-pound hammer, free-falling 30 inches, or by pushing a 2.5-inch inside-diameter split-spoon sampler with downward hydraulic pressure. The soil samples were obtained at a 2.5-foot or 5-foot interval. The sampler was advanced 18 inches at each sampling and the blow counts required to advance the sampler for each 6-inch interval were recorded. The blow counts for the last 12 inches were summed to get the raw N value. Soil boring locations are presented in Figure 2-1 and 2-2. Soil boring logs are presented in Appendix A.

A total of thirteen (13) Cone Penetration Tests (CPTs) were sounded from March 23 to 26, 2009. The CPTs were advanced with a Vertek 20-ton CPT rig from 17 to 90 feet until refusal. CPT sounding logs are attached in Appendix B.

Following the drilling and sampling, borehole R-09-01 was back-filled grouting and patched with PCC at the surface, while borehole R-09-02, R-09-03, and A-09-04 were converted to peizometers to check the ground water level. Ground water was measured later on 04/21/09 and no ground water was encountered.

3.0 LABORATORY TESTING

Laboratory testing was performed on selected samples retrieved from the borings. Laboratory testing included dry density determination, moisture content, mechanical analysis, Atterberg Limits, maximum dry density and optimum moisture content, direct shear, unconfined

compression and consolidation characteristics. Undisturbed and bulk samples were transported to the Translab for testing. Testing was performed in accordance with California Test Methods and/or ASTM procedures (see Table 3 below). Results for the laboratory tests are presented in Appendix C, and in the boring logs in Appendix A.

Table 3 – Laboratory Test Methods

Test	Standard
Dry Density	CTM 212
Moisture Content	CTM 226
Direct Shear	ASTM D3080
Mechanical (sieve) Analysis	CTM 201, 202, 203
Atterberg Limits	CTM 204
Consolidation	ASTM 2435
Maximum dry density	ASTM D1557
Unconfined Compression	ASTM D2166
Corrosion – Resistivity, pH	CTM 643
Corrosion – Chloride content	CTM 422
Corrosion – Sulfate content	CTM 417

4.0 SUBSURFACE CONDITIONS

4.1 Location 1, Bridge 55-0293l

Abut #1 (bridge NW and SW)
Based on the results of the soil boring exploration, underlying soils at Abut #1 at this location consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) mixture in the upper 24 feet, and loose to medium dense sandy material (SM/ML) in the lower 10 feet. The height of the embankment is approximately 34 feet. The underlying **native** material consisted of medium dense to very dense Silty Sand (SM) interbedded with some Silt/Clay (ML/CL).

Abut #6 (bridge NE and SE)
Underlying soils at Abut #6 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 34 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

4.2 Location 2, Bridge 55-0472s

Abut #1 (bridge NW and SW)
Underlying soils at Abut #1 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 37 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

Abut #6 (bridge NE and SE)
Underlying soils at Abut #6 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) in the upper 20 feet, and loose to medium dense sandy material (SM/SP) in the lower 5 feet. The height of the embankment is approximately 25 feet. The underlying **native** material consisted of medium dense to very dense sandy material.

4.3 Location 3, Bridge 55-0503g

Abut #1 (bridge NW and SW)
Underlying soils at Abut #1 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 37 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

Abut #5 (bridge NE and SE)
Underlying soils at Abut #5 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) in the upper 20 feet, and loose to medium dense sandy material (SM/SP) in the lower 5 feet. The height of the embankment is approximately 25 feet. The underlying **native** material consisted of medium dense to very dense sandy material.

4.4 Ground Water

No ground water was encountered during this exploration for all locations, with borings advanced to a depth of 51.5 feet below existing pavement (ground) surface. According to As-Built log of test borings drilled for these bridges in 1957, no ground water was encountered for Location 2 and 3. However, ground water was encountered for Location 1 at elevation 67 to 70.5 feet, approximately 50 to 54.5 feet below existing pavement (ground) surface at Location 1. A 1956 literature also mentioned that the ground water was encountered at a project 800 feet away at an elevation of 67-70 feet.

5.0 GEOLOGY

5.1 Regional Geology

The site is within the Los Angeles Basin of the Peninsular Ranges geomorphic province. The Peninsular Ranges province is composed of mountain ranges that are oriented northwest-southeast, which are roughly parallel and related to the San Andreas fault. The Los Angeles Basin is an alluvium filled basin that is up to several miles thick at its deepest point. Quaternary alluvium underlies the project area. The site lies south of the Coyote Hills.

5.2 Site Geology

The site is underlain by artificial fill and alluvial material that consists of various amounts of lean clay, silt, and sand with trace amounts of gravel. The fill extends to roughly 25 to 35 feet below ground surface. Densities are generally medium dense and stiff with some layers of harder and softer material. Asphalt and concrete pieces were observed in the fill. Bedrock was not encountered in any of the borings. The maximum depth of the borings was 51.5 feet below ground surface.

6.0 SEISMICITY

The project site is not located within an Alquist-Priolo Earthquake Fault Zone as established by the California Geological Survey (CGS, 1997). Therefore, the possibility of fault rupture is considered to be low. The project does not lie within an area with potential for seismically induced landslides. Therefore, the risk of landslides is also low.

The controlling fault for the subject bridge is Puente Hills Blind Thrust, which is not on the current Caltrans Seismic Hazard Map (1996), but is on the Caltrans new fault list to be considered in design. The Puente Hills Blind Thrust largely runs in an east-west direction. It starts from downtown Los Angeles (west) at depths between 2 and 9 miles and continues eastward, dipping under the San Gabriel Mountains. It is a reverse/thrust fault of MCE Moment Magnitude $M_w = 7.3$. The controlling fault is located 5.28 miles from this bridge. The peak ground acceleration (PGA) is 0.5g based on Sadigh et al. (1997) attenuation with assigned soil type D.

The standard and adjusted ARS curves of the bridge are included in Appendix D. The adjusted curve is obtained from standard curve with adjustment according to Caltrans SDC (2006) to account for near source and/or long period effect.

7.0 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon in which loose, saturated, fine-grained granular soils behave like liquid after subjected to high-intensity of ground shaking. Liquefaction occurs when three general conditions exist:

1. Shallow groundwater;
2. Low density fine, sandy soils; and
3. High-intensity ground motion.

Screening for liquefaction hazard was performed using the California Division of Mines and Geology (CDMG) Seismic Hazard Map for the Anaheim quadrangles (http://gmw.consrv.ca.gov/shmp/download/pdf/ozn_anah.pdf). According to this map, the project site is located within the liquefaction zone. However, **the liquefaction potential of the**

subject sites is considered low due to the low ground water level and relatively clayey material encountered on the sites. Liquefaction analysis was performed in general accordance with the methods outlined in the National Center for Earthquake Engineering Research workshops (NCEER, 1997).

8.0 SCOUR EVALUATION

Scour can occur when a current or flow of water removes mud or granular material from a stream or riverbed. There is no possibility of scour at this site since there are no waterways within the project limits.

9.0 CORROSION EVALUATION

Corrosion tests were performed on soil samples collected during the field investigation. Test results for soil samples are summarized in Table 4. Test results indicate a non-corrosive environment at the job locations. Normal design and construction materials are advised.

Table 4 – Soil -Corrosion Test Summary

Boring No.	Depth Interval (feet)	PH	Minimum Resistivity (ohm-cm)	Chloride Content (PPM)	Sulfate Content (PPM)
R-08-01	0 –46.5	8.57	1500	--[1]	--[1]
R-08-02	0 –46.5	8.34	2100	--[1]	--[1]
R-08-03	0 –46.5	7.99	1300	--[1]	--[1]
A-08-04	0 –15.0	8.27	2000	--[1]	--[1]

Note 1: The Corrosion Technology Branch states that if the minimum Resistivity is greater than 1000 ohm-cm and the pH is greater than 5.5, the sample is considered to be non-corrosive and sulfate and chloride content do not need to be tested.

10.0 ASSESSMENT OF SUBSURFACE FINDINGS

10.1 Earthwork Quality

Based on current findings and laboratory test results, it is our opinion that the main causes of distress at the subject sites are the result of compressible clayey soils below the bottom of footings, and the quality of compaction. Almost all embankment fill material at the three locations is composed of soft to stiff clayey material (Sandy Lean Clay, Lean Clay, Clayey Sand, etc). The relative compaction ratio found is 85%. The retaining walls were found to have bearing capacity failure, and/or excessive settlement due to the clayey material underneath the bottom of the footing.

10.2 Settlement

Settlement was evaluated for the fill embankment and underlying native soils at the three locations. The settlement of the two major components (embankment fill & native) was analyzed in order to evaluate the potential for future settlement amounts.

Settlement analysis of the **upper clayey embankment fill** was based on consolidation tests performed on retrieved soil samples from the soil boring. Based on a starting time for consolidation when the embankment was built in 1970s to the present time (2008), duration of 38 years was used as the total time for consolidation. Having this total consolidation time and Coefficient of Consolidation (C_v) factors, derived from laboratory test results, the percent consolidation is estimated to be over 88%, leaving 1 to 5 inches further settlement at the three locations (see Table 5), if no ground improvement will be performed.

In considering settlement of the **lower native sandy soil**, given the nature of the lower **medium dense** to dense sandy soil (SM/SP), and that the embankment was built around 1970s, no further settlement is anticipated in the lower native sandy soil. The potential for future settlement is considered to be low (less than 1 inch).

Table 5 – Retaining Wall Settlement Summary

Location No. (Bridge No.)	Abut No.	Designated Walls	Settlement Occurred as of 2008 (inch)	Estimated Further Settlement without ground improvement (inch)	Estimated Further Settlement with ground improvement (inch)
1 (55-0293L)	Abut #1	NW Rtw	4	2	<1
		SW Rtw	-[1]	-[1]	-[1]
	Abut #6	NE Rtw	6	2	<1
		SE Rtw	0	0	0
2 (55-0472S)	Abut #1	NW Rtw	5.5	6.5	<1
		SW Rtw	10	2	<1
	Abut #6	NE Rtw	3.25	3	<1
		SE Rtw	0	0	0
3 (55-0503G)	Abut #1	NW Rtw	5.5	6.5	<1
		SW Rtw	6	6	<1
	Abut #5	NE Rtw	Wall Removed	Wall Removed	Wall Removed
		SE Rtw	4	1	<1

Note 1: No distress reported per Bridge Inspection Report.

10.3 Lateral Movement

Retaining wall lateral movement was observed in the field and also reported in the Bridge Inspection Report. Based on the lab testing results, the backfill soil (generally has 40% Sand and 60% Lean Clay) shows low to moderate expansibility. Therefore, the retaining wall lateral movement was judged NOT due to the soil expansibility; it was due to the footing's bearing capacity failure and/or uneven settlement underneath the bottom of the footing. As for the wingwalls, the wingwalls' movement at Location 1 – Abut 6, is due to the bridge frame rotation, not due to the backfill soil expansibility, as explained in detail in Table 6.

11.0 RECOMMENDATIONS FOR REPAIR

Based on the subsurface results, and our discussion with Structure Design Diamond Bar office, compaction grouting is recommended for the retaining wall stabilization. In addition to the grouting stabilization measure, structure integrity repairing measures such as rebuilding the top of the distressed concrete barrier rail is also necessary (However, this is beyond the scope of this report).

We initially also considered the "CIDH Piles" option. However, this alternative involves removing and replacing existing retaining walls and was judged very costly and may exert huge traffic disturbance. For these reasons, pile foundation recommendation is excluded from this report.

Grouting improvement recommendations are summarized in Table 6, 7, and 8 for Location 1, 2 and 3 respectively. It should be noted severe roadway distresses such as cracking and differential settlement were observed in the roadway areas right next to the retaining walls. However, this report will focus on the retaining wall structure stabilization itself only.

Table 6 – Summary of Grouting for Location 1

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
1 (55-0293L)	Abut #1	NW Rtw	25 x 10	From bottom of footings to Elev. 102.25	16	24	Fig 3-1, 3-2
		SW Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
	Abut #6	NE Rtw	23 x 10	From bottom of footings to Elev. 102.0	11.5	20	Fig 4-1, 4-2
		SE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
		SE Wingwall	-[2]	-[2]	-[2]	-[2]	-[2]

Note 1: No distress reported per Bridge Inspection Report; therefore, no grouting improvement is proposed.
Note 2: This wingwall was reported a 4-inch outward movement per bridge inspection report. Soil at this location shows low to medium expansibility. Per bridge inspection report, the east frame of the bridge has rotated clockwise, causing the east abutment (Abut #6) to move sideways from the pile cap. Therefore, the outward movement was judged NOT due to the soil expansibility; it is judged due to the bridge frame rotation; therefore, no grouting improvement is proposed here. However, structure integrity repairing measures are necessary at this location per our discussion with Structure Design Diamond Bar office.

Table 7 – Summary of Grouting for Location 2

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
2 (55-0472S)	Abut #1	NW Rtw	19 x 10	From bottom of footing to Elev. 109.5	15.0	23	Fig 5-1, 5-2
		SW Rtw	32 x 10	From bottom of footings to Elev. 109.5	15.0	23	Fig 5-1, 5-2
	Abut #6	NE Rtw	19 x 10	From bottom of footing to Elev. 98.5	15.0	23	Fig 6-1, 6-2
		SE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]

Note 1: No distress reported per Bridge Inspection Report, so no grouting improvement is proposed.

Table 8 – Summary of Grouting for Location 3

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
3 (55-0503G)	Abut #1	NW Rtw	43.5 x 10	From bottom of footings to Elev. 104.5	15.0	23	Fig 7
		SW Rtw	21 x 10	From bottom of footing to Elev. 104.5	15.0	23	Fig 7
	Abut #5	NE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
		SE Rtw	-[2]	-[2]	-[2]	-[2]	-[2]

Note 1: This retaining wall was removed.
Note 2: Per bridge inspection engineer Ben Phan, this location was repaired by Caltrans in 2001. About 1" settlement was observed at this location currently in June 2009; and the retaining wall and roadway appear to be in very good shape; it is anticipated that less than 1" further settlement is to be occurred at this location; therefore, no improvement is recommended for this location.

After ground improvement, the existing Retaining Walls can be supported on existing spread footings with improved soil underneath. With adequate ground improvement, we estimate that further settlement should not exceed one (1) inch. A post-grout improvement CPT program should be implemented during the grouting process to ensure adequate grout improvement. The post-grout improvement should achieve adequate soil strengths, bearing failure, and tolerable settlement. Settlement will be verified based on post-improvement CPT results. Our office should review the post improvement results to verify that adequate improvement has been made.

11.0 CONSTRUCTION CONSIDERATIONS

1. Utility lines, drainage lines and irrigation pipelines existing in these locations should be protected during construction.

2. Grouting contractor should record the pressure and grout quantity at every interval level. In addition, inclusion of the time should be made for all entries.

3. The grouting pressure should be monitored. Since the grouting is near the bridge structure, the bridge structure movement should be monitored as well. In addition, the grouting is near slope face, the contractor should monitor the face of the slope to make sure there is no grout leaking out.

4. The optimum pumping rate should be determined during the field grouting procedure.

5. Hole spacing within the grout area should be determined such that zones of injection will slightly overlap to ensure complete filling of the proposed area to be grouted.

6. The contractor should have a post-grout improvement CPT program implemented. The contractor should provide post-grout improvement CPT results to the Resident Engineer (RE) as each CPT sounding is completed. The RE should have our office review the CPT results to ensure adequate grout improvement.

7. The District 7 Materials Division should be contacted regarding the removal and replacement of the PCC concrete for all locations if necessary.

12.0 CONCLUSIONS

Based on our analysis, compaction grouting is the most feasible measure for this project. This option is most likely to provide a repair with minimal cost and construction disturbance.

If you have any questions or comments, please call Quanyan "Michael" Liao at 213-620-2662 or Sam Sukiasian at (213) 620-2135.

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6/11/09

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Figure 1: Site Plan
Figure 2-1 and 2-2: Boring Locations
Figure 3-1 and 3-2: Grouting Zone for Location 1, Abut #1, NW Rtw
Figure 4-1 and 4-2: Grouting Zone for Location 1, Abut #6, NE Rtw
Figure 5-1 and 5-2: Grouting Zone for Location 2, Abut #1, NW & SW Rtw
Figure 6-1 and 6-2: Grouting Zone for Location 2, Abut #6, NE Rtw
Figure 7 : Grouting Zone for Location 3, Abut #1, NW & SW Rtw

CC: OGDS1 – Los Angeles File
OGDS1 – SAC File (MS-5)
GS – SAC File (MS-5)
SD – Howard Ng (Diamond Bar)
SD – Sharareh Bikaee (Diamond Bar)

State of California

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: Mr. SON NGUYEN, Branch Chief
Design Branch E

Date: April 12, 2010

File: 12-ORA-91-PM 3.51/3.64
EA 12-0C9701
Structures Rehab of Retaining Walls next to three bridges (55-0293L, 55-0472S, and 55-0503G)

Attn: Mr. James Lai

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design South-1 Branch B

Subject: Revised Foundation Report for Structures Rehabilitation of Retaining Walls next to Three Bridges (55-0293L, 55-0472S, and 55-0503G)

Per your request dated April 12, 2010, the Office of Geotechnical Design – South 1, Branch B has revised the original June 11, 2009 Foundation Report (FR) with this Revised Foundation Report. This Revised Report differs from the original report in that a Section on Slab Replacement has been added (see Section 11.1).

1.0 SITE CONDITIONS AND DISTRESS

Retaining wall and wingwall distresses were observed next to three bridges (55-0293L, 55-0472S, and 55-0503G at location W91/5, E91/S5 connector, and E91/Magnolia Offramp respectively). Their locations are shown in Figure 1. Caltrans D7 maintenance has been performing regular observation and investigation on these structures, and Bridge Inspection Reports for these locations were provided to us on 1/29/2009.

According to the Bridge Inspection Reports, the retaining walls at these locations have been moving vertically and/or horizontally since they were built in 1970s. Total vertical displacement 3.25 to 10 inches and horizontal displacement 0.5 to 4.5 inches were observed. It is worth noting that the retaining walls founded on spread footings have experienced noticeable movement since they were built; while retaining walls on pile foundation do not appear to settle so far.

For wingwalls, horizontal movement of 4 to 4.5 inches was observed at bridge 55-0293L Northeast and Southeast wingwalls. No vertical and/or horizontal movement was observed or reported for all other wingwalls. A summary of the settlement and horizontal movement of these retaining walls and wingwalls is given in Table 1.

Preliminary foundation reports for the subject project have been conducted by Geotechnical Design – South 1 Branch B and submitted to your office on 11/18/2008.

Table 1: Bridge Inspection Report Summary

Maintenance Inspection report			Ver. Disp.				Hor. Disp.				
Br. #	Type of str.	Inspection date	NW	NE	SW	SE	NW	NE	SW	SE	Notes
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	
55-0472S	Ret. Wall	10/28/2008	5.5	3.25	10	0	.5' out	1' out	2.5' out	0.5' out	Measured 10/28/08
55-0472S	Ret. Wall	10/3/2006	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	4/7/2004	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	14/2/2002	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall	28/03/2000	4	2.5	7	0	.5' out	1' out	2.5' out	0	From Previous insp. Rep.
55-0472S	Ret. Wall**	4/8/1991	3.75	2.625	6.5		0	1' out	2.5' out	NA	
55-0472S	Ret. Wall**	12/29/1982	2.75	2.125	4.5	0					
55-0472S	Ret. Wall**	5/20/1980	2.75	2	3.5	ok					
55-0472S	Ret. Wall**	10/31/1978	1.625	1.75	2.875	0.125	0.125 out	0.1875 out	0.75 out	0.125 out	
55-0472S	Ret. Wall**	5/12/1977	1.25	1.5	2.25	normal					

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement.

Maintenance Inspection report			Ver. Disp.					Hor. Disp.					
Br. #	Type of str.	Inspection date	NW Abut. Joint	NW	NE	SW	SE	NW Abut. Joint	NW	NE	SW	SE	Notes
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)	
55-0503G	Ret. Wall	10/28/2008	0.5	5.5	Removed	6	4	2 out	4	Removed	0	0.5 out	Measured 10/28/08
55-0503G	Ret. Wall	10/3/2006	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	4/7/2004	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	14/2/2002	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
55-0503G	Ret. Wall	28/3/2000	0	4	Removed	6	4	1.5 out	3 out	Removed	0	0.5 out	From Previous insp. Rep.
													From Previous insp. Rep.
55-0503G	Ret. Wall**	4/8/1991	.25 up	4	2.875	5.375	3.25	1.5 out	3 out	1.75 out		0.625 out	
55-0503G	Ret. Wall**	12/29/1982		0	2.25	4.75	2.625		1.125 out				
55-0503G	Ret. Wall**	5/27/1980		3	1.75	4.375	2.5						
55-0503G	Ret. Wall**	10/31/1979			1.875	4.25*	2.375*			1.5 out	0.1875 in	0.75 out	
55-0503G	NW Ret. Wall** (Outer)	10/31/1979		2.375					1.625 out				
55-0503G	NW Wing wall (Inner)	10/31/1979		0					.75 out				
55-0503G	Ret. Wall**	5/12/1977		normal	1.25	3.25	2.125						

*There are two settlement for SE (4.25" and 2.375"), and with considering the next reports , I think 4.25" is for SW and 2.375" is for SE.

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement.

Maintenance Inspection report			Ver. Disp.				Hor. Disp.			
Br. #	Type of str.	Inspection date	NW	NE	SW	SE	NW	NE	SW	SE
			(in)	(in)	(in)	(in)	(in)	(in)	(in)	(in)
55-0293L	Ret. Wall	1/12/2009	4.5***	5***			.5 out***			
55-0293L	Ret. Wall	10/28/2008	6or4*	6		0	1 out			
55-0293L	Ret. Wall	10/3/2006	6or4*	6		0	1 out			
55-0293L	Ret. Wall	4/7/2004	6or4*	6		0	1 out			
55-0293L	Ret. Wall	14/2/2002	6or4*	6		0	1 out			
55-0293L	Ret. Wall	3/28/2000	6or4*	6		0	1 out			
55-0293L	Wing wall	1/12/2009						4.5 inward***		
55-0293L	Wing wall	10/28/2008						4 inward		4 out
55-0293L	Wing wall	10/3/2006						4 inward		4 out
55-0293L	Wing wall	4/7/2004						4 inward		4 out
55-0293L	Wing wall	14/2/2002						4 inward		4 out
55-0293L	Wing wall	3/28/2000						4 inward		4 out
55-0293L	Ret. Wall**	4/8/1991	2.625	3.75	1	0.5 up	0.5 out	2.875 out	1.125 out	1.125 out

* 6" per last paragraph pg.1 and 4" per 7th paragraph pg.2

** In bridge maintenance inspection report it mentioned wing wall, but I think they are retaining walls. Because wing walls are part of abutment structures and for abutments on pile footing , it does not make sense to observe any settlement. *** Per my last visit accompanying by James Lai from district 12 and Ben Phan from Maintenance (This report is provided By Sharareh Bikaee (SD - Diamond Bar Office))

2.0 GEOTECHNICAL SUBSURFACE INVESTIGATION

The subsurface exploration program conducted for the project consisted of four (4) soil borings and thirteen (13) Cone Penetrometer Tests (CPTs). The boring and CPT locations are shown in Figure 2-1 and 2-2, and summarized in Table 2. The borings were drilled to a depth from 46.5 feet to 51.5 feet from March 23 to April 2, 2009. A log of soil boring is shown in Appendix A. CPTs were terminated at a depth from 17 feet to 90 feet. The CPT test results are attached in Appendix B.

Table 2 – Summary of Soil Borings

Location No.	Br. No.	Location Name	Soil Boring Drilled	
			Bridge NW and SW (Abut #1)	Bridge NE and SE (Abut #6 or #5)
1	55-0293L	W91/5 Separation & Overhead	C4,C5,C6 and R-09-02	C1,C2,C3 and R-09-01
2	55-0472S	E91/Magnolia Ave Offramp Overhead	C11,C12,C13 and A-09-04	C10
3	55-0503G	E91/5S Connector Overhead	C7,C8,C9 and R-09-03	C10

A Caltrans-operated Mobile B-80 drill rig and an Acker MP-8 drill rig were used to drill the 4 soil borings. The rig was outfitted with hollow stem auger or rotary wash drilling equipment. The diameter of the boring was 8 inches. Samples were obtained from the borings by driving a 1.4-inch inside-diameter split-spoon sampler with a 140-pound hammer, free-falling 30 inches, or by pushing a 2.5-inch inside-diameter split-spoon sampler with downward hydraulic pressure. The soil samples were obtained at a 2.5-foot or 5-foot interval. The sampler was advanced 18 inches at each sampling and the blow counts required to advance the sampler for each 6-inch interval were recorded. The blow counts for the last 12 inches were summed to get the raw N value. Soil boring locations are presented in Figure 2-1 and 2-2. Soil boring logs are presented in Appendix A.

A total of thirteen (13) Cone Penetration Tests (CPTs) were sounded from March 23 to 26, 2009. The CPTs were advanced with a Vertek 20-ton CPT rig from 17 to 90 feet until refusal. CPT sounding logs are attached in Appendix B.

Following the drilling and sampling, borehole R-09-01 was back-filled grouting and patched with PCC at the surface, while borehole R-09-02, R-09-03, and A-09-04 were converted to peizometers to check the ground water level. Ground water was measured later on 04/21/09 and no ground water was encountered.

3.0 LABORATORY TESTING

Laboratory testing was performed on selected samples retrieved from the borings. Laboratory testing included dry density determination, moisture content, mechanical analysis, Atterberg Limits, maximum dry density and optimum moisture content, direct shear, unconfined

compression and consolidation characteristics. Undisturbed and bulk samples were transported to the Translab for testing. Testing was performed in accordance with California Test Methods and/or ASTM procedures (see Table 3 below). Results for the laboratory tests are presented in Appendix C, and in the boring logs in Appendix A.

Table 3 – Laboratory Test Methods

Test	Standard
Dry Density	CTM 212
Moisture Content	CTM 226
Direct Shear	ASTM D3080
Mechanical (sieve) Analysis	CTM 201, 202, 203
Atterberg Limits	CTM 204
Consolidation	ASTM 2435
Maximum dry density	ASTM D1557
Unconfined Compression	ASTM D2166
Corrosion – Resistivity, pH	CTM 643
Corrosion – Chloride content	CTM 422
Corrosion – Sulfate content	CTM 417

4.0 SUBSURFACE CONDITIONS

4.1 Location 1, Bridge 55-0293l

Abut #1 (bridge NW and SW)
Based on the results of the soil boring exploration, underlying soils at Abut #1 at this location consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) mixture in the upper 24 feet, and loose to medium dense sandy material (SM/ML) in the lower 10 feet. The height of the embankment is approximately 34 feet. The underlying **native** material consisted of medium dense to very dense Silty Sand (SM) interbedded with some Silt/Clay (ML/CL).

Abut #6 (bridge NE and SE)
Underlying soils at Abut #6 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 34 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

4.2 Location 2, Bridge 55-0472s

Abut #1 (bridge NW and SW)
Underlying soils at Abut #1 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 37 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

Abut #6 (bridge NE and SE)
Underlying soils at Abut #6 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) in the upper 20 feet, and loose to medium dense sandy material (SM/SP) in the lower 5 feet. The height of the embankment is approximately 25 feet. The underlying **native** material consisted of medium dense to very dense sandy material.

4.3 Location 3, Bridge 55-0503g

Abut #1 (bridge NW and SW)
Underlying soils at Abut #1 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) for the full height of the embankment (approximately 37 feet). The underlying **native** material consisted of medium dense to very dense sandy material (SP/SM).

Abut #5 (bridge NE and SE)
Underlying soils at Abut #5 consisted of embankment (fill) overlying native alluvial material. Embankment **fill** consisted predominantly soft to medium stiff Silt/Clay (ML/CL) in the upper 20 feet, and loose to medium dense sandy material (SM/SP) in the lower 5 feet. The height of the embankment is approximately 25 feet. The underlying **native** material consisted of medium dense to very dense sandy material.

4.4 Ground Water

No ground water was encountered during this exploration for all locations, with borings advanced to a depth of 51.5 feet below existing pavement (ground) surface. According to As-Built log of test borings drilled for these bridges in 1957, no ground water was encountered for Location 2 and 3. However, ground water was encountered for Location 1 at elevation 67 to 70.5 feet, approximately 50 to 54.5 feet below existing pavement (ground) surface at Location 1. A 1956 literature also mentioned that the ground water was encountered at a project 800 feet away at an elevation of 67-70 feet.

5.0 GEOLOGY

5.1 Regional Geology

The site is within the Los Angeles Basin of the Peninsular Ranges geomorphic province. The Peninsular Ranges province is composed of mountain ranges that are oriented northwest-southeast, which are roughly parallel and related to the San Andreas fault. The Los Angeles Basin is an alluvium filled basin that is up to several miles thick at its deepest point. Quaternary alluvium underlies the project area. The site lies south of the Coyote Hills.

5.2 Site Geology

The site is underlain by artificial fill and alluvial material that consists of various amounts of lean clay, silt, and sand with trace amounts of gravel. The fill extends to roughly 25 to 35 feet below ground surface. Densities are generally medium dense and stiff with some layers of harder and softer material. Asphalt and concrete pieces were observed in the fill. Bedrock was not encountered in any of the borings. The maximum depth of the borings was 51.5 feet below ground surface.

6.0 SEISMICITY

The project site is not located within an Alquist-Priolo Earthquake Fault Zone as established by the California Geological Survey (CGS, 1997). Therefore, the possibility of fault rupture is considered to be low. The project does not lie within an area with potential for seismically induced landslides. Therefore, the risk of landslides is also low.

The controlling fault for the subject bridge is Puente Hills Blind Thrust, which is not on the current Caltrans Seismic Hazard Map (1996), but is on the Caltrans new fault list to be considered in design. The Puente Hills Blind Thrust largely runs in an east-west direction. It starts from downtown Los Angeles (west) at depths between 2 and 9 miles and continues eastward, dipping under the San Gabriel Mountains. It is a reverse/thrust fault of MCE Moment Magnitude $M_w = 7.3$. The controlling fault is located 5.28 miles from this bridge. The peak ground acceleration (PGA) is 0.5g based on Sadigh et al. (1997) attenuation with assigned soil type D.

The standard and adjusted ARS curves of the bridge are included in Appendix D. The adjusted curve is obtained from standard curve with adjustment according to Caltrans SDC (2006) to account for near source and/or long period effect.

7.0 LIQUEFACTION POTENTIAL

Liquefaction is a phenomenon in which loose, saturated, fine-grained granular soils behave like liquid after subjected to high-intensity of ground shaking. Liquefaction occurs when three general conditions exist:

1. Shallow groundwater;
2. Low density fine, sandy soils; and
3. High-intensity ground motion.

Screening for liquefaction hazard was performed using the California Division of Mines and Geology (CDMG) Seismic Hazard Map for the Anaheim quadrangles (http://gmw.consrv.ca.gov/shmp/download/pdf/ozn_anah.pdf). According to this map, the project site is located within the liquefaction zone. However, **the liquefaction potential of the**

subject sites is considered low due to the low ground water level and relatively clayey material encountered on the sites. Liquefaction analysis was performed in general accordance with the methods outlined in the National Center for Earthquake Engineering Research workshops (NCEER, 1997).

8.0 SCOUR EVALUATION

Scour can occur when a current or flow of water removes mud or granular material from a stream or riverbed. There is no possibility of scour at this site since there are no waterways within the project limits.

9.0 CORROSION EVALUATION

Corrosion tests were performed on soil samples collected during the field investigation. Test results for soil samples are summarized in Table 4. Test results indicate a non-corrosive environment at the job locations. Normal design and construction materials are advised.

Table 4 – Soil -Corrosion Test Summary

Boring No.	Depth Interval (feet)	PH	Minimum Resistivity (ohm-cm)	Chloride Content (PPM)	Sulfate Content (PPM)
R-08-01	0 –46.5	8.57	1500	--[1]	--[1]
R-08-02	0 –46.5	8.34	2100	--[1]	--[1]
R-08-03	0 –46.5	7.99	1300	--[1]	--[1]
A-08-04	0 –15.0	8.27	2000	--[1]	--[1]

Note 1: The Corrosion Technology Branch states that if the minimum Resistivity is greater than 1000 ohm-cm and the pH is greater than 5.5, the sample is considered to be non-corrosive and sulfate and chloride content do not need to be tested.

10.0 ASSES SMENT OF SUBSURFACE FINDINGS

10.1 Earthwork Qua lity

Based on current findings and laboratory test results, it is our opinion that the main causes of distress at the subject sites are the result of compressible clayey soils below the bottom of footings, and the quality of compaction. Almost all embankment fill material at the three locations is composed of soft to stiff clayey material (Sandy Lean Clay, Lean Clay, Clayey Sand, etc). The relative compaction ratio found is 85%. The retaining walls were found to have bearing capacity failure, and/or excessive settlement due to the clayey material underneath the bottom of the footing.

10.2 Settle ment

Settlement was evaluated for the fill embankment and underlying native soils at the three locations. The settlement of the two major components (embankment fill & native) was analyzed in order to evaluate the potential for future settlement amounts.

Settlement analysis of the **upper clayey embankment fill** was based on consolidation tests performed on retrieved soil samples from the soil boring. Based on a starting time for consolidation when the embankment was built in 1970s to the present time (2008), duration of 38 years was used as the total time for consolidation. Having this total consolidation time and Coefficient of Consolidation (C_v) factors, derived from laboratory test results, the percent consolidation is estimated to be over 88%, leaving 1 to 5 inches further settlement at the three locations (see Table 5), if no ground improvement will be performed.

In considering settlement of the **lower native sandy soil**, given the nature of the lower **medium dense** to dense sandy soil (SM/SP), and that the embankment was built around 1970s, no further settlement is anticipated in the lower native sandy soil. The potential for future settlement is considered to be low (less than 1 inch).

Table 5 – Retaining Wall Settlement Summary

Location No. (Bridge No.)	Abut No.	Designated Walls	Settlement Occurred as of 2008 (inch)	Estimated Further Settlement without ground improvement (inch)	Estimated Further Settlement with ground improvement (inch)
1 (55-0293L)	Abut #1	NW Rtw	4	2	<1
		SW Rtw	-[1]	-[1]	-[1]
	Abut #6	NE Rtw	6	2	<1
		SE Rtw	0	0	0
2 (55-0472S)	Abut #1	NW Rtw	5.5	6.5	<1
		SW Rtw	10	2	<1
	Abut #6	NE Rtw	3.25	3	<1
		SE Rtw	0	0	0
3 (55-0503G)	Abut #1	NW Rtw	5.5	6.5	<1
		SW Rtw	6	6	<1
	Abut #5	NE Rtw	Wall Removed	Wall Removed	Wall Removed
		SE Rtw	4	1	<1

Note 1: No distress reported per Bridge Inspection Report.

10.3 Lateral Move ment

Retaining wall lateral movement was observed in the field and also reported in the Bridge Inspection Report. Based on the lab testing results, the backfill soil (generally has 40% Sand and 60% Lean Clay) shows low to moderate expansibility. Therefore, the retaining wall lateral movement was judged NOT due to the soil expansibility; it was due to the footing's bearing capacity failure and/or uneven settlement underneath the bottom of the footing. As for the wingwalls, the wingwalls' movement at Location 1 – Abut 6, is due to the bridge frame rotation, not due to the backfill soil expansibility, as explained in detail in Table 6.

11.0 RECOMMENDATION S FOR REPAIR

Based on the subsurface results, and our discussion with Structure Design Diamond Bar office, compaction grouting is recommended for the retaining wall stabilization. In addition to the grouting stabilization measure, structure integrity repairing measures such as rebuilding the top of the distressed concrete barrier rail is also necessary (However, this is beyond the scope of this report).

We initially also considered the "CIDH Piles" option. However, this alternative involves removing and replacing existing retaining walls and was judged very costly and may exert huge traffic disturbance. For these reasons, pile foundation recommendation is excluded from this report.

Grouting improvement recommendations are summarized in Table 6, 7, and 8 for Location 1, 2 and 3 respectively. It should be noted severe roadway distresses such as cracking and differential settlement were observed in the roadway areas right next to the retaining walls. However, this report will focus on the retaining wall structure stabilization itself only.

Table 6 – Summary of Grouting for Location 1

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
1 (55-0293L)	Abut #1	NW Rtw	25 x 10	From bottom of footings to Elev. 102.25	16	24	Fig 3-1, 3-2
		SW Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
	Abut #6	NE Rtw	23 x 10	From bottom of footings to Elev. 102.0	11.5	20	Fig 4-1, 4-2
		SE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
		SE Wingwall	-[2]	-[2]	-[2]	-[2]	-[2]

Note 1: No distress reported per Bridge Inspection Report; therefore, no grouting improvement is proposed.
Note 2: This wingwall was reported a 4-inch outward movement per bridge inspection report. Soil at this location shows low to medium expansibility. Per bridge inspection report, the east frame of the bridge has rotated clockwise, causing the east abutment (Abut #6) to move sideways from the pile cap. Therefore, the outward movement was judged NOT due to the soil expansibility; it is judged due to the bridge frame rotation; therefore, no grouting improvement is proposed here. However, structure integrity repairing measures are necessary at this location per our discussion with Structure Design Diamond Bar office.

Table 7 – Summary of Grouting for Location 2

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
2 (55-0472S)	Abut #1	NW Rtw	19 x 10	From bottom of footing to Elev. 109.5	15.0	23	Fig 5-1, 5-2
		SW Rtw	32 x 10	From bottom of footings to Elev. 109.5	15.0	23	Fig 5-1, 5-2
	Abut #6	NE Rtw	19 x 10	From bottom of footing to Elev. 98.5	15.0	23	Fig 6-1, 6-2
		SE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]

Note 1: No distress reported per Bridge Inspection Report, so no grouting improvement is proposed.

Table 8 – Summary of Grouting for Location 3

Location No. (Bridge No.)	Abut No.	Designated Walls	Grouting Dimension (ft x ft)	Grouting Depth Limits	Maximum Grouting Pressure at Bottom of Footing (psi)	Maximum Grouting Pressure at bottom of Grouting Zone (psi)	Figures Refer
3 (55-0503G)	Abut #1	NW Rtw	43.5 x 10	From bottom of footings to Elev. 104.5	15.0	23	Fig 7
		SW Rtw	21 x 10	From bottom of footing to Elev. 104.5	15.0	23	Fig 7
	Abut #5	NE Rtw	-[1]	-[1]	-[1]	-[1]	-[1]
		SE Rtw	-[2]	-[2]	-[2]	-[2]	-[2]

Note 1: This retaining wall was removed.
Note 2: Per bridge inspection engineer Ben Phan, this location was repaired by Caltrans in 2001. About 1" settlement was observed at this location currently in June 2009; and the retaining wall and roadway appear to be in very good shape; it is anticipated that less than 1" further settlement is to be occurred at this location; therefore, no improvement is recommended for this location.

After ground improvement, the existing Retaining Walls can be supported on existing spread footings with improved soil underneath. With adequate ground improvement, we estimate that further settlement should not exceed one (1) inch. A post-grout improvement CPT program should be implemented during the grouting process to ensure adequate grout improvement. The post-grout improvement should achieve adequate soil strengths, bearing failure, and tolerable settlement. Settlement will be verified based on post-improvement CPT results. Our office should review the post improvement results to verify that adequate improvement has been made.

11.1 SLAB REPAIR RECOMMENDATIONS

We recommend excavating about 4 feet below the bottom of the approach slabs for following approach slab areas per General Structure Plans dated 5/11/09.

- W/B 91/5 Separation (55-0293L) East End (Part of per Plan) and West End (Entire Width)
- E/B-91/Magnolia Offramp (55-0472S) West End Only – Entire Width

After excavation the bottom should be cleaned of any loose material and proofrolled for a relative compaction of 90 percent for a depth of 6 inches. After compaction a Woven Polypropylene Geotextile should be placed over the bottom of the excavation to serve as a

bridge over the compressible materials. The geotextile should conform to the following requirements:

Ultimate Tensile Strength:	4800 plf (minimum)
Tensile Strength @ 5% strain:	2400 plf (minimum)
Apparent Opening Size:	0.6 mm (maximum)

Note: Strengths pertain to Machine Direction.

The backfill material placed and compacted under the approach slab should have a Sand Equivalent of at least 20 (and an Expansion Index of less than 50) and should be in accordance with Section 19-3.06 of the Standard Specifications with a relative compaction of at least 95 percent.

11.0 CONSTRUCTION CONSIDERATIONS

1. Utility lines, drainage lines and irrigation pipelines existing in these locations should be protected during construction.

2. Grouting contractor should record the pressure and grout quantity at every interval level. In addition, inclusion of the time should be made for all entries.

3. The grouting pressure should be monitored. Since the grouting is near the bridge structure, the bridge structure movement should be monitored as well. In addition, the grouting is near slope face, the contractor should monitor the face of the slope to make sure there is no grout leaking out.

4. The optimum pumping rate should be determined during the field grouting procedure.

5. Hole spacing within the grout area should be determined such that zones of injection will slightly overlap to ensure complete filling of the proposed area to be grouted.

6. The contractor should have a post-grout improvement CPT program implemented. The contractor should provide post-grout improvement CPT results to the Resident Engineer (RE) as each CPT sounding is completed. The RE should have our office review the CPT results to ensure adequate grout improvement.

7. The District 7 Materials Division should be contacted regarding the removal and replacement of the PCC concrete for all locations if necessary.

12.0 CONCLUSIONS

Based on our analysis, compaction grouting is the most feasible measure for this project. This option is most likely to provide a repair with minimal cost and construction disturbance.

If you have any questions or comments, please call Quanyan "Michael" Liao at 213-620-2662 or Sam Sukiasian at (213) 620-2135.

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Figure 1: Site Plan
Figure 2-1 and 2-2: Boring Locations
Figure 3-1 and 3-2: Grouting Zone for Location 1, Abut #1, NW Rtw
Figure 4-1 and 4-2: Grouting Zone for Location 1, Abut #6, NE Rtw
Figure 5-1 and 5-2: Grouting Zone for Location 2, Abut #1, NW & SW Rtw
Figure 6-1 and 6-2: Grouting Zone for Location 2, Abut #6, NE Rtw
Figure 7 : Grouting Zone for Location 3, Abut #1, NW & SW Rtw

CC: OGDS1 – Los Angeles File
OGDS1 – SAC File (MS-5)
GS – SAC File (MS-5)
SD – Howard Ng (Diamond Bar)
SD – Sharareh Bikaee (Diamond Bar)

Appendix A

Log of Soil Borings

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
Q. Liao	4-2-09	4-2-09		A-09-04
DRILLING CONTRACTOR: Caltrans			BOREHOLE LOCATION (Offset, Station, Line): ' Lt Sta See Figure 3	SURFACE ELEVATION: See Figure 3
DRILLING METHOD: Hollow-Stem Auger			DRILL RIG: Acker MP-8	BOREHOLE DIAMETER: 8 in
SAMPLER TYPE(S) AND SIZE(S) (ID): Other, SPT (1.4")			SPT HAMMER TYPE: 140 lbs, 30", Automatic	HAMMER EFFICIENCY, ERi: 74%
BOREHOLE BACKFILL AND COMPLETION: Converted to a well			GROUNDWATER READINGS: DURING DRILLING: No; AFTER DRILLING (DATE): No	TOTAL DEPTH OF BORING: 51.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		PCC CONCRETE.												0-15 feet, Corrosion Test (CR) 0-15 feet, Compaction Curve (CP)
	1														
	2		SANDY lean CLAY (CL); stiff; brown; moist; coarse to fine SAND; low to medium plasticity fines; trace fine gravel, (-FILL).												
	3				1					15	113				PA, PI
	4														
	5				2							PP = 1.25			SG=2.69, Swell Potential (SW)
	6														
	7														
	8		Medium to fine SAND; medium plasticity fines; trace Asphalt pieces.		3					17	107	PP = 1.25 UC = 0.952			SG=2.66, Consolidation Test (C) PA, PI
	9														
	10		Low plasticity fines; trace fine gravel.		4	3 5 6	11								PA
	11														
	12														
	13				5					10 10	112 108	PP = 1.25			
	14														
	15				6	3 4 7	11								PA, PI
	16														
	17		SANDY SILT (ML); stiff; brown; moist; nonplastic to low plasticity fines; interbedded with Poorly Graded Sand (SP); medium dense, gray, moist, fine-grained sand.												
	18				7					13	104	PP = 1.5			PA
	19														
	20		Trace fine to coarse gravel.		8	4 6 6	12								PA
	21														
	22														
	23		Dark brown; interbedded with Silty Sand (SM); medium dense, brown, moist, fine-grained sand; trace Asphalt pieces, trace fine gravel.		9					9	119				
	24														
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				A-09-04
DIST. 12	COUNTY Orange	ROUTE 91/5	POSTMILE D/D	EA 12-0C9701
PROJECT OR BRIDGE NAME: 91/5 Retaining Wall Repair				
BRIDGE NUMBER 55-0472S	PREPARED BY Q. Liao	DATE 5-28-09	SHEET 1 of 2	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Sandy Lean CLAY (CL); very stiff; brown; moist; medium plasticity fines.		10	2 2 5	7								PA
	26														
	27														
	28				11					15	116	PP = 3			SG=2.73, Consolidation Test (C) PI
	29														
	30				12	4 6 8	14								PA, PI
	31														
	32														
	33		Interbedded with Poorly Graded Sand (SP); medium dense, light gray, moist, fine-grained sand.		13							PP = 3			
	34														
	35				14	3 4 7	11								PI
	36														
	37		SILTY SAND (SM); loose to medium dense; dark brown; moist; fine SAND; (-Native).												
	38				15	3 4 4	8								PA
	39														
	40														
	41														
	42														
	43		Medium dense; light gray mottled with brown.		16	1 4 6	10								PA
	44														
	45														
	46														
	47														
	48		Brown.		17	1 8 9	17								
	49														
	50		Dense; light gray.		18	8 12 24	36								
	51														
	52		Borehole converted to a well No groundwater encountered. Bottom of borehole at 51.5 ft bgs												
	53														
	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**A-09-04**
DIST. **12**	COUNTY **Orange**	ROUTE **91/5**	POSTMILE **D/D**	EA **12-0C9701**
PROJECT OR BRIDGE NAME **91/5 Retaining Wall Repair**				
BRIDGE NUMBER **55-0472S**	PREPARED BY **Q. Liao**	DATE **5-28-09**	SHEET **2 of 2**	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
Q. Liao	3-23-09	3-23-09		R-09-01
DRILLING CONTRACTOR: Caltrans			BOREHOLE LOCATION (Offset, Station, Line): ' Lt Sta See Figure 2	SURFACE ELEVATION: See Figure 2
DRILLING METHOD: Rotary Wash			DRILL RIG: Mobile B-80	BOREHOLE DIAMETER: 8 in
SAMPLER TYPE(S) AND SIZE(S) (ID): Other, SPT (1.4")			SPT HAMMER TYPE: 140 lbs, 30", Safety Hammer	HAMMER EFFICIENCY, ERi: 59%
BOREHOLE BACKFILL AND COMPLETION: Backfilled with grout			GROUNDWATER READINGS: DURING DRILLING No; AFTER DRILLING (DATE) No	TOTAL DEPTH OF BORING: 51.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		PCC CONCRETE.												0-46.5 feet, Corrosion Test (CR)
	1														
	2		CLAYEY SAND (SC); loose; brown; moist; coarse to fine SAND; medium plasticity fines; trace fine gravel, (-FILL).												
	3				1	2 3 3	6					PP = 0.75			PA, PI
	4														
	5				2										
	6														
	7														
	8				3										
	9		SILTY SAND (SM); medium dense; brown; moist; coarse to fine SAND; nonplastic fines.												
	10				4	11 10 6	16								PA
	11														
	12		SANDY lean CLAY (CL); stiff; brown; moist; medium to fine SAND; low to medium plasticity fines.												
	13				5					16	115	PP = 1.5 UC = 0.7165			SG=2.69, Swell Potential (SW) PA, PI
	14														
	15		CLAYEY SAND (SC); medium dense; brown; moist; medium to fine SAND; medium plasticity fines; interbedded with Lean Clay (CL); dark brown, stiff, medium plasticity.		6	8 8 9	17								PA, PI
	16														
	17														
	18				7										
	19		Lean CLAY with SAND (CL); stiff; dark brown; moist; fine SAND; medium plasticity fines.												
	20				8	3 6 11	17					PP = 1.5			PI
	21														
	22														
	23		Hard; yellowish brown.		9					15	115	PP = 4.5			SG=2.67, Consolidation Test (C)
	24														
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				R-09-01
DIST. 12	COUNTY Orange	ROUTE 91/5	POSTMILE D/D	EA 12-0C9701
PROJECT OR BRIDGE NAME: 91/5 Retaining Wall Repair				
BRIDGE NUMBER 55-0293L	PREPARED BY Q. Liao	DATE 5-28-09	SHEET 1 of 2	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Stiff; dark brown. Lean CLAY with SAND (CL)*(continued)*.		10	3 6 10	16					PP = 1.8			PA, PI
	26														
	27														
	28														
	29														
	30		Hard.		11					14 12	113 115	PP = 4.25 UC = 1.4045			SG=2.72, Consolidation Test (C)
	31														
	32														
	33		Poorly graded SAND with SILT (SP-SM); medium dense; brown; moist; fine SAND; trace mica, (-Native).												
	34														
	35				12	13 13 16	29								PA
	36														
	37														
	38														
	39														
	40				13					21	98				Direct Shear (DS)
	41														
	42														
	43		SILTY SAND (SM); dense; brown; moist; fine SAND; trace mica.												
	44														
	45				14	13 15 24	39								PA
	46														
	47														
	48														
	49														
	50				15	20 23 27	50								
	51														
	52		Boring backfilled with bentonite grout. Bottom of borehole at 51.5 ft bgs												
	53														
	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-01**
DIST. **12**	COUNTY **Orange**	ROUTE **91/5**	POSTMILE **D/D**	EA **12-0C9701**
PROJECT OR BRIDGE NAME **91/5 Retaining Wall Repair**				
BRIDGE NUMBER **55-0293L**	PREPARED BY **Q. Liao**	DATE **5-28-09**	SHEET **2 of 2**	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
Q. Liao	3-25-09	3-25-09		R-09-02
DRILLING CONTRACTOR: Caltrans			BOREHOLE LOCATION (Offset, Station, Line): ' Lt Sta See Figure 2	SURFACE ELEVATION: See Figure 2
DRILLING METHOD: Rotary Wash			DRILL RIG: Mobile B-80	BOREHOLE DIAMETER: 8 in
SAMPLER TYPE(S) AND SIZE(S) (ID): Other, SPT (1.4")			SPT HAMMER TYPE: 140 lbs, 30", Safety Hammer	HAMMER EFFICIENCY, ERi: 59%
BOREHOLE BACKFILL AND COMPLETION: Converted to a well			GROUNDWATER READINGS: DURING DRILLING No; AFTER DRILLING (DATE) No	TOTAL DEPTH OF BORING: 46.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		PCC CONCRETE.												0-46.5 feet, Corrosion Test (CR)
	1														
	2		SANDY SILT (ML); stiff; brown; moist; medium to fine SAND; nonplastic to low plasticity fines; trace fine gravel, (-FILL).		1							PP = 1.25			PA
	3														
	4														
	5		SANDY lean CLAY (CL); stiff to very stiff; brown; moist; medium to fine SAND; low to medium plasticity fines; trace fine gravel.		2	5 6 8	14								
	6														
	7				3					14	120	PP = 2.0 UC = 0.895			SG=2.69, Swell Potential (SW) PI
	8														
	9														
	10				4	13 8 9	17								
	11														
	12				5										PA, PI
	13														
	14														
	15		Lean CLAY (CL); stiff; brown; moist; medium plasticity fines.		6	4 6 6	12								PI
	16														
	17				7					18	110	PP = 1.5 UC = 1.263			SG=2.73, Consolidation Test (C)
	18									18	113				
	19														
	20		Trace fine gravel.		8	4 3 4	7								
	21														
	22				9					18	109	PP = 1.25			
	23		Dark brown.												
	24														
	25		SILTY SAND (SM); medium dense; dark brown; moist;												

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				R-09-02
DIST. 12	COUNTY Orange	ROUTE 91/5	POSTMILE D/D	EA 12-0C9701
PROJECT OR BRIDGE NAME: 91/5 Retaining Wall Repair				
BRIDGE NUMBER 55-0293L	PREPARED BY Q. Liao	DATE 5-28-09	SHEET 1 of 2	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		fine SAND; low plasticity fines; micaceous, (-Native).		10	10 9 9	18								PA
	26														
	27				11					13	121				PI
	28									15	115				
	29														
	30		Hit pieces of concrete & gravel, blow counts may not be reliable;.		12	15 28 34	62								
	31														
	32														
	33														
	34														
	35				13	9 8 6	14								
	36														
	37														
	38		Lean CLAY (CL); stiff; brown; moist; medium plasticity fines.												
	39														
	40				14	2 6 7	13					PP = 1.9			PI
	41														
	42														
	43		Poorly graded SAND with SILT (SP-SM); very dense; brown; moist; fine SAND; nonplastic fines; micaceous.												
	44														
	45				15	18 23 29	52								PA
	46														
	47		Borehole converted to a well No groundwater encountered. Bottom of borehole at 46.5 ft bgs												
	48														
	49														
	50														
	51														
	52														
	53														
	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				**R-09-02**
DIST. **12**	COUNTY **Orange**	ROUTE **91/5**	POSTMILE **D/D**	EA **12-0C9701**
PROJECT OR BRIDGE NAME **91/5 Retaining Wall Repair**				
BRIDGE NUMBER **55-0293L**	PREPARED BY **Q. Liao**	DATE **5-28-09**	SHEET **2 of 2**	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
Q. Liao	3-26-09	3-26-09		R-09-03
DRILLING CONTRACTOR: Caltrans			BOREHOLE LOCATION (Offset, Station, Line): ' Lt Sta See Figure 3	SURFACE ELEVATION: See Figure 3
DRILLING METHOD: Rotary Wash			DRILL RIG: Mobile B-80	BOREHOLE DIAMETER: 8 in
SAMPLER TYPE(S) AND SIZE(S) (ID): Other, SPT (1.4")			SPT HAMMER TYPE: 140 lbs, 30", Safety Hammer	HAMMER EFFICIENCY, ERi: 54%
BOREHOLE BACKFILL AND COMPLETION: Converted to a well			GROUNDWATER READINGS: DURING DRILLING: No; AFTER DRILLING (DATE): No	TOTAL DEPTH OF BORING: 46.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		PCC CONCRETE.												0-46.5 feet, Corrosion Test (CR)
	1														
	2		SILTY SAND (SM); medium dense; yellowish brown; moist; fine SAND; trace fine gravel, (-FILL).		1										PA
	3														
	4														
	5		CLAYEY SAND (SC); loose; brown; moist; coarse to fine SAND; trace fine gravel.		2	5 5 5	10								PA, PI
	6														
	7		Interbedded Sandy Lean Clay (CL); stiff, brown, moist, fine-grained sand, medium plasticity fines.		3					18	110	PP = 1.1			
	8									18	109				
	9														
	10				4	3 4 4	8								
	11														
	12		SANDY lean CLAY (CL); soft; brown; moist; fine SAND; medium plasticity fines; trace fine gravel.		5							PP = 0.4			SG=2.71, Consolidation Test (C) PA, PI
	13														
	14														
	15		Lean CLAY (CL); very stiff; dark brown; moist; medium plasticity fines; trace fine gravel.		6	8 8 11	19					PP = 3.0			PI
	16														
	17		Stiff.		7							PP = 1.5			SG=2.69, Consolidation Test (C)
	18														
	19														
	20		Very stiff.		8	4 7 16	23					PP = 2.1			PI
	21														
	22		Stiff; trace pieces of Asphalt, few fine to coarse sand, trace fine gravel.		9							PP = 1.5			
	23														
	24														
	25														

(continued)

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

REPORT TITLE				HOLE ID
BORING RECORD				R-09-03
DIST. 12	COUNTY Orange	ROUTE 91/5	POSTMILE D/D	EA 12-0C9701
PROJECT OR BRIDGE NAME: 91/5 Retaining Wall Repair				
BRIDGE NUMBER 55-0503G	PREPARED BY Q. Liao	DATE 5-28-09	SHEET 1 of 2	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Very stiff; no Asphalt, no gravel. Lean CLAY (CL) *(continued)*.		10	10 7 5	12					PP = 3.0			PI
	26														
	27				11							PP = 2.3			
	28														
	29														
	30				12	17 16 19	35								
	31														
	32		Lean CLAY with SAND (CL); hard; dark brown; moist; fine SAND; medium plasticity fines.		13							PP = 4.25			PA, PI
	33														
	34														
	35				14	9 12 13	25								
	36														
	37														
	38		SILTY SAND (SM); medium dense; dark brown; moist; fine SAND; nonplastic fines; trace mica, (-Native).												
	39														
	40				15	9 9 11	20								PA
	41														
	42														
	43														
	44														
	45		Dense; brown.		16	15 21 28	49								PA
	46														
	47		Borehole converted to a well No groundwater encountered. Bottom of borehole at 46.5 ft bgs												
	48														
	49														
	50														
	51														
	52														
	53														
	54														
	55														

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South 1

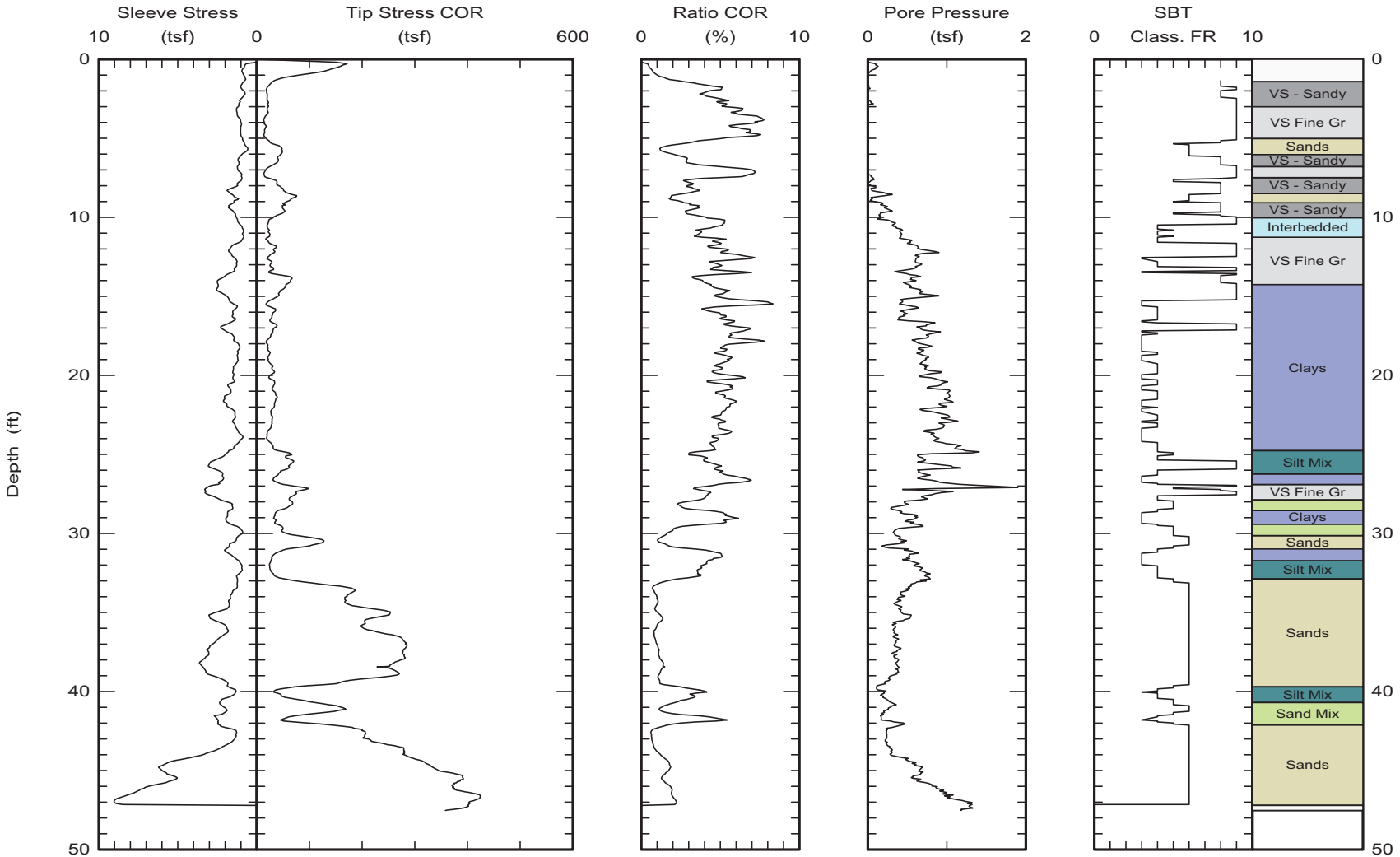
REPORT TITLE				HOLE ID
BORING RECORD				**R-09-03**
DIST. **12**	COUNTY **Orange**	ROUTE **91/5**	POSTMILE **D/D**	EA **12-0C9701**
PROJECT OR BRIDGE NAME **91/5 Retaining Wall Repair**				
BRIDGE NUMBER **55-0503G**	PREPARED BY **Q. Liao**	DATE **5-28-09**	SHEET **2 of 2**	

CALTRANS BORING RECORD MET+ENG FIXED 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 6/9/09

Appendix B

Cone Penetrometer Test (CPT) Data

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 24/Mar/2009 Test ID: CPT-1 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

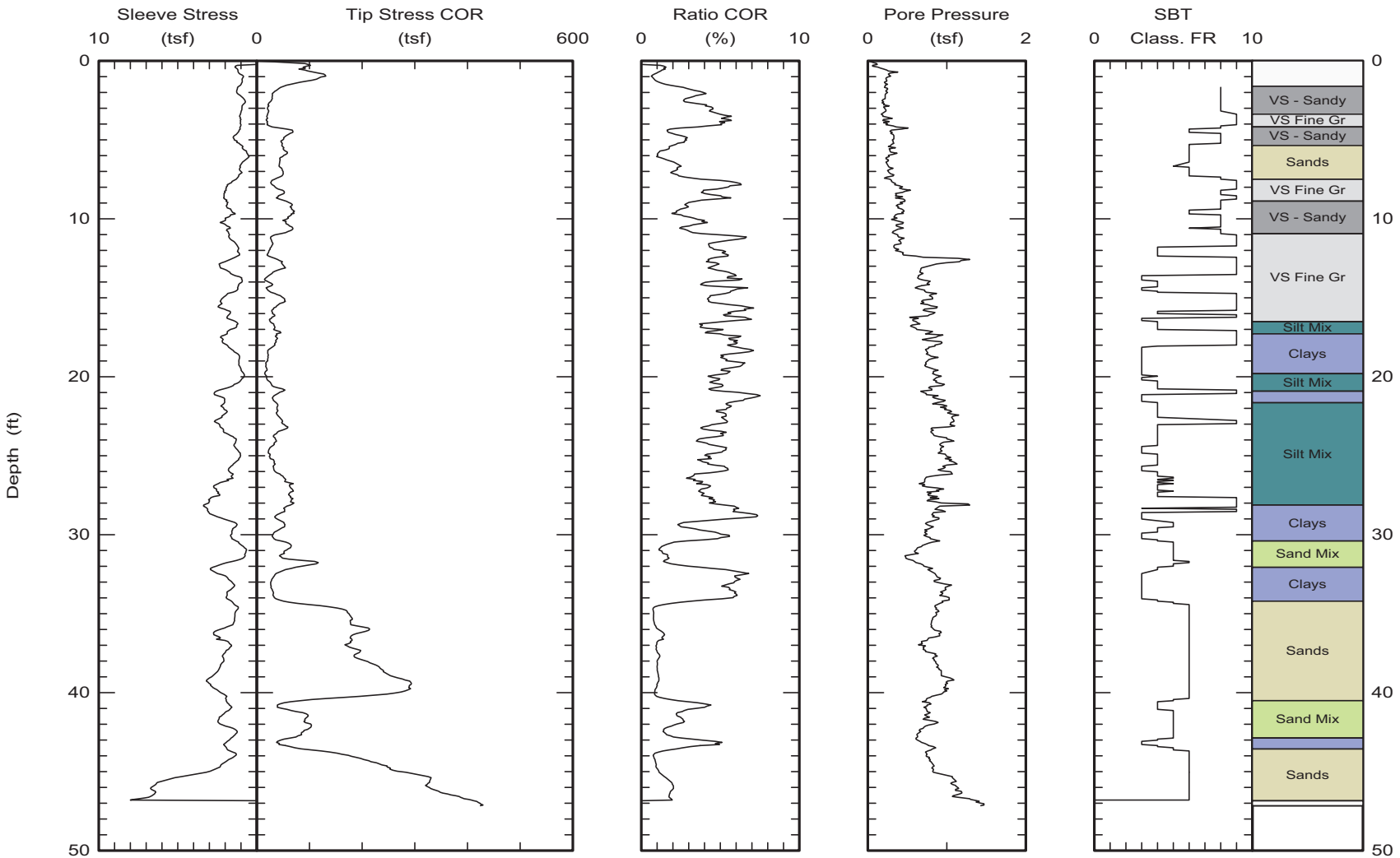


Maximum depth: 47.53 (ft)

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

Test ID: 24M904-4
File: CPT24M0904C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 24/Mar/2009 Test ID: CPT-2 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

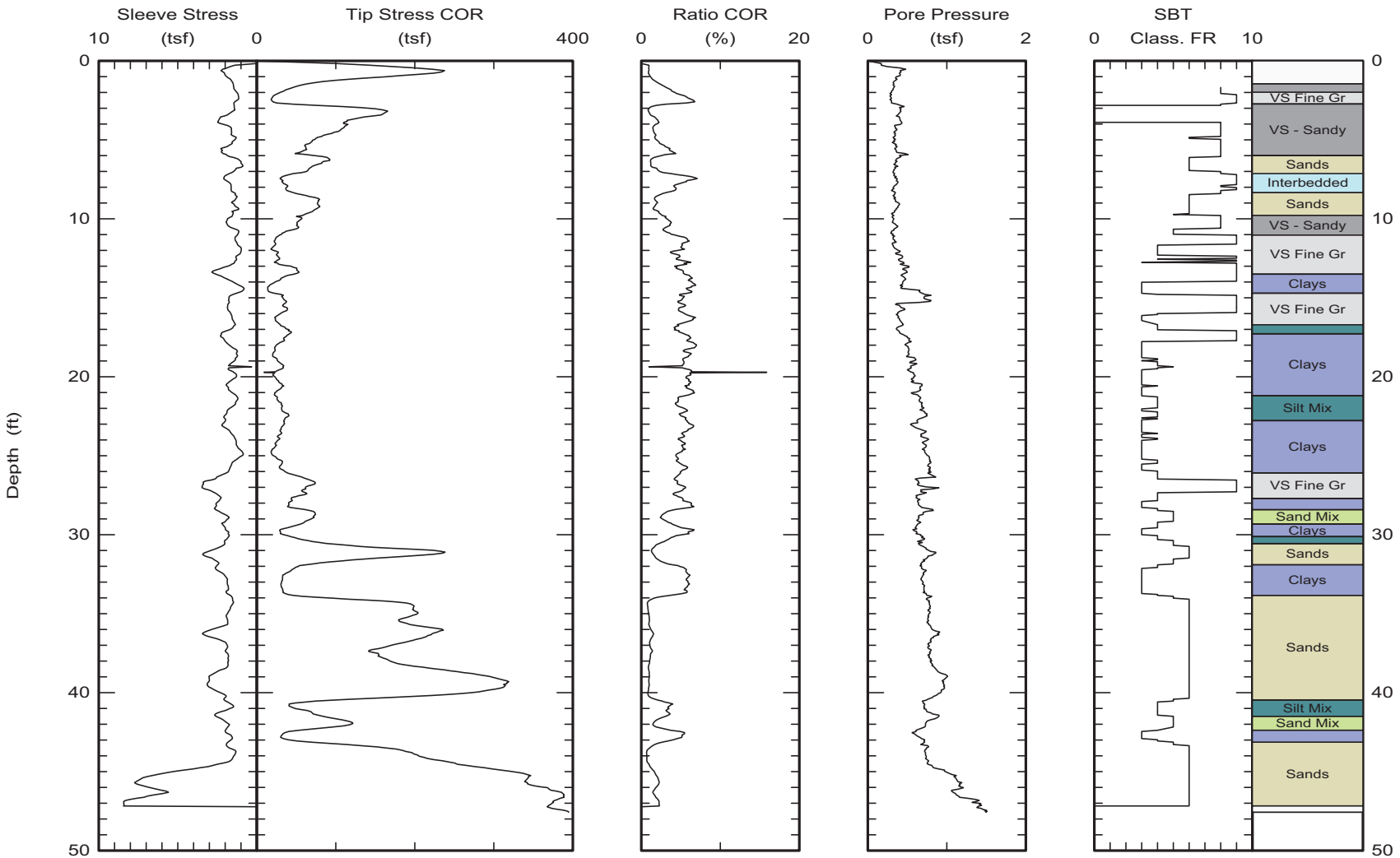


Maximum depth: 47.16 (ft)

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

Test ID: 24M905-5
File: CPT24M0905C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 25/Mar/2009 Test ID: CPT-3 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

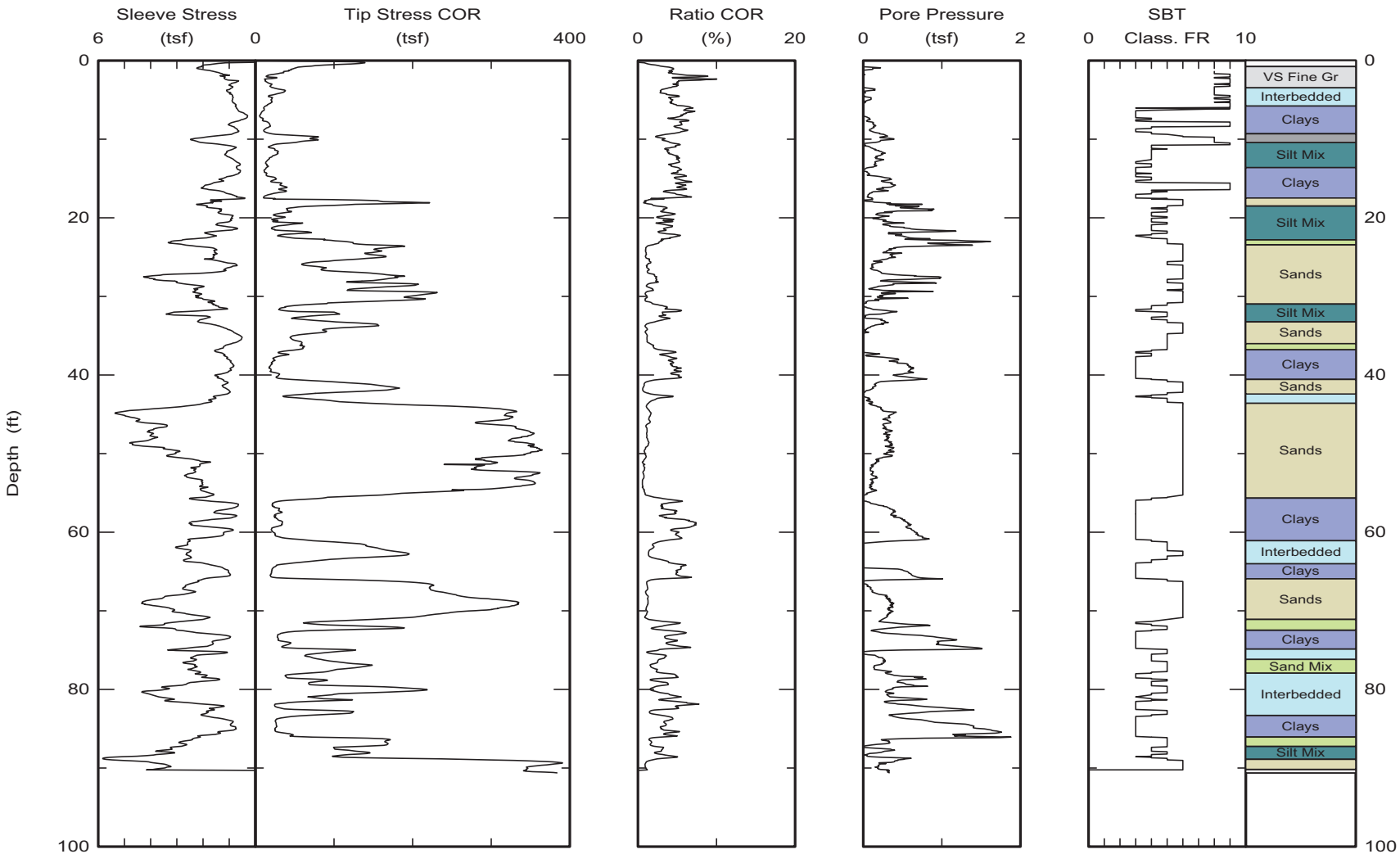


Maximum depth: 47.57 (ft)

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

Test ID: 25M901-6
File: CPT25M0901C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 24/Mar/2009 Test ID: CPT-4 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

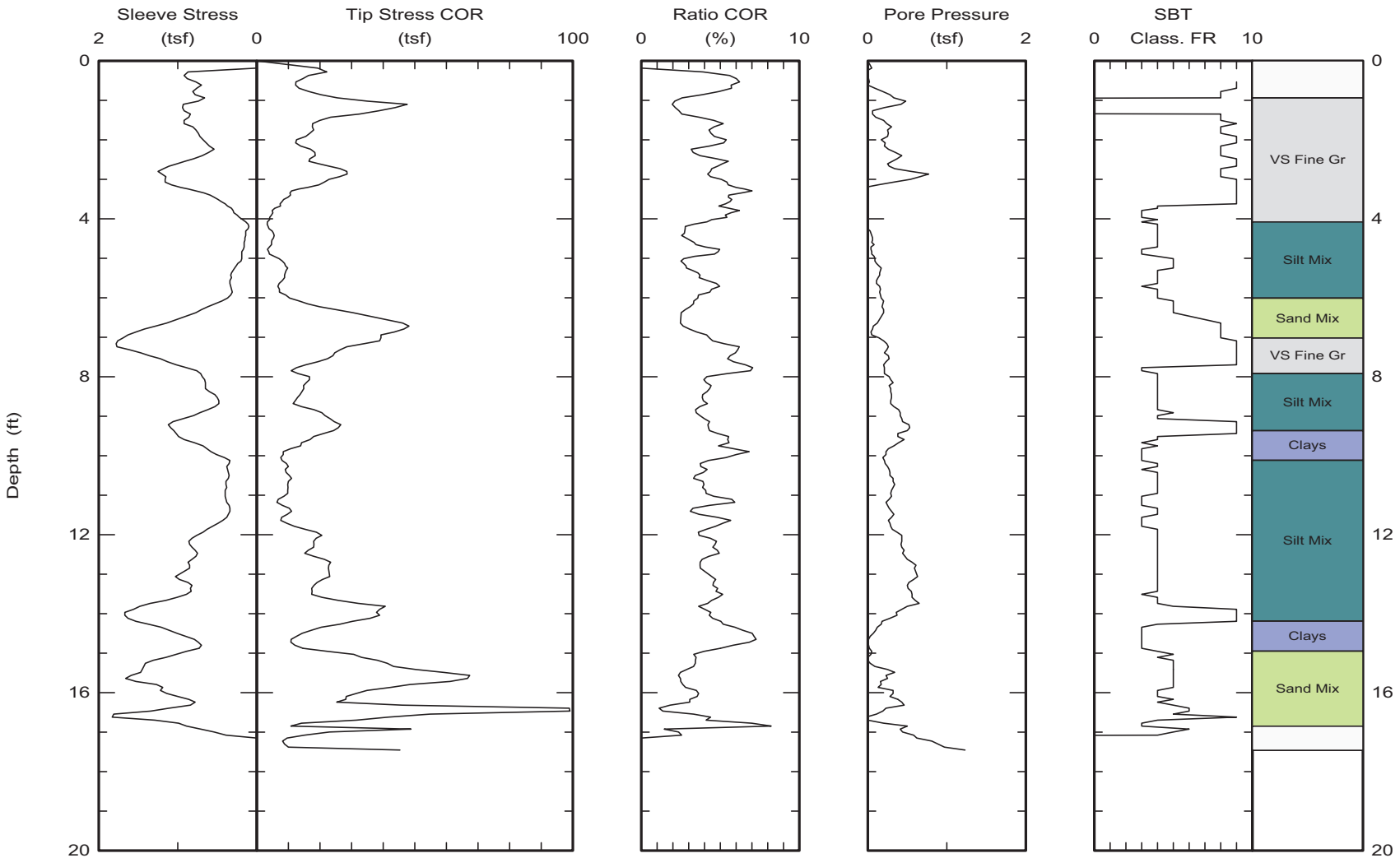


Maximum depth: 90.63 (ft)

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

Test ID: 23M901-1
File: CPT23M0901C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 24/Mar/2009 Test ID: CPT-5 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

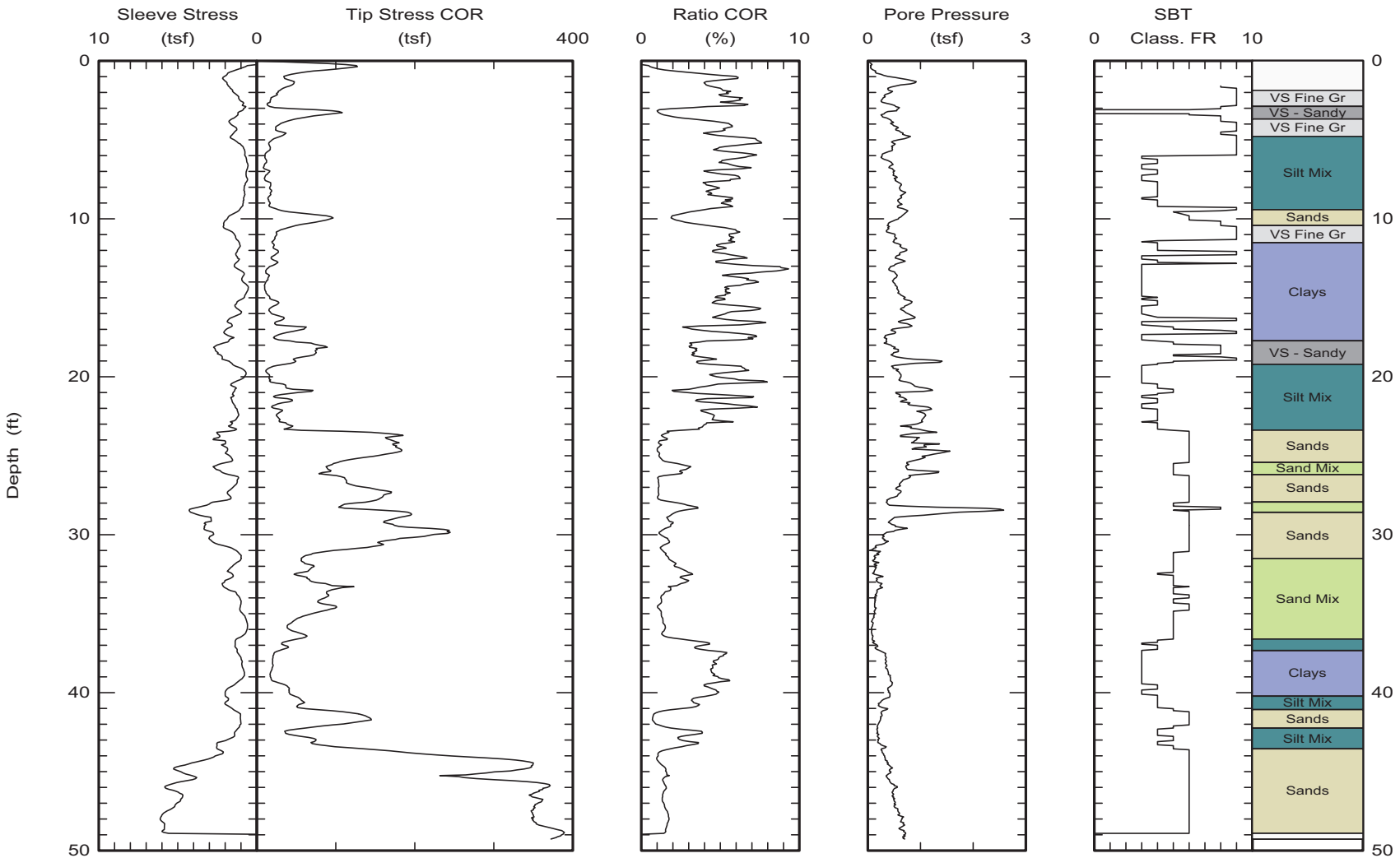


Maximum depth: 17.46 (ft)

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

Test ID: 24M902-2
File: CPT24M0902C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 24/Mar/2009 Test ID: CPT-6 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

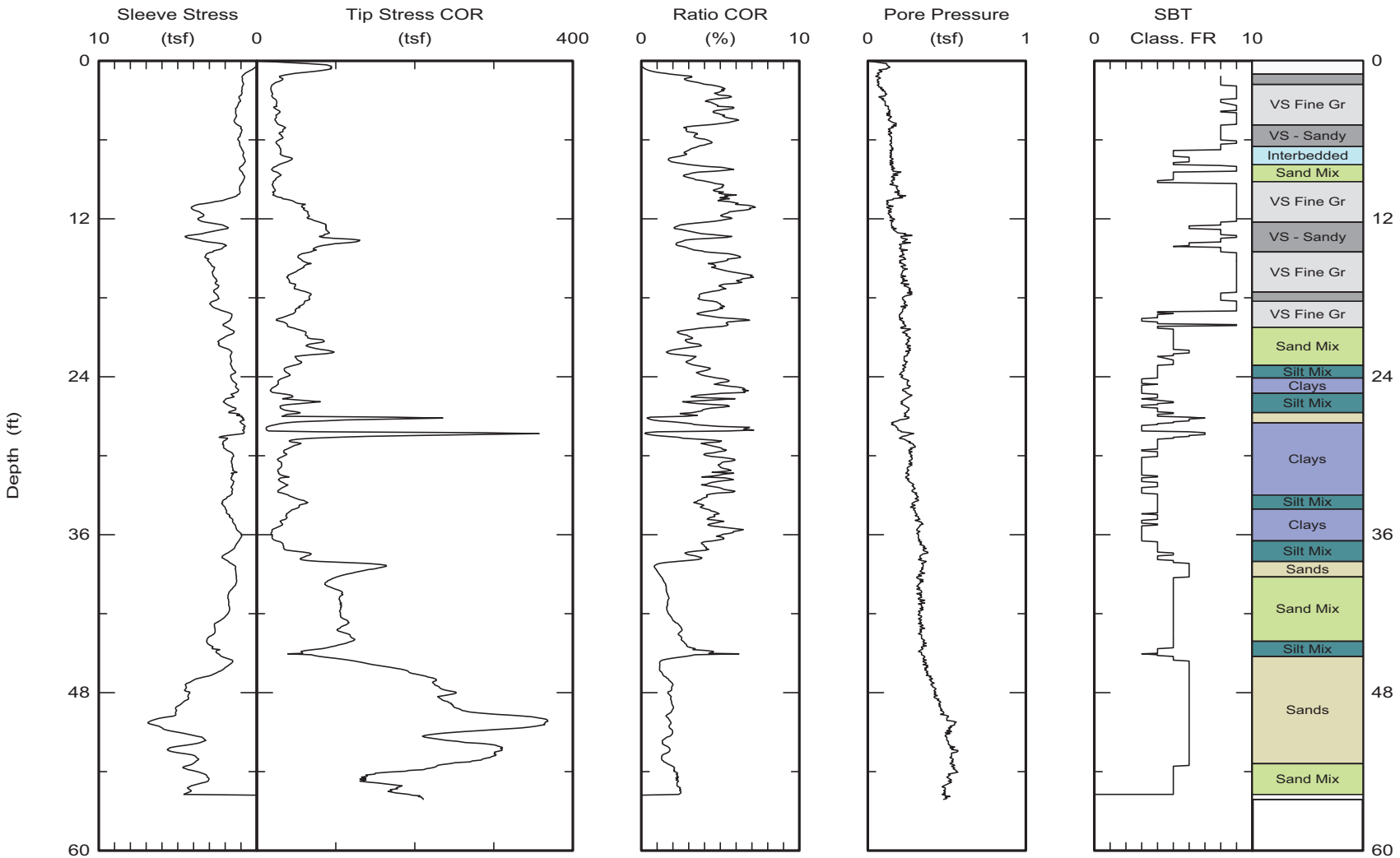


Maximum depth: 49.27 (ft)

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

Test ID: 24M903-2
File: CPT24M0903C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 26/Mar/2009 Test ID: CPT-7 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

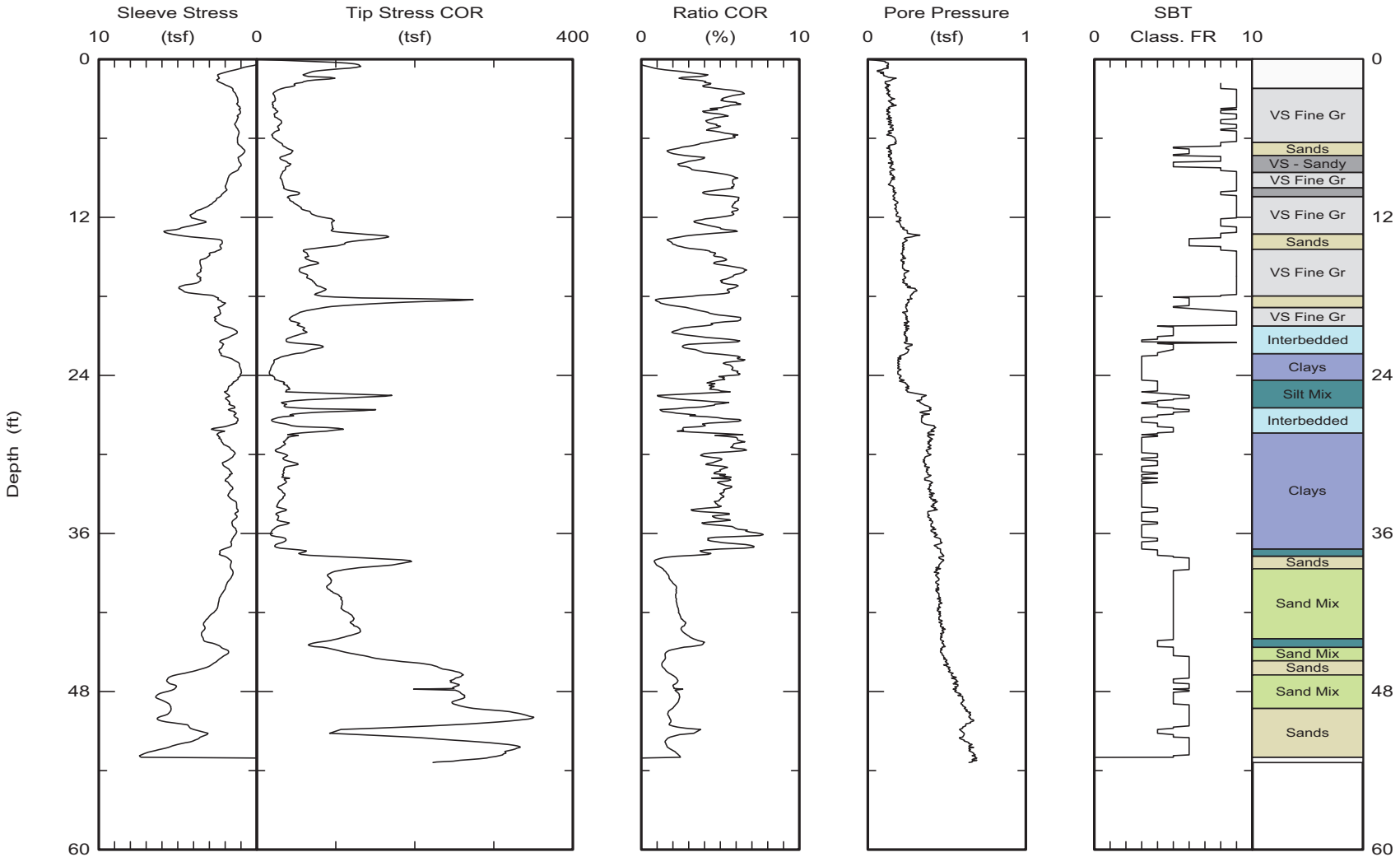


Maximum depth: 56.11 (ft)

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

Test ID: 26M904-C9
File: CPT26M0904C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 27/Mar/2009 Test ID: CPT-8 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

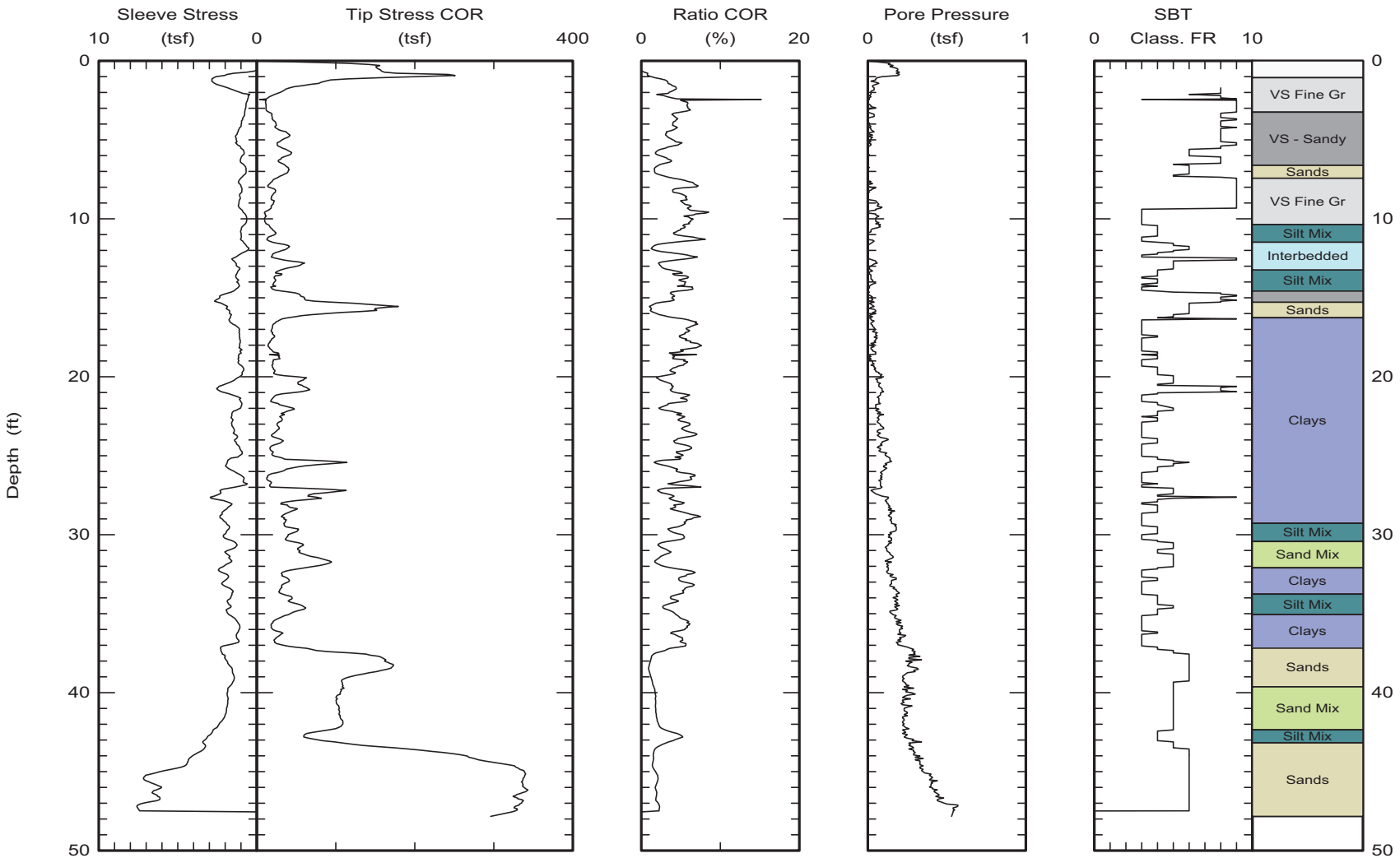


Maximum depth: 53.39 (ft)

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

Test ID: 27M901-C10
File: CPT27M0901C.ecp

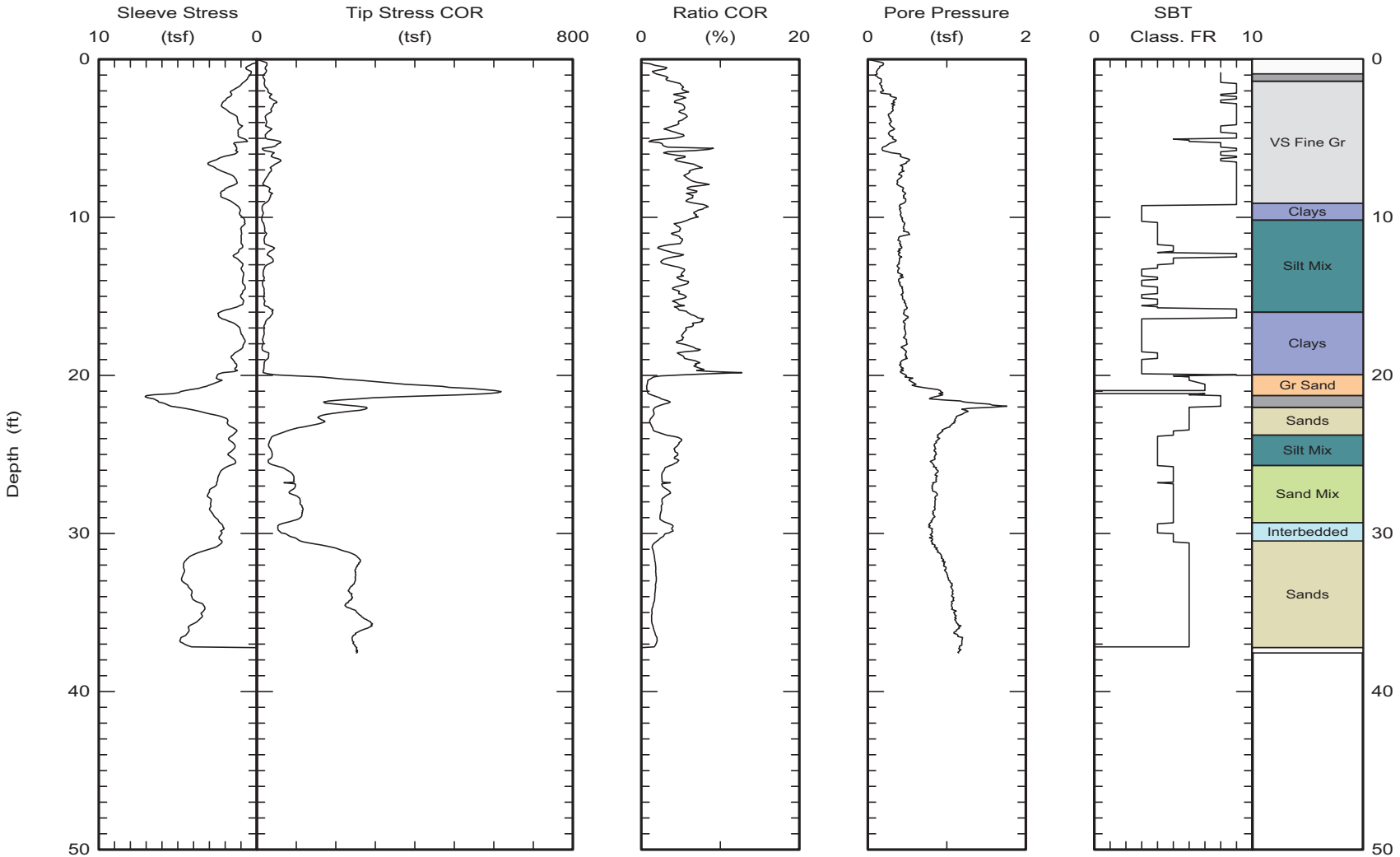
Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 26/Mar/2009 Test ID: CPT-9 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	



Maximum depth: 47.84 (ft)

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

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 26/Mar/2009 Test ID: CPT-10 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

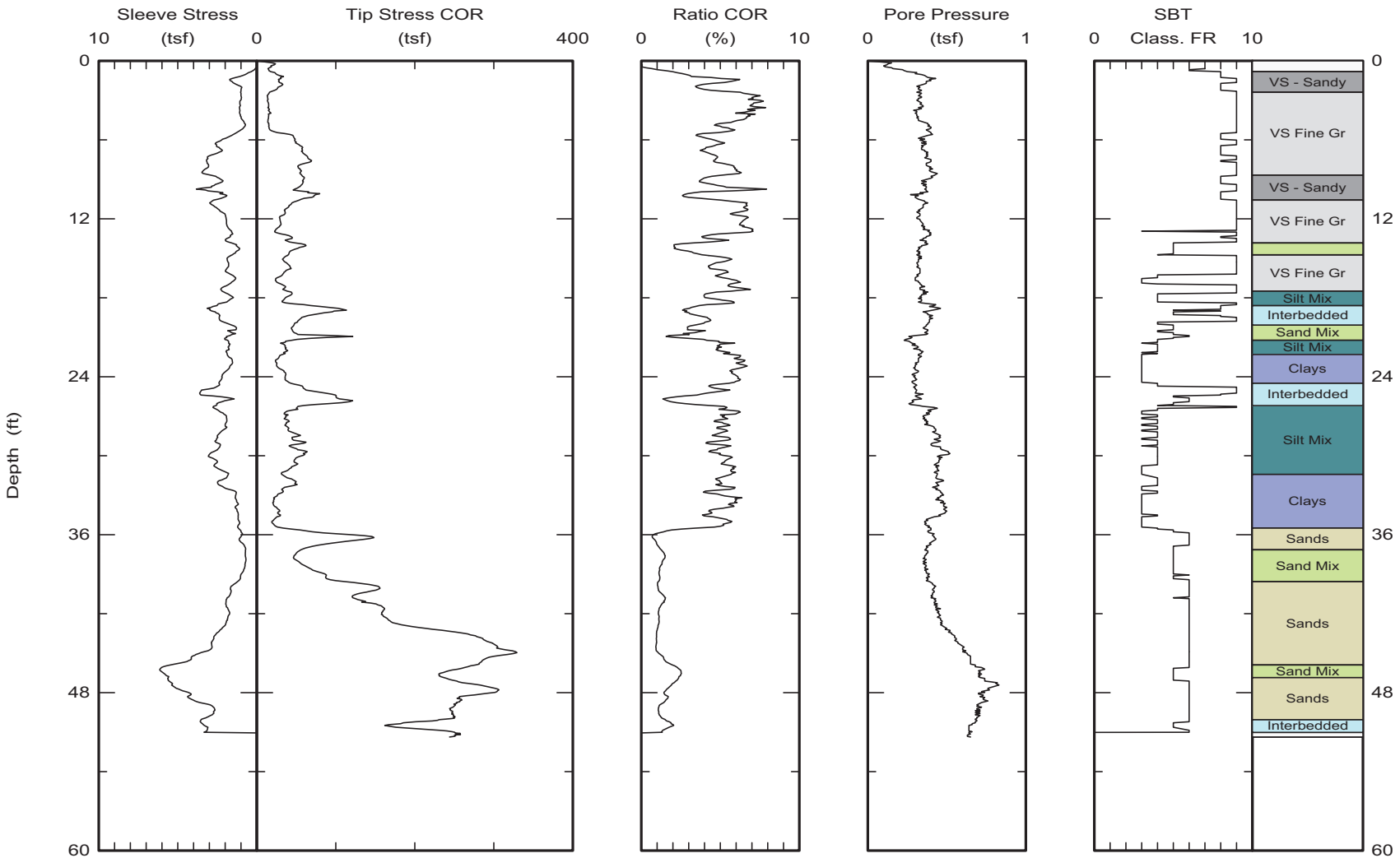


Maximum depth: 37.56 (ft)

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

Test ID: 26M902-C8
File: CPT26M0902C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 26/Mar/2009 Test ID: CPT-11 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

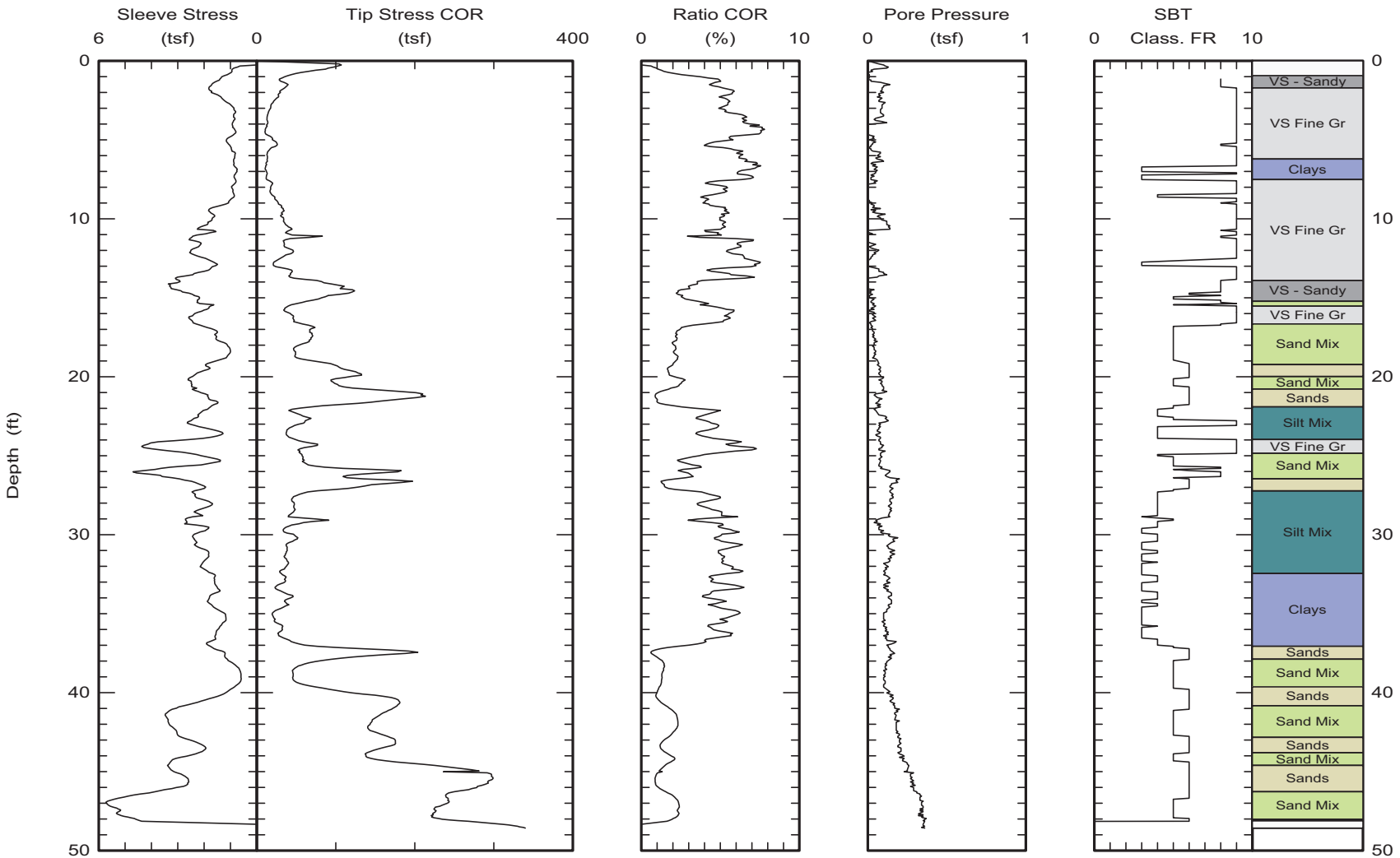


Maximum depth: 51.37 (ft)

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

Test ID: 26M901-C1
File: CPT26M0901C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 25/Mar/2009 Test ID: CPT-12 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	

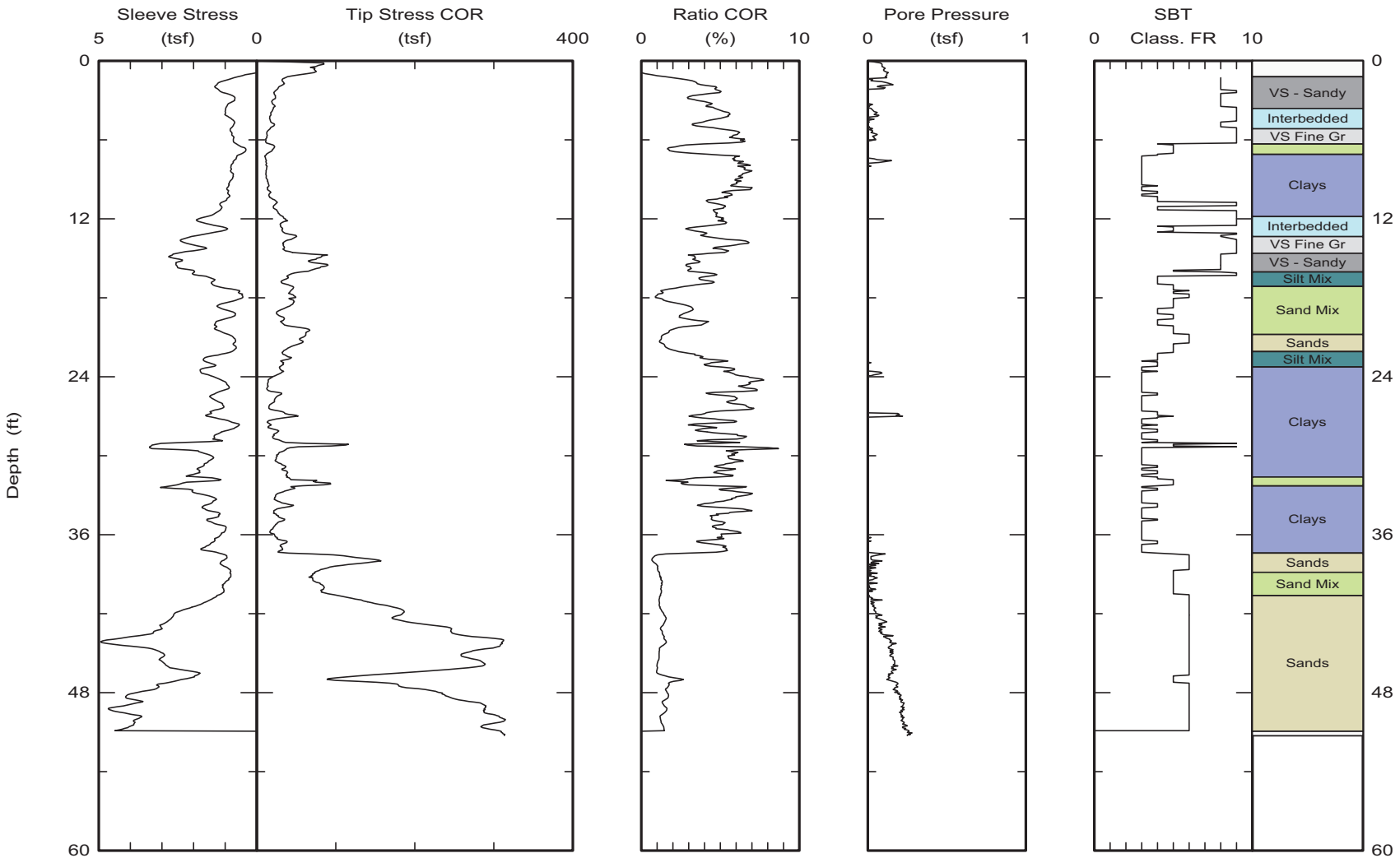


Maximum depth: 48.58 (ft)

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

Test ID: 25M903-C3
File: CPT25M0903C.ecp

Applied Research Associates, Inc. South Royalton, VT 05068 802-763-8348 cpt@ned.ara.com www.ara.com	Northing: Easting: Elevation:	Date: 25/Mar/2009 Test ID: CPT-13 Project: 12-0C9701
	Customer: MICHAEL LIAO Job Site: ROUTES 91-5 WINGWALL RE.	



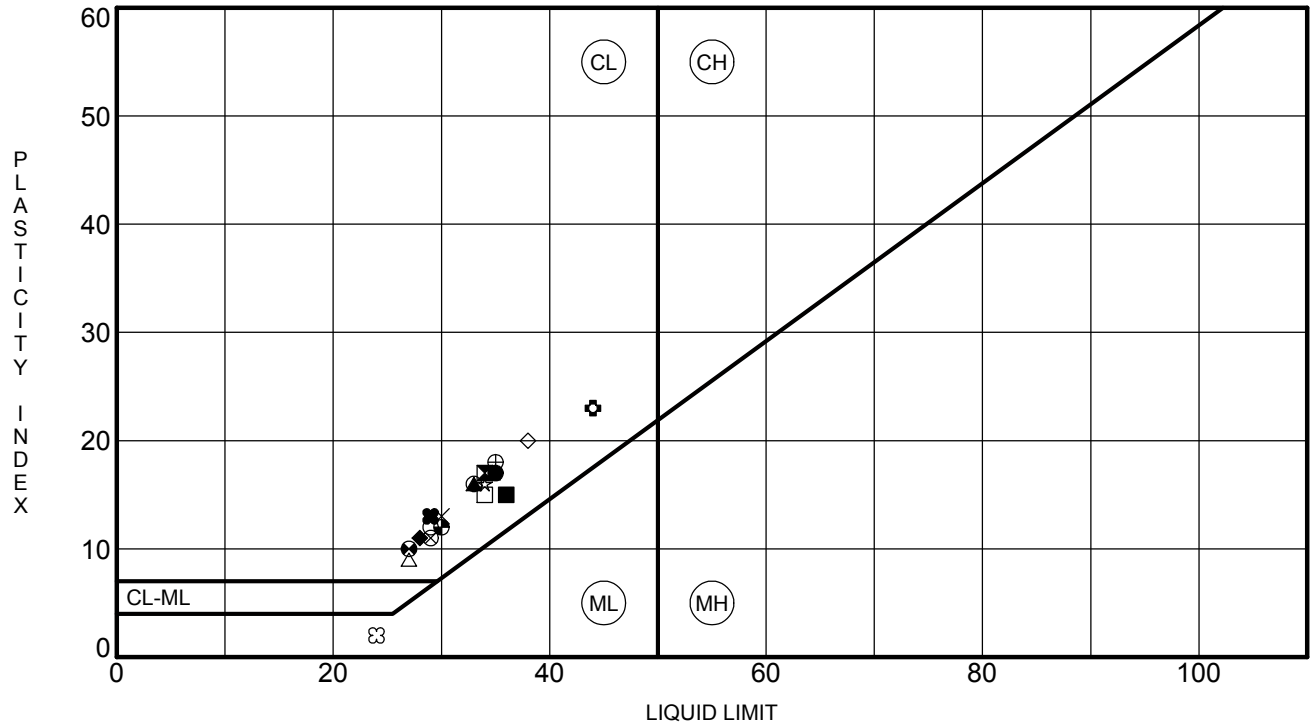
Maximum depth: 51.27 (ft)

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

Test ID: 25M902-C6
File: CPT25M0902C.ecp

Appendix C

Laboratory Test Results



	Specimen Identification		LL	PL	PI	Fines	Classification
●	A-09-04	2.5	35	18	17	55	SANDY LEAN CLAY(CL)
⊠	A-09-04	7.5	34	17	17	57	SANDY LEAN CLAY(CL)
▲	A-09-04	15.0	33	17	16	62	SANDY LEAN CLAY(CL)
★	A-09-04	27.5	35	18	17		SANDY LEAN CLAY (CL)
⊙	A-09-04	30.0	33	17	16	61	SANDY LEAN CLAY (CL)
✿	A-09-04	35.0	44	21	23		SANDY LEAN CLAY (CL)
○	R-09-01	2.5	29	17	12	35	CLAYEY SAND(SC)
△	R-09-01	12.5	27	18	9	54	SANDY LEAN CLAY(CL)
⊗	R-09-01	15.0	29	18	11	42	CLAYEY SAND(SC)
⊕	R-09-01	20.0	35	17	18		LEAN CLAY with SAND (CL)
□	R-09-01	25.0	34	19	15	71	LEAN CLAY with SAND (CL)
❂	R-09-02	6.5	27	17	10		SANDY LEAN CLAY (CL)
◕	R-09-02	11.5	30	18	12	64	SANDY LEAN CLAY (CL)
☆	R-09-02	15.0	34	18	16		LEAN CLAY (CL)
⌘	R-09-02	26.5	24	22	2		SILTY SAND (SM)
■	R-09-02	40.0	36	21	15		LEAN CLAY (CL)
◆	R-09-03	5.0	28	17	11	33	CLAYEY SAND(SC)
◇	R-09-03	11.5	38	18	20	56	SANDY LEAN CLAY(CL)
╳	R-09-03	15.0	30	17	13		LEAN CLAY (CL)
✖	R-09-03	20.0	29	16	13		LEAN CLAY (CL)

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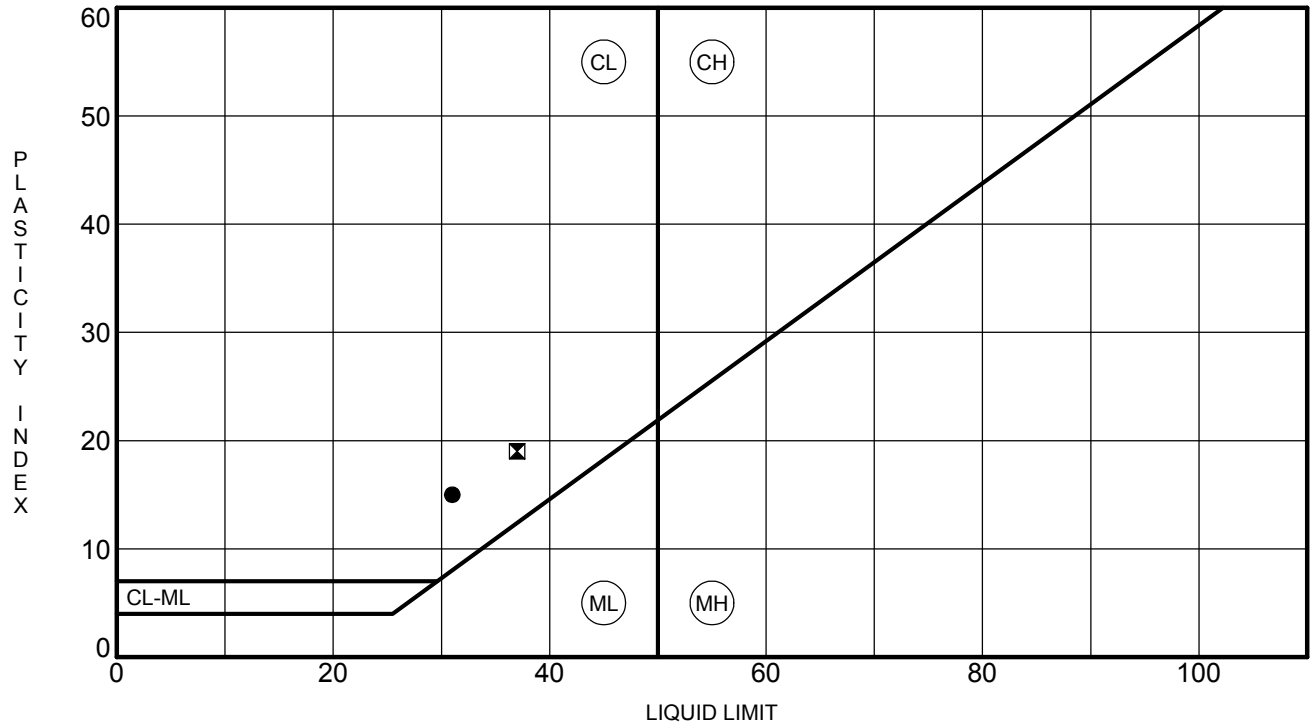
ATTERBERG LIMITS RESULTS

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0503G	Q. Liao	5-28-09	1 of 2

CALTRANS ATTERBERG 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**R-09-03**	**25.0**	**31**	**16**	**15**		**LEAN CLAY (CL)**
⧓	**R-09-03**	**31.5**	**37**	**18**	**19**	**76**	**LEAN CLAY with SAND(CL)**

Department of Transportation
Division of Engineering Services
Geotechnical Services
Office of Geotechnical Design - South

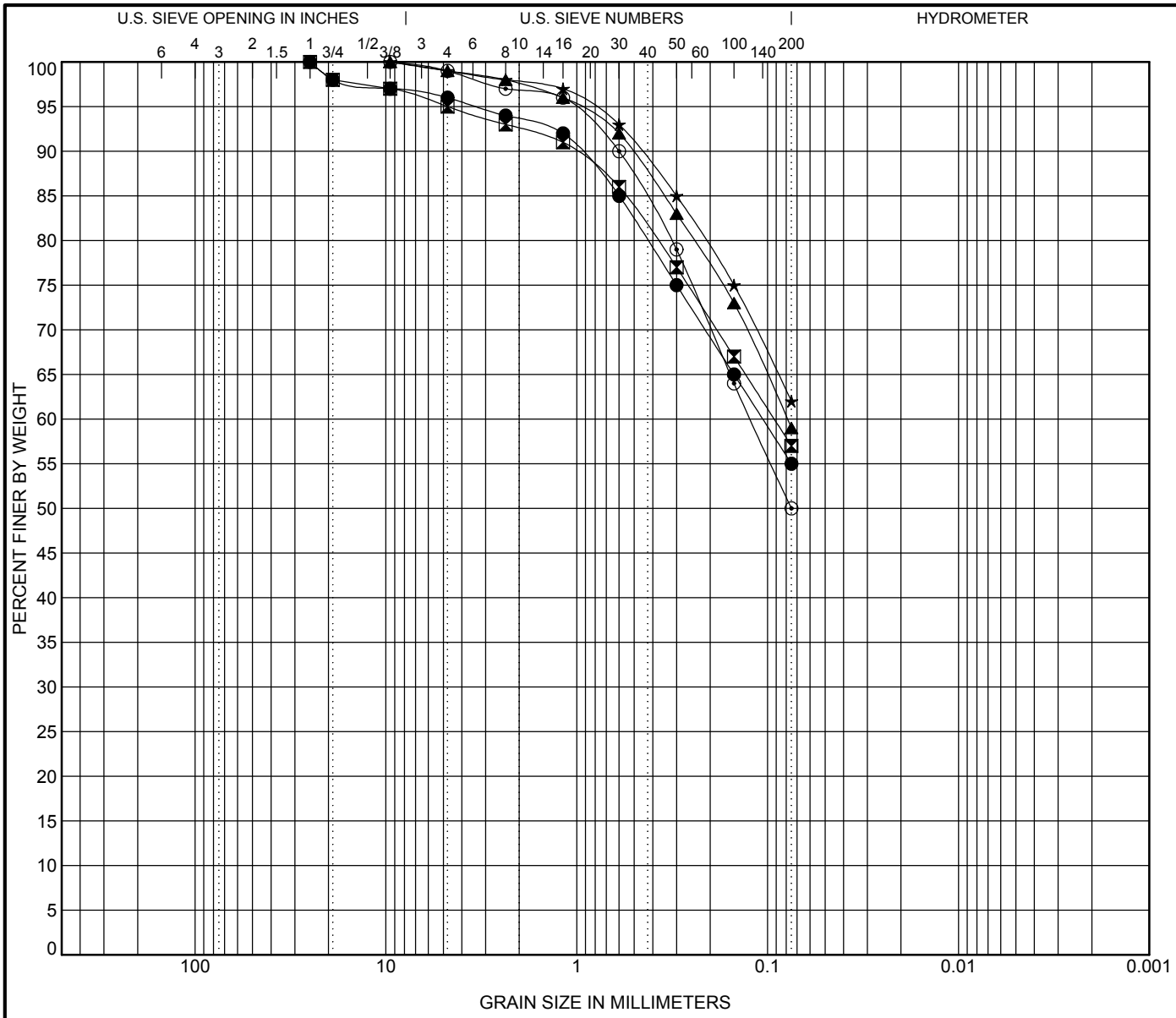
ATTERBERG LIMITS RESULTS

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	**Orange**	**91/5**	**D/D**	**12-0C9701**

PROJECT OR BRIDGE NAME
1 **91/5 Retaining Wall Repair**

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0503G	**Q. Liao**	**5-28-09**	**2 of 2**

CALTRANS ATTERBERG 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	A-09-04	2.5	SANDY LEAN CLAY(CL)	35	18	17		
⊠	A-09-04	7.5	SANDY LEAN CLAY(CL)	34	17	17		
▲	A-09-04	10.0	SANDY LEAN CLAY (CL)					
★	A-09-04	15.0	SANDY LEAN CLAY(CL)	33	17	16		
⊙	A-09-04	17.5	SANDY SILT (ML)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	A-09-04	2.5	25	0.106			4.0	41.0	55.0	
⊠	A-09-04	7.5	25	0.092			5.0	38.0	57.0	
▲	A-09-04	10.0	9.5	0.079			1.0	40.0	59.0	
★	A-09-04	15.0	9.5				1.0	37.0	62.0	
⊙	A-09-04	17.5	9.5	0.123			1.0	49.0	50.0	

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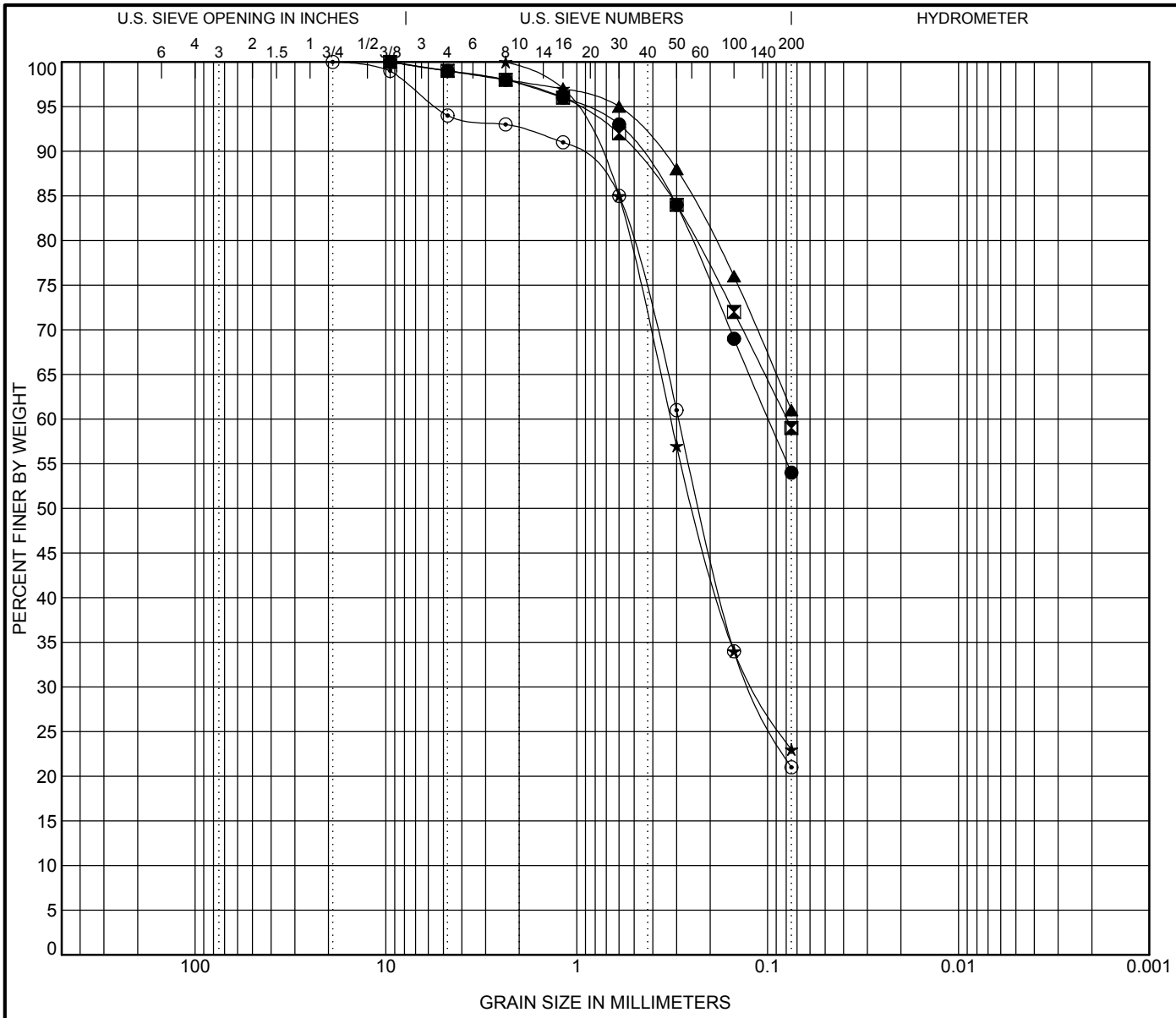
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0472S	Q. Liao	5-28-09	1 of 6

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	A-09-04	20.0	**SANDY SILT (ML)**					
⊠	A-09-04	25.0	**SANDY LEAN CLAY (CL)**					
▲	A-09-04	30.0	**SANDY LEAN CLAY (CL)**	**33**	**17**	**16**		
★	A-09-04	37.5	**SILTY SAND (SM)**					
⊙	A-09-04	42.5	**SILTY SAND (SM)**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	A-09-04	20.0	**9.5**	**0.099**			**1.0**	**45.0**	**54.0**	
⊠	A-09-04	25.0	**9.5**	**0.079**			**1.0**	**40.0**	**59.0**	
▲	A-09-04	30.0	**9.5**				**1.0**	**38.0**	**61.0**	
★	A-09-04	37.5	**2.36**	**0.323**	**0.117**		**0.0**	**77.0**	**23.0**	
⊙	A-09-04	42.5	**19**	**0.292**	**0.121**		**6.0**	**73.0**	**21.0**	

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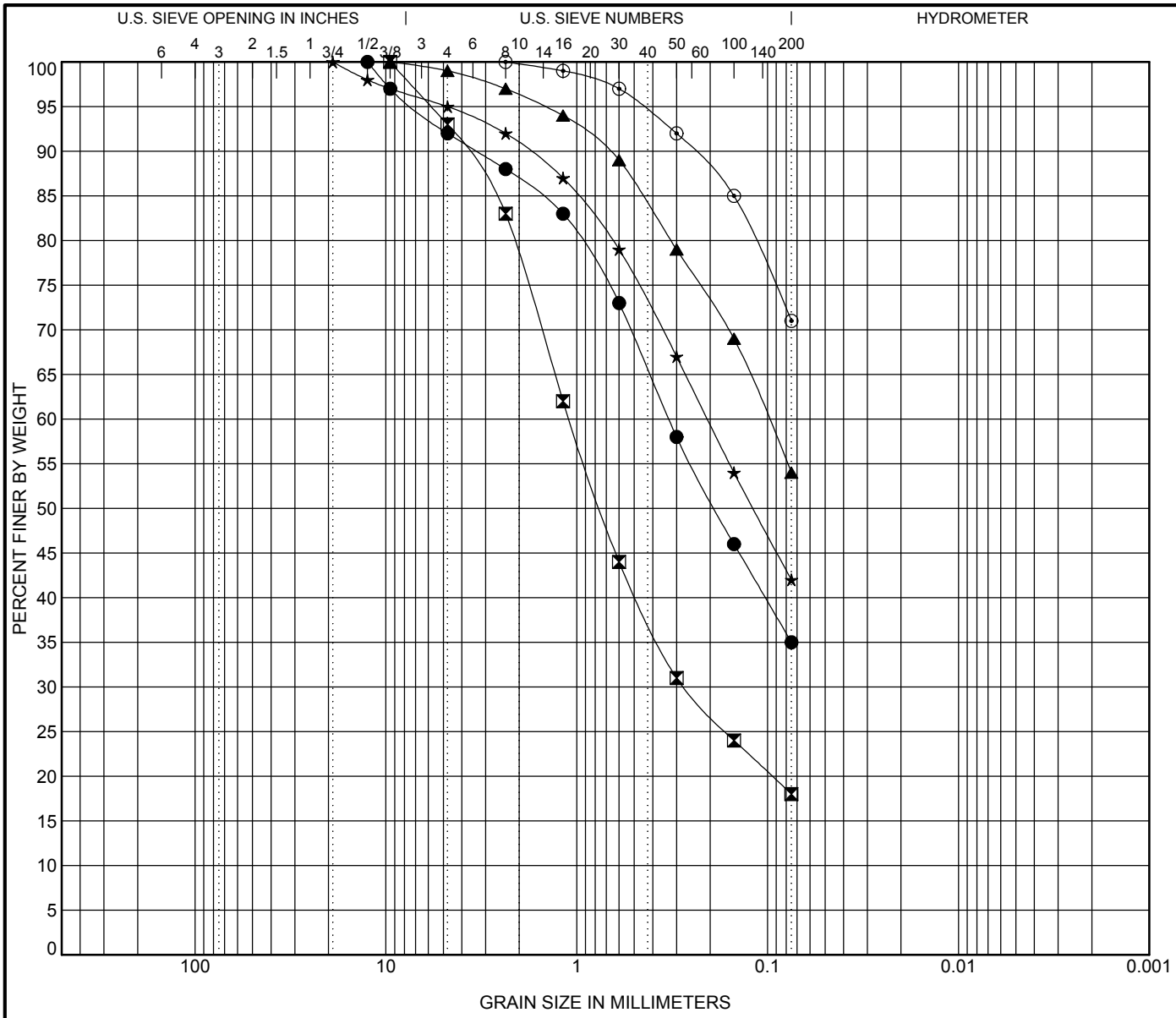
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 **91/5 Retaining Wall Repair**

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0472S	Q. Liao	5-28-09	2 of 6

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	R-09-01	2.5	CLAYEY SAND(SC)	29	17	12		
⊠	R-09-01	10.0	SILTY SAND (SM)					
▲	R-09-01	12.5	SANDY LEAN CLAY(CL)	27	18	9		
★	R-09-01	15.0	CLAYEY SAND(SC)	29	18	11		
⊙	R-09-01	25.0	LEAN CLAY with SAND (CL)	34	19	15		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-09-01	2.5	12.5	0.329			8.0	57.0	35.0	
⊠	R-09-01	10.0	9.5	1.095	0.272		7.0	75.0	18.0	
▲	R-09-01	12.5	9.5	0.099			1.0	45.0	54.0	
★	R-09-01	15.0	19	0.207			5.0	53.0	42.0	
⊙	R-09-01	25.0	2.36				0.0	29.0	71.0	

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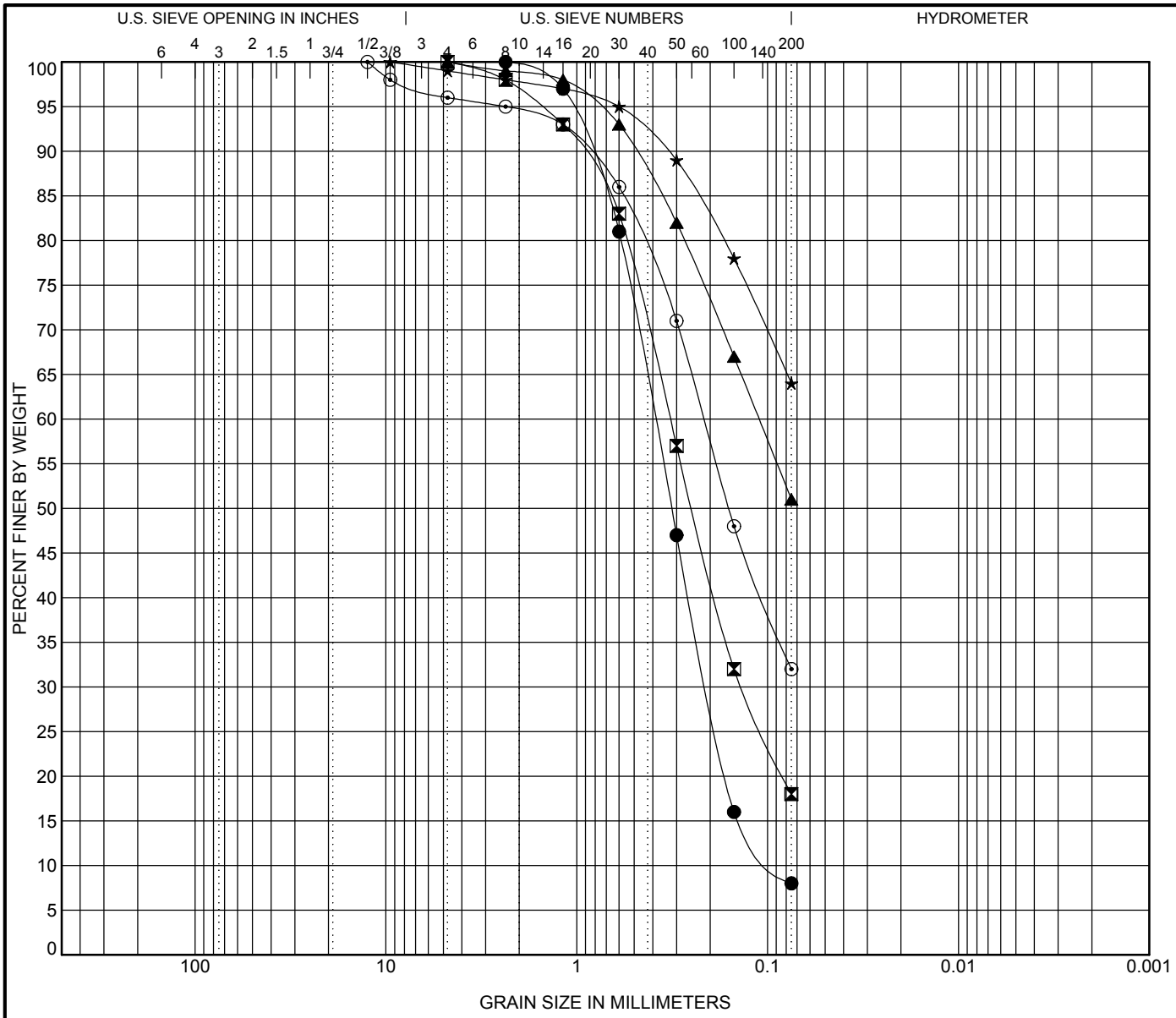
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0293L	Q. Liao	5-28-09	3 of 6

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	R-09-01	35.0	POORLY GRADED SAND with SILT (SP-SM)				1.21	4.38
⊠	R-09-01	45.0	SILTY SAND (SM)					
▲	R-09-02	1.5	SANDY SILT (ML)					
★	R-09-02	11.5	SANDY LEAN CLAY (CL)	30	18	12		
⊙	R-09-02	25.0	SILTY SAND (SM)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-09-01	35.0	2.36	0.391	0.205	0.089	0.0	92.0	8.0	
⊠	R-09-01	45.0	4.75	0.325	0.136		0.0	82.0	18.0	
▲	R-09-02	1.5	4.75	0.111			0.0	49.0	51.0	
★	R-09-02	11.5	9.5				1.0	35.0	64.0	
⊙	R-09-02	25.0	12.5	0.215			4.0	64.0	32.0	

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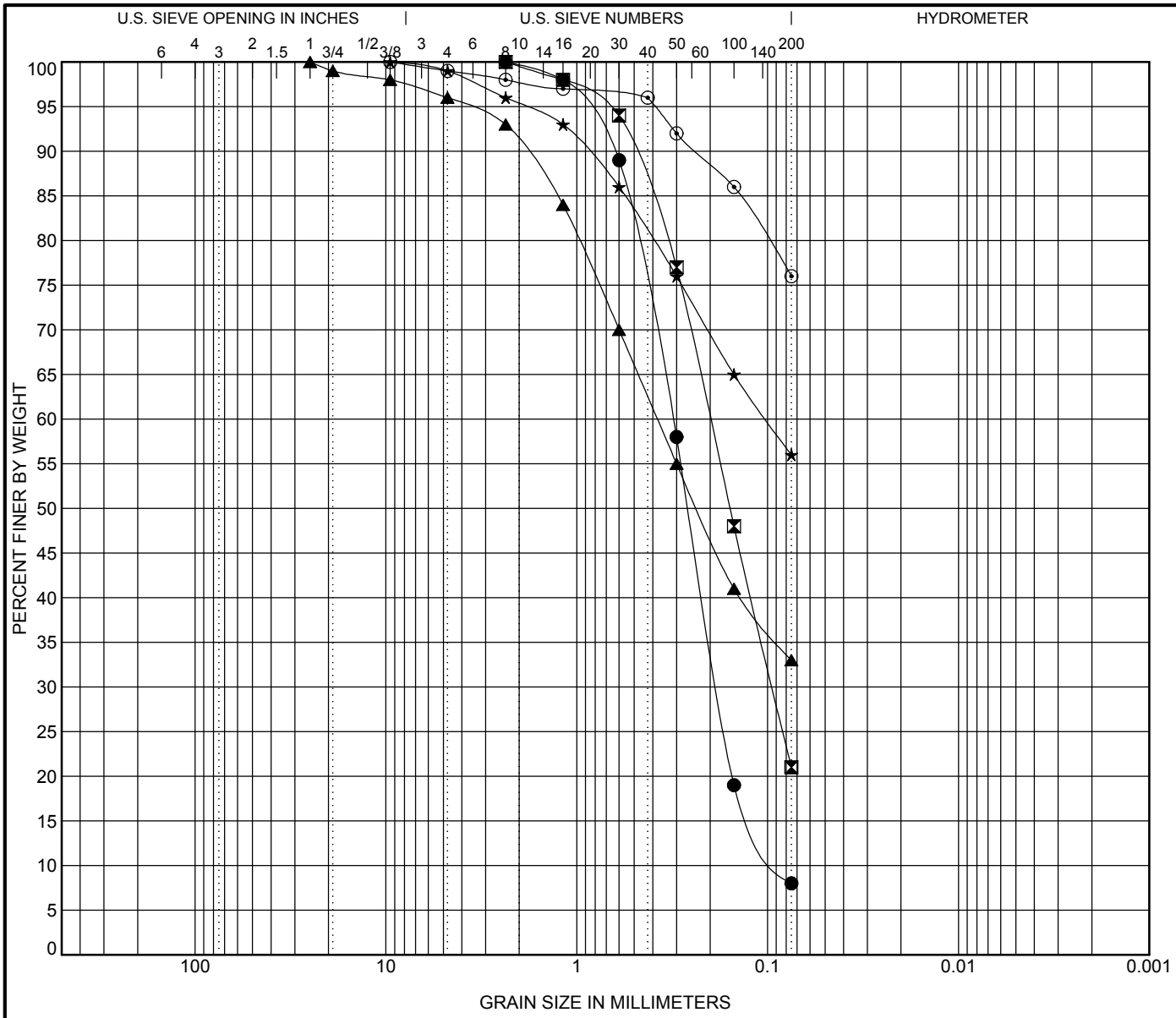
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0293L	Q. Liao	5-28-09	4 of 6

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	R-09-02	45.0	POORLY GRADED SAND with SILT (SP-SM)				1.25	3.69
⊠	R-09-03	1.5	SILTY SAND (SM)					
▲	R-09-03	5.0	CLAYEY SAND(SC)	28	17	11		
★	R-09-03	11.5	SANDY LEAN CLAY(CL)	38	18	20		
⊙	R-09-03	31.5	LEAN CLAY with SAND(CL)	37	18	19		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-09-02	45.0	2.36	0.314	0.182	0.085	0.0	92.0	8.0	
⊠	R-09-03	1.5	2.36	0.2	0.094		0.0	79.0	21.0	
▲	R-09-03	5.0	25	0.378			4.0	63.0	33.0	
★	R-09-03	11.5	9.5	0.102			1.0	43.0	56.0	
⊙	R-09-03	31.5	9.5				1.0	23.0	76.0	

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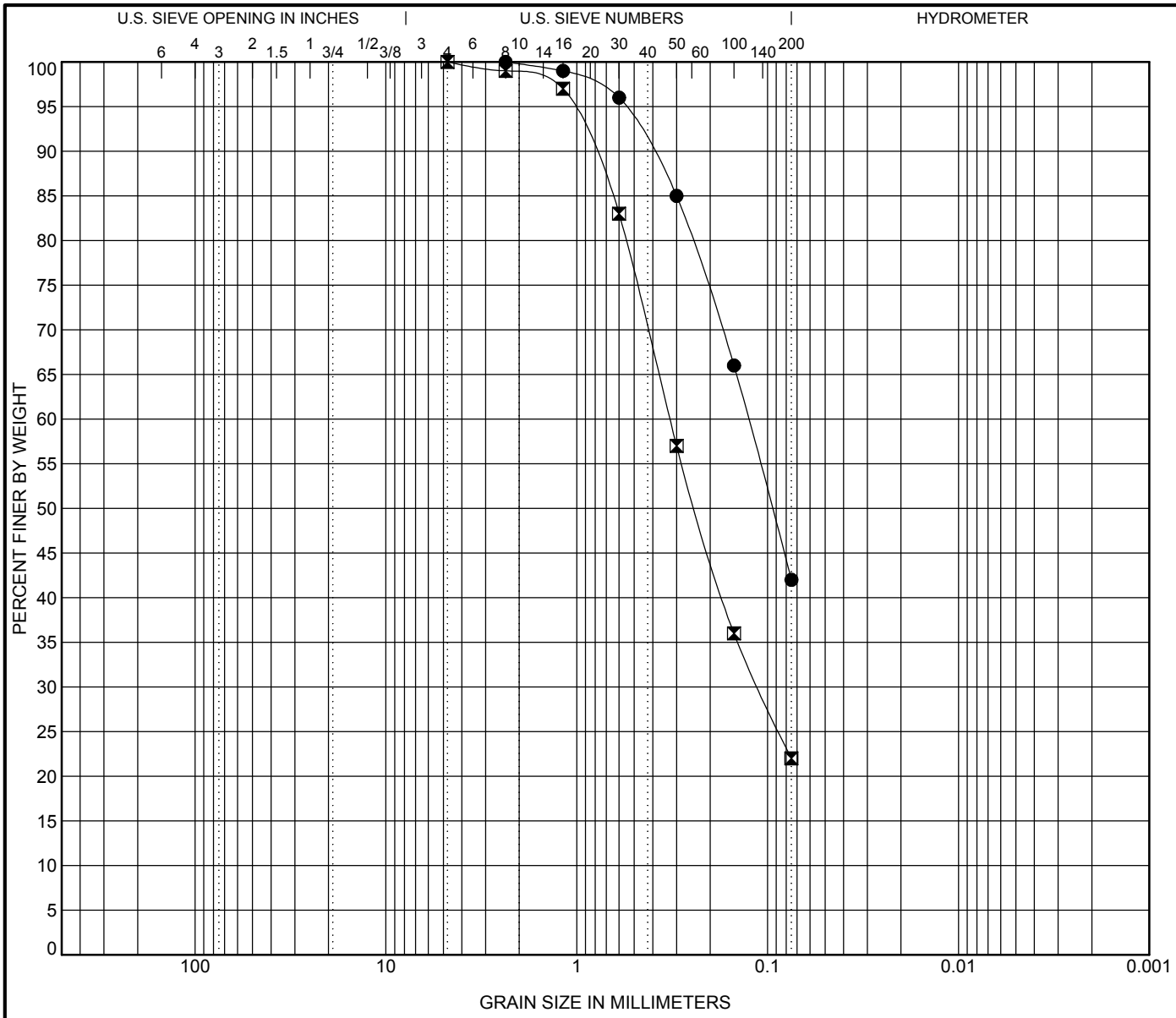
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0503G	Q. Liao	5-28-09	5 of 6

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**R-09-03**	**40.0**	**SILTY SAND (SM)**					
⊠	**R-09-03**	**45.0**	**SILTY SAND (SM)**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**R-09-03**	**40.0**	**2.36**	**0.126**			**0.0**	**58.0**	**42.0**	
⊠	**R-09-03**	**45.0**	**4.75**	**0.325**	**0.111**		**0.0**	**78.0**	**22.0**	

Department of Transportation
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Office of Geotechnical Design - South

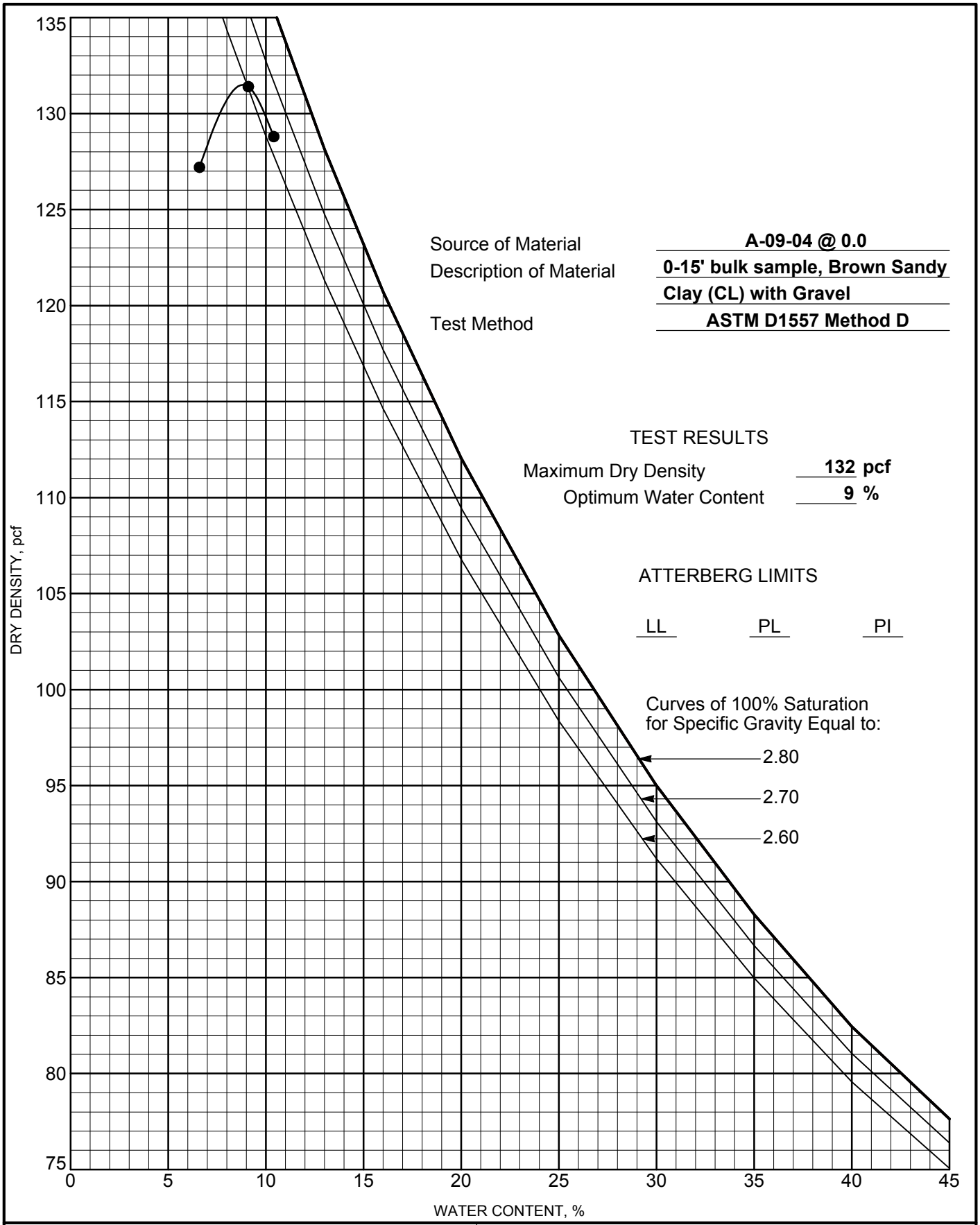
GRAIN SIZE DISTRIBUTION

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	**Orange**	**91/5**	**D/D**	**12-0C9701**

PROJECT OR BRIDGE NAME
1 **91/5 Retaining Wall Repair**

BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0503G	**Q. Liao**	**5-28-09**	**6 of 6**

CALTRANS GRAIN SIZE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09



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MOISTURE-DENSITY RELATIONSHIP

DIST.	COUNTY	ROUTE	POSTMILE	EA
12	Orange	91/5	D/D	12-0C9701

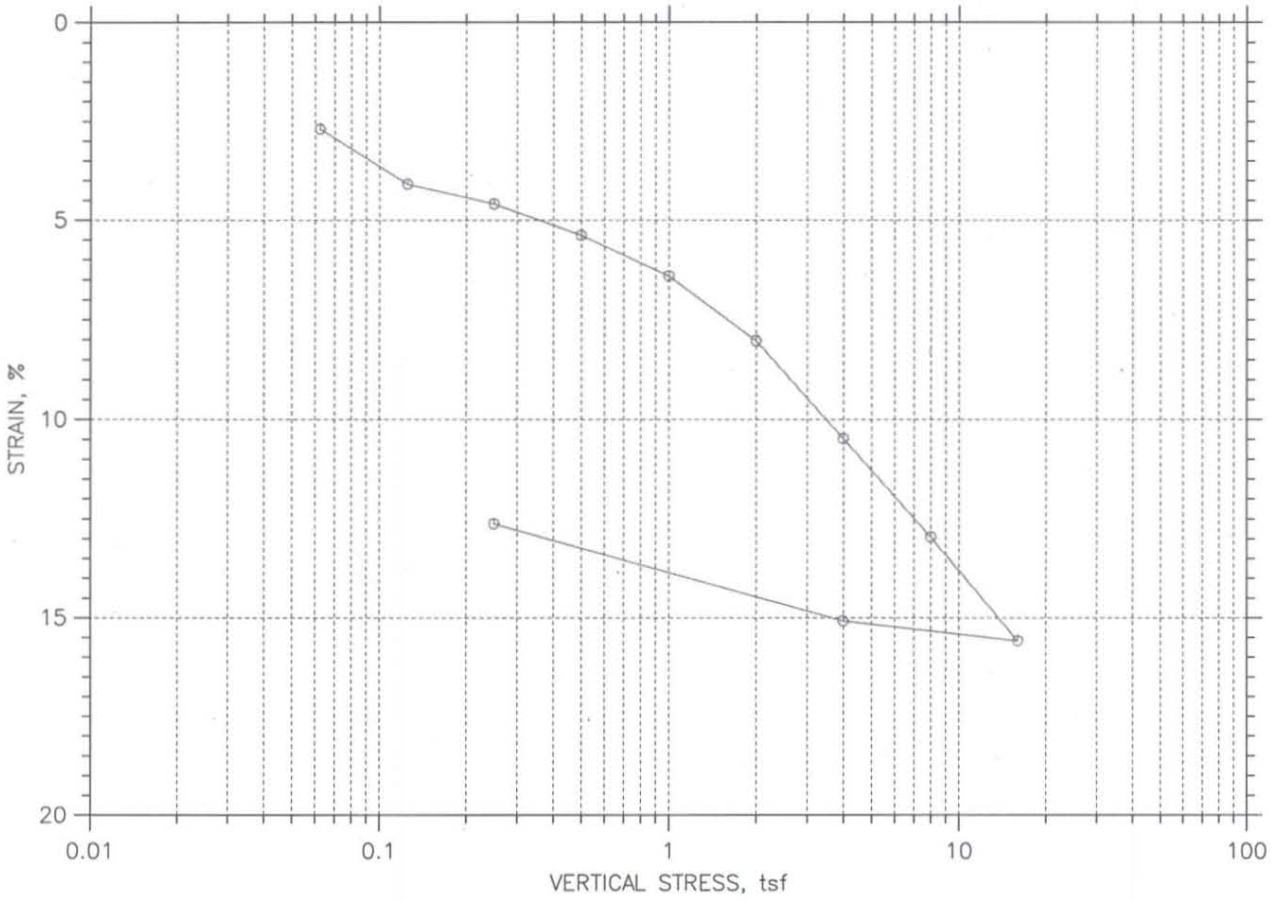
PROJECT OR BRIDGE NAME
1 91/5 Retaining Wall Repair

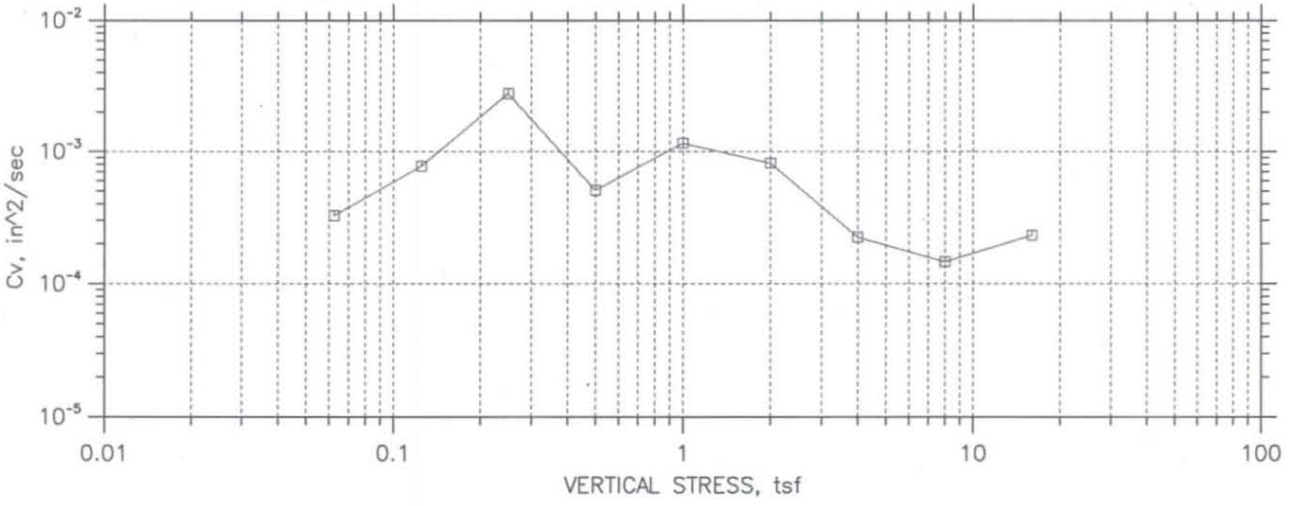
BRIDGE NUMBER	PREPARED BY	DATE	SHEET
55-0472S	Q. Liao	5-28-09	1 of 1

CALTRANS COMPACTION-SINGLE CURVE 12-0C9701-91-5-WINGWALL.GPJ CALTRANS LIBRARY 040808.GLB 5/21/09

CONSOLIDATION TEST DATA

SUMMARY REPORT



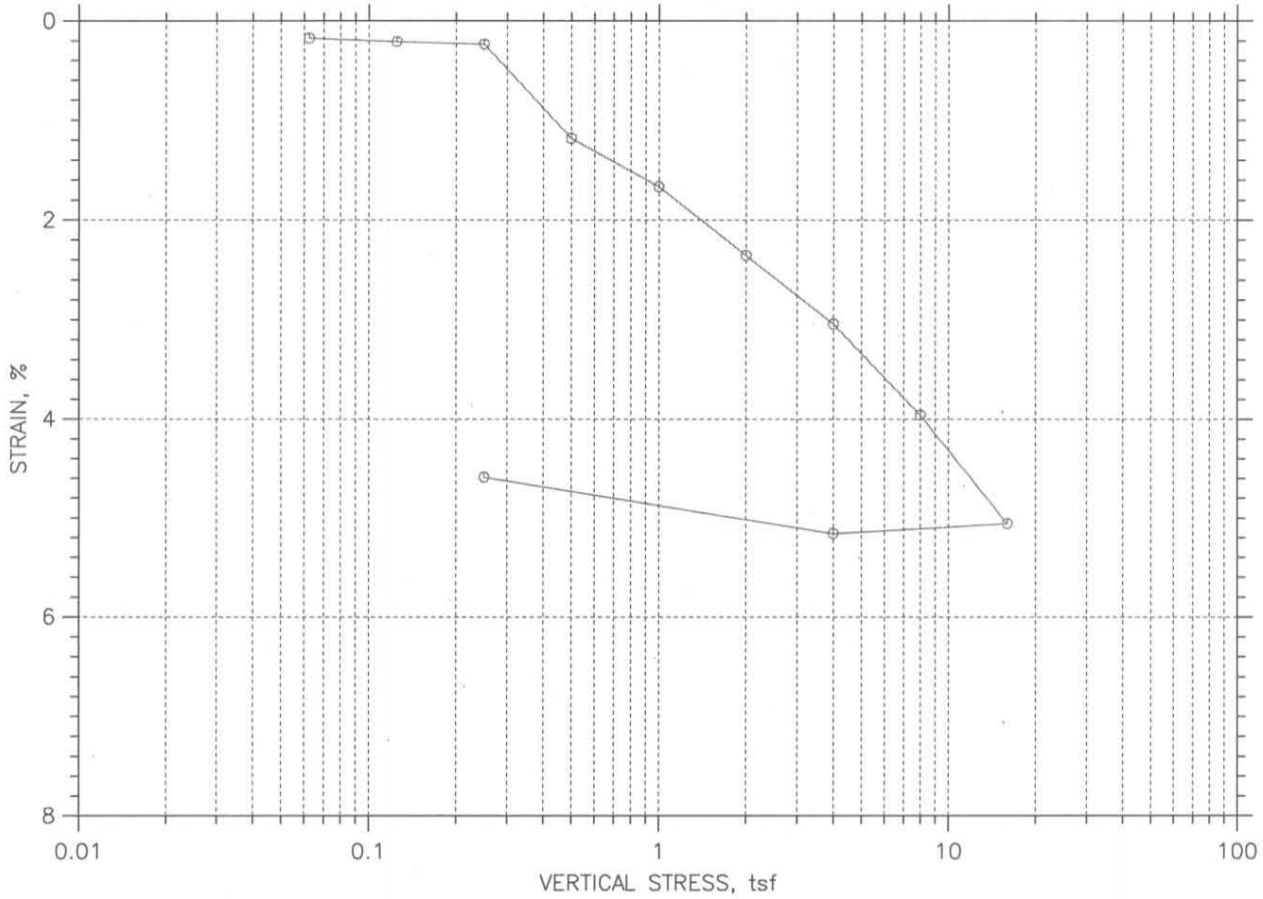


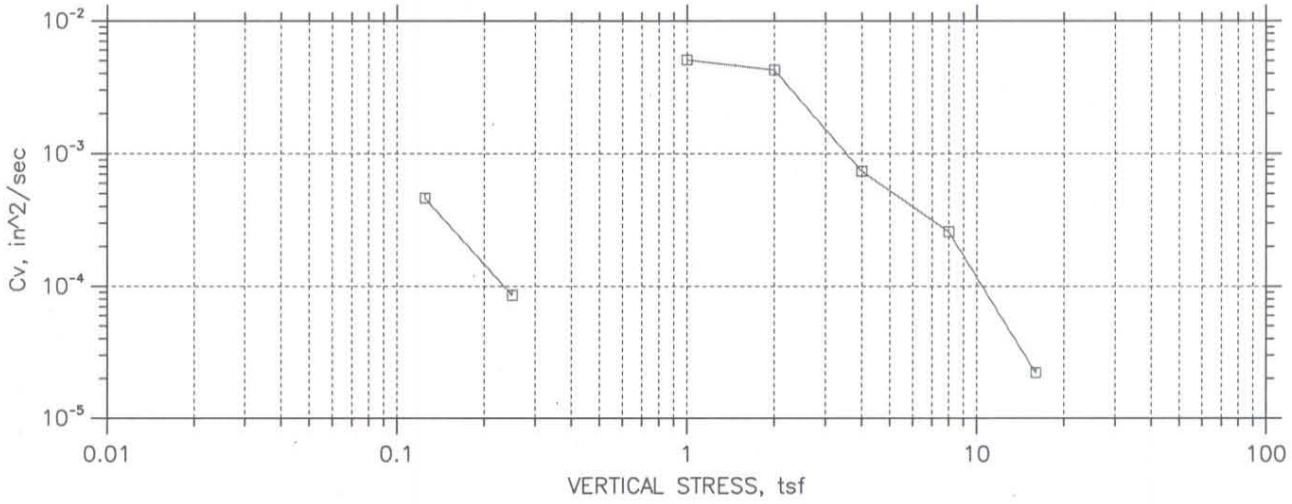
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: A09-04	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 03B	Test Date: 4/20/2009	Depth: 7.5'
	Test No.: 09-002-G1	Sample Type: TUBE	Elevation:
	Description: Moist, brown,stiff,silty clay		
	Remarks:		

Wed, 06-MAY-2009 20:10:26

CONSOLIDATION TEST DATA

SUMMARY REPORT



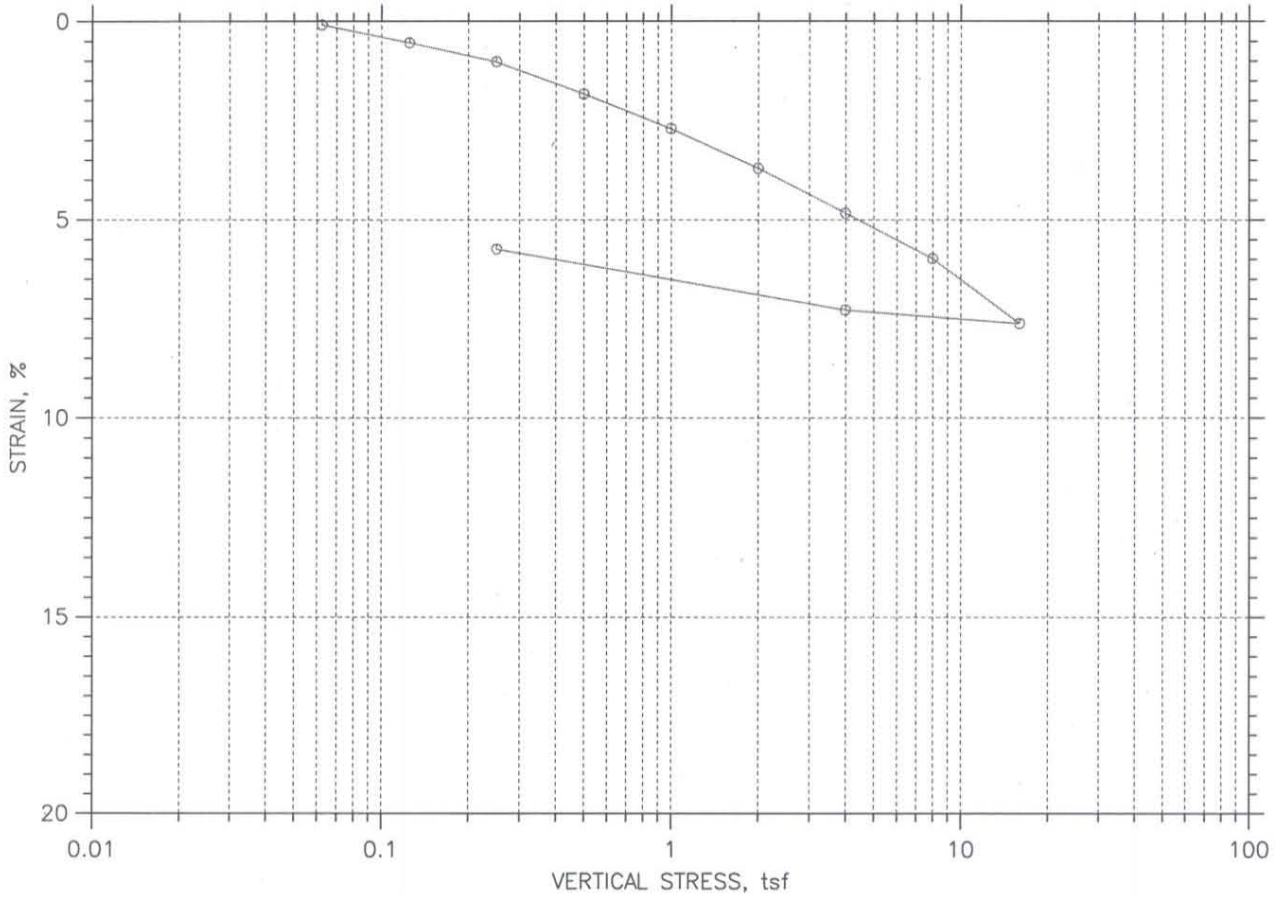


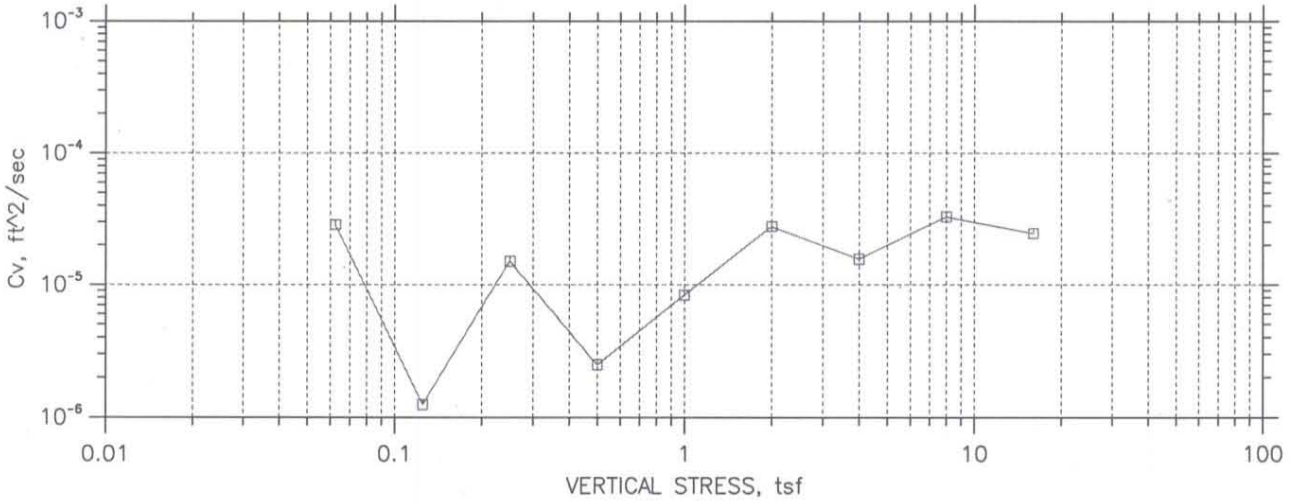
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: A09-04	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 11A	Test Date: 4/20/2009	Depth: 27.5
	Test No.: 09-003-G3	Sample Type: TUBE	Elevation:
	Description: Moist, dark brown, stiff clay,		
	Remarks:		

Mon, 04-MAY-2009 12:46:16

CONSOLIDATION TEST DATA

SUMMARY REPORT



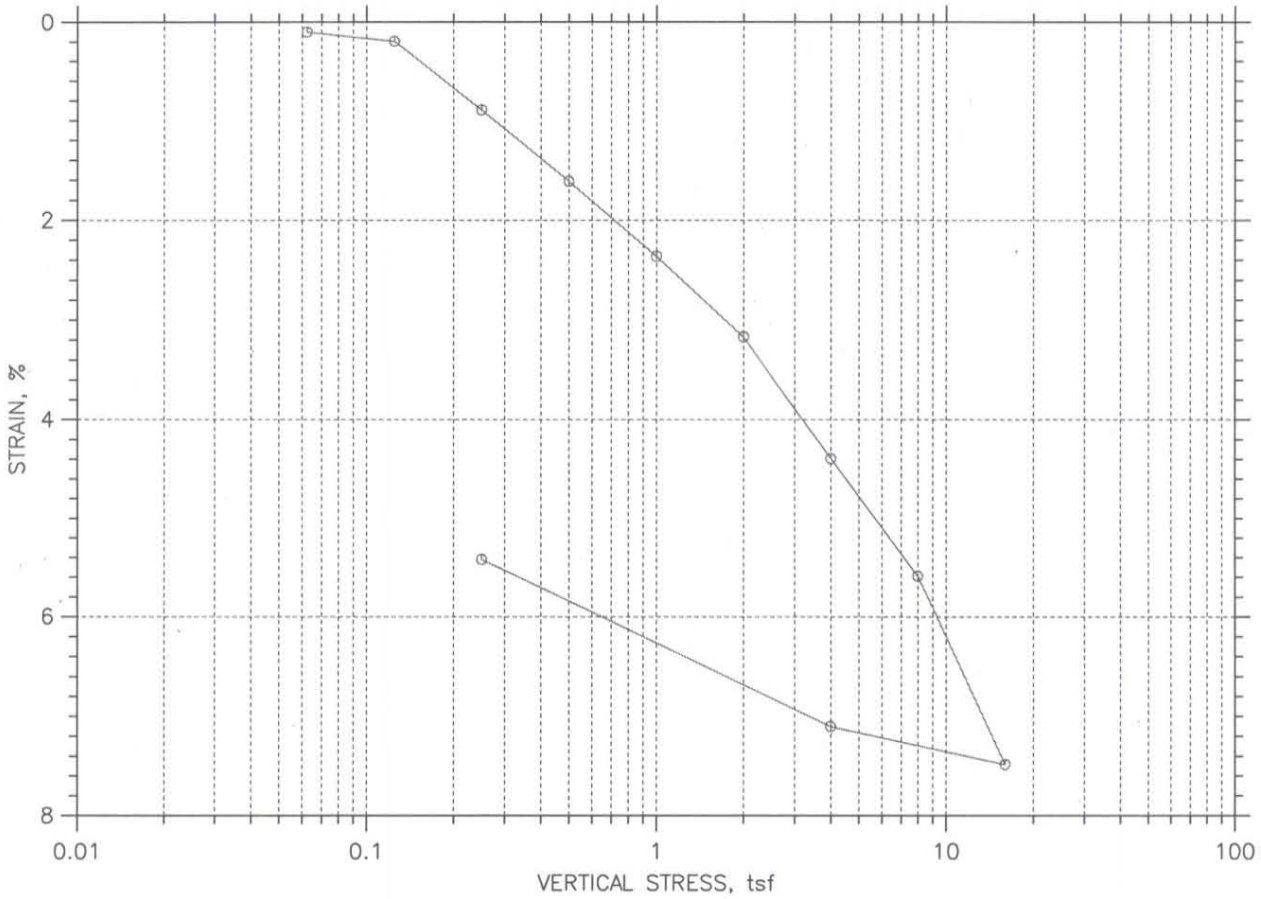


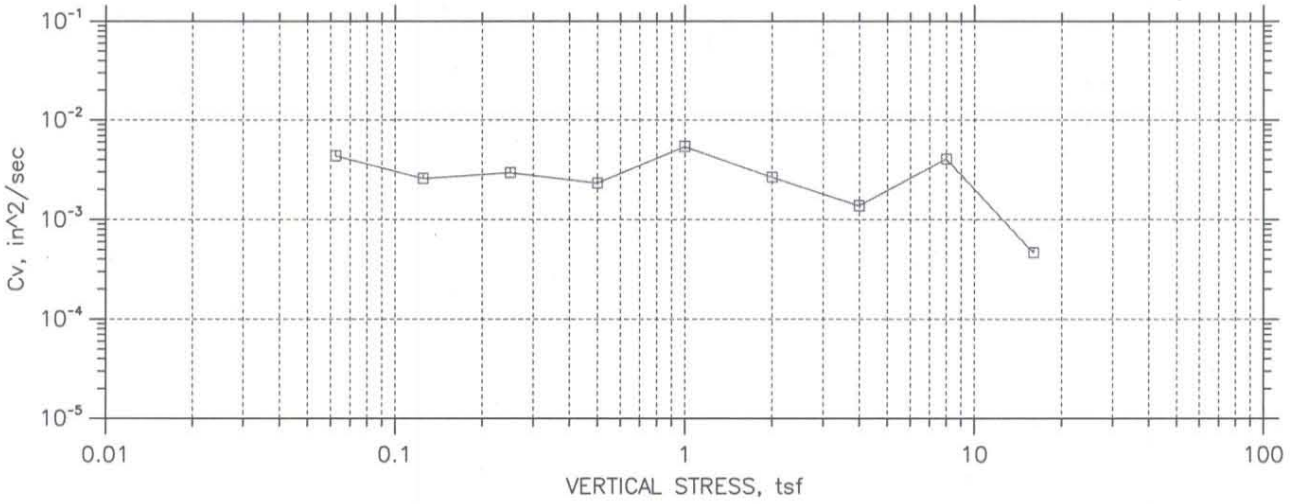
	Project: Route 91/5 Wingwall	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-01	Tested By: AZM	Checked By: GL09-012
	Sample No.: 09A	Test Date: 4/20/2009	Depth: 22.5'
	Test No.: 09-004-G4	Sample Type:	Elevation: ---
	Description: Moist, brown-tan,hard,silty clay w/gravel		
	Remarks:		

Wed, 06-MAY-2009 20:14:43

CONSOLIDATION TEST DATA

SUMMARY REPORT



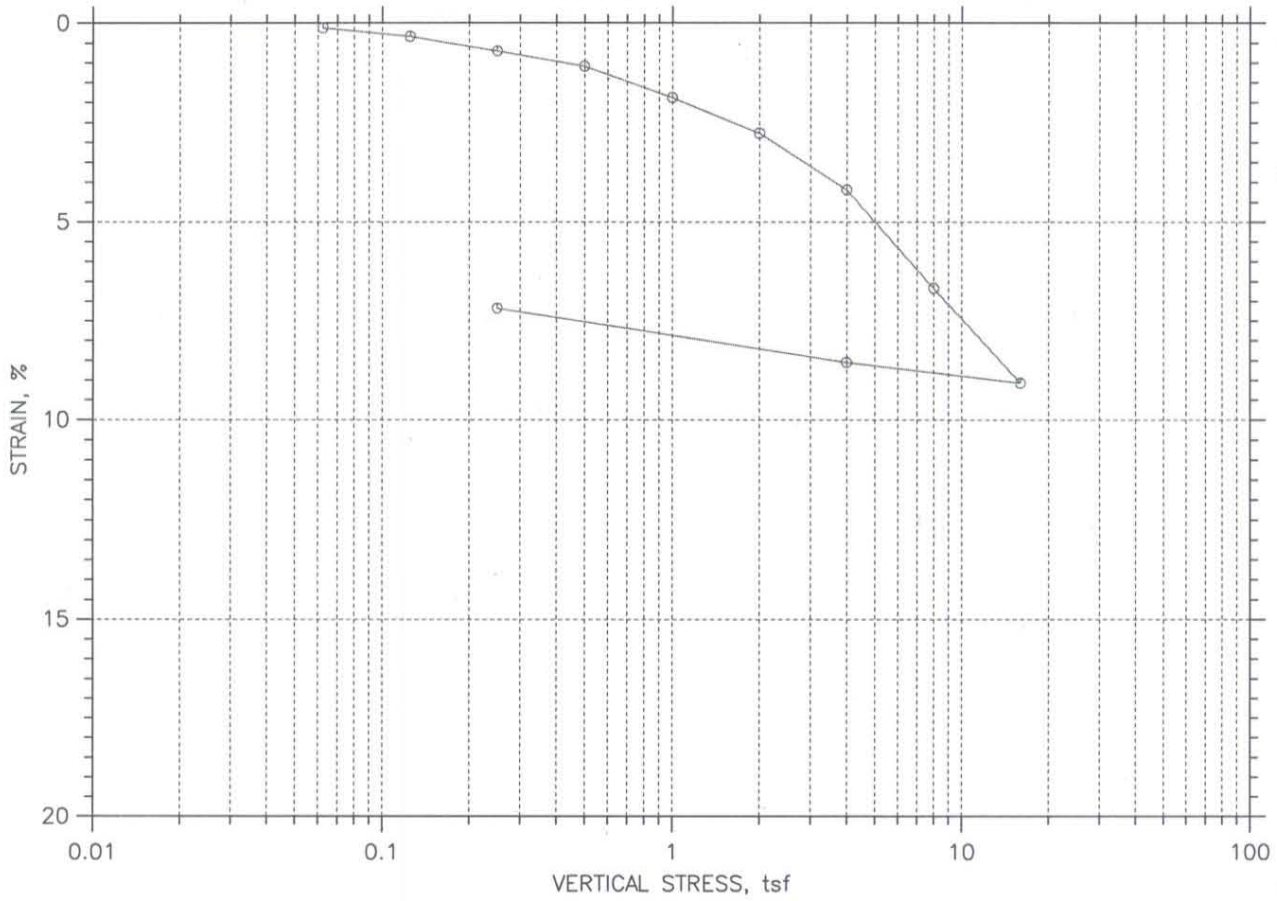


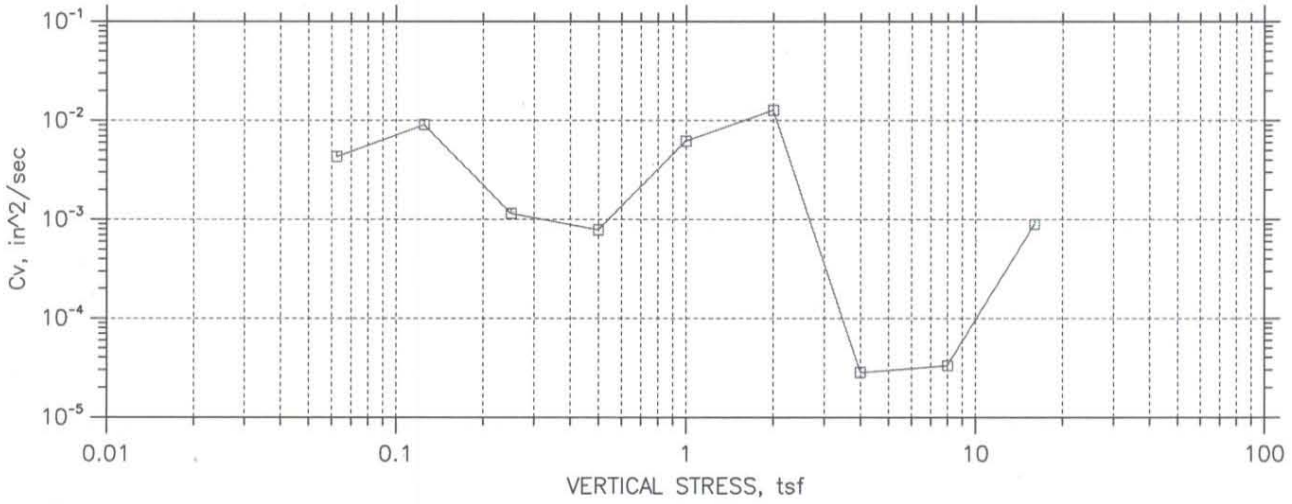
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-01	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 11A	Test Date: 4/22/2009	Depth: 30'
	Test No.: 09-005-G1	Sample Type: TUBE	Elevation:
	Description: Moist, brown,stiff,clay		
	Remarks:		

Wed, 06-MAY-2009 20:19:07

CONSOLIDATION TEST DATA

SUMMARY REPORT



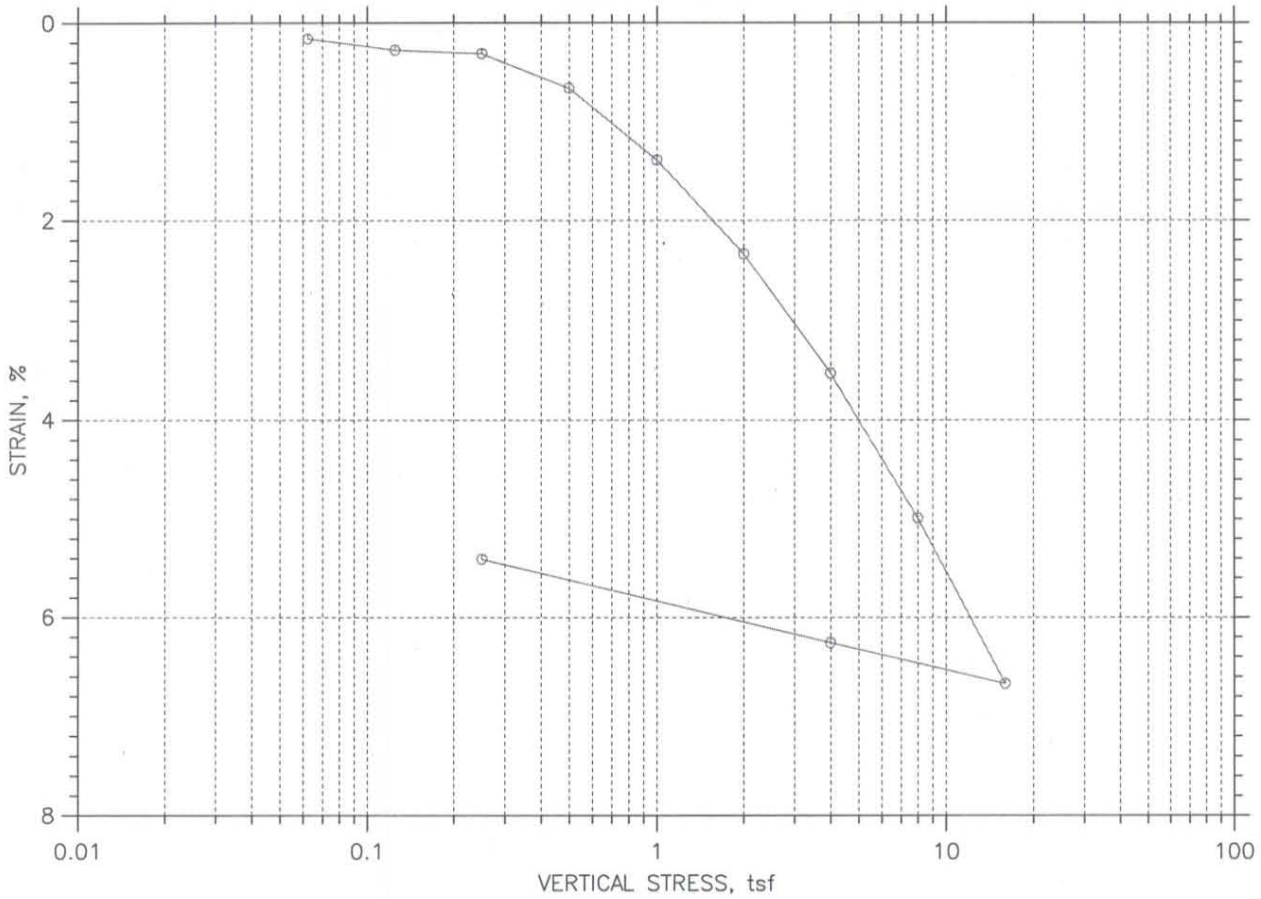


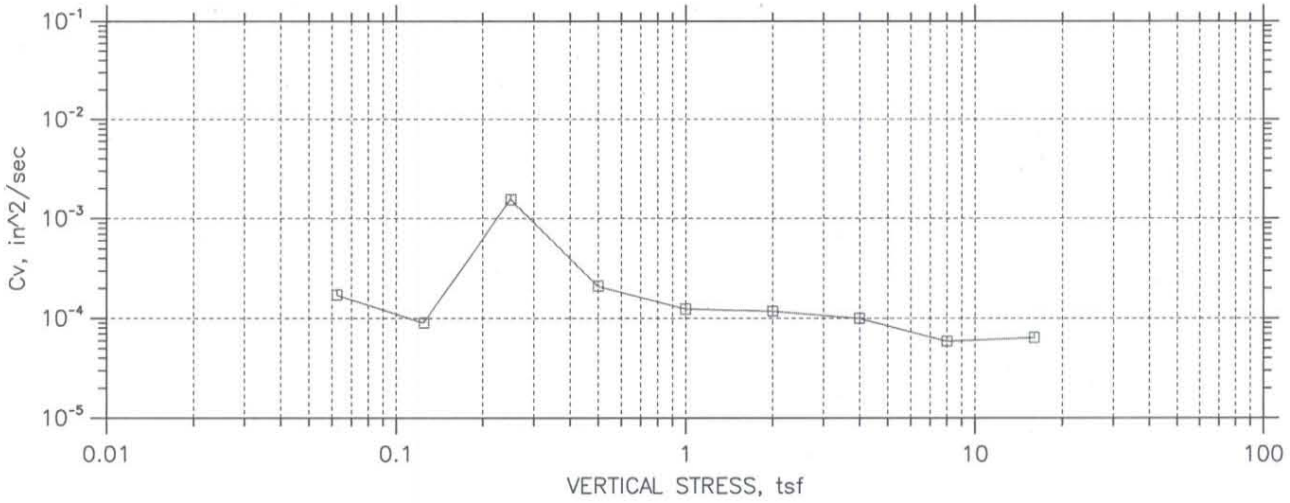
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-02	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 07A	Test Date: 4/27/2009	Depth: 16.5-20
	Test No.: 09-006-G1	Sample Type: TUBE	Elevation:
	Description: Moist, brown,soft,silty clay w/peat		
	Remarks:		

Wed, 06-MAY-2009 20:24:28

CONSOLIDATION TEST DATA

SUMMARY REPORT



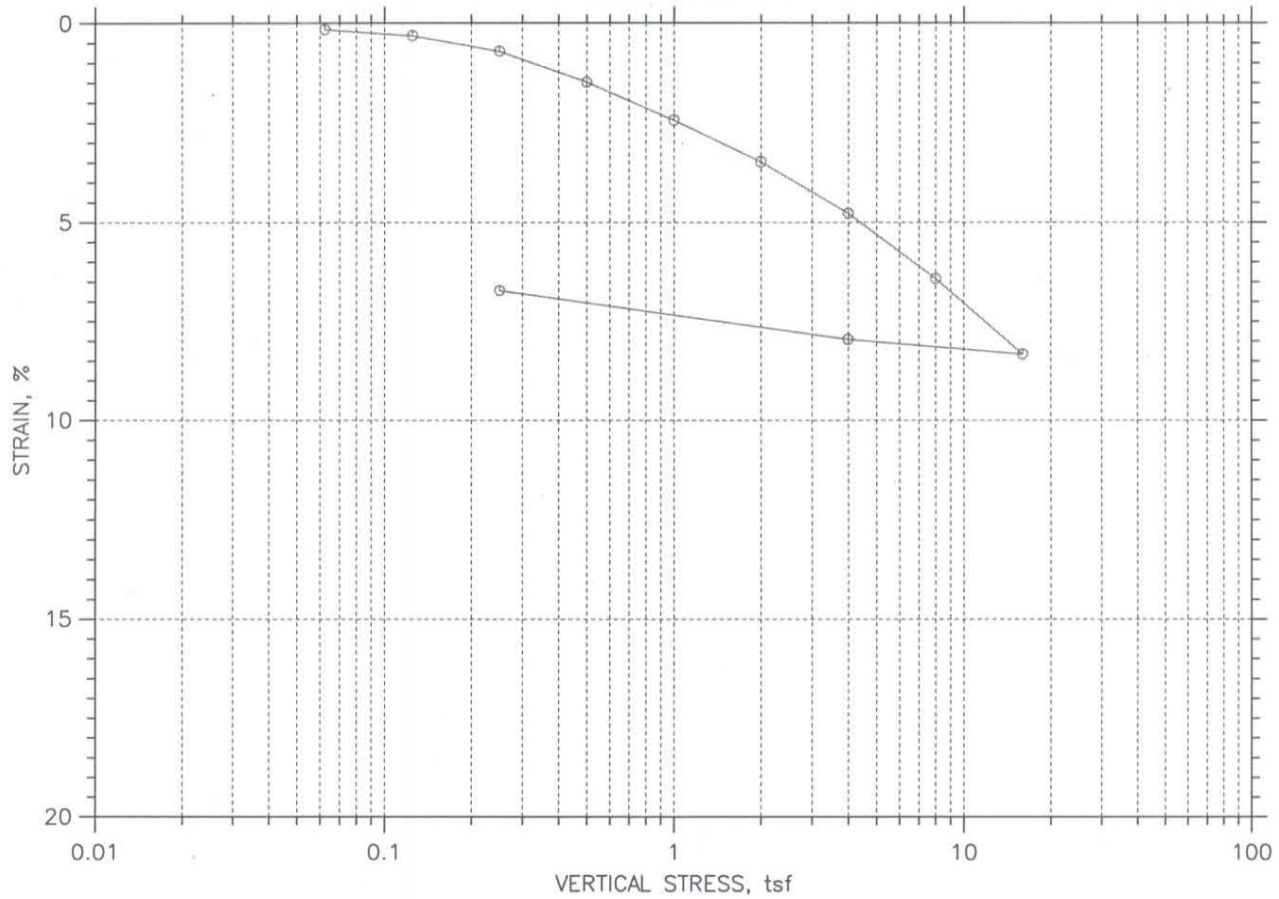


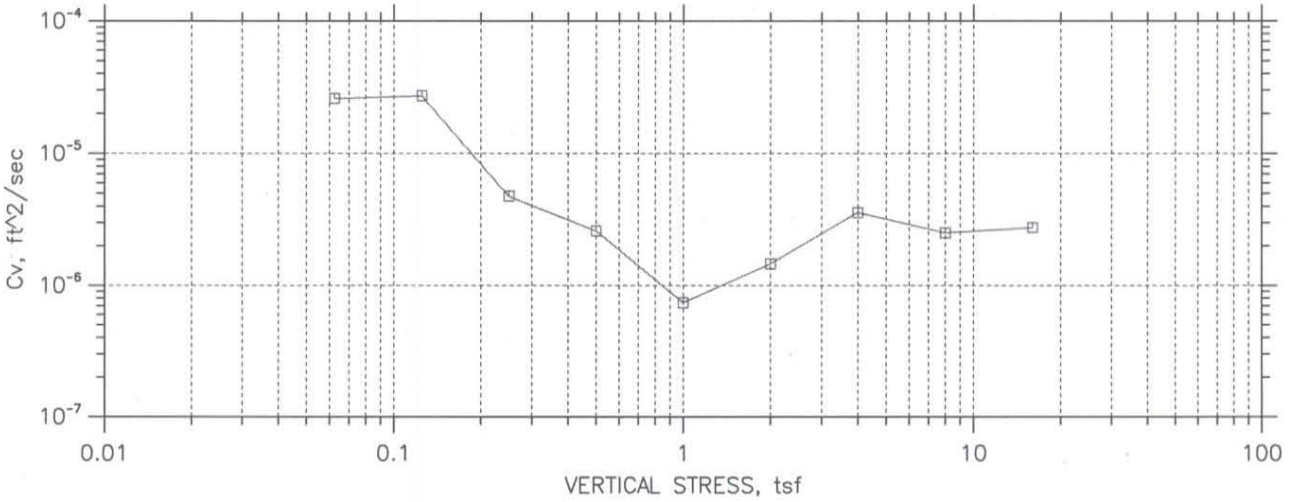
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-03	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 05A	Test Date: 4/27/2009	Depth: 11.5-15
	Test No.: 09-007-G3	Sample Type: TUBE	Elevation:
	Description: Moist, dark brown, stiff silty clay, w/gravel		
	Remarks:		

Thu, 07-MAY-2009 09:15:54

CONSOLIDATION TEST DATA

SUMMARY REPORT



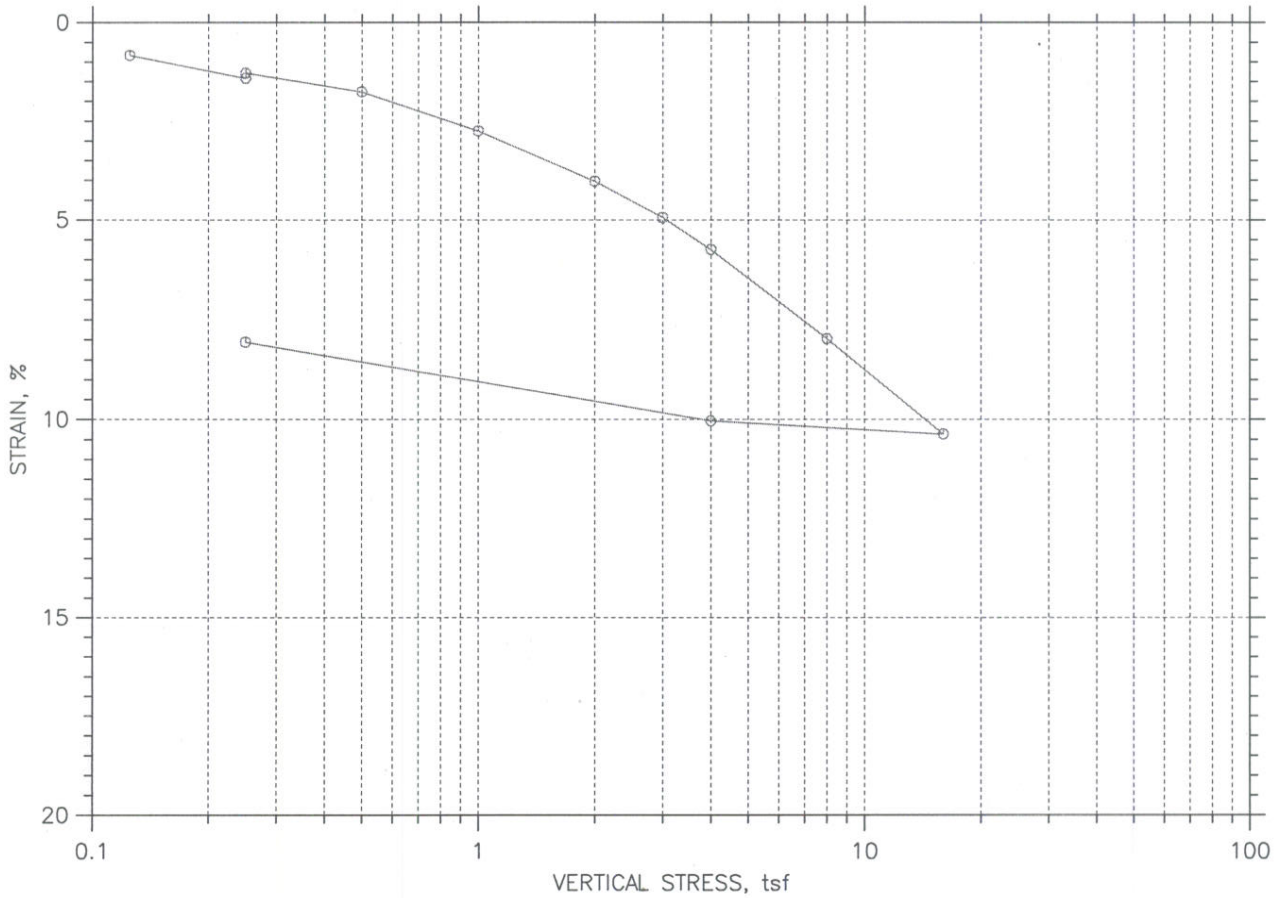


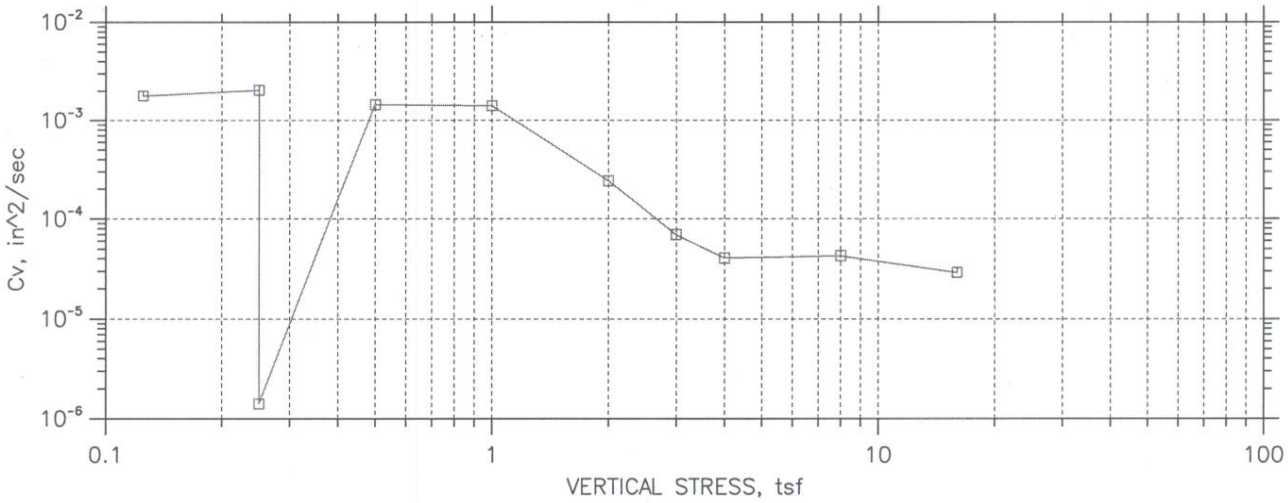
	Project: Route 91/5 Wingwall	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-03	Tested By: AZM	Checked By: GL09-012
	Sample No.: 07	Test Date: 4/27/2009	Depth: 16.5-20
	Test No.: 09-008-G4	Sample Type:	Elevation: ---
	Description: Moist, brown, stiff, silty clay w/gravel		
	Remarks:		

Thu, 07-MAY-2009 09:19:26

SWELL POTENTIAL TEST

SUMMARY REPORT



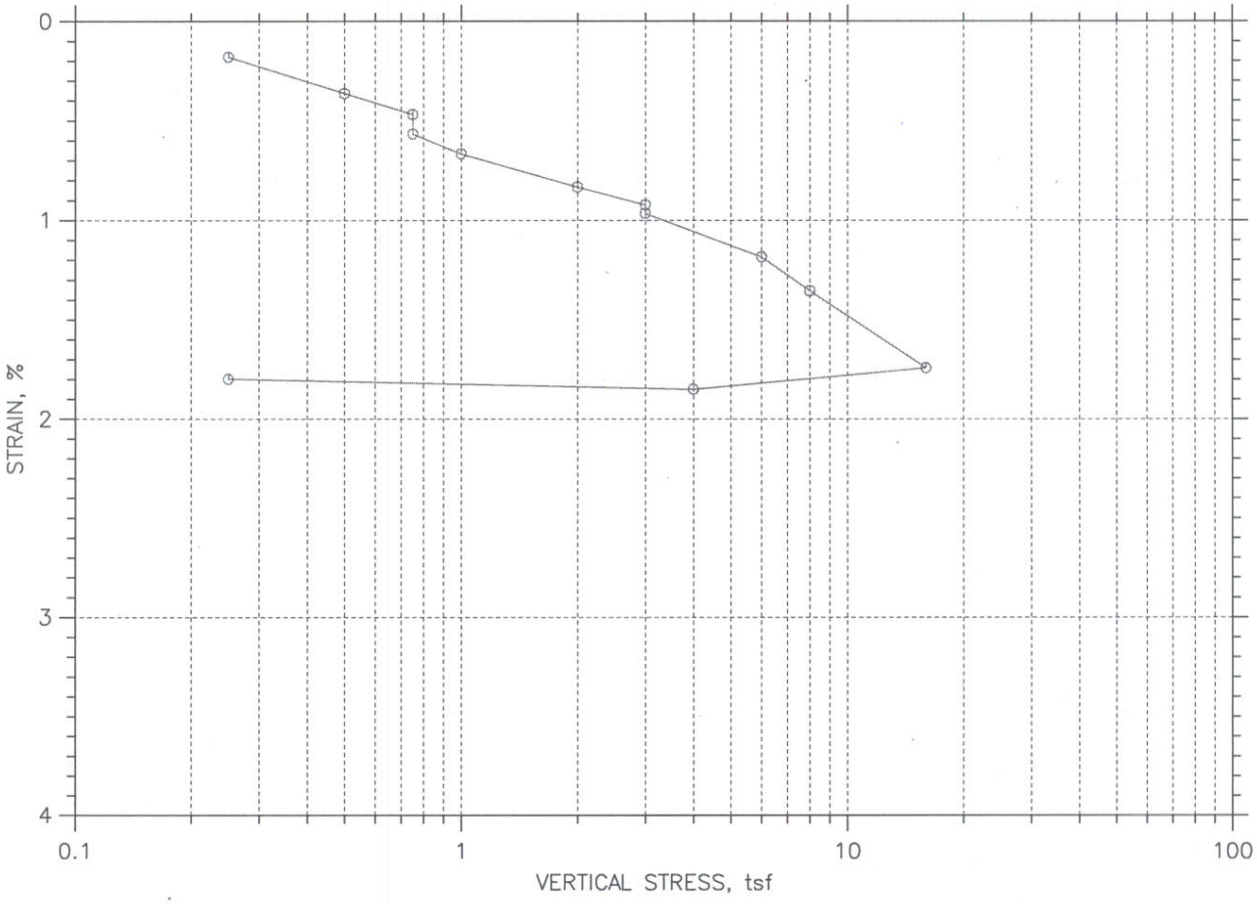


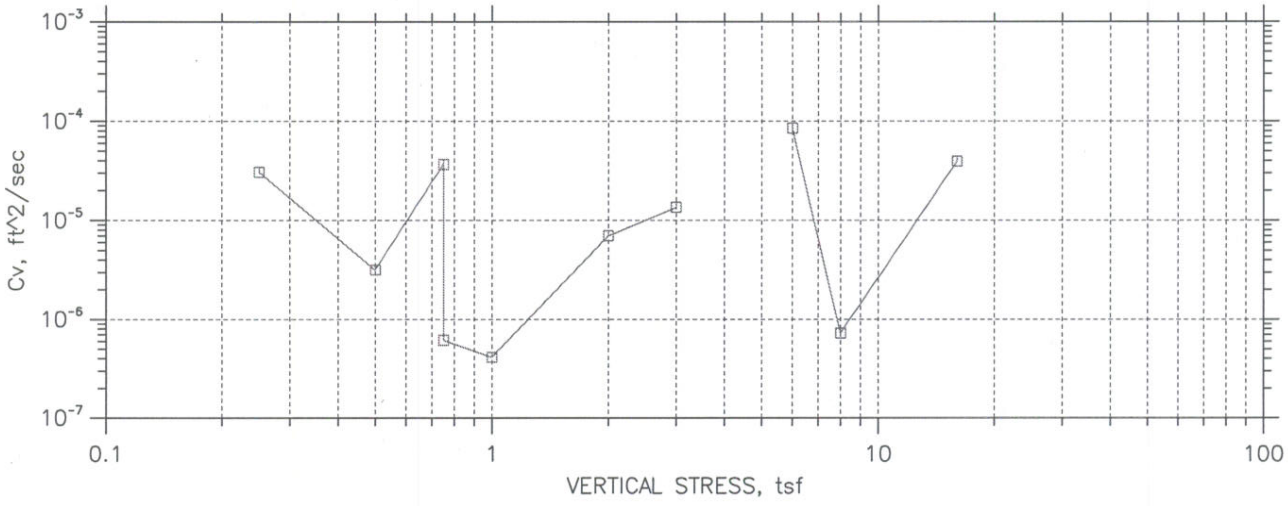
	Project: ROUTE 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: A09-04	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 02	Test Date: 5/19/09	Depth: 5'
	Test No.: 09-009-G1	Sample Type: Swell-test	Elevation:
	Description: Moist, brown, soft silt w/fine sand		
	Remarks: Swell Volumn		

Mon, 01-JUN-2009 10:19:38

SWELL POTENTIAL TEST

SUMMARY REPORT



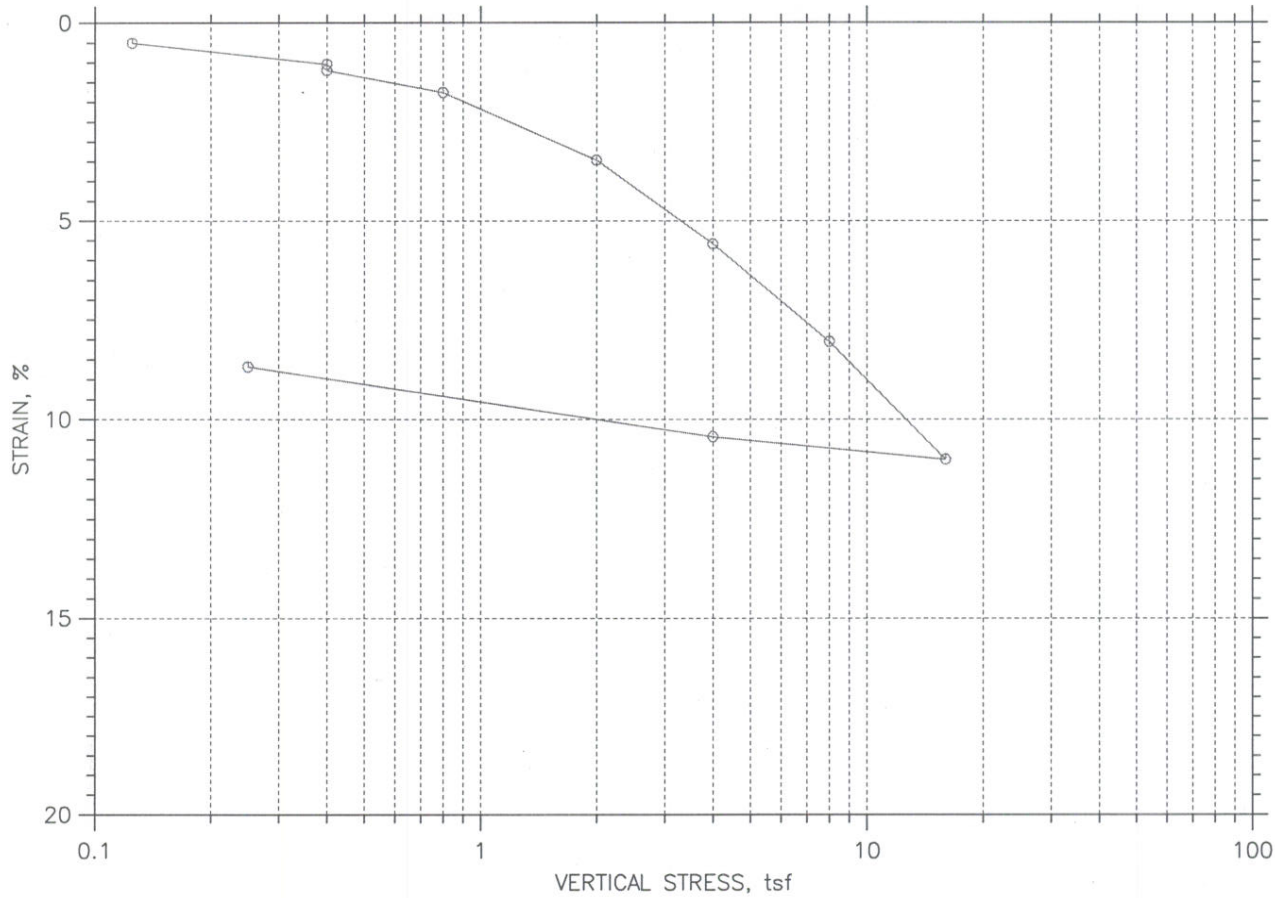


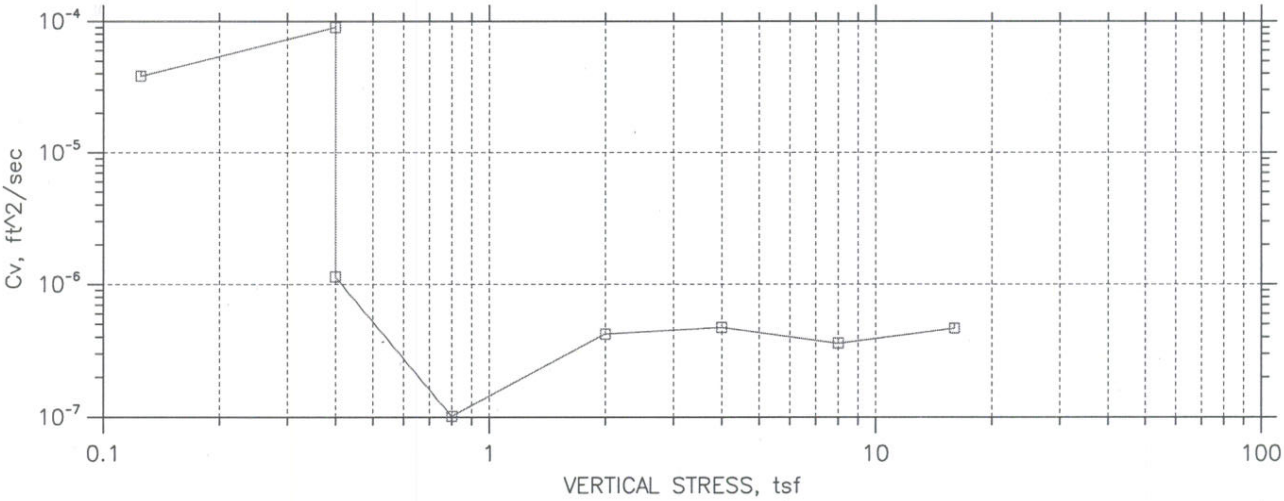
	Project: 91/5 WINGWALL	Location: 12-ORA-91	Project No.: 12-0C9701
	Boring No.: R09-01	Tested By: AZM	Checked By: GIL#09-012
	Sample No.: 05A	Test Date: 5/20/09	Depth: 12.5
	Test No.: 09-010-G3	Sample Type: Swell-test	Elevation:
	Description: Moist, brown, stiff, silty clay w/fine sand		
	Remarks: Swell Volumn		

Mon, 01-JUN-2009 10:13:16

SWELL POTENTIAL TEST

SUMMARY REPORT

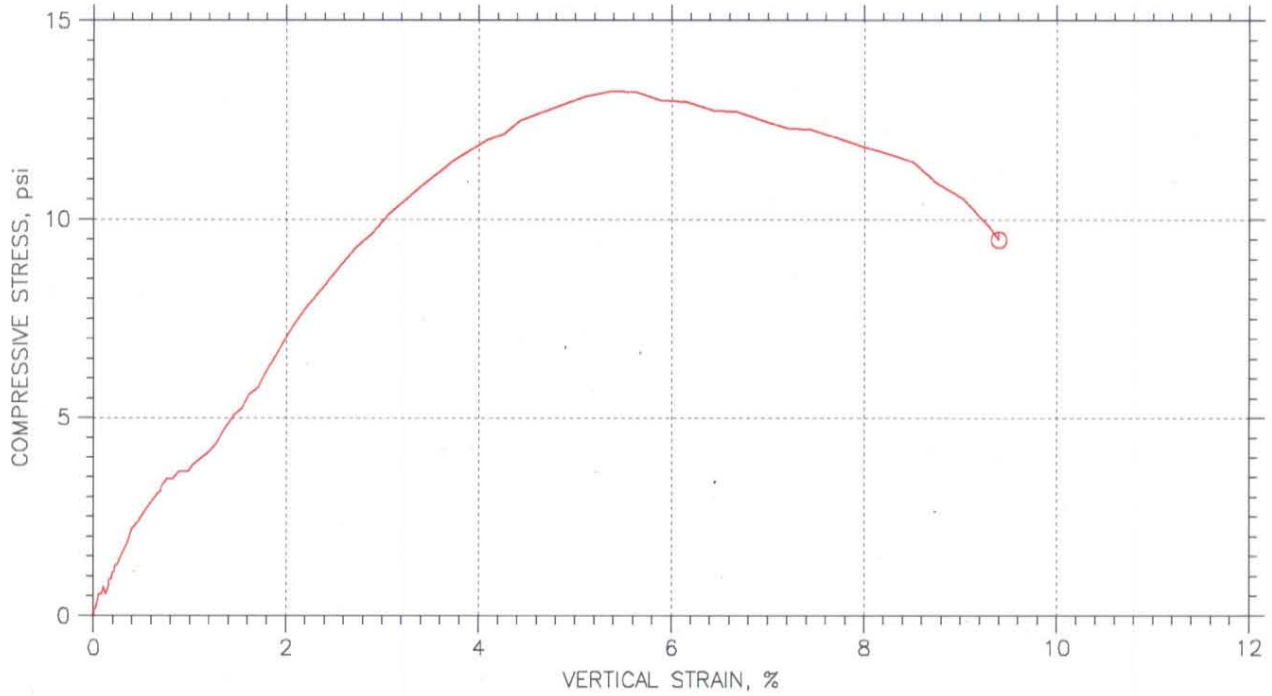




	Project: Route 91/15 Wingwall	Location: 12-0C9701	Project No.: 12-0C9701
	Boring No.: R09-02	Tested By: AZM	Checked By: GL#09-012
	Sample No.: 03A	Test Date: 5/20/2009	Depth: 6.5-10'
	Test No.: 09011-G4	Sample Type:	Elevation: ---
	Description: Moist, brown, hard silty clay w/fine sand and gravel		
	Remarks: Swell Volumn		

Mon, 01-JUN-2009 10:47:54

UNCONFINED COMPRESSION TEST REPORT

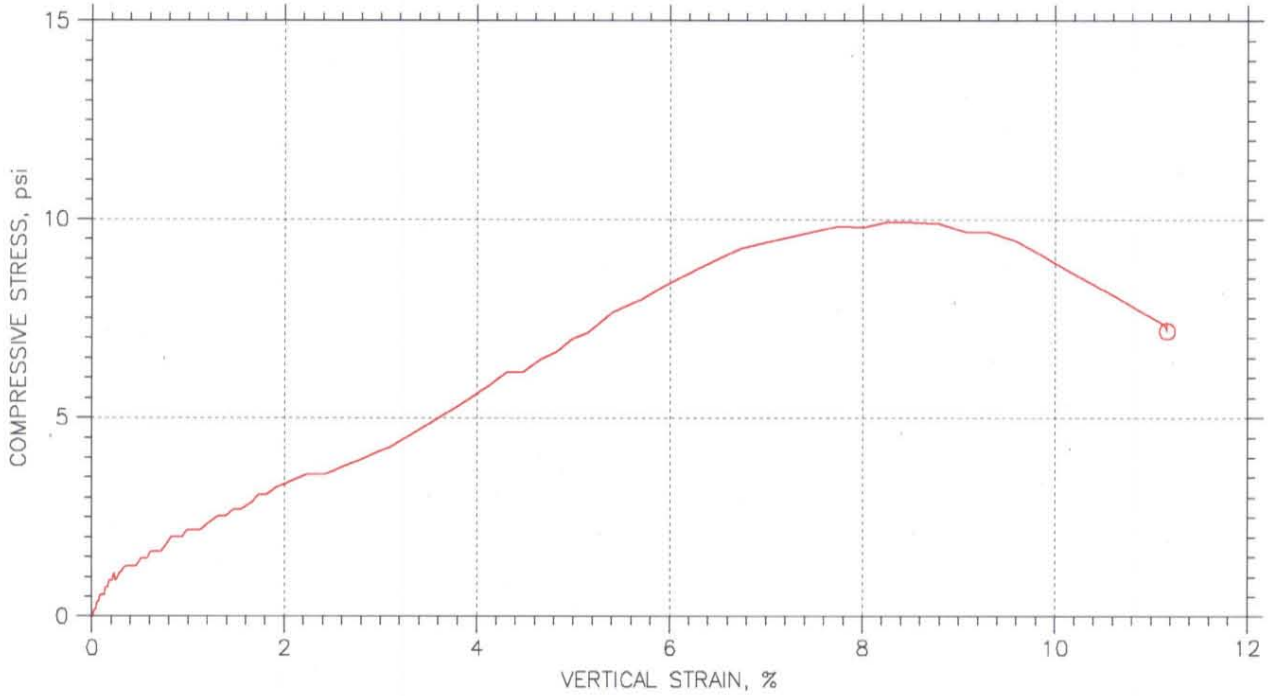


Symbol		⊙
Test No.		Q09-009
Initial	Diameter, in	1.93
	Height, in	3.9
	Water Content, %	16.92
	Dry Density, pcf	106.5
	Saturation, %	
	Void Ratio	
Unconfined Compressive Strength, psi		13.22
Undrained Shear Strength, psi		
Time to Failure, min		
Strain Rate, %/min		1
Implied Specific Gravity		
Liquid Limit		---
Plastic Limit		---
Plasticity Index		---
Failure Sketch		

Caltrans	Project: ROUTE 91/5 WINGWALL
	Location: 12-ORA-91
	Project No.: 12-0C9701
	Boring No.: A09-04
	Sample No. : 03A
	Description: MOIST BROWN CLAY
	Remarks: ASTM D 2166.

Fri, 29-MAY-2009 11:48:33

UNCONFINED COMPRESSION TEST REPORT

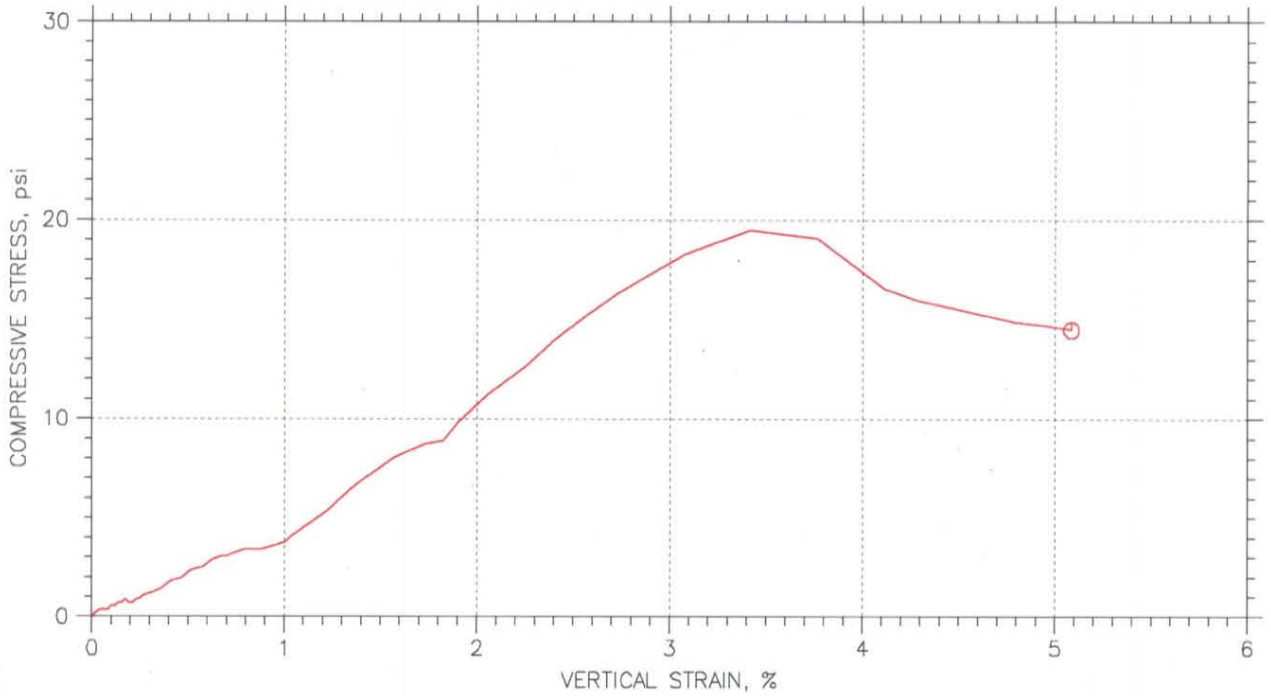


Symbol		⦶
Test No.		Q09-011
Initial	Diameter, in	1.93
	Height, in	3.76
	Water Content, %	16.12
	Dry Density, pcf	114.6
	Saturation, %	
	Void Ratio	
Unconfined Compressive Strength, psi		9.953
Undrained Shear Strength, psi		
Time to Failure, min		
Strain Rate, %/min		1
Implied Specific Gravity		
Liquid Limit		---
Plastic Limit		---
Plasticity Index		---
Failure Sketch		

Caltrans	Project: ROUTE 91/5 WINGWALL
	Location: 12-ORA-91
	Project No.: 12-0C9701
	Boring No.: R09-01
	Sample No.: 05B
	Description: MOIST BROWN CLAY W/SAND
	Remarks: ASTM D 2166. 40 L 2.0 WP 6/2

Fri, 29-MAY-2009 12:13:44

UNCONFINED COMPRESSION TEST REPORT

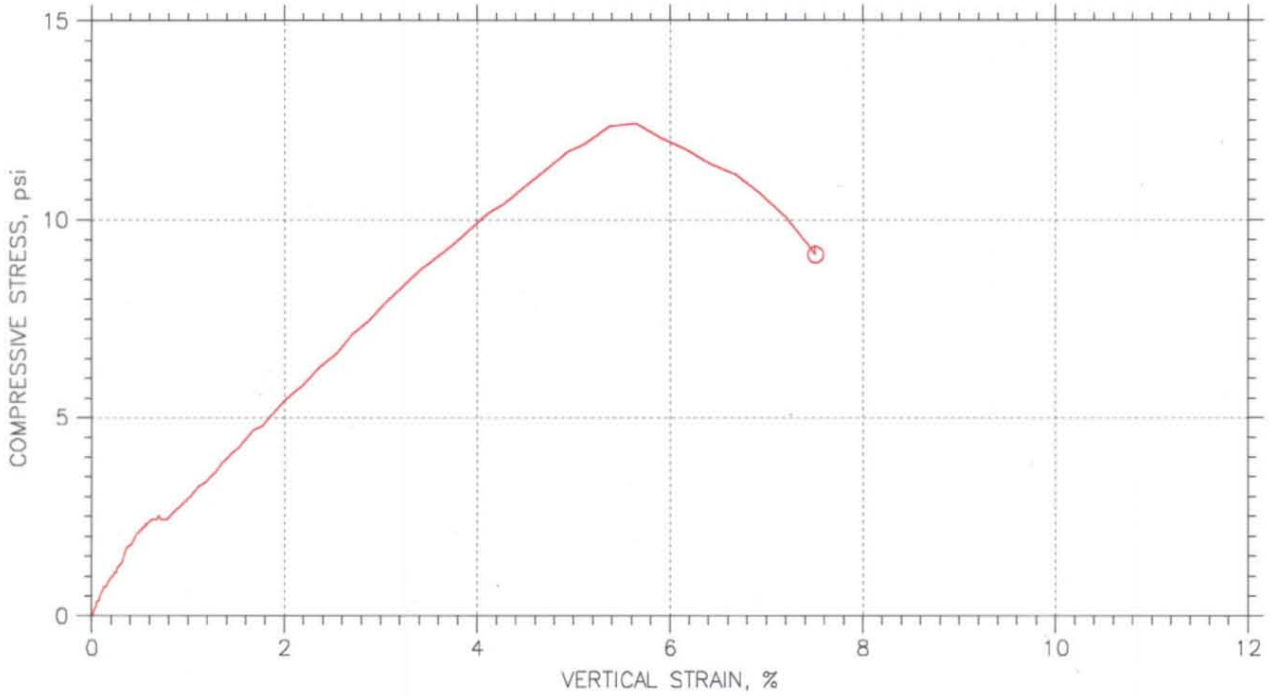


Symbol		⊙
Test No.		Q09-012
Initial	Diameter, in	1.94
	Height, in	4.01
	Water Content, %	12.31
	Dry Density, pcf	114.6
	Saturation, %	
	Void Ratio	
Unconfined Compressive Strength, psi		19.51
Undrained Shear Strength, psi		
Time to Failure, min		
Strain Rate, %/min		1
Implied Specific Gravity		
Liquid Limit		---
Plastic Limit		---
Plasticity Index		---
Failure Sketch		

Caltrans	Project: ROUTE 91/5 WINGWALL
	Location: 12-ORA-91
	Project No.: 12-0C9701
	Boring No.: R09-01
	Sample No. : 11B
	Description: MOIST BROWN CLAY
	Remarks: ASTM D 2166.

Fri, 29-MAY-2009 12:27:08

UNCONFINED COMPRESSION TEST REPORT

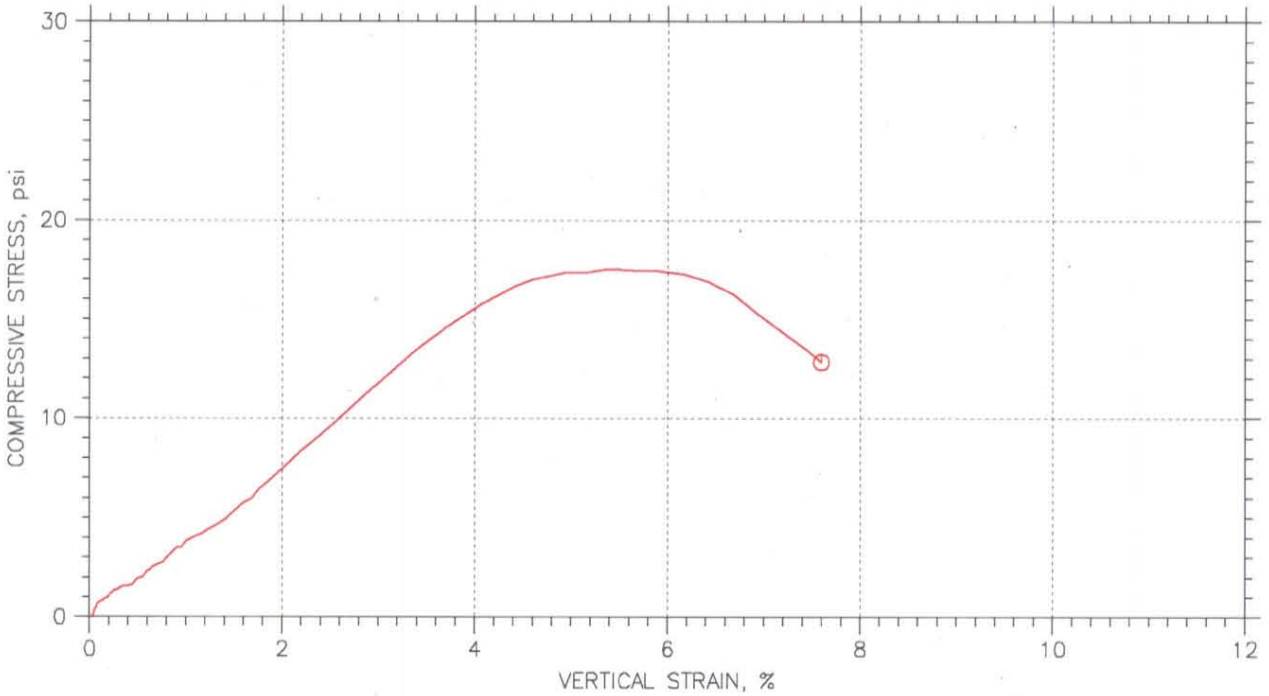


Symbol		⊙
Test No.		Q09-013
Initial	Diameter, in	2.37
	Height, in	5.63
	Water Content, %	13.74
	Dry Density, pcf	119.6
	Saturation, %	
	Void Ratio	
Unconfined Compressive Strength, psi		12.43
Undrained Shear Strength, psi		
Time to Failure, min		
Strain Rate, %/min		1
Implied Specific Gravity		
Liquid Limit		---
Plastic Limit		---
Plasticity Index		---
Failure Sketch		

Caltrans	Project: ROUTE 91/5 WINGWALL
	Location: 12-ORA-91
	Project No.: 12-0C9701
	Boring No.: R09-02
	Sample No. : 03B
	Description: MOIST BROWN CLAY w/SILT AND GRAVEL
	Remarks: ASTM D 2166.

Fri, 29-MAY-2009 12:36:25

UNCONFINED COMPRESSION TEST REPORT

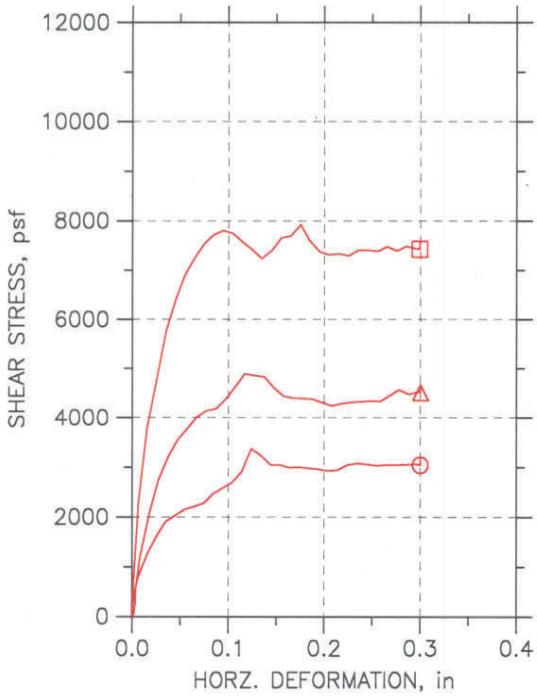


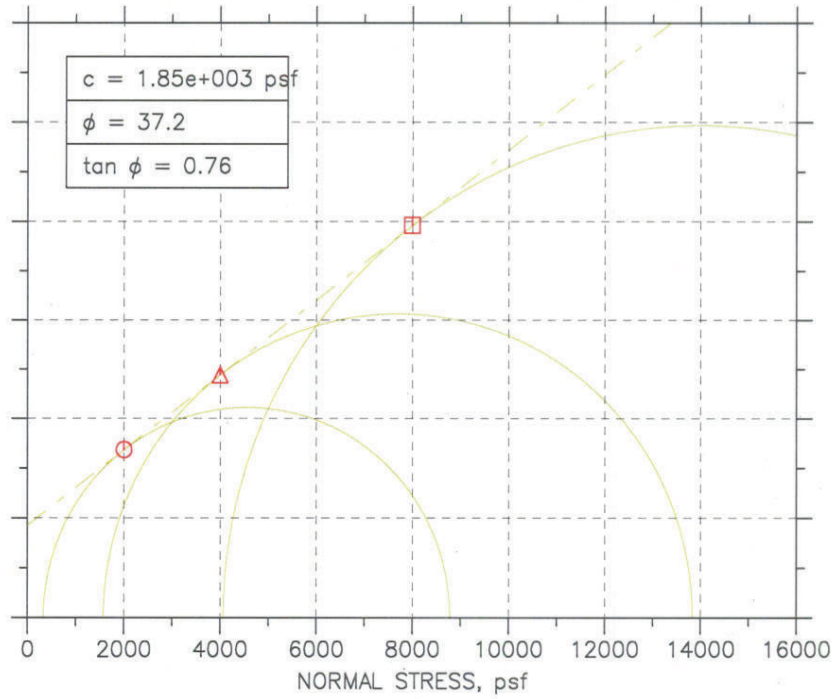
Symbol		⏲
Test No.		Q09-014
Initial	Diameter, in	2.37
	Height, in	5.11
	Water Content, %	17.77
	Dry Density, pcf	113.2
	Saturation, %	
	Void Ratio	
Unconfined Compressive Strength, psi		17.54
Undrained Shear Strength, psi		
Time to Failure, min		
Strain Rate, %/min		1
Implied Specific Gravity		
Liquid Limit		---
Plastic Limit		---
Plasticity Index		---
Failure Sketch		

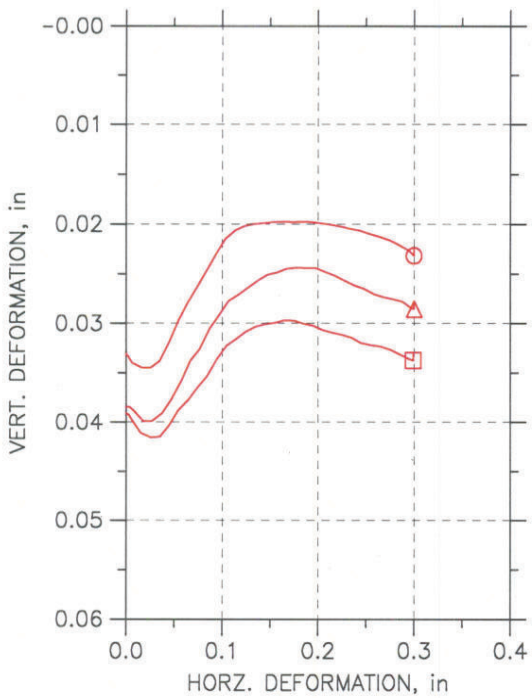
Caltrans	Project: ROUTE 91/5 WINGWALL
	Location: 12-ORA-91
	Project No.: 12-0C9701
	Boring No.: R09-02
	Sample No. : 07B
	Description: MOIST BROWN SILTY CLAY
	Remarks: ASTM D 2166.

Fri, 29-MAY-2009 12:50:00

DIRECT SHEAR TEST REPORT







Symbol		⊙	△	⊡	
Test No.		DS09046A	DS09046B	DS09046C	
Sample No.		13A	13A	13A	
Shape		Circular	Circular	Circular	
Initial	Dimension, in	1.94	1.94	1.94	
	Area, in^2	2.9559	2.9559	2.9559	
	Height, in	1	1	1	
	Water Content, %	23.88	23.22	24.46	
	Dry Density, pcf	94.984	96.015	102.2	
	Saturation, %	81.33	81.04	98.97	
	Void Ratio	0.80742	0.78801	0.67979	
Consol. Height, in		0.96962	0.96342	0.96172	
Consol. Void Ratio		0.75252	0.7226	0.61549	
Final	Water Content, %	26.73	24.97	22.57	
	Dry Density, pcf	97.242	98.842	105.77	
	Saturation, %	96.03	93.17	99.63	
	Void Ratio	0.76546	0.73688	0.62306	
Normal Stress, psf		2003.1	4001	7998.1	
Max. Shear Stress, psf		3365.5	4882.3	7914.5	
Ult. Shear Stress, psf		3037.5	4508.4	7417.3	
Time to Failure, min		13.004	12.002	18.002	
Disp. Rate, in/min		0.01	0.01	0.01	
Implied Specific Gravity		2.75	2.75	2.75	
Liquid Limit		---	---	---	
Plastic Limit		---	---	---	
Plasticity Index		---	---	---	

Project: Rte 91/5 Wingwall Repair	
Location: 12-ORA-91	
Project No.: 12-0C9701	
Boring No.: R-09-01 at 40'	
Sample Type: BRASS	
Description: Moist, Medium Dense, Tan, Sand	
Remarks: ASTM D3080	

Thu, 30-APR-2009 15:36:44

Appendix D

ARS Curves

To: HOWARD NG
Branch Chief
Bridge Design Branch 20

Date: October 23, 2008
Project EA: 12-0C9701

From: Jie Huang
Office of Geotechnical Design South 1

Subject: Communication between GS and Bridge Design regarding ARS Curves

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Howard,

Office of Geotechnical Design South-1 received request for Preliminary Foundation Report (PFR) for the subject project from your side on October 17th 2008. The PFR will be submitted by November 14th 2008. Per your request via telephone, GS agreed to communicate with Bridge Design on ARS curves for the subject project site before the delivery of the PFR. Please find the ARS curves for the project sites. It is worth pointing out even though the controlling fault, i.e., Puente Hill Blind Thrust, is not on the current Caltrans Seismic Hazard Map, it is on the Caltrans new fault list to be considered in design. Again, all the information provided herein will be included in the upcoming PFR.

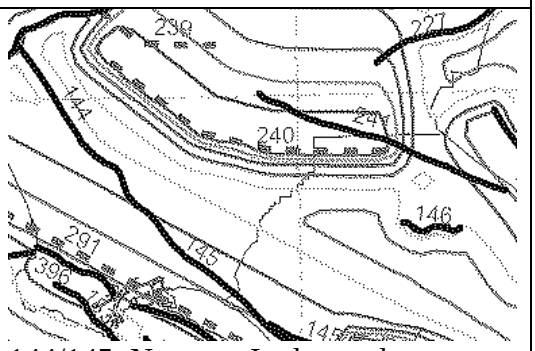
Should you have any question about this communication, please do not hesitate to contact me 213-620-2367 or my supervisor- Sam Sukiasian at 213-620-2135.

Jie Huang

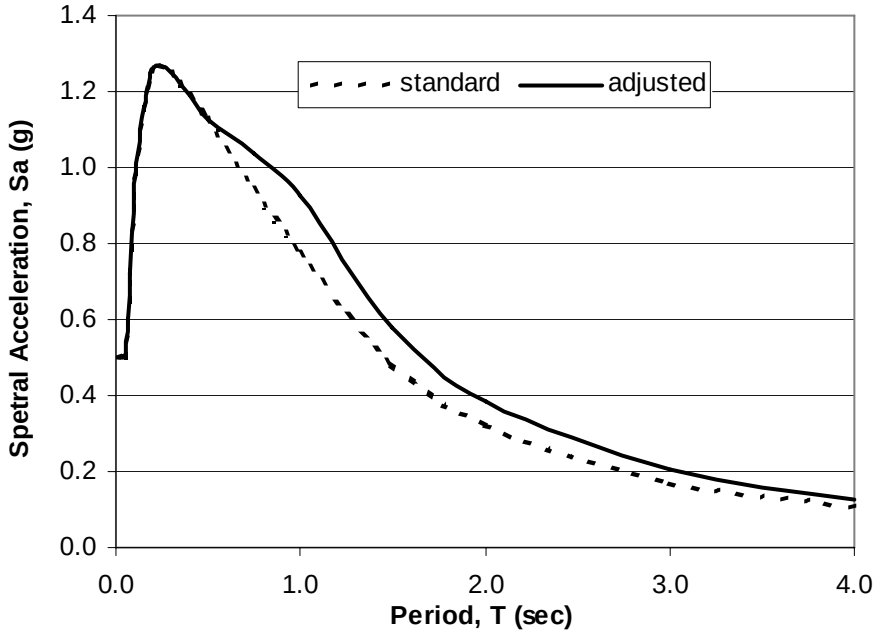
Caltrans Design ARS CURVE	
Project Information	
Project Name	Bridge Rehabilitation
Project EA	12-0C9701
Structure Name	W91/5 Separation OH structure Connector OH
Structure No.	55-0293L
Posted Mile	3.56

Seismic Information	
Controlling Fault Name	Puente Hill Blind Thrust
Fault Type	Reverse/Thrust
MCE Moment Magnitude	7.3
Distance to Site	8.5 km
Peak Ground Acceleration	0.5 g (Sadigh et al. 1997)
Soil Profile Type	D

Note: When a structure is within 15km of the controlling fault, the standard ARS curve is modified to account for near source and/or long period effect per the Caltrans SDC (Section 6-1).



144/145: Newport Inglewood
240: Puente Hill Blind Thrust
241: Elsinore fault zone (Whittier)

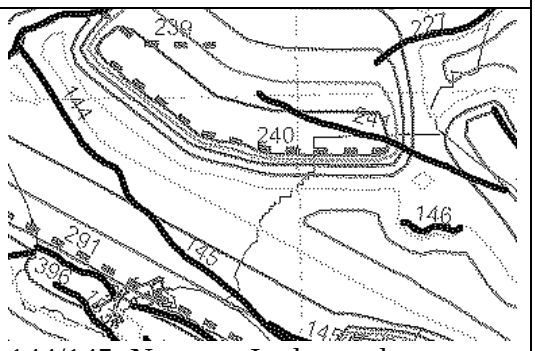


Period T (Sec)	Standard ARS Sa (g)	Standard ARS Sa (g)
0.01	0.5003	0.5003
0.02	0.5003	0.5003
0.03	0.5002	0.5002
0.05	0.5002	0.5002
0.08	0.7192	0.7192
0.10	0.9186	0.9186
0.12	1.0367	1.0367
0.15	1.1564	1.1564
0.17	1.2091	1.2091
0.20	1.2591	1.2591
0.24	1.2660	1.2660
0.30	1.2467	1.2467
0.40	1.1898	1.1898
0.50	1.1249	1.1249
0.75	0.9438	1.0382
1.00	0.7722	0.9267
1.50	0.4839	0.5807
2.00	0.3213	0.3856
3.00	0.1698	0.2038
4.00	0.1064	0.1277

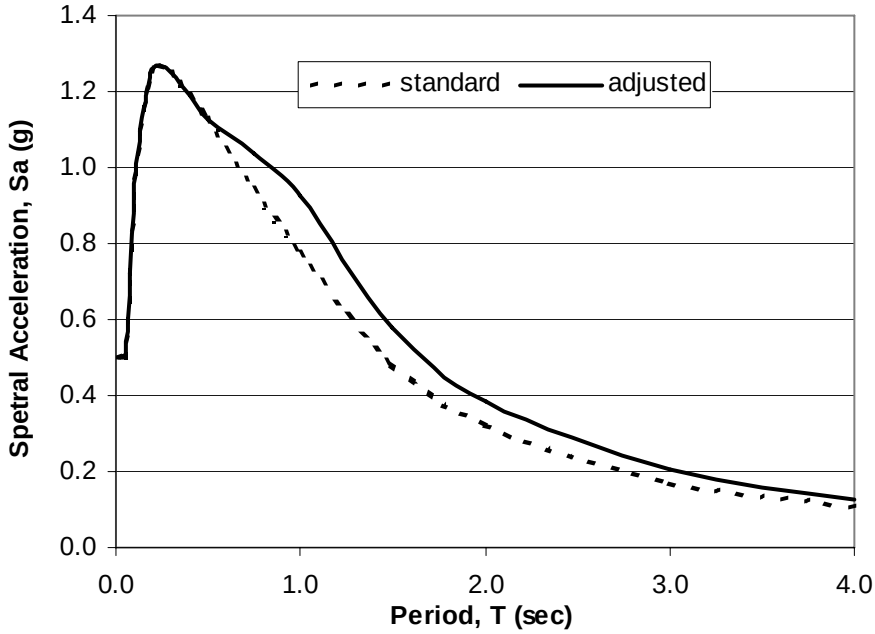
Caltrans Design ARS CURVE	
Project Information	
Project Name	Bridge Rehabilitation
Project EA	12-0C9701
Structure Name	Magnolia Avenue off-ramp OH
Structure No.	55-0472S
Posted Mile	3.64

Seismic Information	
Controlling Fault Name	Puente Hill Blind Thrust
Fault Type	Reverse/Thrust
MCE Moment Magnitude	7.3
Distance to Site	8.48 km
Peak Ground Acceleration	0.5 g (Sadigh et al. 1997)
Soil Profile Type	D

Note: When a structure is within 15km of the controlling fault, the standard ARS curve is modified to account for near source and/or long period effect per the Caltrans SDC (Section 6-1).



144/145: Newport Inglewood
240: Puente Hill Blind Thrust
241: Elsinore fault zone (Whittier)

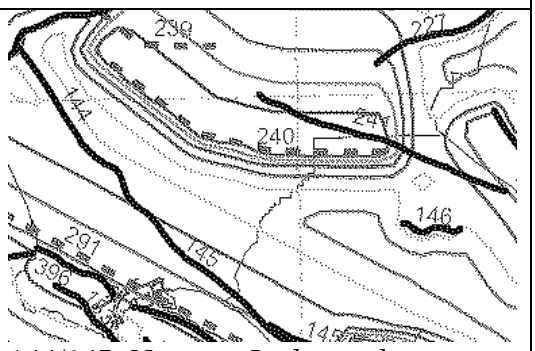


Period T (Sec)	Standard ARS Sa (g)	Standard ARS Sa (g)
0.01	0.5003	0.5003
0.02	0.5003	0.5003
0.03	0.5002	0.5002
0.05	0.5002	0.5002
0.08	0.7192	0.7192
0.10	0.9186	0.9186
0.12	1.0367	1.0367
0.15	1.1564	1.1564
0.17	1.2091	1.2091
0.20	1.2591	1.2591
0.24	1.2660	1.2660
0.30	1.2467	1.2467
0.40	1.1898	1.1898
0.50	1.1249	1.1249
0.75	0.9438	1.0382
1.00	0.7722	0.9267
1.50	0.4839	0.5807
2.00	0.3213	0.3856
3.00	0.1698	0.2038
4.00	0.1064	0.1277

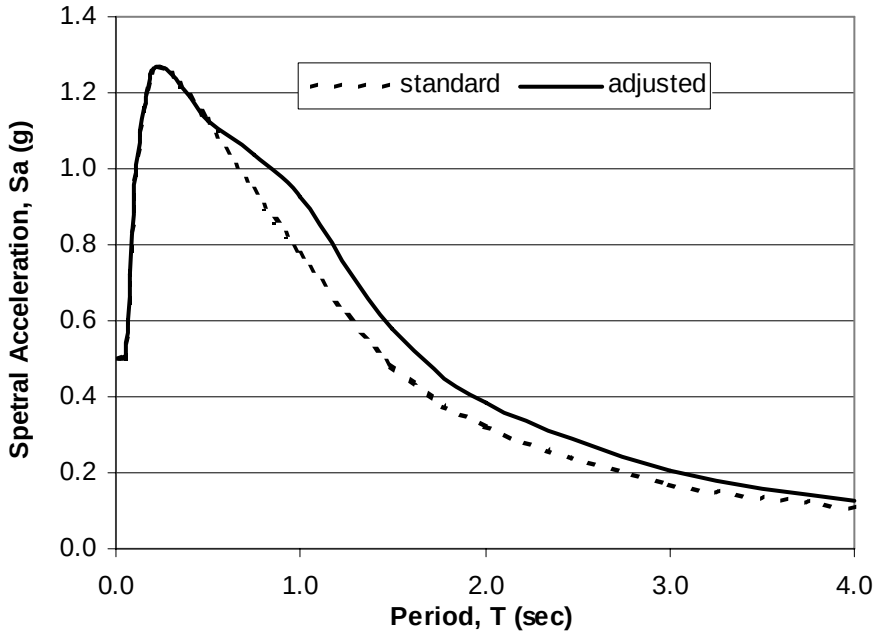
Caltrans Design ARS CURVE	
Project Information	
Project Name	Bridge Rehabilitation
Project EA	12-0C9701
Structure Name	E91-S5 Connector OH
Structure No.	55-0503GL
Posted Mile	5.81

Seismic Information	
Controlling Fault Name	Puente Hill Blind Thrust
Fault Type	Reverse/Thrust
MCE Moment Magnitude	7.3
Distance to Site	8.76 km
Peak Ground Acceleration	0.5 g (Sadigh et al. 1997)
Soil Profile Type	D

Note: When a structure is within 15km of the controlling fault, the standard ARS curve is modified to account for near source and/or long period effect per the Caltrans SDC (Section 6-1).



144/145: Newport Inglewood
240: Puente Hill Blind Thrust
241: Elsinore fault zone (Whittier)



Period T (Sec)	Standard ARS Sa (g)	Standard ARS Sa (g)
0.01	0.5003	0.5003
0.02	0.5003	0.5003
0.03	0.5002	0.5002
0.05	0.5002	0.5002
0.08	0.7192	0.7192
0.10	0.9186	0.9186
0.12	1.0367	1.0367
0.15	1.1564	1.1564
0.17	1.2091	1.2091
0.20	1.2591	1.2591
0.24	1.2660	1.2660
0.30	1.2467	1.2467
0.40	1.1898	1.1898
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