CGI TECHNICAL SERVICES, INC.

FUGRO CONSULTANTS, INC.

REDWOOD CREEK LEVEE
GEOTECHNICAL EVALUATION PROJECT
ORICK, HUMBOLDT COUNTY, CALIFORNIA

Prepared for:
HUMBOLDT COUNTY,
PUBLIC WORKS DEPARTMENT

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June 2011
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

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Attention: Mr. Hank Seemann, Environmental Services Manager

Subject: Geotechnical Report, Redwood Creek Levee Geotechnical Evaluation Project, Orick, Humboldt County, California

Dear Mr. Seemann:

CGI Technical Services, Inc., in conjunction with Fugro Consultants, Inc., is pleased to present this revised draft Geotechnical Report for the Redwood Creek Levee Geotechnical Evaluation Project located in the Orick area of Humboldt County, California. This report is being submitted in accordance with the Agreement for Professional Services established between CGI and the County under County Project No. 251056.

This revised draft report summarizes the geotechnical engineering analyses performed to evaluate the levees for their ability to function in accordance with current United States Army Corps of Engineers performance guidelines and presents remedial-concept recommendations, where appropriate. In addition, this report also discusses field explorations performed, laboratory testing results, and general subsurface conditions encountered at the site during this study.

The report is being submitted as a revised draft to allow the County the opportunity to review and comment on the findings, conclusions, and recommendations presented, herein. We will finalize this report after receiving your comments and, where appropriate, editing the report.

Please call if further information is required or if we can answer any questions.

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LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	ASTM International
bgs	below ground surface
cfs	cubic feet per second
CGS	California Geologic Survey
CPT	Cone Penetration Test
CRR	Cyclic Resistance Ratio
CSR	Cyclic Stress Ratio
El.	Elevation
FS	Factor of Safety
GIS	Geographic Information System
h:v	horizontal:vertical
NAVD88	North American Vertical Datum of 1988
NCEER	National Center for Earthquake Engineering Research
PHGA	Peak Horizontal Ground Acceleration
Station	Survey Station
SPT	Standard Penetration Test
USA	Underground Service Alert
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey

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1.0 INTRODUCTION

1.1 PROJECT DESCRIPTION

CGI Technical Services, Inc. (CGI) has been authorized by Humboldt County Department of Public Works (County) to perform a geotechnical investigation of the Redwood Creek Levee system. This geotechnical evaluation has been performed in conjunction with Fugro Consultants, Inc. (Fugro), and our team is referred to as CGI/Fugro throughout this report. Funding for this study was provided by the California Department of Water Resources Local Levee Assistance Program and by a Department of Housing and Community Development Block Grant.

The purpose of the project was to collect and analyze selected geotechnical information in order to estimate the stability of the levee foundation and embankment, and to evaluate the potential for settlement, seepage, underseepage, or erosion to cause instability. Available information prior to this study was not sufficient to assess these risks for the Redwood Creek Flood Control Project. The results of the project will assist Humboldt County in assessing the public safety risks associated with the levee system and in determining whether the levee meets the embankment and foundation stability criteria of FEMA's National Flood Insurance Program standards at 44 CFR 65.10.

Redwood Creek is about 67 miles long and drains a watershed encompassing about 285 square miles (Redwood Creek Watershed Group, 2006). The Redwood Creek levee system extends from about one-half mile upstream of Orick for approximately 3.4 miles through the lower Orick Valley to the Pacific Ocean. The project site vicinity is shown on Plate 1-1. Construction of the levee system was completed in October 1968 by the Army Corps of Engineers (USACE) as part of the Redwood Creek Federal Flood Control Act of 1962 and responsibility for the levee system was transferred to the County on November 14, 1968. Prior to the levee construction, significant floods impacted the Orick area in 1861, 1890, 1915, 1953, 1955, and 1964, with the 1964 event having a particularly significant impact on the region (Redwood Creek Watershed Group; 2006; Harden, 1995). We understand that flooding during those events had flow volumes ranging from 45,000 to more than 50,000 cubic feet per second.

The Redwood Creek levee system is maintained and operated by Humboldt County. We understand that since the completion of construction of the levee, significant unanticipated aggradation of the channel bottom has occurred due to sediment influx from the upper Redwood Creek system (HDR, 2009; NHE, 2010b; USACE, 1966). According to HDR, an average of about 90,000 cubic yards of gravel are deposited within the levee system channel annually. We understand that removal of that sediment was not anticipated as normal maintenance during design of the project (USACE, 1966; USACE, 1969; NHE, 2010b) and that it has been a long-standing maintenance challenge for the County due to fiscal and regulatory restrictions and limitations, especially with Redwood Creek being a significant anadromous fishery. In addition, we understand that those same regulatory restrictions and limitations have hampered the ability of the County to remove some vegetative growth that has established along the waterside and landside flanks of the levee system, which has, to some degree, constrained the County's ability to maintain the levee system in accordance with the Operations and Maintenance Manual (USACE, 1969) for the levee system.

As part of the National Flood Insurance Program (NFIP), FEMA develops Flood Insurance Studies (FISs) and Flood Insurance Rate Maps (FIRMs) to depict the floodplain for the base flood (also known as the 1%-annual-chance-flow or 100-year recurrence interval flood). In order for a levee to be accredited by FEMA, the levee owner must provide data and information certified by a licensed engineer demonstrating that the levee meets, and will continue to meet, the minimum standards at 44 CFR Section 65.10. FEMA's standards address hydraulic, geotechnical, operational, and maintenance aspects of levee performance. When a levee is accredited by FEMA, the levee is recognized as providing flood protection for the base flood, and the Special Flood Hazard Area (also known as Zone A, the 100-year flood zone, or the regulated floodplain) on the FIRM will end at the levee centerline. If a levee does not meet FEMA standards, or if the technical documentation is insufficient or incomplete, then FEMA will not accredit the levee and the FIRM is modified to show the 100-year floodplain as if the levee does not exist.

In August 2009, FEMA released the preliminary updated FIRM and FIS for Humboldt County, including the community of Orick and the Redwood Creek levee system. It is our understanding that the Redwood Creek levee system is not accredited on this preliminary updated FIRM because FEMA has not received a complete documentation package demonstrating eligibility for accreditation. Therefore, portions of the Orick valley are expected to be mapped within the Special Flood Hazard Area when the updated FIRM is finalized. It is our understanding that the updated FIRM is currently undergoing revisions and is expected to be finalized in 2012. We understand that Humboldt County has been working since 2007 with available funding to perform the technical studies necessary to determine whether the Redwood Creek levee system meets the FEMA accreditation standards and whether a complete documentation package can be developed. This study is intended to assist Humboldt County in developing a documentation package and/or identifying repair or upgrade needs for the levee system to be eligible for accreditation.

The U.S. Army Corps of Engineers (USACE) administers a Rehabilitation and Inspection Program (RIP) under Public Law (PL) 84-99 for levees built by the USACE and operated by local sponsors. Continued eligibility in this program is contingent upon periodic inspections by the USACE and a determination that the levees are adequately maintained. Levees that have active status within this program are eligible for federal assistance following a damaging event, whereby the USACE is authorized to repair damages back to pre-flood conditions if the work is economically justifiable. It is our understanding that in January 2007 the USACE placed the Redwood Creek levee system on a national list of levees with maintenance deficiencies due to the presence of sediment within the channel and reduced flood capacity, and that in March 2008 the USACE disapproved Humboldt County's Maintenance Deficiency Correction Plan and placed the Redwood Creek levee system in inactive status under the RIP. As a result of its inactive status under the USACE RIP, the levee system was not eligible for preliminary accreditation status (effectively a two-year grace period) when FEMA was preparing the updated FIRM. Although currently inactive under the RIP, the Redwood Creek levee system remains a federal flood control project and continues to be inspected annually by the USACE.

1.2 PURPOSE AND SCOPE OF SERVICES

The purpose of our investigation was to explore subsurface conditions at the project site to aid the County in evaluating the ability of the Redwood Creek levee system within the project extent to function in accordance with current FEMA/USACE performance criteria. To achieve this objective, CGI/Fugro performed subsurface exploration, laboratory testing, and engineering analyses.

Criteria for establishment of adequacy of levee systems to provide intended flood protection are set forth by Title 44 of the Code of Federal Regulations Section 65.10 of the National Flood Insurance Program (NFIP). FEMA is the federal agency responsible for administering the NFIP. Under these provisions, FEMA utilizes evaluation standards established by the USACE's National Flood Risk Management Program through various policy letters, engineering circulars, and engineering manuals (USACE, 2010a). The primary USACE standards utilized during this study consist of the following:

- Engineering Circular 1110-2-6067, Certification of Levee Systems for the NFIP (2010a)
- REF10L0 Rev 2, Geotechnical Levee Practice (2008)
- ETL 1110-2-569, Design Guidance for Levee Underseepage (2005)
- EM 1110-2-1902, Slope Stability (2003);
- EM 1110-2-1913, Design and Construction of Levees (2000a)
- EM 1110-2-301, Guidelines for Landscape Planting and Vegetation Management at Floodwalls, Levees, and Embankment Dams (2000b);
- 1110-2-1914, Design, Construction, and Maintenance of Relief Wells (1992); and
- EM 1110-2-1901, Determination of Permeability of Soil (1986)

References for those standards are included in Section 10.0 of this report.

The scope of work for this study included the following:

1.2.1 Data Review, Site Reconnaissance, and Access Coordination

In preparation for the field exploration program, CGI/Fugro performed a site reconnaissance, and reviewed historic data, aerial photographs, and other documents, maps, and existing geologic and geotechnical literature relevant to the site. In addition, we met with County representatives at the site to discuss exploration and cross section locations in the field.

Relevant geotechnical data from previous reports prepared by the USACE and local consultants, including site and subsurface descriptions, groundwater data, laboratory test results, drill hole logs, and as-built plans, were reviewed during the study. Further details regarding previous reports are presented in Section 3.0 and in Appendix A.

Prior to performing sonic cores, drill holes, and cone penetrometer test (CPT) soundings, CGI contacted Underground Service Alert (USA) to help identify potential buried utility conflicts at the proposed exploration locations, as required by California law. In addition, we marked all exploration locations and worked with the County to coordinate access onto private properties.

1.2.2 Field Exploration

Field exploration consisted of advancing a total of 91 subsurface explorations at selected locations along the levee alignment. In total, we performed the following explorations for this study:

Explorations Performed for Study	
Exploration Type	**Total Advanced**
Sonic Coring	18
Cone Penetrometer Soundings	37
Hollow-Stem-Auger Drilling	36

The field exploration program was initiated in September 2010 and completed in October 2010. Locations of explorations are presented on Plate 5-3 and additional information regarding the field exploration program are presented in Section 3.0 and Appendix B.

1.2.3 Laboratory Testing

Laboratory testing was performed on selected soil samples obtained during the field exploration program. The types and numbers of tests were chosen to help classify and characterize selected subsurface soil characteristics and engineering properties. Further details regarding the laboratory testing program are presented in Section 4.0 and in Appendix C.

1.2.4 Geotechnical Analyses and Evaluation

Using data obtained from the data review, field exploration, and laboratory testing programs, CGI/Fugro performed geotechnical analyses, as specified in the scope of work, at 10 cross sections established across Redwood Creek and its associated levees. The analyses were consistent with geotechnical criteria specified in EM 1110-2-1913 (USACE, 2000a), REFP10L0 (USACE, 2008) and EM 1110-2-569 (USACE, 2005). This report summarizes the geotechnical analyses and presents recommendations for remedial action where applicable. The following analyses were performed:

- Seismic Design Criteria (Section 6.0)
- Liquefaction Potential (Section 8.1)
- Permeability and Seepage (Section 8.2)
- Slope Stability (Section 8.3)
- Seismic Deformation (Section 8.4)
- Settlement (Section 8.5)
- Evaluations of vegetative impacts and erosion on levee system (Sections 9.2.1, 9.2.2, and 9.2.3)

1.3 AUTHORIZATION

This study was authorized by the County in the Agreement for Professional Services under County Project No. 251056.

1.4 LIMITATIONS

The factual findings for this investigation, described herein, are applicable for the project description as contained in Section 1.1. The factual information presented in this report was documented by CGI/Fugro solely for the County for use in evaluating the ability of the existing Redwood Creek Levee system within the project extent to function in accordance with current USACE performance criteria. Although information contained in this report may be of some use for other purposes, it may not contain sufficient information for other parties or other uses.

The scope of services did not include any environmental assessments for the presence or absence of hazardous/toxic materials in surface water, groundwater, or atmosphere. Any statements, or absence of statements, in this report or data presented, herein, regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous/toxic assessment.

In performing our professional services, we have used generally accepted geologic and geotechnical engineering principles and have applied that degree of care and skill ordinarily exercised under similar circumstances, by reputable geotechnical engineers and engineering geologists currently practicing in this or similar localities. No other warranty, either express or implied, is made.

2.0 SITE DESCRIPTION

The Redwood Creek levee system extends from the Pacific Ocean upstream until the creek reaches the boundary with Redwood National Park, upstream of Orick. This approximately 3.4-mile alignment of earthen embankment levees extends through relatively flat terrain within the Orick Valley, as shown on Plates 2-1a through 2-1c. The waterside levee faces are rip-rap protected. The following sections describe the site conditions along segments of the levee system. Where the terms "right" and "left" are used to distinguish one levee from the other, the perspective is always as viewed looking downstream.

2.1 STATION NOS. 10+00 (DOWNSTREAM TERMINUS) TO 55+00

This lower reach of the levee system extends about 4,500 feet, from the ocean to the first major bend of Redwood Creek. This section of the levee system extends through the coastal estuary and bypasses a former oxbow (South Slough) of the creek system. It traverses a portion of Redwood National Park along the immediate coastal zone then transitions through relatively flat, privately-owned, agricultural grounds. The right levee is bordered by an unnamed dirt access road that leads from Hufford Road to the coastal fishing access area. Redwood Creek in this section of the levee system is subject to tidal influxes from the Pacific Ocean and is under varying stages of inundation throughout the day.

At approximate Station No. 32+00, a levee penetration, consisting of a gated concrete box structure, extends through the left levee system and into South Slough. In addition, a culvert with a flap-gate has been noted penetrating through the left levee system at about Station No. 44+00 (Humboldt County, 2008a); however, we could not locate that culvert during field studies. A drainage ditch is located adjacent to the right landside levee toe between about Station Nos. 43+00 and 55+00.

The landside banks along the levee system are covered with seasonal grasses, and locally with brambles and shrubs. Waterside banks are covered with seasonal vegetation, local brambles, and local shrubs. Trees and other larger vegetation are locally present along the waterside and landside toes of the levee system. The landside and waterside levee embankments are generally inclined at about 2h:1v and 3h:1v (horizontal to vertical), respectively; however local variances in the slope inclinations are present.

2.2 STATION NOS. 55+00 TO 85+00

This section of the levee system is oriented in a general north-south direction as it progresses through relatively flat, privately-held agricultural lands. In this area, the creek appears to be a braided drainage system with aggregate point bars, lateral bars, and mid-channel bars distributed across the channel. Adjacent lands are largely undeveloped and rangeland, with the exception of a barn, well house, and other structures adjacent to the left levee near Station No. 77+00.

Six existing relief wells were observed adjacent to the left levee between about Station Nos. 77+00 though 84+00. These relief wells are located at the landside levee toe and are adjacent to a drainage ditch that extends from about Station Nos. 75+00 to 85+00. Another drainage ditch is located along the right levee between about Station Nos. 55+00 and 62+00. In addition, a culvert with a flap-gate has been noted penetrating through the left levee system at about Station No. 76+00 (Humboldt County, 2008a).

The landside banks along the levee system are covered with seasonal grasses, brambles, and shrubs, with trees locally present at the levee toe. Waterside banks are covered with seasonal vegetation, brambles, and shrubs. Trees and other larger vegetation are present along the waterside toes of the levee. The landside levee embankments are generally inclined at about 2.5h:1v. Waterside levee slopes are generally inclined at about 2.8h:1v to 3h:1v. Local variances in the slope inclinations are present.

2.3 STATION NOS. 85+00 TO 135+00

Redwood Creek changes to a generally easterly direction in this segment. It progresses through relatively flat, privately-held agricultural lands along its right embankment for the westerly two-thirds of this section. The remaining easterly third of the right levee is bordered by residential improvements, a commercial establishment, and a segment of Hufford Road. The left embankment is bordered by residential and commercial improvements from about Station Nos. 85+00 to 95+00 and 115+00 to 127+00. At about Station 128+00 to 132+00, the left levee is located adjacent to Orick School. At about Station No. 127+00, the levee is crossed by the Highway 101 Bridge spanning Redwood Creek. The remainder of the alignment is adjacent to privately owned, relatively flat agricultural or fallow lands. In this area, the creek appears to be a braided drainage system with aggregate point bars, lateral bars, and mid-channel bars distributed across the channel.

Two existing relief wells were observed adjacent to the right levee at about Station Nos. 110+00 and 111+50. A drainage ditch is located along the right levee between about Station Nos. 111+00 and 118+00. In addition, culverts with flap-gates have been noted penetrating through the left levee system at about Station Nos. 76+00 and 291+00 (Humboldt County, 2008a).

The landside banks along the levee system are covered with seasonal grasses, brambles, and shrubs, with trees locally present at the levee toe, especially adjacent to residential developments on the left levee between Station Nos. 114+00 and 120+00 and on the right levee between Station Nos. 124+00 and 127+00. Between about Station Nos. 86+00 and 89+00, aggregate extraction from Redwood Creek has resulted in a gravel stockpile along the left levee. Waterside banks are covered with seasonal vegetation, brambles, and shrubs. Trees and other larger vegetation are present along the waterside toes of the levee. Trees and shrubs are also present on mid-channel bars within Redwood Creek. The landside levee embankments are generally inclined at about 2.5h:1v. Waterside levee slopes are generally inclined at about 2.8h:1v to 3h:1v. Local variances in the slope inclinations are present.

2.4 STATION NOS. 135+00 TO 177+00

This section of the levee system is oriented in a general north-northeast direction through relatively flat, privately-held agricultural lands along its left embankment and through a portion of the community of Orick adjacent to its right embankment. Drydens Road extends along the southerly about three-quarters of this segment along the left levee system. The Orick Chamber of Commerce Rodeo Grounds extend along the approximately northern quarter of the left levee. In this area, the creek appears to be a braided drainage system with aggregate point bars, lateral bars, and mid-channel bars distributed across the channel. The right levee extends to about Station 173+00 then terminates, whereas the left levee continues upstream.

Twenty existing relief wells were observed adjacent to the right levee between about Station Nos. 135+00 and 144+00. An additional relief well is located in an access ramp on the right levee at about Station 159+00. A drainage ditch is located along the left levee along Drydens Road, between about Station Nos. 135+00 and 160+00. Between about Station Nos. 138+00 and 144+00, aggregate extraction from Redwood Creek has resulted in a gravel stockpile along the left levee. A USGS gaging station (No. 11482500) is present on the right levee at about Station No. 171+50. In addition, culverts with flap-gates have been noted penetrating through the left levee system at about Station Nos. 142+00 and 159+00 and through the right levee at about Station Nos. 166+00 and 170+00 (Humboldt County, 2008a). An additional culvert penetration with a gate valve is located at the right levee at about Station No. 170+00.

The landside banks along the levee system are covered with seasonal grasses, brambles, and shrubs, with trees locally present at the right levee toe. Waterside banks are covered with seasonal vegetation, brambles, and shrubs. Trees and shrubs are present along the waterside toes of the levee, and are also present on mid-channel bars within Redwood Creek. The landside levee embankments are generally inclined at about 2h:1v. Waterside levee slopes are generally inclined at about 3h:1v. Local variances in the slope inclinations are present.

2.5 STATION NOS. 177+00 TO 193+00 (UPSTREAM TERMINUS)

Only the left levee is present within this generally easterly-oriented section. It extends through relatively flat, privately-held agricultural lands to its upstream terminus at Redwood National Park. An active gravel extraction and processing plant is present north of the creek, between about Station Nos. 181+00 to 187+0. The creek in this segment appears to be a braided drainage system with aggregate point bars, lateral bars, and mid-channel bars distributed across the channel.

The landside banks along the levee system are predominantly covered with seasonal grasses. Waterside banks are covered with seasonal vegetation, brambles, and shrubs. Trees and other larger vegetation are present along the waterside toe, especially where a vegetated bench up to about 120 feet wide is present above the active creek channel. The landside levee embankments are generally inclined at about 2h:1v. Waterside levee slopes are generally inclined at about 3h:1v. Local variances in the slope inclinations are present.

3.0 FIELD EXPLORATION

3.1 FIELD EXPLORATION PLANNING

3.1.1 Review of Previous Reports

The County provided us with the following documents for use in the geotechnical investigation:

- Report of soils tests for foundation materials at the Redwood Creek levee project (USACE, 1960);
- A survey report for the Redwood Creek levee system (USACE, 1961);
- Report of soils tests for undisturbed foundation materials for the Redwood Creek levee project (USACE, 1965a);
- General Design Memorandum for the project (USACE, 1966);
- Redwood Creek Local Flood Protection Project Operations and Maintenance Manual (USACE, 1969);
- Annual USACE inspection reports for the levee system between 2006, 2007, 2008a, 2009a, and 2009b;
- A geotechnical report for the South Slough drainage structure (Geo/Resource Consultants, 1986);
- Subsurface exploration logs and a map of exploration locations for the Orick wastewater treatment facility (SHN, 2009); and
- A recent geotechnical report for a bridge crossing Strawberry Creek, in the vicinity of the levee system (Galli Group, 2011).

These documents and additional reports are referenced in Section 10 and Appendix A of this report.

Relevant geotechnical information from the reports listed above was reviewed during the investigation, including site and subsurface descriptions, historical groundwater data, laboratory testing results, drill hole logs, test pit logs, and as-built plans. Data from previous reports reviewed for the Redwood Creek Levee study are presented in Appendix A of this report.

According to the USACE (1966), field exploration programs were conducted during the following periods:

- August 1956;
- October 1958;
- March 1960;
- October through November 1964; and
- August through September 1965.

In total, those exploration programs advanced 85 explorations to depths ranging from 3 to 100 feet. The explorations ranged from test pits, hand-auger drill holes, bucket-auger drill holes, push-tube (Shelby tube) holes, a trench, and disturbed-sample holes. Table 3-1 presents information regarding explorations performed by the USACE (1966) prior to construction of the levee system:

Table 3-1. USACE Pre-Levee Construction Explorations

Exploration Period	Exploration No.	Type of Exploration	Depth Range (ft)
August 1956	2F-1 - 2F-4	4 Hand-Augers	3' - 17'
October 1958	4B-1	1 Trench	Unknown
March 1960	2F-5 - 2F-18	6 Hand-Augers 8 Bucket-Augers	6' - 19' 12' - 25'
October-November 1964	2F-19 - 2F-41 2F-42 7F-1 - 7F-5 & 7F-2A	29 Bucket-Augers (24" - 36") 1 Hand-Auger 6 Push-Tubes	10' - 40' 5.5' 6' - 12'
August-September 1965	2F-43 - 2F-71 4F-2 7F-6 - 7F-13	29 Disturbed-Holes 1 Test Pit 8 Push-Tube	11' - 100' Unknown 8' - 15'

In all of the explorations reported by USACE, alluvium was encountered for the full depth of the exploration. The alluvium was not fully penetrated by any of their explorations. Alluvial soils range from clay to sandy gravel, with interbedded silt, fine silty sand, coarse silty sand, and gravelly sand. Layers of organic-rich silty clay to clay are reported in the exploration logs. In addition, pieces of wood and logs are reported at depths ranging from 2 to 28 feet in 12 of the explorations.

The USACE (1966) noted that fine-grained, impervious soil layers ranging in depth from 0 to 25 feet and 6.5 to 19 feet for the right and left levee, respectively, are present. The impervious soils are described as silt, sandy silt, and silty sand with some sandy clay. Below the impervious layers are pervious materials consisting of sand and sandy gravel with cobbles and boulders. The pervious layer is reported to be greater than 100 feet thick and could be 200 feet or more in thickness (USACE, 1966).

Stabilized groundwater depths were not established in the USACE explorations (USACE, 1966). The explorations were backfilled immediately upon completion of exploration; therefore, the stabilized water elevations were not measured. Depth to groundwater within the exploration programs advanced by USACE ranged from 2.5 to 19 feet below the existing ground surface at the time of exploration. Based on those explorations, the USACE (1966) states:

"In general, the free water surfaces encountered during drilling of the holes near the creek correspond with the water level in the channel."

3.1.2 Exploration Plan

CGI/Fugro prepared an exploration plan for performing and executing the subsurface exploration for this study. The plan was described, in general, in our proposal to provide geotechnical services for this study, and in greater detail in a spreadsheet and maps forwarded to the County on July 28, 2010. The work plan, spreadsheet, and maps detailed the following:

Exploration numbers, locations and methods, including:

- Sonic core locations;
- CPT locations; and
- Hollow-stem auger locations;
- Station number for each exploration;
- Relative locations on the levee, levee toe, or offsets for each exploration;
- Target depths of each exploration;
- The Assessor's Parcel Number and landowner name for proposed exploration locations;
- Dates or date ranges that each exploration were to be performed;
- Anticipated permits required for the explorations; and
- Methods of destruction of each exploration following completion.

This information was used for landowner notification by the County and also for permitting, as discussed in Section 3.1.3. In addition, a health and safety work plan was prepared for field personnel during exploration.

3.1.3 Site Access & Permitting

Exploration for this project was performed on private and public properties. Public properties included lands or easements controlled by the County and the California Department of Transportation (Caltrans). Private lands owned by nine individuals or entities were located in areas of our exploration along proposed cross section lines. Per our contractual relationship, the County secured or attempted to secure permission to access and explore private properties at selected locations along the levee system. Of the nine private landholders, the County was able to secure permission for access and exploration from seven of the property owners. Only the properties at the offset location at the left side of the levee at about Station No. 185+00 and at the offset location on the right side of the levee at about Station No. 132+00 were inaccessible to us during this study.

Encroachment and/or environmental permits were required to perform exploration on public and private properties for this study. An encroachment permit was obtained from the California Department of Transportation (Caltrans) to perform exploration at the offset location on the right side of the levee at about Station 158+50. Environmental permits for all exploration locations for this project were obtained by CGI/Fugro from Humboldt County Department of Environmental Health (HCDEH). Prior to our field exploration program, the well permits were issued and documented in the project file.

3.1.4 Site Visit and Utility Clearance

Prior to performing drill holes, sonic core holes, and CPTs, each exploration location was visually inspected for the presence of overhead and underground utilities, and then marked with white paint and wood lathe, as required by USA. Following the marking of the exploration locations, USA was contacted a minimum of 48 hours prior to subsurface investigation of the site. A total of ten USA ticket numbers, as well as clearance dates, expiration dates, and call-back-to-extend dates, were obtained for the project and documented in the project file. In addition, during field exploration, it was necessary to relocate one drill hole due to a landowner conflict, thus, necessitating contact with USA for an additional ticket number.

No utility conflicts were identified at the site of any of CGI/Fugro's exploration locations and no manmade subsurface obstructions were encountered during our field exploration program. However, it should be noted that other buried utilities and structures not located by USA or observed by CGI/Fugro may be present along the project extent.

The proximity to overhead utilities was evaluated at each exploration location. In general, a clearance of at least 10 feet was maintained between drill rig mast and active overhead utilities (power lines).

3.2 EXPLORATION PROGRAM

The field exploration program completed by CGI/Fugro for the Redwood Creek Levee Geotechnical Evaluation project consisted of sounding and observations of existing relief wells, and subsurface exploration using sonic core holes, hollow-stem-auger drill holes, and CPTs. The following sections discuss those exploration services.

3.2.1 Relief Wells

As part of this study, existing, accessible relief wells located at various locations along the levee system were observed and sounded to estimate the depth to water and the existing bottom depth of each well. Prior to CGI/Fugro accessing the wells, the County removed vegetation where known wells were obscured. CGI/Fugro then opened well covers on each of those wells, photographed the well casings, sounded the wells (where possible), and down-hole videotaped portions of each well.

The relief wells were observed to consist of 12-inch internal diameter corrugated metal pipe (CMP) capped with a locking, hinged, plate-steel cover. As indicated by the down-hole camera, the CMP extended to varying depths then transitioned to a screened pipe near the groundwater table. The screened pipe is noted on the project plans as consisting of a wood-stove screen that extends to the bottom of the relief well (USACE, 1969). It is anticipated that the relief wells were installed contemporaneously with or shortly after the construction of the levee system.

According to USACE (1969), a total of 54 relief wells were installed by 1967 and should be present along the levee system. During this study, we located a total of 39 relief wells for which the locations are noted on Plate 5-3. Table 3-2 presents the information gathered from our observations and sounding of relief wells during this study.

Table 3-2. Relief Well Information

Relief Well No.	Date Observed/ Sounded	Sounded Depth to Relief Well Bottom	Sounded Depth of Well in 1966[1]	Depth to Water	Comments
1	9/28/10	NA	NA	15.1	
2	9/28/10	NA	NA	14.5	
4	9/8/10	62.4	63.0	15.4	
5	9/8/10	NA	64.1	NA	Obstructed at depth of 15.4 feet.
6	9/8/10	91.0	92.9	14.3	
7	9/8/10	91.5	92.6	14.8	
8	9/8/10	86.3	87.3	14.2	
9	9/8/10	92.5	93.1	14.4	
10	9/8/10	91.1	91.6	14.7	
11	9/8/10	98.0	98.3	14.4	
12	9/8/10	NA	100.9	NA	Obstructed at a depth of 7.6 feet.
13	9/8/10	79.3	81.9	14.0	
15[3]	9/8/10	100.3	87.9[3]	13.4	
16	9/8/10	NA	96.1	NA	Could not open lock on casing.
17	9/8/10	96.3	98.1	13.8	
18	9/8/10	96.2	97.8	14.2	
19	9/8/10	95.5	97.2	14.2	Wood or pipe obstruction at 7.5 feet.
20	9/8/10	92.4	92.2	14.7	
21	9/8/10	84.6	85.2	16.3	
23	9/8/10	96.6	98.1	16.5	
24	9/8/10	95.1	IL	16.4	Wood obstruction at a depth of 6.8 feet
25	9/8/10	NA	IL	NA	Rock and wood obstructions at 9.5 feet
26	9/8/10	84.3	95.4	16.2	Obstruction at a depth of 72 feet.
27	9/8/10	94.2	IL	15.8	
28	9/8/10	80.7	95.4	15.1	Obstruction observed at a depth of 73 feet.
29	9/8/10	NA	82.2	NA	Within well house. Pump and piping obstructed sounder and downhole camera.
30	9/8/10	NA	96.1	23.5	Debris obscuring well at depth of 28.3 feet.
31	9/8/10	90.5	91.1	15.4	
32	9/8/10	90.2	90.8	15.9	
33	9/8/10	87.8	88.7	16.1	Top of well deformed, partially obscuring opening
34	9/8/10	48.8	50.3	16.1	

Table 3-2. Relief Well Information (Continued)

Relief Well No.	Date Observed/ Sounded	Sounded Depth to Relief Well Bottom	Sounded Depth of Well in 1966[1]	Depth to Water	Comments
35	9/8/10	NA	49.1	NA	Cobbles & debris obstructions at 3.4 feet.
36[4]	9/14/10	NA	51.0	NA	Cobbles & debris obstructions at 4.5 feet.
49	9/8/10	48.7	50.7[2]	11.7	PVC pipeline extending into well casing and cap to offsite well house.
50	9/8/10	52.0	IL[2]	12.8	Heavy algal growth of water surface. Obstruction at a depth of 13.9 feet.
51	9/8/10	54.0	55.3[2]	13.3	Heavy algal growth on water surface.
52	9/8/10	54.8	55.3[2]	13.1	Heavy algal growth on water surface.
53	9/8/10	48.5	51.0[2]	13.2	Heavy algal growth on water surface.
54	9/8/10	50.2	51.4[2]	13.6	Heavy algal growth on water surface.

NA - Not available; IL - Illegible

[1] - per USACE (1969); [2] - 1967 measurement from USACE (1969); [3] - Well No. 15 likely corresponds to Well No. 14 from USACE (1969); [4] - Well No. 36 likely corresponds to USACE (1969) Well No. 48.

USACE (1969) records show that Relief Well Nos. 3, 14, and 37 through 48 at one time were present along the alignment. Levee stationing presented in USACE (1969) appears very close to stationing used within this study and using historical relief well station locations, we can approximate where the missing relief wells should be present. Relief Well No. 3 should be present at about Station No. 128+50 on the right levee, immediately downstream from the Highway 101 Bridge. That area is moderately overgrown with brambles and a relief well was not observed while we were making measurements; however, it was observed at another time during this study and is present. Relief Well No. 14 might correspond with Relief Well No. 15 noted in this study. The missing relief well (14 or 15) is likely present beneath fill material located adjacent to the toe of the levee. Relief Well Nos. 37 through 48 are noted as being present along the right levee between about Station Nos. 144+50 and 158+50. Those wells were not observed during this study and could be obscured by vegetation along the toe of the levee. Based on the historical data, it is likely that our Relief Well No. 36 corresponds to Relief Well No. 48 of USACE (1969).

As noted on Table 3-2, a number of relief wells were observed to have debris, rocks, and other obstructions present at varying depths. In addition, at Relief Well Nos. 29 and 49, PVC or metal piping has been installed into the wells apparently to be used for extraction of water. Heavy algal growth is present on the water surface within Relief Well Nos. 50 through 54.

Comparing the bottom depths of the wells sounded during this study to wells sounded in 1966 or 1967 (USACE, 1969) indicates that some sanding of the wells has occurred during that 44-year period. In general, approximately 0.3 to 14.7 feet of sanding were measured in the accessible wells. Some of that sanding could be the result of debris at or near the bottom of the wells.

3.2.2 Subsurface Exploration

The locations of core holes, drill holes, and CPTs performed for this investigation are shown on Plate 5-3. Information for each exploration including latitude and longitude, ground surface elevations, and total exploration depth are tabulated in Tables 3-3a and 3-3b.

3.3 REFERENCE DATUM

The following reference datums were used for this project:

Horizontal Datum. The horizontal datum reference for this project is State Plane, Zone 1, North American Datum 83 (NAD83, feet).

Vertical Datum. The vertical datum reference for this project is the North American Vertical Datum of 1988 (NAVD88, feet).

Coordinates and elevations for the exploration locations were estimated by CGI/Fugro during the week of November 1, 2010 using an Ashtech (Magellan Professional) MobileMapper 6 global positioning system receiver. Lidar data were provided by the National Park Service and Humboldt County for CGI/Fugro's use in engineering analyses.

Table 3-3a. Subsurface Explorations Summary - HSA and Sonic Drill Holes

Drill Hole	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	NAD83 Coordinates	
					Northing	Easting
HSA Drill Holes						
H057LW	15.7	26.5	10/15/2010	10/15/2010	2361058	5991233
H057RO	19.2	26.5	10/13/2010	10/13/2010	2361477	5991575
H057RW	19.2	26.5	10/12/2010	10/12/2010	2361355	5991407
H073LL	29.6	26.5	10/15/2010	10/15/2010	2359772	5991199
H073LW	17.1	26.5	10/15/2010	10/15/2010	2359813	5991248
H073RW	20.5	26.5	10/12/2010	10/12/2010	2359816	5991545
H087LW	18.9	26.5	10/15/2010	10/15/2010	2358415	5991851
H087RW	17.9	26.5	10/8/2010	10/8/2010	2358638	5992081
H098LW	21.6	26.5	10/14/2010	10/14/2010	2358561	5993174
H098RW	22.6	26.5	10/7/2010	10/7/2010	2358816	5993027
H114LW	23.2	26.5	10/14/2010	10/14/2010	2358970	5994614
H114RL	20.1	26.5	10/7/2010	10/7/2010	2359387	5994624
H114RW	24.9	26.5	10/7/2010	10/7/2010	2359258	5994611
H132LL	32.0	26.5	10/6/2010	10/6/2010	2359230	5996539
H132LO	31.5	26.5	10/6/2010	10/6/2010	2359169	5996543
H132LW	25.3	26.5	10/5/2010	10/5/2010	2359307	5996464
H132RL	28.7	26.5	9/29/2010	9/29/2010	2359656	5996257
H132RO	30.6	26.5	10/13/2010	10/13/2010	2359973	5996361
H132RW	21.4	26.5	9/29/2010	9/29/2010	2359538	5996325
H146LL	33.4	26.5	10/5/2010	10/5/2010	2360462	5997220
H146LO	32.1	26.5	10/7/2010	10/7/2010	2360425	5997319
H146LW	26.6	26.5	10/5/2010	10/5/2010	2360481	5997118
H146RL	33.8	26.5	10/13/2010	10/13/2010	2360699	5996761

Table 3-3a. Subsurface Explorations Summary - HSA and Sonic Drill Holes (Continued)

Drill Hole	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	NAD83 Coordinates	
					Northing	Easting
H146RO	33.1	26.5	10/14/2010	10/14/2010	2360739	5996706
H146RW	17.4	26.5	9/29/2010	9/29/2010	2360638	5996889
H158LL	36.5	26.5	10/1/2010	10/1/2010	2361622	5997652
H158LO	31.8	26.5	10/6/2010	10/6/2010	2361597	5997720
H158LW	29.7	26.5	10/4/2010	10/4/2010	2361648	5997554
H158RL	34.0	26.5	9/28/2010	9/28/2010	2361793	5997186
H158RO	34.6	26.5	10/14/2010	10/14/2010	2361819	5997132
H158RW	21.7	26.5	9/28/2010	9/28/2010	2361746	5997315
H171LL	36.4	26.5	10/1/2010	10/1/2010	2362531	5998205
H171LO	35.9	26.5	10/1/2010	10/1/2010	2362514	5998246
H171LW	32.3	26.5	9/30/2010	9/30/2010	2362592	5998137
H185LL	41.1	26.5	9/30/2010	9/30/2010	2362619	5999862
H185LW	31.5	26.5	9/30/2010	9/30/2010	2362793	5999709
Sonic Drill Holes						
S057LC	27.8	50	9/24/2010	9/24/2010	2361009	5991202
S057RC	28.7	50	9/18/2010	9/18/2010	2361390	5991452
S073LC	29.4	50	9/23/2010	9/23/2010	2359809	5991200
S073RC	28.0	50	9/17/2010	9/17/2010	2359829	5991609
S087LC	32.2	50	9/23/2010	9/23/2010	2358356	5991852
S087RC	32.8	50	9/17/2010	9/17/2010	2358703	5992130
S098LC	33.2	50	9/23/2010	9/23/2010	2358522	5993213
S098RC	33.7	50.5	9/16/2010	9/16/2010	2358875	5993028
S114LC	35.2	50	9/21/2010	9/21/2010	2358917	5994632
S114RC	35.2	50	9/16/2010	9/16/2010	2359318	5994607
S132LC	40.4	50	9/21/2010	9/21/2010	2359249	5996502
S132RC	41.1	50	9/15/2010	9/15/2010	2359615	5996289
S146LC	39.9	50	9/20/2010	9/20/2010	2360460	5997184
S146RC	41.6	50	9/15/2010	9/15/2010	2360683	5996813
S158LC	41.6	50	9/20/2010	9/20/2010	2361631	5997624
S158RC	42.5	51.5	9/14/2010	9/14/2010	2361775	5997209
S171LC	42.3	50	9/18/2010	9/18/2010	2362553	5998192
S185LC	48.6	50	9/20/2010	9/20/2010	2362728	5999676

Table 3-3b. Subsurface Explorations Summary - Cone Penetration Tests

CPT	Estimated Ground Surface Elevation (feet, NAVD88)	Completion Depth (feet)	Start Date	Completion Date	NAD83 Coordinates	
					Northing	Easting
C-57LC	27.7	50.2	9/24/2010	9/24/2010	2361026	5991192
C-57LL	20.3	25.1	9/23/2010	9/23/2010	2360999	5991145
C-57LO	20.5	25.1	9/23/2010	9/23/2010	2361017	5991145
C-57RC	28.6	50.0	9/22/2010	9/22/2010	2361403	5991435
C-57RL	27.1	50.0	9/22/2010	9/22/2010	2361423	5991486
C-57RO	19.4	25.1	9/22/2010	9/22/2010	2361467	5991572
C-73LC	29.3	44.6	9/24/2010	9/24/2010	2359820	5991194
C-73LL	21.6	25.1	9/24/2010	9/24/2010	2359817	5991166
C-73LO	22.0	25.1	9/23/2010	9/23/2010	2359816	5991144
C-73RC	28.6	50.0	9/21/2010	9/21/2010	2359828	5991605
C-73RL	23.6	25.1	9/21/2010	9/21/2010	2359823	5991634
C-73RO	21.3	25.1	9/22/2010	9/22/2010	2359826	5991658
C-87LC	32.5	31.3	9/23/2010	9/23/2010	2358357	5991844
C-87LL	27.5	25.1	9/23/2010	9/23/2010	2358322	5991833
C-87LO	23.7	25.4	9/23/2010	9/23/2010	2358275	5991805
C-87RC	32.6	25.6	9/21/2010	9/21/2010	2358710	5992107
C-87RL	26.9	25.1	9/21/2010	9/21/2010	2358731	5992124
C-87RO	26.8	25.1	9/22/2010	9/22/2010	2358740	5992128
C-98LC	33.4	38.7	9/24/2010	9/24/2010	2358517	5993202
C-98LL	26.8	25.1	9/23/2010	9/23/2010	2358470	5993221
C-98LO	25.6	25.1	9/23/2010	9/23/2010	2358386	5993274
C-98RC	33.7	50.5	9/21/2010	9/21/2010	2358872	5993013
C-98RL	28.2	25.4	9/21/2010	9/21/2010	2358899	5993005
C-98RO	28.3	25.1	9/21/2010	9/21/2010	2358923	5992999
C-114LC	35.3	26.2	9/24/2010	9/24/2010	2358918	5994641
C-114LL	28.6	25.3	9/22/2010	9/22/2010	2358841	5994627
C-114LO	28.5	25.1	9/22/2010	9/22/2010	2358786	5994643
C-114RC	34.2	50.0	9/21/2010	9/21/2010	2359329	5994587
C-114RO	26.7	50.2	9/24/2010	9/24/2010	2359428	5994591
C-132LC	40.1	50.0	9/24/2010	9/24/2010	2359243	5996497
C-132RC	40.9	50.2	9/20/2010	9/20/2010	2359612	5996278
C-146LC	40.2	39.9	9/24/2010	9/24/2010	2360459	5997183
C-146RC	41.1	50.0	9/20/2010	9/20/2010	2360675	5996804
C-158LC	41.4	50.5	9/24/2010	9/24/2010	2361622	5997627
C-158RC	41.4	50.0	9/20/2010	9/20/2010	2361764	5997202
C-171LC	41.6	42.0	9/23/2010	9/23/2010	2362561	5998199
C-185LC	47.0	50.0	9/23/2010	9/23/2010	2362725	5999672

The sonic cores were advanced through the levee crest at about where each cross section crosses the levee system. Core depths of 50 feet were generally obtained during this study. Continuous core samples were obtained to the depths explored in each sonic core hole, with the exception of isolated depth increments where no recovery occurred. Samples were

bagged in about 3-foot depth increments and delivered to CGI's laboratory in Redding, California, for testing and evaluation.

Thirty-seven CPTs were advanced as part of this study. Generally, one CPT sounding was advanced adjacent to each sonic core hole within the crown of the levee system. Those CPTs were targeted to a depth of 50 feet; however, Table 3-4 presents CPTs that encountered practical refusal at depths of less than 50 feet:

Table 3-4. CPT Refusal Depths

CPT Sounding	Refusal Depth (feet)
C73LC	44.5'
C87LC	31.5'
C98LC	38.5'
C114LC	26'
C146LC	40'
C171LC	42'

In addition to CPT soundings in the levee crown, a number of CPT soundings were performed at the landside toe and offset locations along the levees downstream of the Highway 101 bridge. The toe and offset CPTs were targeted to depths of 25 feet.

Thirty-six drill holes were advanced for this study using a track-mounted, hollow-stem auger drill rig. The drill holes were advanced in the following locations:

- At all waterside toe locations at the cross section sites;
- At all accessible landside and offset locations upstream of the Highway 101 bridge;
- At selected landside toe and offset locations downstream from the Highway 101 bridge.

The target depth of the drill holes was 25 feet (up to 26.5 feet following sampling at the bottom of the drill hole), which was achieved by each of the drill holes. Soil samples were obtained at selected depth intervals within the drill holes using Shelby tubes, California modified split-spoon, and Standard Penetration Test (SPT) samplers. A CGI engineering geologist logged the drill holes as they were advanced. All Shelby tube and California Modified split-spoon samples were delivered to Fugro's San Luis Obispo office for testing. All SPT samples were transmitted to CGI's Redding laboratory for testing.

All explorations were destroyed using cement grout in accordance with HCDEH permit conditions. The grout was placed through the sonic core barrel, hollow-stem auger, or CPT rods, which were extracted as the grout was being placed to reduce the potential for bridging or collapse of the holes prior to grout placement.

3.4 INVESTIGATION DERIVED CUTTINGS DISPOSAL

CPT and sonic cores did not generate cuttings that required disposal during the course of this study. The CPT soundings displace underlying sediments and, therefore, do not generate cuttings that require disposal. The sonic cores were collected during the sampling process and returned to our laboratory, thus, few cuttings were generated.

Hollow-stem-auger drill holes did generate cuttings during the exploration process. Because those holes were backfilled using cement grout, the cuttings required disposal. With the exception of explorations on private properties along Drydens Road, the cuttings were dispersed adjacent to the drill hole locations, as discussed in our exploration plan and as reviewed and approved of by HCDEH during permit application. Those cuttings generated on the private properties adjacent to Drydens Road were disposed of at the aggregate stockpile locations along the levee system.

4.0 LABORATORY TESTING PROGRAM

The purpose of the laboratory testing program was to supplement field classification of soils and provide relevant physical indices and engineering properties of the subsurface materials. The primary objectives of the program were to:

- Classify and characterize sampled subsurface materials;
- Evaluate the existing in situ conditions; and
- Develop relevant consolidation, strength, and permeability estimates of selected subsurface materials.

To meet these objectives, various tests were performed on selected samples. Test types are generally grouped into the following categories: classification/index tests, moisture content/density evaluations, consolidation tests, permeability tests, relevant strength tests, and subgrade characterization tests. Classification/index and subgrade characterization tests were performed on both disturbed and relatively undisturbed samples, including 3.0-inch diameter thin-wall push (i.e., Shelby) samples, 2.4-inch diameter drive (i.e., ring) samples, SPT samples, and bulk samples. Density evaluations, consolidation tests, permeability tests and strength tests were typically performed only on relatively undisturbed Shelby and ring samples.

The numbers of the various tests conducted for the Redwood Creek Levee Evaluation are listed in Table 4-1.

Table 4-1. Summary of Laboratory Tests Performed on Selected Samples

Laboratory Testing	Number of Tests	ASTM Test Designation[1]
Moisture Content	146	ASTM D2216
Density	27	ASTM D2937
Sieve Analysis with #200 Wash	114	ASTM D422
Sieve and Hydrometer	13	ASTM D422
Atterberg Limits	18	ASTM D4318
Modified Proctor	2	ASTM D1557
Consolidation (Incremental Load Control)	3	ASTM D2435
Flexible Membrane Permeability	15	ASTM D5084
Constant Head Permeability	1	ASTM D2434
Direct Shear	14	ASTM D3080
Consolidated Undrained (CU) Triaxial Compression Test on Cohesive Soils with R-Pore Pressure Measurement	1	ASTM D4767

1) ASTM International (2005)

Laboratory test results are tabulated or presented graphically in Appendix C. A tabular summary of laboratory test results for the Redwood Creek Levee Evaluation is presented on Plates C-1a through C-1e. Various laboratory test results are also tabulated versus depth on the individual drill hole logs (Plates B-2 through B-55). Test results that cannot be conveniently tabulated or plotted versus depth on logs are also provided in Appendix C. Test results in this category include: grain-size curves, plasticity charts, direct shear test results, triaxial test results, and compaction test results.

5.0 GEOLOGIC AND SUBSURFACE CONDITIONS

5.1 REGIONAL SETTING

The project site is located in the Coast Ranges Geologic/Geomorphic Province of Northern California. The Coast Ranges province consists of an approximately 50-mile wide range of mountains extending from Santa Barbara County approximately 400 miles northward into Shasta and Humboldt Counties (Hines, 1952). It is bounded to the north and east by the Klamath Mountains province, to the south by the Transverse Ranges province, to the southeast by the Great Valley province, and to the west by the Pacific Ocean.

The project region occupies a complex geologic environment characterized by high rates of active tectonic deformation and seismicity. The area lies immediately north of the Mendocino Triple Junction, which is the location of intersection of three crustal plates (i.e., the North American, Pacific, and Gorda plates). North of Cape Mendocino, the Gorda plate is being actively subducted beneath North America, forming what is commonly referred to as the Cascadia subduction zone, which is located west and offshore of the study area. In Humboldt County, stresses from the offshore subduction zone are manifested on-land as a series of northwest-trending, southeast-vergent thrust faults, and intervening folds (i.e., "fold and thrust belt"). The geomorphic landscape of the project region is largely a manifestation of the active tectonic processes and the setting in this dynamic coastal environment.

Basement rock within the Redwood Creek region consists of the Cretaceous-Jurassic Franciscan Formation (Cashman et al., 1995). The Franciscan Formation is a sequence of metasedimentary, metavolcanic, metamorphic, and ultramafic rocks that have been and are continuing to be accreted to the North American plate during subduction of the Pacific plate. As a consequence, the Franciscan Formation has been mapped as three broad belts (Eastern, Central, and Coastal belts) that become younger from east to west (McLaughlin et al., 2000). The Redwood Creek basin is situated on the Eastern Belt and is juxtaposed to the relatively older Klamath Mountains province to the northeast (Harden et al., 1982). In the project region, it is composed of northwest-trending units of schist, sandstone, and mudstone, each separated by faults (Harden et al., 1995).

5.2 LOCAL GEOLOGIC SETTING

Coastal valleys, such as Orick Valley, represent sediment-filled estuaries that reflect the late Quaternary history of sea level changes and tectonic deformation. During most of the late Quaternary, sea level was lower than its present position, resulting in a shoreline located farther to the west, and a lower fluvial base level to which all coastal streams would be graded. During these low sea levels, streams within the coastal valleys around Humboldt County would be incised. Subsequent sea level fluctuations would result in cycles of filling and incision in these coastal valleys, depending on the relative base level (i.e., the ocean shoreline). It is thought that sea level reached its current high level in the mid-Holocene, about 6,000 years ago. As such, most of the sediment filling the Orick Valley would be anticipated to be mid-Holocene in age, or younger.

The sediment filling Orick Valley is alluvium derived from Redwood Creek, Prairie Creek, and other upstream sources, and it is relatively unconsolidated and locally contains high concentrations of organics and woody debris. Associated with the alluvium are colluvial soils

along the margins of the valley and concentrations of artificial fill materials, such as the levee system and approach ramps for the Highway 101 bridge crossing Redwood Creek. A geologic map of the project area and a regional fault map are shown on Plates 5-1 and 5-2., respectively.

5.3 SUBSURFACE CONDITIONS

As previously noted, the project field exploration program included sonic cores, CPT soundings, and hollow-stem auger drill holes along the crest of the Redwood Creek levees, at the landside and waterside toes, and at landside levee offset locations within the project extent. Subsurface conditions were explored to a depth of up to approximately 50 feet below ground surface (see Section 3.0 for details of the field exploration program). Subsurface conditions are described and illustrated in the sonic core, drill hole, and CPT logs (see Appendix B). The logs have also been projected onto cross sections to depict subsurface conditions across and along the levee system. See Plate 5-3 for a map showing the location of the cross-sections and Plates 5-4 and 5-5 for the cross sections. Ten transverse cross sections (57, 73, 87, 98, 114, 132, 146, 158, 171 [left levee only], and 185 [left levee only]) were created by projecting exploration logs onto regional topographic data provided by the County and by LIDAR surveys performed for Redwood National Park.

5.3.1 Earth Materials

Subsurface conditions are generally similar throughout the project site, although some variability is seen along the levee system. In general, the embankment materials within the levee were relatively similar along both sides of the levee system. Foundation soils showed some variability. Earth materials encountered within the levee embankment and in the foundation soils are discussed in the following sections.

Levee Embankment Materials. Levee embankment thicknesses appear to range from about 6 feet to over 24 feet, as estimated from cross sections presented on Plates 5-4 and 5-5. A total of 36 explorations, consisting of sonic cores and CPT soundings, were advanced through the levee embankment materials to sample and characterize selected geotechnical conditions within the embankments.

Subsurface conditions within levee embankment materials were observed to be generally consistent throughout the levee system. The explorations observed that about 1 to 4 feet of granular soils are present below the crown of the levee. Those granular soils consist of sand, gravelly sand, sandy gravel, and gravel, some of which appears to be aggregate base materials. The granular soils were generally dry to damp, dense to very dense, with fine to coarse sand and fine to coarse gravel ranging from subrounded to angular. Tested samples of these granular soils indicate that they have a moisture content ranging from 3- to 8-percent, 10- to 16-percent soil fraction passing the No. 200 sieve, and plasticity indices (PI) of about 4. In addition, the near-surface levee granular soils have angles of internal friction (Ø) ranging from about 28 to 36 degrees and hydraulic conductivity values ranging from $1.6x10^{-4}$ to $1.3x10^{-3}$ centimeters per second (cm/sec). Unit dry weights of these materials ranged from 110 to 144 pounds per cubic foot (pcf). Locally, the upper few inches of the granular soils were loose. Local silt to sandy silt fill layers are present within these granular soils.

Silty clay, clay, and clay with gravel, clayey silt, and silt was encountered beneath the surficial granular soils within the levee. Those materials generally constitute the "impervious fill" noted on the USACE plans (1966) and extend to the bottom of the levee embankment soils. Occasionally, thin granular interbeds are present within the impervious fill, as discerned from the CPT logs. The impervious fill materials were damp, stiff to very stiff, and locally slightly plastic. In-situ moisture contents ranged from 8- to 15-percent and unit dry weights ranged from 111 to 117 pcf. These materials had PIs ranging from about 5 to 8, and hydraulic conductivities ranging from $3x10^{-7}$ to $2.8x10^{-5}$ cm/s. The impervious fill materials tested had Ø values ranging from 30 to 34 degrees.

Foundation Soils. The USACE (1966) notes, on Plate A-11, that imperious blanket materials and pervious foundation soils are present beneath the levee embankment. The following sections discuss foundation soils encountered during this study relative to generalized soil descriptions presented by USACE (1966).

Impervious Blanket Materials. The USACE (1966) report indicates the presence of impervious blanket materials consisting of silty sand, sandy silt, silty, clayey silt, silty clay, and clay varying in thickness from nonexistent to about 25 feet within the upper portion of the foundation soils. The USACE projected that the thickness of the impervious blanket materials decreases significantly beneath the right levee, especially between Station Nos. 85+00 to 105+00 and 133+00 to 140+00, and slightly beneath the left levee as the levees progresses upstream.

CGI/Fugro encountered similar materials during this study as described by the USACE as "impervious blanket materials." Those materials predominantly consisted of clayey silt, silty clay, sandy silt, with lesser amounts of silty clay to clay and silty sand to sand, as noted on Plates 5-4 and 5-5. We encountered thicker sections and relatively more abundant silty clay to clay between about Station Nos. 57+00 and 100+00 beneath the left levee and 57+00 and 70+00 beneath the right levee, relative to the remainder of the levee system explored. Minor, thin silty clay to clay interbeds were encountered in CPT soundings upstream from Station No. 158+00 on the left levee and upstream from about Station 114+00 on the right levee.

Thicknesses of those materials varied from a few feet to about 25 feet, with an average thickness of about 18.4 and 14.5 feet for the right and left levee, respectively. For the right levee, the impervious blanket materials encountered had a maximum and minimum thickness of about 25 and 13 feet, respectively. The maximum and minimum thickness of those materials for the left levee was estimated to be about 18 and 11 feet, respectively. Table 5-1 presents some material properties for the impervious blanket materials encountered during our study:

Table 5-1. Impervious Blanket Material Properties

Soil Property Ranges	Average Thickness (ft)	Approximate Amounts Silty Clay & Clay (%)	Dry Unit Weight (pcf)	Moisture Content (%)	Fines (%)	Plasticity Index	Angle of Internal Friction (degrees)	Hydraulic Conductivity (cm/sec)
Left Levee								
Station 57+00 to 98+00	13	44	125	32	25	NA	36	$9.4x10^{-4}$
Station 98+00 to 185+00	17	53	75-103	5-58	8-27	7-12	33-34	$6.4x10^{-3}$ - $1.8x10^{-6}$
Right Levee								
Station 57+00 to 73+00	23	74	78-95	27-33	60	1-15	36-39	$3.3x10^{-6}$ - $9.3x10^{-6}$
Station 73+00 to 87+00	13	42	NA	NA	NA	NA	NA	NA
Station 87+00 to 114+00	10	57	NA	NA	NA	NA	NA	NA
Station 114+00 to 185+00	16	57	NA	10-19	10-27	NA	NA	NA

NA - Not Available.

Pervious Foundation Soils. The USACE (1966) encountered pervious foundation soils underlying the impervious blanket materials in all explorations. Those materials were reported as silty sand, sand, sand with gravel, gravel with sand, and gravel, with few thin interbeds of sandy silt, silty clay, and clay. The USACE explorations did not fully penetrate the thickness of the pervious foundation materials to depths of 100 feet.

CGI/Fugro encountered similar pervious foundation materials as reported by the USACE (1966). In general, the pervious foundation materials encountered during our study consisted of loose to very dense, moist to wet, poorly- to well-graded sand, sand with gravel, and gravel with sand. The pervious foundation soils were not fully penetrated by explorations performed for this study.

Relatively fine-grained interbeds, consisting of silty sand, sandy silt, silty clay, and clay, were encountered locally within the pervious explorations. Those interbeds were encountered predominantly below an elevation of about -23 to -28 feet (NAVD88) at Station 57+00 at both levees, and between elevations -14 and -21 feet (NAVD88) at Station 114+00 in the right levee. Additional relatively fine-grained interbeds ranging in thickness from about 1 to 3 feet were encountered within other explorations, as noted on Plates 5-4 and 5-5.

The pervious foundation soils tested as part of this study had dry, in-situ unit weights ranging from 83 to 106 pcf, in-situ moisture contents ranging from 3 to 30 percent, Ø values ranging from 36 to 44 degrees, and hydraulic conductivity values ranging from $1.3x10^{-2}$ to $7.9x10^{-3}$ cm/sec.

5.3.2 Groundwater

Depths to groundwater were measured in existing relief wells, hollow-stem auger drill holes, and sonic coring holes advanced as part of this study. Depths to groundwater cannot be measured directly using CPT soundings and dissipation tests were not performed because those soundings were generally placed proximal to the drill holes or sonic core holes.

The observed groundwater levels varied from about 5 to 32 feet below ground surface, with elevations ranging from about -2 to 26 feet (NAVD88). Groundwater levels observed in the field are summarized on Table 5-2 and presented graphically on Plate 5-9.

Table 5-2. Groundwater Level Observations in Study Explorations

Station & Measurement Date	Groundwater Elevations (NAVD88)							
	Left Levee				Right Levee			
	Offset	Landside Toe	Crest	Water-side Toe	Water-side Toe	Crest	Landside Toe	Offset
Station 57+00			2	8	8	9		14
Date			9/24/10	10/15/10	10/12/10	9/18/10		10/13/10
Station 73+00		14	-2	5	11	-1		
Date		10/15/10	9/23/10	10/15/10	10/12/10	9/17/10		
Station 87+00			6	5	9	5		
Date			9/23/10	10/15/10	10/8/10	9/17/10		
Station 98+00			5	6.5	12.5	6		
Date			9/23/10	10/14/10	10/7/10	9/16/10		
Station 114+00			11	10	14	6	9	
Date			9/21/10	10/14/10	10/7/10	9/16/10	10/7/10	
Station 132+00	15	15	10.5	15	12	11		13
Date	10/6/10	10/6/10	9/21/10	10/5/10	9/29/10	9/15/10		10/13/10
Station 146+00	15		12	16.5	13	14	15	8
Date	10/7/10		9/20/10	10/5/10	9/29/10	9/15/10	10/13/10	10/14/10
Station 158+00	19	19	11.5	19	17	18.5	19	16
Date	10/6/10	10/1/10	9/20/10	10/4/10	9/28/10	9/14/10	9/28/10	10/14/10
Station 171+00	19	19	14.5	18				
Date	10/1/10	10/1/10	9/18/10	9/30/10				
Station 185+00		26	21	24				
Date		9/30/10	9/20/10	9/30/10				

In addition, groundwater levels in the project area were researched through the California Department of Water Resources (2011) and through the California State Water Resources Control Board Geotracker database (CSWRCB, 2011). Based on information obtained from those sources and from data provided by the County at the start of this project, we have compiled historical groundwater levels in the project area. Those data are presented in Table 5-3. Groundwater levels were also measured for relief wells and were presented in Table 3-2.

Table 5-3. Groundwater Data Reported by Others

Source	General Location			Groundwater Elevation Range (NAVD 88)	Monitoring Period Range
	Site	Longitude	Latitude		
SHN (2006b)	121444 Highway 101	41° 17' 39"	124° 3' 21"	11.75 to 16.35 NGVD29	2/2004 to 2/2006
SHN (2006a)	Shoreline Market	41° 17' 6"	124° 4' 24.5"	7.36 to 14.33 NGVD29	1/2004 to 4/2006
HCDEH (2008)	120784 Highway 101	41° 17' 5"	124° 3' 48"	>14' bgs	NA
SHN (2009)	Orick WWTF	41° 17' 33"	124° 3' 31"	17.2 to 22.25 datum unknown	10/2008 to 3/2009
Galli Group (2011)	Strawberry Creek Bridge	41° 17' 13"	124° 4' 43"	3.0 to -2.5 datum unknown	2/18/2011
DWR (2011)	10N01E04D004H	41° 17' 6"	124° 4' 20"	5.8 to 6.7 datum unknown	10/2010 to 4/2011
DWR (2011)	10N01E04C001H	41° 17' 6"	124° 3' 17"	4.6 to 14.4 datum unknown	3/1983 to 10/2002

In general, groundwater levels were measured to be at relatively consistent depths beneath the ground surface along the levee system. Some variations in depths to water were observed; however, in a depositional environment that has the potential to have significant changes in soil types over relatively short distances, variations in groundwater depths should be anticipated. None of the variations measured during this study imply the presence of a significant aquitard or aquiclude impeding horizontal groundwater flow through sediments in the vicinity of the levee system. In addition, some variations in groundwater depths could be related to on site waste disposal systems present at residential developments located adjacent to the levee system, such as between Station Nos. 132+00 and 146+00. Variations in groundwater levels and soil moisture conditions can occur as a result of rainfall, runoff, and other factors. Therefore, groundwater conditions should be assumed to fluctuate.

6.0 SEISMIC DESIGN CRITERIA

6.1 STRONG GROUND MOTION

As part of our geotechnical analyses, a probabilistic seismic hazard evaluation was conducted with the aid of the United States Geological Survey (USGS) 2008 Interactive Deaggregation (beta) website. The USGS website provides probabilistic estimations of seismic hazards using three-dimensional earthquake sources. The USGS hazard model includes ground motions up to 2 standard deviations above or below the median for each earthquake considered. EC 1110-2-6067 (2010a) specifies that a Statistical Return Period of 100 years (1 percent annual chance of exceedance) be used when performing seismic evaluations; however, at the time of our analyses, the USGS website did not have the capability to provide estimations for a 100-year return period. Consequently, we utilized the next longest return period available on the website of 134 years (0.7 percent annual chance of exceedance) to determine spectral accelerations needed for the probabilistic seismic hazard evaluation.

The probabilistic spectral accelerations were calculated by the USGS website using equally-weighted ground motion values from three (3) attenuation relationships: Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and Youngs (2008). In addition, documentation provided by USGS in support of their website application indicates that, due to the site's proximity to the Cascadia subduction zone, weighted ground motion values from the following three attenuation relationships were also included in the USGS hazard model: Zhao and others (2006), Youngs and others (1997), and Atkinson and Boore (2003). For the purposes of our evaluation, the site coordinates (latitude and longitude) for the Redwood Creek project site were estimated to be 41.289 degrees north latitude and 124.059 degrees west longitude.

The estimated values of spectral acceleration (S_a) for the probabilistic response spectrum at a damping ratio of 5 percent are shown graphically on Plate 6-1. According to the USGS website, the peak horizontal ground acceleration (PHGA) for the project site is estimated to be approximately 0.2 g, corresponding to deaggregated modal and mean magnitudes of 9.0 and 6.85, respectively. According to the USGS (2008), this PHGA value is, on average, approximately 1.3 standard deviations below the median value and 0.1 standard deviations above the median value for the modal and mean earthquake sources, respectively.

Based on correlations developed by Sykora (1987), Mayne (2007), Dickenson (1994), and Mayne and Rix (1995), shear wave velocity data were estimated for the subsurface conditions encountered at the site. The average shear wave velocity for the upper 100 feet was estimated to be approximately 180 meters per second (m/s), based on data collected from explorations C57RC and H146RO.

6.2 SURFACE FAULT RUPTURE

The State of California designates faults as active, potentially active, and inactive depending on the recency of surface fault rupture that can be substantiated for a fault. Table 6-1 presents the current California fault activity ratings.

Table 6-1. Fault Activity Ratings

Fault Activity Rating	Geologic Period of Last Rupture	Time Interval (Years)
Active	Holocene	Within last 11,000 Years
Potentially Active	Quaternary	>11,000 to 1.6 Million Years
Inactive	Pre-Quaternary	Greater than 1.6 Million Years

The California Geologic Survey (CGS) evaluates the activity rating of a fault in fault evaluation reports (FER). FERs compile available geologic and seismologic data, and evaluate if a fault should be zoned as active, potentially active, or inactive. If an FER evaluates a fault as active, then it is typically incorporated into a Special Studies Zone in accordance with the Alquist-Priolo Earthquake Hazards Act (AP). AP Special Studies Zones require site-specific evaluation of fault location and require a structure setback if the fault is found traversing a project site.

The site is not located within an Alquist-Priolo Earthquake Fault Zone and no active faults are known to pass through the project site (Harden et al., 1982; Jennings, 1994; Hart & Bryant, 1997; Jennings & Bryant, 2010). However, a number of regional and local faults traverse the project region. The closest of these faults is the potentially active Grogan fault, located about 0.8 miles northeast of the northeast terminus of the levee system, as shown on Plate 5-2. The Grogan fault is a north-west trending, northeast-dipping thrust or reverse fault (Smith, 1981), or possibly a dip-slip/strike-slip fault (Cashman et al., 1995). The Grogan fault separates the schist of Redwood Creek from incoherent and coherent Franciscan sandstone and mudstone (Harden et al., 1982). Some authors report the fault as low angle (Smith, 1981); however, Harden et al. (1982) indicate that the straightness of the fault implies the fault is vertical to near-vertical. According to Smith (1981), the Grogan fault is poorly exposed near Orick except locally where clear cuts are present, and exhibits no geomorphic features that would imply relative recency in movement of the fault. Jennings & Bryant (2010) indicate the Grogan fault has failed during the Quaternary but do not differentiate when, during the last 1.6-million years, the fault last ruptured. Cashman et al. (1995) report that exposures of Franciscan Formation rocks juxtaposed against Pliocene or Pleistocene sediments were at one time exposed near Prairie Creek, thus, further constraining the age of movement.

The potentially active Bald Mountain fault is located about 3.2 miles southwest of the westerly terminus of the levee system, as shown on Plate 5-2. The Bald Mountain fault system juxtaposes unmetamorphosed Franciscan Formation and the schist of Redwood Creek (Smith, 1981; Harden et al., 1982). It is reported as a low-angle east-dipping thrust fault based on its sinuous and discontinuous exposures (Harden et al., 1982). Geomorphic features of the fault are locally well expressed; however, there is no evidence that the fault ruptures Holocene or late Pleistocene rocks or sediments along its length (Smith, 1981). Thus, the State (Smith, 1981) and Jennings & Bryant (2010) have labeled the fault as potentially active.

The closest zoned active fault is the Trinidad fault, located about 16 miles south of the project site, as shown on Plate 5-2. The Trinidad fault is part of the larger Mad River fault zone, which includes the Trinidad, McKinleyville, Mad River, Fickle Hill, and related faults (Smith,

1982), which extends from south of Arcata to west and offshore of Trinidad. The fault is northwest trending, east dipping, and offsets a number of marine terraces along the coastal zone (Carver, 1982, Smith 1982).

In addition to the continental faulting noted above, the project area rests above the Cascadia subduction zone. West of the site, off the coast of California, the oceanic crust of the Gorda plate is being subducted beneath the continental crust of the Pacific Plate, in an area known as the Gorda Escarpment. The descending ramp caused by that subduction, called the Cascadia Subduction zone, extends beneath the project area at a depth of about 9 to 12 miles (McLaughlin et al., 2000). That ramp is capable of storing elastic stress that periodically causes earthquakes that could affect the project area.

7.0 CROSS SECTIONS FOR ANALYSES

As part of our geotechnical investigation, ten cross sections were analyzed for seepage and stability. The locations of the cross sections are shown on Plate 5-3. The cross section locations generally conform to the locations presented in the County's Work Plan developed for the project (Humboldt County Department of Public Works, 2010), with the exception of sections located at about Station Nos. 171+00 and 185+00. The original work plan proposed Cross Section 171+00 to extend from east of Redwood Creek to west of Redwood Creek; however, the presence of formational rock materials on the west side of the creek precluded the need to extend the section to the west side. Instead, a new cross section encompassing the levee located south of Redwood Creek at about Station No. 185+00 was included in this study.

The cross sections analyzed are located between 1,100 and 1,800 feet apart, with an average of about 1,425-foot separations. They are generally equally distributed along the levee system, with five cross sections located upstream and five cross sections located downstream of the Highway 101 bridge crossing Redwood Creek.

The cross sections evaluated, herein, have generalized station number names to indicate the approximate locations of the cross section. Table 7-1 presents the stationing where the cross sections cross the stationing line established along the approximate centerline of Redwood Creek.

Table 7-1. Cross Section Station Numbers

Cross Section	Station Number
57+00	57+60
73+00	72+55
87+00	86+90
98+00	98+25
114+00	114+25
132+00	132+55
146+00	145+80
158+00	157+90
171+00	169+25(east side only)
185+00	189+30(south side only)

CGI/Fugro approximated cross section topography on the basis of Lidar data collected by the National Park Service and provided by Humboldt County. In order to minimize the effect of vegetation on Lidar-based elevations, we compared the topography at each cross section location to measurements approximated in the field.

Our idealized seepage and stability analysis models were based on both the northern (right) levee and southern (left) levee of each cross section. For the purposes of our analyses, the subsurface conditions were modeled as levee fill overlying fine- and coarse-grained alluvial deposits. Based on our review of the USACE General Design Memorandum (1966), the

Operations and Maintenance Manual (USACE, 1969), and field exploration logs, we modeled the levee as a core of impervious fill material covered by a shell of pervious fill material. Additionally, we modeled the alluvium as an impervious top stratum overlying a pervious substratum.

Estimated model dimensions were based on our review of USACE (1966, 1969) and field exploration logs. In general, the landside and waterside slope inclinations of our models were estimated to be about 2.5h:1v and 3h:1v, respectively; the impervious core landside and waterside slope inclinations of our models were estimated to be 2h:1v and 1h:1v, respectively.

As a measure of conservatism, the 12- to 24-inch-thick layer of riprap slope protection was not included in our stability models. Based on our experience, including the riprap slope protection in our models would likely result in a relatively small increase in estimated factors of safety.

For existing and flood-stage conditions, creek water surfaces were modeled to represent the median annual and 100-year water surface elevations, respectively, as defined by Northern Hydrology & Engineering (NHE, 2010a). Groundwater elevations were estimated based on data collected during our field exploration efforts, between September 9 and October 15, 2010; groundwater data are presented in Table 5-2 and on Plate 5-9.

8.0 GEOTECHNICAL ANALYSES

8.1 LIQUEFACTION

Liquefaction triggering analyses were performed for all 37 CPTs located in the project area. Proprietary software programmed into ArcGIS was used to: 1) perform the CPT-based liquefaction triggering analyses according to the 1997 National Center for Earthquake Engineering Research (NCEER) guidelines (NCEER, 1997), and 2) to estimate seismic settlement using Ishihara and Yoshimine (1992). The results of the analyses are presented on individual CPT plots in Appendix D as Plates D-2 through D-38. A key to the liquefaction logs is presented on Plate D-1. In addition, individual logs are projected onto cross sections as Plates D-39 and D-40.

Liquefaction analyses were performed as follows:

1. In accordance with EC 1110-2-6067 (USACE, 2010a), groundwater depths corresponding to the median annual water surface elevation were assumed to approximate existing phreatic conditions.
2. Liquefaction triggering was evaluated for a PHGA of 0.2 g and a moment magnitude of 9.0 (greater of the deaggregated modal and mean magnitudes), corresponding to a statistical return period of 134 years.
3. Liquefaction analyses are based on estimates of two values: the cyclic stress ratio (CSR), which characterizes the seismic demand on the soil, and the cyclic resistance ratio (CRR), which characterizes the soil's capacity to resist liquefaction. CSR versus depth was calculated using 1997 NCEER guidelines (NCEER, 1997). CRR values versus depth for the CPT-based liquefaction triggering procedure were estimated using the 1997 NCEER guidelines (NCEER, 1997).
4. Seismic settlement resulting from potential liquefaction was estimated for each CPT using procedures presented in Ishihara and Yoshimine (1992).

8.1.1 Liquefaction Triggering Analyses per NCEER (1997)

NCEER (1997) guidelines (Youd and Idriss, 2001) present deterministic liquefaction triggering procedures based on CPT data. The CRR function to determine liquefaction potential is estimated by the following equation:

If $(q_{c1N})_{CS} < 50$, $CRR_{7.5} = 0.833[(q_{c1N})_{CS}/1{,}000] + 0.05$

If $50 \leq (q_{c1N})_{CS} < 160$, $CRR_{7.5} = 93[(q_{c1N})_{CS}/1{,}000]_3 + 0.08$

where:

$(q_{c1N})_{CS}$ = clean-sand cone penetration resistance normalized to approximately 100 kPa (1 atm)

The factor of safety (FS) against liquefaction is computed as the ratio of CRR to CSR. The results of the analyses are presented on the CPT plots (Plates D-2 through D-40). The red lines on the plots are the estimated CPT tip resistance that is needed to resist liquefaction for the seismic conditions considered. A blue zone between the red line and the CPT tip resistance indicates a zone of potentially liquefiable soil.

As noted above, discontinuous, interbedded layers of silty sand and clayey sand were encountered within predominantly fine-grained subsurface stratigraphic units. Depending on the thickness of sandy layers relative to overlying and underlying fine-grained materials, the full cone tip resistance in sandy layers may not be realized (termed the "thin layer" effect). For liquefaction evaluations presented herein, a thin layer correction was applied to the stiff sandy layers within the softer interbedded fine-grained materials.

8.1.2 Seismic Settlement per Ishihara and Yoshimine (1992)

Seismic settlement resulting from liquefaction was estimated using procedures presented in Ishihara and Yoshimine (1992). The procedure relates volumetric strain to the FS against liquefaction and normalized CPT tip resistance (see Fig. 10 in Ishihara and Yoshimine, 1992). Estimated volumetric strains are multiplied by layer thickness to obtain incremental settlement in each liquefiable layer. The increments are summed from the bottom of the exploration to the ground surface. Cumulative seismic settlement versus depth estimates are presented on the CPT plots and tabulated in Table 8-1.

8.1.3 Seismically Induced Dry Settlement per Pradel (1998)

Seismically induced dry settlement can occur in association with liquefaction, or in soils not prone to liquefaction (above the water table) that are loose to medium dense. Seismically induced dry settlement differs from settlement resulting from liquefaction of saturated granular materials, discussed above.

We estimated the potential for seismically induced dry settlement to occur at the site using procedures presented in Pradel (1998). In general, the granular materials encountered in our field explorations ranged from very loose to very dense sandy silt, silty sand, sand, sand with gravel, gravelly sand, gravel with sand, sandy gravel, and gravel. The very loose to medium dense granular materials may be susceptible to dry seismic settlement. On the basis of our analysis, we estimate the potential magnitude of seismically induced dry settlement to be up to about 1 inch.

8.1.4 Results

The results of our seismically induced settlement analyses for the ten cross sections are summarized in Table 8-1 below, and presented graphically in Appendix D as Plates D-2 through D-40.

Table 8-1. Estimated Seismically-Induced Settlement Analyses Results

Section	Levee	Cumulative Liquefaction-Induced Settlement (inches)	Cumulative Seismically-Induced Dry Settlement (inches)
57+00	Left	2½ - 4½	≤1
	Right	2½ - 5	≤1
73+00	Left	1½ - 3½	≤1
	Right	2 - 5	≤1
87+00	Left	½ - 1½	≤1
	Right	½ - 1	≤1
98+00	Left	½ - 1	≤1
	Right	0 - 3½	≤1
114+00	Left	½ - 1	≤1
	Right	3 - 6½	≤1
132+00	Left	3½ - 4	≤1
	Right	0 - 1	≤1
146+00	Left	2 - 2½	≤1
	Right	2½ - 3	≤1
158+00	Left	4½ - 5	≤1
	Right	3½ - 4	≤1
171+00	Left	1 - 1½	≤1
185+00	Left	1½ - 2	≤1

8.2 PERMEABILITY AND SEEPAGE

Seepage analyses were performed for the ten cross sections along the project extent of Redwood Creek. The analyses were performed using the two-dimensional numerical modeling program SLIDE (Rocscience, 2010) to account for site-specific conditions, including irregular slope geometries and anisotropic permeabilities. This method of evaluation is generally consistent with the recommendations regarding seepage analysis computer programs in ETL 1110-2-569 (2005) and ETL 1110-2-555 (1997).

In general, SLIDE is a reputable program that has been favorably compared with similar modeling programs utilized within the geotechnical engineering industry (Pockoski and Duncan, 2000). The validity of our seepage and stability models was qualitatively verified by comparing the output estimated for existing conditions with conditions observed in the field. In addition, our models were reviewed internally by multiple team personnel for quality assurance purposes.

It should be noted that our idealized seepage and stability models represent the general site conditions approximated by our investigation and a review of historical data. Although localized, anomalous subsurface conditions are present within the levee system, the lateral extent of anomalous areas was not estimated as part of our evaluation. Therefore, the potential effects of anomalous conditions on seepage and stability were not included in our analyses.

As input to the seepage analyses, soil permeability values were selected based on a comparison of laboratory test results, well testing data collected by SHN (2006a, 2006b), values calculated using the empirical correlation presented in Chapuis (2004), a review of design documents, and limited sensitivity analyses. In addition, values were compared to typical permeability values presented in USACE EM-1110-2-1901 (1986), and Domenico and Schwartz (1998) before we selected the input value of saturated permeability for each material. Plates D-41 and D-42 show the estimated permeability values for the levee fill and foundation material, respectively.

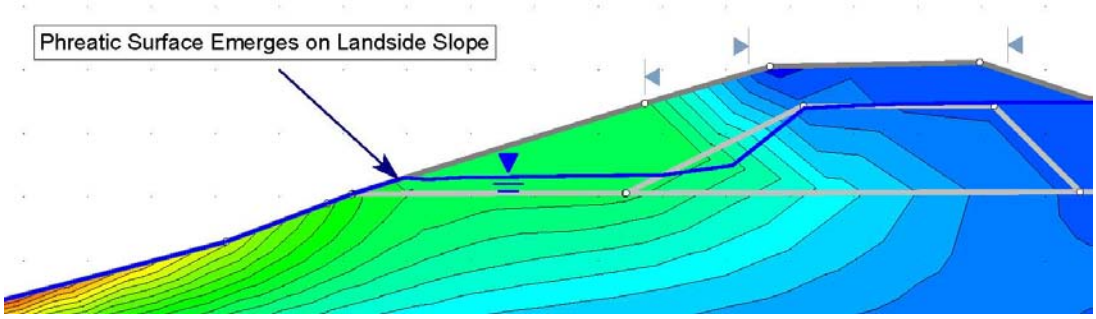
Both horizontal (k_h) and vertical permeability (k_v) values are required for modeling in SLIDE. Permeability values are assigned by inputting the saturated permeability in the horizontal direction and inputting the vertical to horizontal permeability ratio (k_v/k_h). Estimated k_v/k_h ratios and additional material properties are presented with the results of our seepage and stability analyses in Appendix E.

In addition, curves representing the variation of permeability (unsaturated permeability) versus matric suction were estimated for our seepage analyses. Without direct measurements of unsaturated permeability, the curve estimates were based on data available for similar soils.

As input to our slope stability analyses and in accordance with EM 1110-2-1913 (USACE, 2000a), seepage analyses were performed for both existing conditions (in lieu of the 'End of Construction' case), and steady-state seepage during a full flood event. It should be noted that the effects of relief wells were not included in our seepage analyses.

As noted above, creek water surfaces for existing and flood-stage conditions were modeled to represent the median annual and 100-yr water surface elevations, respectively, as defined by Northern Hydrology & Engineering (NHE, 2010a). Groundwater elevations were estimated on the basis of data collected during our field exploration.

The potential for through-seepage was estimated at each section by reviewing the seepage analyses output to determine if the phreatic surface emerges on the landside slope during the design flood event. As noted in USACE (2000), seepage exiting on the landside slope could potentially decrease the stability of the slope as a result of sloughing or internal erosion of the slope. An example of output illustrating through-seepage is presented below.



8.2.1 USACE Acceptable Seepage Criteria

Acceptance criteria have been established by the USACE to reduce the potential impacts of levee underseepage (USACE, 2005; USACE, 2000a). Those criteria specify that underseepage beneath an existing levee is acceptable if the exit gradient is 0.5 or less, which

would provide a factor of safety against seepage-related failures of at least about 1.6 (USACE, 2005).

8.2.2 Steady-State Seepage

For the full flood steady-state seepage analyses, the landside extent of our models was defined by the lesser of the perpendicular horizontal distance to the valley basin limits (bedrock slope) and a distance of 2,000 feet from the creek centerline.

To simulate the general hydrogeologic conditions we anticipate during a flood event, a no-flow condition was assigned as the landside boundary condition if the landside model extent was defined by the valley basin limits (i.e. relatively impermeable bedrock). Alternatively, the phreatic surface was modeled at the ground surface if the landside model extent was defined by a distance of 2,000 feet from the creek centerline.

8.2.3 Transient Seepage

Based on the results of our steady-state analyses, we identified cross sections likely to develop through-seepage, or underseepage at the landside toe with exit gradients in excess of 0.5 and corresponding factors of safety that do not comply with USACE performance criteria. Steady-state evaluations assume that base flood elevations are maintained for a sufficient time to allow steady-state seepage flow conditions to develop through and beneath the levee system. Our evaluations of exit gradients under steady-state conditions were estimated to range up to 2.7, which significantly exceeds the allowable exit gradient of 0.5, per ETL 110-2-569 (USACE, 2005).

It is our opinion that steady-state conditions are generally not representative of the anticipated base flood conditions at Redwood Creek. Redwood Creek is about 67 miles long and drains a watershed encompassing about 285 square miles. It is, thus, a relatively small drainage basin that, in our discussions with NHE (the County's project hydrologist), is relatively responsive to storm events. Accordingly, it is our understanding that the water elevations within Redwood Creek rise and fall relatively rapidly during and following storm events and do not have sustained peak crests as observed along rivers such as the Sacramento, Mississippi, and Missouri rivers. With responsive drainages such as Redwood Creek, water elevations typically are not elevated for durations sufficient to establish steady-state seepage flow through the embankment and foundation materials. Thus, steady-state evaluations of seepage flow paths and exit gradients may represent improbable, excessively conservative geotechnical conditions.

In an effort to model the development of seepage forces and phreatic surfaces during a full flood event that is representative of the Redwood Creek drainage, we conducted transient seepage and stability analyses of the select cross sections likely to develop through-seepage or sections with estimated exit gradients in excess of 0.5 under steady-state conditions. Because steady-state conditions represent a worst-case scenario, those cross sections unlikely to develop through-seepage *and* with estimated exit gradients below 0.5 were not evaluated in our transient analyses, having already satisfied performance criteria. The purpose of our transient analyses was to estimate if the conditions evaluated in our steady-state analyses are likely to develop during the projected duration of a 100-yr flood event.

Input parameters applied to the transient seepage models were identical to those applied to the steady-state models, with the exception of the initial boundary conditions. For the

transient seepage analyses, initial boundary conditions included water surface elevations corresponding to an assumed base flow of 5,000 cubic feet per second (cfs), and groundwater levels estimated on the basis of data collected during our field exploration efforts. In addition, volumetric water content values were estimated on the basis of laboratory results and assigned to subsurface materials to model the initial pore pressure conditions. Volumetric water content estimates are presented in Appendix D.

To model the changes in creek water surface elevations during the 100-year storm event, we applied the hydrograph data defined by NHE (NHE, 2011b). Along the project extent, the estimated duration of flow above the base flow (5,000 cfs) during the 100-year flood event is approximately 8 days. Following limited sensitivity analyses, the transient seepage analyses were conducted with the following time stages:

Table 8-2. Time Stages of Transient Analyses

Transient Analysis Stage (hours)	Redwood Creek Water Surface Elevation Trend
0	Rising
12	Rising
24	Rising
36	Rising
45.5	Maximum
48	Falling
60	Falling
72	Falling
84	Falling
96	Falling
108	Falling
120	Falling
132	Falling
144	Falling
156	Falling
168	Falling
180	Falling
192	Falling

8.2.4 Results

The results of our seepage analyses for the 10 cross sections are summarized below, and presented graphically in Appendix E. The results are discussed in section 9.4.

Table 8-3. Summary of Results for Seepage Analyses

Section	Potential for Through-Seepage		Steady-State		Transient	
	Steady-State	Transient	Exit Gradient at Landside Toe	Factor of Safety	Exit Gradient at Landside Toe	Factor of Safety
57+00 Left	Yes*	No	0.3**	2.54	< 0.1***	> 7.62
57+00 Right	No	--	0.2	3.81	--	--
73+00 Left	No	No	0.6	1.27	0.2	3.81
73+00 Right	Yes*	No	0.3**	2.54	< 0.1***	> 7.62
87+00 Left	No	--	0.1	7.62	--	--
87+00 Right	Yes*	No	1.2	0.63	0.6	1.27
98+00 Left	No	No	0.3**	2.54	0.2	3.81
98+00 Right	No	No	0.8	0.95	< 0.1***	> 7.62
114+00 Left	Yes*	No	0.4**	1.90	< 0.1***	> 7.62
114+00 Right	Yes*	No	2.7	0.28	0.7	1.08
132+00 Left	No	--	0.5	1.52	--	--
132+00 Right	Yes*	No	1.2	0.63	< 0.1***	> 7.62
146+00 Left	Yes*	No	0.3**	2.54	0.3	2.54
146+00 Right	Yes*	No	0.5	1.52	0.4	1.90
158+00 Left	No	No	0.7	1.08	0.4	1.90
158+00 Right	Yes*	No	0.4**	1.90	0.3	2.54
171+00 Left	Yes*	No	0.3**	2.54	0.2	3.81
185+00 Left	Yes*	No	0.4**	1.90	0.2	3.81

* If column response is "yes", this indicates that the phreatic surface is estimated to encounter the landside levee slope face above the adjacent natural ground surface under the conditions evaluated. If the response is "No", then it is estimated that the phreatic surface will not daylight on the landside levee face.

** Transient analyses were performed on sections with estimated exit gradient gradients less than 0.5 if the section was likely to develop through-seepage or the estimated FS for Case III (refer to Section 8.3.1) was less than 1.4.

*** Phreatic surface does not infiltrate impervious foundation stratum in transient analysis; therefore, underseepage forces at the landside toe are anticipated to be minimal.

8.3 SLOPE STABILITY

Slope stability analyses were performed for the ten cross sections along Redwood Creek. The analyses were performed using the numerical modeling program SLIDE

(Rocscience, 2010). Stability analyses were computed by SLIDE using the Spencer method (Spencer, 1967) and the GLE/Morgenstern and Price method (Fredlund and Krahn, 1977; Morgenstern and Price, 1965). These methods are briefly described below.

Spencer Method. The Spencer Method assumes that the normal forces are located at the center of the base of each slice and that all side forces are parallel. The result is an equation that satisfies complete moment and force equilibrium. Although the Spencer Method was directly applicable to a circular shear surface, the procedure may be readily extended to slip surfaces of a general shape.

Because of the complexity of the procedure, the Spencer Method is suitable only for computer-aided slope stability analyses. Although the Spencer Method typically yields a relatively accurate estimate of the factor of safety for a slope, its solution requires several iterations.

GLE/Morgenstern and Price's Method. GLE/Morgenstern and Price's Method as originally formulated took a somewhat different approach to the solution of complete slice equilibrium. While Spencer considered overall moment equilibrium, Morgenstern and Price have considered only the moment equations of individual slices. Each method satisfies all conditions of equilibrium but Spencer's Method requires about half the computation time. When static equilibrium is satisfied, there is little practical difference among Spencer's and Morgenstern and Price's procedures.

8.3.1 USACE Acceptable Slope Stability Criteria

The USACE has established minimum factor of safety (FS) thresholds for levee slope stability conditions (USACE, 2000a). The FS against slope failure is estimated by calculating the forces resisting slope failure divided by the forces causing slope failure. Thus, a FS > 1 implies a stable slope, a FS < 1 implies a slope that is failing, and a FS = 1 implies a slope that is on the verge of failure.

The conditions for analysis specified by the USACE consist of four slope stability cases:

- Case I - End of Construction;
- Case II - Sudden Drawdown;
- Case III - Steady Seepage from Full Flood Stage; and
- Case IV - Earthquake.

Under Case I, soils are modeled to simulate engineered embankment conditions that would be present at the time when levee construction is just completed. Under this scenario, fine-grained soils (impervious embankment and foundation soils) are modeled in an undrained condition, whereas, granular soils (pervious soils) are modeled in a drained condition. Slope stability analyses for this case are performed for both the landside and waterside slopes. Case I is typically not performed for existing levees.

Case II represents the scenario where a prolonged flood stage saturates the major portion of the waterside face of the levee and then recedes faster than the soil can drain (rapid drawdown). Slope stability analyses for this case are performed on the waterside slopes.

Conditions for **Case III** occur when a prolonged flood stage allows steady state seepage flow to occur through the levee. Under this scenario, the landslide slope stability is evaluated.

Case IV includes the effects of earthquake forces on the stability of a levee slope.

The USACE (2000) has established minimum FS values for each levee slope stability case evaluated. Those allowable minimum FS values, presented in Table 8-4 below, were referenced in our interpretation of slope stability analyses discussed herein.

Table 8-4 - Minimum Acceptable Factor of Safety Values

Case	Minimum Factor of Safety
Case I - End of Construction	1.30
Case II - Rapid Drawdown	1.00 to 1.20[1]
Case III - Steady State Seepage	1.40
Case IV - Earthquake Loading	1.01

[1] FS of 1.0 applies to pool levels prior to drawdown for conditions where these water levels are unlikely to persist for long periods preceding drawdown. FS of 1.2 applies to pool levels likely to persist prior to drawdown.

8.3.2 Methodology

As input to the stability analyses, parameters including soil unit weight, and drained and undrained shear strength parameters were estimated based on laboratory test results, CPT correlations, and review of design documents. As noted above, consolidated drained direct shear and consolidated, undrained triaxial strength testing was performed on relatively undisturbed samples collected during our field exploration program. The results of our direct shear and triaxial testing are presented in Appendix C. Correlations relating CPT tip resistance to friction angle were also reviewed in our estimation of drained shear strength parameters. Friction angle estimates based on CPT data are presented on the CPT logs in Appendix B.

Geotechnical design values for levee fill and foundation materials were also included in the *General Design Memorandum* (USACE, 1966) and *Survey Report for Flood Control and Allied Purposes [Appendices]* (USACE, 1961). Listed values include dry unit weights, moist weights, saturated weights, buoyed weights, shear strength parameters and permeability. These values are presented in Appendix A.

For our stability analyses of existing conditions, pseudo-static conditions, and landside slope conditions during a full flood event, drained shear strength parameters were assigned to the subsurface materials. The results of direct shear and triaxial testing conducted by the USACE (1966, 1965a, and 1965b) are presented with our drained strength estimates presented on Plates D-43 through D-46.

For our stability analyses of rapid drawdown, we conducted three-stage computations for the impervious levee fill and foundation material. Input to the three-stage computations included both drained and undrained shear strength parameters, which were estimated according to the methods outlined in Appendix G of EM 1110-2-1902 (USACE, 2003) for rapid drawdown analyses. The results of triaxial testing conducted by Fugro and USACE (1965a) are presented with our estimate of the consolidated undrained shear strength [CU(R)] envelope presented on Plate D-47.

Phreatic surfaces and pore pressures modeled in our stability analyses of full flood and rapid drawdown conditions were based on the results of our steady-state seepage analyses. Based on the results of our stability analyses of steady-state full flood conditions, we identified cross sections with estimated factors of safety that do not meet or exceed the minimum FS of 1.4 defined for long-term (steady-state seepage) flood conditions in USACE (2000a).

In an effort to model the development of phreatic surfaces and pore pressures during a full flood event, we conducted transient seepage and stability analyses of the select cross sections discussed in the preceding paragraph. The purpose of our transient analyses was to estimate if the conditions evaluated in our steady-state analyses are likely to develop during the projected duration of a 100-yr flood event.

For post-earthquake stability analyses of slopes with soils considered to be potentially liquefiable during the design seismic event, undrained residual strength parameters were estimated for potentially liquefiable strata in accordance with the empirical correlations proposed by Seed and Harder (1990), and Idriss and Boulanger (2007); undrained strength estimates are presented on Plates D-2 through D-38, and on Plates D-39 and D-40. Our evaluation of potentially liquefiable strata is discussed in Section 8.1.

If the post-earthquake FS was estimated to be between 1.2 and 1.0, we performed a seismic deformation analysis to estimate the levee's performance during the design seismic event. Slopes with estimated factors of safety less than 1.0 in our post-earthquake stability analyses are considered unstable under static conditions and generally susceptible to flow failure following the design seismic event. Large displacements are typically associated with flow failure of slopes, and a seismic deformation analysis method is not suitable for estimation of static flow failure deformation.

8.3.3 Results

The results of our slope stability analyses for the ten cross sections are summarized below, and presented graphically in Appendix E.

Table 8-5. Summary of Slope Stability Analyses Results

Section	Levee Slope	Factor of Safety For Each Case Evaluated					
		Existing Conditions (USACE min. 1.3)	Pseudostatic (USACE min. undefined)	Seepage During a Full Flood Event (USACE min. 1.4)		Rapid Drawdown (USACE min. 1.0)	Post-Earthquake (USACE min. undefined)
				Steady-State	Transient		
57+00 Left	Landside	1.76	1.04	1.15	1.81	--	1.75
	Waterside	2.19	1.20	----------		2.19	1.91
57+00 Right	Landside	3.56	1.64	2.25	--	--	3.56
	Waterside	2.10	1.06	----------		1.10	0.54
73+00 Left	Landside	1.83	1.11	1.55	1.83	--	1.83
	Waterside	2.10	1.08	----------		1.07	1.85
73+00 Right	Landside	2.30	1.30	1.37	2.30	--	2.27
	Waterside	1.90	1.05	----------		0.86	1.1
87+00 Left	Landside	2.18	1.26	1.64	--	--	**
	Waterside	1.91	1.09	----------		0.99	**
87+00 Right	Landside	2.69	1.44	1.75	2.69	--	**
	Waterside	2.15	1.25	----------		1.28	**
98+00 Left	Landside	1.38	0.97	1.07	1.38	--	1.38
	Waterside	1.80	1.12	----------		0.90	1.65
98+00 Right	Landside	2.72	1.46	2.59	2.68	--	2.72
	Waterside	1.79	1.06	----------		0.86	1.32
114+00 Left	Landside	2.05	1.22	1.29	2.05	--	2.05
	Waterside	2.00	1.19	----------		1.18	2.00
114+00 Right	Landside	1.86	1.08	0.40	1.75	--	0.69
	Waterside	2.21	1.10	----------		1.10	0.47

Table 8-5. Summary of Slope Stability Analyses Results (Continued)

Section	Levee Slope	Factor of Safety For Each Case Evaluated					
		Existing Conditions (USACE min. 1.3)	Pseudostatic (USACE min. undefined)	Seepage During a Full Flood Event (USACE min. 1.4)		Rapid Drawdown (USACE min. 1.0)	Post-Earthquake (USACE min. undefined)
				Steady-State	Transient		
132+00 Left	Landside	2.22	1.28	1.42	--	--	2.15
	Waterside	2.09	1.14	----------		1.22	1.09
132+00 Right	Landside	1.54	1.07	0.88	1.73	--	**
	Waterside	2.47	1.31	----------		1.34	**
146+00 Left	Landside	1.96	1.18	1.43	1.96	--	1.87
	Waterside	2.64	1.31	----------		1.23	1.22
146+00 Right	Landside	1.52	1.00	1.12	1.57	--	1.42
	Waterside	1.85	1.06	----------		0.91	0.91
158+00 Left	Landside	2.50	1.38	1.80	2.46	--	2.28
	Waterside	1.98	1.07	----------		1.00	0.93
158+00 Right	Landside	1.35	0.88	1.14	1.46	--	1.36
	Waterside	2.02	1.15	----------		1.14	1.76
171+00 Left	Landside	1.98	1.17	1.66	2.20	--	1.97
	Waterside	2.01	1.15	----------		1.18	1.47
185+00 Left	Landside	1.87	1.22	1.48	2.07	--	2.00
	Waterside	2.10	1.08	----------		1.01	1.42

** Soils are not considered to be potentially liquefiable during the design seismic event, or potentially liquefiable strata are localized and unlikely to affect the strength of materials along estimated failure planes.

8.4 SEISMIC DEFORMATION

In accordance with EC 1110-2-6067 (USACE, 2010a), we performed deformation analyses for levee cross sections with factors of safety between 1.2 and 1.0 estimated in our post-earthquake stability analyses, which are discussed in sections 8.3 and 9.5 of this report. Slopes with factors of safety less than 1.0 are considered unstable under static conditions and generally susceptible to flow failure following the design seismic event. Therefore, a seismic deformation analysis method is not suitable for estimation of flow failure deformation.

The analyses were performed according to procedures presented in Bray and Travasarou (2007) to evaluate seismic displacement potential, and estimate displacements corresponding to specified probabilities. The seismic displacement model requires the following input parameters (see Equations 5 and 6 in Bray and Travasarou, 2007):

- T_s = initial fundamental period of the sliding mass in seconds
- $S_a(1.5T_s)$ = spectral acceleration of the input ground motion at a period of 1.5Ts

- MW = moment magnitude of design earthquake event
- k_y = yield coefficient (defined as the seismic coefficient corresponding to an estimated FS equal to 1.0 in a pseudostatic stability analysis.)

In order to estimate a yield coefficient and initial fundamental period of each sliding mass for input to our seismic deformation analyses, pseudo-static stability analyses were performed with post-earthquake undrained residual strengths assigned to potentially liquefiable strata.

Following the procedure proposed by Marcuson et al. (1983), a seismic coefficient (k) equal to half of the PHGA (approximately 0.1g) was initially applied in pseudo-static analyses. If the corresponding FS was estimated to be less than 1.0, the seismic coefficient was iteratively decreased until a yield coefficient was determined.

As noted above, we applied spectral accelerations estimated to have approximately 0.7 percent annual chance of exceedance (Statistical Return Period ≈ 134 years). Additionally, a moment magnitude of 9.0 (greatest of the deaggregated modal and mean magnitudes for the spectral periods evaluated) was applied in all of the seismic deformation analyses.

8.4.1 Results

In the absence of a displacement threshold defined by the USACE, the results of our analyses are presented in terms of the median displacement estimate (i.e. the displacement with a 50 percent probability of exceedance). The results of the analyses are tabulated below and the calculations are presented in Appendix D as Plates D-49.

Table 8-6. Summary of Results for Seismic Deformation Analyses

Representative Cross Section	Slope Location	Yield Coefficient	Approximate Estimated Median Displacement (i.e. displacement with a 50% probability of exceedance)	
			Centimeters	Feet
73+00 Right	Waterside	0.022	91.1	3.0
132+00 Left	Waterside	0.025	114.3	3.8
146+00 Left	Waterside	0.035	81.2	2.7

8.5 SETTLEMENT

In addition to liquefaction-induced settlement analyses, as discussed above, a qualitative evaluation of static settlement was also performed. The potential for static settlement can arise through several cases, including consolidation of underlying soils due to fill or structural loads at the ground surface; subsidence due to removal of groundwater or other subsurface fluids, such as petroleum; and hydroconsolidation due to saturation of collapsible soils.

Due to the age of the levees (on the order of 42 years for most of the project site), it is very likely that all of the consolidation of underlying soils has already taken place in response to the weight of the levee fill material. Additional settlements are possible if fill or structural loads are placed on or in close proximity to the levees.

The project site is not in an area where the withdrawal of groundwater or other subsurface fluids is known to have caused subsidence. There is a potential for settlement to occur under the levees if sufficient lowering of the groundwater table were to occur in close proximity to the project site. Two scenarios that could induce such settlement are construction dewatering and large-scale pumping of groundwater for industrial, agricultural, or municipal purposes.

Hydroconsolidation, or hydrocollapse, is a phenomenon associated with soils that are prone to relatively rapid settling when subjected to wetting or saturation. Near-surface deposits of dry, porous soils where the particles are cemented with soluble salts are particularly vulnerable to hydrocollapse. The results of our subsurface exploration and laboratory testing did not indicate the presence of such soils within or below the levees.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 GENERAL

The purpose of our investigation was to explore subsurface conditions at the project site to aid the County in evaluating the ability of the Redwood Creek levee system within the project extent to function in accordance with current FEMA/USACE performance criteria. To achieve this objective, CGI/Fugro performed subsurface exploration, laboratory testing, and engineering analyses in accordance with the standards of FEMA (2008), and USACE (2010a, 2008, 2005, 2003, and 2000a).

The following paragraphs summarize the analyses that were performed to assess the geotechnical aspects of the levee system and include brief summaries of our findings. It should be noted that our analyses addressed the geotechnical aspects of flood control protection for the 100-year recurrence interval (or 1% annual chance exceedance) flood event within the project extent at Redwood Creek. Our evaluation did not address the hydrologic, hydraulic, or any other aspects of flood protection for Redwood Creek.

Liquefaction and Seismic Settlement Potential. Based on our analysis, there is a potential for liquefaction and seismically induced dry settlement of the pervious foundation material during the design seismic event. The maximum estimated liquefaction and seismically induced dry settlements are approximately 6-1/2 inches and 1 inch, respectively. For post-earthquake stability analyses, undrained residual strength parameters were estimated for potentially liquefiable strata in accordance with published empirical correlations.

Permeability and Seepage. For our initial evaluation, the potential for underseepage and through-seepage was evaluated for steady-state flood stage conditions. Following identification of sections considered to be deficient under steady-state conditions, we conducted transient seepage analyses to determine if the seepage forces and phreatic surfaces estimated by our steady-state analysis are likely to develop during the 100-year flood event. Based on our analyses, only two sections do not meet performance criteria: the estimated vertical exit gradients at the landside toe of the right levee at about Station No. 87+00 and the right levee at about Station No. 114+00 are 0.6 and 0.7, respectively, which exceed the USACE minimum allowable exit gradient of 0.5. However, as discussed below, the synthetic hydrograph applied to our analyses may be considered conservative.

Slope Stability. Our slope stability analyses indicated that the slopes evaluated are generally stable for each of the conditions discussed in section 8.3.1, with the exception of the post-earthquake condition. Based on our post-earthquake stability analyses, five of the slopes evaluated were estimated to have a FS less than 1.0. In addition, three of the slopes evaluated were estimated to have a FS between 1.2 and 1.0. The anticipated instability of these slopes is primarily attributable to the undrained residual strengths applied to our models.

Seismic Deformation. Displacements ranging between 2.7 and 3.8 feet were estimated for the three waterside levee slopes identified by our post-earthquake stability analysis to have an estimated FS between 1.2 and 1.0. Slopes with estimated factors of safety less than 1.0 in our post-earthquake stability analyses are considered unstable under static conditions and generally susceptible to flow failure following the design seismic event. Large displacements are typically associated with flow failure of slopes.

Settlement. Based on our qualitative evaluation, the potential for static settlement to impact the levees is considered to be minimal under most present conditions. However, the potential for settlement due to gravel stockpiles located on the levee crest is discussed below.

9.1.1 Summary of Findings and Recommendations

On the basis of field observations, subsurface exploration, laboratory testing and engineering analyses performed for this investigation, it is our opinion that the Redwood Creek levee system, within the limits of the project extent as defined in the scope of work, is generally capable of providing flood control protection to adjacent improvements during static, stable conditions.

However, based on our evaluation, the ability of the levee to provide flood protection will likely be compromised during and/or following a seismic event equal to or greater than the design seismic event discussed in Section 6.0 of this report. Specifically, the loss of soil strength due to liquefaction of very loose to medium dense granular soils encountered at the site is likely to compromise the stability of up to eight of the levee slopes we evaluated.

Relative to performance standards, FEMA (2008) suggests that an embankment stability analysis should demonstrate that a levee system is stable under Case IV (earthquake) loading conditions, as defined by USACE (2000a). As previously noted, portions of the levee alignments have been evaluated to be susceptible to liquefaction and, therefore, are likely not stable under Case IV conditions. While this is a deficiency in the stability of the levee system, it should be noted that the likelihood of a large earthquake occurring at the same time as a large flow event in Redwood Creek is, in the opinion of CGI/Fugro and USACE (2000a), relatively low. A more likely scenario is that a large earthquake event will occur at a time when the levee system is not retaining peak flows and that there will be sufficient time for emergency repairs to be made to the levee prior to a peak flow occurring.

While a number of mitigation measures to reduce the potential for liquefaction are discussed in Section 9.3.1 of this report, each of those ground modification measures is expensive to implement. It is our opinion that an evaluation of the probability of both a large earthquake and peak flood event occurring at the same time and a cost-benefit analysis of mitigating liquefaction potential will indicate that implementing ground modification measures will not be justifiable. Such an analysis will likely indicate that establishment of an emergency response plan (ERP) be performed that can address assessment and response procedures for the levee following seismic events. The ERP should identify the potential for liquefaction and seismic hazards to impact the levee, and designate high hazard areas that should be inspected for damage following an earthquake. ERPs typically include elements addressing potential damage scenarios, storage locations for supplies and equipment associated with repair, and evacuation plans for any communities potentially affected by the hazard.

9.1.2 Opinion Regarding Geotechnical Aspects of Levee Certification

Based on the results of our study, the levee system was evaluated to be stable under static conditions for all conditions evaluated at the ten cross section locations, with the exception of two locations with marginally high vertical exit gradients. Additional transient analyses at those locations using data-generated hydrographs will likely reduce those exit gradients from the values reported herein. The only additional deficiencies identified during this

study occur under dynamic (earthquake) conditions. Those deficiencies should be addressed using ERPs outlining procedures to be implemented following a seismic event.

Based on the results of our evaluations, it is our opinion that geotechnical stability aspects of the levee system are likely certifiable under FEMA and USACE standards provided the ERPs are prepared and additional transient analyses are performed with results conforming to USACE thresholds.

9.2 OPERATION AND MAINTENANCE

During our site inspection and mapping efforts, we identified a number of potentially detrimental geotechnical conditions that are typically addressed by an operation and maintenance program. These site conditions are briefly discussed below.

9.2.1 Encroachment of Levee Landside Toe

At the time of our field studies, the northern (right) levee landside toe between approximately STA 30+00 to STA 40+00 had been excavated to accommodate an adjacent unpaved road. In our opinion, that nearly vertical toe, measuring approximately 1 to 2 feet in height, could have destabilized the slope. We recommend the slope be restored to the original 2.5h:1v inclination specified in USACE (1966). We understand that during January and May, 2011, the County (Humboldt County, 2011) restored the landside slope toe to the original 2.5h:1v inclination specified in USACE (1966) and corrected the slope modification, thus, mitigating the potentially destabilizing condition.

9.2.2 Vegetation on Levee Embankment and within 15 Feet of Levee Toes

According to USACE (2000b), landscape within 15 of the levee should be free of vegetation. Based on our observations, there is generally dense vegetation on segments of the levee slopes and within 15 feet of both the landside and waterside levee toes along the entire project extent.

Vegetation on the waterside slopes of the levee generally consists of seasonal grasses, berry vines, and other low shrubs. Trees and shrubs were observed in narrow bands at the lower approximate 5 feet of the waterside levee slope face. We understand that the presence of these trees is the result of the County's inability to remove them due to restrictions placed on such activities by outside regulatory agencies.

Similarly, seasonal grasses, berry vines, and low shrubs were observed along the landside levee face; however, relatively large trees have been established along the left landside levee face between Station Nos. 115+00 and 125+00, and on the right landside levee face between Station Nos. 122+00 and 127+00, and at about Station No. 150+00. Relatively dense vegetation and trees are also present within 15 feet of the landside levee toe along much of the levee extent.

According to the USACE, vegetation in these areas has the potential to compromise the functionality of the levee and limit access for operations and maintenance (USACE, 2009a and 2009b). The County has made considerable effort to control vegetation along the waterside levee slopes and toes but it is constrained on vegetative removal due to regulatory restrictions and limitations, especially along the waterside portions of the levee system. In our opinion, based on observations at the site, the waterside vegetation, while not desirable according to the

USACE, might not be an adverse condition to the stability of the levee system. The vegetation could induce more turbulent water and cause some mounding effect during high flows; however, it also appears to have helped anchor foundation soils along the waterside levee toes and helps stabilize channel banks, thus reducing erosion within these areas.

While the vegetation treatments should attempt to address recommendations presented in the most recent inspection reports (USACE, 2009a and 2009b), it is a much more complex issue that we understand is currently under consideration and development at the national and state level (personal communication with Humboldt County). Until updated guidelines are developed, we recommend that the County continue efforts to reduce vegetation along the waterside and landside levee faces and toes. We also recommend that trees on the landside levee face be removed because they can form seepage conduits through the embankment materials and potentially compromise the levee at those locations. Root balls from those trees should also be removed and the resulting void should be backfilled with impermeable engineered fill materials placed in a manner that meets USACE standards.

9.2.3 Erosion and Erosional Impact of Culverts

In general, we did not observe signs of significant erosion occurring along the levee system, with the exception of erosion occurring at specific culvert discharge locations. We observed culverts daylighting at about mid-slope or higher near Station Nos. 142+00, 160+00, 166+00, and 170+00. Erosion observed at waterside culvert discharge locations appears to have been the result of water discharge from the culverts and not scour from elevated flows within Redwood Creek. In our opinion, heavy discharge from the culverts may potentially erode and impact the stability of the slope. Though we did not observe evidence of active erosion at the time of our site inspection and mapping efforts, we recommend an assessment of the slope protection adequacy below the culverts. Additionally, slopes below the culverts should be inspected for any evidence of erosion following major discharge episodes.

9.2.4 Rutting

We noted scattered depressions/ruts measuring approximately 1 foot or less in depth on the levee crest along the entire project. In addition, scattered depressions/ruts measuring approximately 1 foot or less in depth were observed on the unpaved road adjacent to the landside toe approximately between Station Nos. 25+00 and 45+00. In our opinion, water may pond in the depressions/ruts and adversely impact the levee stability. We recommend filling the voids with well-compacted impervious material to facilitate proper drainage.

9.2.5 Rip-rap Slope Protection

Historical occurrences of slumping and subsequent repair of the left levee waterside slope near approximately Station No. 19+00 and Station No. 25+00 are noted in the most recent Inspection report (USACE, 2009b) and the 2009 Levee Operation & Maintenance Annual Report (County of Humboldt), respectively. Moreover, removal of rip-rap stones is noted in the 2008 Inspection report (USACE, 2008a), and fracture/fragmentation of rip-rap stones at the downstream end of the project is noted in the 2006 Inspection report (USACE). Though we did not observe evidence of slope protection deficiencies at the time of our site inspection and mapping efforts, we recommend regular inspection of the slope protection, especially following high-flow events.

9.2.6 Gravel stockpiles

We understand the gravel stockpiles observed between about Station Nos. 86+00 and 89+00 and approximately between about Station Nos. 138+00 and 144+00 have been placed by the County of Humboldt as part of the County's gravel extraction efforts. We understand the County requires storage sites in close proximity to Redwood Creek in order to effectively remove aggregated sediment and improve the hydraulic capacity of the creek channel (Humboldt County, 2011).

In our opinion, the additional surcharge of the stockpiles will likely cause some settlement of the levee and foundation material, and increase the potential for instability of the levee slopes. Although the impact of increased settlement and instability may be minimal relative to the impact of improved channel capacity, we recommend the County consider removing stockpiles whenever possible in accordance with the recommendations presented in the most recent inspection report (USACE, 2009b).

9.3 LIQUEFACTION AND SEISMICALLY INDUCED DRY SETTLEMENT

There is a likely potential for liquefaction and seismically induced dry settlement of the pervious foundation material at the project site during the design seismic event, as described in Section 8.1 of this report. The maximum estimated liquefaction and seismically induced dry settlement is approximately 6½ inches and 1 inch, respectively.

In our opinion, the need for any remedial action should be based on an assessment of risk posed to adjacent improvements. It should be noted that the probability of a high-water flood event and design seismic event occurring simultaneously is considered to be relatively low. If levee slopes settle during or after the design seismic event, water levels in the creek will likely be lower than the adjacent land, and the consequences of settlement may be relatively minimal. At a minimum, it is recommended that the levees be inspected for signs of settlement, cracking, or failure as soon as possible following an earthquake and repaired as soon as conditions will allow. Typical mitigation measures for liquefaction hazard and seismically induced dry settlement are detailed below.

9.3.1 Mitigation of Liquefaction and Seismically Induced Dry Settlement

Ground improvement consisting of deep compaction can be employed to mitigate the potential for liquefaction and dry seismic settlement of the pervious foundation material encountered at the site. It is our opinion that deep compaction by vibroflotation, vibro-replacement, compaction grouting, permeation grouting, or jet grouting are the most suitable methods for the site conditions. Advantages and disadvantages of each method relative to performance, entitlement, construction, maintenance, and estimated implementation costs are noted in Table 9-1 below.

Although existing relief wells may provide drainage and, thus, some measure of liquefaction mitigation, based on our observations and review of historical documents, the ability of relief wells to facilitate dissipation of earthquake-induced pore pressures is undocumented and very likely limited by obstructive debris and sediment.

Table 9-1. Mitigation Methods, Advantages and Disadvantages

Mitigation Method	Advantages	Disadvantages
Vibroflotation	Least expensive relative to other mitigation methods presented herein	Effectiveness may be limited by the clay content of potentially liquefiable materials within the project limits
Vibro-replacement	May provide additional mitigation by facilitating dissipation of both earthquake-induced pore pressures and seepage forces during high-flow events	Generally more expensive, but more effective than vibroflotation in fine-grained soils. Typically requires more space for equipment access than vibroflotation
Compaction grouting	Generally suitable for all soil types; for treatment of soils at sufficient depth, grouting may be performed at greater grid intervals than vibroflotation and vibro-replacement.	Generally more expensive and requires more space for equipment access than vibroflotation and vibro-replacement; chemical grout may not be compliant with environmental regulations
Permeation grouting	Generally suitable for all soil types; minimal space required for equipment access relative to other mitigation methods presented herein	Expensive relative to other mitigation methods presented herein; determination of treatment extent and effectiveness is typical challenge; chemical grout may not be compliant with environmental regulations
Deep Soil Mixing	Generally suitable for all soil types; strength of soil-cement mixture typically greater than strength of native, untreated soil	Assessing the appropriate treated soil to untreated soil ratio is a challenge, and the cost of treatment is high relative to the other options described herein

Vibroflotation consists of advancing a crane-suspended vibratory probe to the depth of the potentially liquefiable material by a combination of vibration and water or air jetting. Surrounding soil is densified in successive layers as the vibrating probe is extracted incrementally. This method is generally most effective in clean granular sands with less than about 5-percent clay fines, and has been used successfully up to depths of about 200 feet (Seed et al. 2003). Vibroflotation is typically performed in a grid pattern until the targeted area of the site has been suitably densified. Subsidence of the ground surface above the probe may be a consequence of vibroflotation, and would require backfill and compaction. Pre-drilling with an auger may be required to more easily penetrate dense or cohesive material that may be encountered.

In general, vibroflotation is the least expensive mitigation method described herein, and based on the results of our gradation testing, the fines content of the pervious foundation

material is generally 5-percent or less. However, it should be noted that the gradation of alluvial deposits is typically variable, and the effectiveness of vibroflotation may be limited if soils with higher fines content are encountered.

Vibro-replacement (stone columns) is similar in concept to vibroflotation, except that gravel or crushed stone is added to the ground to assist with the densification. Deep compaction with stone columns typically consists of advancing a vibratory probe similar to vibroflotation, except that the probe is hollow to allow aggregate to be placed at the base of the probe. As the probe is extracted, the resulting void is backfilled with compacted gravel to densify the surrounding granular soil layers. Some surface subsidence may occur, particularly in untreated areas along the perimeter of the deep compaction, however, subsidence in the treated area is somewhat offset by the addition of gravel or crushed stone to the subsurface.

In general, vibro-replacement with stone columns is slightly more expensive and requires more space for equipment access than vibroflotation. However, the presence of relatively permeable stone columns may provide additional mitigation by facilitating dissipation of both earthquake-induced pore pressures and seepage forces during high-flow events.

Compaction grouting typically consists of driving a steel casing to the depth of potentially liquefiable material and then injecting a low slump grout into the casing under pressure to form a bulb within the ground around the casing. The bulb is expanded to densify the ground around the casing; the casing is then extracted in stages and the grouting process is repeated. Compaction grouting is typically performed in a grid pattern until the targeted area of the site has been suitably densified. For treatment of soils at sufficient depth, higher grout pressures may be used, and grouting may be performed at greater grid intervals.

Compaction grouting is generally more expensive and requires more space for equipment access than vibroflotation and vibro-replacement. However, compaction grouting is generally suitable for all soil types.

Permeation grouting involves injection of a low-viscosity grouting agent into voids within the potentially liquefiable material. Grouted soil is improved by strengthened bonds between individual soil grains, and minimal void space. Typical grouting agents include particulate grouts and chemical grouts, which are generally lower viscosity and capable of penetrating fine-grained soils. The permeation potential of particulate grouts is generally limited in soils with greater than about 6- to 10-percent fines (Seed et al. 2003). Typically, grout injection pipes are installed in boreholes spaced in a grid pattern covering the targeted area of the site. Drawbacks of this method include the relatively high cost of treatment, and the uncertainty in determining the volume of treated soil. Additionally, testing the effectiveness of the treatment usually requires relatively expensive drill holes because the grout impedes penetration of relatively inexpensive CPTs.

Deep Soil Mixing is a technique whereby cementitious material is mixed with potentially liquefiable soils by a hollow stem auger and rotating paddles. This method is generally applicable to any type of inorganic soil, and has been used up to depths of about 200 feet. The cementitious material is pumped through the auger stem to the open auger tip and mixed with the surrounding soil as the borehole is advanced to the target depth. The resulting soil-cement columns are generally uniform in diameter, and typically spaced to maximize the ratio of treated to untreated soil volume.

In addition, the strength of the resulting soil-cement mixture is typically greater than the strength of the native, untreated soil. However, assessing the appropriate treatment ratio is a challenge, and the cost of treatment is high relative to the other options described herein (Seed et al. 2003).

9.4 PERMEABILITY AND SEEPAGE

The steady-state seepage analyses resulted in estimated vertical exit gradients ranging from 0.13 to 2.71 at the levee landside toe, for the conditions analyzed at each of the ten cross sections. According to USACE (2005), the minimum allowable FS for underseepage corresponds to a maximum exit gradient of 0.5.

Additionally, the steady-state seepage analyses indicated through-seepage could develop at 11 of the 18 slopes evaluated, which are identified in Table 8.3 of this report. As noted in section 8.2, the potential for through-seepage was estimated at each section by reviewing the seepage analyses output to determine if the phreatic surface emerges on the landside slope during the design flood event. Excessive seepage forces acting on the landward slope could potentially decrease the stability of the slope as a result of sloughing or internal erosion of the slope.

In an effort to model the development of seepage forces and phreatic surfaces during a full flood event that is representative of the Redwood Creek drainage, we conducted transient seepage and stability analyses of the select cross sections likely to develop through-seepage or sections with estimated exit gradients in excess of 0.5 under steady-state conditions. Because steady-state conditions represent a worse-case scenario, those cross sections unlikely to develop through seepage *and* with estimated exit gradients below 0.5 were not evaluated in our transient analyses because they already satisfy performance criteria. The purpose of our transient analyses was to estimate if the conditions evaluated in our steady-state analyses are likely to develop during the projected duration of a 100-yr flood event. The transient seepage analyses for those cross sections estimated vertical exit gradients ranging from less than 0.1 to 0.7 at the levee landside toe, and indicated through-seepage is unlikely to develop at any of the cross sections during the 100-year flood event.

Based on our transient seepage analyses, the estimated vertical exit gradients at the landside toe of the right levee at about Station No. 87+00 and the right levee at about Station No. 114+00 are 0.6 and 0.7, respectively, for the 100-year flood event.

Based on the Lidar data provided and our field exploration, the high exit gradient at the Station No. 114+00 right levee is likely attributable to the interior drainage ditch abutting the levee, and the relatively thin impermeable foundation stratum underlying the ditch. Existing relief wells #1 and #2 may provide drainage and, thus, some measure of seepage mitigation at this location. However, based on our observations and review of historical documents, the functionality of relief wells is undocumented and very likely limited by obstructive debris and sediment.

In our opinion, the high exit gradient at the Station No. 87+00 right levee is likely attributable to the relatively thin impermeable foundation estimated on the basis of our field exploration logs.

Although these two estimated exit gradients exceed the allowable exit gradient defined by ETL 110-2-569 (USACE, 2005), it should be noted that the synthetic hydrograph applied to our analyses modeled a flood event with a greater duration than the typical flood event for Redwood Creek (NHE, 2011a, 2011b and 2011c), and may be considered conservative as a result. Prior to developing any remedial actions to address underseepage at the deficient locations, we recommend additional engineering analyses to better evaluate the anticipated hydrologic conditions and refine the seepage model.

We note that existing relief wells scattered along the project extent are expected to provide some measure of seepage mitigation. However, to ensure relief wells are capable of mitigating seepage forces during a high-flow event, we recommend wells be inspected annually (preferably prior to the wet season), desanded, and pump tested every five years, in accordance with the operation and maintenance manual (USACE, 1969) and EM 1110-2-1914 (USACE, 1992).

According to the 2006 (USACE) inspection report, relief wells have been tested, although test data were not included with the report. As noted in EM 1110-2-1914 (USACE, 1992), pump test data should be documented for future reference.

9.5 SLOPE STABILITY

As discussed in Section 8.3 of this report, slope stability analyses were performed at each cross section for various conditions. The results are discussed relative to each condition below.

9.5.1 Existing

Our slope stability analyses of existing levee conditions estimated factors of safety ranging from approximately 1.4 to 3.6 and 1.8 to 2.6 for the landside and waterside slopes, respectively. Based on our review of historical information and observations during field exploration, we understand the levee slopes have not experienced past instability, which is consistent with our estimated factors of safety.

Although a minimum FS is not defined for existing levees in USACE (2000a), our estimated factors of safety for existing levee conditions meet or exceed the minimum end-of-construction FS for a new levee, defined as 1.3 (USACE, 2000a).

9.5.2 Pseudostatic

Our slope stability analyses of existing levee conditions subjected to pseudostatic (i.e. earthquake) loading estimated factors of safety ranging from approximately 0.9 to 1.6 and 1.0 to 1.3 for the landside and waterside slopes, respectively. A minimum FS is not defined for pseudostatic loading conditions in USACE (2000a).

Based on our analyses, the estimated failure surfaces of potentially unstable slopes are generally surficial. As noted in Section 7.0, the 12- to 24-inch thick layer of riprap slope protection was not included in our stability models. However, we anticipate the riprap would likely reduce the potential for slope instability during a seismic event.

Based on our review of historical information, we understand the levee slopes have not experienced instability during a seismic event. However, according to limited historical

seismicity data, the levee system has not been subjected to a horizontal ground acceleration greater than or equal to 0.2g, which corresponds to the estimated design seismic event with an approximately 1 percent annual chance of exceedance (Statistical Return Period ≈ 100 years).

It should be noted that the probability of a high-water flood event and design seismic event occurring simultaneously is considered to be relatively low. If levee slopes failed during or after the design seismic event, water levels in the creek will likely be lower than the adjacent land, and the consequences of failure may be relatively minimal.

At a minimum, it is recommended that the levees be inspected for signs of instability or slope failure as soon as possible following an earthquake and, if necessary, repaired as soon as conditions will allow.

9.5.3 Full Flood Event

Our slope stability analyses of existing landside levee slopes, based on steady-state full flood conditions, estimated factors of safety ranging from approximately 0.4 to 2.6. A minimum FS of 1.4 is defined for long-term (steady-state seepage) flood conditions in USACE (2000a).

As noted in Section 8.3, we performed transient seepage and stability analyses of select sections that did not meet or exceed the minimum FS defined by USACE (2000a), based on our steady-state analyses. The purpose of our transient analyses was to estimate if the conditions evaluated in our steady-state analyses are likely to develop during the projected duration of a 100-year flood event. Our slope stability analyses of select landside levee slopes, based on transient full flood conditions, estimated factors of safety ranging from approximately 1.38 to 2.69.

Based on our review of historical information, we understand the landside levee slopes have not experienced instability during previous flood events. However, according to USACE (2010b), the USGS gauge located at the upstream end of the project extent has not recorded historical flows greater than or equal to the estimated design flood flow of 58,868 cubic feet per second (cfs).

On the basis of our analyses results, no remedial action is considered necessary at this time. However, it is recommended that the levees be inspected for signs of instability or slope failure during a flood event and, if necessary, repaired as soon as conditions will allow.

9.5.4 Rapid Drawdown

Our slope stability analyses of existing waterside levee slopes following a rapid drawdown of full flood water levels estimated factors of safety ranging from approximately 0.86 to 2.19. According to USACE (2000a), a minimum FS of 1.0 is defined for rapid drawdown conditions where water levels are unlikely to persist for long periods preceding drawdown.

Although the estimated factors of safety at seven of the analyzed cross section slopes are about 1.0 or less, we note that phreatic surfaces and pore pressures modeled in our analyses were based on the results of our steady-state seepage analyses. Based on our transient seepage analyses of select sections discussed above, we anticipate the phreatic surfaces and pore pressures estimated by our steady-state analyses are unlikely to develop during the estimated duration of a 100-year flood event.

Therefore, the potential for waterside slope failures due to rapid drawdown during the 100-year flood event is considered to be low. Following flood events, we recommend that the levees be inspected for signs of instability or slope failure and, if necessary, repaired as soon as conditions will allow.

9.5.5 Post-Earthquake

As noted in Section 8.3, we performed post-earthquake stability analyses for select levee cross sections with soils considered to be potentially liquefiable during the design seismic event. Our post-earthquake slope stability analyses of select levee sections estimated factors of safety ranging from approximately 0.69 to 3.56 and 0.47 to 2.00 for the landside and waterside slopes, respectively.

A minimum FS is not defined for post-earthquake conditions in USACE (2000a). However, USACE (2010a) states "if post-earthquake factors of safety are greater than 1.2, then no further evaluation is necessary." If the post-earthquake FS was estimated to be between 1.2 and 1.0, we performed a seismic deformation analysis to estimate the levee's performance during the design seismic event.

Based on our post-earthquake stability analyses, five of the slopes evaluated were estimated to have a FS less than 1.0. Slopes with estimated factors of safety less than 1.0 in our post-earthquake stability analyses are considered unstable under static conditions and generally susceptible to flow failure following the design seismic event. Large deformations are typically associated with flow failure of slopes.

Estimated factors of safety below 1.2 in our post-earthquake stability analyses are primarily attributable to the undrained residual strengths applied to our models, discussed in section 8.3. We note that although our methodology in estimating undrained residual strengths is consistent with the recommendation presented in USACE (2010a), the number of published empirical correlations is relatively limited and the current standard of practice is poorly defined. In addition, it should be noted that, to our knowledge, a specific guidance document for seismic stability analysis has yet to be published by the USACE.

The Redwood Creek levee is infrequently subjected to water loading. Therefore, the probability of a high-water flood event and design earthquake event occurring simultaneously is considered to be relatively low. If levee slopes failed during or after the design seismic event, water levels in the creek will likely be lower than the adjacent land, and the consequences of failure may be relatively minimal.

To minimize the potential for post-earthquake instability, flow failure deformations, and the general impacts of liquefaction, typical remedial actions are discussed in Section 9.3.1 of this report. At a minimum, it is recommended that the levees be inspected for signs of instability or slope failure as soon as possible following an earthquake and, if necessary, repaired as soon as conditions will allow.

9.6 SEISMIC DEFORMATION

As stated in Section 8.4 of this report, we performed deformation analyses for levee slopes with factors of safety between 1.2 and 1.0 estimated in our post-earthquake analyses.

As shown in Table 8.2, displacements ranging between 2.7 and 3.8 feet were estimated for the three waterside levee slopes evaluated.

Based on our review of historical information, we understand the levee slopes have not experienced instability or deformation following an earthquake event. Following a magnitude 6.5 earthquake on January 9, 2010, no indications of earthquake damage were observed by Humboldt County inspectors, and no reports of damage were received by the County (County of Humboldt, 2010). According to the USGS' Earthquake Hazards Program website, the 2010 earthquake's epicenter was located approximately 70 miles southwest of Orick. Additionally, the project site is estimated to have been subjected to a PHGA between 0.05g and 0.1g during the 2010 event (USGS).

To reduce the magnitude of seismically induced displacements and the general impacts of liquefaction, typical remedial actions are discussed in Section 9.3.1 of this report. At a minimum, we recommend the levees be inspected for signs of excessive deformation or failure as soon as possible following an earthquake and, if necessary, repaired as soon as conditions will allow.

9.7 STATIC SETTLEMENT

As discussed in Section 8.5, the potential for static settlement to impact the levees is considered to be minimal under the present conditions. Therefore, no remedial actions for the majority of the project extent are considered necessary at this time.

However, as noted in Section 9.2, to minimize the potential for static settlement of the levee and foundation material between about Station Nos. 86+00 and 89+00 and between about Station Nos. 138+00 and 144+00, we recommend the observed gravel stockpiles be removed in accordance with the recommendations presented in the most recent inspection report (USACE, 2009b).

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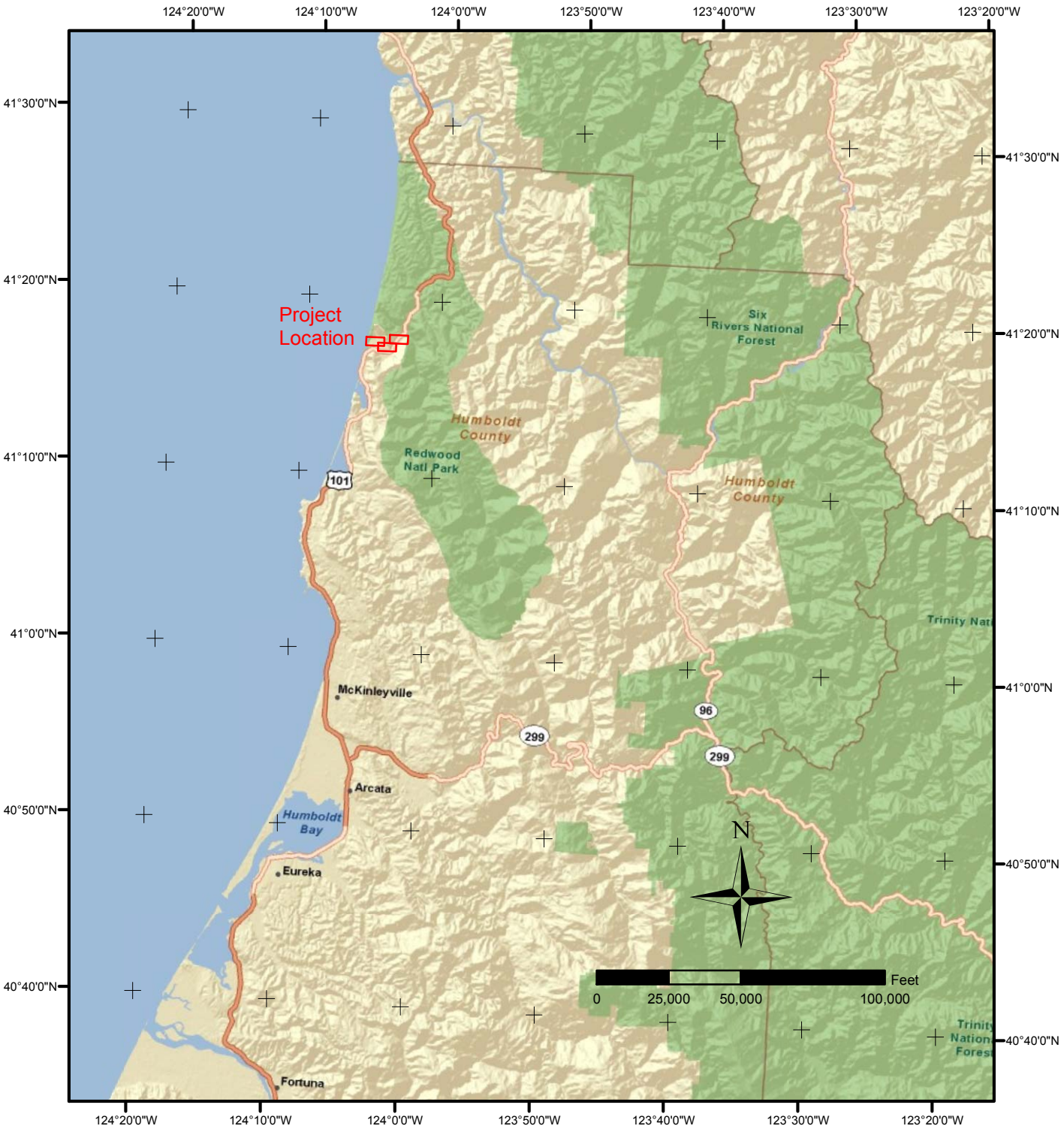
PLATES



VICINITY MAP
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 1-1

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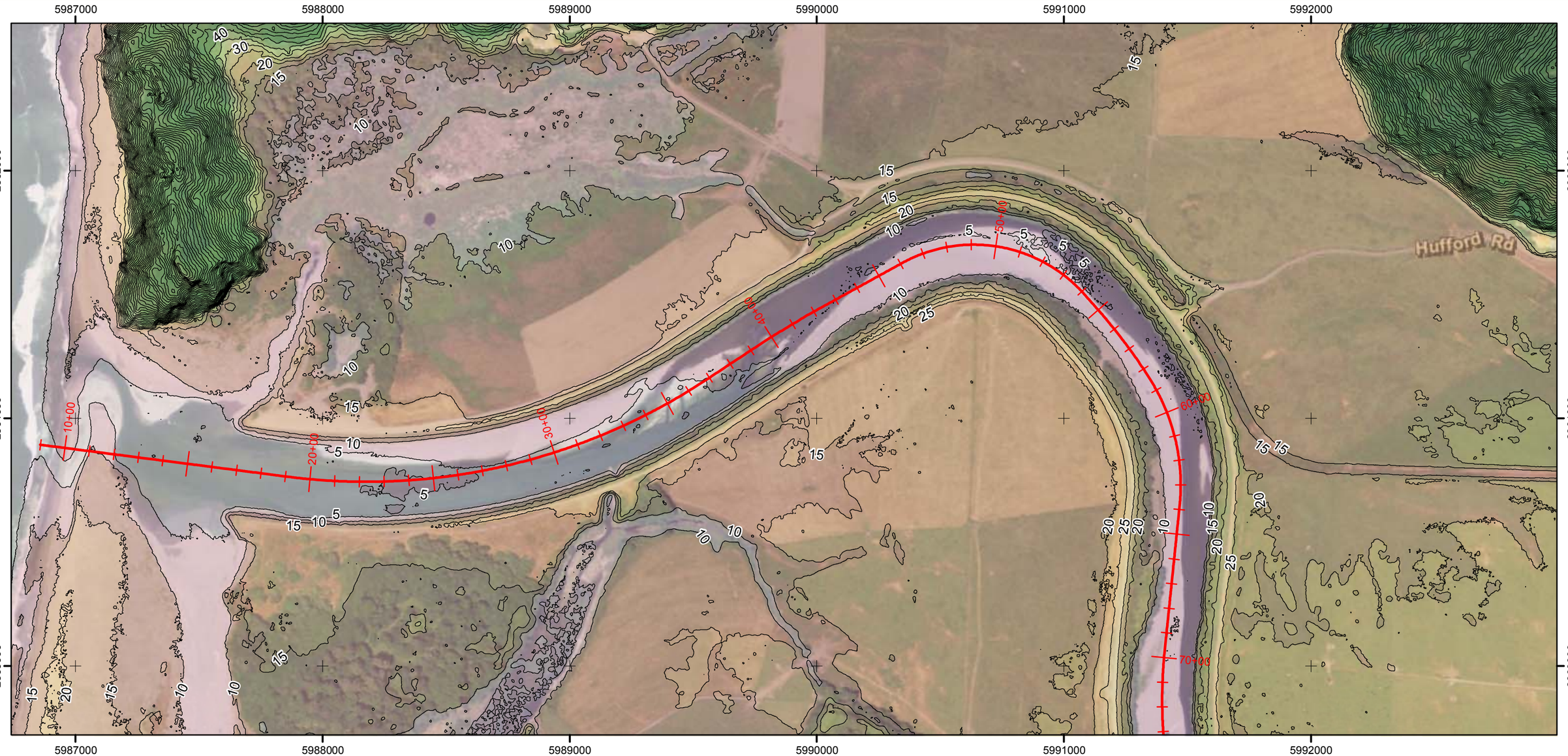
Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

FUGRO



Legend

Approximate River Centerline with Stations

LIDAR Contour, interval = 5 ft

Coordinate System: CA State Plane, Zone 1, NAD83, Feet

2007 LIDAR Topography, Feet (re. NAVD88)

- < 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- > 40

N

1:4,800

0 200 400 800 Feet

SITE MAP
Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 2-1a

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Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

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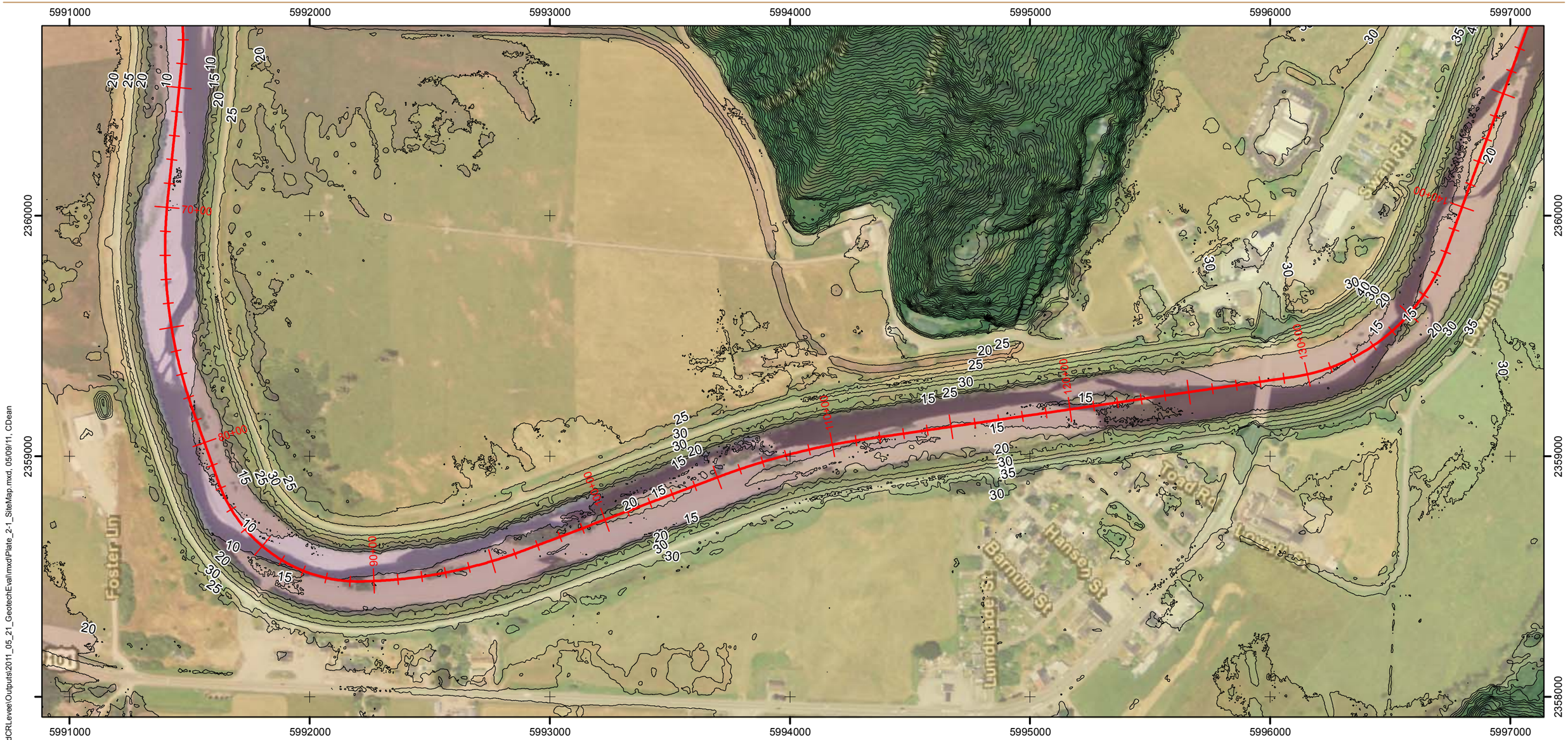

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Legend

2+00 4+00 — Approximate River Centerline with Stations

LIDAR Contour, interval = 5 ft

Coordinate System: CA State Plane, Zone 1, NAD83, Feet

2007 LIDAR Topography, Feet (re. NAVD88)

< 5	25 - 30
5 - 10	30 - 35
10 - 15	35 - 40
15 - 20	> 40
20 - 25	

N

1:4,800

0 200 400 800 Feet

SITE MAP
Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 2-1b

Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

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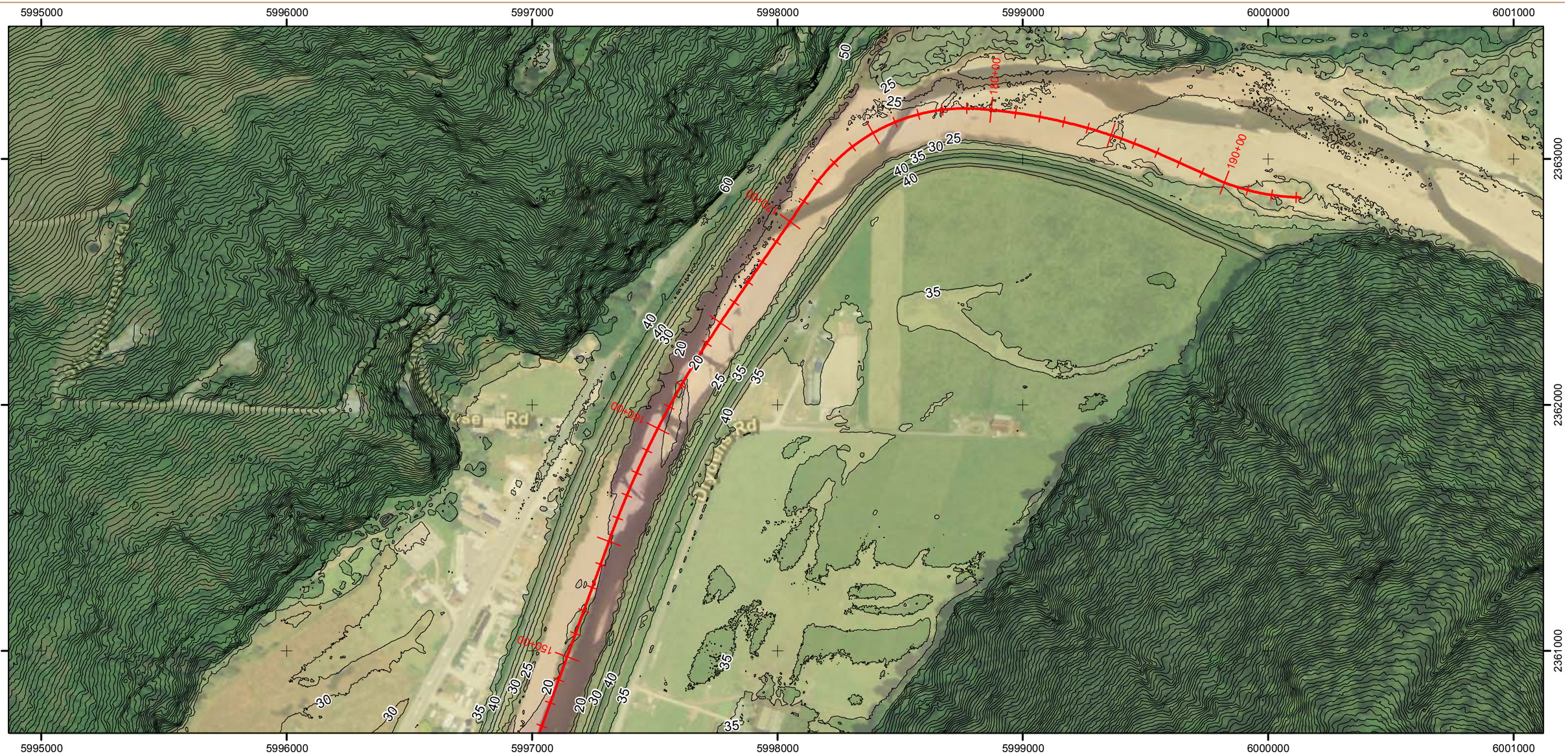

Legend

- Approximate River Centerline with Stations (2+00, 4+00)
- LIDAR Contour, interval = 5 ft

Coordinate System: CA State Plane, Zone 1, NAD83, Feet

2007 LIDAR Topography, Feet (re. NAVD88)

< 5	25 - 30
5 - 10	30 - 35
10 - 15	35 - 40
15 - 20	> 40
20 - 25	

N

1:4,800

0 200 400 800 Feet

SITE MAP
Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 2-1c

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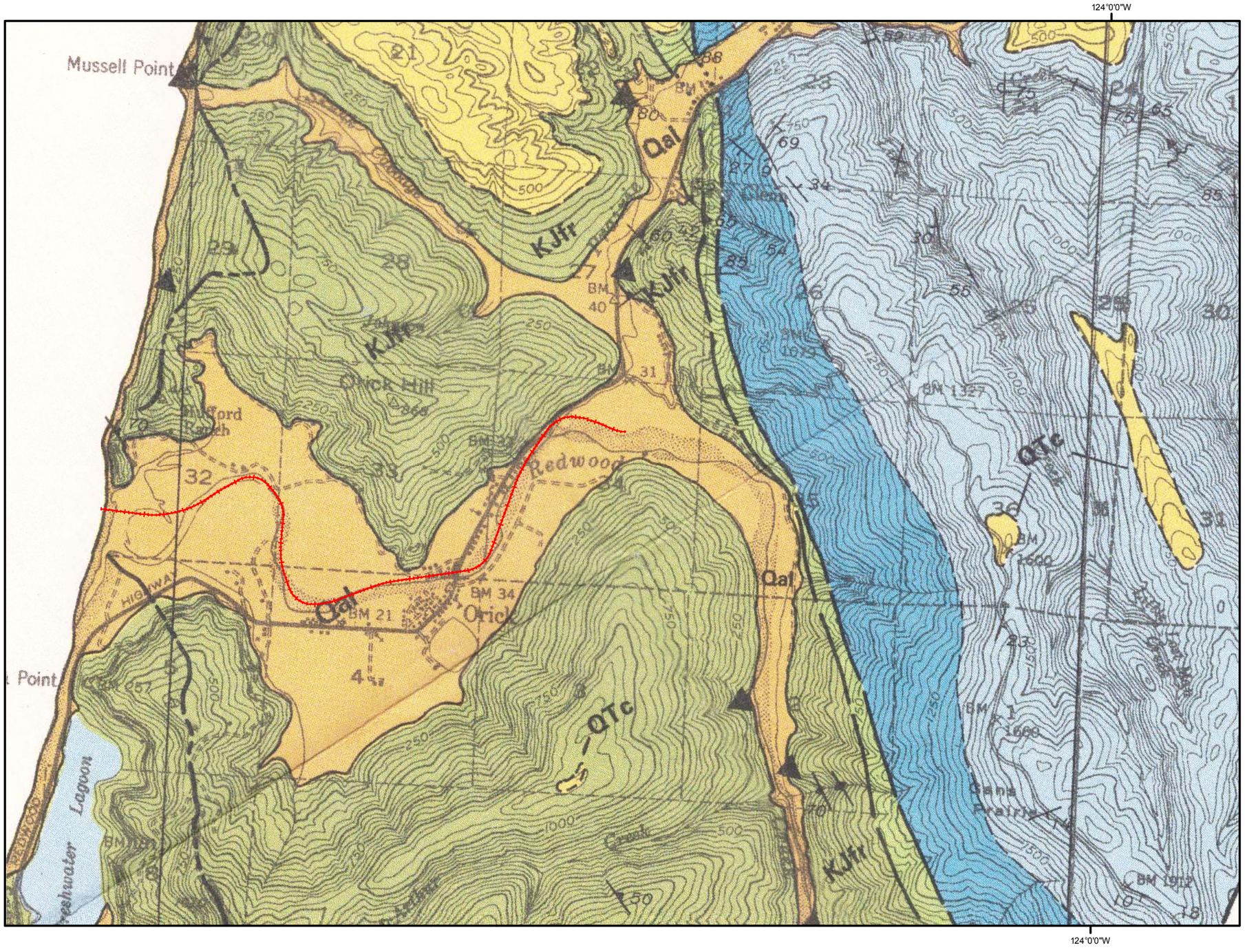

Legend

- Redwood Creek Centerline
- Drainage divide
- Contact—dashed where approximately located, short dashes where gradational and/or sheared, dotted where concealed
- Fault—dashed where approximately located, short dashes where inferred, dotted where concealed
- Thrust fault—sawteeth on upper plate, dashed where approximately located
- Photo-geological lineaments
- Area of common greenstone, chert, or sandstone outcrops
- Outcrops of metabasalt and metatuff

Strike and dip of beds
- Inclined
- Vertical
- Vertical; dot indicates top of bed
- Overturned

Strike and dip of foliation
- Inclined
- Vertical

- Crenulated bedding; arrow shows trend of minor fold axes
- Minor folds, showing plunge of axes

Geologic Units
- Qal - Modern Alluvium
- QTc - Coastal Plain Sediments
- KJfl - Coherent Unit of Lacks Creek
- KJfc - Incoherent Unit of Coyote Creek
- KJfr - Schist of Redwood Creek

SOURCE: Water-Resources Investigations Open-File Report 81-496, Department of the Interior, United States Geological Survey.

N

0 1,500 3,000 6,000 Feet

0 0.25 0.5 1 Miles

GEOLOGIC MAP
Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 5-1

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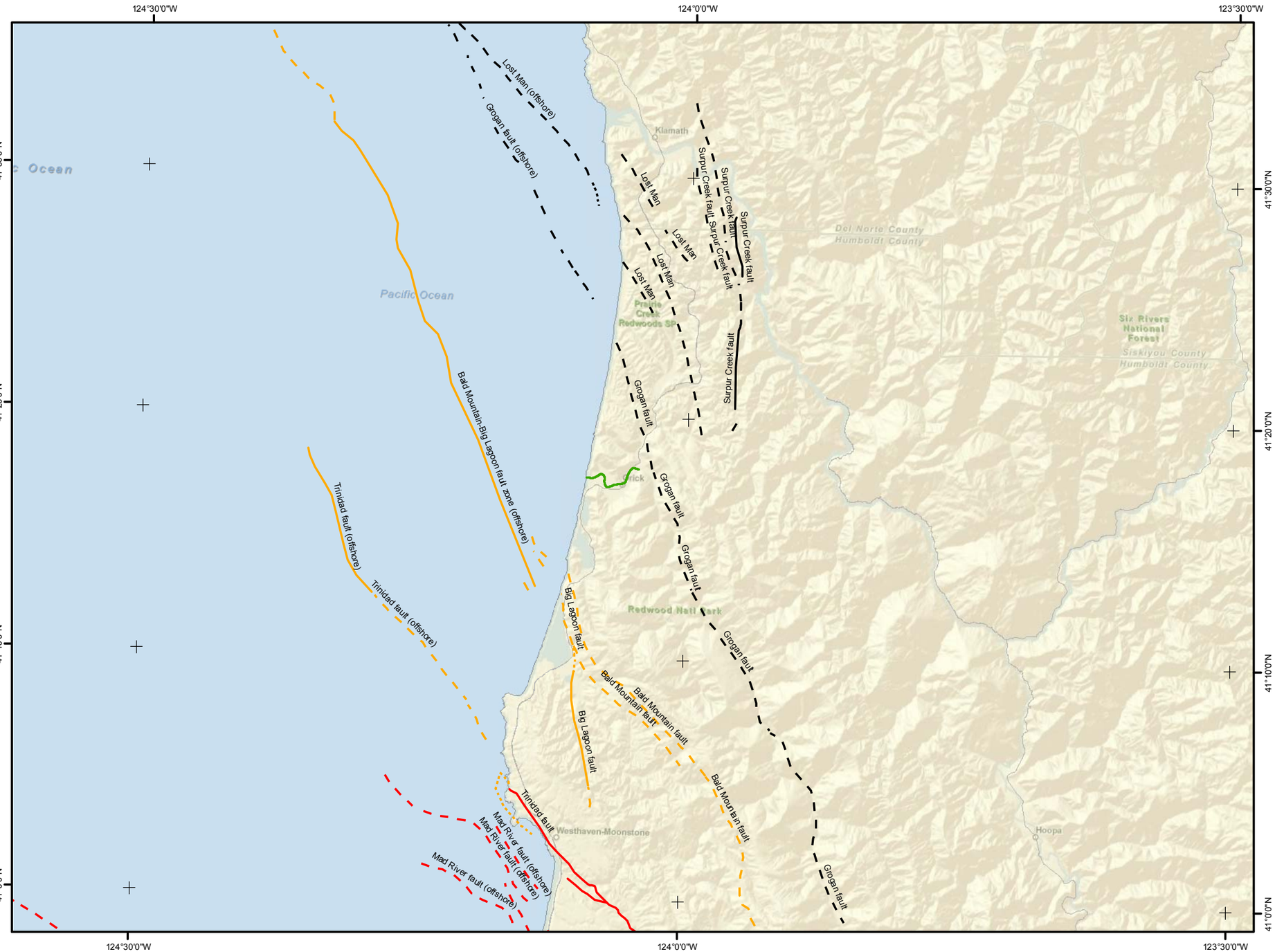

Legend

- Site
- Highways

Faults

- Active Fault
- Potentially Active Fault
- Inactive Fault

Dashed where approximate,
dotted where concealed

SOURCES:
Faults:

1) Bryant, W.A. (compiler), 2005, Digital Database of Quaternary and Younger Faults from the Fault Activity Map of California, version 2.0: California Geological Survey Web Page, http://www.consrv.ca.gov/CGS/information/publications/QuaternaryFaults_ver2.htm>; (2005).

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3) Bing Yen & Associates, Inc., Earthquake Faults, (2000).

N

0 15,000 30,000 60,000 Feet

0 2.5 5 10 Miles

REGIONAL FAULTS
Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 5-2

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5988000 5990000 5992000 5994000 5996000 5998000 6000000

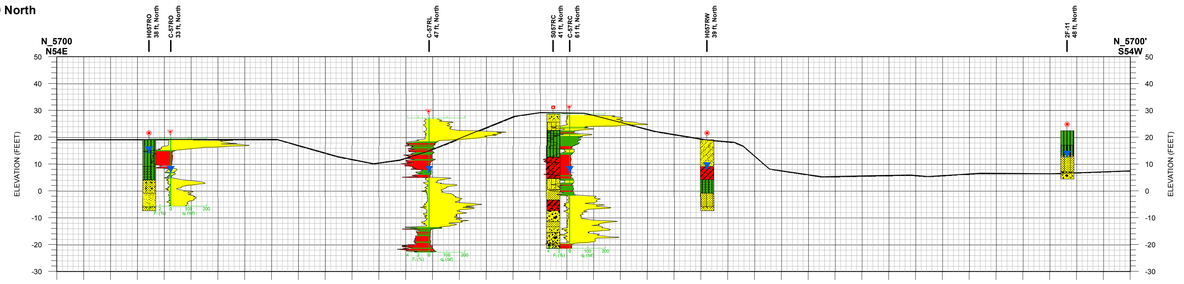
2294000 2292000 2290000 2288000

North
South
North'
South'
See Inset
Legend
Control Point
Relief Well
Cross Section Line
Approximate River Centerline with Stations
Explorations
CGI/Fugro Hollow Stem Auger
CGI/Fugro Vibracore
CGI/Fugro CPTs
Historical SHN Borings
Historical USACE Borings
N
1:3,600
0 300 600 1,200 Feet
Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01
CGI Technical Services Inc.
FUGRO
EXPLORATION LOCATION PLAN
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2011	Exploration Plan	DRP	CBD	GE

PLATE 5-3

57+00 North



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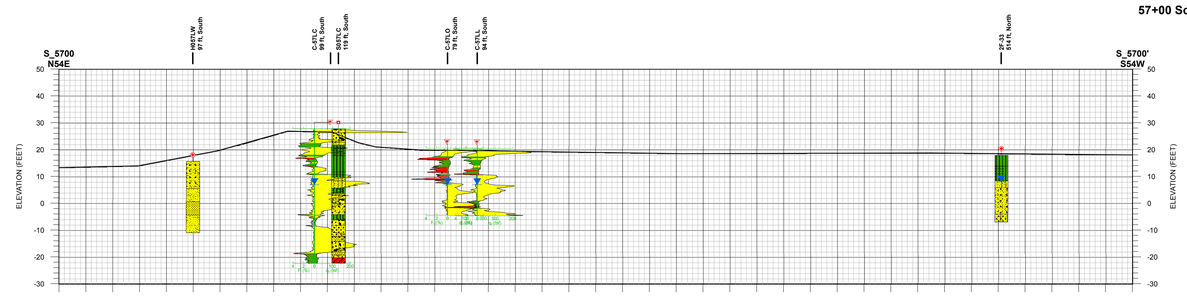
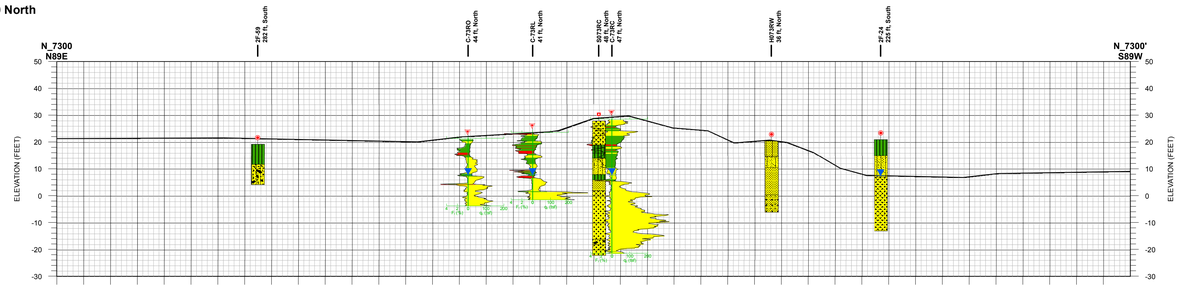
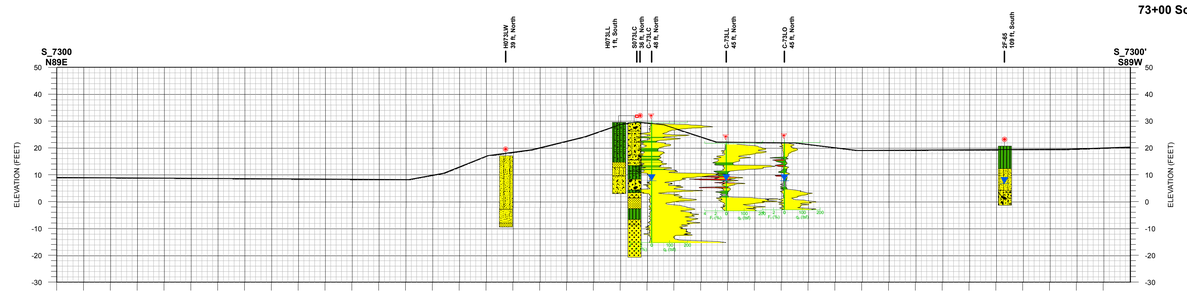


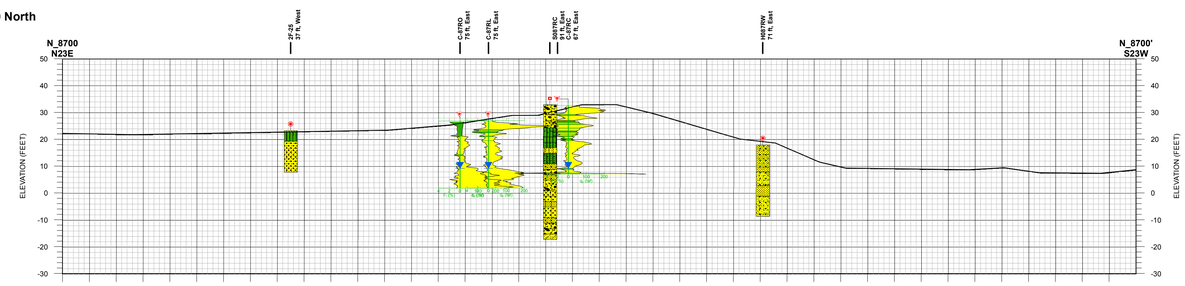
73+00 North



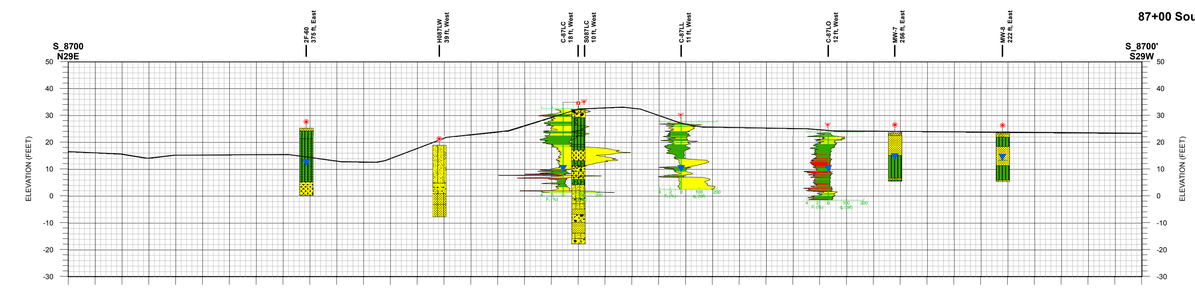
73+00 South



87+00 North



87+00 South



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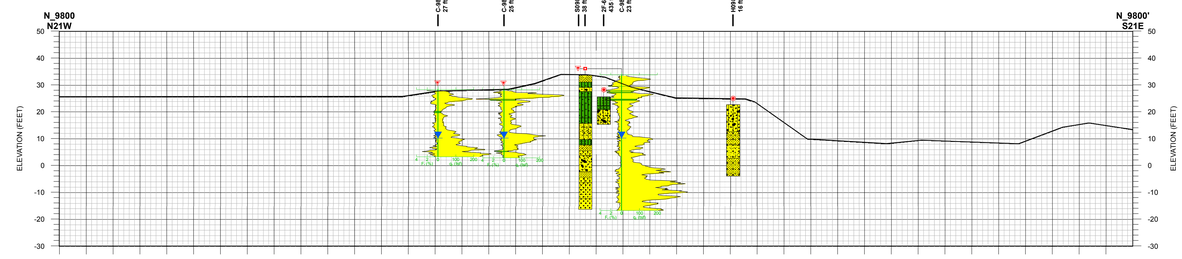

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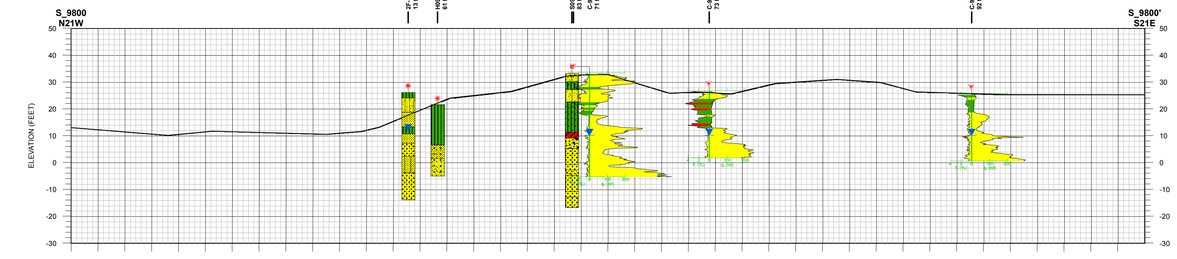

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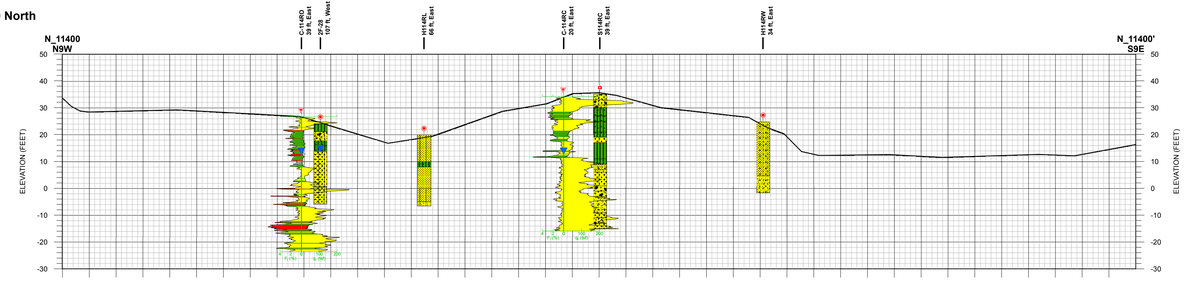

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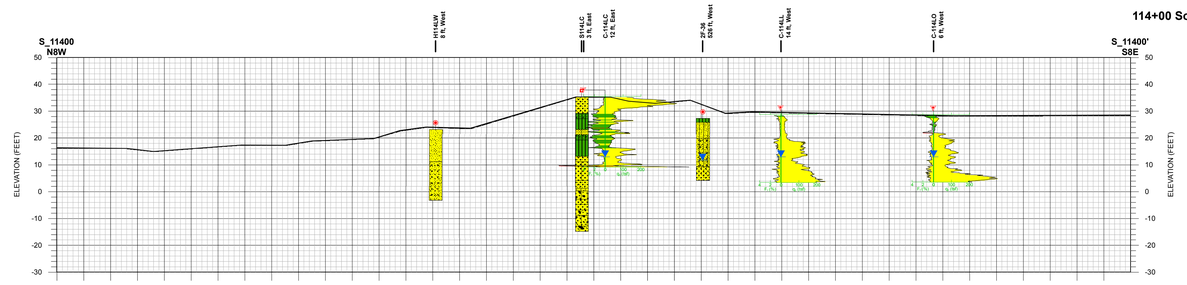
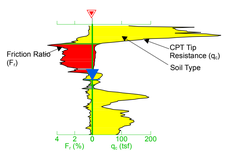
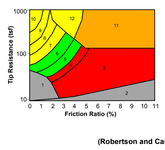




COLOR LEGEND FOR FRICTION RATIO TRACES

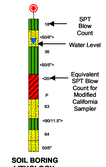


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-CH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

(Robertson and Campanella, 1988)



- Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Sandy Lean Clay (CL)
- Sandy, Gravelly Lean CLAY (CL)
- Gravelly Lean CLAY (CL)
- Silt (ML)
- Sandy, Gravelly SILT (ML)
- Sandy SILT (ML)
- Gravelly SILT (ML)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND (SP)
- Well-Graded SAND (SW)
- Well-Graded SAND with Clay (SW)
- Well-Graded SAND with Silt (SW-SM)
- Gravelly Well-Graded SAND (SW)
- Clayey SAND (SC)
- Gravelly, Clayey SAND (SC)
- Silty SAND (SM)
- Gravelly Silty SAND (SM)
- Poorly-Graded GRAVEL (GP)
- Poorly-Graded GRAVEL with Clay (GP-GC)
- Poorly-Graded GRAVEL with Silt (GP-GM)
- Sandy GRAVEL with Silt (GP-GM)
- Sandy GRAVEL (GP)
- Well-Graded GRAVEL with Clay (GW-GC)
- Well-Graded GRAVEL with Silt (GW-GM)
- Sandy Well-Graded GRAVEL (GW)
- Sandy, Clayey GRAVEL (GC)
- Silty Gravel (GM)
- Sandy, Silty GRAVEL (GM)
- Fill
- Asphaltic Concrete

Humboldt County Public Works Department
Fugro Project No. 04 B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

FUGRO

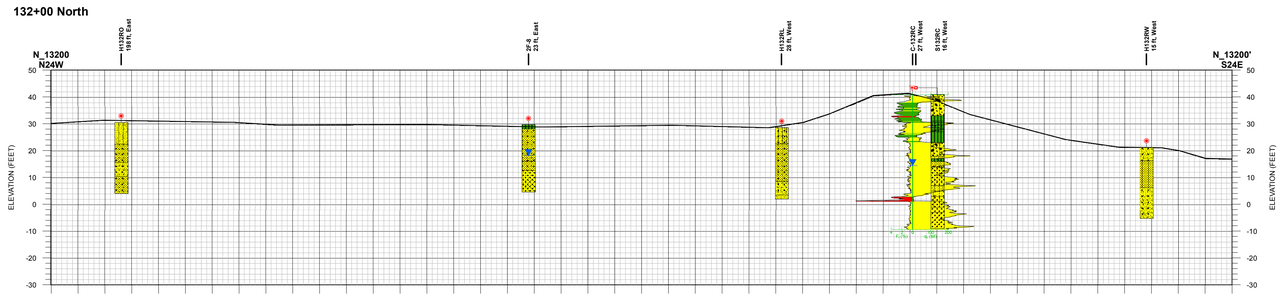
CROSS SECTIONS
STATION 57+00, 73+00, 87+00, 98+00 AND 114+00
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2011	Levee Cross Sections	DRP	CBD	GE

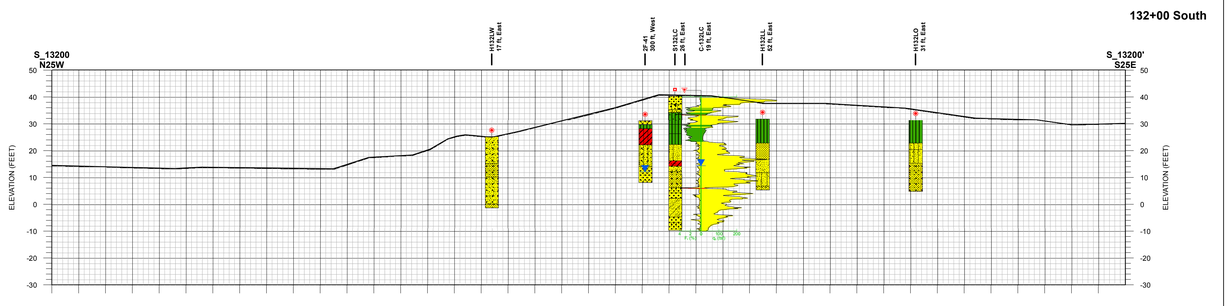
PLATE 5-4

N:\Projects\B3502_Orick\Tasks\B3502 Redwood\Drawings\Arcs\2011_05_31_CrossSectionsPlate_5-4_CrossSection_Pages.mxd, 05/11/11, Chien

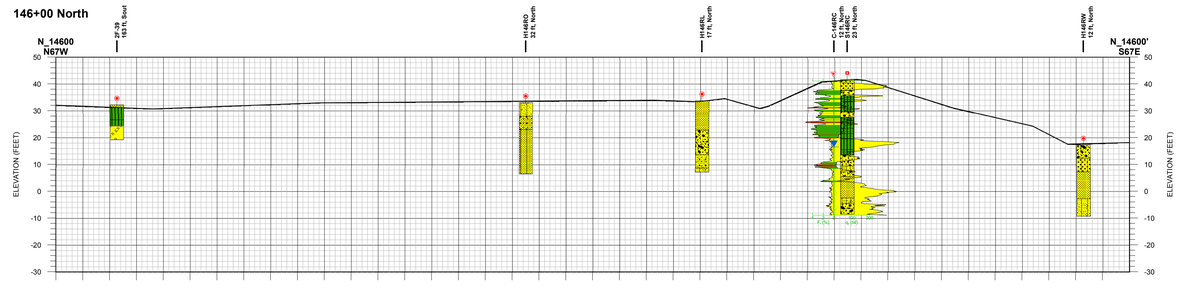
132+00 North



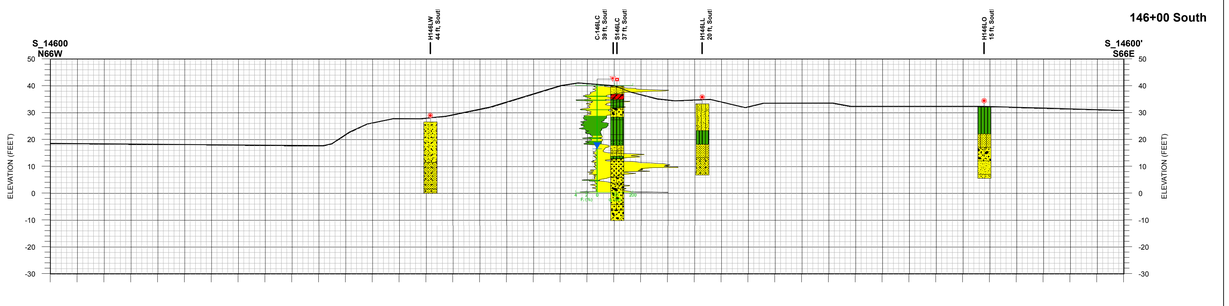
132+00 South



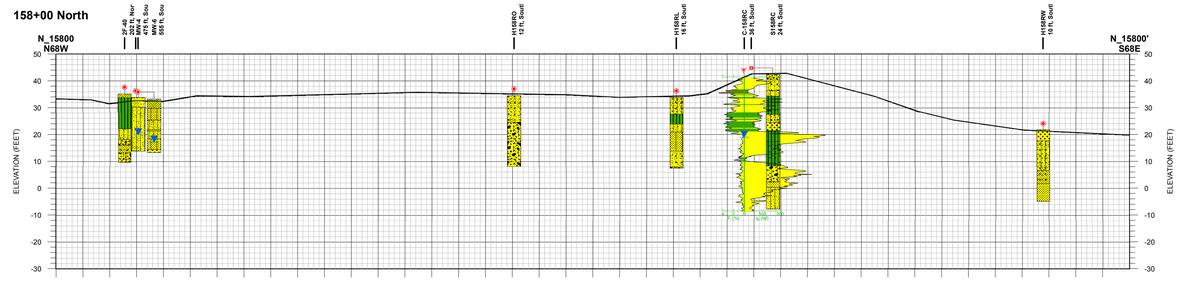
146+00 North



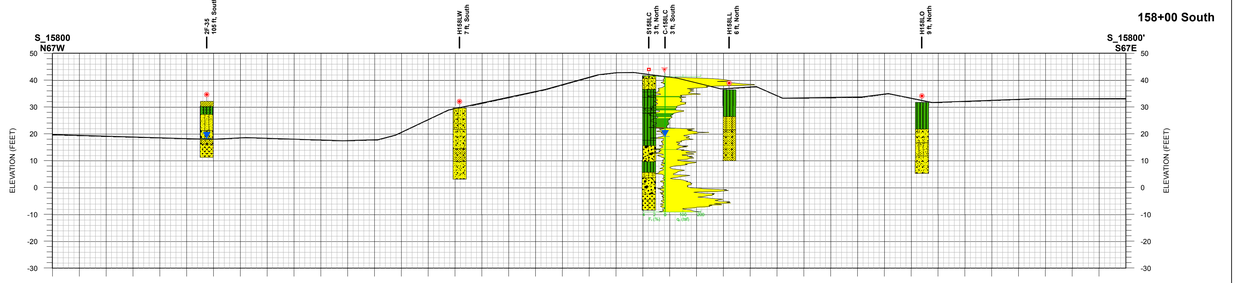
146+00 South



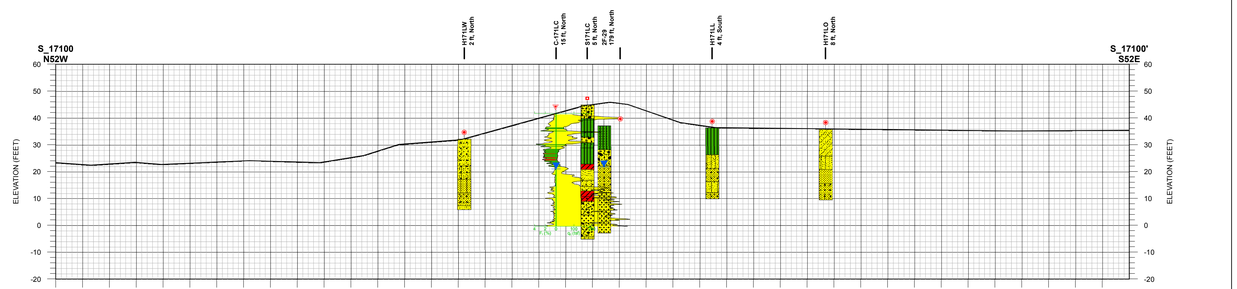
158+00 North



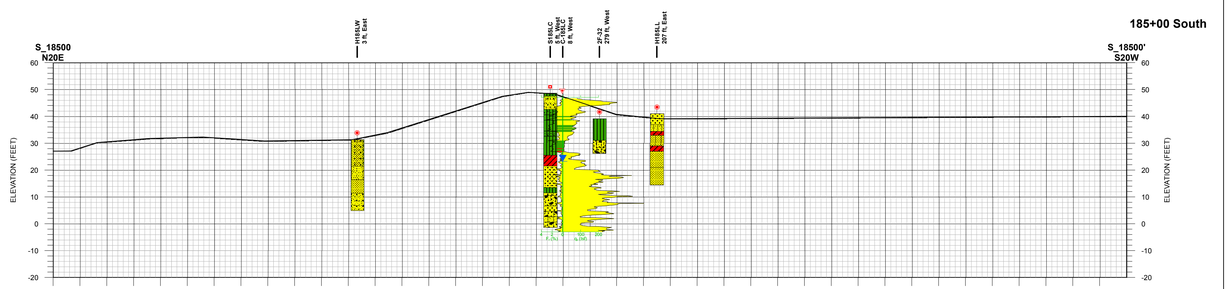
158+00 South

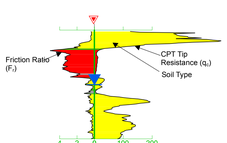


171+00 North

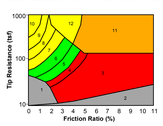


185+00 South





COLOR LEGEND FOR FRICTION RATIO TRACES

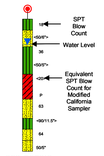


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-CH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

(Robertson and Campanella, 1988)



SOIL BORING LITHOLOGY

- Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Sandy Lean Clay (CL)
- Sandy, Gravelly Lean CLAY (CL)
- Gravelly Lean CLAY (CL)
- Silt (ML)
- Sandy, Gravelly SILT (ML)
- Sandy SILT (ML)
- Gravelly SILT (ML)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND (SP)
- Well-Graded SAND (SW)
- Well-Graded SAND with Clay (SW)
- Well-Graded SAND with Silt (SW-SM)
- Gravelly Well-Graded SAND (SW)
- Clayey SAND (SC)
- Gravelly, Clayey SAND (SC)
- Silty SAND (SM)
- Gravelly Silty SAND (SM)
- Poorly-Graded GRAVEL (GP)
- Poorly-Graded GRAVEL with Clay (GP-GC)
- Poorly-Graded GRAVEL with Silt (GP-GM)
- Sandy GRAVEL with Silt (GP-GM)
- Sandy GRAVEL (GP)
- Well-Graded GRAVEL with Clay (GW-GC)
- Well-Graded GRAVEL with Silt (GW-GM)
- Sandy Well-Graded GRAVEL (GW)
- Sandy, Clayey GRAVEL (GC)
- Silty Gravel (GM)
- Sandy, Silty GRAVEL (GM)
- Fill
- Asphaltic Concrete

Humbolt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc. | Fugro

CROSS SECTIONS
STATION 132+00, 146+00, 158+00, 171+00 AND 185+00
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2011	Levee Cross Sections	DRP	CBD	GE

PLATE 5-5

N:\Projects\B3502_EurekaArea\B3502.06_Reviews\Rv.work\xls\[xsplot01_08.1] standard plotsp\Rev 4.5 Cross Section Pages.xls, 05/11/11, Oliver

Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

FUGRO

S057RC 9 ft, East
C-57RC 2 ft, East
C-73RL 22 ft, East
C-73RC 7 ft, West
S073RC 2 ft, West
C-87RL 4 ft, North
C-87RC 20 ft, South
S087RC 22 ft, South
C-98RL 12 ft, North
C-98RC 16 ft, South
S098RC 19 ft, South
C-114RC 16 ft, South
H132RL 19 ft, North
S146RC 20 ft, East
C-146RC 14 ft, East
S158RC 1 ft, East
C-158RC 2 ft, West

North
N83W

North'
N36E

ELEVATION (FEET)

50
40
30
20
10
0
-10
-20
-30

6
28
14
17
40

4 2 0 100 200
F_r (%) q_c (tsf)

10 ft
1000 ft
Vertical Exaggeration = 100

50+00 60+00 70+00 80+00 90+00 100+00 110+00 120+00 130+00 140+00 150+00 160+00 170+00

NORTH LEVEE PROFILE

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 5-6

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Outputs\2011_05_21_GeotechEval\mxd\Plate_5-6_Profile_North.mxd, 05/11/11, CDean

Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

FUGRO

South
S85W

S057LC 5 ft, East C-57LC 5 ft, East

S073LC 2 ft, East C-73LC 3 ft, West

H073LL 1 ft, West

S087LC 2 ft, North C-87LC 0 ft, North

2F-60 16 ft, South

S098LC 1 ft, North C-98LC 1 ft, North

S114LC 4 ft, South C-114LC 4 ft, South

2F-41 24 ft, South

S146LC 21 ft, East C-146LC 19 ft, East

S171LC 11 ft, East C-171LC 0 ft, East

S185LC 19 ft, South C-185LC 24 ft, South

South'
S66E

ELEVATION (FEET)

50
40
30
20
10
0
-10
-20
-30

<52>
P
P
22
28

F_r (%) q_c (tsf)

10 ft
1000 ft
Vertical Exaggeration = 100

50+00 60+00 70+00 80+00 90+00 100+00 110+00 120+00 130+00 140+00 150+00 160+00 170+(

SOUTH LEVEE PROFILE

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 5-7

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Outputs\2011_05_21_GeotechEval\mxd\Plate_5-7_Profile_South.mxd, 05/11/11, CDean

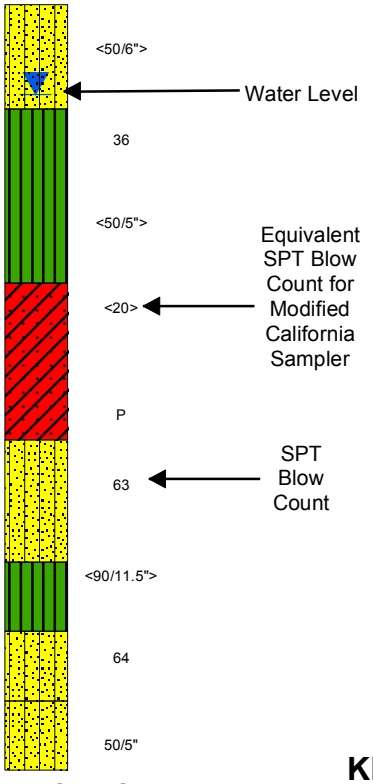
Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

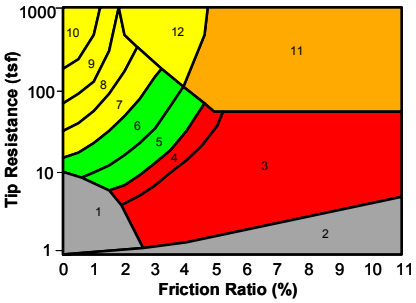
FUGRO

SOIL TYPES

- Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Sandy Lean Clay (CL)
- Gravelly Lean CLAY (CL)
- Lean to Fat CLAY (CL-CH)
- Fat CLAY (CH)
- Silt (ML)
- Clayey SILT (ML)
- Sandy, Gravelly SILT (ML)
- Sandy SILT (ML)
- Gravelly SILT (ML)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND (SP)
- Well-Graded SAND (SW)
- Well-Graded SAND with Clay (SW)
- Well-Graded SAND with Silt (SW-SM)
- Gravelly Well-Graded SAND (SW)
- Clayey SAND (SC)
- Clayey SAND to Lean CLAY (SC-CL)
- Gravelly, Clayey SAND (SC)
- Silty SAND (SM)
- Gravelly Silty SAND (SM)
- Poorly-Graded GRAVEL (GP)
- Poorly-Graded GRAVEL with Clay (GP-GC)
- Poorly-Graded GRAVEL with Silt (GP-GM)
- Sandy GRAVEL (GP)
- Well-Graded GRAVEL (GW)
- Well-Graded GRAVEL with Clay (GW-GC)
- Well-Graded GRAVEL with Silt (GW-GM)
- Sandy Well-Graded GRAVEL (GW)
- Clayey GRAVEL (GC)
- Sandy, Clayey GRAVEL (GC)
- Silty Gravel (GM)
- Sandy, Silty GRAVEL (GM)
- Fill



SOIL BORING LITHOLOGY

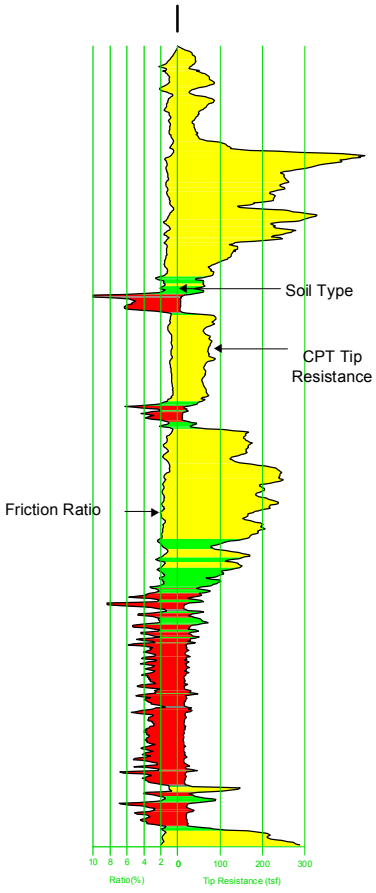


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

(Robertson and Campanella, 1988)



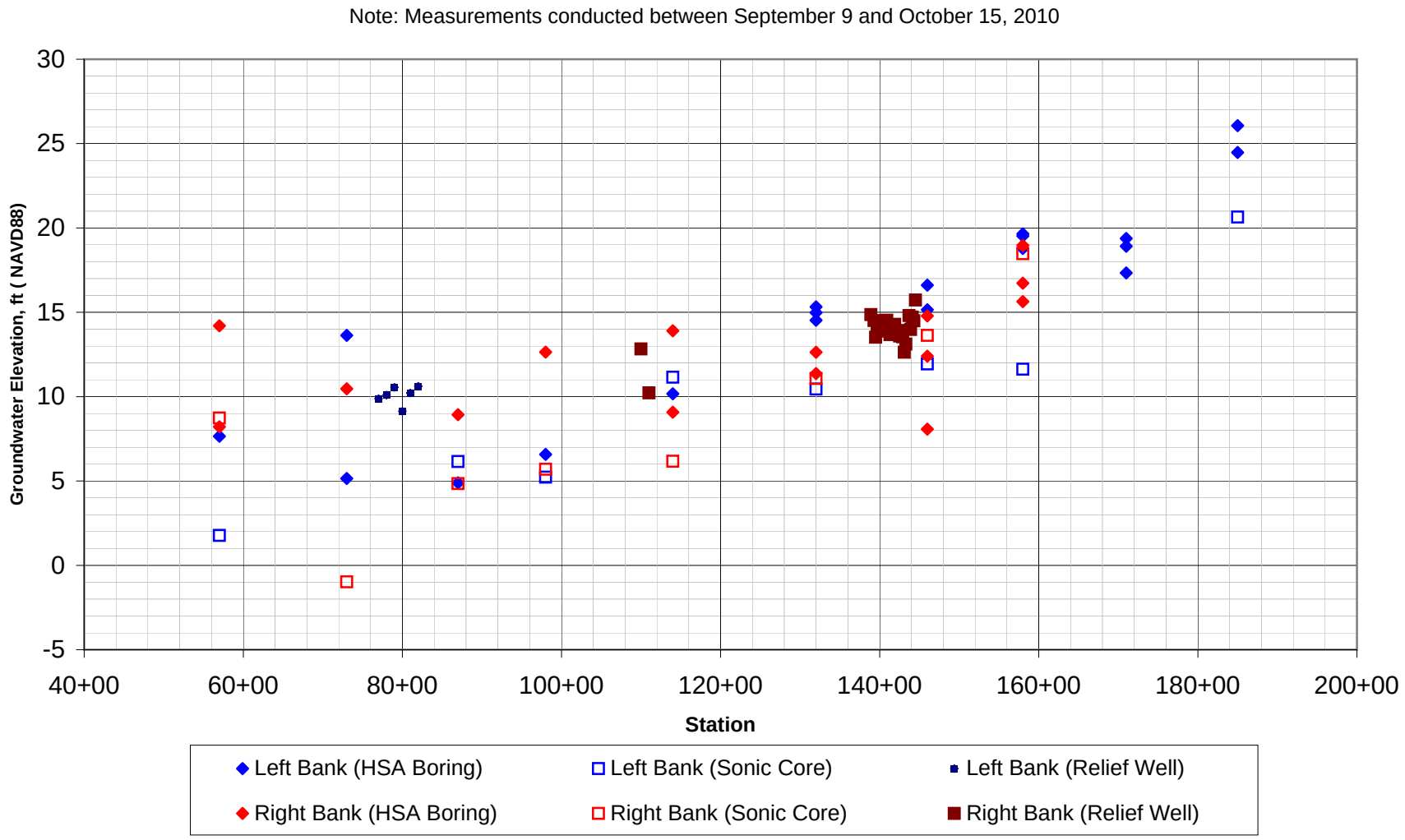
CPT SOUNDING WITH INTERPRETED LITHOLOGY

KEY TO CROSS SECTIONS

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

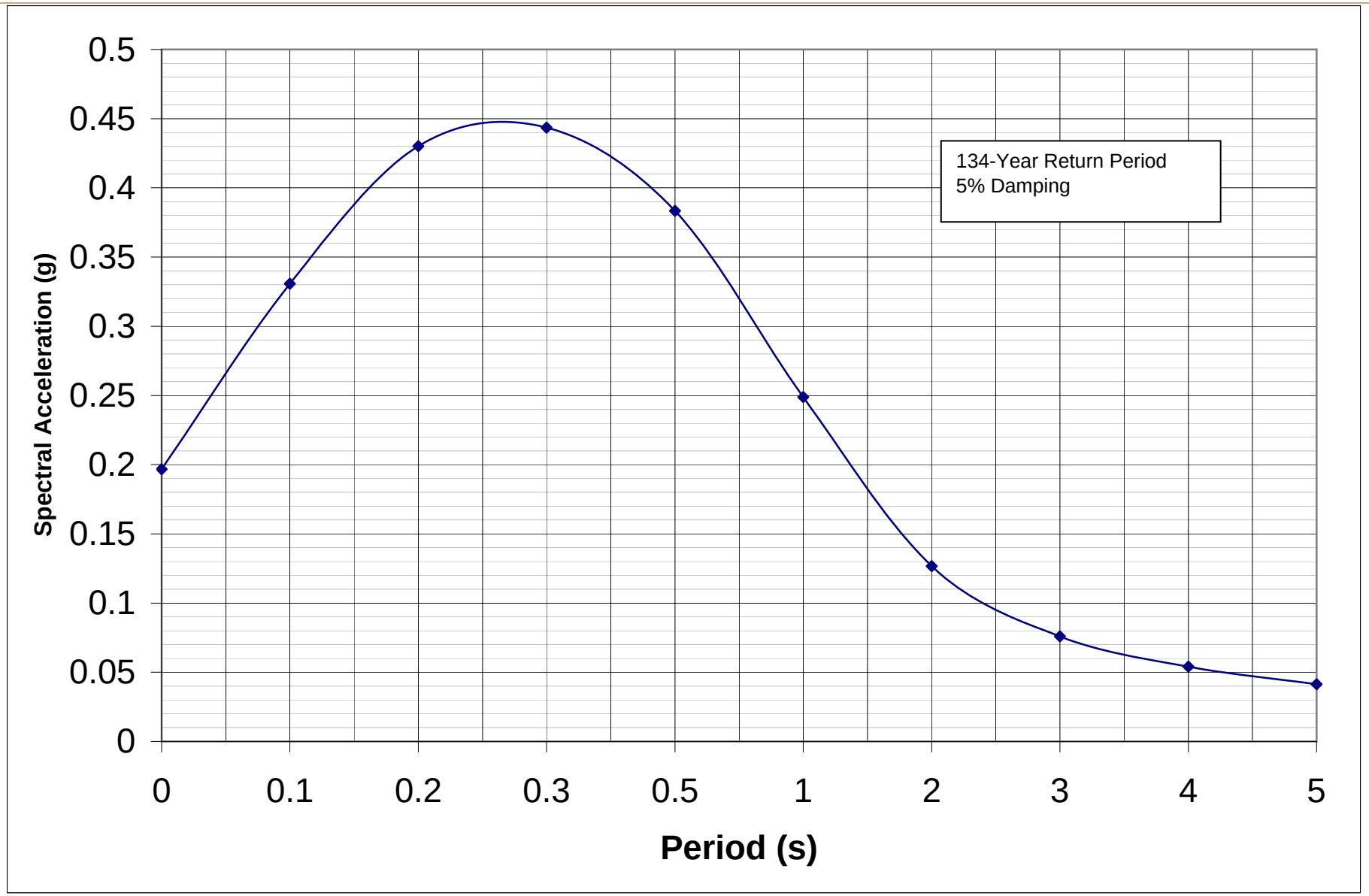
PLATE 5-8

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Outputs\2011_05_21_GeotechEval\mxd\Plate_5-8_Xsect_Key.mxd, 05/12/11, CDean



GROUNDWATER MEASUREMENTS
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 5-9



PROBABILISTIC SEISMIC HAZARD RESPONSE SPECTRUM
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE 6-1

APPENDIX A
HISTORICAL BORING LOGS, LABORATORY DATA, AND PLANS

APPENDIX A - HISTORICAL BORING LOGS, LABORATORY DATA, AND PLANS

As part of our investigation, we reviewed the following documents for geotechnical data or qualitative information relevant to our evaluation, including site and subsurface descriptions, groundwater data, laboratory testing results, boring logs, and as-built plans.

HDR Engineering

- *Technical Memorandum, Levee System Basic Needs Assessment - Redwood Creek (Orick) and Mad River (Blue Lake), Humboldt County, CA,* HDR Engineering, Inc., Folsom, California, March 2009.

Humboldt County

- *Levee Operation & Maintenance Annual Report, Redwood Creek Levee System, Orick, California, July 1, 2009 - June 30, 2010,* County of Humboldt, Department of Public Works, Natural Resources Division, Eureka, California, August 2010.
- *Levee Operation & Maintenance Annual Report, Redwood Creek Levee System, Orick, California, July 1, 2008 - June 30, 2009,* County of Humboldt, Department of Public Works, Natural Resources Division, Eureka, California, August 2009.

Northern Hydrology & Engineering

- *Technical Memorandum, Preliminary Design Review and Geomorphic Evaluation of Redwood Creek Flood Control Project, Orick, Humboldt County,* Northern Hydrology & Engineering, Mckinleyville, California, August 2010.
- *Technical Memorandum, Outstanding Work Products (Tasks) Pertaining to Redwood Creek Flood Control Project,* Northern Hydrology & Engineering, Mckinleyville, California, June 2010.
- *Technical Memorandum, Review and Comment of Army Corps of Engineers, San Francisco District, "Fail All Left Levees" and "Fail All Right Levees" HEC-RAS Models for the FEMA Restudy Work of Redwood Creek, Humboldt County,* Northern Hydrology & Engineering, Mckinleyville, California, March 2010.
- *Technical Memorandum, Review and Comment of Army Corps of Engineers, San Francisco District, Redwood Creek Channel Capacity Analysis and Associated FEMA Restudy Work,* Northern Hydrology & Engineering, Mckinleyville, California, December 2009.

SHN Consulting Engineers & Geologists

- *Second Quarter 2006 Groundwater Monitoring Report, Shoreline Market, Orick, California; Case No. 12777,* SHN Consulting Engineers & Geologists, Eureka, California, June 2006.
- *Well Installation, Pilot Study Report of Findings, and Remedial Action Work Plan, Former Parkwoods Service Station, Orick, California; Case No. 12738,* SHN Consulting Engineers & Geologists, Eureka, California, April 2006.

U. S. Army Corp of Engineers, San Francisco District (USACE)

- *Redwood Creek Channel Capacity Analysis, Memorandum for File,* US Army Corps of Engineers, San Francisco District, San Francisco, California, updated June 2010.
- *Flood Damage Reduction Segment/System, Inspection Report, Redwood Creek at Orick Right Bank REDR,* US Army Corps of Engineers, San Francisco District, San Francisco, California, prepared June 2009.
- *Flood Damage Reduction Segment/System, Inspection Report, Redwood Creek at Orick Left Bank REDL,* US Army Corps of Engineers, San Francisco District, San Francisco, California, prepared June 2009.
- *Flood Damage Reduction Segment/System, Inspection Report, Redwood Creek at Orick REDO,* US Army Corps of Engineers, San Francisco District, San Francisco, California, prepared December 2008.
- *Redwood Creek Channel Capacity Analysis, Memorandum for File,* US Army Corps of Engineers, San Francisco District, San Francisco, California, December 2008.
- *Flood Damage Reduction System, Inspection Report, Redwood Creek at Orick,* US Army Corps of Engineers, San Francisco District, San Francisco, California, prepared October 2007.
- *Redwood Creek Local Flood Protection Project, Operation and Maintenance Manual, Humboldt County, California,* US Army Engineer District, San Francisco, Corps of Engineer, San Francisco, California, prepared June 1969.
- *General Design Memorandum, Redwood Creek Local Flood Control Project, Humboldt County, California,* US Army Engineer District, San Francisco, Corps of Engineer, San Francisco, California, prepared February 1966.
- *Report of Soil Tests, Undisturbed Foundation Materials Obtained with Open-Drive Sampler, Redwood Creek Project,* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared December 1965.
- *Report of Soil Tests, Disturbed Foundation Materials, Holes 7F-6 to 7F-12, Redwood Creek - Orick,* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared August 1965.
- *Quarry Rock Investigation, Crivelli's Quarry and Upper Salmon Creek, Redwood Creek Project at Orick, California,* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared March 1965.
- *Report of Soil Tests, Disturbed Foundation Materials, Redwood Creek, Orick,* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared January 1965.
- *Report of Soil Tests, Undisturbed Foundation Materials, Redwood Creek, Orick,* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared January 1965.

- *Survey Report for Flood Control and Allied Purpose, Appendices, Redwood Creek, Humboldt County, California,* US Army Engineer District, San Francisco, Corps of Engineer, San Francisco, California, prepared August 1961.
- *Report of Soil Tests, Foundation Materials, Redwood Creek (Orick),* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared April 1960.
- *Report of Soil Tests, Pervious Borrow Material, Test Pit 4B-1, Redwood Creek Dam (Orick),* US Army Engineer Division Laboratory, South Pacific, Corps of Engineer, Sausalito, California, prepared December 1959.

The *General Design Memorandum* (USACE, 1966) notes that approximately 85 borings would have been drilled along the banks and proposed channel alignment of Redwood Creek between August 1956 and September 1965. The locations and logs of these explorations are presented in the *Operation and Maintenance Manual* (USACE, 1969), and are presented in this appendix as Plates A-1 and A-2, respectively. In addition, a plate showing a profile of soils along the project extent and proposed typical channel sections was presented in the *General Design Memorandum* (USACE, 1966), and is presented herein as Plate A-3.

Design unit weight, strength, and permeability values for both foundation and embankment materials were included in the *Survey Report for Flood Control and Allied Purpose, Appendices* (USACE, 1961) and *General Design Memorandum* (USACE, 1966). These are presented in this appendix as Plates A-4 and A-5, respectively.

As-built plans, profiles, and typical channel sections for the project extent were presented in the *Operation and Maintenance Manual* (USACE, 1969). The following figures were included in the original manual and are included in this appendix as Plates A-6 to A-11:

- Sheets 2 to 9: Plan and Profile
- Sheet 10: Typical Cross Sections and Profiles
- Sheets 11 to 16: Cross Sections
- Sheets 19 and 20: Centerline Profile, Interior Drainage Systems
- Sheet 51: Alternate Alignment, Interior Drainage Ditches
- Sheet 52: Profiles and Typical Sections, Berms and Alternate Drainage Ditches

LEGEND

- 2F – AUGER BORING
- 7F – UNDISTURBED SAMPLE BORING
- TH – TEST HOLES FURNISHED BY DIVISION OF HIGHWAYS.

NOTES:

1. Logs of borings are shown on Sheets 28 through 36
2. Detailed locations of borings are shown on Sheets 2 through 9.

SYMBOL	DESCRIPTION	DATE	APPROVAL
	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 60	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: H.O.
TRACED BY:
CHECKED BY: K.E.
SUBMITTED: Chief, Engineering Division
APPROVAL RECOMMENDED:

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOCATION OF EXPLORATION HOLES

APPROVED: DATE: 10 FEB 1956
PREPARED UNDER THE DIRECTION OF ROBERT H. ALLAN LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE AS SHOWN JOB NO.

DRAWING NUMBER
SHEET 27 | 85 | 45 | 6

PLATE A-1

PESCADERO 4115

2F-48
8 Sept 65
El. 9.4

Depth
0ft — SP: Sand, grey, damp, loose, poorly graded, mostly fine.
5ft — GM: Sand, grey, wet, loose, well graded fine to coarse, angular, some gravel to 2".
9ft — ▽ N=9
11ft — SP: Sandy Gravel, gray, wet, med. dense, gravel well graded to 1½", rounded, Sand well graded fine to coarse.
13ft — N=10
GP-GM: Gravelly Sand, gray, wet, med. dense, Sand well graded fine to coarse, gravels well graded to 2", occasional cobble to 5".
18ft — SP-SM: Sandy Gravel, gray, wet, med. dense, gravel well graded to 3", sand well graded fine to coarse. [Gr.46, Sa.33, Fi.7, NP]
22ft — GW: Gravelly Sand, gray, wet, med. dense, sand well graded fine to coarse, gravel well graded to 1½".
24ft — SP
N=11
30ft

2F-45
3 Sept 65
El. 9.5

Depth
0ft — SP: Sand, gray, damp, loose, poorly graded, mostly fine.
6ft — SP: Sand, gray, wet, loose, well-graded fine to coarse, angular, some gravel to 1".
9½ft — ▽
[Gr.10, Sa.87, Fi.3, NP]
16ft — SP
GP-GM: Sandy Gravel, gray, wet, loose, gravel well graded to 1½", rounded, sand well graded fine to coarse, angular.
19ft — SP-SM: Gravelly Sand, gray, wet, loose, sand well graded fine to coarse, gravel well graded to 2", rounded.
27½ft — GW: Sandy Gravel, gray, wet, loose, well graded to 1½", rounded, sand well graded fine to coarse.
30ft
[Gr.51, Sa.47, Fi.2, NP]

2F-46
3 Sept 65
El. 8.0

Depth
0ft — SP: Sand, gray damp, loose, poorly graded, mostly fine.
5ft — ▽ N=6
SP-SM: Sand, gray, wet, loose, well graded, fine to coarse, angular, w/some gravel to 1" max.
10ft — SW
[Gr.16, Sa.82, Fi.2, NP]
N=8
14ft — GP: Sandy Gravel, gray, wet, med-dense, well graded to 1½", rounded, sand is angular.
17ft — N=11
SP: Gravelly Sand, gray, wet, med. dense, sand well graded fine to coarse, angular gravel well graded to 2", rounded.
N=11
SP: Same, matrl w/an occasional cobble to 5" max. below 13.0'.
30ft

2F-27
17 OCT. 64
El. 9.5

Depth
0ft — SP: Sand (Beach) wet, well graded many small pieces of wood.
Water at surface (high tide)
[Ja 99, Fi.1, NP, D10 0.3]
some gravel below 3". 1" max.
5ft — SP
10ft — SP: Gravelly Sand wet well-graded subrounded to rounded gravel to 2".
17ft — SP: Sandy Gravel subrounded to rounded 2½" max.
[Gr 41 Sa 58, Fi.1, NP, D10 0.55]
23ft

2F-50
10 Sept 65
El. 2.0

Depth
0ft — ▽ T
2ft — SP: Sand, gray, wet, loose, poorly graded, mostly fine to coarse, angular.
[Gr.15, Sa.82, Fi.3, NP]
SP: Sand, gray, wet, loose, well graded, fine to coarse, w/some gravel to 2".
N=11
12ft — SP
GP: Gravelly Sand, gray, wet, med. dense, Sand well graded fine to coarse, gravel well graded to 2½ rounded.
N=4
GP
18ft — N=4
SP: Sand, gray, wet, med. dense, sand well graded fine to coarse, w/some small gravels.
25ft

2F-49
9 Sept 65
El. 3.0

Depth
0ft — ▽ SP: Sand, dark gray, wet, loose, sand well graded fine to coarse w/some gravel to 1".
6ft — GP: Sandy Gravel, gray, wet, med. dense, gravel well graded to 2", sand well graded fine to coarse.
9ft — GP: Gravelly Sand, gray, wet, loose, sand well graded fine to coarse, gravel well graded to 2".
[Gr.19, Sa.80, Fi.1, NP]
16ft — SP: Sand, gray, wet, loose, well graded fine to coarse, w/some small gravel.
16½ft — EP: Gravelly Sand, gray, wet, med. dense, sand well graded fine to coarse, gravel well graded to 2".
25ft

2F-47
7 Sept 65
El. 3.5

Depth
0ft — ▽ T
1ft — SP-SM: Sand, gray, wet, loose, poorly graded, mostly fine, some small gravel. ∠ 10" rounded boulder @ 1.0'.
4ft — SP: Sand, dark gray, wet, loose, well graded fine to coarse, some gravels to 1" max..
SP: Sandy Gravel, gray, wet, loose, gravel well graded to 2" rounded, Sand well graded fine to coarse, angular.
10ft — SP: Gravelly Sand, gray, wet, loose, sand well graded fine to coarse, Gravel well graded to 2" max, rounded.
16ft — SP: Sand, gray, wet, med dense, sand well graded fine to coarse, w/ some small gravels.
[Gr. 4, Sa. 95 Fi. 1, NP]
25ft

2F-51
11 Sept 65
El. 2.0

Depth
0ft — P SM: Sand, gray, wet, loose, well graded, fine to coarse.
[Gr.3, Sa.91, Fi.6, NP]
4ft — SP: Gravelly Sand, gray, wet, loose, Sand well graded, fine to coarse, gravel well graded to 2".
C.B. — SP
9ft
14ft — SP: Sandy Gravel, gray, wet, med. dense, gravel well graded to 2", sand well graded fine to coarse.
17½ft — SP
25ft — SP: Gravelly Sand, gray, wet, med. dense, sand well graded, fine to coarse, gravel well graded to 1½".
31ft — GP: Sandy Gravel, gray, wet, med. dense, gravel well graded to 2", sand well graded fine to coarse.
33ft — GP
35ft — GP: Gravelly Sand, gray, wet, med. dense, Sand well graded, fine to coarse, gravel well graded to 1½".

Notes:

1. Elevation indicates approximate ground surface at boring location Elevations are based on the datum of Mean Sea Level.
2. Soil classifications are in accordance with Corps of Engineers "Unified Soil Classification System", revised April 1960.
3. Field visual classifications and descriptions of the various soils encountered in the boring are shown to the right of the log.
4. Soil symbols shown on the boring logs are based on laboratory classification tests.
5. All holes were drilled to required depth except as noted.

Legend:

Gr.10	10 percent gravel
Sa 20	20 percent sand
Fi. 70	10 percent fines.
LL 25	Liquid Limit 25%
PI 5	Plasticity Index = 5
NP	Non plastic
G	Specific gravity
w	Moisture content
γd	Dry unit weight
[ ]	Laboratory test results
2F	Auger boring
7F	Undisturbed sample boring
C.B.	Channel Bottom
▽	Free water level at completion of hole
D_{10}	Effective grain size (in millimeters)
N	Number of blows - Standard Penetration test.

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 68	CJN

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: N.D
SUBMITTED:
CHIEF, ENGINEERING DIVISION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 10+00 TO STATION 16+20

APPROVAL RECOMMENDED:
APPROVED:
DATE: 10 FEB 1966

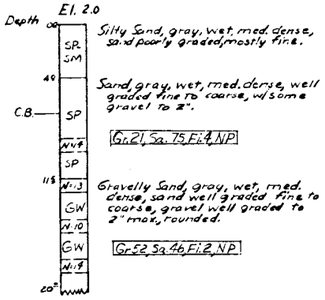
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO
DRAWING NUMBER
SHEET 28 | 85 | 45 | 6

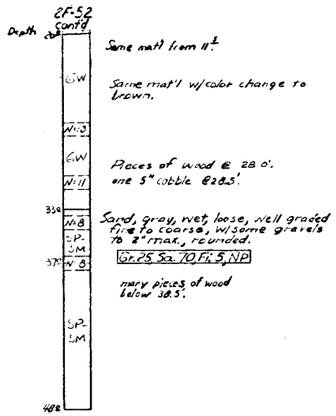
PLATE A-2a

PESCADERO 4117

2F-52
12 Sept 65
El. 2.0

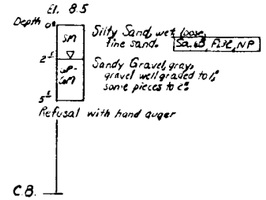


2F-52 cont'd

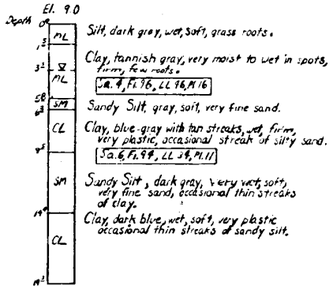


Refusal by Auger.

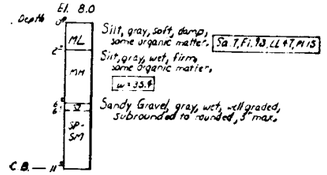
2F-92
3 Nov. 64
El. 8.5



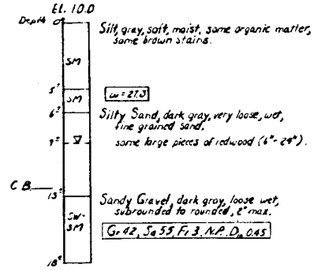
2F-5
9 MARCH 1960
El. 9.0



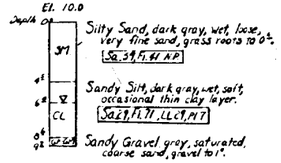
2F-19
10 Sept. 64
El. 8.0



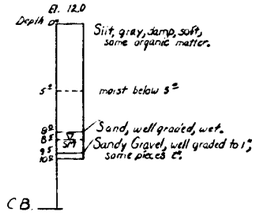
2F-20
12 OCT. 64
El. 10.0



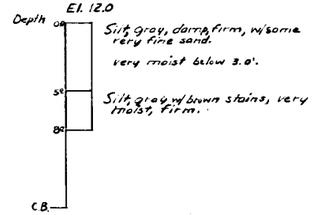
2F-6
9 Mar. 60
El. 10.0



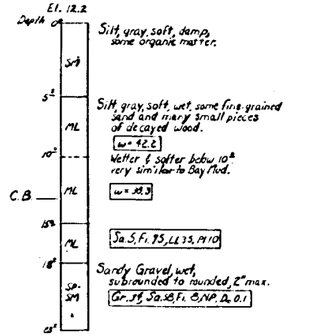
7F-2
2 NOV. 64
El. 12.0



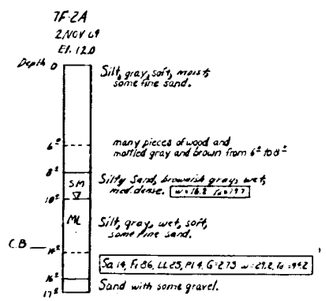
7F-13
2 Sept 65
El. 12.0



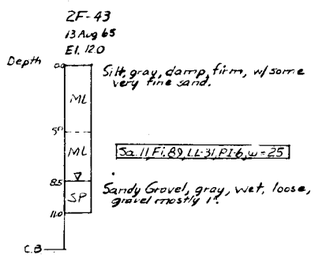
2F-21
12 OCT. 64
El. 12.2



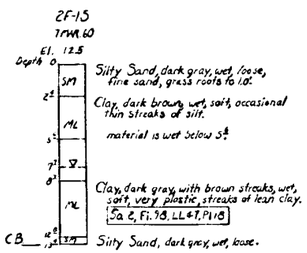
7F-2A
2 NOV 64
El. 12.0



2F-43
13 Aug 65
El. 12.0



2F-15
7 MAR. 60
El. 12.5



NOTES AND LEGEND ARE SHOWN ON SHEET 28

SYMBOL	DESCRIPTION	DATE	APPROVAL
1	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 69	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: M.O.
SUBMITTED:

HUMBOLDT COUNTY — CALIFORNIA

REDWOOD CREEK CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 16+20 TO STATION 92+50

APPROVAL RECOMMENDED: ATSL
APPROVED: [signature] DATE: 10 FEB. 1966

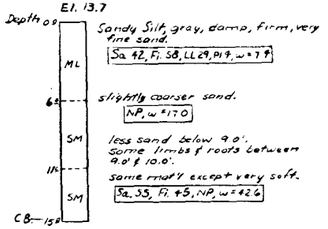
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 29 | 65 | 45 | 6

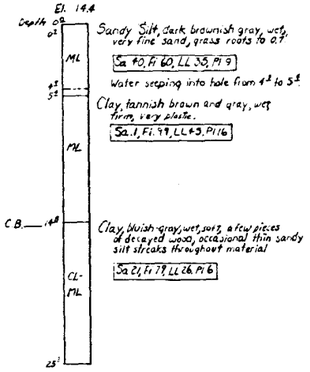
PLATE A-2b

PESCADERO 4119

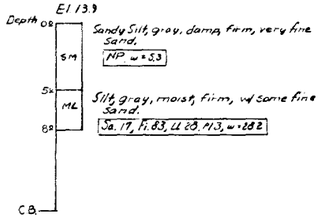
7F-9
13 Aug 65
El. 13.7



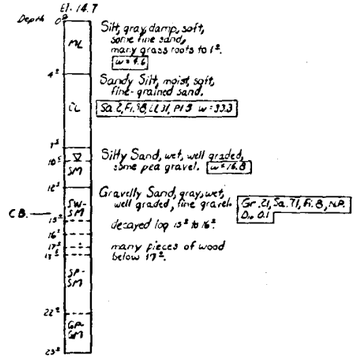
2F-10
14 MAR 60
El. 19.4



7F-12
16 Aug 65
El. 13.9



2F-33
27 OCT. 64
El. 18.7



2F-22
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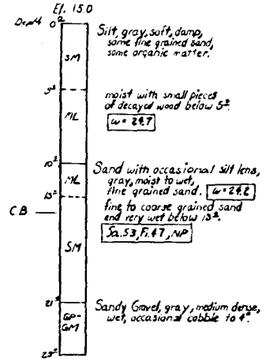
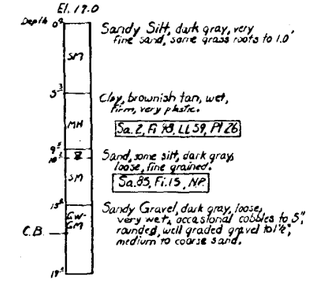
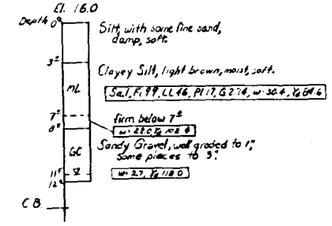
El. 15.0



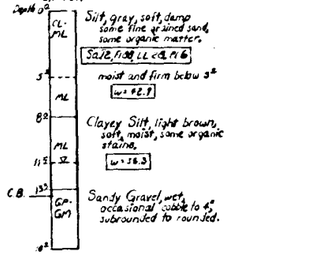
2F-11
15 Mar. 60
El. 17.0



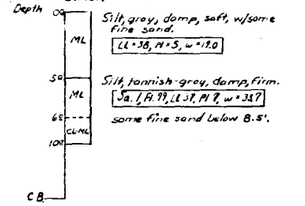
7F-1
2 NOV. 64
El. 16.0



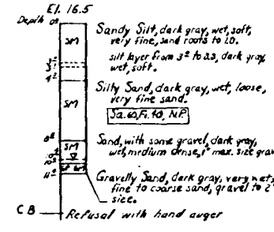
2F-23
10 Oct 64
El. 15.9



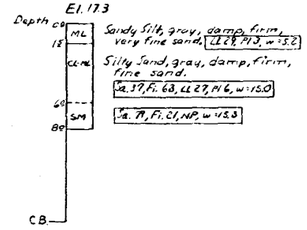
7F-10
13 Aug 65
El. 15.9



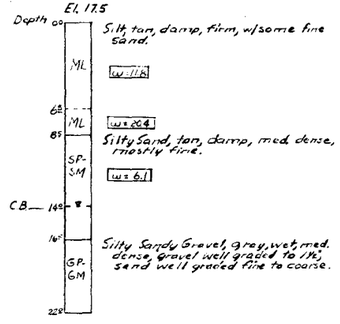
2F-16
17 Mar 60
El. 16.5



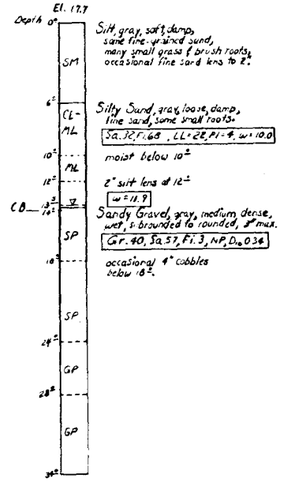
7F-11
16 Aug 65
El. 17.3



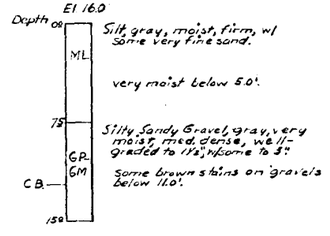
2F-65
15 Sept 65
El. 17.5



2F-24
14 OCT 64
El. 17.7



2F-59
14 Sept 65
El 16.0



NOTES AND LEGEND ARE SHOWN ON SHEET 28

SYMBOL	DESCRIPTION	DATE	APPROVAL
1	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 69	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: H.O.
SUBMITTED: [signature]
CHIEF, ENGINEERING DIVISION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 42+50 TO STATION 76+50

APPROVAL RECOMMENDED: [signature] CHIEF, ENGINEERING DIVISION
APPROVED: [signature] COLONEL, CORPS OF ENGINEERS, DISTRICT ENGINEER
DATE: 10 FEB 1966

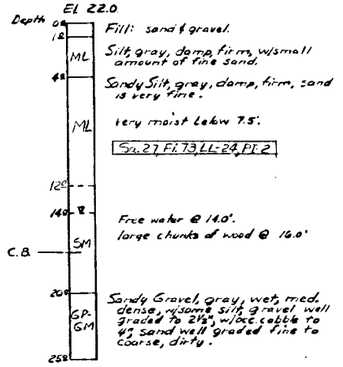
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 30 | 85 | 45 | 6

PLATE A-2c

PESCADERO 4121

2F-60
15 Sept 65
El 22.0



Fill: sand & gravel.

Silt, gray, damp, firm, w/small amount of fine sand.

Sandy Silt, gray, damp, firm, sand is very fine.

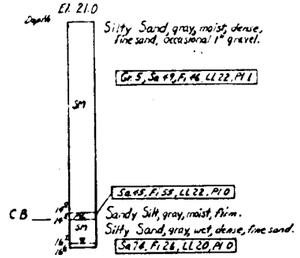
Very moist below 7.5'.

Sa. 27, Fi. 73, LL-24, PI. 2

Free water @ 14.0'.
large chunks of wood @ 16.0'

Sandy Gravel, gray, wet, med. dense, w/some silt & gravel well graded to 2½", w/occ cobble to 4", sand well graded fine to coarse, dirty.

2F-4
29 Aug 56
El. 21.0



Silty Sand, gray, moist, dense, fine sand, occasional 1" gravel.

Gr 5, Sa 69, Fi 16, LL 22, PI 1

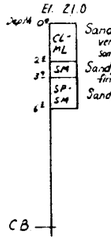
Sa 45, Fi 55, LL 22, PI 0

Sandy Silt, gray, moist, firm.

Silty Sand, gray, wet, dense, fine sand.

Sa 76, Fi 24, LL 20, PI 0

2F-17
17 Mar. 60
El. 21.0



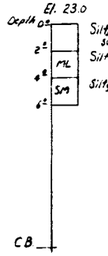
Sandy Silt, dark gray, wet, soft, very fine grained sand, some grass roots to 1.0'

Sa 42, Fi 58, LL 24, PI 5

Sand, dark gray, wet, loose, fine grained.

Sandy Gravel, dark gray, wet, dense.

7F-3
2 Nov. 64
El. 23.0



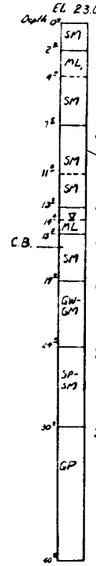
Silt, with some fine sand, light brown, soft, damp.

Silty Sand, damp, loose, very fine grained.

Sa. 16, Fi 84, NP, D 0.16 with a 1g 7.3

Silty Sand, moist, dense.

2F-37
29 Oct 64
El 23.0



Silt, gray, damp, soft, grass roots, fine-grained sand.

Silty sand, gray, damp, loose, fine grained. w = 8.5

moist below 9'

Sand, gray, loose, fine-grained, some silt. w = 7.7

Silt, dark gray, wet, very soft, organic stain, & pieces of wood, some fine grained sand. Sa. 11 Fi. 89, LL = 33, PI = 8, w = 36.9

Sand, dark gray, wet, loose, fine-grained, some organic material & pieces of wood, some silt. w = 33.6

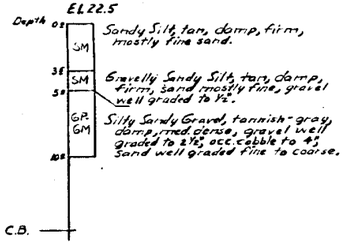
Sandy Gravel, gray, very wet, cobbles to 9" rounded gravel, angular sand.

Sand, gray, wet, loose, fine-grained, many partially decayed chunks of wood, some gravel to 1".

Sandy Gravel, gray, wet, rounded, some cobbles to 6", angular sand, some silt.

Gr. 67, Sa. 29, Fi. 4, NP, D_{10} 0.3

2F-66
16 Sept 65
EL 22.5

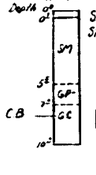


Sandy Silt, tan, damp, firm, mostly fine sand.

Gravelly Sandy Silt, tan, damp, firm, sand mostly fine, gravel well graded to ¾".

Silty Sandy Gravel, tarnish-gray, damp, med. dense, gravel well graded to 2½", occ. cobble to 4", sand well graded fine to coarse.

2F-26
16 Oct. 64
El. 15.5



Silt, gray, soft, some fine grained sand, grass roots.

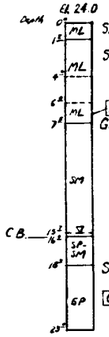
Silty, Sandy Gravel, gray, loose, dry, 2" max.

3" max. size gravel below 3'

occasional 4" cobble below 7'

Gr. 38, Sa. 32, Fi. 10, LL = 29, PI = 3, D_{10} 0.06

2F-36
28 Oct. 64
El. 24.0



Silt, gray, damp, firm, some sand, grass roots. w = 8.7

Silty Sand, gray, damp, loose, fine grained, dark gray below 4'

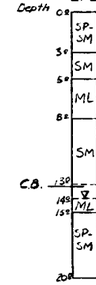
Sa. 38, Fi. 66, NP

Gravelly Silty Sand, brown, moist, loose, gravel to 1".

Sandy Gravel, gray, rounded, 3" max. angular sand.

Gr 60, Sa 36, Fi 4, NP, D_{10} 0.35

2F-68
16 Sept 65
El 21.0



Sandy Silt, tan, damp, firm, sand-poorly graded, mostly fine.

Silty Sandy Gravel, damp, med. dense, gravel well graded to 2½", occ. cobble to 6" rounded, sand well graded fine to coarse.

Sandy Silt, brown & gray, wet, firm, sand mostly fine, small pieces of wood, brown coloring due to organic stains. Sa. 15 Fi 85, LL-32, PI-6, w = 34.6

Sandy Silt, gray, wet, firm, Sand poorly graded, mostly fine.

Gravelly Sand, gray, wet, med. dense, sand well graded fine to medium, gravel well graded to 1".

NOTES AND LEGEND ARE SHOWN ON SHEET 28

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 69	GJ

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: HD
SUBMITTED:
APPROVAL RECOMMENDED:
APPROVED: DATED: 10 FEB 1966

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 76+50 TO STATION 87+00

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 31 | 85 | 45 | 6

PLATE A-2d

PESCADERO 4123

2F-64
15 Sept 65
El. 16.5

Depth 0'
- 0'–7': SM — Sandy Silt, tan, dry, firm, poorly graded-mostly fine.
- 7'–12': SP-SM — Silty Sand, tan, damp, med. dense, w/some small gravel, sand is mostly fine.
- 12'–14': SM — Sandy Silt, tan, very wet, firm, sand is mostly fine, w/some small gravel.
- 14'–13': GP-GM — Silty Sandy Gravel, brownish-gray, very wet, med-dense, gravel well graded to 1½", w/some to 3", Sand well graded fine to coarse.

CB 13'

2F-69
16 Sept 65
El. 17.0

Depth 0'
- 0'–2': Fill: Sandy Gravel.
- 2'–8': SP-SM — Sandy Silt, gray, damp, firm, sand poorly graded, mostly fine. [w=11.5]
- 8'–: SM — Silty Sandy Gravel, gray, damp, med dense, gravel well graded to 1½", Sand well graded fine to coarse. Getting wet @ 12.5'.

CB 14' — Free water @ 14.0'.

2F-67
16 Sept 65
El. 22.0

Depth 0'
- 0'–5': ML — Silt, tan, damp, firm. [w=22.1]
- 5'–9': ML — [w=26.8]
- 9'–15': M — Sandy Silt, tan, damp, firm, sand is mostly fine. [w=?]
- 15'–20': GW — Silty Sandy Gravel, gray, wet, med. dense, gravel well graded to 2½", rounded, sand well graded fine to coarse.

CB 20'

2F-13
16 Mar. 60
El. 19.0

Depth 0'
- 0'–1½': GP-SM — Silty Sandy Gravel (Fill), dark gray, wet, dense, fine to coarse sand, occasional cobbles to 3".
- 1½'–8½': SM — Silt, dark gray, wet, soft, some very fine sand.
- 8½'–12½': GP-GM — Sandy Gravel, dark gray, very moist, loose, fine to coarse sand, gravel to 1½" max. [Gr. 54, Sa. 36, Fi: 10, LL21, PI 3, D. 045]

CB

2F-63
15 Sept 65
El. 18.5

Depth 0'
- 0'–2': Fill: sand & gravel.
- 2'–6': Silt, gray, damp, firm, w/some fine sand.
- 6'–15': SP-SM — Silty Sandy Gravel, gray, damp, med. dense, gravel well graded to 1", Sand well graded fine to coarse. [Gr. 35, Sa. 51, Fi. 8, LL 19, PI 2, G=2.67, w=10.4]

CB 15'

2F-62
15 Sep'65
El. 18.5

Depth 0'
- 0'–2½': Fill: sand & gravel.
- 2½'–12': ML — Silt, gray, damp, firm, w/some fine Sand. [Gr 3, Sa 47, Fi 50, NP]
- 12'–15': SM — Same mat'l. Wood in hole @ 11.0'.

CB 15'

Refusal by Auger.

2F-1
29 Aug 56
El. 21.0

Depth 0'
- 0'–3½': SC-SM — Sandy Gravel (Fill), gray, moist, medium dense, gravel to 2" max.
- 3½'–4½': SM — Clayey Sand, dark gray, moist, medium dense. [Gr 5, Sa 44, Fi 49, LL 23, PI 9]
- 4½'–6½': GP-GM — Silty Gravelly Sand, gray, moist medium dense, fine gravel. [G 5, Sa 40, Fi 9, NP, D=0.1]

Refusal with hand auger

CB

2F-61
15 Sept 65
El. 20.0

Depth 0'
- 0'–4': Fill: Silt, Sand, Gravel, some pieces of wood.
- 4'–9': ML — Silt, tan, damp, firm, w/some fine sand. [LL=24.1, PI=5.1, NP]
- 9'–10': SM — Silty Sand, tannish-gray, damp, med. dense, fine grained.
- 10'–: GM — Silty Gravelly Sand, gray, damp, med dense, sand well graded, fine to coarse, gravel well graded to 1".

CB 15'

2F-25
16 Oct 64
El. 20.0

Depth 0'
- 0'–8': ML — Sandy Gravel, 3" max., occasional 5" cobble. Silty Sand, gray, loose, damp, fine grained sand, some rocks. [Gr. 18, Sa. 28, Fi. 45, LL 27, PI 5, w=3.9]
- 8'–10': SP-SM — Sandy Gravel, gray, damp, subrounded to rounded, gravel 1½" max.
- 10'–: SP — [Gr. 46, Sa. 43, Fi 3, NP, D=0.4] moist below 12'. decayed log at 13' to 14'

CB 15'

2F-2
29 Aug 56
El. 21.0

Depth 0'
- 0'–3': Gravel (Fill), moist, dense.

Refusal with hand auger

CB

2F-3
29 Aug 56
El. 21.0

Depth 0'
- 0'–2': Sandy Gravel (Fill), gray, moist, dense.
- 2'–7': CL-ML — Sandy Clay, gray, moist, firm. Some roots. [Sa 25, Fi 75, LL 23, PI 6]
- 7'–8': CL — [Sa 25, Fi 75, LL 30, PI 8] Silty Clay, dark gray, moist, stiff.
- 8'–10': SM — Silty Sand, gray, moist, dense, some roots.
- 10'–12': ML — Clayey Silt, brown-gray, moist, firm. [Sa 9, Fi 91, LL 34, PI 7]

CB

NOTES AND LEGEND ARE SHOWN ON SHEET 28.

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 68	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: HD
SUBMITTED:
CORPS CONSTRUCTION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 87+00 TO STATION 109+00

APPROVAL RECOMMENDED: Chief, Engineering Division
APPROVED: Colonel, Corps of Engineers
DATE: 10 FEB 1966

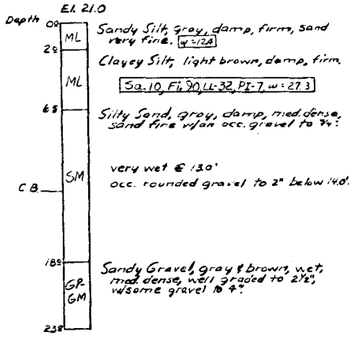
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 32 | 85 | 45 | 6

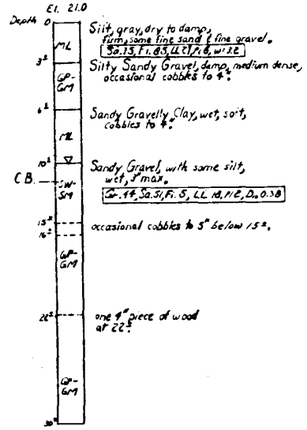
PLATE A-2e

PESCADERO 4125

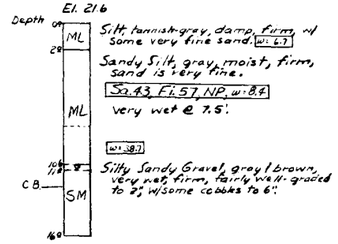
2F-58
14 Sept 65
El. 21.0



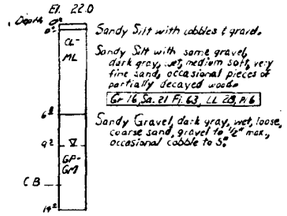
2F-28
20 Oct 64
El. 21.0



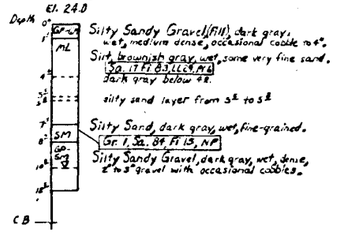
2F-57
14 Sept 65
El. 21.6



2F-9
14 Mar 60
El. 22.0



2F-14
16 Mar 60
El. 24.0

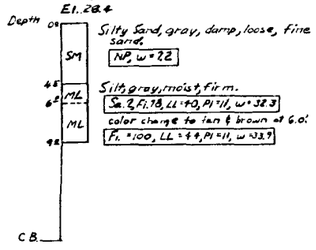


2F-38
31 Oct 64
El. 24.0

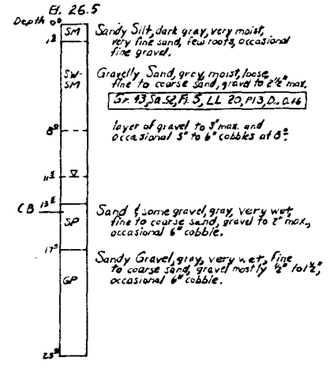
2F-41
1 Nov 64
El. 28.0

2F-55
14 Sept 65
El. 25.0

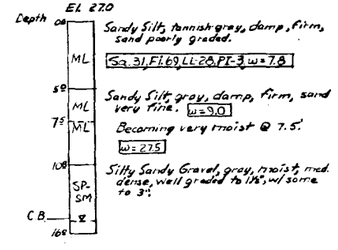
7F-8
13 May 65
El. 28.4



2F-8
11 Mar. 60
El. 26.5



2F-56
14 Sept 65
EL 27.0



NOTES:

1. SEE SHEET 36 FOR BORINGS TH-1, TH-2, TH-3, ALSO LOCATED IN THIS REACH.
2. NOTES AND LEGEND ARE SHOWN ON SHEET 28.

SYMBOL	DESCRIPTION	DATE	APPROVAL
1	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 69	FJH

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: N.D.
SUBMITTED BY: H. Lemings
CHIEF, ENGINEERING DIVISION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 109+00 TO STATION 137+50

APPROVAL RECOMMENDED: A. T. Ippen, CHIEF OF ENGINEERING DIVISION
APPROVED: E. C. Kelly, COL, CORPS OF ENGINEERS, DISTRICT ENGINEER
DATED: 10 FEB. 1966

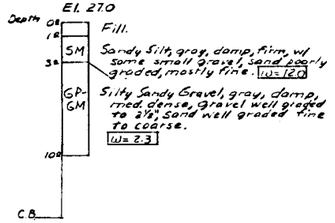
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 33 | 85 | 45 | 6

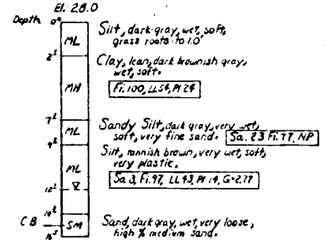
PLATE A-2f

PESCADERO 4127

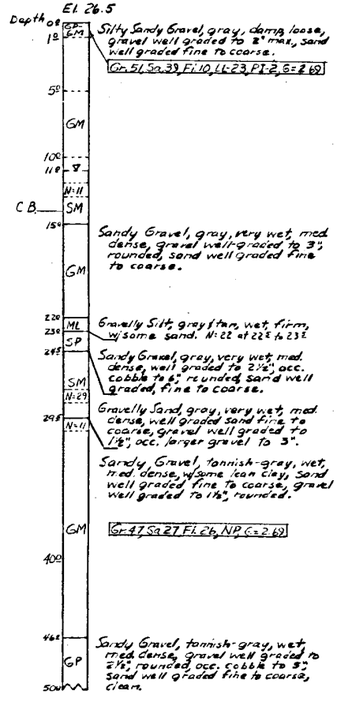
2F-70
16 Sept 65
El. 27.0



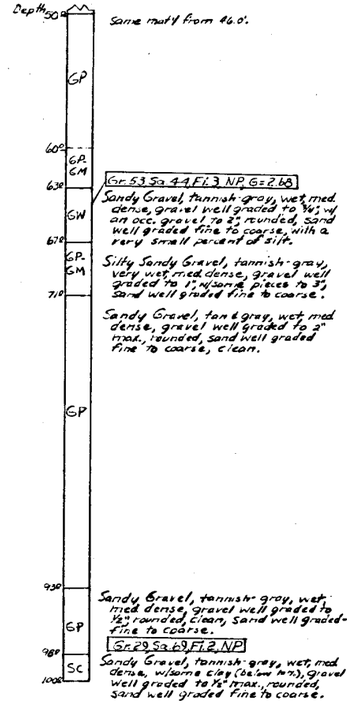
2F-18
18 March 60
El. 28.0



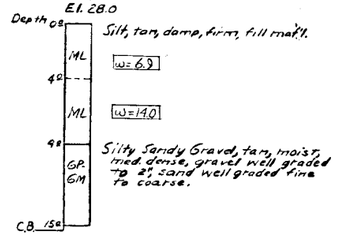
2F-44
1 Sept 65
El. 26.5



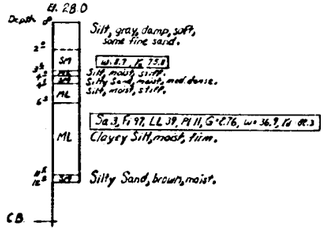
2F-44
Cont'd.



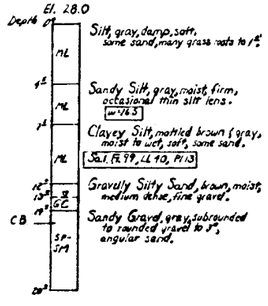
2F-71
16 Sept 65
El. 28.0



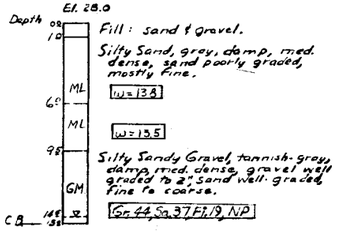
TF-5
3 NOV. 64
El. 28.0



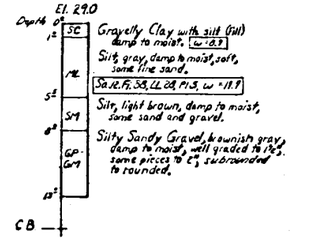
2F-34
28 Oct. 64
El. 28.0



2F-54
13 Sept 65
El. 28.0



2F-39
31 Oct. 64
El. 29.0



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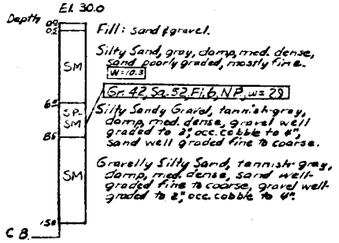
13 Sept 65
El. 30.0



NOTES AND LEGEND ARE SHOWN ON SHEET 28.

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 68	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: N.D.
SUBMITTED BY: H. Glover
CHIEF, ENGINEERING DIVISION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 137+50 TO STATION 150+00

APPROVAL RECOMMENDED: Alton Bush, CHIEF, ENGINEERING DIVISION
APPROVED: [illegible], DISTRICT ENGINEER
DATE: 10 FEB 1966

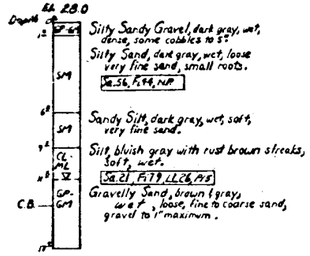
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB No.
DRAWING NUMBER
SHEET 34 | 65 | 45 | 6

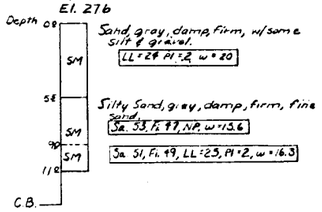
PLATE A-2g

PESCADERO 4129

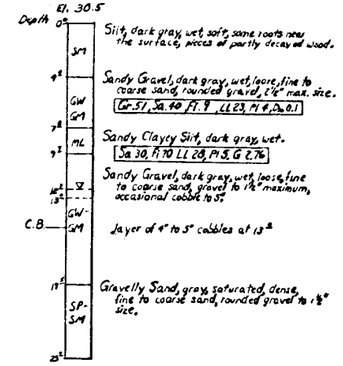
2F-12
13 Mar. 60
El. 28.0



7F-7
13 Aug 65
El. 27.6



2F-7
10 Mar 60
El. 30.5



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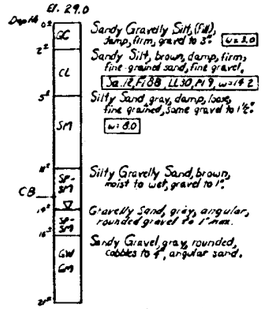
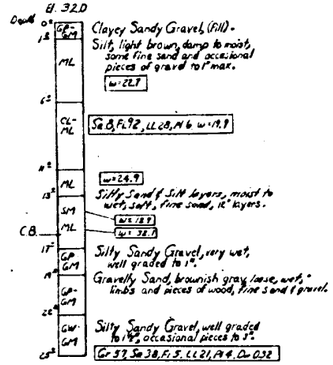
28 Oct. 64
El. 29.0



2F-40
31 Oct. 64
El. 32.0



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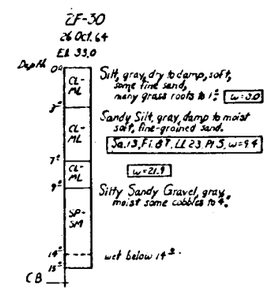
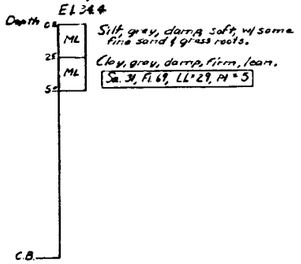
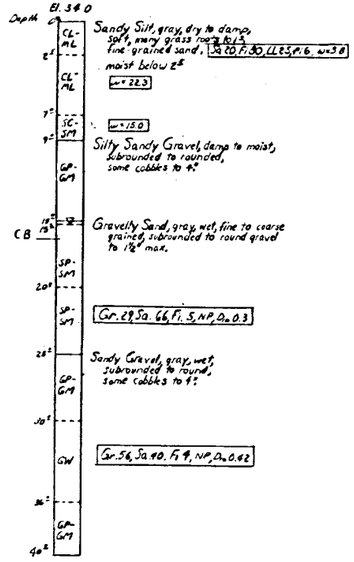
26 Oct. 64
El. 33.0



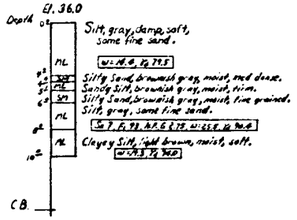
7F-6
13 Aug 65
EL 34.4



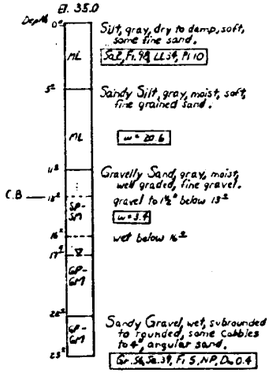
2F-29
22 Oct 64
El. 34.0



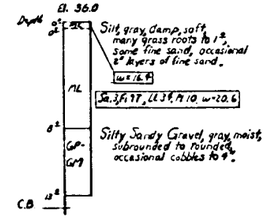
7F-4
3 Nov. 64
El. 36.0



2F-31
27 Oct. 64
El. 35.0



2F-32
27 Oct. 64
El. 36.0



NOTES AND LEGEND ARE SHOWN ON SHEET 28.

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 MAR 66	HN

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: N.D.
SUBMITTED:
RECOMMENDED FOR APPROVAL:
APPROVED:
DATED: 10 FEB. 1966

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 150+00 TO STATION 192+83

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALED | JOB NO.
DRAWING NUMBER
SHEET 35 | 85 | 45 | 6

PLATE A-2h

PESCADERO 4131

Test Hole No. 3
El. 25.0
Nov 1924

Depth	
0	Sandy Silt, Willow Stumps, Roots and Trash.
C.B. 15.0	Loose streambed Gravel.
25.0	Gravel with small percentage of Yellow Clay.
35.0	Fine Gravel and Yellow Clay grading into Sand and Blue Clay at 42.0'.
42.0	
46.6	Fairly clean coarse Gravel.
66.0	Fine Gravel and Yellow Clay.
69.0	Blue Clay with trace of Sand.
76.0	Fine Gravel and Yellow Clay.
78.0	

Test Hole No. 2
El. 16.0
Nov 1924

Depth	
0	
C.B.	Loose Streambed Gravel.
31.5	Soft Yellow Clay and Fine Gravel.
33.0	Loose Coarse Gravel.
43.0	Compact Gravel.
45.0	Loose Coarse Gravel
51.0	Blue Lagoon Mud
55.0	Loose Coarse Gravel
59.5	Blue Clay and Black Sand
62.0	Brown Clay and Gravel
70.0	

Test Hole No. 1
El. 24.3
Nov 1924

Depth	
0	Loose Gravel Recent Deposit.
10.3	
C.B.	Loose Gravel Old Deposit Gradually becoming more compact.
65.0	Hard Blue Clay and Black Sand
67.8	Soft Brown Clay and Coarse Sand.
80.3	Clay and Gravel, well cemented.
82.3	

NOTES:
1. NOTES AND LEGEND ARE SHOWN ON SHEET 28.
2. THESE BORINGS WERE FURNISHED BY STATE OF CALIFORNIA, DEPARTMENT OF PUBLIC WORKS, DIVISION OF HIGHWAYS, DISTRICT 1

SYMBOL	DESCRIPTION	DATE	APPROVAL
△	AS CONSTRUCTED - NO CHANGES MADE	10 JAN 68	RDH

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GH
TRACED BY:
CHECKED BY: HO
SUBMITTED: [illegible]
APPROVAL RECOMMENDED: [illegible] CHIEF, ENGINEERING DIVISION

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
LOGS OF EXPLORATION HOLES
STATION 127+20 TO STATION 128+05

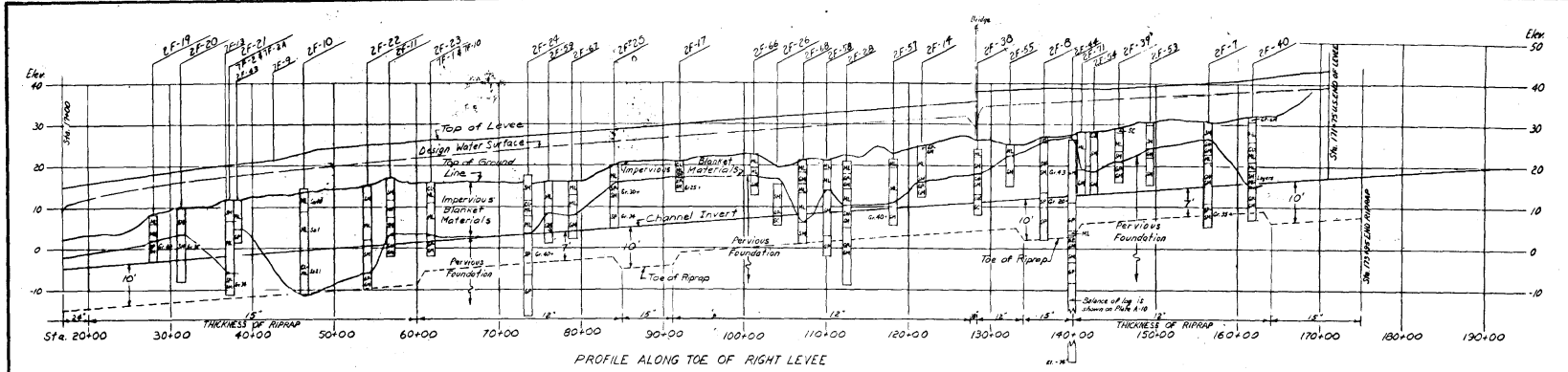
APPROVED: [illegible] DATE: 10 FEB. 1966

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
COLONEL, C.E., DISTRICT ENGINEER

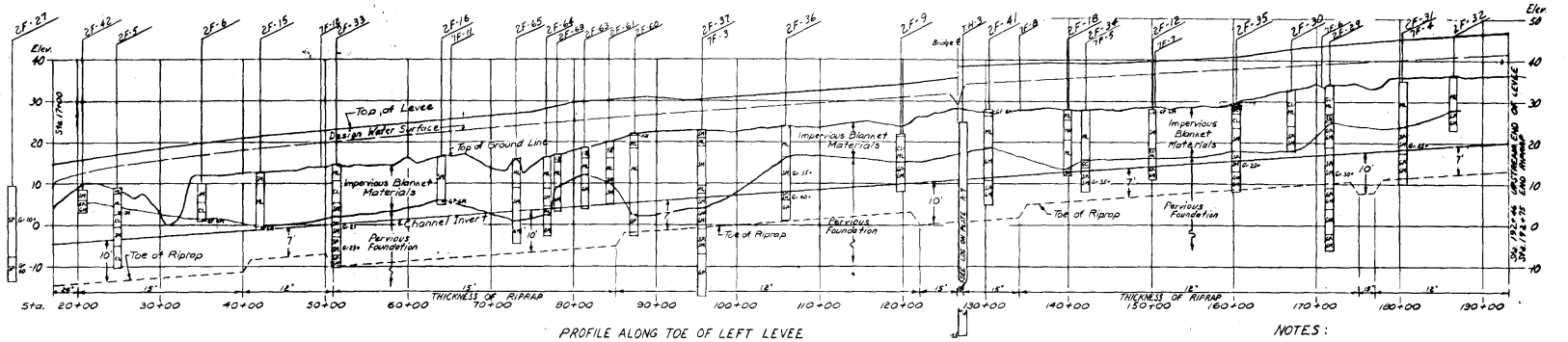
SCALE: AS SHOWN JOB NO.

DRAWING NUMBER
SHEET 36 | 85 | 45 | 6

CORPS OF ENGINEERS U. S. ARMY



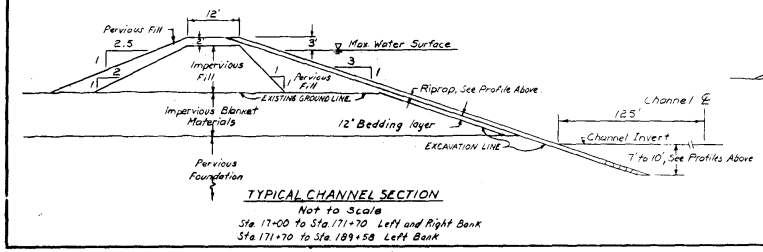
PROFILE ALONG TOE OF RIGHT LEVEE



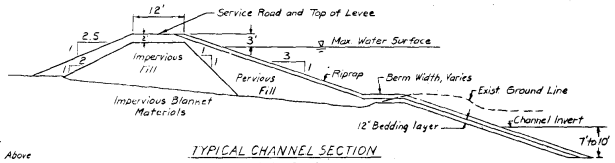
PROFILE ALONG TOE OF LEFT LEVEE

NOTES:

1. Borings which are not representative of the soil profile along the toe of the levee are not shown on this drawing.
2. Logs of exploration holes are shown on Plates A-3 through A-11.
3. Location of exploration holes are shown on Plate A-2
4. Legend is shown on Plate A-3.



TYPICAL CHANNEL SECTION
Not to Scale
Sta. 171+00 to Sta. 171+70 Left and Right Bank
Sta. 171+70 to Sta. 189+58 Left Bank



TYPICAL CHANNEL SECTION
Not to Scale
Sta. 189+58 to Sta. 192+90 : Left Bank

FLOOD CONTROL
GENERAL DESIGN MEMORANDUM
REDWOOD CREEK PROJECT - HUMBOLDT COUNTY, CALIF.
CHANNEL IMPROVEMENTS

SOIL PROFILES AND TYPICAL SECTIONS

U.S. ARMY ENGINEER DISTRICT, SAN FRANCISCO, CORPS OF ENGINEERS
FILE NO. 85-36-5

PLATE A-12

In the right bank, the fine grained material is approximately 8 feet in depth between Station 165/60 (upstream end of levee) and Station 140/00, approximately 5 feet in depth between Station 140/00 and Station 90/00, and from 16 to more than 25 feet in depth downstream of Station 90/00. In the left bank, except between Station 123/00 and Station 110/00, the fine grained material is more than 10 feet in depth. Between Station 123/00 and Station 110/00, approximately 5 feet of fine grained materials overlie the sand and gravel.

B-5. GROUND WATER

Stabilized ground water table was not established as the exploration holes were backfilled immediately upon completion of the drilling. During exploration, ground water was encountered in the exploration holes from 6 to 12 feet below the existing ground surface. Materials were saturated to the ground surface at most locations as a result of heavy rains just prior to and during explorations. Due to the pervious zone of sand and gravel in the foundation, ground water encountered in the exploration holes drilled near the creek channel reflected the water level in the channel. Water level readings made during explorations are shown on the logs of exploration holes on Plates B-2 and B-3.

B-6. DESIGN VALUES

Based on laboratory tests, field description and experience with similar soils, the following design values are adopted for the various materials.

a. Foundation (Undisturbed)

(1) Overburden - Silty Sand, Sandy Silt, Sandy Clays

Dry Weight	90 lbs. per cu. ft.
Moist Weight	104 lbs. per cu. ft.
Saturated Weight	119 lbs. per cu. ft.
Buoyed Weight	57 lbs. per cu. ft.
ϕ	25 degrees

(2) Gravelly Material, Sand and Gravel

Dry Weight	120 lbs. per cu. ft.
Moist Weight	126 lbs. per cu. ft.
Saturated Weight	137 lbs. per cu. ft.
Buoyed Weight	75 lbs. per cu. ft.
ϕ	31 degrees

PHRCADERO 3007

b. Embankment Materials

(1) Impervious Fill from Overburden Soils

Dry Weight	100 lbs. per cu. ft.
Moist Weight	115 lbs. per cu. ft.
Saturated Weight	126 lbs. per cu. ft.
Buoyed Weight	63 lbs. per cu. ft.
ϕ	26 degrees

(2) Streambed Sand and Gravel

Dry Weight	120 lbs. per cu. ft.
Moist Weight	126 lbs. per cu. ft.
Saturated Weight	137 lbs. per cu. ft.
Buoyed Weight	75 lbs. per cu. ft.
ϕ	31 degrees

B-7. STABILITY OF SLOPES

a. Channelside.

The levee and channel slopes are to be 1 vertical to 3 horizontal. The stability of the channelside slope was analyzed by the circular arc method. As the foundation consists of materials with varying strength, the analyses were made for the most critical foundation as represented by the depth of fine grained overburden material extending to the full depth of the channel bank. The following conditions were analyzed:

(1) Gravity Forces.

Stability analysis for gravity forces with water surface at half slope height is shown on Plate B-4. A most critical safety factor of 1.24 was determined for a 1 vertical to 3.0 horizontal slope.

(2) Gravity and 0.1g Earthquake Forces.

Stability analysis for gravity plus 0.1g earthquake forces is shown on Plate B-5. Since the probability of high water and earthquake occurring simultaneously is very remote, normal flow condition of approximately 2 feet depth of water in the channel was used for this analysis. A most critical factor of safety of 1.10 was determined for the 1 vertical to 3.0 horizontal slope.

PLATE A-4b

square foot, the levees to be constructed would experience very little or no settlement. Therefore, no generalized consolidation values were developed for the project.

d. Permeability Values: The value of the coefficient of permeability for the impervious blanket was computed from the results of consolidation tests on the fine-grained materials (silts). The results ranged in value from 3.8×10^{-11} to 1.6×10^{-8} ft/sec. and are shown on Table A-1. An average value of 8.2×10^{-9} ft/sec. was used for all design calculations. The design permeability value for the impervious blanket will be reviewed when permeability tests now underway on samples from the additional borings are completed. Since no permeability tests were made on the pervious sand and gravel, a horizontal coefficient of permeability of 0.01 ft/sec. was selected for underseepage studies based on grain size distributions and experience with similar materials. In general, the sand and gravel substratum is moderately stratified and a vertical permeability of 0.0011 ft/sec. was adopted for design, assuming a horizontal to vertical permeability ratio of 9 to 1.

e. Summary of Design Values: The adopted design values for the various zones of the levee foundation and embankment, including assumed values for riprap slope protection, are shown in the following summary tabulation.

Soil	Foundation		Embankment		
	Imper. Blanket	Perv. Fdn.	Imper. Fill	Perv. Fill	Riprap
Dry Weight, lbs./cu. ft.	89	124	99	128	120
Moist Weight, lbs./cu. ft.	110	132	118	138	124
Saturated Weight, lbs./cu. ft.	119	140	125	143	138
Buoyed Weight, lbs./cu. ft.	56	78	63	81	75
Q Shear Strength: ϕ, Degrees	0	35	0	35	45
Cohesion, lbs./sq. ft.	500	0	500	0	0
R Shear Strength: ϕ, Degrees	20	35	20	35	45
Cohesion, lbs./sq. ft.	200	0	200	0	0
S Shear Strength: ϕ, Degrees	29	35	31	35	45
Cohesion, lbs./sq. ft.	0	0	0	0	0
Horiz. Permeability, ft./sec:	-	0.010			
Vert. Permeability, ft./sec:	8.2×10^{-9}	0.0011			

A-8. LEVEE STABILITY

a. General. The stability of the channelside and landside slopes was analyzed by the circular arc method partially with a computer program and partially by manual methods, using the design strengths

PESCADERO 4063

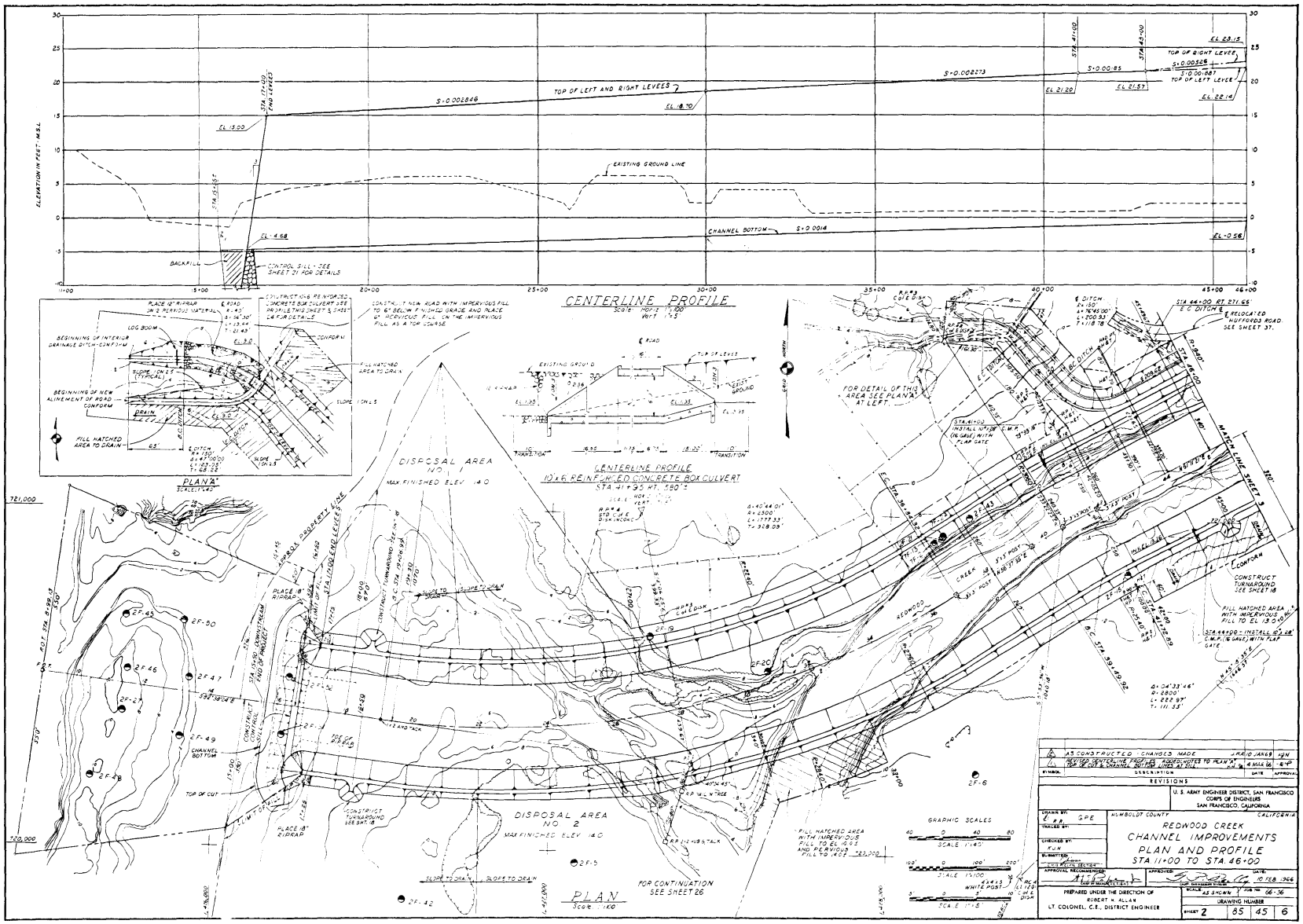


PLATE A-6a

PESCADERO 4065

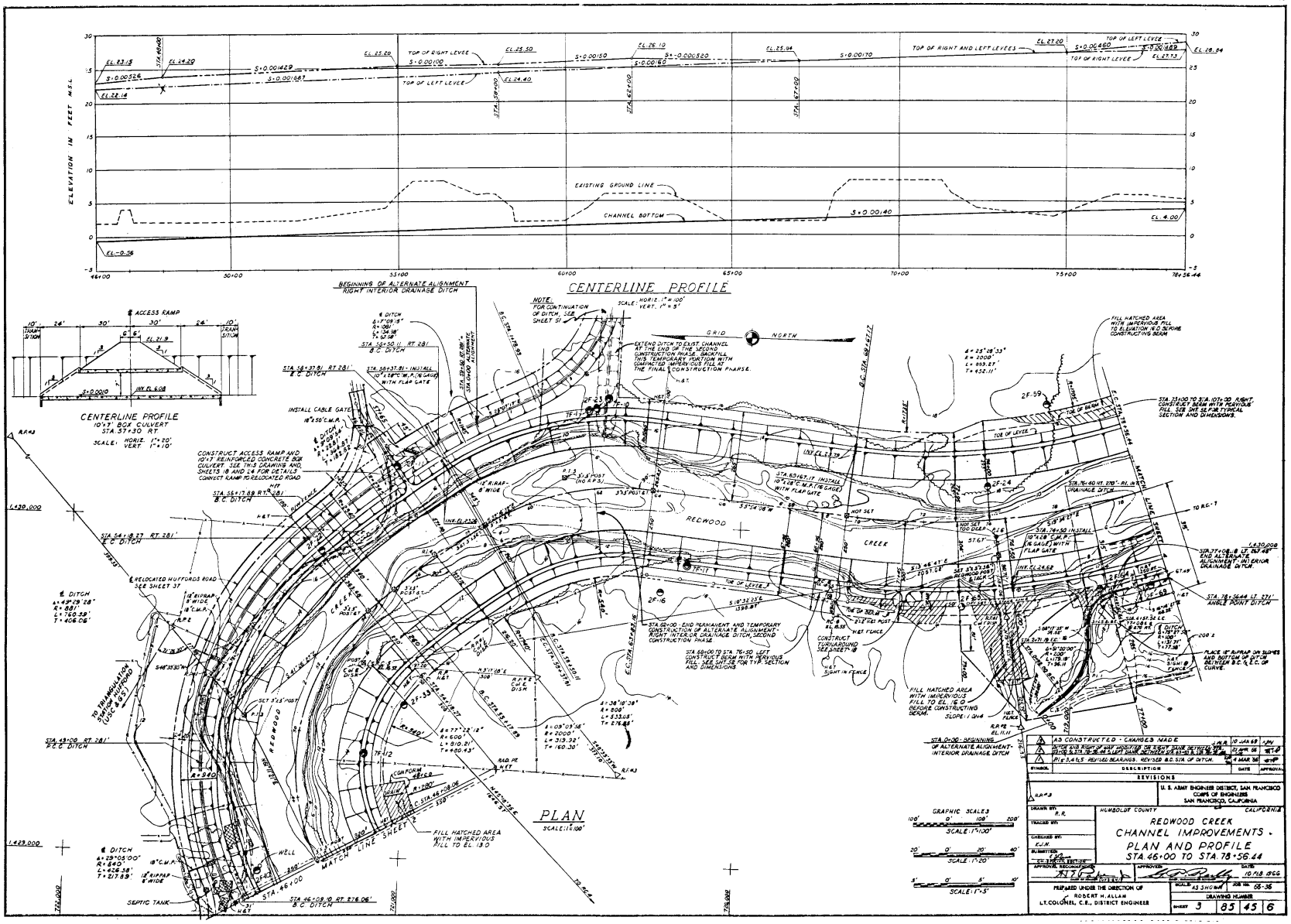


PLATE A-6b

PESCADERO 4067

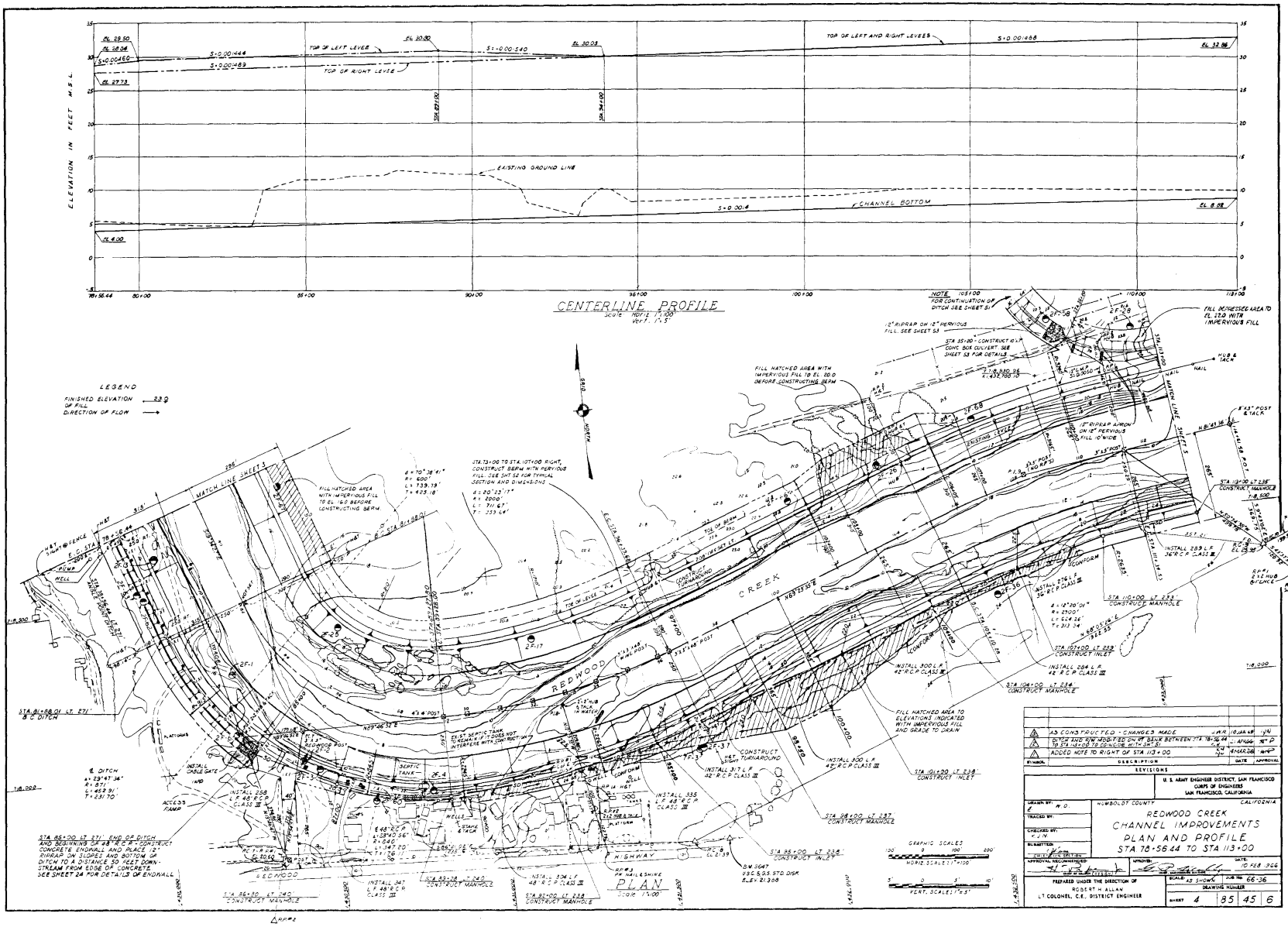


PLATE A-6c

PESCADERO 4069

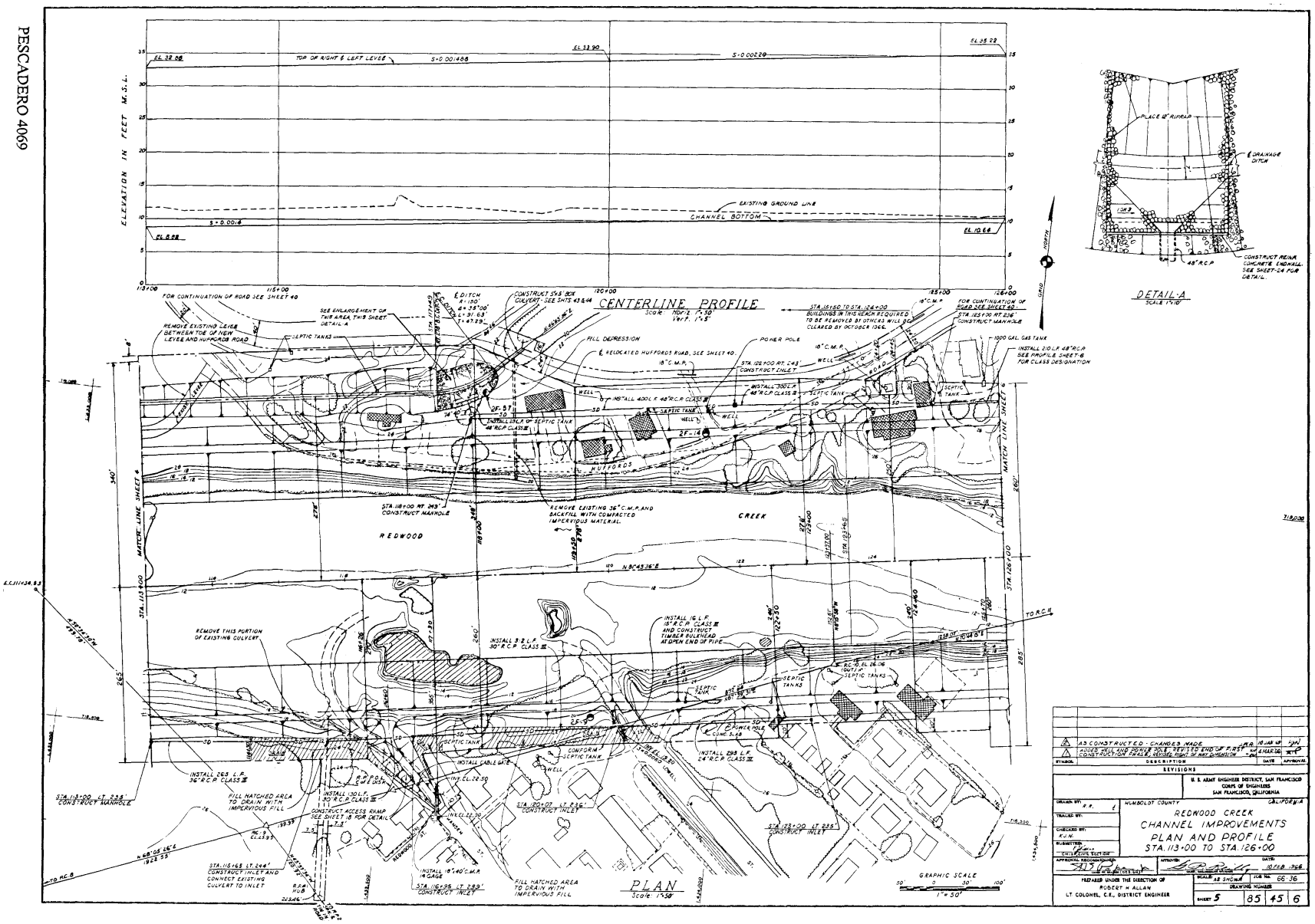


PLATE A-6d

PESCADERO 4071

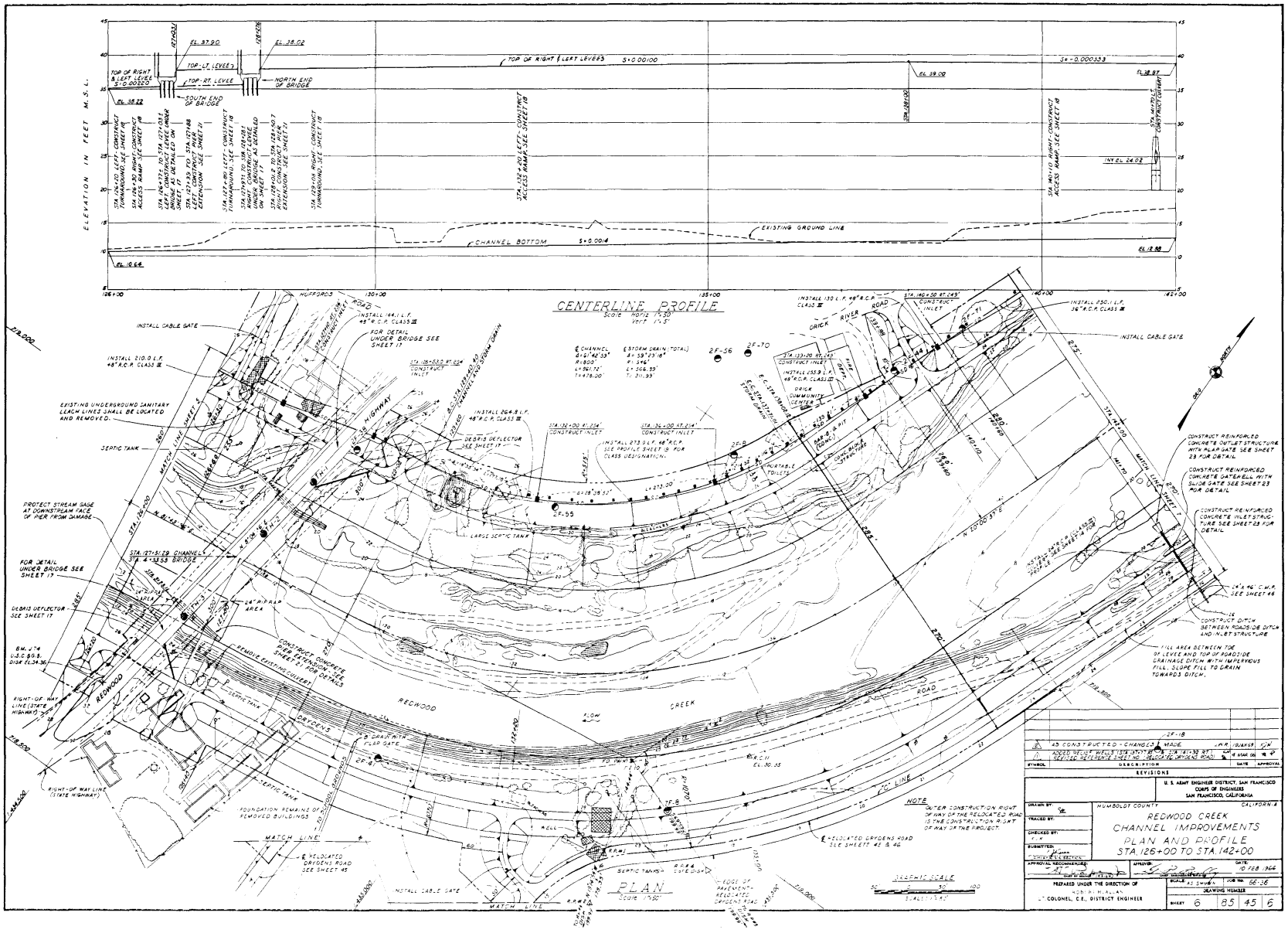


PLATE A-6e

PESCADERO 4073

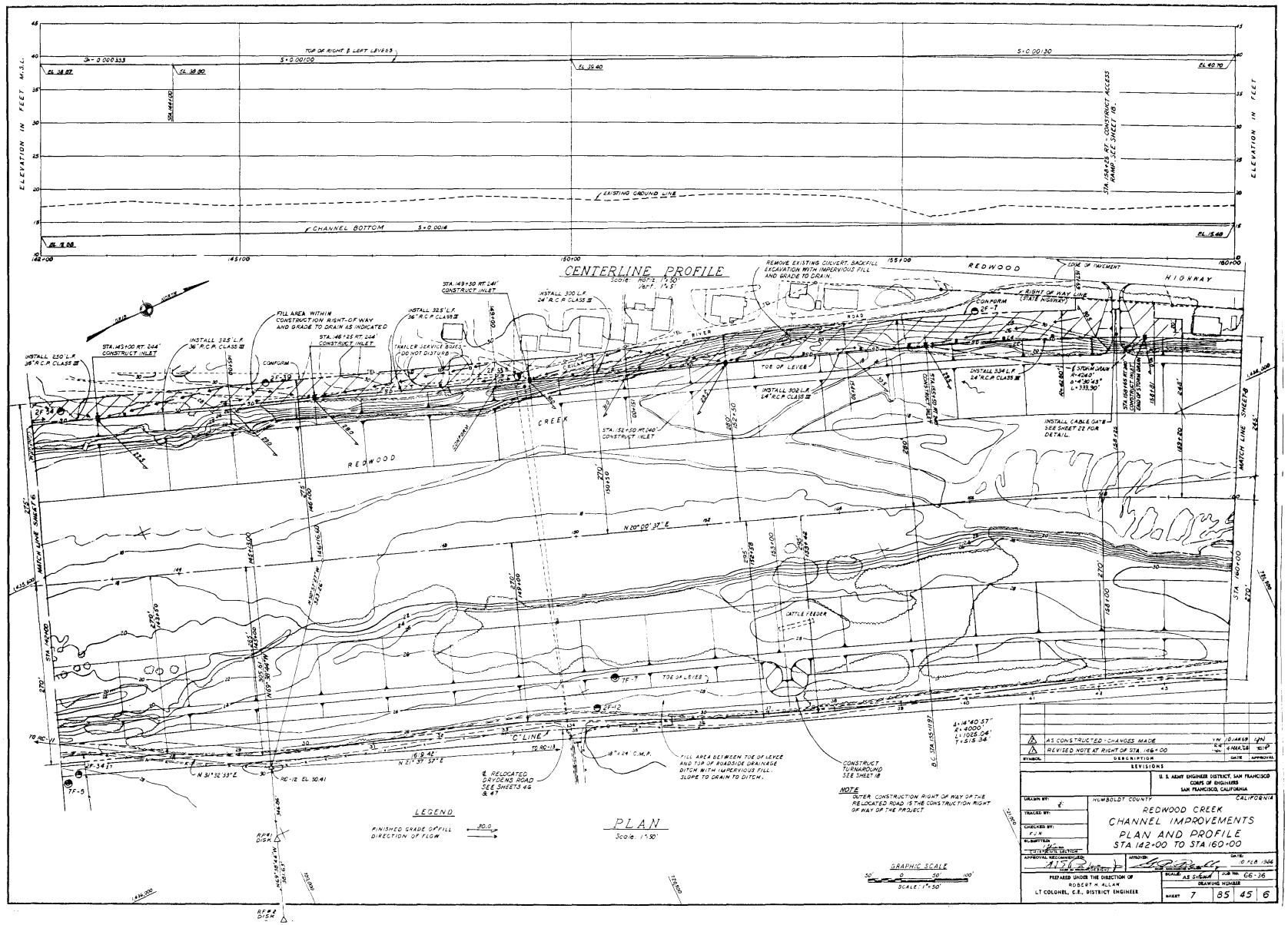


PLATE A-6f

PESCADERO 4075

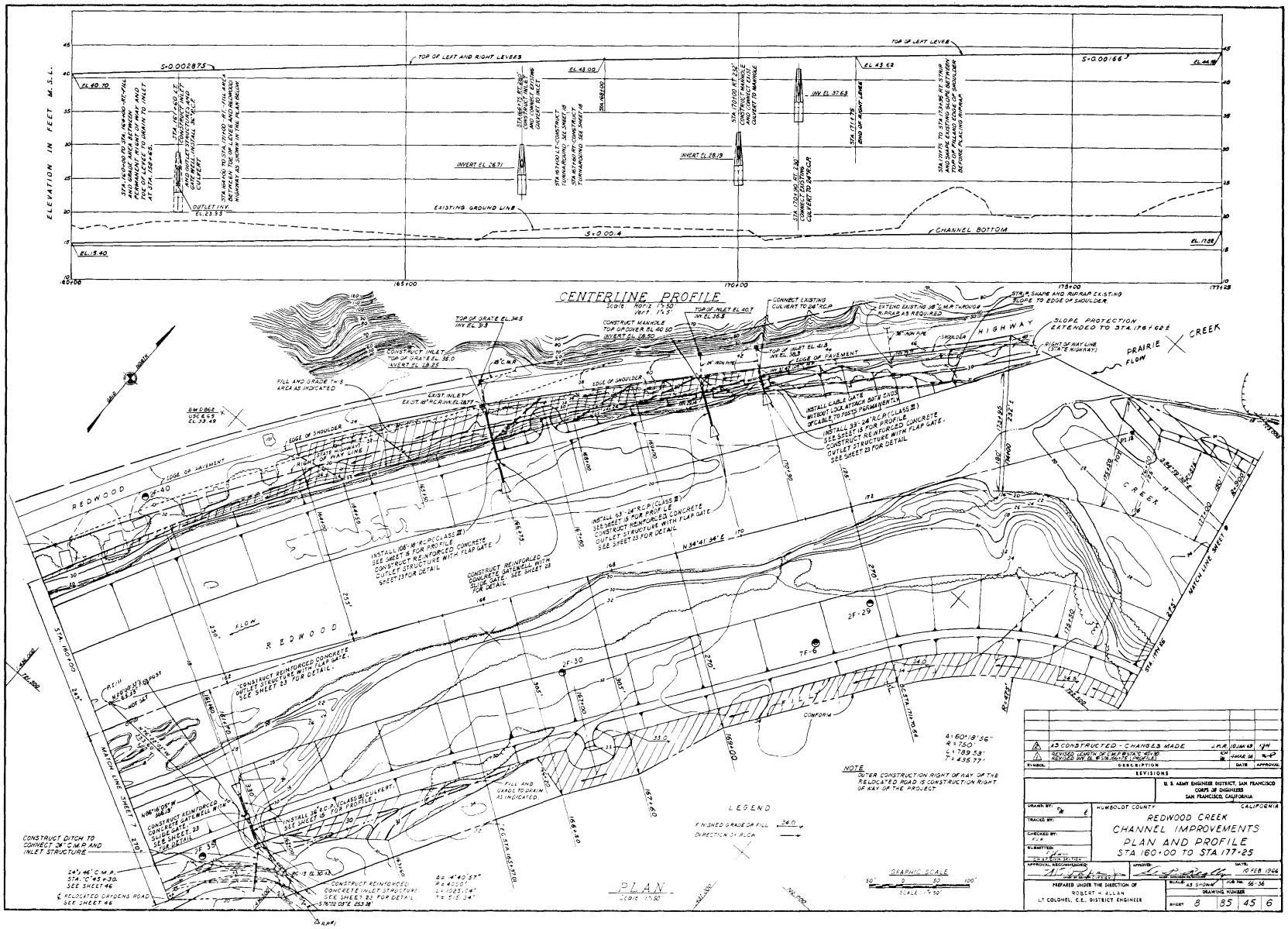


PLATE A-6g

PESCADERO 4077

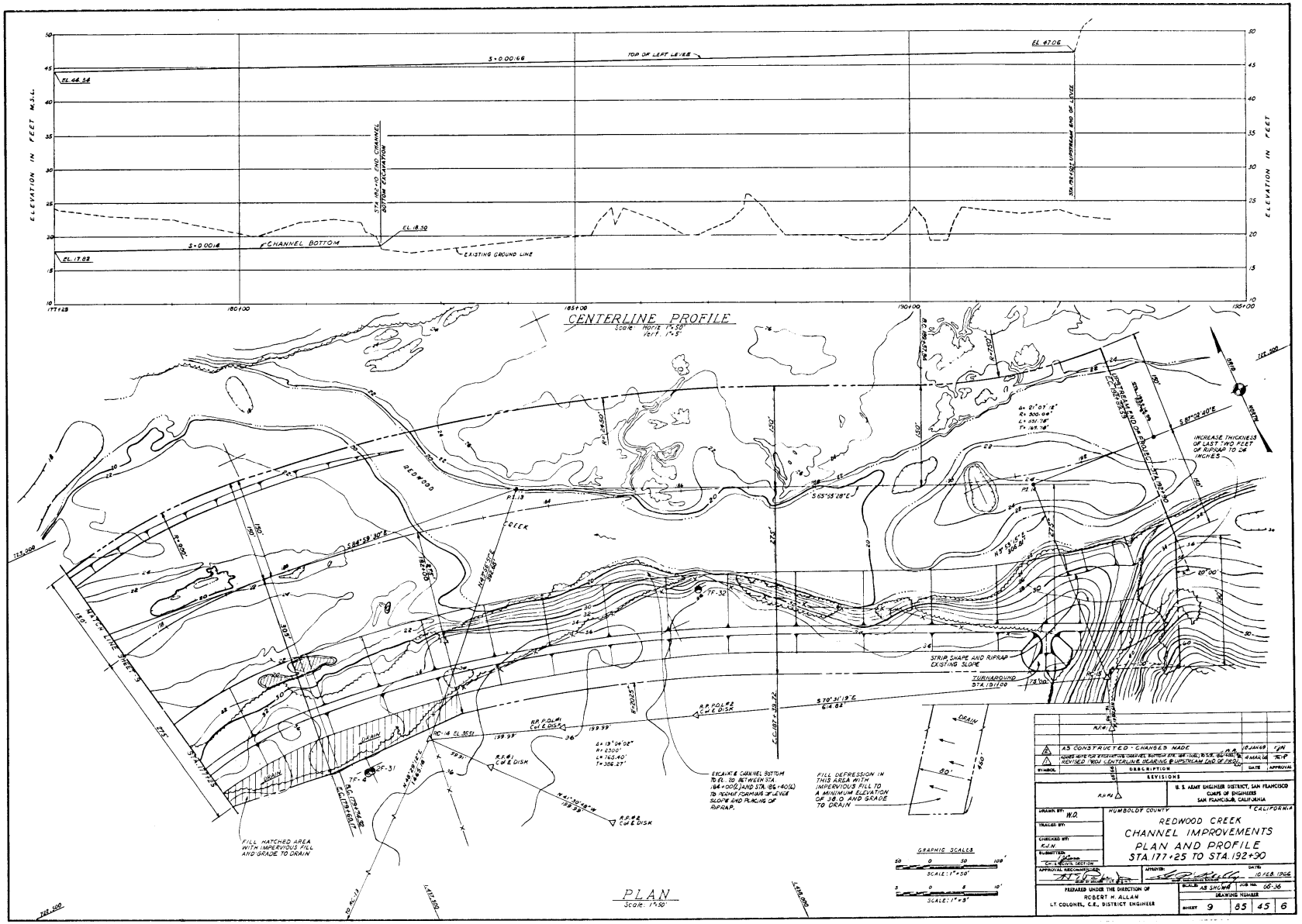
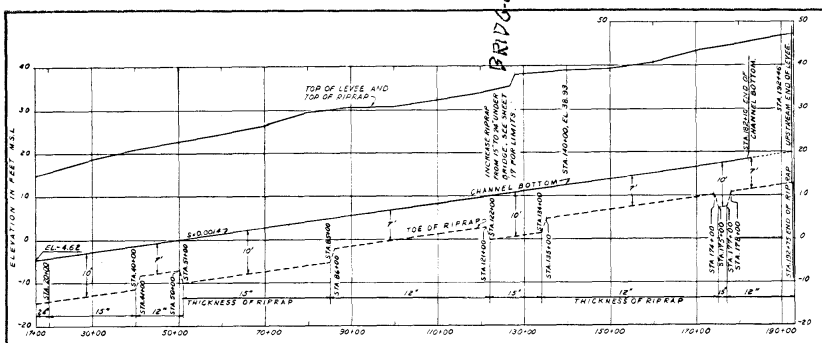


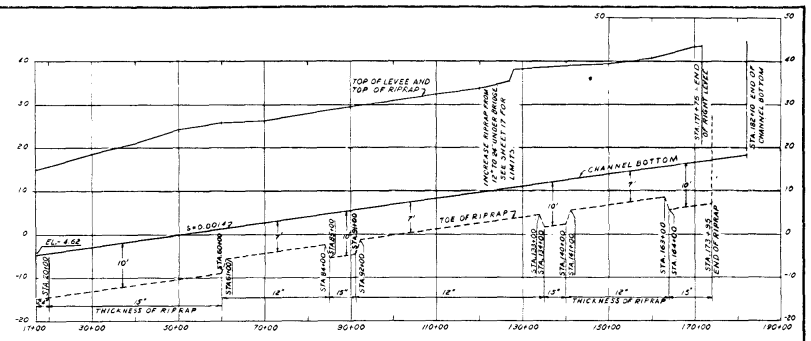
PLATE A-6h

PESCADERO 4079



PROFILES — LEFT LEVEE

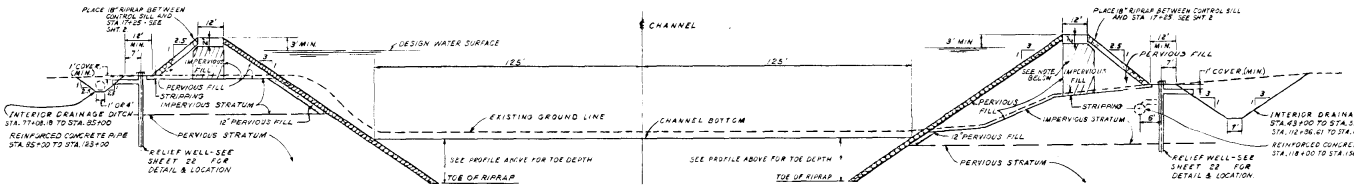
SCALE: HORIZ 1"=1000'
VERT. 1"=10'



PROFILES — RIGHT LEVEE

SCALE: HORIZ 1"=1000'
VERT. 1"=10'

NOTE:
THICKNESS OF RIPRAP AND PERVIOUS FILL UNDER RIPRAP TO BE INCREASED BY 30% WHEN PLACED UNDER WATER.



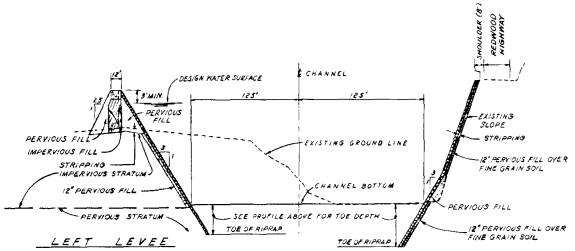
LEFT LEVEE

TYPICAL CROSS SECTION
STA. 17+00 TO STA. 171+75

SCALE: HORIZ 1"=20'
VERT. 1"=10'

RIGHT LEVEE

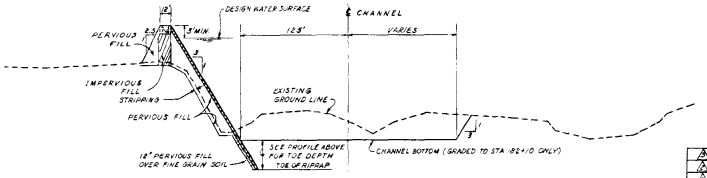
NOTE
TYPICAL - WIDTH OF CORE = 14'-6"



LEFT LEVEE

TYPICAL CROSS SECTION
STA. 171+75 TO STA. 173+95

SCALE: HORIZ 1"=50'
VERT. 1"=10'



LEFT LEVEE

TYPICAL CROSS SECTION
STA. 173+95 TO STA. 192+90

SCALE: HORIZ 1"=100'
VERT. 1"=10'

GRAPHIC SCALES

1000' 0' 1000' 2000'
SCALE: 1"=1000'

50' 0' 50' 100'
SCALE: 1"=50'

10' 0' 10' 20'
SCALE: 1"=10'

20' 0 20' 40'
SCALE: 1"=20'

SYMBOL	DESCRIPTION	DATE	APPROVAL
3	AS CONSTRUCTED - CHANGES MADE	J.N.R	10 JAN 68
2	CHANGED STATIONING INT. DRAINAGE DITCH, 5 & 6 TYP. CROSS SECT.	21 APR 66	
1	ADDED 18" RIPRAP TO TYP CROSS SECTION STA. 171+00 TO STA. 171+75	6 MAR 66	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: GPE
TRACED BY:
CHECKED BY: E.J.K.
SUBMITTED:
SUPERVISORY ENGINEER
APPROVAL RECOMMENDED:

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
TYPICAL CROSS SECTIONS AND PROFILES

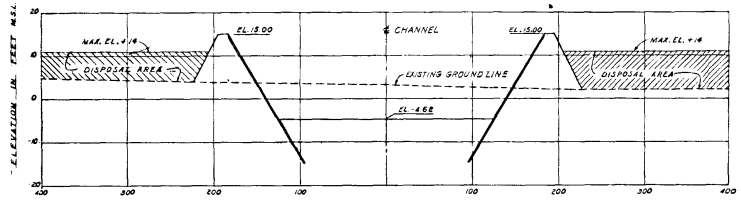
APPROVED: DATE: 10 FEB 1966

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

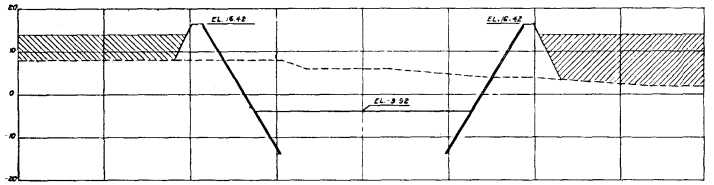
SCALE: AS SHOWN
JOB NO. 66-36
DRAWING NUMBER
SHEET 10 85 45 6

PLATE A-7

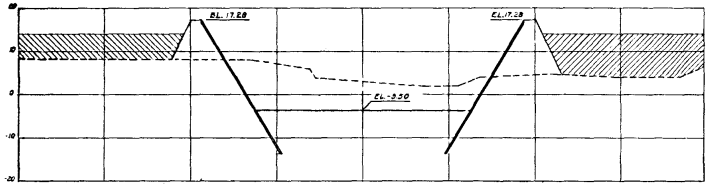
PESCADERO 4081



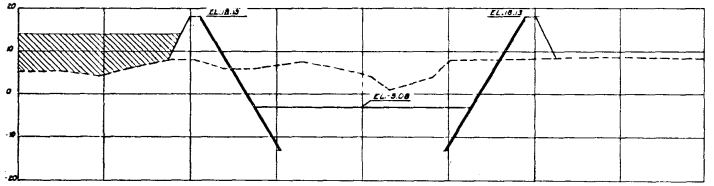
STA. 17+00



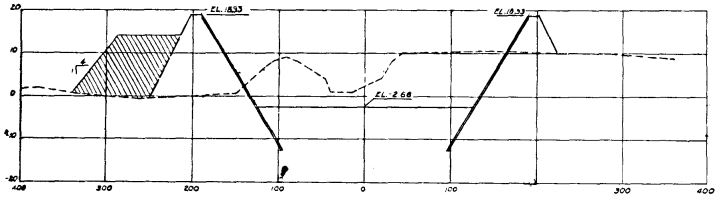
STA. 22+00



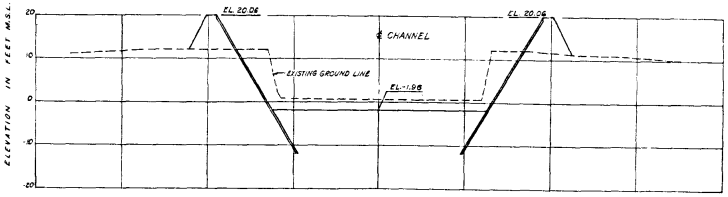
STA. 25+00



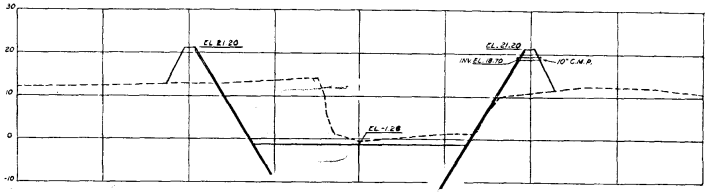
STA. 28+00



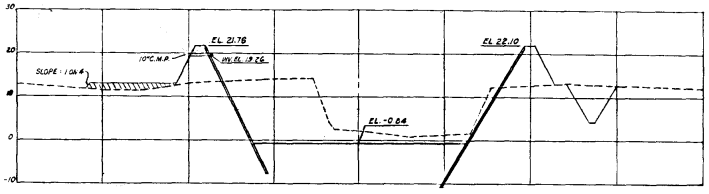
STA 31+00



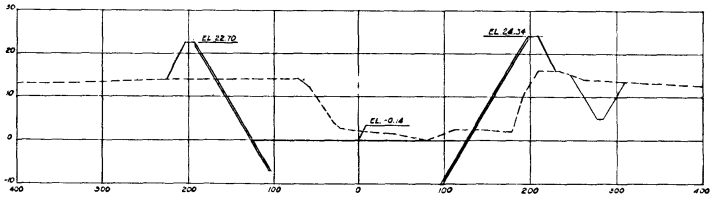
STA. 36+00



STA. 41+00



STA. 44+00



STA. 49+00

GRAPHIC SCALES

50' 0 50' 100'
SCALE: 1"=50'

10' 0 10' 20'
SCALE: 1"=10'

SYMBOL	DESCRIPTION	DATE	APPROVED
△	AS CONSTRUCTED - NO CHANGES MADE	JAN. 29	J.M.
	REVISIONS		

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY:
TRACED BY:
CHECKED BY: K.J.K.
SUBMITTED: [illegible]
APPROVED RECOMMENDED: [illegible]
APPROVED: [illegible]
DATE: 10 FEB 1966

HUMBOLDT COUNTY CALIFORNIA

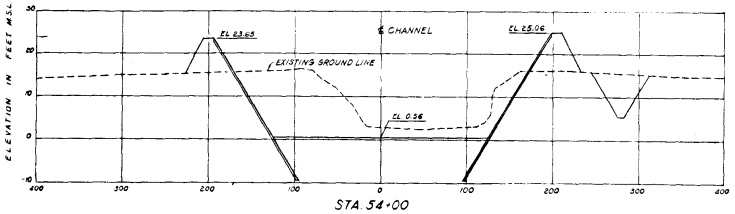
REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 17+00 TO STA. 49+00

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

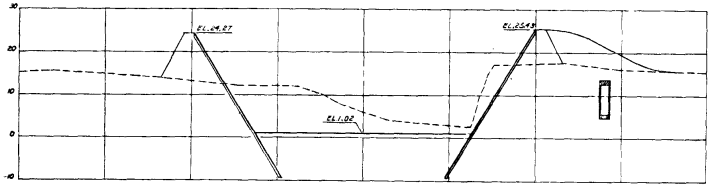
SCALE AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 11 | 83 | 45 | 6

PLATE A-8a

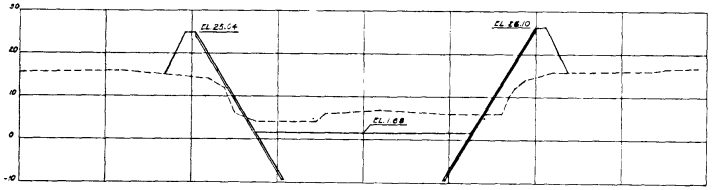
PESCADERO 4083



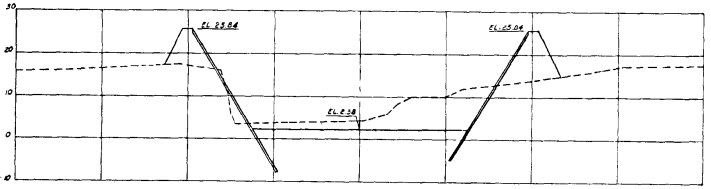
STA. 54+00



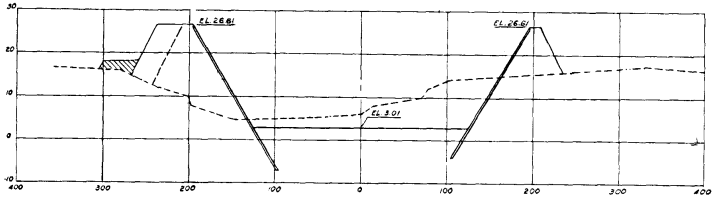
STA. 57+30



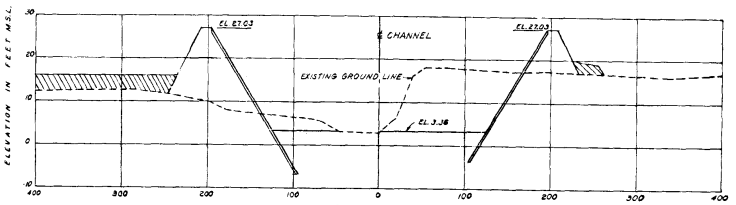
STA. 62+00



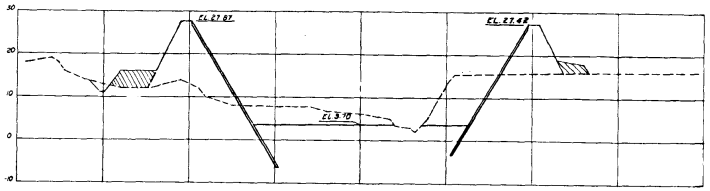
STA. 67+00



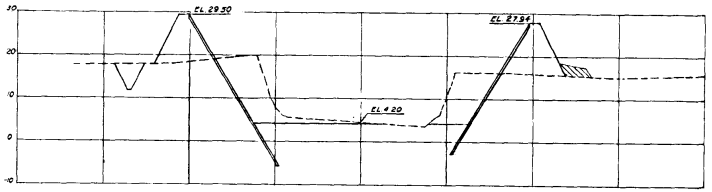
STA. 71+50



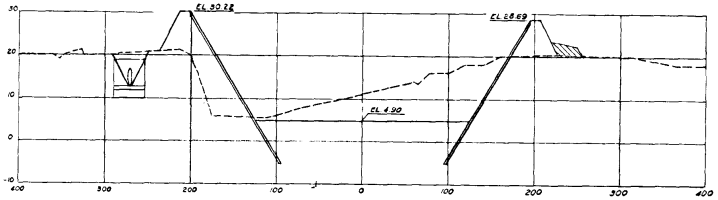
STA. 74+00



STA. 76+45



STA. 80+00



STA. 85+00

GRAPHIC SCALES

50' 0 50' 100'
SCALE: 1"=50'

10' 0 10' 20'
SCALE: 1"=10'

3	AS CONSTRUCTED - NO CHANGES MADE	J.H.A.	G.D.JANO
2	DELETED INTERIOR DRAINAGE DITCHES & ADDED BERMS		21 APR 66
1	REVISED CROSS SECTION STA. 57+30		4 MAR 66
SYMBOL	DESCRIPTION		DATE APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: J
TRACED BY:
CHECKED BY: K.J.H.
QUANTITIES BY:
CHIEF, DESIGN SECTION
APPROVED RECOMMENDED

HUMBOLDT COUNTY
CAL. 4-0201-18

REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 54+00 TO STA. 85+00

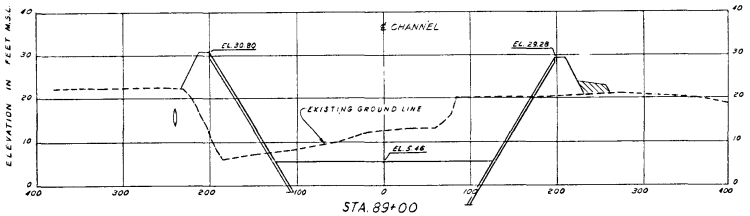
APPROVED
DATE 10 FEB 1964

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

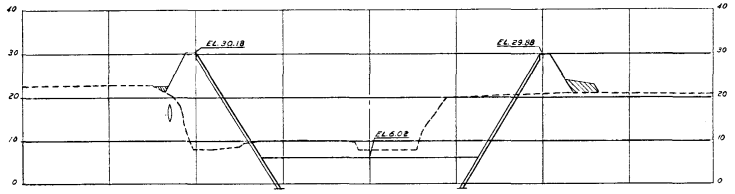
SCALE AS SHOWN
DRAWING NUMBER
SHEET 12 | 85 45 6

PLATE A-8b

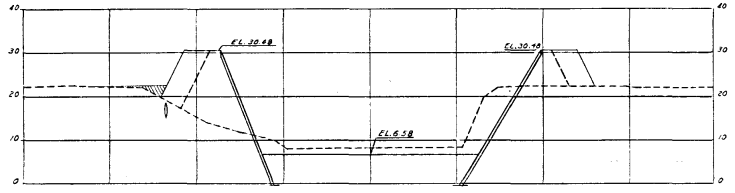
PESCADERO 4085



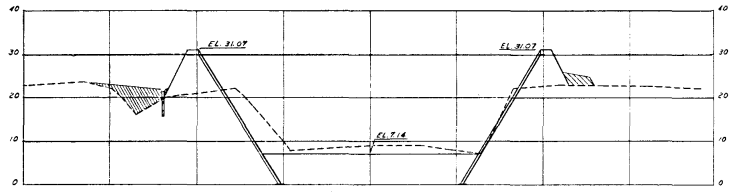
STA. 89+00



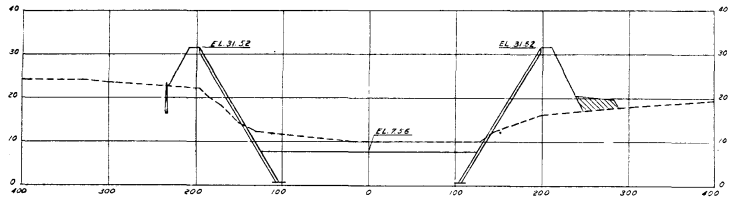
STA. 93+00



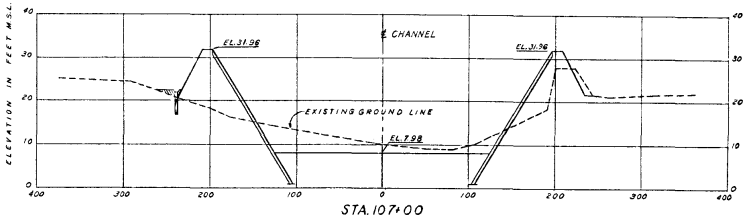
STA. 97+00



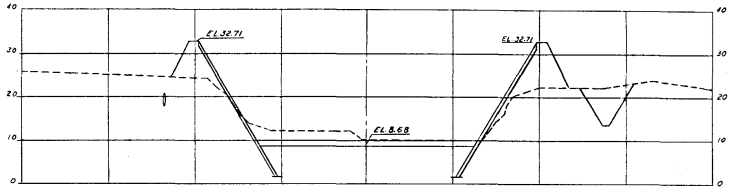
STA. 101+00



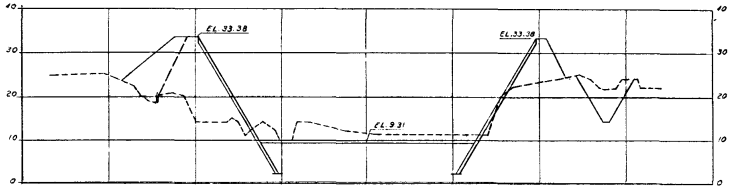
STA. 104+00



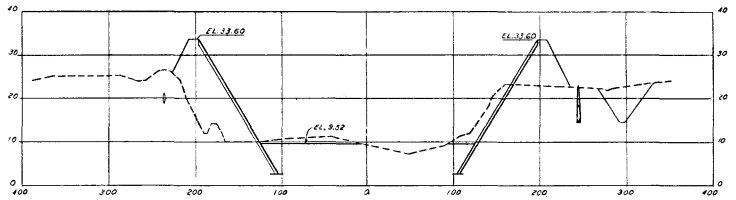
STA. 107+00



STA. 112+00



STA. 116+50



STA. 118+00

GRAPHIC SCALES

SCALE: 1"=50'

SCALE: 1"=10'

SYMBOL	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
3	AS CONSTRUCTED - NO CHANGES MADE	J.N.R.	E.D.JANIO	RJM	
2	DELETED INTCHOR DRAINAGE DITCH, ADDED BERMS	RJM			21 APR 66

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: G.P.E.
TRACED BY:
CHECKED BY: R.J.M.
SUBMITTED:
APPROVED RECOMMENDED:

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 89+00 TO STA. 118+00

APPROVED: DATE: 10 FEB 1956

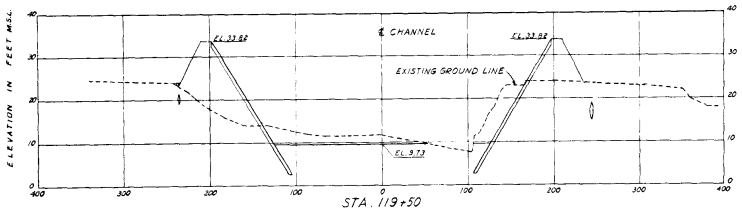
PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN JOB NO. 66-36

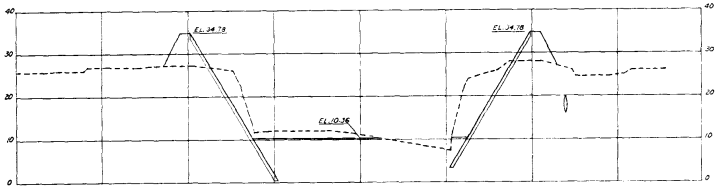
DRAWING NUMBER
SHEET 13 | 85 | 45 | 6

PLATE A-8c

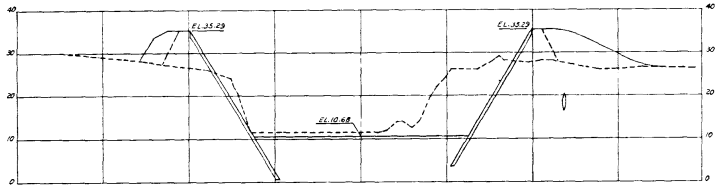
PESCADERO 4087



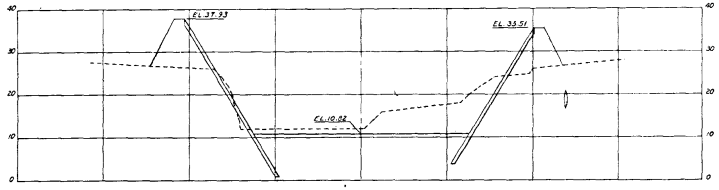
STA. 119+50



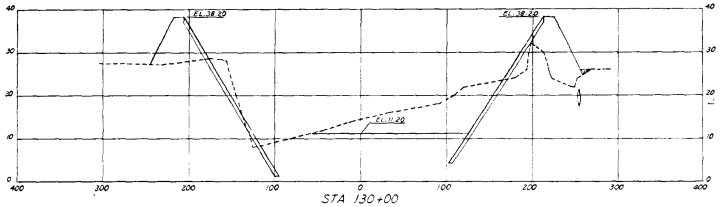
STA. 124+00



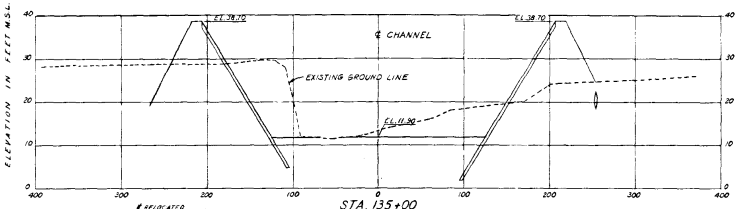
STA. 126+30



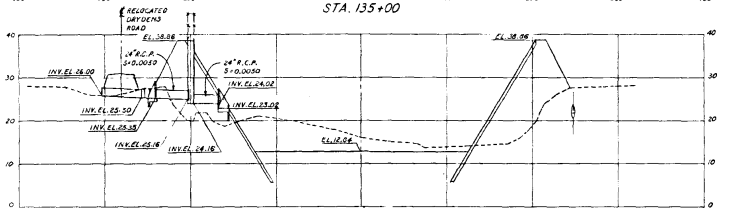
STA. 127+30



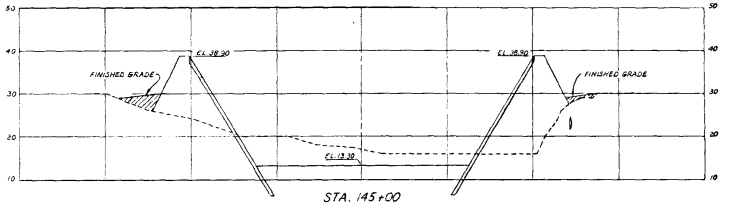
STA. 130+00



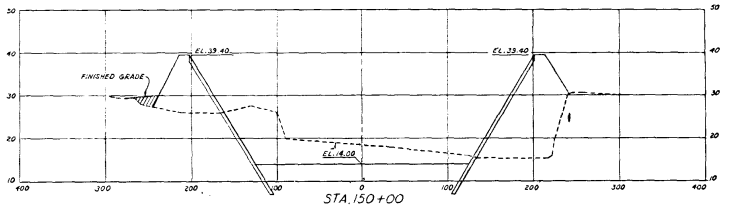
STA. 135+00



STA. 141+70



STA. 145+00



STA. 150+00

GRAPHIC SCALES

50' 0 50' 100'
SCALE: 1"=50'

10' 0 10' 20'
SCALE: 1"=10'

SYMBOL	DESCRIPTION	DATE	APPROVAL
	REVISIONS		
⚠	AS CONSTRUCTED - NO CHANGES MADE	23 JAN. 70	RJM

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY:
TRACED BY:
CHECKED BY: R.J.M
SUBMITTED:
DIVISION CHIEF
APPROVAL RECOMMENDED:
DISTRICT ENGINEER

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 119+50 TO STA. 150+00

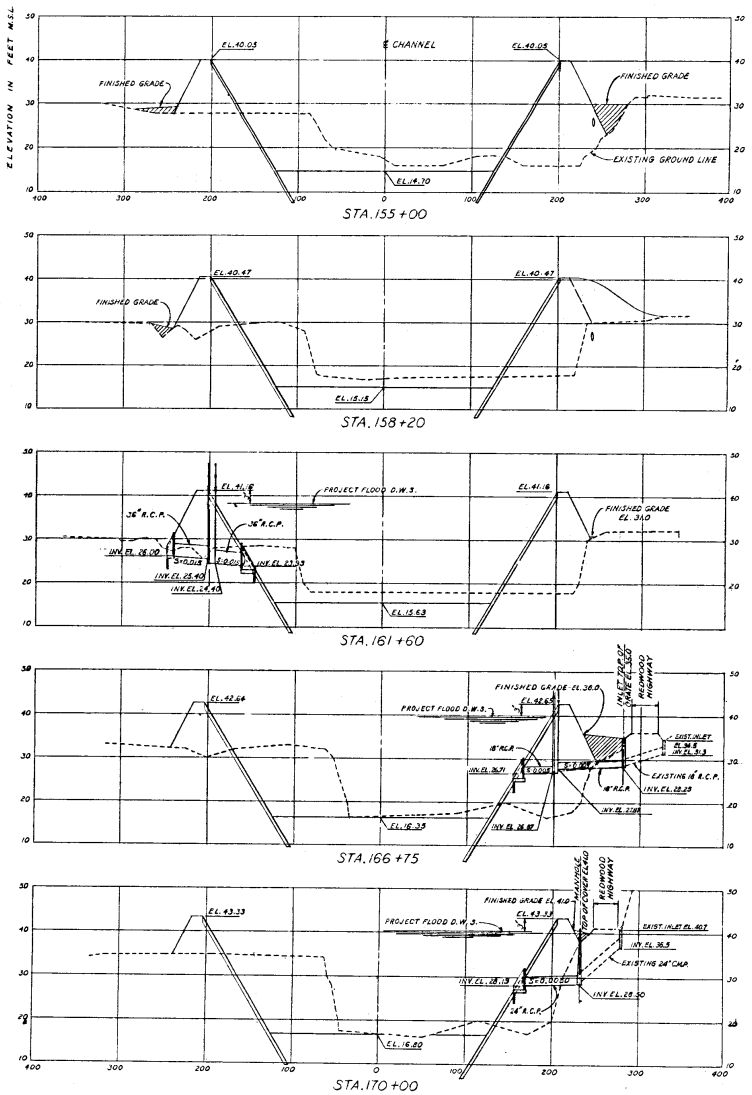
APPROVED:
DIVISION ENGINEER
DATE: 10 FEB. 1970

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
DRAWING NUMBER
SHEET 14 | 85 | 45 | 6

PLATE A-8d

PESCADERO 4089



GRAPHIC SCALES

50' 0 50' 100'

SCALE: 1"=50'

10' 0 10' 20'

SCALE: 1"=10'

SYMBOL	DESCRIPTION	DATE	APPROVAL
1	AS CONSTRUCTED - NO CHANGES MADE J.M.A.B. JAN 67		

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: R.R.
TRACED BY:
CHECKED BY: K.J.N.
SUBMITTED: Chief, Design Section
APPROVAL RECOMMENDED:
APPROVED:
DATE: 10 FEB. 1966

HUMBOLDT COUNTY CALIFORNIA

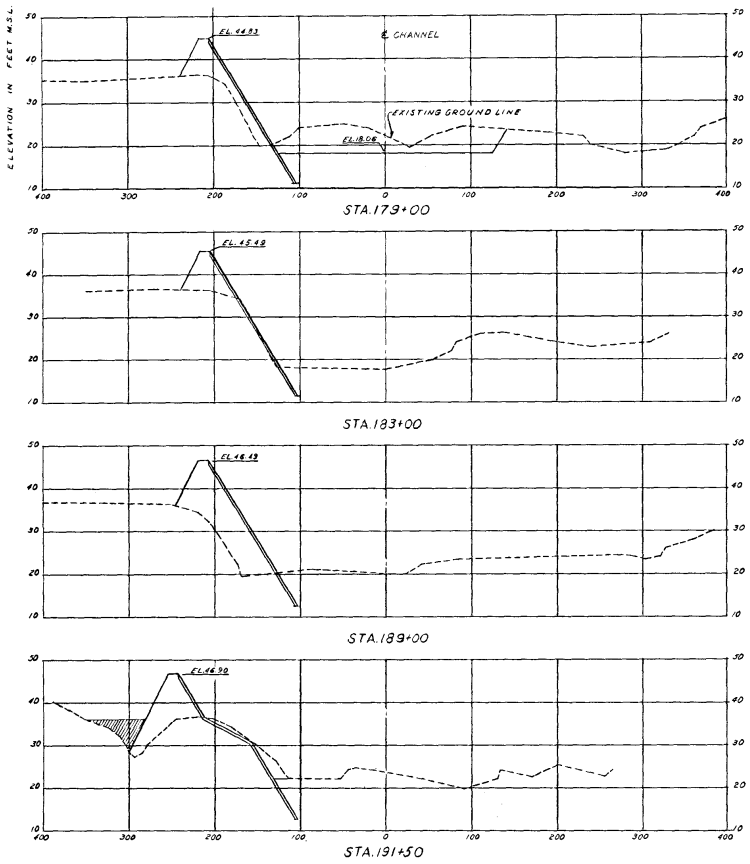
REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 155+00 TO STA. 175+50

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 13 | 85 45 6

PLATE A-8e

PESCADERO 4091



GRAPHIC SCALES

SCALE: 1"=50'

SCALE: 1"=10'

1	AS CONSTRUCTED - NO CHANGES MADE	JNR	8 JAN 19
SYMBOL	DESCRIPTION	DATE	APPROVAL

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: G.P.E.
TRACED BY:
CHECKED BY: R.J.N.
QUANTITIES BY:
LAID OUT BY:
APPROVAL RECOMMENDED:

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
CROSS SECTIONS
STA. 179+00 TO STA. 191+50

APPROVED:
DATE: 12 FEB 1968

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN
JOB NO.
DRAWING NUMBER
SHEET 16 | 85 | 45 | 6

PLATE A-8f

PESCADERO 4097

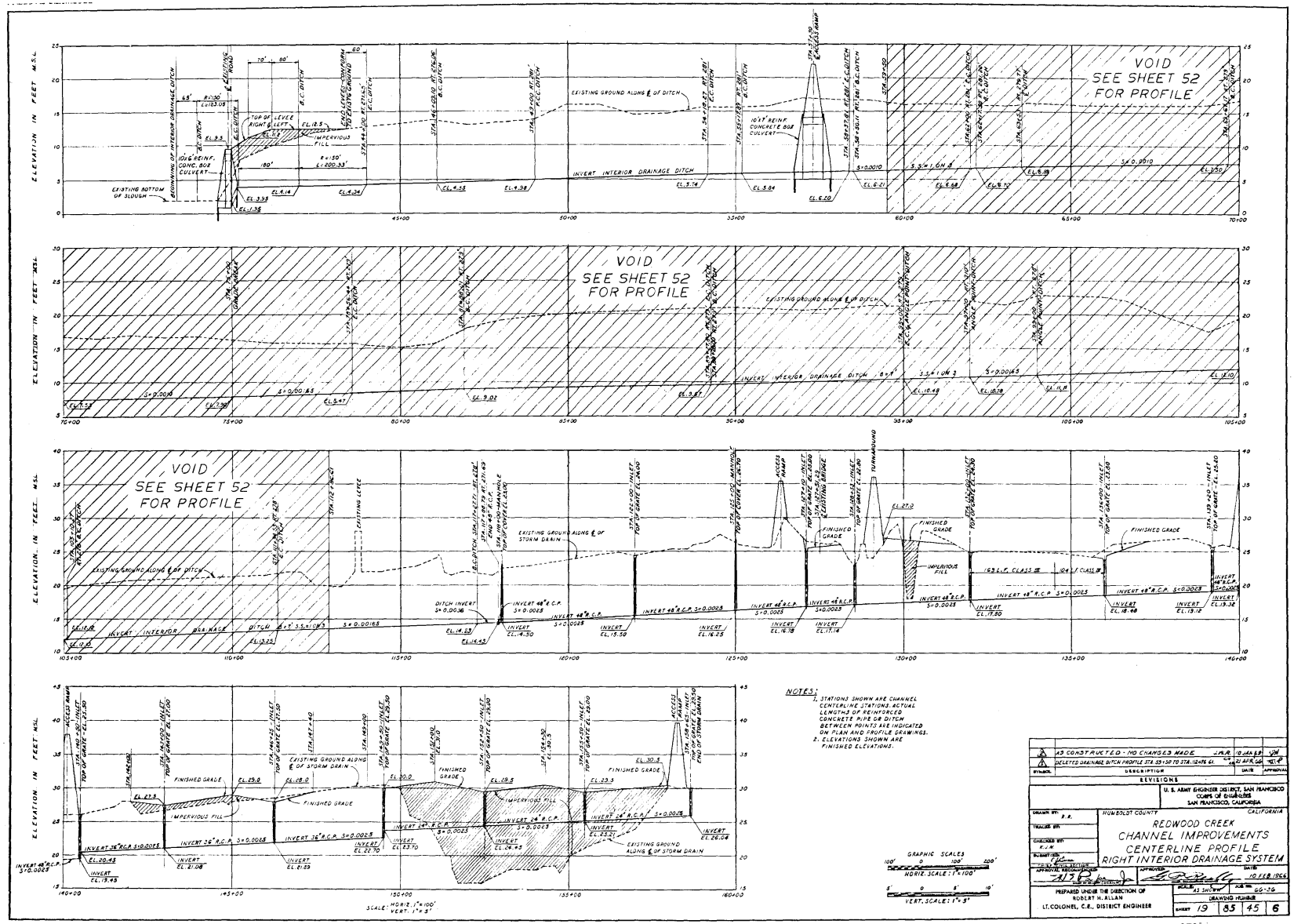
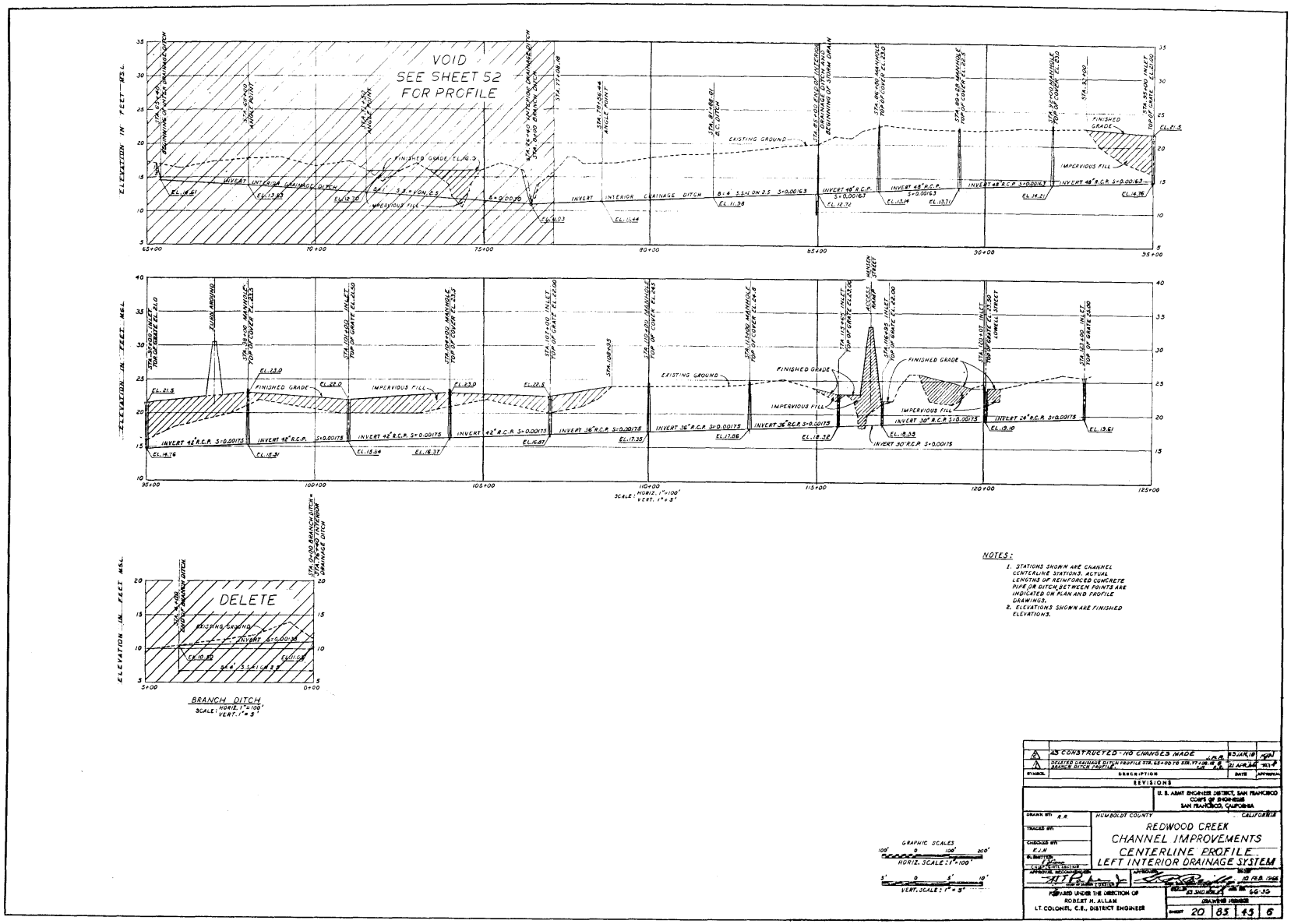


PLATE A-9a

PESCADERO 4099



NOTES:

1. STATIONS SHOWN ARE CHANNEL CENTERLINE STATIONS. ACTUAL LENGTHS OF REINFORCED CONCRETE PIPE OR DITCH BETWEEN POINTS ARE INDICATED ON PLAN AND PROFILE DRAWINGS.
2. ELEVATIONS SHOWN ARE FINISHED ELEVATIONS.

SYMBOL	DESCRIPTION	DATE	APPROVAL
3	AS CONSTRUCTED - NO CHANGES MADE	83 JAN 18	
2	DELETED DRAINAGE DITCH PROFILE STA. 63+00 TO STA. 77+18.18 & BRANCH DITCH PROFILE	82 NOV 22	
1			

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY R.B.
TRACED BY
CHECKED BY E.J.N.
QUANTITY CHECKED
APPROVED FOR CONSTRUCTION

HUMBOLDT COUNTY — CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
CENTERLINE PROFILE
LEFT INTERIOR DRAINAGE SYSTEM

APPROVED 10 FEB 1966

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAM
LT. COLONEL, C.E., DISTRICT ENGINEER

DESIGNED
DRAWN
CHECKED
SUBMITTED
RECOMMENDED
APPROVED
DATE 83 JAN 18
SCALE AS SHOWN
DRAWING NUMBER 56-30
SHEET 20 | 85 | 45 | 6

PLATE A-9b

PESCADERO 4161

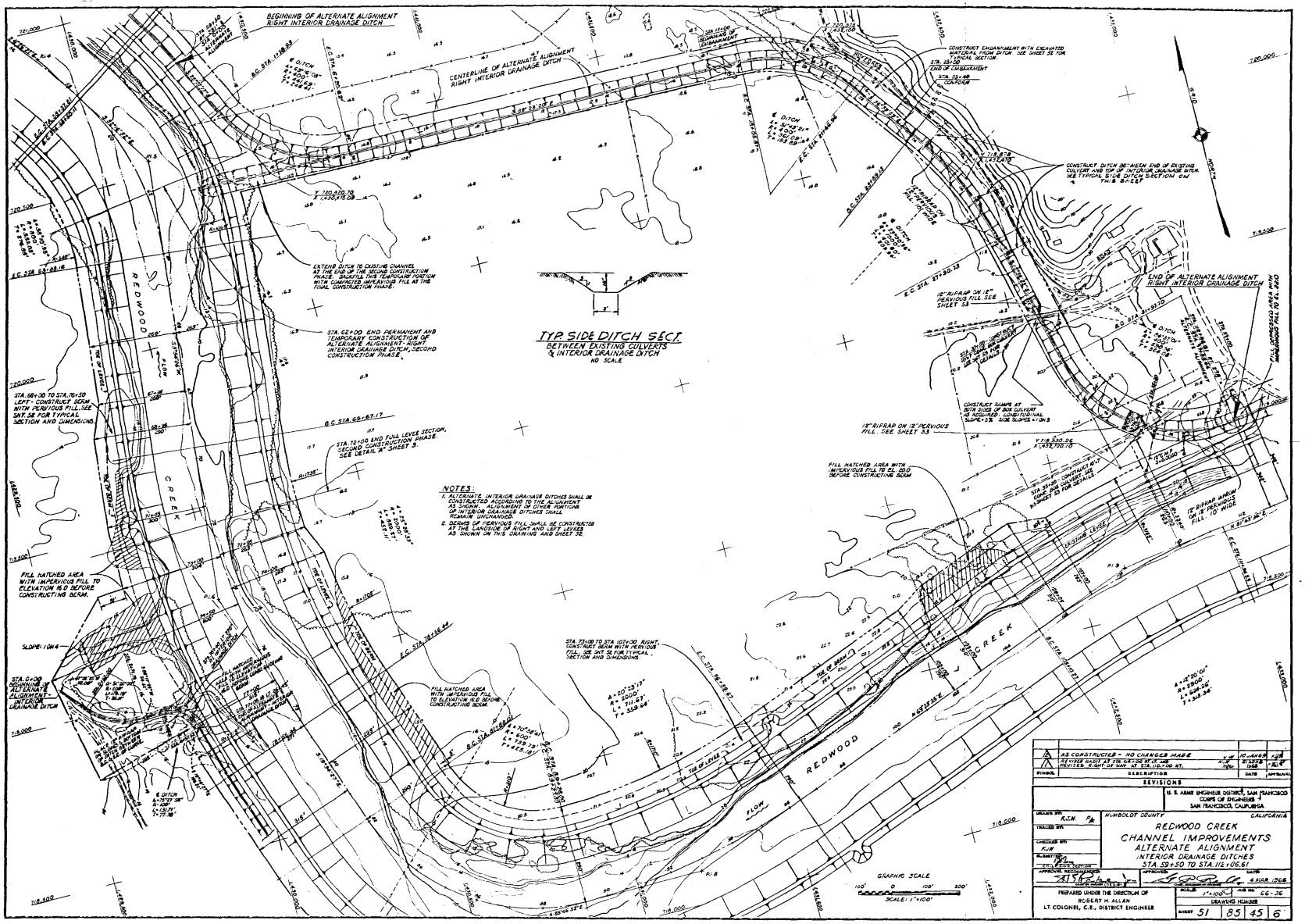
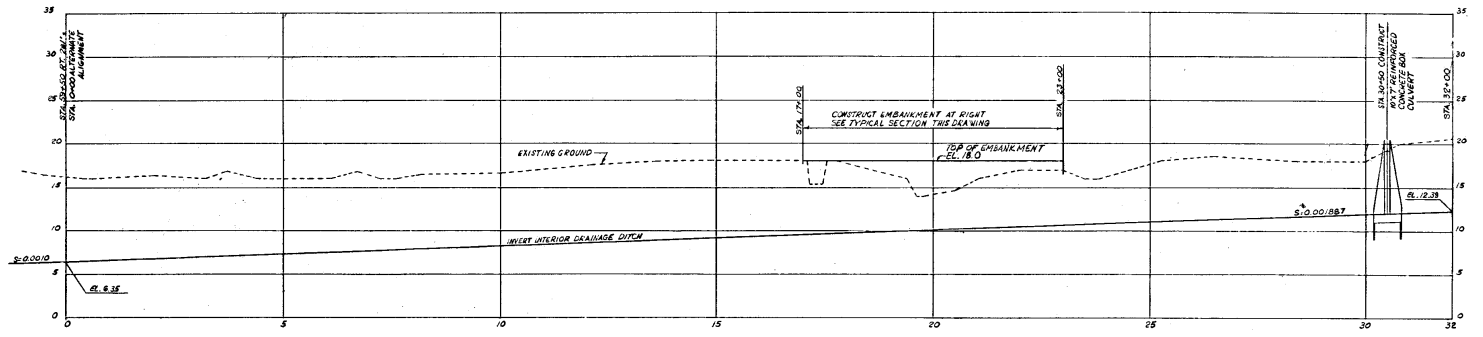


PLATE A-10

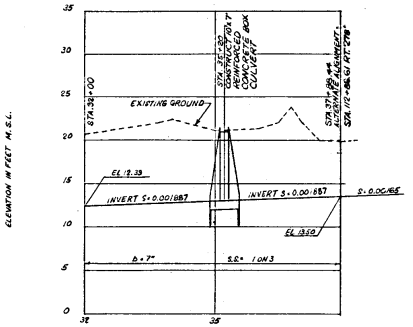
PESCADERO 4163



CENTERLINE PROFILE

ALTERNATE ALIGNMENT - RIGHT INTERIOR DRAINAGE DITCH

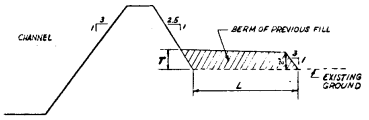
SCALE : HOR. 1"=100'
VERT. 1"=5'



CENTERLINE PROFILE

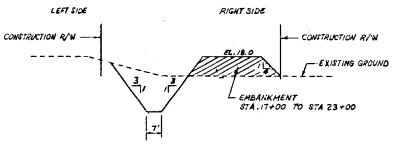
ALTERNATE ALIGNMENT - RIGHT INTERIOR DRAINAGE DITCH

SCALE : HOR. 1"=100'
VERT. 1"=5'



TYPICAL BERM SECTION

NO SCALE



TYPICAL SECTION

RIGHT INTERIOR DRAINAGE DITCH - ALTERNATE ALIGNMENT

NO SCALE

LEVEE BERM

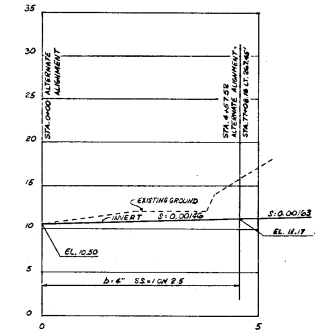
STA. 68+00 TO STA. 107+00

LEFT BANK			RIGHT BANK		
STATION	L (ft)	T (ft)	STATION	L (ft)	T (ft)
68+00	0	3.0	73+00	0	3.0
69+00	26	3.0	74+00	20	3.0
70+00	32	3.3	75+00	30	3.0
71+00	36	3.5	76+00	30	3.0
72+00	40	3.7	77+00	30	3.2
73+00	43	3.0	78+00	30	3.2
74+00	46	4.0	79+00	30	3.2
75+00	50	3.3	80+00	30	3.2
76+00	26	3.0	81+00	30	3.2
76+50	0	3.0	82+00	30	3.0
			83+00	30	3.0
			84+00	30	3.0
			85+00	30	3.0
			86+00	30	3.0
			87+00	30	3.0
			88+00	30	3.0
			89+00	30	3.0
			90+00	30	3.0
			91+00	30	3.0
			92+00	30	3.0
			93+00	30	3.0
			94+00	30	3.0
			95+00	30	3.0
			96+00	30	3.0
			97+00	0	3.0
			98+00	30	3.0
			99+00	30	3.0
			100+00	30	3.0
			101+00	30	3.0
			102+00	30	3.0
			102+80	30	3.2
			103+90	40	3.7
			104+90	40	3.7
			106+00	40	3.2
			107+00	0	3.3

STATION	WELL NO.	ELEV. COVER	COVER PLATE TO GROUND WATER	SOUNDED DEPTH 1967	SOUNDED DEPTH 1968
110 00 R	1	21.97	14.6	34.6	
111 25 R	2	24.18	13.8	38.0	
1.25 68 (R)	3	24.68	13.5	48.4	49.2
1.25 63 (R)	4	27.24	13.7	41.0	43.0
1.31 38 (R)	5	25.68	15.1	53.0	44.1
1.31 75 (R)	6	25.84	14.8	53.0	52.9
1.32 48 (R)	7	26.48	14.8	55.6	52.6
1.32 73 (R)	8	25.18	14.8	57.2	57.2
1.33 21 (R)	9	25.88	14.3	55.0	53.1
1.33 88 (R)	10	26.07	14.4	51.0	51.6
1.34 04 (R)	11	25.78	13.8	58.2	58.2
1.34 41 (R)	12	25.28	13.8	101.0	100.8
1.34 77 (R)	13	25.58	13.8	79.2	81.0
1.35 14 (R)	14	26.07	14.4	100.8	100.8
1.35 38 (R)	15	26.87	15.0	67.2	67.1
1.35 87 (R)	16	26.78	15.0	67.2	66.1
1.36 24 (R)	17	25.78	15.0	79.2	78.1
1.36 60 (R)	18	25.38	14.1	67.2	67.2
1.36 98 (R)	19	25.38	14.1	67.2	67.2
1.37 34 (R)	20	24.4	13.2	82.2	82.2
1.37 71 (R)	21	25.18	15.2	82.2	82.2
1.38 08 (R)	22	25.68	15.2	101.0	101.0
1.38 31 (R)	23	25.68	15.0	66.1	66.1
1.38 58 (R)	24	25.68	15.0	66.1	66.1
1.38 82 (R)	25	25.73	17.3	66.4	66.4
1.39 06 (R)	26	27.38	15.0	66.1	66.4
1.39 31 (R)	27	27.38	15.0	66.1	82.8
1.39 78 (R)	28	27.58	15.0	66.1	97.2
1.40 03 (R)	29	27.68	15.0	66.7	66.7
1.40 41 (R)	30	27.68	15.0	66.1	66.1
1.40 62 (R)	31	27.68	15.0	66.1	81.1
1.40 73 (R)	32	28.08	15.0	81.0	80.9
1.41 28 (R)	33	28.28	15.0	66.7	80.9
1.41 66 (R)	34	28.88	16.0	30.2	30.3
1.42 03 (R)	35	28.88	16.0	66.7	66.7
1.44 28 (R)	36	30.78	17.4	30.9	31.0
1.44 67 (R)	37	31.08	18.0	30.7	30.7
1.45 15 (R)	38	30.68	17.3	46.8	46.8
1.45 52 (R)	39	30.8	17.4	44.8	45.0
1.51 67 (R)	40	30.81	17.2	38.8	38.9
1.52 67 (R)	41	31.08	17.4	38.8	38.7
1.56 87 (R)	42	30.71	17.1	38.4	38.4
1.58 68 (R)	43	30.88	16.8	73.7	73.7
1.52 28 (R)	44	30.5	16.8	66.8	66.8
1.53 91 (R)	45	30.14	16.7	65.8	65.8
1.55 38 (R)	46	30.38	16.7	60.8	60.8
1.57 28 (R)	47	30.38	16.8	60.8	60.8
1.58 28 (R)	48	30.72	24.6	60.8	60.9
78.00 (L)		18.28	14.7	99.7	
79.35 (L)	49	18.87	14.7	88.8	
80.45 (L)	50	19.58	15.2	88.8	
81.38 (L)	51	20.18	15.2	58.8	
82.35 (L)	52	20.78	15.2	51.8	
83.87 (L)	54	21.13	14.5	51.4	

GROUND WATER MEASURED 28 SEPTEMBER 1967.

ELEVATION IN FEET M.S.L.



CENTERLINE PROFILE

ALTERNATE ALIGNMENT - LEFT INTERIOR DRAINAGE DITCH

SCALE : HOR. 1"=100'
VERT. 1"=5'

NOTE:
1. STATIONS SHOWN ARE CENTERLINE STATIONS OF ALTERNATE INTERIOR DRAINAGE DITCHES.
2. TERMINI OF THE ALTERNATE ALIGNMENT OF INTERIOR DRAINAGE DITCHES WILL CONFORM TO THE UPSTREAM AND DOWNSTREAM PORTIONS OF THE PROPOSED DITCHES.

GRAPHIC SCALES

100' 0 100' 200'
SCALE: 1"=100'

5' 0 5' 10'
SCALE: 1"=5'

SYMBOL	DESCRIPTION	DATE	APPROVED
1	AS CONSTRUCTED - CHANGES MADE	18 JAN 68	

REVISIONS

U. S. ARMY ENGINEER DISTRICT, SAN FRANCISCO
CORPS OF ENGINEERS
SAN FRANCISCO, CALIFORNIA

DRAWN BY: MPC
TRACED BY:
CHECKED BY: CJK
SUBMITTED: [illegible]
CHIEF, ENGR. DIVISION
APPROVED RECOMMENDED:

HUMBOLDT COUNTY CALIFORNIA

REDWOOD CREEK
CHANNEL IMPROVEMENTS
PROFILES AND TYPICAL SECTIONS
BERMS AND ALTERNATE DRAINAGE DITCHES

APPROVED: [signature] DATE: 4 MAR 1968

PREPARED UNDER THE DIRECTION OF
ROBERT H. ALLAN
LT. COLONEL, C.E., DISTRICT ENGINEER

SCALE: AS SHOWN JOB NO.
DRAWING NO. 14-B68

SHEET 52 85 45 6

PLATE A-11

APPENDIX B
FIELD EXPLORATION

APPENDIX B - FIELD EXPLORATION

The field exploration program for the Redwood Creek Geotechnical Levee Evaluation Program consisted of explorations advanced using rotosonic (sonic) cores, cone penetration test (CPT) soundings, and hollow-stem auger drill holes. The sonic coring was performed by Major Drilling Environmental, LLC of Sherwood, Oregon. Sonic cores were advanced using a track-mounted Geoprobe Model 8140LS rig. CPT services were provided by Gregg Drilling and Testing, Inc., of Martinez, California using a 20-ton track-mounted CPT rig. A CME-850 track-mounted drill rig was provided by PC Exploration, Inc., of Lincoln, California, for hollow-stem-auger drill holes.

Rotosonic Coring

Sonic cores were advanced through the levee embankment at 1,100- to 1,800-foot intervals along the right and left levee crests, as shown on Plate 5-3. A total of 18 sonic cores were advanced to depths ranging from 50 to 51.5 feet below the existing ground surface. Sonic coring was performed between September 14 and 23, 2010.

Sonic coring systems employ simultaneous high-frequency vibration and low-speed rotational motion with down-pressure to advance the cutting edge of the core barrel. The Model 8140LS equipped with a GV4 sonic head maintains an oscillator frequency range of 0 to 135 Hz, a rotation speed range of 75 to 150 rotations per minute, reaction force of 20,000 pounds, and torque range of 1,750 to 3,500 foot-pounds.

The action of the coring produces a uniform core hole while providing near-continuous, representative, relatively undisturbed core samples. For this project, the cores were extruded into plastic bags at about 3-foot-depth increments.

The sonic logs present descriptions of the earth materials encountered, sampling method used, and field and laboratory tests performed. The logs also show the location, sonic number, date of start and completion, and the name of the logger and drilling subcontractor. A field engineering geologist logged the cores in general accordance with ASTM D2488 for visual soil classification. The boundaries between soil types shown on the logs are approximate and the transition between different soil layers may be gradual. The logs of the sonic core holes are presented as Plates B-38 through B-55 - Logs of Drill Holes. A legend to the logs is presented on Plate B-1 - Key to Terms & Symbols Used on Logs.

Each core hole was backfilled with cement-bentonite grout pumped through the sonic casing from the surface to the bottom of the hole and filled upward. When grout returned to the surface, the grout hose was removed, sonic casing pulled, and the holes were topped off with additional grout as needed.

Cone Penetration Tests

CPTs were located at roughly 1,100- to 1,800-foot intervals along the levee crests and at various landside toe and offset locations, as shown on Plate 5-3. Thirty-seven CPT soundings were performed between September 20 and 24, 2010 and advanced to depths ranging from about 25.1 to 50.5 feet below the existing ground surface. Six CPT soundings along the levee crest (C73LC, C87LC, C98LC, C114LC, C146LC, and C171LC) met refusal on shallow obstructions (less than 50 feet depth).

The CPTs were performed using an electric cone penetrometer with a diameter of approximately 15 square centimeters. The instrumented cone is hydraulically pushed into the ground at a rate of about 2 centimeters per second (cm/s). Cone penetration resistance (q_c), and sleeve resistance (f_s) were monitored continuously during penetration and recorded. The friction ratio (FR) was computed for each value of q_c and f_s recorded. CPT data and soil classifications were used in conjunction with drill hole and core hole information to estimate soil boundaries encountered at the site. A key to the CPT logs is provided on Plate B-56 - Key to CPT Logs. Logs of the CPT profiles are shown on Plates B-57 through B-93.

Each CPT hole was backfilled with cement-bentonite grout pumped through open-ended CPT casing from the surface to the bottom of the hole and filled upward. When grout returned to the surface, the grout hose was removed, CPT casing pulled, and the holes were topped off with additional grout as needed.

Hollow-stem Auger Drill Holes

Drill holes were located next to selected CPTs, at all waterside levee toes and at selected landside toes and offset locations along the levee system. Approximate drill hole locations are shown on Plate 5-3. Drill holes were advanced between September 28 and October 15, 2010.

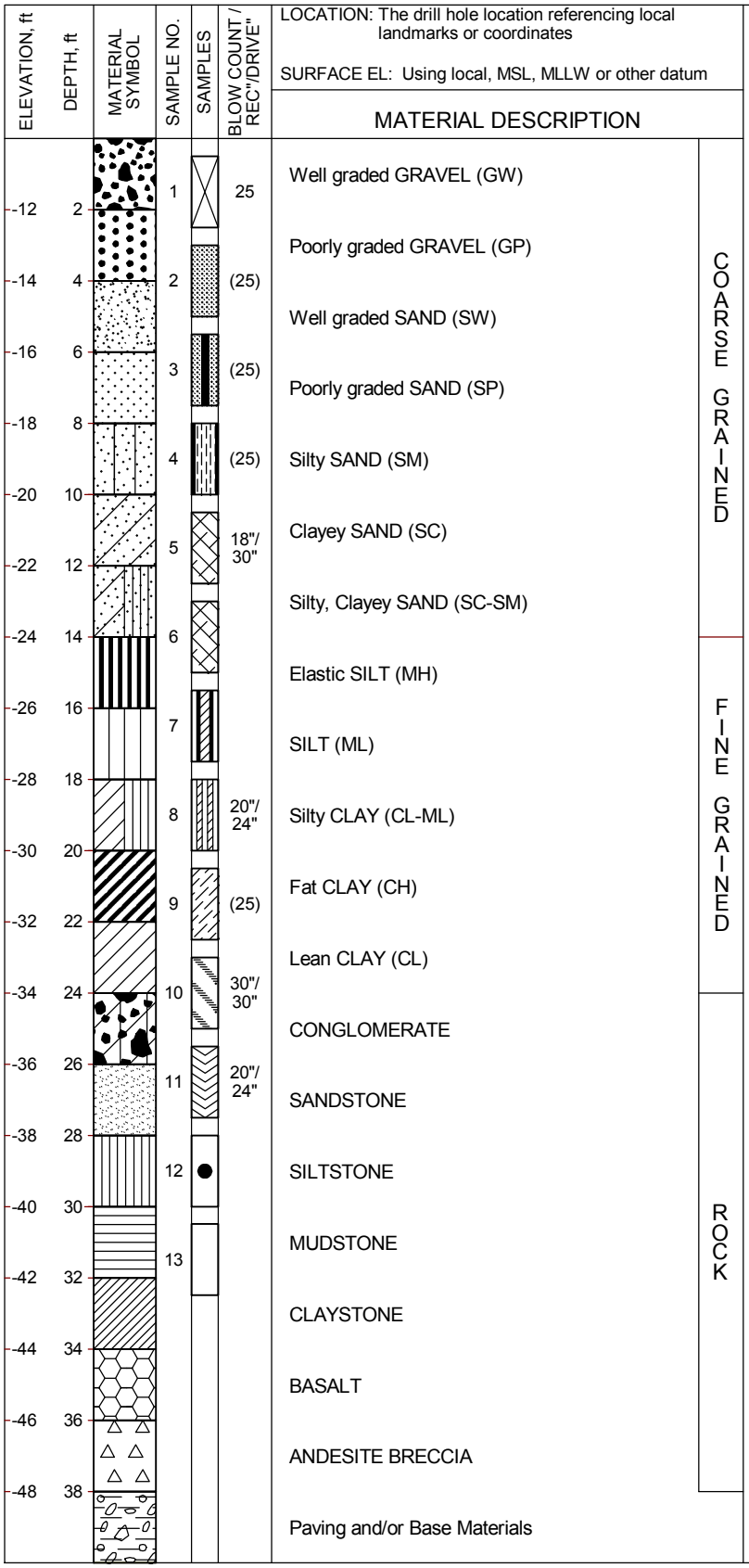
To advance the drill holes, hollow-stem flight augers were used for the entire depth of each drill hole. The hollow-stem augers have an outside diameter of 8.25-inches and have a center tube that is 4.25 inches in diameter. During drilling, a plug is inserted at the cutting shoe of the auger to keep the interior tube open. During drilling, cuttings are mobilized upwards by the flights along the outside of the auger. To sample, the interior plug was removed and the selected sampler extended down to the hole bottom using drilling rods. The samplers for this project were driven using a 140-pound CME automatic-trip hammer having a vertical throw of 30 inches, in conformance with standard test method ASTM D1586-99.

Thirty-six drill holes were advanced to approximately 26.5 feet bgs. Soil samples were obtained from the drill holes at selected depths using a driven 2-3/8 inch-inside-diameter (ID) modified California sampler and a 1-3/8-inch ID Standard Penetration Test (SPT) sampler. Samples were obtained at roughly 5-foot depth intervals, although the interval was frequently adjusted to sample critical layers encountered in the CPT soundings. The samplers were driven using the automatic-trip hammer discussed above. The number of blows needed to drive the sampler the last 12 inches into the soils was recorded, and is shown on the drill hole logs. Recovered samples were placed in containers and transported to the laboratory for further classification and testing.

A Shelby tube sampler was used to obtain relatively undisturbed samples of soft cohesive soils for laboratory strength testing. The Shelby tube sampler was pushed in a single, continuous motion using the drill rig's hydraulic system. After the push was completed, the driller waited at least 5 minutes and then rotated the sampler through several complete revolutions to shear off the sample at the cutting edge before bringing the sample to the surface. Recovered samples were sealed and transported to the laboratory for further classification and testing.

The drill hole logs present descriptions of the earth materials encountered, sampling method used, and field and laboratory tests performed. The logs also show the location, drill hole number, date of start and completion, and the name of the logger and drilling subcontractor. A field engineering geologist logged the drill holes in general accordance with ASTM D2488 for visual soil classification. The boundaries between soil types shown on the logs are approximate and the transition between different soil layers may be gradual. The logs of the drill holes are presented as Plates B-2 through B-37 - Logs of Drill Holes. A legend to the logs is presented on Plate B-1 - Key to Terms & Symbols Used on Logs.

Each drill hole was backfilled with cement-bentonite grout pumped from the surface to the bottom of the hole and filled upward. When grout returned to the surface, the grout hose was removed and the holes were topped off with additional grout as needed.



General Notes

Soil Texture Symbol

Sloped line in symbol column indicates transitional boundary

Samplers and sampler dimensions
(unless otherwise noted in report text) are as follows:

Symbol for:

1	SPT Sampler, driven 1-3/8" ID, 2" OD
2	CA Liner Sampler, driven 2-3/8" ID, 3" OD
3	CA Liner Sampler, disturbed 2-3/8" ID, 3" OD
4	Thin-walled Tube, pushed 2-7/8" ID, 3" OD
5	Bulk Bag Sample (from cuttings)
6	CA Liner Sampler, Bagged
7	Hand Auger Sample
8	CME Core Sample
9	Pitcher Sample
10	Lexan Sample
11	Vibracore Sample
12	No Sample Recovered
13	Sonic Soil Core Sample

Sampler Driving Resistance

Number of blows with 140 lb. hammer, falling 30" to drive sampler 1 ft. after seating sampler 6"; for example,

Blows/ft	Description
25	25 blows drove sampler 12" after initial 6" of seating
86/11"	After driving sampler the initial 6" of seating, 36 blows drove sampler through the second 6" interval, and 50 blows drove the sampler 5" into the third interval
50/6"	50 blows drove sampler 6" after initial 6" of seating
Ref/3"	50 blows drove sampler 3" during initial 6" seating interval

Blow counts for California Liner Sampler shown in ( )

Length of sample symbol approximates recovery length

Classification of Soils per ASTM D2487 or D2488

Geologic Formation noted in bold font at the top of interpreted interval

Strength Legend

Q = Unconfined Compression
u = Unconsolidated Undrained Triaxial
t = Torvane
p = Pocket Penetrometer
m = Miniature Vane

Water Level Symbols

- Initial or perched water level
- Final ground water level
- Seepages encountered

Rock Quality Designation (RQD) is the sum of recovered core pieces greater than 4 inches divided by the length of the cored interval.

KEY TO TERMS & SYMBOLS USED ON LOGS

PLATE B-1

LOCATION: N 2,361,058 E 5,991,233 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 15.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
14	2					**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW) to well-graded GRAVEL with sand (GW): olive gray, moist, fine gravel, medium to coarse sand - riprap encountered at 2'							
12	4												
10	6		R-1		(17)	- medium dense at 5'							
8	8												
6	10		S-1		22	Well-graded SAND (SW): medium dense, olive gray, wet, fine to coarse sand			20	4			
4	12												
2	14												
0	16		S-2		18	Poorly-graded SAND (SP): medium dense, olive gray, wet, fine to coarse sand			17	5			
-2	18												
-4	20		S-3		32	Well-graded SAND (SW): medium dense, olive gray, wet, fine to coarse sand			14	4			
-6	22												
-8	24												
-10	26		S-4		38				14	3			
-12	28												
-14	30												
-16	32												
-18	34												
-20	36												
-22	38												
-24													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 8.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 15, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H057LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-2

LOCATION: N 2,361,477 E 5,991,575 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 19.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
18	2					**ALLUVIUM (Qal)** SILT (ML): gray-brown, moist							
16	4												
14	6		ST-1			- color change to green-gray, wet at 5'	122	93	31		42	15	
12	8		B-1			- color change to olive gray, trace fine to medium sand at 6'							
10	10		R-1		(7)	SILT with sand (ML): medium stiff, brown-gray, wet, fine to coarse sand, trace coarse gravel		95	27	61			
8	12												
6	14												
4	16		S-1		12	Poorly-graded SAND with gravel (SP): medium dense, brown-gray, wet, fine to coarse sand			14	2	25	6	
2	18												
0	20		S-2		15	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine to coarse sand			16	5			
-2	22												
-4	24												
-6	26		S-3		25	Poorly-graded SAND with gravel (SP): dense, olive gray, wet, fine to coarse sand			14	3			
-8	28												
-10	30												
-12	32												
-14	34												
-16	36												
-18	38												
-20													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 13, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H057RO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-3

LOCATION: N 2,361,355 E 5,991,407 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 19.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
18	2				**ALLUVIUM (Qal)** Clayey SAND (SC): olive gray, moist, fine sand, some organic debris - riprap encountered at 1'							
16	4											
14	6	R-1		(5)	- very loose at 5'							
12	8											
10	10	ST-1			Sandy lean CLAY (CL): soft, olive gray, moist to wet, some organic debris							
8	12											
6	14											
4	16	R-2		(4)	Sandy SILT (ML): soft, olive gray, wet, few organic debris		78	33		31	1	
2	18											
0	20	S-1		17	Poorly-graded SAND with silt and gravel (SP-SM): medium dense, olive gray, wet, fine to coarse sand, trace gravel			15	5			
-2	22											
-4	24											
-6	26	S-2		29	Poorly-graded SAND with gravel (SP): dense, olive gray, wet, fine to coarse sand, fine to coarse gravel			12	4			
-8	28											
-10	30											
-12	32											
-14	34											
-16	36											
-18	38											
-20												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 11.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 12, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H057RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-4

LOCATION: N 2,359,772 E 5,991,199 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 29.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
28	2				**ALLUVIUM (Qal)** Sandy SILT with gravel (ML): olive gray, moist, fine gravel, fine sand, trace organic debris							
26	4											
24	6	R-1		(83)	- hard at 5'							
22	8											
20	10			(17)	- stiff at 10'							
18	12											
16	14											
14	16	ST-1			Poorly-graded SAND (SP): olive gray, moist, fine sand							
12	18	ST-2			Silty SAND (SM): olive gray, wet, fine sand, few organic debris		76	32	25			
10	20	S-1		22	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine to coarse sand, trace coarse gravel			15	2			
8	22											
6	24											
4	26	S-2		28	- dense at 25'			14	4			
2	28											
0	30											
-2	32											
-4	34											
-6	36											
-8	38											
-10												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 16.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 15, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H073LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-5

LOCATION: N 2,359,813 E 5,991,248 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 17.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
16	2				**ALLUVIUM (Qal)** Well-graded SAND with silt and gravel (SW-SM): olive gray, moist, fine to coarse gravel, fine to coarse sand, few organic debris - riprap encountered at 2.5'							
14	4											
12	6	S-1		55	- very dense at 5'			10	6			
10	8											
8	10			(50/5")	- rock in sampler tip at 10'							
6	12			(13)	- medium dense, wet at 12'							
4	14											
2	16			10	- loose, less drilling resistance noted by driller at 16'							
0	18											
-2	20	S-2		16	Well-graded SAND (SW): medium dense, olive gray, wet, fine to coarse sand			17	4			
-4	22											
-6	24											
-8	26	S-3		6	Poorly-graded SAND (SP): loose, olive gray, wet, fine sand			26	4			
-10	28											
-12	30											
-14	32											
-16	34											
-18	36											
-20	38											
-22												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 12.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 15, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H073LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-6

LOCATION: N 2,359,816 E 5,991,545 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 20.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
20	2				**ALLUVIUM (Qal)** Poorly-graded SAND (SP): olive gray, moist, fine sand							
18	4				- riprap encountered at 3.5'							
16	6	R-1		(9)	- loose at 5'							
14	8				Silty SAND (SM): loose, olive gray, wet, fine sand, few brown mottles and organics							
12	10	S-1		9	Poorly-graded SAND (SP): medium dense, olive gray, wet, fine sand			20	5			
10	12											
8	14	S-2		13				24	4			
6	16											
4	18											
2	20			43	Poorly-graded SAND with gravel (SP): very dense, olive gray, wet, fine to medium sand, fine gravel, rock in sampler tip at 20'							
0	22											
-2	24											
-4	26	S-3		66				17	2			
-6	28											
-8	30											
-10	32											
-12	34											
-14	36											
-16	38											
-18												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 12, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H073RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-7

LOCATION: N 2,358,415 E 5,991,851 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 18.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft / DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
18 / 2				**ALLUVIUM (Qal)** Well-graded SAND with silt and gravel (SW-SM): gray, moist, fine to coarse gravel, fine to coarse sand - riprap encountered at 1'							
16 / 4											
14 / 6	S-1		40	- very dense, rock in sampler tip at 5'			10	7			
12 / 8											
10 / 10			(38)	- dense at 10'							
8 / 12											
6 / 14				Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine gravel, fine to coarse sand							
4 / 16	S-2		14				14	4			
2 / 18				Poorly-graded SAND with silt (SP-SM): loose, olive gray, wet, fine to medium sand, trace coarse gravel							
0 / 20	S-3		8				17	9			
-2 / 22				Poorly-graded SAND with silt and gravel (SP-SM): medium dense, olive gray, wet, fine to coarse gravel, fine to coarse sand							
-4 / 24											
-6 / 26	S-4		14				15	6			
-8 / 28											
-10 / 30											
-12 / 32											
-14 / 34											
-16 / 36											
-18 / 38											
-20											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 14.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 15, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H087LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-8

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,358,638 E 5,992,081 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 17.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
					Poorly-graded SAND with gravel (SP): gray, moist							
16	2				- riprap encountered at 2'							
14	4											
12	6	S-1		21	- medium dense at 5'			11	4			
10	8											
8	10	S-2		10	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine gravel, medium to coarse sand			11	3			
6	12											
4	14											
2	16	S-3		18	Poorly-graded SAND (SP): medium dense, olive gray, wet, fine to coarse sand, trace fine gravel			19	3			
0	18											
-2	20			26	Well-graded SAND with gravel (SW): dense, olive gray, wet, fine to coarse sand, fine gravel, trace coarse gravel							
-4	22											
-6	24											
-8	26	S-4		33				14	4			
-10	28											
-12	30											
-14	32											
-16	34											
-18	36											
-20	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 9.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 8, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H087RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-9

LOCATION: N 2,358,561 E 5,993,174 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 21.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
20	2				**ALLUVIUM (Qal)** SILT (ML): brown-gray, moist, some organic debris							
					- riprap encountered at 2.5'							
18	4											
16	6	R-1		(26)	- very stiff, rock in sampler tip at 5'							
14	8											
12	10			(49)	- hard at 10'							
10	12				- coarse gravel at 12'							
8	14											
6	16	S-1		14	Poorly-graded SAND with gravel (SP): medium dense, olive gray, wet, fine gravel, fine to coarse sand			13	2			
4	18											
2	20	S-2		12	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine to coarse sand, fine gravel, trace coarse gravel			15	2			
0	22											
-2	24											
-4	26	S-3		29	- dense at 25'			14	3			
-6	28											
-8	30											
-10	32											
-12	34											
-14	36											
-16	38											
-18												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 15.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 14, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H098LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-10

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,358,816 E 5,993,027 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 22.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
22	0					**ALLUVIUM (Qal)** Gravelly SILT (ML): gray, dry to moist, fine gravel							
20	2					- riprap encountered at 2.5'							
18	4		R-1		(28)	- very stiff at 5'							
16	6												
14	8												
12	10		S-1		12	Poorly-graded SAND with gravel (SP): medium dense, olive gray, wet, trace coarse gravel, fine to coarse sand			13	3			
10	12												
8	14												
6	16		S-2		19	Well-graded SAND with gravel (SW): medium dense, wet, fine to coarse sand, trace fine to coarse gravel			17	2			
4	18												
2	20		S-3		13	Poorly-graded SAND with gravel (SP): medium dense, wet, fine to coarse gravel			11	3			
0	22												
-2	24												
-4	26		S-4		18				14	4			
-6	28												
-8	30												
-10	32												
-12	34												
-14	36												
-16	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 7, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H098RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-11

LOCATION: N 2,358,970 E 5,994,614 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 23.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
22	2					**ALLUVIUM (Qal)** Well-graded SAND (SW): olive gray, wet, fine to coarse sand, trace fine gravel - riprap encountered at 2'							
20	4												
18	6				(50/4")	- very dense, rock in sampler tip, coarse gravel at 5'							
16	8												
14	10				(25)	- medium dense at 10'							
12	12					Well-graded SAND with gravel (SW): dense, olive gray, wet, fine gravel, fine to coarse sand, trace coarse gravel							
10	14												
8	16		S-1		33				15	2			
6	18												
4	20				10	- medium dense at 20'							
2	22												
0	24												
-2	26		S-2		22				12	1			
-4	28												
-6	30												
-8	32												
-10	34												
-12	36												
-14	38												
-16													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 13.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 14, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H114LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-12

LOCATION: N 2,359,387 E 5,994,624 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 20.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
18	2				**ALLUVIUM (Qal)** Poorly-graded SAND with silt (SP-SM): olive gray, wet							
16	4											
14	6	ST-1										
12	8											
10	10	R-1		(5)	Sandy SILT (ML): soft, olive gray, moist, fine sand, wood debris in sample							
8	12				Poorly-graded SAND (SP): loose, olive gray, wet, fine sand							
6	14											
4	16	S-1		6				18	3			
2	18											
0	20	S-2		24	Poorly-graded SAND with silt (SP-SM): dense, olive gray, wet, fine to coarse sand			30	8			
-2	22											
-4	24											
-6	26	S-3		45	Well-graded SAND with silt (SW-SM): very dense, wet, fine gravel, fine to coarse sand			13	6			
-8	28											
-10	30											
-12	32											
-14	34											
-16	36											
-18	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 11.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 7, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H114RL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-13

LOCATION: N 2,359,258 E 5,994,611 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 24.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
24	2				**ALLUVIUM (Qal)** Poorly-graded SAND with gravel (SP): olive gray, wet, fine to coarse sand, few fine gravel							
22	4				- riprap (cobble/boulders) encountered at 3.5'							
20	6				- riprap encountered at 5', unable to sample							
18	8											
16	10			(46)	- dense, rock in sampler tip at 10'							
14	12											
12	14											
10	16	S-1		25				14	4			
8	18											
6	20	S-2		14	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, fine gravel, fine to coarse sand			11	3			
4	22											
2	24											
0	26	S-3		30	- dense at 25'			11	4			
-2	28											
-4	30											
-6	32											
-8	34											
-10	36											
-12	38											
-14												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 11.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 7, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H114RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-14

LOCATION: N 2,359,230 E 5,996,539 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	2				**ALLUVIUM (Qal)** SILT (ML): brown-gray, moist							
28	4											
26	6	ST-1				128	103	23		35	9	
24	8											
22	10	R-1		(6)	Poorly-graded SAND (SP): loose, gray, moist, fine sand							
20	12											
18	14											
16	16	R-2		(23)	Well-graded SAND (SW): medium dense, gray-brown, moist, fine to coarse sand, some coarse gravel							
14	18											
12	20	R-3		(35)	Well-graded SAND with silt and gravel (SW-SM): dense, tan-gray, wet, fine to coarse gravel, fine to coarse sand							
10	22											
8	24											
6	26	S-1		57	Poorly-graded SAND with gravel (SP): very dense, brown-gray, wet, fine to coarse gravel, fine to coarse sand			13	3			
4	28											
2	30											
0	32											
-2	34											
-4	36											
-6	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 6, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-15

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,359,169 E 5,996,543 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 31.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	2				**ALLUVIUM (Qal)** SILT (ML): gray-tan, moist, few mottles and organic debris							
28	4											
26	6	ST-1				114	86	33		40	12	
24	8											
22	10	R-1		(5)	Silty SAND (SM): very loose, brown-gray, moist, fine sand		91	13	35			
20	12				Silty SAND (SM) to Clayey SAND (SC): very loose, brown-gray, moist, fine sand							
18	14											
16	16	R-2		(44)	- dense, color change to olive gray at 15'							
14	18				Poorly-graded SAND with gravel (SP): dense, tan-gray, wet, fine gravel, fine to coarse sand							
12	20	S-1		19	- medium dense at 20'			13	3			
10	22											
8	24											
6	26	S-2		42	- very dense, color change to olive gray at 25'			14	3			
4	28											
2	30											
0	32											
-2	34											
-4	36											
-6	38											
-8												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 6, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132LO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-16

CGI Technical Services Inc. | FUGRO

LOCATION: N 2,359,307 E 5,996,464 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 25.3 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
24	2					**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW): tan-gray, dry to moist, fine gravel, fine to medium sand							
22	4					- rip-rap (cobble/ boulders) encountered from 3.5' to 5'							
20	6												
18	8		S-1		24	- dense at 7.5'			3	5			
16	10		S-2		12	Poorly-graded SAND with gravel (SP): medium dense, olive gray, wet, medium to coarse sand, few fine gravel			10	3			
14	12												
12	14												
10	16		S-3		24	Well-graded SAND with gravel (SW): dense, olive gray, wet, few coarse sand and fine gravel			12	3			
8	18												
6	20		S-4		50/5"	- very dense, fine to coarse sand, fine gravel at 20'			8	2			
4	22												
2	24												
0	26		S-5		48	Poorly-graded SAND with gravel (SP): very dense, olive gray, wet, fine gravel, fine to coarse sand			10	3			
-2	28												
-4	30												
-6	32												
-8	34												
-10	36												
-12	38												
-14													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 5, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-17

LOCATION: N 2,359,656 E 5,996,257 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 28.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
28	0					**ALLUVIUM (Qal)** Silty SAND with gravel (SM): olive gray, moist, medium sand, few fine gravel							
26	2												
24	4		S-1	☒	6	- loose at 5'			10	13	21	3	
22	6					Poorly-graded SAND with gravel (SP): olive gray, moist, fine gravel, medium sand							
20	8												
18	10		S-2	☒	28	- dense at 10'			3	2			
16	12												
14	14		S-3	☒	14	- medium dense at 15'			12	4			
12	16												
10	18												
8	20		S-4	☒	17	Well-graded SAND with gravel (SW): medium dense, olive gray, wet, medium to coarse sand			15	3			
6	22												
4	24												
2	26		S-5	☒	40	Well-graded SAND (SW): very dense, olive gray, wet, fine to coarse sand, scattered organic debris			18	3			
0	28												
-2	30												
-4	32												
-6	34												
-8	36												
-10	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout
DRILLING DATE: September 29, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132RL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-18

LOCATION: N 2,359,973 E 5,996,361 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 30.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	0				Silty SAND (SM): olive gray, moist, fine sand							
28	2											
26	4											
24	6	R-1		(5)	- very loose at 5'							
22	8				Poorly-graded SAND with gravel (SP): orange-brown and gray, moist, fine to coarse sand, fine gravel							
20	10	ST-1										
18	12											
16	14											
14	16	R-2		(16)	Well-graded SAND with gravel (SW): medium dense, olive gray, moist to wet, fine gravel, medium to coarse sand	111	106	5	4			
12	18				▽							
10	20	S-1		10	Poorly-graded SAND with gravel (SP): medium dense, olive gray, wet, fine gravel, fine to coarse sand			15	3			
8	22											
6	24											
4	26	S-2		70	- very dense at 25'			14	3			
2	28											
0	30											
-2	32											
-4	34											
-6	36											
-8	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 18.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 13, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132RO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-19

LOCATION: N 2,359,538 E 5,996,325 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 21.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
20	2				**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW): gray, dry to moist, medium to coarse sand, fine to coarse gravel							
18	4											
16	6	S-1		20	Poorly-graded SAND with silt and gravel (SP): medium dense, tan-gray, wet, fine to coarse sand, fine gravel			4	10			
14	8				- difficult drilling due to gravel/cobble zone at 8'							
12	10	S-2		19	▽ - wet at 10'			12	10			
10	12											
8	14											
6	16	S-3		13	Well-graded SAND with gravel (SW): medium dense, gray, wet, fine gravel, fine to coarse sand			18	2			
4	18											
2	20	S-4		22	- color change to olive gray at 20'			13	4			
0	22											
-2	24											
-4	26	S-5		40	- dense, color change to tan-gray at 25'			15	5			
-6	28											
-8	30											
-10	32											
-12	34											
-14	36											
-16	38											
-18												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 29, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H132RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-20

LOCATION: N 2,360,462 E 5,997,220 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	2					**ALLUVIUM (Qal)** Silty SAND (SM): olive gray, moist, fine sand, scattered organic debris							
30	4												
28	6		S-1		6	- loose at 5'			26	27	NP	NP	
26	8												
24	10		ST-1			SILT (ML): olive gray, moist, scattered organic debris		83	34		34	7	
22	12												
20	14												
18	16		S-2		3	Poorly-graded SAND with silt (SP-SM): very loose, olive gray, moist to wet, fine sand, some organic debris			29	8			
16	18												
14	20		S-3		20	Poorly-graded SAND with gravel (SP): medium dense, brown-gray, wet, fine gravel, fine to coarse sand			12	3			
12	22												
10	24												
8	26		S-4		33	- dense at 25'			12	3			
6	28												
4	30												
2	32												
0	34												
-2	36												
-4	38												
-6													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: Not Encountered
BACKFILLED WITH: Grout
DRILLING DATE: October 5, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-21

LOCATION: N 2,360,425 E 5,997,319 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	2				**ALLUVIUM (Qal)** SILT (ML): gray-brown, moist							
28	4											
26	6	ST-1										
24	8											
22	10	R-1		(8)	Poorly-graded SAND with silt (SP-SM): loose, olive gray, moist, fine to medium sand		101	5	8			
20	12											
18	14											
16	16	R-2		(24)	Well-graded GRAVEL with sand (GW): medium dense, olive gray, moist, fine to coarse gravel, fine to coarse sand							
14	18											
12	20	S-1		14	Well-graded SAND (SW): medium dense, olive gray, wet, fine gravel, fine to coarse sand			14	4			
10	22											
8	24											
6	26	S-2		31	Well-graded SAND with gravel (SW): dense, olive gray, wet, fine to coarse sand, fine gravel			13	4			
4	28											
2	30											
0	32											
-2	34											
-4	36											
-6	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 7, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146LO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-22

LOCATION: N 2,360,481 E 5,997,118 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 26.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
26	2				**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW): olive gray, wet, medium to coarse sand, fine to coarse gravel							
24	4											
22	6			76	- very dense, rock in sampler tip at 5'							
20	8											
18	10	S-1		5	- loose at 10'			13	3			
16	12											
14	14											
12	16	S-2		49	Poorly-graded SAND (SP): very dense, gray, wet, fine to coarse sand			19	4			
10	18											
8	20	S-3		27	- dense, fine gravel at 20'			15	1			
6	22											
4	24											
2	26	S-4		36	Poorly-graded SAND with gravel (SP): dense, tan-gray, wet, fine to coarse sand, fine gravel			14	4			
0	28											
-2	30											
-4	32											
-6	34											
-8	36											
-10	38											
-12												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 5, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-23

LOCATION: N 2,360,699 E 5,996,761 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	2			Poorly-graded SAND (SP): gray-brown, moist, fine sand							
30	4										
28	6	ST-1									
26	8										
24	10	R-1	(7)	- loose at 10'							
22	12			Well-graded GRAVEL with sand (GW): loose, olive gray to gray-brown, moist, fine to coarse sand, fine to coarse gravel, some red-brown staining at 15.5'							
20	14										
18	16	R-2	(38)	- dense, color change to olive gray at 15'							
16	18										
14	20	S-1	7	Well-graded SAND with gravel (SW): loose, olive gray, wet, fine to coarse sand, fine to coarse gravel			11	3			
12	22										
10	24										
8	26	S-2	10	Well-graded SAND with silt and gravel (SW-SM): medium dense, wet, fine to coarse sand			24	9	NP	NP	
6	28										
4	30										
2	32										
0	34										
-2	36										
-4	38										
-6											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 19.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 13, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146RL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-24

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,360,739 E 5,996,706 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft / DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32 / 2				**ALLUVIUM (Qal)** Well-graded SAND with silt and gravel (SW-SM): olive gray, moist, fine gravel, medium to coarse sand							
28 / 6	R-1		(22)	Poorly-graded SAND with gravel (SP): medium dense, olive gray, moist, fine to coarse sand, fine to coarse gravel							
22 / 12	R-2		(21)	Poorly-graded SAND with silt (SP-SM): medium dense, olive gray, moist, fine to coarse sand, fine to coarse gravel	111	108	3	7			
18 / 16			(3)	- loose at 15'							
12 / 22			(17)	- medium dense at 20'							
8 / 26	S-1		11	- wet, fine sand, abundant organic debris at 25'			29	12	NP	NP	
2 / 32											
-2 / 36											
-6 / 38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 25.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 14, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146RO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-25

LOCATION: N 2,360,638 E 5,996,889 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 17.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
16	2					**ALLUVIUM (Qal)** Well-graded GRAVEL with sand (GW): gray, moist, medium to coarse sand, fine to coarse gravel, few cobbles							
14	4												
12	6		S-1		32	Poorly-graded GRAVEL with silt and sand (GP-GM): dense, gray-brown, wet, medium to coarse sand, fine to coarse gravel			10	12			
10	8												
8	10		S-2		18	Poorly-graded SAND (SP): medium dense, olive gray, wet, fine to medium sand			17	3			
6	12												
4	14												
2	16		S-3		47	- very dense, color change to tan-gray, fine to coarse sand at 15'			14	3			
0	18												
-2	20		S-4		36	Well-graded SAND with silt (SW-SM): dense, olive gray, wet, fine to coarse sand			15	6			
-4	22												
-6	24												
-8	26		S-5		41	- very dense, color change to tan-gray at 25'			15	5			
-10	28												
-12	30												
-14	32												
-16	34												
-18	36												
-20	38												
-22													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 29, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H146RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-26

LOCATION: N 2,361,622 E 5,997,652 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 36.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
36	0					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist							
34	2												
32	4												
			ST-1										
30	6												
28	8												
26	10		S-1		3	Poorly-graded SAND with silt (SP-SM): loose, olive gray, moist, fine sand			8	6			
24	12												
22	14												
20	16		S-2		15	Poorly-graded SAND with gravel (SP): medium dense, olive gray, moist to wet, fine sand			22	5			
18	18												
16	20		S-3		32	- dense, wet, fine to coarse sand, fine gravel at 20'			11	4			
14	22												
12	24												
10	26		S-4		20	- medium dense at 25'			16	2			
8	28												
6	30												
4	32												
2	34												
0	36												
-2	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 1, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-27

LOCATION: N 2,361,597 E 5,997,720 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 31.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-30	2				**ALLUVIUM (Qal)** SILT (ML): gray brown, moist, few mottles							
-28	4											
-26	6	ST-1				118	75	58		34	9	
-24	8											
-22	10	R-1		(18)	Well-graded SAND with gravel (SW): medium dense, olive gray, moist, fine gravel, fine to coarse sand							
-20	12											
-18	14											
-16	16	S-1		10	Silty SAND (SM): medium dense, olive gray, wet, fine sand			30	26	NP	NP	
-14	18											
-12	20	S-2		40	Well-graded SAND with gravel (SW): very dense, olive gray, wet, fine to coarse sand			14	4			
-10	22											
-8	24											
-6	26	S-3		72	- olive gray and brown gray, fine gravel at 25'			14	2			
-4	28											
-2	30											
0	32											
-2	34											
-4	36											
-6	38											
-8												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 13.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 6, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158LO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-28

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,361,648 E 5,997,554 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 29.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
28	2				**ALLUVIUM (Qal)** Silty SAND with gravel (SM): brown-gray, dry to moist, fine to medium sand, fine to coarse gravel							
26	4											
24	6	S-1		31	- dense, color change to gray, moist to wet, medium to coarse sand at 5'			3	14			
22	8				Well-graded SAND with gravel (SW): medium dense, gray, moist to wet, fine to coarse sand							
20	10	S-2		13	▽			3	3			
18	12											
16	14											
14	16	S-3		22	Poorly-graded SAND with gravel (SP): medium dense, olive gray, wet, few fine gravel, fine to coarse sand			16	3			
12	18											
10	20	S-4		25	Well-graded SAND with gravel (SW): dense, olive-gray, wet, fine to coarse sand, fine gravel			14	3			
8	22											
6	24											
4	26	S-5		39	- very dense, color change to brown-gray at 25'			9	4			
2	28											
0	30											
-2	32											
-4	34											
-6	36											
-8	38											
-10												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 10.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 4, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-29

LOCATION: N 2,361,793 E 5,997,186 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 34 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	2				**ALLUVIUM (Qal)** Silty SAND with gravel (SM): olive gray, moist, fine sand							
30	4											
28	6	S-1		7	- loose at 5'			10	16	22	3	
26	8	ST-1			SILT (ML): olive gray, moist							
24	10	S-2		3	Silty SAND (SM): very loose, olive gray, moist to wet, medium to coarse sand			19	27	NP	NP	
22	12											
20	14				Poorly-graded SAND with silt and gravel (SP-SM): medium dense, olive gray, wet, fine to coarse sand, few fine gravel							
18	16	S-3		9				12	6			
16	18											
14	20	S-4		24	Well-graded SAND with silt and gravel (SW-SM): dense, olive gray, wet, fine sand, fine gravel			13	8			
12	22											
10	24	S-5		36				14	5			
8	26				Well-graded GRAVEL with silt and sand (GW-GM): dense, gray-brown, wet, medium to coarse sand, fine gravel							
6	28											
4	30											
2	32											
0	34											
-2	36											
-4	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 15.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 28, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158RL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-30

LOCATION: N 2,361,819 E 5,997,132 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 34.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
34	0					**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW): gray, moist, medium to coarse sand, fine to coarse gravel							
32	2												
30	4												
28	6		ST-1										
26	8												
24	10		R-1		(26)	Well-graded GRAVEL with sand (GW): medium dense, brown-gray, moist, medium to coarse sand, fine to coarse gravel							
22	12												
20	14		R-2		(16)	- 6" layer of brown-gray well-graded SAND with gravel (SW) at 15'		96	3	4			
18	16												
16	18					▽							
14	20				6	- loose at 20'							
12	22												
10	24												
8	26				29	- dense at 25'							
6	28												
4	30												
2	32												
0	34												
-2	36												
-4	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 19.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 14, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158RO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-31

LOCATION: N 2,361,746 E 5,997,315 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 21.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
20	2				**ALLUVIUM (Qal)** Poorly-graded GRAVEL (GP): fine to coarse gravel, some cobbles							
18	4	S-1		35	Silty SAND with gravel (SM): dense, olive gray, wet, medium to coarse sand, fine to coarse gravel			7	37			
16	6											
14	8											
12	10			10	- medium dense, rock in sampler tip at 10'							
10	12											
8	14											
6	16	S-2		29	Poorly-graded SAND with gravel (SP): dense, gray, wet, medium sand, fine gravel			14	1			
4	18											
2	20	S-3		56	Poorly-graded SAND (SP): very dense, olive gray, wet, fine to coarse sand, fine gravel			15	1			
0	22											
-2	24											
-4	26	S-4		75	- color change to tan gray, medium to coarse sand, some fine gravel at 25'			14	2			
-6	28											
-8	30											
-10	32											
-12	34											
-14	36											
-16	38											
-18												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 5.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 28, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H158RW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-32

LOCATION: N 2,362,531 E 5,998,205 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 36.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
36	0			**ALLUVIUM (Qal)** SILT (ML): gray-brown, moist							
34	2										
32	4										
		ST-1				79	31		33	7	
30	6										
28	8										
26	10	S-1	4	Silty SAND (SM): very loose, olive gray, moist, fine sand			9	13			
24	12										
22	14										
		S-2	11	Poorly-graded SAND with gravel (SP): medium dense, olive gray to brown gray, moist, fine to coarse sand			3	2			
20	16										
18	18										
16	20	S-3	22	Well-graded SAND with silt and gravel (SW-SM): medium dense, gray-brown, wet, fine to very coarse sand, fine gravel			10	6			
14	22										
12	24			Poorly-graded SAND with gravel (SP): dense, tan-gray, wet, fine to coarse sand, fine gravel							
10	26	S-4	33				13	3			
8	28										
6	30										
4	32										
2	34										
0	36										
-2	38										

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 1, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H171LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-33

LOCATION: N 2,362,514 E 5,998,246 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 35.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
34	2				**ALLUVIUM (Qal)** Clayey SAND (SC): brown-gray, moist, fine sand							
32	4											
30	6	ST-1										
28	8											
26	10	S-1		4	Silty SAND (SM): very loose, olive gray, moist, fine to coarse sand			10	16			
24	12											
22	14											
20	16	S-2		13	Poorly-graded SAND (SP): medium dense, olive gray, moist, fine to coarse grained			3	2			
18	18											
16	20	S-3		29	Poorly-graded SAND with gravel (SP): dense, tan-gray, wet, fine to coarse sand, fine gravel			12	4			
14	22											
12	24											
10	26	S-4		54	- very dense, gray-tan, fine to coarse gravel at 25'			13	2			
8	28											
6	30											
4	32											
2	34											
0	36											
-2	38											

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 17.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: October 1, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H171LO

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-34

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,362,592 E 5,998,137 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.3 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	0					**ALLUVIUM (Qal)** Well-graded SAND with gravel (SW): gray, moist, fine to coarse gravel, fine to medium sand							
30	2												
28	4												
			S-1		18	- medium dense at 5'			3	4			
26	6												
24	8												
22	10		S-2		13	Silty SAND with gravel (SM): medium dense, olive gray, wet, fine sand			5	25			
20	12												
18	14												
			ST-1			Poorly-graded SAND with silt (SP-SM): olive gray, wet, fine sand		101	10	5			
16	16					- color change to gray-brown, fine to coarse gravel at 16'							
14	18												
12	20		S-3		36	Poorly-graded SAND with gravel (SP): dense, olive gray, wet, fine to coarse sand			13	3			
10	22												
8	24												
			S-4		33	Well-graded SAND (SW): dense, olive gray, wet, fine to coarse sand			16	2			
6	26												
4	28												
2	30												
0	32												
-2	34												
-4	36												
-6	38												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 15.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 30, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H171LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-35

LOCATION: N 2,362,619 E 5,999,862 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
40	2				**ALLUVIUM (Qal)** Poorly-graded GRAVEL (GP): gray, moist, fine to coarse gravel							
38	4											
36	6	S-1		18	Silty SAND (SM): medium dense, olive gray, moist, fine sand			13	24			
34	8	ST-1			Sandy lean CLAY (CL): gray, moist							
32	10	S-2		3	Poorly-graded SAND with silt (SP-SM): very loose, olive gray, moist, fine sand			11	11			
30	12	B-1			Lean CLAY (CL): olive gray, moist							
28	14	ST-2			Poorly-graded SAND (SP): olive gray, wet, fine to medium sand, trace fine gravel							
26	16											
24	18											
22	20	S-3		24	Poorly-graded SAND (SP): dense, olive gray, wet, fine to medium sand, trace fine gravel			12	4			
20	22											
18	24											
16	26	S-4		36	- fine to coarse sand at 25'			15	5			
14	28											
12	30											
10	32											
8	34											
6	36											
4	38											
2												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 15.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 30, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H185LL

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-36

LOCATION: N 2,362,793 E 5,999,709 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 31.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	2					**ALLUVIUM (Qal)** Poorly-graded SAND with silt and gravel (SP-SM): tan-gray, dry to moist, fine to coarse gravel, fine to coarse sand							
28	4					- difficult drilling due to gravel/cobble zone from 3' to 5'							
26	6		S-1		52	- very dense at 5'			1	6			
24	8												
22	10		S-2		6	Well-graded SAND with silt and gravel (SW-SM): loose, tan-gray, wet, fine to coarse sand, trace fine gravel			15	8			
20	12												
18	14												
16	16		S-3		15	Poorly-graded SAND (SP): medium dense, olive gray, wet, fine to coarse sand, trace fine gravel			16	2			
14	18												
12	20		S-4		27	Well-graded SAND with gravel (SW): dense, tan-gray, wet, fine to coarse sand, trace fine gravel			15	2			
10	22												
8	24												
6	26		S-5		38				12	3			
4	28												
2	30												
0	32												
-2	34												
-4	36												
-6	38												
-8													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 26.5 ft
DEPTH TO WATER: 7.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 30, 2010

DRILLING METHOD: 8-inch-dia. Hollow Stem Auger
HAMMER TYPE: Automatic Trip
DRILLED BY: PC Exploration Co.
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF BORING NO. H185LW

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-37

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,361,009 E 5,991,202 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 27.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
26	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): gray, dry to moist, medium sand, fine to coarse gravel							
24	4												
22	6					Well-graded SAND with silt and gravel (SW-SM): gray, dry to moist, fine gravel, fine to medium sand							
20	8					Sandy SILT with gravel (ML): olive gray, moist, medium to coarse sand, fine to coarse gravel							
18	10					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist							
16	12												
14	14												
12	16					SILT (ML): olive gray, moist							
10	18					Silty SAND (SM): mottled gray and brown, moist, fine sand							
8	20												
6	22					Sandy, silty CLAY with gravel (CL-ML): gray, moist, coarse sand, fine gravel							
4	24					Well-graded SAND with gravel (SW): gray, moist, fine to coarse gravel, medium sand,							
2	26					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
0	28					Well-graded SAND with gravel (SW): gray, wet, fine to coarse gravel, medium to coarse sand							
-2	30												
-4	32					SILT with gravel (ML): olive gray, wet, coarse gravel							
-6	34					Well-graded GRAVEL with silt and sand (GW-GM): tan-gray, wet, coarse sand, fine to coarse gravel							
-8	36					Poorly-graded GRAVEL with sand (GP): gray, wet, coarse sand, fine to coarse gravel							
-10	38												
-12													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 26.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 24, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S057LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-38a

LOCATION: N 2,361,009 E 5,991,202 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 27.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-14	42					Poorly-graded SAND with gravel (SP) to poorly-graded GRAVEL with sand (GP): tan-gray, wet, coarse sand, fine gravel							
						Well-graded GRAVEL with silt and sand (GW-GM): gray, wet, medium to coarse sand, fine gravel							
-16	44					- tan-gray, fine to coarse gravel at 44'							
-18	46					Poorly-graded SAND (SP): olive gray, wet, medium grained							
-20	48					Well-graded GRAVEL with silt and sand (GW-GM): brown-gray, wet, medium to coarse sand, fine gravel							
-22	50					Lean CLAY (CL): gray, wet							
-24	52												
-26	54												
-28	56												
-30	58												
-32	60												
-34	62												
-36	64												
-38	66												
-40	68												
-42	70												
-44	72												
-46	74												
-48	76												
-50	78												
-52													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 26.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 24, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S057LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-38b

LOCATION: N 2,361,390 E 5,991,452 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 28.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
28	0					**ARTIFICIAL FILL (af)** Well-graded SAND with gravel (SW): gray, moist, fine to coarse gravel, fine to coarse sand							
26	2					Silty SAND (SM): gray, dry to moist, fine to medium sand, little fine gravel							
24	4					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist							
22	6					Silty CLAY (CL-ML): olive gray, moist							
20	8												
18	10												
16	12												
14	14												
12	16					SILT (ML) to silty CLAY (CL-ML): olive gray, moist							
10	18					Lean CLAY (CL): olive gray, moist							
8	20					- wet at 20'							
6	22												
4	24					Silty SAND (SM): olive gray, wet, fine sand							
2	26					- few organic debris at 26'							
0	28					Poorly-graded SAND (SP): olive gray, wet, fine sand							
-2	30												
-4	32					Fat CLAY (CH): brown gray, wet							
-6	34					Lean CLAY with gravel (CL): olive gray, wet, fine gravel							
-8	36					Clayey GRAVEL (GC): gray-brown, wet, fine gravel							
-10	38					- medium to coarse sand, few fine gravel at 38'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 20.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 18, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S057RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-39a

LOCATION: N 2,361,390 E 5,991,452 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 28.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-12	42					Poorly-graded SAND (SP): gray, wet, fine to medium sand, few fine gravel							
-14	44					Well-graded SAND with gravel (SW): olive gray, wet, fine to coarse gravel, fine to coarse sand							
-16	46					Clayey GRAVEL with sand (GC): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
-18	48												
-20	50												
-22	52												
-24	54												
-26	56												
-28	58												
-30	60												
-32	62												
-34	64												
-36	66												
-38	68												
-40	70												
-42	72												
-44	74												
-46	76												
-48	78												
-50													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 20.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 18, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S057RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-39b

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,359,809 E 5,991,200 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 29.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
28	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with sand (GW): gray, moist, medium sand, fine to coarse gravel							
26	4					**ALLUVIUM (Qal)** Silty SAND with gravel (SM): mottled olive gray and brown, moist, scattered fine to coarse gravel		110	8		21	3	
24	6												
22	8												
20	10												
18	12					Well-graded GRAVEL with sand (GW): olive gray, moist, medium to coarse sand, fine to coarse gravel							
16	14					Well-graded SAND with gravel (SW): olive gray, moist, fine to medium sand, fine to coarse gravel							
14	16					SILT with gravel (ML): olive gray, moist, fine to coarse gravel							
12	18					Sandy SILT with gravel (ML): gray, moist, fine sand, fine gravel							
10	20					SILT with gravel (ML): olive gray, moist, fine gravel							
8	22					Well-graded GRAVEL with silt and sand (GW-GM): gray, moist, medium sand, fine to coarse gravel							
6	24												
4	26					SILT with sand and gravel (ML): olive gray, moist, fine gravel							
2	28					Poorly-graded GRAVEL with sand (GP): gray, moist to wet, coarse sand, fine gravel							
0	30					Poorly-graded SAND (SP): olive gray, moist, medium to coarse sand, scattered fine gravel							
-2	32					SILT with clay and gravel (ML): olive gray, wet, fine gravel							
-4	34												
-6	36					Poorly-graded GRAVEL with sand (GP): gray, wet, coarse sand, fine gravel							
-8	38					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-10													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 32.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S073LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-40a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,809 E 5,991,200 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 29.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-12	42					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-14	44												
-16	46												
-18	48												
-20	50												
-22	52												
-24	54												
-26	56												
-28	58												
-30	60												
-32	62												
-34	64												
-36	66												
-38	68												
-40	70												
-42	72												
-44	74												
-46	76												
-48	78												
-50													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 32.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S073LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-40b

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,829 E 5,991,609 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 28 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
26	2					**ARTIFICIAL FILL (af)** Poorly-graded GRAVEL with sand (GP): brown gray, dry, fine gravel							
24	4												
22	6												
20	8												
18	10					**ALLUVIUM (Qal)** SILT (ML): mottled olive gray and light brown, moist, few organics							
16	12					SILT with clay and gravel (ML): olive gray, moist, fine gravel SILT (ML): olive gray, moist, few organics							
14	14					Silty SAND (SM): olive gray, moist, fine sand							
12	16												
10	18												
8	20					SILT (ML): olive gray, moist							
6	22					**ESTUARINE (Qe)** Poorly-graded SAND (SP): dark gray, moist, fine to medium sand - medium sand at 24'							
4	24												
2	26					Poorly-graded GRAVEL with sand (GP): dark gray, moist, medium sand, fine gravel							
0	28					Poorly-graded GRAVEL (GP): medium gray, wet, fine to coarse gravel							
-2	30												
-4	32												
-6	34					- gray, wet at 34'							
-8	36					- fine gravel at 36'							
-10	38					Poorly-graded GRAVEL with clay (GP-GC): light brown, wet, fine to coarse gravel							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 29.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 17, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S073RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-41a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,829 E 5,991,609 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 28 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-14	42					Poorly-graded GRAVEL with clay (GP-GC): light brown, wet, fine to coarse gravel							
-16	44					Poorly-graded GRAVEL with sand (GP): gray, wet, fine sand							
-18	46					Poorly-graded GRAVEL with clay and sand (GP-GC): blue gray, wet, fine to coarse gravel							
-20	48					Poorly-graded GRAVEL with clay (GP-GC): gray-brown, wet, fine gravel							
-22	50												
-24	52												
-26	54												
-28	56												
-30	58												
-32	60												
-34	62												
-36	64												
-38	66												
-40	68												
-42	70												
-44	72												
-46	74												
-48	76												
-50	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 29.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 17, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S073RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-41b

LOCATION: N 2,358,356 E 5,991,852 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
30	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): gray, moist, fine sand, fine to coarse gravel							
28	4					Sandy Lean CLAY with gravel (CL): olive gray, moist	133	117	14				
26	6					- scattered fine gravel at 5' - moist at 6'							
24	8					**ALLUVIUM (Qal)** Sandy SILT (ML): olive gray, moist, fine sand, trace coarse gravel							
22	10					SILT (ML): olive gray, moist							
20	12					- moist at 11'							
18	14					SILT with clay and gravel (ML): olive gray, moist, fine gravel							
16	16					Poorly-graded GRAVEL with sand (GP): olive gray, moist, fine gravel							
14	18												
12	20					SILT with clay and gravel (ML): olive gray, moist, fine gravel							
10	22					Well-graded GRAVEL with silt and sand (GW-GM): gray, moist, fine sand, fine gravel							
8	24					Poorly-graded GRAVEL with sand (GP): gray, moist, fine sand, fine to coarse gravel							
6	26					- olive gray at 25' ▽ SILT with gravel (ML): olive gray, wet, fine to coarse gravel, some organic debris							
4	28					Silty SAND (SM): olive gray, wet, few organic debris							
2	30												
0	32												
-2	34					Silty SAND with gravel (SM): olive gray, wet, fine to coarse gravel, fine sand, scattered organic debris							
-4	36					Silty SAND (SM): olive gray, moist, fine sand							
-6	38					Poorly-graded SAND (SP): olive gray, wet, fine sand							
						Well-graded GRAVEL with clay and sand (GW-GC): olive							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 26.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S087LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-42a

LOCATION: N 2,358,356 E 5,991,852 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
						gray, wet, medium to coarse sand, fine to coarse gravel							
-10	42					Poorly-graded SAND (SP): olive gray, wet, fine sand							
-12	44												
-14	46					Well-graded SAND with silt and gravel (SW-SM): olive gray, wet, fine gravel, medium to coarse sand							
-16	48					Well-graded GRAVEL with silt (GW-GM): brown-gray, wet, fine to coarse gravel							
-18	50												
-20	52												
-22	54												
-24	56												
-26	58												
-28	60												
-30	62												
-32	64												
-34	66												
-36	68												
-38	70												
-40	72												
-42	74												
-44	76												
-46	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 26.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S087LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-42b

LOCATION: N 2,358,703 E 5,992,130 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	0					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): brown-gray, dry to moist, fine to coarse gravel							
30	2												
28	4												
26	6												
24	8												
22	10					**ALLUVIUM (Qal)** SILT with gravel (ML): olive gray, moist, fine gravel, scattered organic debris							
20	12					SILT (ML): gray, dry to moist, scattered fine gravel, increased gravel content at bottom of sample							
18	14					Sandy SILT (ML): olive gray, moist, fine sand							
16	16					Silty SAND (SM): olive gray, moist, few fine gravel							
14	18					Sandy SILT with gravel (ML): olive gray, moist, fine sand, fine to coarse gravel							
12	20												
10	22					Poorly-graded SAND with gravel (SP): olive gray, moist, medium sand, fine to coarse gravel							
8	24					Well-graded GRAVEL with silt and sand (GW-GM): olive gray, moist, medium sand, fine to coarse gravel							
6	26					Poorly-graded SAND with gravel (SP): olive gray, moist, fine gravel							
4	28					Well-graded GRAVEL with silt and sand (GW-GM): olive gray, moist, coarse sand, fine to coarse gravel							
2	30												
0	32					Poorly-graded GRAVEL with sand (GP): dark gray, wet, coarse sand, fine to coarse gravel							
-2	34					Poorly-graded GRAVEL with silt and sand (GP-GM): tan-gray, wet, coarse sand, fine gravel							
-4	36					Poorly-graded SAND with silt (SP-SM): gray, wet, few fine gravel							
-6	38					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, wet, fine gravel							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 17, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S087RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-43a

LOCATION: N 2,358,703 E 5,992,130 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 32.8 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-8	42					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, wet, fine gravel							
-10	44					Poorly-graded SAND with gravel (SP) to poorly-graded GRAVEL (GP): blue gray, wet, coarse sand, fine gravel							
-12	46					Well-graded GRAVEL with silt and sand (GW-GM): tan-gray, wet, coarse sand, fine gravel							
-14	48					Well-graded GRAVEL with clay and sand (GW-GC): tan-gray, wet, medium sand, fine to coarse gravel							
-16	50					Clayey SAND (SC): olive gray, wet, medium sand, few fine gravel							
-18	52												
-20	54												
-22	56												
-24	58												
-26	60												
-28	62												
-30	64												
-32	66												
-34	68												
-36	70												
-38	72												
-40	74												
-42	76												
-44	78												
-46													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 17, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S087RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-43b

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,358,522 E 5,993,213 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	2					**ARTIFICIAL FILL (af)** Poorly-graded GRAVEL with sand (GP): olive gray, moist, medium sand, fine gravel		125	3	10			
30	4					Well-graded SAND with silt and gravel (SW-SM): olive gray, moist, medium sand, fine gravel							
28	6					SILT with gravel (ML): mottled olive gray and light brown, moist, fine gravel - olive gray, fine to coarse gravel at 5'							
26	8					Well-graded SAND with silt and gravel (SW-SM): olive gray, moist, fine sand, fine gravel							
24	10												
22	12					**ALLUVIUM (Qal)** SILT with gravel (ML): olive gray, moist, fine to coarse gravel							
20	14												
18	16												
16	18												
14	20												
12	22					Silty lean CLAY (CL-ML): olive gray, moist							
10	24					Well-graded GRAVEL with sand (GW): brown-gray, moist, fine to coarse sand, fine gravel							
8	26					- moist, medium to coarse sand, fine to coarse gravel at 26'							
6	28					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, wet fine to coarse gravel							
4	30												
2	32												
0	34					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-2	36					Well-graded GRAVEL with sand (GW) and poorly graded GRAVEL (GP): gray, wet, medium to coarse sand, fine gravel							
-4	38					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, wet, fine gravel							
-6													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S098LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-44a

LOCATION: N 2,358,522 E 5,993,213 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-8	42					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, wet, fine gravel							
-10	44					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-12	46					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine to coarse gravel							
-14	48												
-16	50												
-18	52												
-20	54												
-22	56												
-24	58												
-26	60												
-28	62												
-30	64												
-32	66												
-34	68												
-36	70												
-38	72												
-40	74												
-42	76												
-44	78												
-46													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 23, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S098LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-44b

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,358,875 E 5,993,028 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
32	2					**ARTIFICIAL FILL (af)** Roadway gravel							
30	4					SILT with gravel (ML): olive gray, moist, fine gravel							
28	6					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, moist, fine to coarse gravel							
26	8					SILT with gravel (ML) to poorly-graded GRAVEL with silt (GP-GM): olive gray, moist, fine gravel							
24	10					**ALLUVIUM (Qal)** SILT with gravel (ML): olive gray, moist, fine gravel							
22	12												
20	14					- moist at 14'							
18	16					SILT with gravel (ML) to poorly-graded GRAVEL with silt (GP-GM): olive gray, moist, fine gravel							
16	18					Silty SAND with gravel (SM): olive gray, moist, fine gravel, medium sand							
14	20												
12	22												
10	24					Sandy SILT (ML): olive gray, moist, fine sand							
8	26					Poorly-graded SAND with gravel (SP): olive gray, moist, medium sand, fine gravel							
6	28					Poorly-graded GRAVEL with sand (GP): olive gray, wet, fine gravel							
4	30					Well-graded GRAVEL with clay and sand (GW-GC): olive gray, wet, fine gravel							
2	32					- coarse sand at 32'							
0	34					- fine to coarse gravel at 34'							
-2	36					Poorly-graded SAND (SP): gray, wet, coarse sand							
-4	38					Poorly-graded GRAVEL with silt (GP-GM): brown-gray, wet, fine gravel							
-6													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.5 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 16, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S098RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-45a

LOCATION: N 2,358,875 E 5,993,028 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 33.7 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-8	42					Poorly-graded GRAVEL with sand (GP): tan-gray, wet, fine to coarse gravel							
-10	44												
-12	46												
-14	48					Poorly-graded GRAVEL (GP): tan-gray, wet, fine to coarse gravel							
-16	50												
-18	52												
-20	54												
-22	56												
-24	58												
-26	60												
-28	62												
-30	64												
-32	66												
-34	68												
-36	70												
-38	72												
-40	74												
-42	76												
-44	78												
-46													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.5 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 16, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S098RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-45b

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,358,917 E 5,994,632 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 35.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
34	2					**ARTIFICIAL FILL (af)** Poorly-graded GRAVEL with sand (GP): dark gray, moist, medium sand, fine to coarse gravel							
32	4												
30	6					**ALLUVIUM (Qal)** Sandy SILT with gravel (ML): olive gray, moist, fine gravel							
28	8					SILT (ML): olive gray, moist, scattered fine gravel							
26	10					- scattered organic debris, trace fine gravel at 10'							
24	12					Poorly-graded SAND with silt and gravel (SP-SM): gray, moist, fine sand, fine to coarse gravel							
22	14					Sandy SILT with gravel (ML): olive gray, moist, fine to o medium sand, fine to coarse gravel							
20	16					SILT (ML): olive gray, moist, scattered fine gravel, organic debris							
18	18					- scattered organic debris at 18'							
16	20												
14	22					**ALLUVIUM (Qal)** Poorly-graded GRAVEL with sand (GP): gray, moist, coarse sand, fine to coarse gravel							
12	24					Poorly-graded GRAVEL with silt (GP-GM): tan-gray, moist to wet, fine to coarse gravel							
10	26												
8	28												
6	30												
4	32					Poorly-graded GRAVEL with sand (GP): gray, wet, coarse sand, fine to coarse gravel							
2	34					Silty SAND (SM): olive gray, wet, fine sand							
0	36					Well-graded GRAVEL with silty clay and sand (GW-GM): gray-brown, wet, coarse sand, fine to coarse gravel							
-2	38					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine to coarse gravel							
-4													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 24.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 21, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S114LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-46a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,358,917 E 5,994,632 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 35.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-6	42					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-8	44					Well-graded GRAVEL with clay and sand (GW-GC): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
-10	46					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, wet, coarse sand, fine to coarse gravel							
-12	48												
-14	50					Well-graded GRAVEL with clay and sand (GW-GC): gray-brown, wet, medium sand, fine to coarse gravel							
-16	52												
-18	54												
-20	56												
-22	58												
-24	60												
-26	62												
-28	64												
-30	66												
-32	68												
-34	70												
-36	72												
-38	74												
-40	76												
-42	78												
-44													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 24.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 21, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S114LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-46b

LOCATION: N 2,359,318 E 5,994,607 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 35.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
34	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): gray, dry to moist, fine to coarse gravel							
32	4												
30	6					SILT with gravel (ML): olive gray, moist, fine gravel - scattered organic debris at 6'							
28	8												
26	10					Silty CLAY with gravel (CL-ML): olive gray, moist, fine to coarse gravel, trace organic debris							
24	12					**ALLUVIUM (Qal)** Silty CLAY with gravel (CL-ML): olive gray, moist, fine to coarse gravel, trace organic debris - fine gravel at 12'							
22	14					SILT with gravel (ML): olive gray, moist, fine gravel							
20	16					Poorly-graded GRAVEL with silt (GP-GM): olive gray, moist, fine to coarse gravel							
18	18					Sandy SILT (ML): olive gray, moist, fine sand							
16	20												
14	22												
12	24					Silty CLAY (CL-ML): olive gray, moist							
10	26					Poorly-graded SAND with gravel (SP): olive gray, moist, fine gravel							
8	28					Silty SAND (SM): olive gray, moist, fine sand							
6	30					Poorly-graded GRAVEL with silt (GP-GM): olive gray, wet, fine to coarse gravel							
4	32												
2	34					Well-graded GRAVEL (GW): gray, wet, fine to coarse gravel							
0	36					Well-graded GRAVEL with clay (GW-GC): brown-gray, wet, fine to coarse gravel							
-2	38					Well-graded SAND with gravel (SW) to well-graded GRAVEL with sand (GW): olive gray to gray brown, wet, fine to coarse gravel, some clay							
-4													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 29.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 16, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S114RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-47a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,318 E 5,994,607 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 35.2 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-6	42					Well-graded SAND with gravel (SW) to well-graded GRAVEL with sand (GW): olive gray to gray brown, wet, fine to coarse gravel, some clay							
-8	44					Poorly-graded GRAVEL with silt (GP-GM): blue gray, wet, fine to coarse gravel							
-10	46					Well-graded GRAVEL with clay and sand (GW-GC): tan-gray, wet, coarse sand, fine to coarse gravel							
-12	48					Poorly-graded GRAVEL with clay (GP-GC): gray, wet, fine to coarse gravel							
-14	50												
-16	52												
-18	54												
-20	56												
-22	58												
-24	60												
-26	62												
-28	64												
-30	66												
-32	68												
-34	70												
-36	72												
-38	74												
-40	76												
-42	78												
-44													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 29.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 16, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S114RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-47b

LOCATION: N 2,359,249 E 5,996,502 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 40.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
40	0					**ARTIFICIAL FILL (af)** Poorly-graded GRAVEL with sand (GP): gray, moist, medium sand, fine to coarse gravel							
38	2												
						Well-graded GRAVEL with silt and sand (GW-GM): tan-gray, dry to moist, medium sand, fine gravel							
36	4												
						Clayey SAND with gravel (SC): olive gray, moist, medium sand, fine to coarse gravel							
34	6					SILT with gravel (ML): olive gray, moist, fine gravel							
32	8												
30	10					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist, trace fine gravel							
28	12												
						Silty CLAY (CL-ML): gray-green, moist							
26	14												
24	16												
22	18					Silty SAND (SM): light brown, moist, trace coarse gravel							
20	20												
18	22												
16	24					Sandy lean CLAY (CL) to clayey SAND (SC): mottled gray and light brown, moist, fine sand							
14	26					Well-graded SAND with gravel (SW): gray-brown, moist, fine to medium sand, fine to coarse gravel							
12	28					Poorly-graded SAND with gravel (SP): gray-brown, moist, medium sand, fine gravel							
10	30					▽							
8	32												
6	34					Poorly-graded GRAVEL with sand (GP): gray, wet, coarse sand, fine to coarse gravel							
4	36					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
2	38					Well-graded SAND with clay and gravel (SW-SC): light brown, wet, fine to medium sand, fine to coarse gravel							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 21, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S132LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-48a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,249 E 5,996,502 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 40.4 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0	42					Well-graded SAND with clay and gravel (SW-SC): light brown, wet, fine to medium sand, fine to coarse gravel							
-2	44												
-4	46					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
-6	48					Poorly-graded GRAVEL with sand (GP): light gray, wet, coarse sand, fine gravel							
-8	50												
-10	52												
-12	54												
-14	56												
-16	58												
-18	60												
-20	62												
-22	64												
-24	66												
-26	68												
-28	70												
-30	72												
-32	74												
-34	76												
-36	78												
-38													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 21, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S132LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-48b

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,359,615 E 5,996,289 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
40	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): gray brown, moist, fine to coarse gravel							
38	4												
36	6					- gray, moist at 6'							
34	8					SILT (ML): mottled olive gray and brown, moist							
32	10					Sandy SILT with gravel (ML) to well-graded GRAVEL with silt and sand (GW-GM): olive gray, moist, fine gravel							
30	12												
28	14					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist							
26	16					- scattered fine gravel at 16'							
24	18					Well-graded GRAVEL with silt and sand (GW-GM): gray, moist, fine to coarse gravel							
22	20												
20	22												
18	24					Silty SAND (SM): olive gray, moist, scattered fine gravel							
16	26					SILT (ML): olive gray, moist							
14	28					Poorly-graded SAND with gravel (SP): dark gray, moist, medium to coarse sand, fine gravel							
12	30					Poorly-graded GRAVEL with sand (GP): olive gray, moist, medium sand, fine to coarse gravel							
10	32												
8	34					Silty SAND (SM): dark gray, wet, medium to coarse sand							
6	36					Well-graded SAND with gravel (SW): olive gray, wet, coarse sand, fine gravel							
4	38					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine to coarse gravel							
2													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 15, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S132RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-49a

LOCATION: N 2,359,615 E 5,996,289 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.1 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0	42					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine to coarse gravel							
-2	44					Poorly-graded GRAVEL (GP): gray to dark gray, wet, fine to coarse gravel							
-4	46					Poorly-graded GRAVEL with clay (GP-GC): brown-gray, wet, fine to coarse gravel							
-6	48												
-8	50												
-10	52												
-12	54												
-14	56												
-16	58												
-18	60												
-20	62												
-22	64												
-24	66												
-26	68												
-28	70												
-30	72												
-32	74												
-34	76												
-36	78												
-38													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 15, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S132RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-49b

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,360,460 E 5,997,184 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 39.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
38	2					**ARTIFICIAL FILL (af)** Well-graded SAND with silt and gravel (SW-SM): gray, moist, medium to coarse sand, fine to coarse gravel - moist, olive gray, fine to medium sand at 2'							
36	4					Sandy lean CLAY with gravel (CL): olive gray, moist	136	126	8		27	8	
34	6					SILT (ML): olive gray, moist,							
32	8					Well-graded GRAVEL with silt and sand (GW-GM): tan gray, dry to moist, medium sand, fine to coarse gravel							
30	10												
28	12					**ALLUVIUM (Qal)** Sandy SILT (ML): olive gray, moist, trace fine gravel							
26	14					SILT (ML): olive gray, moist, trace organic debris							
24	16												
22	18					Silty Clay (CL-ML): olive gray, moist							
20	20					Sandy SILT (ML): olive gray, moist, fine sand, scattered organic debris							
18	22					Silty SAND (SM) to sandy SILT (ML): olive gray, moist							
16	24					Silty SAND (SM): olive gray, wet, fine sand							
14	26					SILT (ML): olive gray, moist, abundant organic debris							
12	28					Poorly-graded GRAVEL with sand (GP): gray, wet, medium sand, fine to coarse gravel							
10	30												
8	32												
6	34					Well-graded GRAVEL with silt and sand (GW-GM): olive gray, wet, medium to coarse sand, fine to coarse gravel							
4	36					Well-graded GRAVEL with clay and sand (GW-GC): gray-brown, wet, coarse sand, fine to coarse gravel							
2	38					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, wet, medium to coarse sand, fine to coarse gravel							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S146LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-50a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,360,460 E 5,997,184 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 39.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-2	42					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
-4	44					Poorly-graded GRAVEL with silt (GP-GM): gray, wet, fine to coarse gravel							
-6	46					Well-graded GRAVEL with clay and sand (GW-GC): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
-8	48												
-10	50												
-12	52												
-14	54												
-16	56												
-18	58												
-20	60												
-22	62												
-24	64												
-26	66												
-28	68												
-30	70												
-32	72												
-34	74												
-36	76												
-38	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S146LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-50b

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,360,683 E 5,996,813 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
40	2					**ARTIFICIAL FILL (af)** Poorly-graded GRAVEL with sand (GP): gray, moist, fine to coarse gravel							
38	4					Well-graded GRAVEL with silt and sand (GW-GM): light gray, moist, fine to coarse gravel							
36	6					SILT (ML): olive gray, moist, trace organics							
34	8					SILT with gravel (ML): olive gray, moist, scattered fine to coarse gravel							
32	10												
30	12					Well-graded GRAVEL with clay and sand (GW-GC): olive gray, moist, fine to coarse gravel							
28	14					Sandy SILT with gravel (ML): olive gray, moist, fine gravel, trace organic debris							
26	16					SILT with gravel (ML): olive gray, moist, fine to coarse gravel, trace organic debris							
24	18					Sandy SILT (ML): olive gray, moist, trace fine sand, trace fine gravel							
22	20					Silty CLAY (CL-ML): gray, moist, trace fine gravel							
20	22					**ALLUVIUM (Qal)** SILT (ML): olive gray, moist							
18	24												
16	26					Sandy SILT (ML): olive gray, moist, fine gravel at bottom of sample bag							
14	28					Well-graded GRAVEL with silty clay (GW-GC): olive gray, wet, fine to coarse gravel, loose sand at bottom of sample bag							
12	30												
10	32					Silty SAND (SM): gray-brown, wet, medium to coarse sand, fine gravel							
8	34					Well-graded GRAVEL with silt (GW-GM): brown gray, wet, coarse sand, fine gravel							
6	36					Poorly-graded SAND (SP): dark gray, wet, medium sand, trace fine gravel							
4	38					- light brown, fine to coarse gravel at 38'							
2						- dark gray, fine to medium gravel at 39'							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 15, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S146RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-51a

LOCATION: N 2,360,683 E 5,996,813 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0	42					Poorly-graded SAND (SP): dark gray, wet, medium sand, trace fine gravel							
						- gray, medium to coarse sand at 42'							
-2	44					Silty SAND (SM): brown gray, wet, medium to coarse sand							
-4	46					Well-graded GRAVEL with silt and sand (GW-GM): brown gray, wet, medium to coarse sand, fine to coarse gravel							
-6	48					Well-graded GRAVEL with clay and sand (GW-GC): gray-brown, wet, coarse sand, fine to coarse gravel							
-8	50												
-10	52												
-12	54												
-14	56												
-16	58												
-18	60												
-20	62												
-22	64												
-24	66												
-26	68												
-28	70												
-30	72												
-32	74												
-34	76												
-36	78												
-38													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 15, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S146RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-51b

LOCATION: N 2,361,631 E 5,997,624 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-40	2					**ARTIFICIAL FILL (af)** Well-graded GRAVEL with silt and sand (GW-GM): olive gray, moist to wet, medium sand, fine to coarse gravel	152	144	5	16			
-38	4					Silty SAND with gravel (SM): olive gray, moist, fine to coarse gravel, medium to coarse sand							
-36	6					Sandy SILT (ML): olive gray, moist							
-34	8					SILT with gravel (ML): olive gray, moist, fine to coarse gravel							
-32	10					SILT (ML): olive gray, moist							
-30	12					**ALLUVIUM (Qal)** SILT with sand and gravel (ML): olive gray, moist, fine sand, fine gravel							
-28	14					SILT (ML): olive gray, moist							
-26	16					- moist, scattered organic debris at 16'							
-24	18												
-22	20												
-20	22												
-18	24					SILT (ML): olive gray, moist							
-16	26					Well-graded GRAVEL with silt and sand (GW-GM): gray to brown-gray, moist, medium to coarse sand, fine to medium gravel							
-14	28					- brownish-gray, moist, fine gravel, loose to weakly cemented at 28'							
-12	30					▽							
-10	32					SILT (ML): olive gray, wet, scattered fine gravel							
-8	34					- moist, scattered organic debris at 34'							
-6	36					Silty SAND (SM): tan-gray, wet, fine to medium sand, scattered fine gravel							
-4	38					Well-graded GRAVEL with clay and sand (GW-GC): tan-gray, wet, medium to coarse sand, fine to coarse gravel							
-2													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S158LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-52a

LOCATION: N 2,361,631 E 5,997,624 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 41.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
0	42					Well-graded GRAVEL with clay and sand (GW-GC): tan-gray, wet, medium to coarse sand, fine to coarse gravel							
-2	44					Poorly-graded GRAVEL (GP): tan-gray, wet, fine to coarse gravel							
-4	46					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine gravel							
-6	48					- fine to coarse gravel at 48'							
-8	50												
-10	52												
-12	54												
-14	56												
-16	58												
-18	60												
-20	62												
-22	64												
-24	66												
-26	68												
-28	70												
-30	72												
-32	74												
-34	76												
-36	78												
-38													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 30.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S158LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-52b

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,361,775 E 5,997,209 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 42.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
42						**ARTIFICIAL FILL (af)**							
	2					Well-graded GRAVEL with sand (GW): gray, moist, scattered coarse gravel							
40						Well-graded SAND with gravel (SW): gray, moist, few coarse gravel							
	4												
38													
	6					Silty SAND (SM): dark gray, moist, slight dark brown staining, few fine gravel							
36													
	8					SILT (ML): dark gray, moist, few fine gravel, friable							
34													
	10					- trace coarse sand at 11'							
32													
	12												
30													
	14					SILT with gravel (ML): dark gray, moist, friable, trace fine gravel							
28													
	16					Silty SAND with gravel (SM): gray to dark gray, moist, mottled, friable, fine gravel							
26													
	18					**ALLUVIUM (Qal)**							
24						Poorly-graded GRAVEL with silt (GP-GM): gray, moist, fine gravel							
	20												
22						SILT (ML): olive gray, moist, trace fine gravel							
	22												
20													
	24					▽							
18						SILT with gravel (ML): olive gray, moist, fine gravel							
	26												
16						- light gray, slightly moist, few coarse gravel at 27'							
	28												
14													
	30												
12													
	32												
10													
	34					Well-graded GRAVEL with silt and sand (GW-GM): olive gray, wet, fine to coarse gravel							
8													
	36												
6													
	38												
4													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 24.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 14, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S158RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-53a

LOCATION: N 2,361,775 E 5,997,209 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 42.5 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-2	42					Poorly-graded SAND (SP): gray, wet, fine to medium grained							
0						Silty SAND (SM): dark gray, wet, medium to coarse sand, some fine gravel							
-2	44					- olive gray, few fine gravel at 44'							
-4	46					- fine gravel at 46'							
-6	48												
-8	50												
-10	52												
-12	54												
-14	56												
-16	58												
-18	60												
-20	62												
-22	64												
-24	66												
-26	68												
-28	70												
-30	72												
-32	74												
-34	76												
-36	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 51.5 ft
DEPTH TO WATER: 24.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 14, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S158RC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-53b

CGI Technical Services Inc.

FUGRO

LOCATION: N 2,362,567 E 5,998,175 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 44.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
44	2					**ARTIFICIAL FILL (af)** Silty GRAVEL with sand (GM): olive gray, moist, fine gravel, fine sand							
42	4												
40	6					SILT (ML): olive gray, moist, few fine gravel - few fine to coarse gravel at 6'							
38	8												
36	10												
34	12					**ALLUVIUM (Qal)** SILT with gravel (ML): olive gray, moist, fine gravel							
32	14					Silty GRAVEL (GM): olive gray, moist, fine to coarse gravel, trace organic debris							
30	16					SILT with gravel (ML): olive gray, moist, fine to coarse gravel							
28	18					SILT (ML): olive gray, moist							
26	20												
24	22					Lean CLAY (CL): brown-gray, moist							
22	24					Well-graded SAND (SW): olive gray, moist, fine to coarse sand, little fine gravel							
20	26												
18	28					Well-graded SAND with gravel (SW): olive gray, moist, fine to coarse gravel, fine to medium sand							
16	30												
14	32					Lean CLAY (CL): olive gray, wet							
12	34					Lean CLAY with gravel (CL): olive gray, wet, fine to coarse gravel							
10	36					Clayey GRAVEL with sand (GC): olive gray, wet, medium to coarse sand, fine to coarse gravel							
8	38												
6													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 18, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S171LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-54a

CGI TECHNICAL SERVICES INC.

FUGRO

LOCATION: N 2,362,567 E 5,998,175 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 44.9 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
-4	42					Poorly-graded GRAVEL (GP): brown-gray, wet, fine to coarse gravel							
-2	44					Clayey GRAVEL with sand (GC): gray brown, wet, medium to coarse sand, fine to coarse gravel							
0	46												
-2	48												
-4	50					Silty SAND (SM): olive gray, wet, fine sand							
-6	52												
-8	54												
-10	56												
-12	58												
-14	60												
-16	62												
-18	64												
-20	66												
-22	68												
-24	70												
-26	72												
-28	74												
-30	76												
-32	78												
-34													

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 18, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S171LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-54b

LOCATION: N 2,362,728 E 5,999,676 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 48.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
48	0					**ARTIFICIAL FILL (af)**							
						SILT with gravel (ML): olive gray, moist to wet, fine to coarse gravel							
46	2					Well-graded SAND with gravel (SW): gray, moist, fine to coarse gravel, fine to medium sand							
44	4					- olive gray, medium sand at 3'							
42	6					SILT with gravel (ML): olive gray, moist, fine to coarse gravel							
40	8					Silty CLAY (CL-ML): olive gray, moist	128	111	15		26	5	
38	10					**ALLUVIUM (Qal)**							
						SILT (ML): olive gray, moist, trace fine gravel at 10'							
36	12					- scattered fine gravel at 12'							
34	14					Sandy SILT with gravel (ML): olive gray, moist, fine sand, fine to coarse gravel, trace organic debris							
32	16					SILT (ML): olive gray, moist, scattered fine gravel							
30	18												
28	20												
26	22												
24	24					Lean CLAY (CL): brownish gray, moist							
22	26												
20	28					Poorly-graded GRAVEL with sand (GP): brown-gray, moist, medium sand, fine gravel							
18	30												
16	32												
14	34												
12	36					SILT (ML): olive gray, moist							
10	38					Poorly-graded GRAVEL with silt (GP-GM): gray-brown, wet, fine gravel							
						Well-graded GRAVEL with sand and clay (GW-GC): slightly brown-gray, wet, medium to coarse sand, fine to							

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S185LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-55a

LOCATION: N 2,362,728 E 5,999,676 CA, State Plane, Zone 1, NAD83, Feet

SURFACE EL: 48.6 ft +/- (rel. NAVD 88 datum)

ELEVATION, ft	DEPTH, ft	MATERIAL SYMBOL	SAMPLE NO.	SAMPLERS	SAMPLER BLOW COUNT	MATERIAL DESCRIPTION	UNIT WET WEIGHT, pcf	UNIT DRY WEIGHT, pcf	WATER CONTENT, %	% PASSING #200 SIEVE	LIQUID LIMIT, %	PLASTICITY INDEX, %	UNDRAINED SHEAR STRENGTH, S_u, ksf
8	40					coarse gravel							
6	42					Poorly-graded GRAVEL (GP): gray, wet, fine to coarse gravel							
4	44					Well-graded GRAVEL with silt and sand (GW-GM): gray-brown, wet, medium to coarse sand, fine to coarse gravel							
2	46					Well-graded SAND with silt and gravel (SW-SM): tan-gray, wet, medium to coarse sand, fine to coarse gravel							
0	48					Well-graded GRAVEL with silt and sand (GW-GM): tan-gray, wet, medium to coarse sand, fine to coarse gravel							
-2	50												
-4	52												
-6	54												
-8	56												
-10	58												
-12	60												
-14	62												
-16	64												
-18	66												
-20	68												
-22	70												
-24	72												
-26	74												
-28	76												
-30	78												

The log and data presented are a simplification of actual conditions encountered at the time of drilling at the drilled location. Subsurface conditions may differ at other locations and with the passage of time.

COMPLETION DEPTH: 50.0 ft
DEPTH TO WATER: 28.0 ft
BACKFILLED WITH: Grout
DRILLING DATE: September 20, 2010

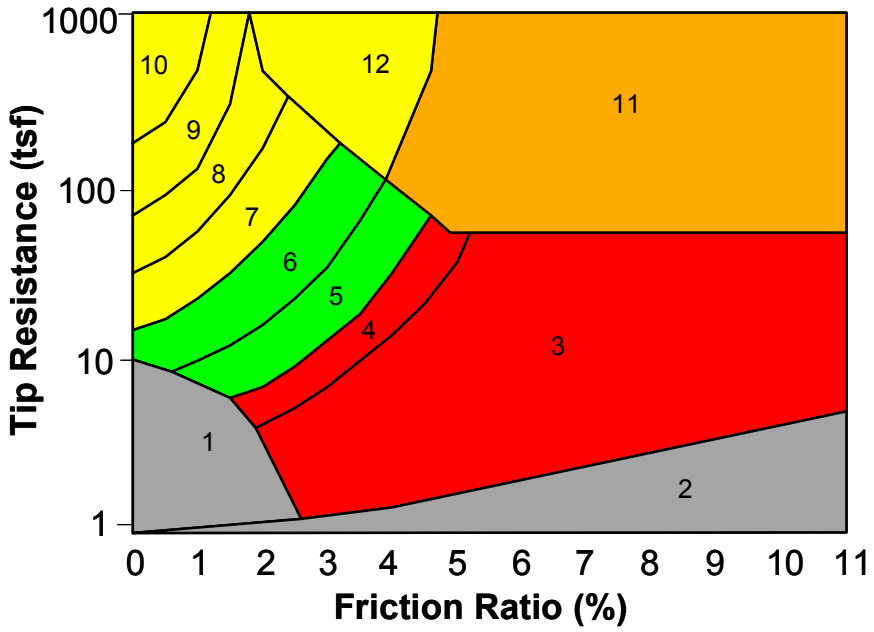
DRILLING METHOD: 6-inch-dia. Vibracore
DRILLED BY: Major Drilling Environmental LLC
LOGGED BY: W Pollard (CGI)
CHECKED BY: J Everett

LOG OF VIBRACORE NO. S185LC

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE B-55b

COLOR LEGEND FOR FRICTION RATIO TRACES



Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

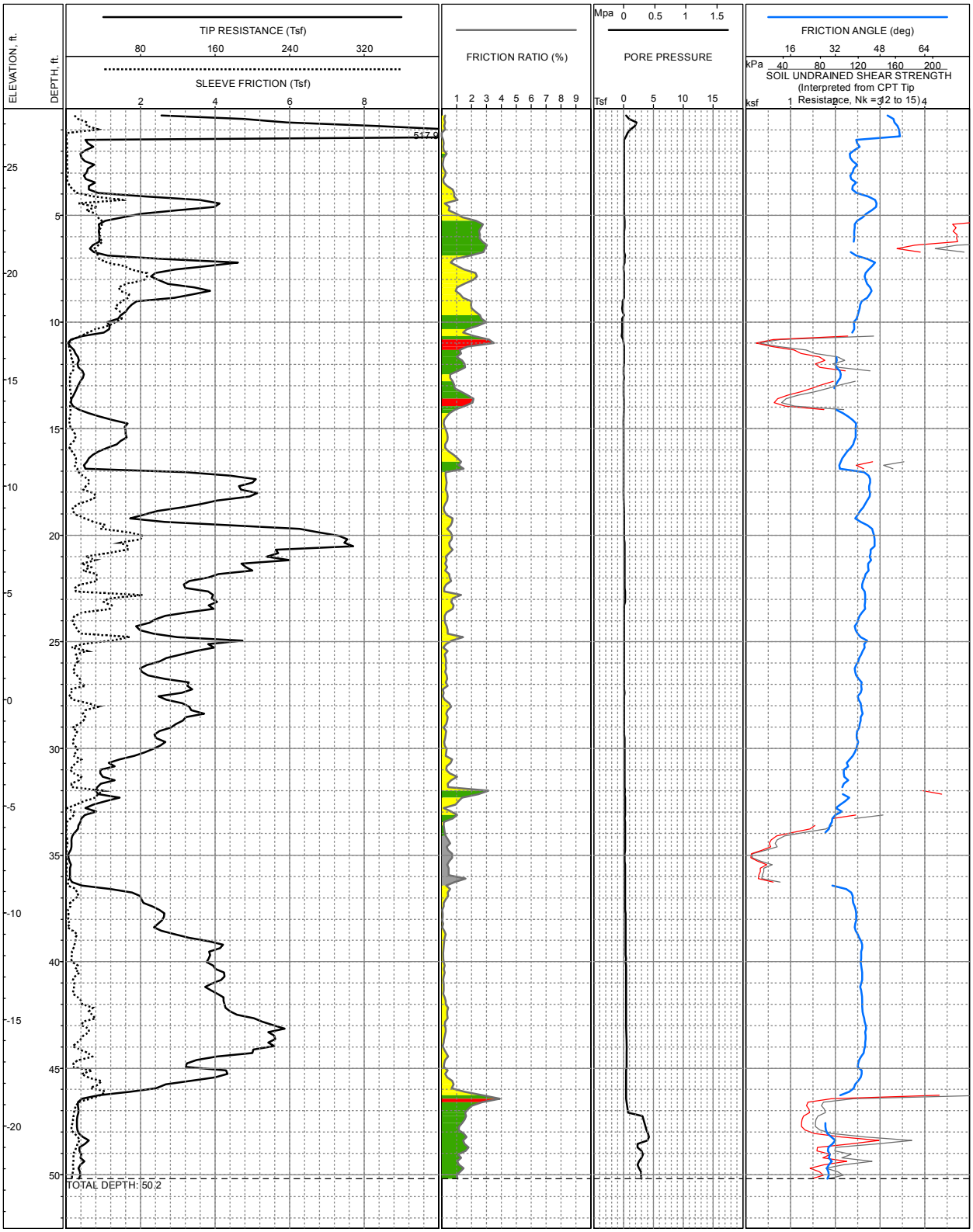
CPT CORRELATION CHART
(Robertson and Campanella, 1988)

KEY TO CPT LOGS

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-56

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Outputs\2011_05_21_GeotechEval\mxd\Plate_B-56_KeytoCPT-RC88.mxd, 05/12/11, CDean



LOCATION: N2,361,026, E 5,991,192
SURFACE EL: 27.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/24/2010

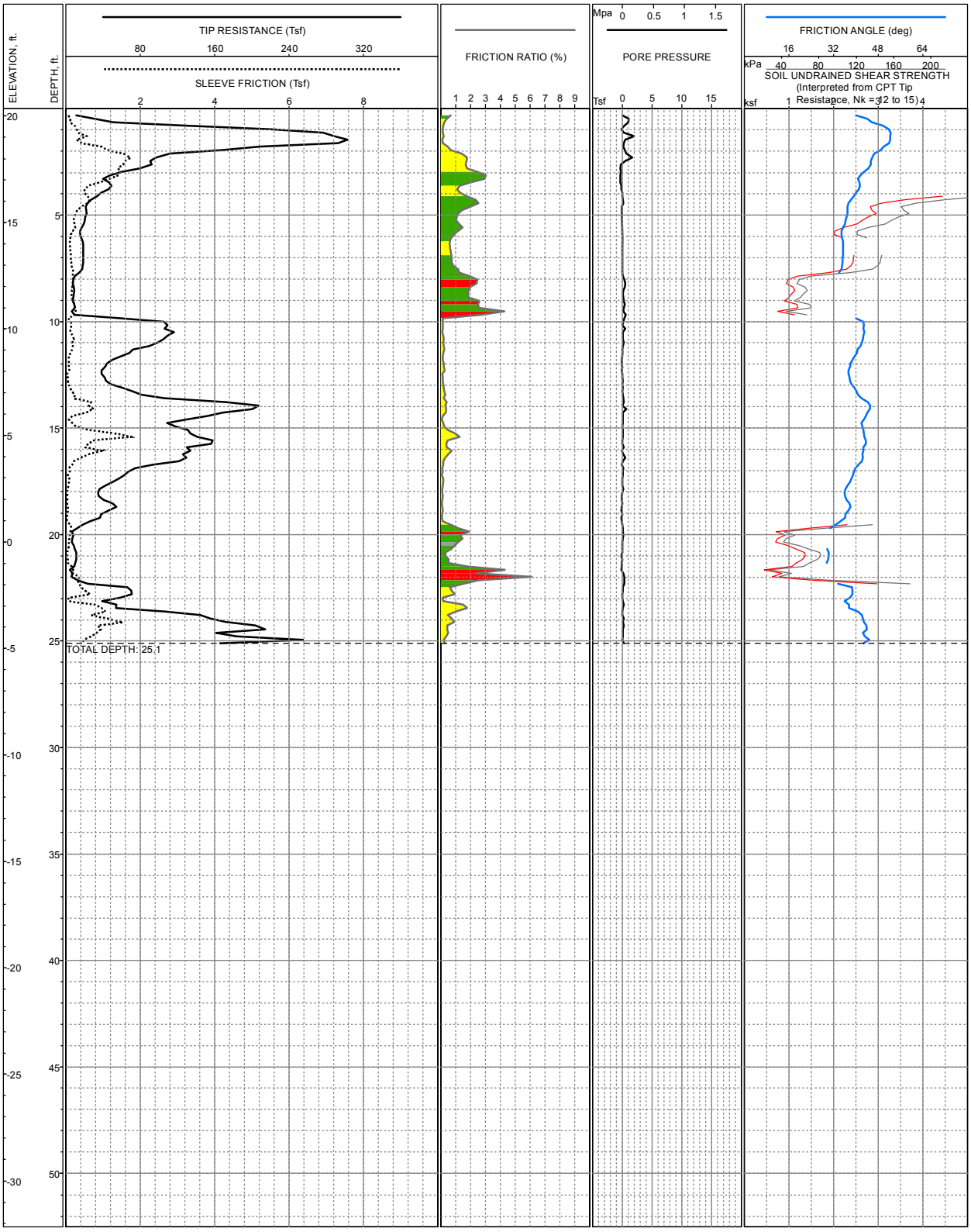
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-57

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,360,999, E 5,991,145
SURFACE EL: 20.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

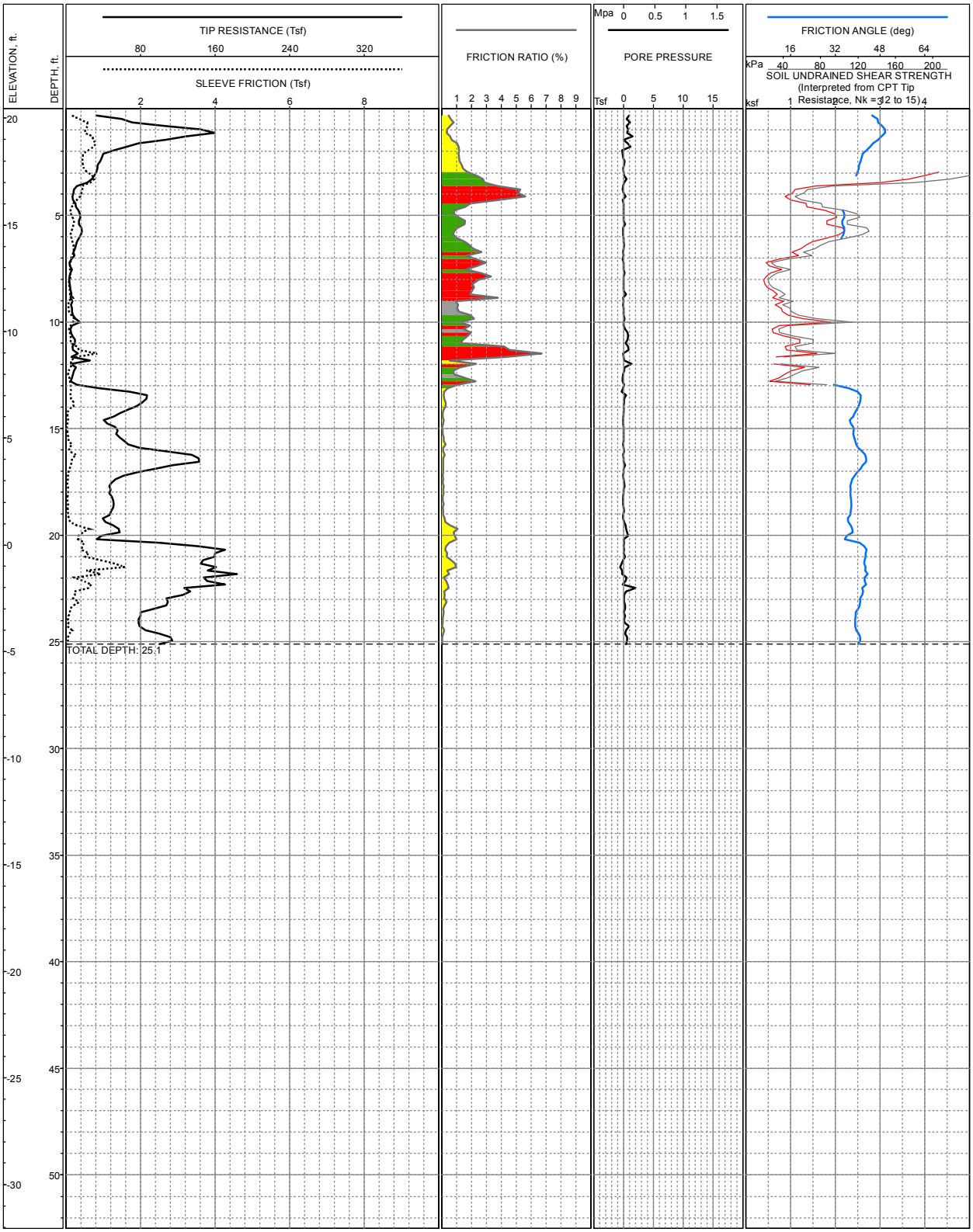
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57LL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-58

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,017, E 5,991,145
SURFACE EL: 20.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

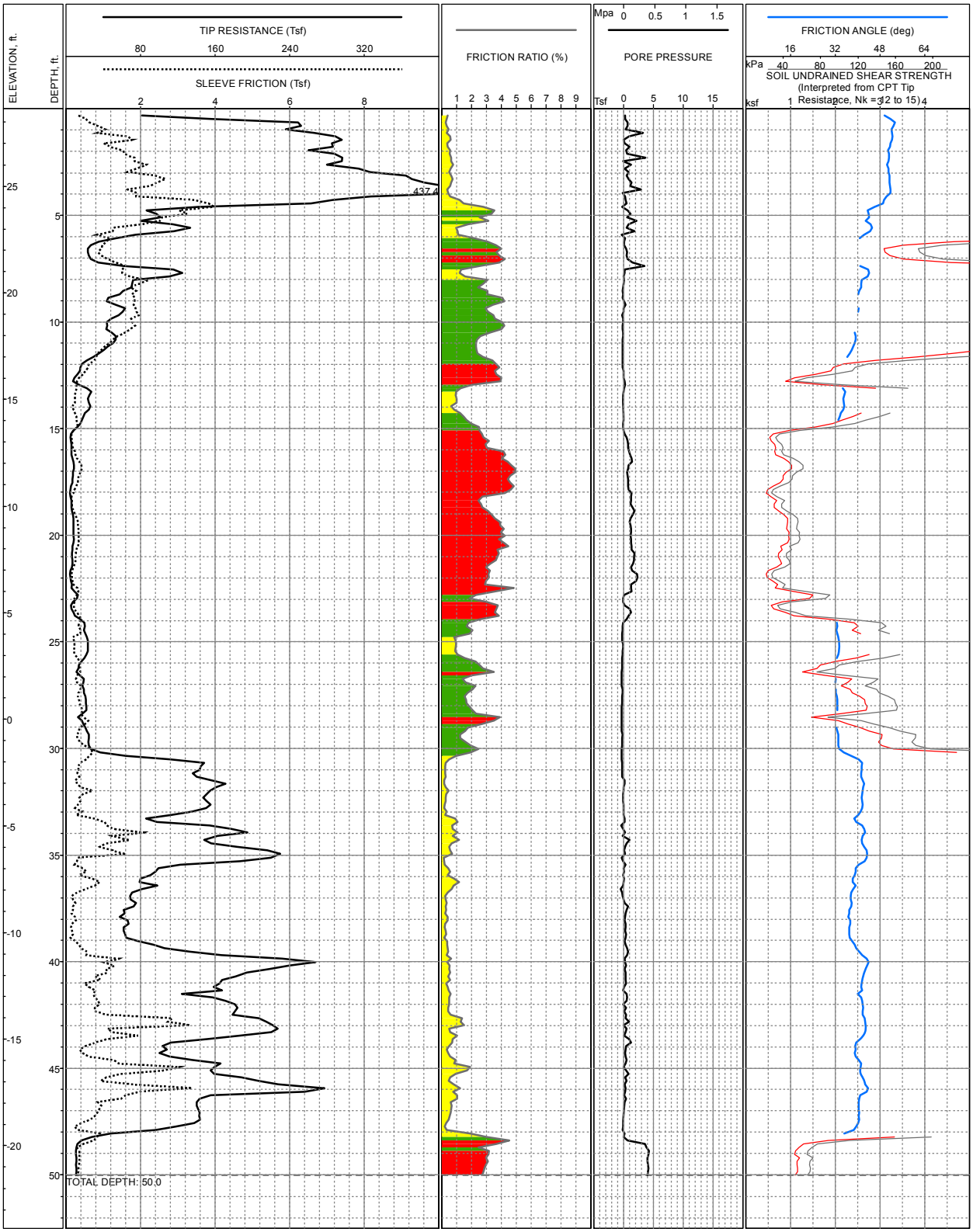
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57LO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-59

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,403, E 5,991,435
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/22/2010

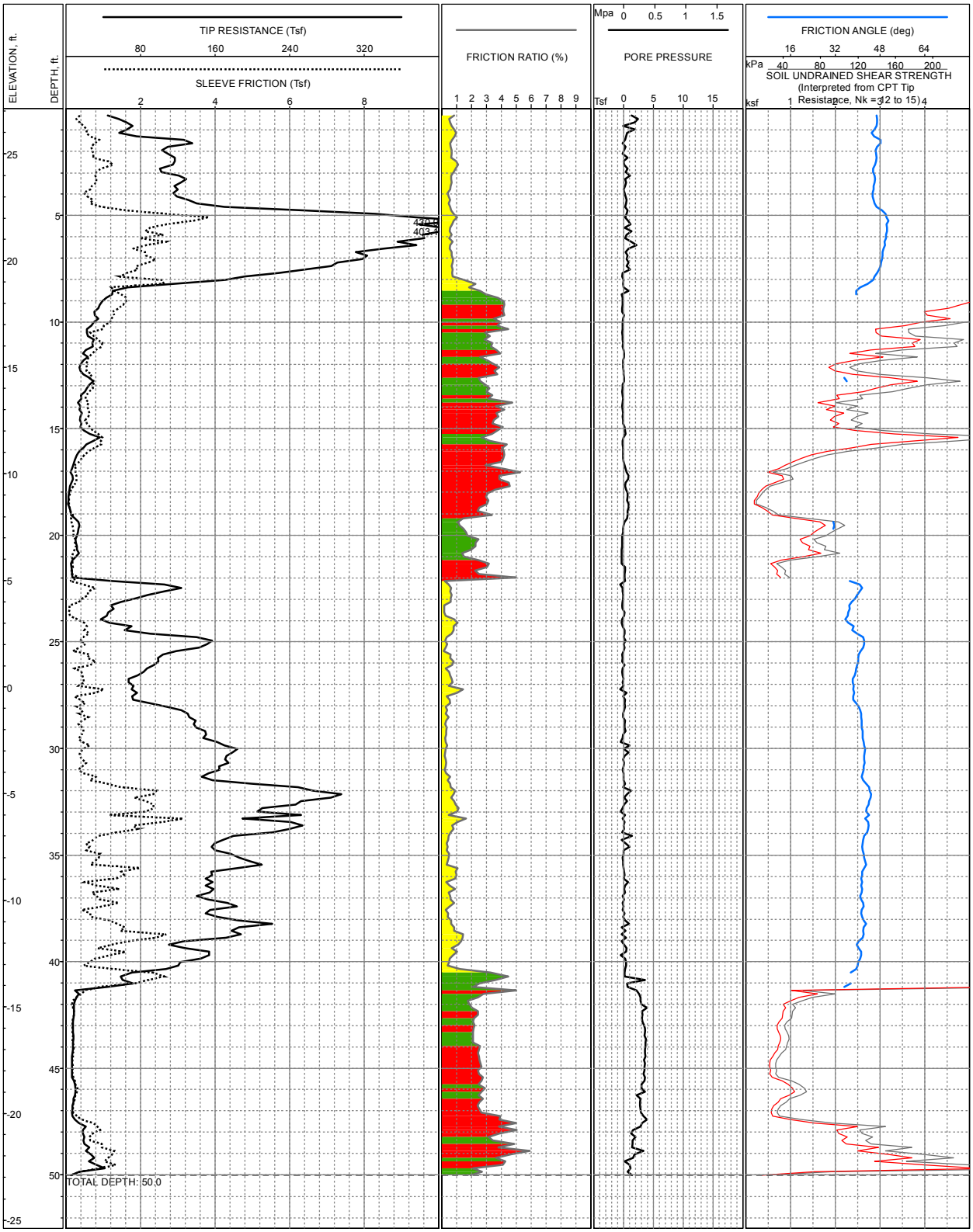
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-60

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,423, E 5,991,486
SURFACE EL: 27.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/22/2010

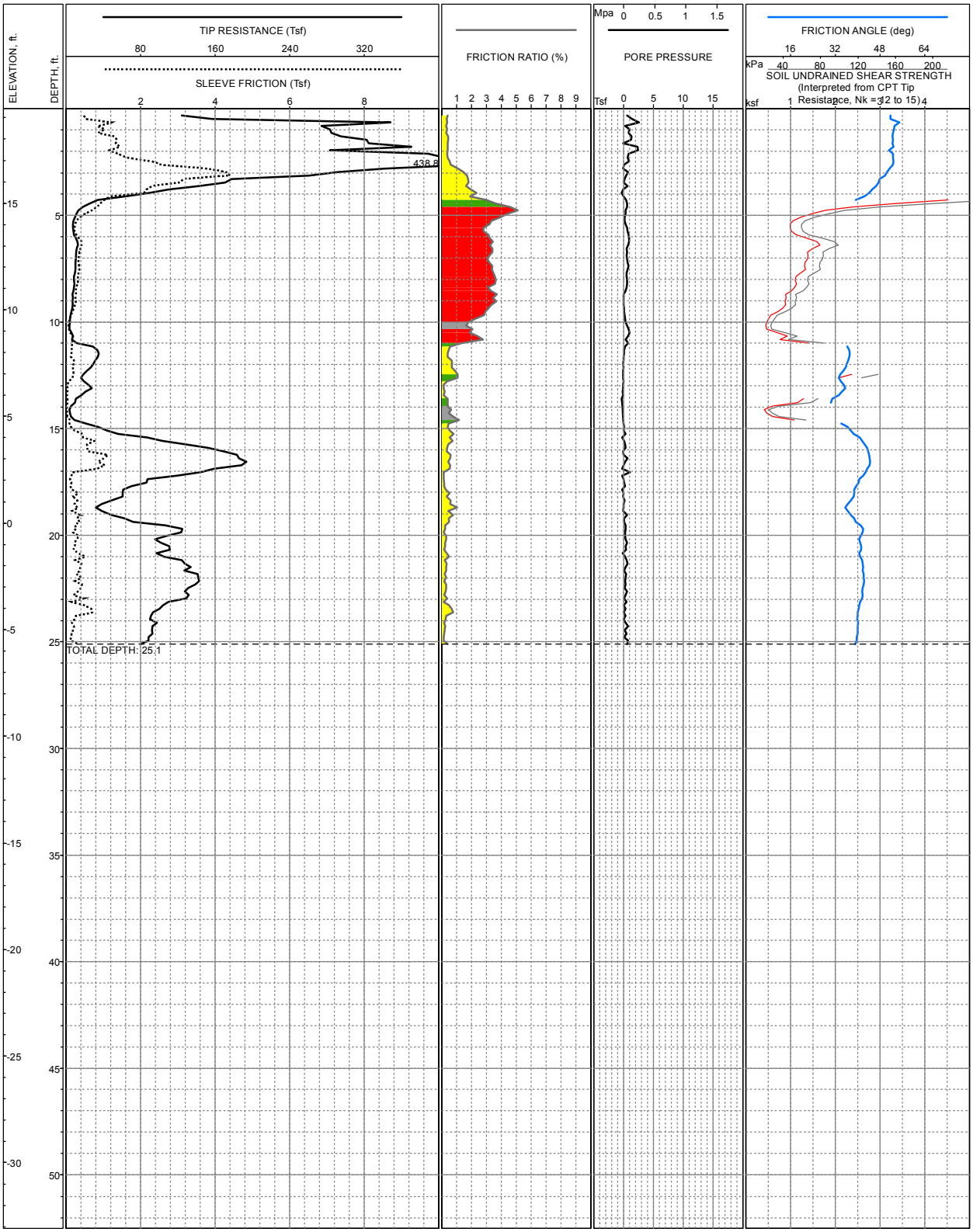
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57RL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-61

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,467, E 5,991,572
SURFACE EL: 19.4ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

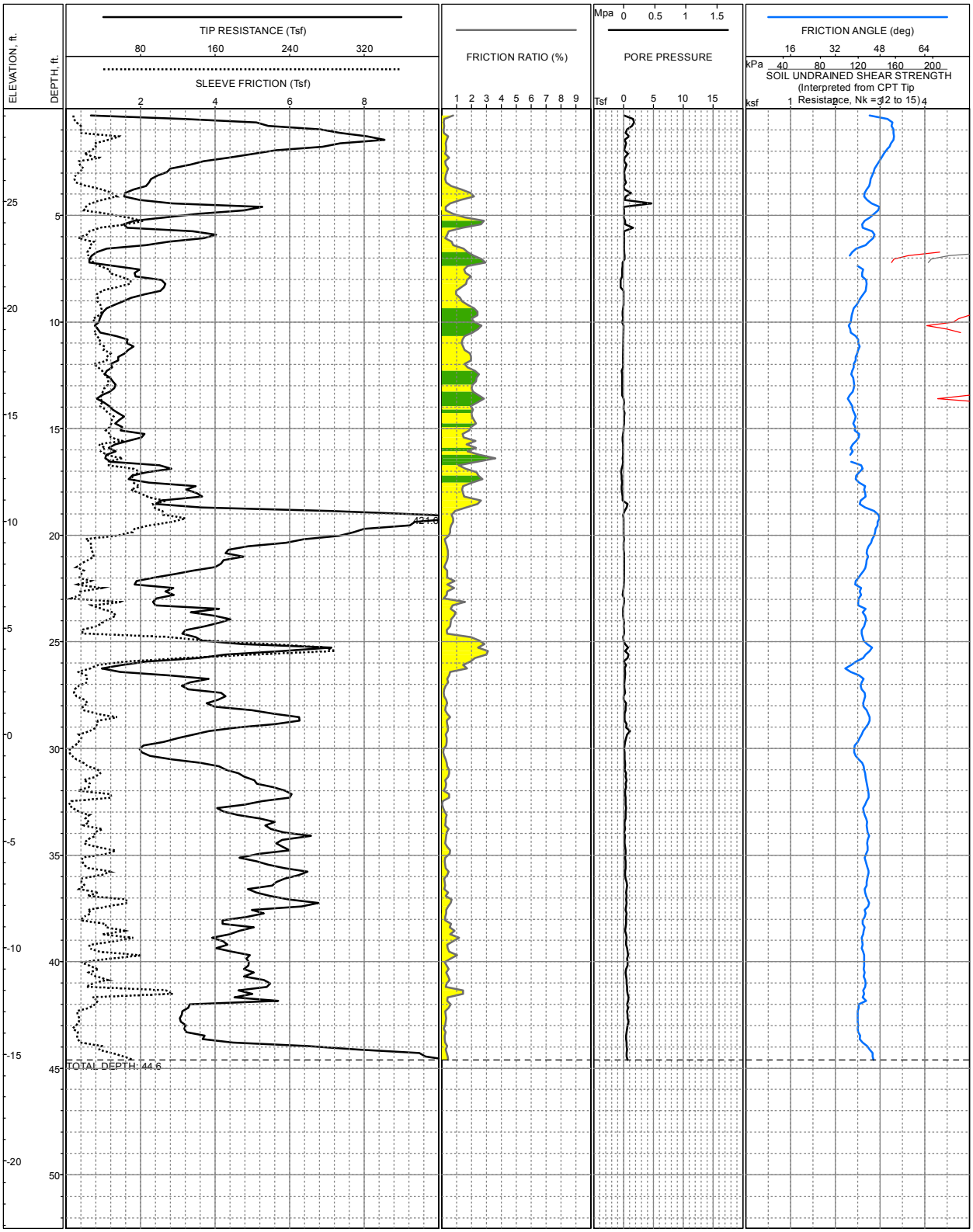
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57RO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-62

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,820, E 5,991,194
SURFACE EL: 29.3ft +/- (NAVD88)
COMPLETION DEPTH: 44.6ft
TESTDATE: 9/24/2010

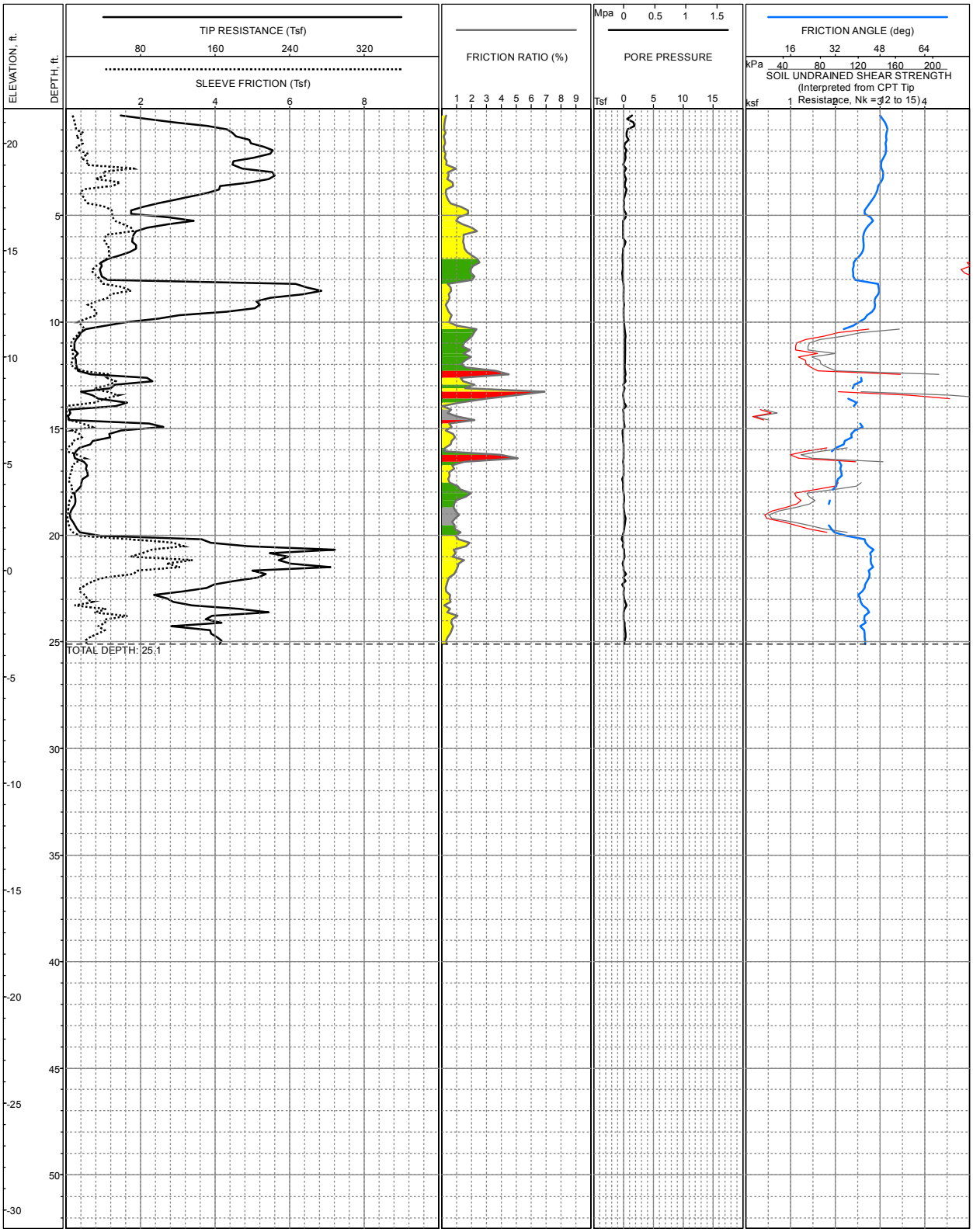
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-63

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,817, E 5,991,166
SURFACE EL: 21.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/24/2010

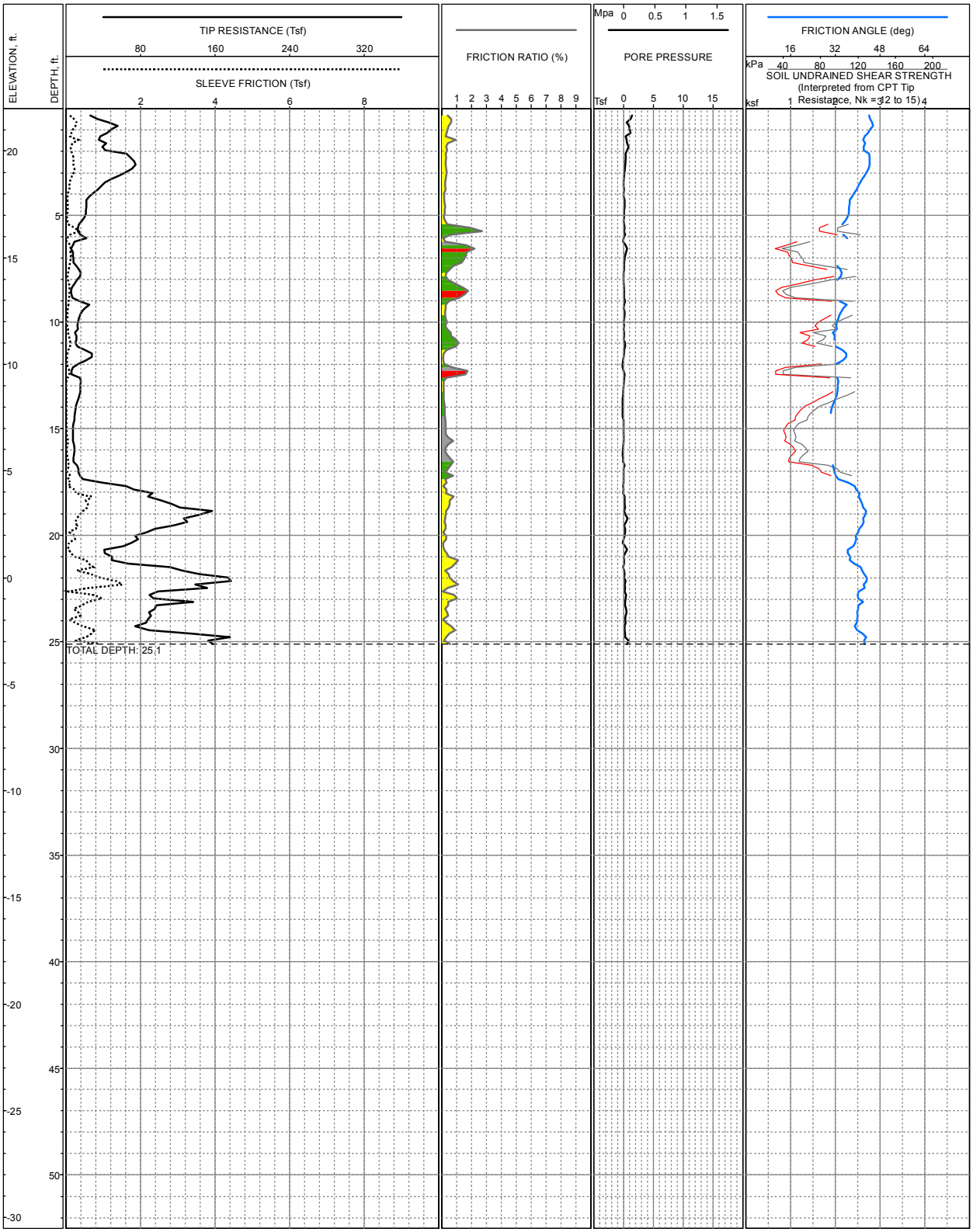
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73LL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-64

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,816, E 5,991,144
SURFACE EL: 22.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73LO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-65

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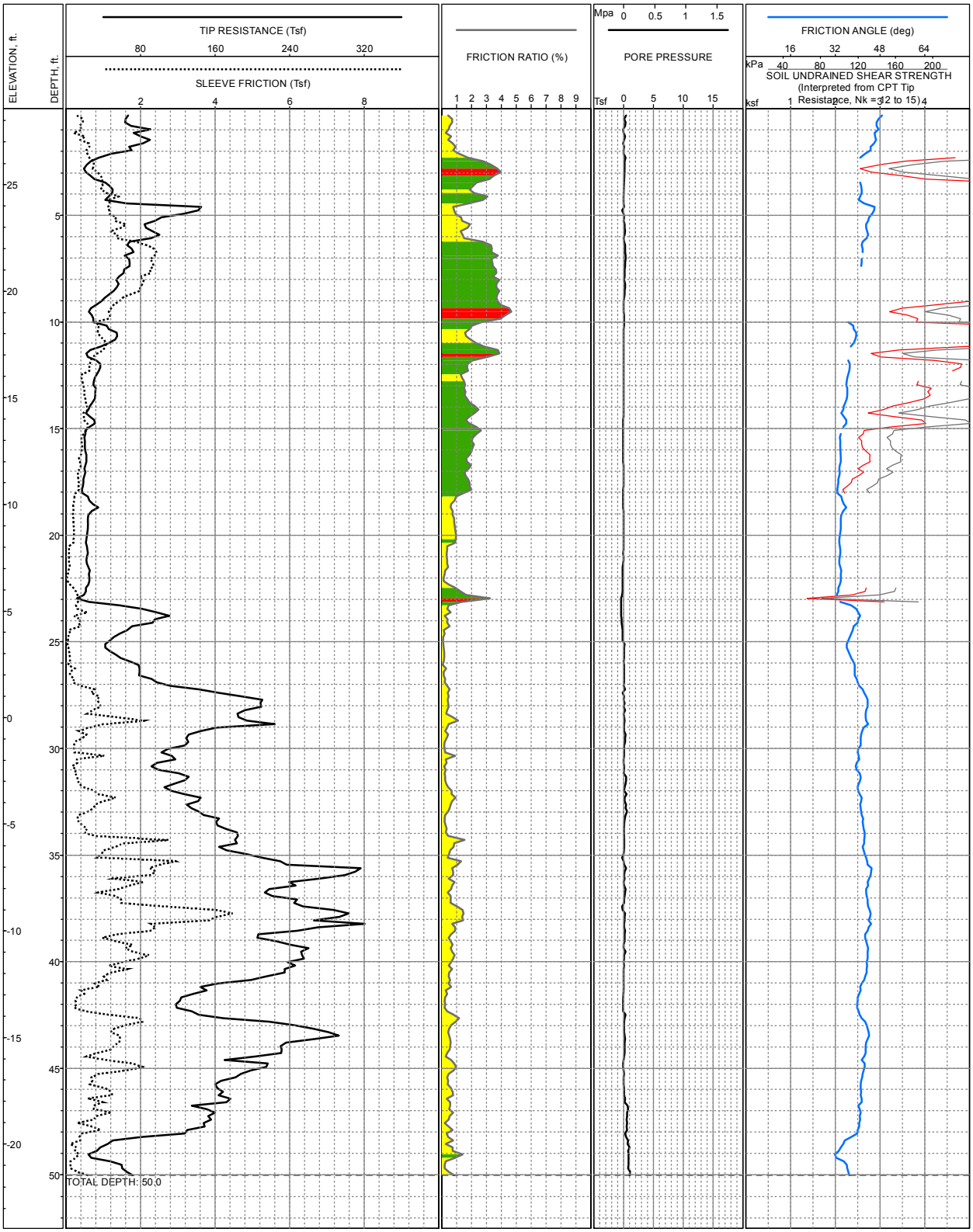


LOCATION: N2,359,828, E 5,991,605
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/21/2010

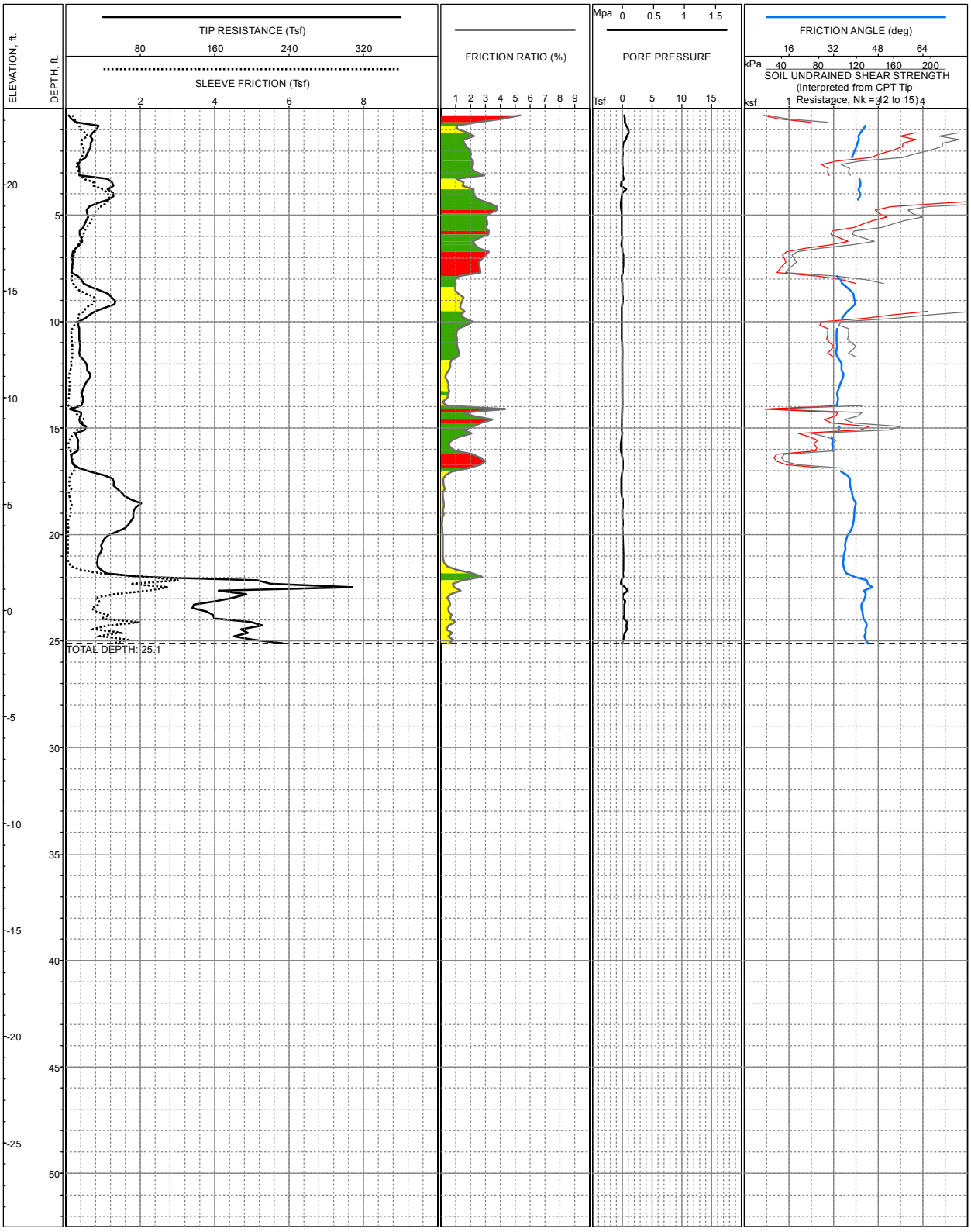
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-66

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,823, E 5,991,634
SURFACE EL: 23.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

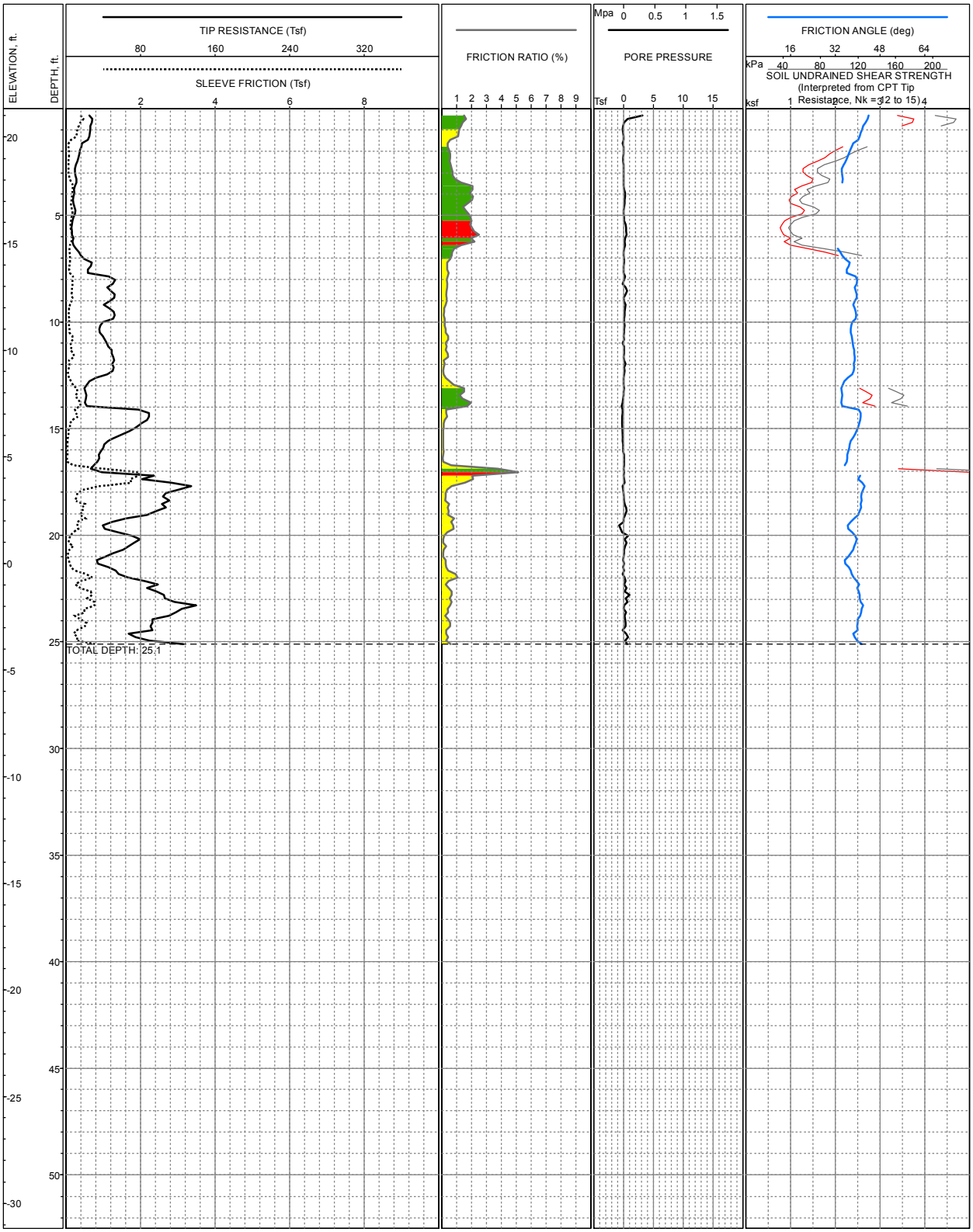
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73RL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-67

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFrMXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,826, E 5,991,658
SURFACE EL: 21.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

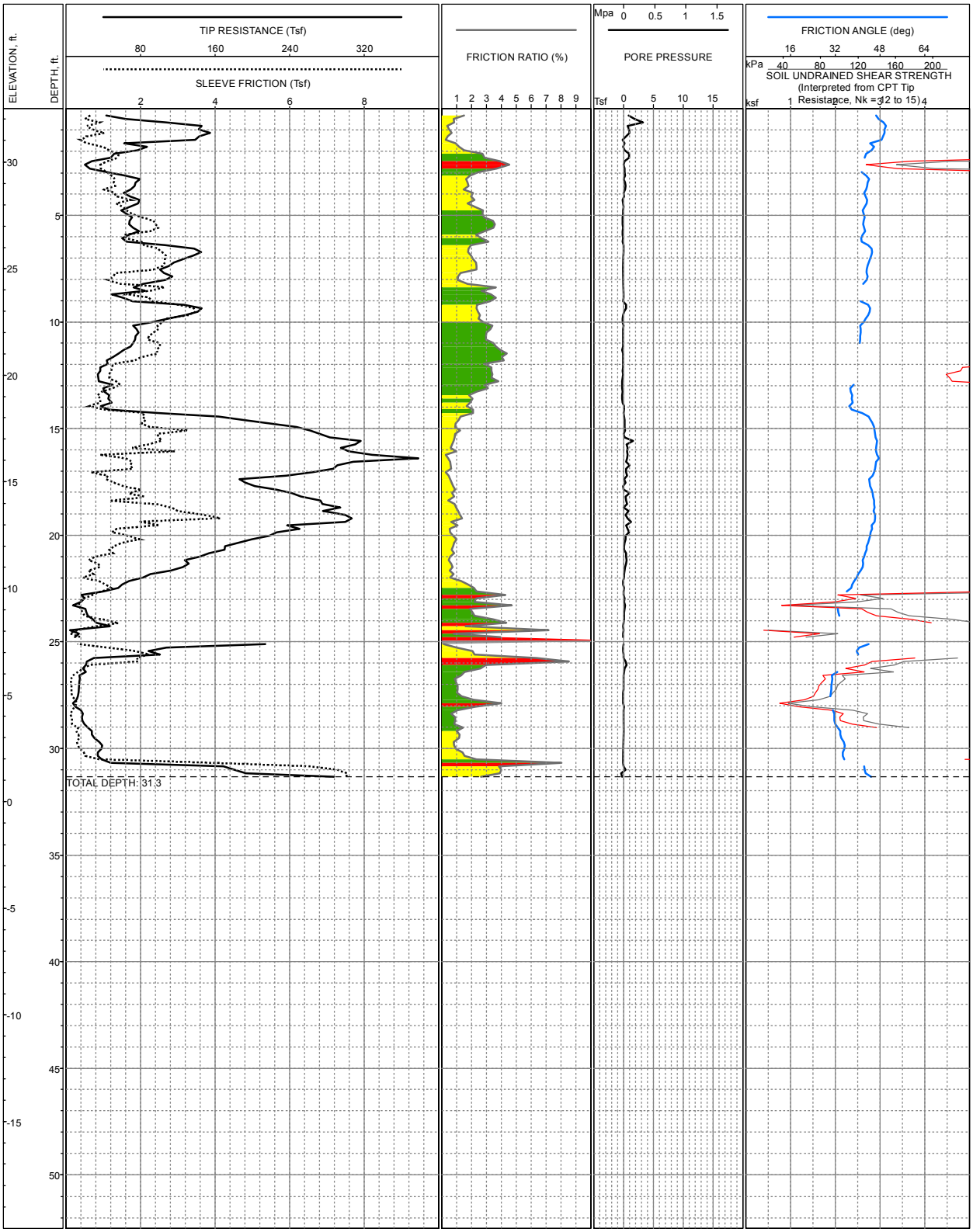
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73RO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-68

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFrMXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,358,357, E 5,991,844
SURFACE EL: 32.5ft +/- (NAVD88)
COMPLETION DEPTH: 31.3ft
TESTDATE: 9/23/2010

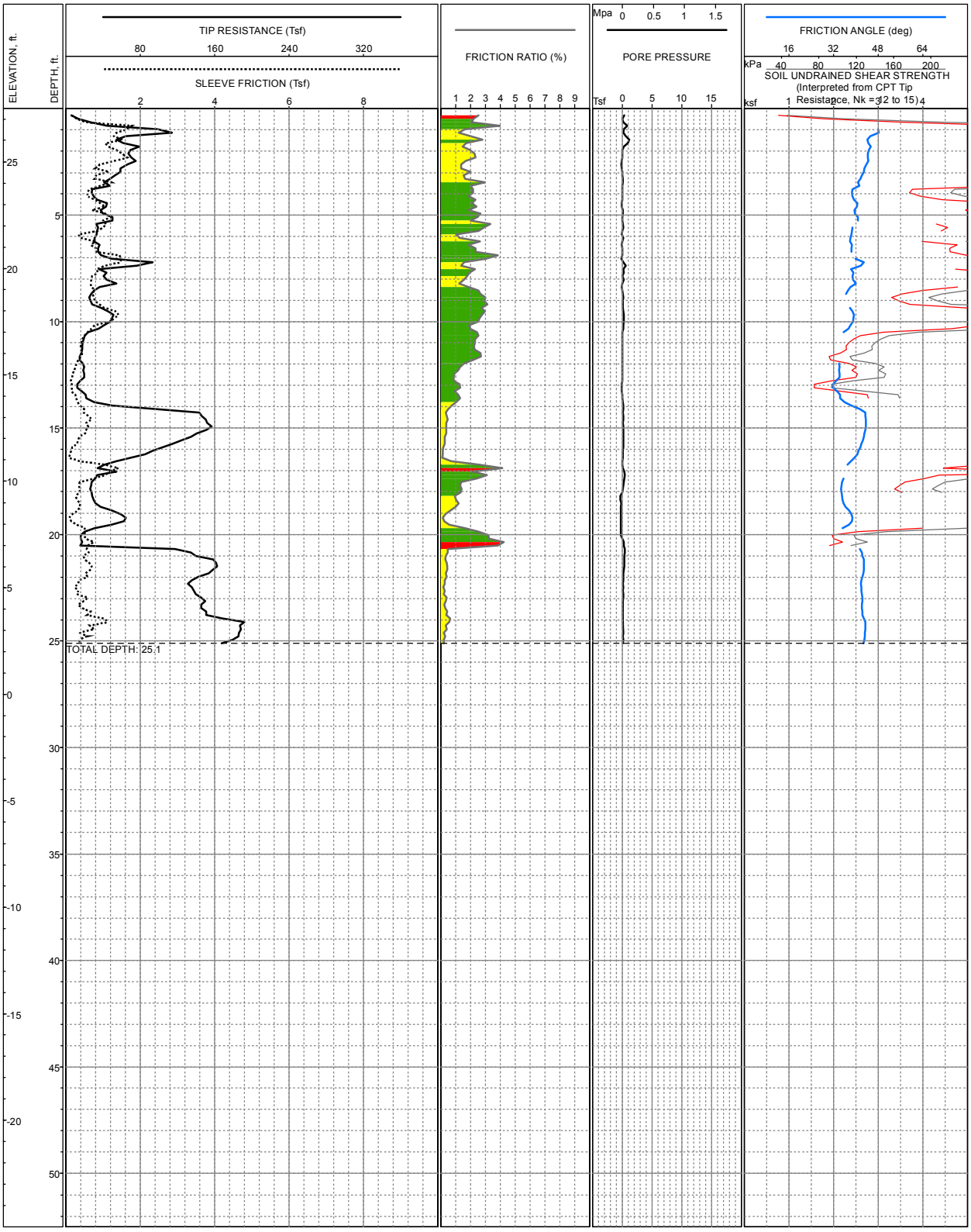
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-69

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,358,322, E 5,991,833
SURFACE EL: 27.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

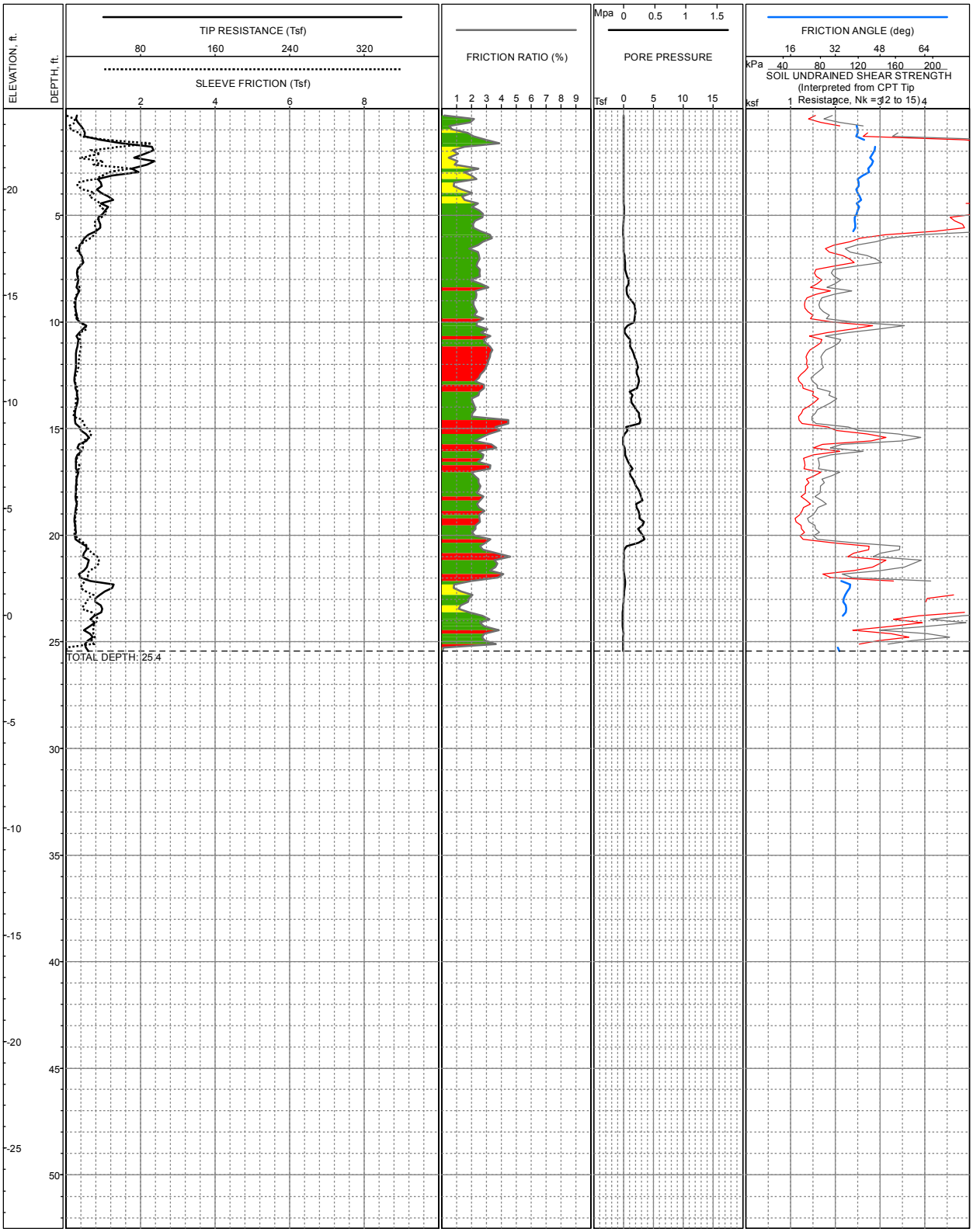
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87LL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-70

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,275, E 5,991,805
SURFACE EL: 23.7ft +/- (NAVD88)
COMPLETION DEPTH: 25.4ft
TESTDATE: 9/23/2010

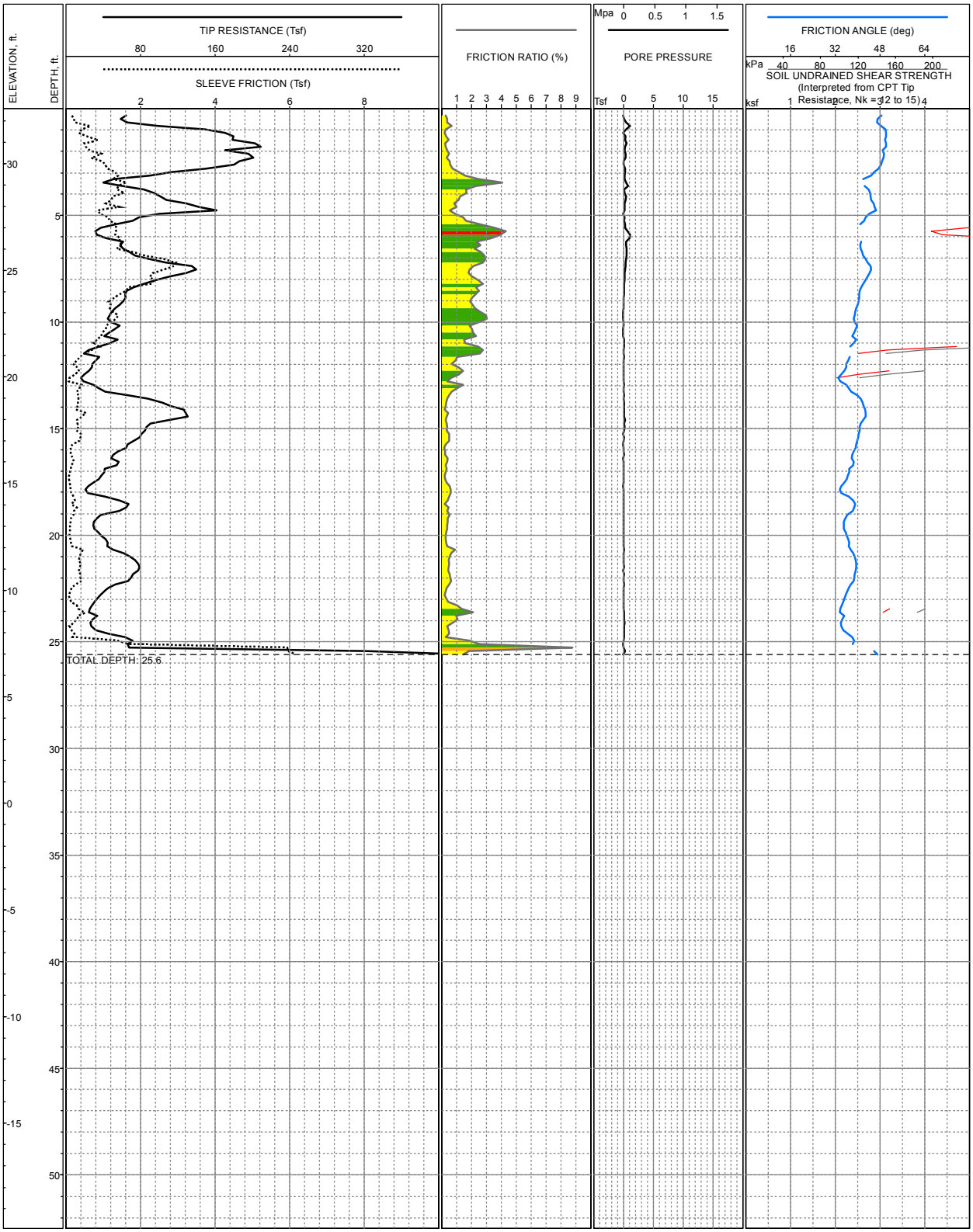
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87LO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-71

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,710, E 5,992,107
SURFACE EL: 32.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.6ft
TESTDATE: 9/21/2010

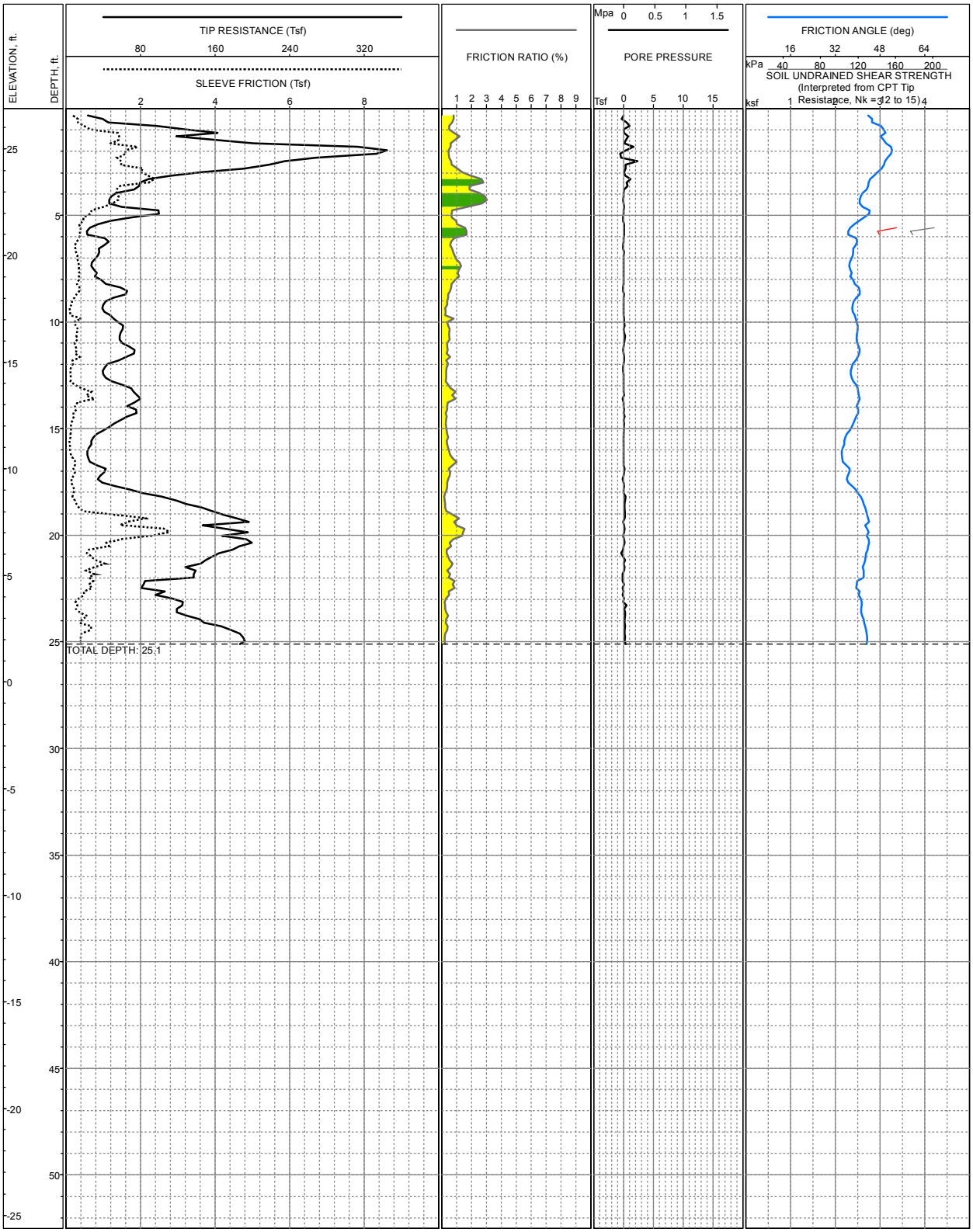
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-72

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,731, E 5,992,124
SURFACE EL: 26.9ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

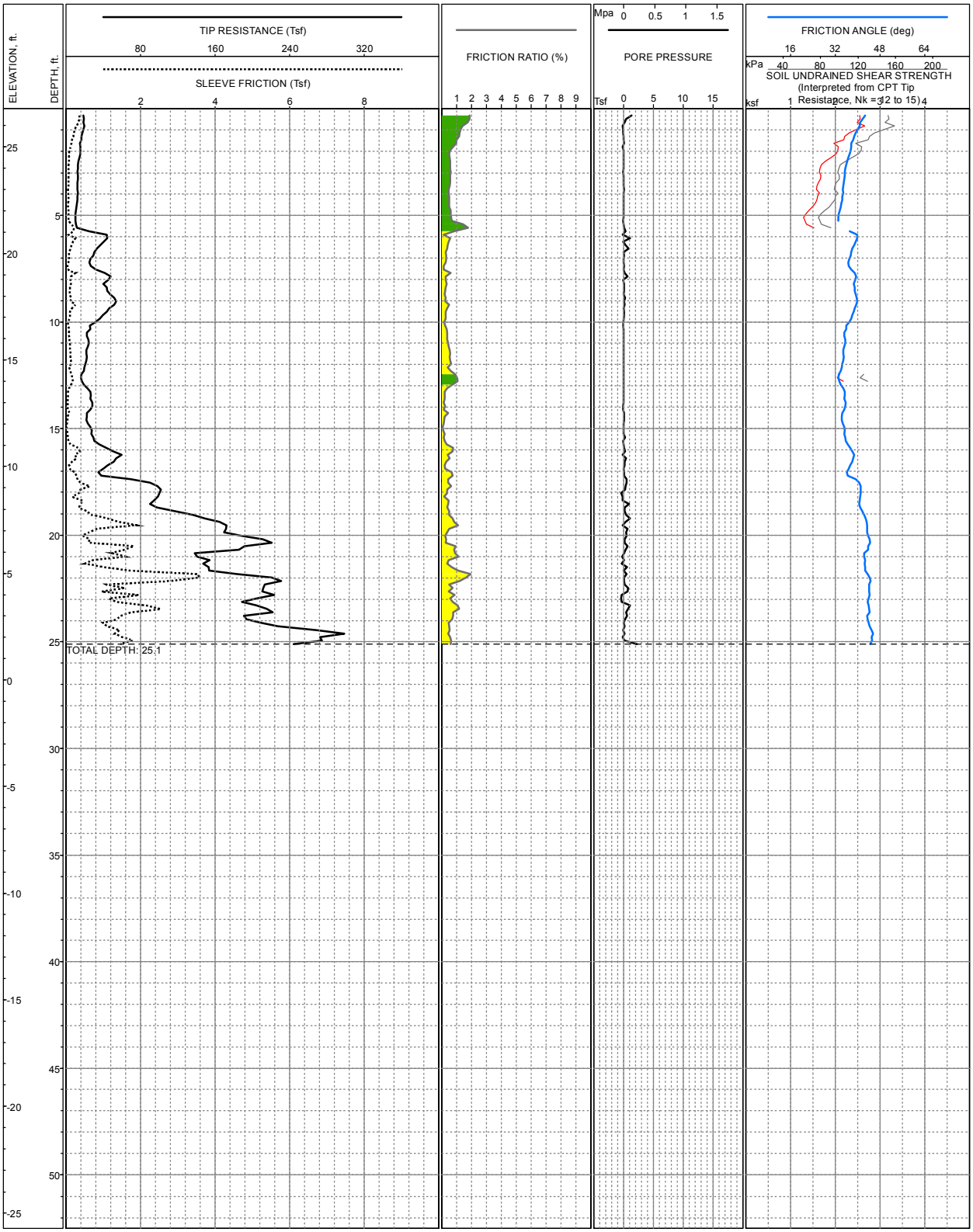
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87RL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-73

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,740, E 5,992,128
SURFACE EL: 26.8ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

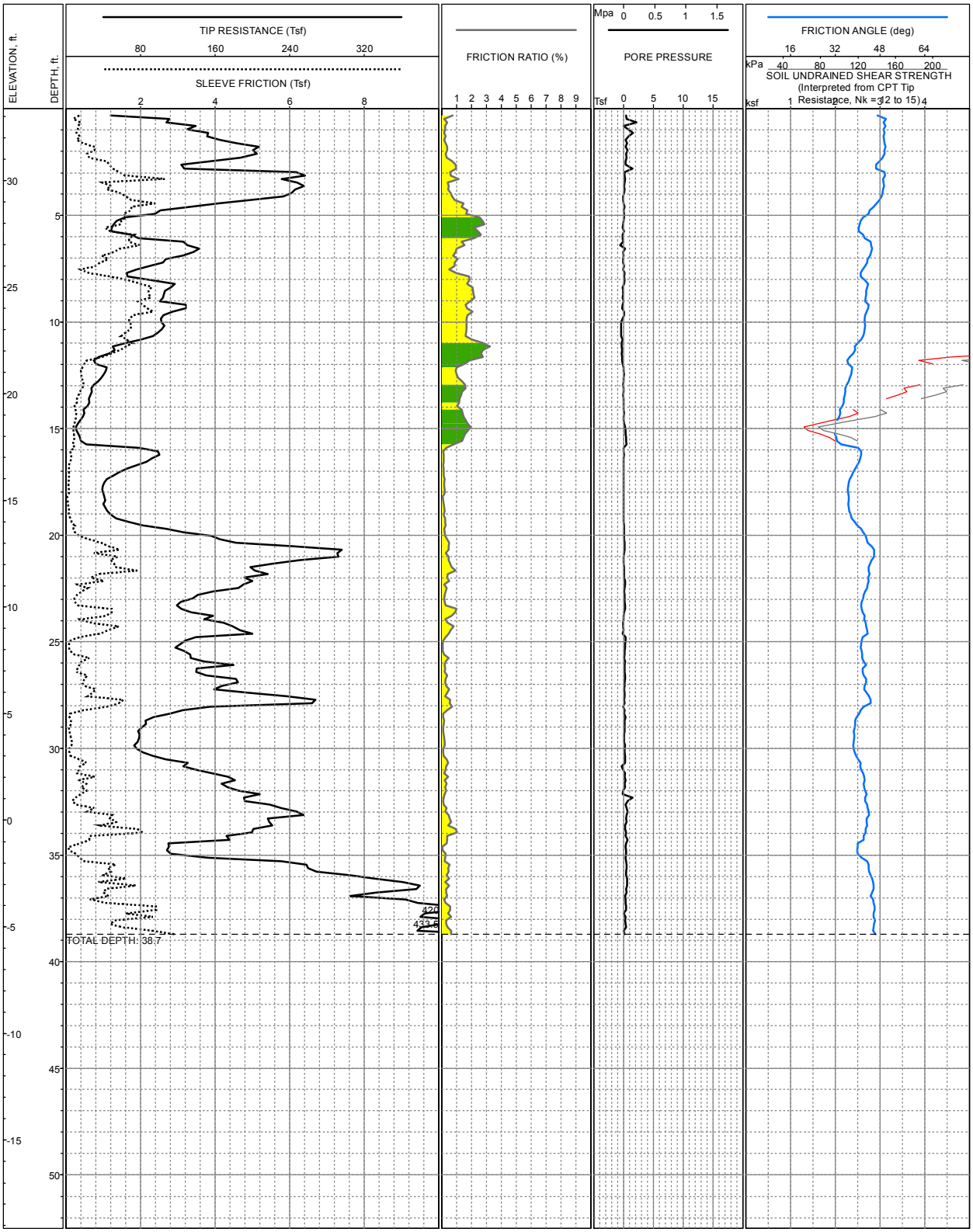
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-87RO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-74

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,517, E 5,993,202
SURFACE EL: 33.4ft +/- (NAVD88)
COMPLETION DEPTH: 38.7ft
TESTDATE: 9/24/2010

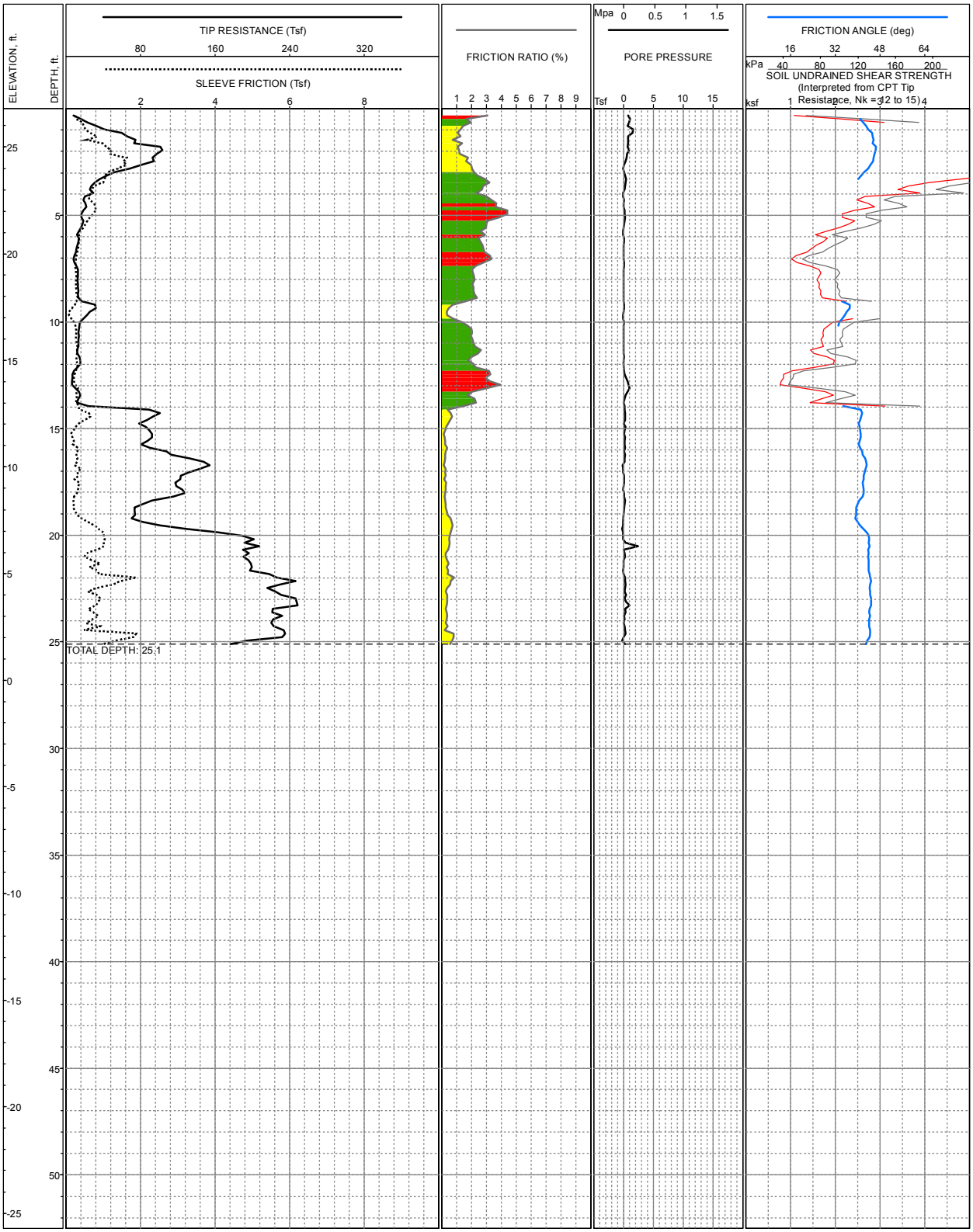
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-75

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,470, E 5,993,221
SURFACE EL: 26.8ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

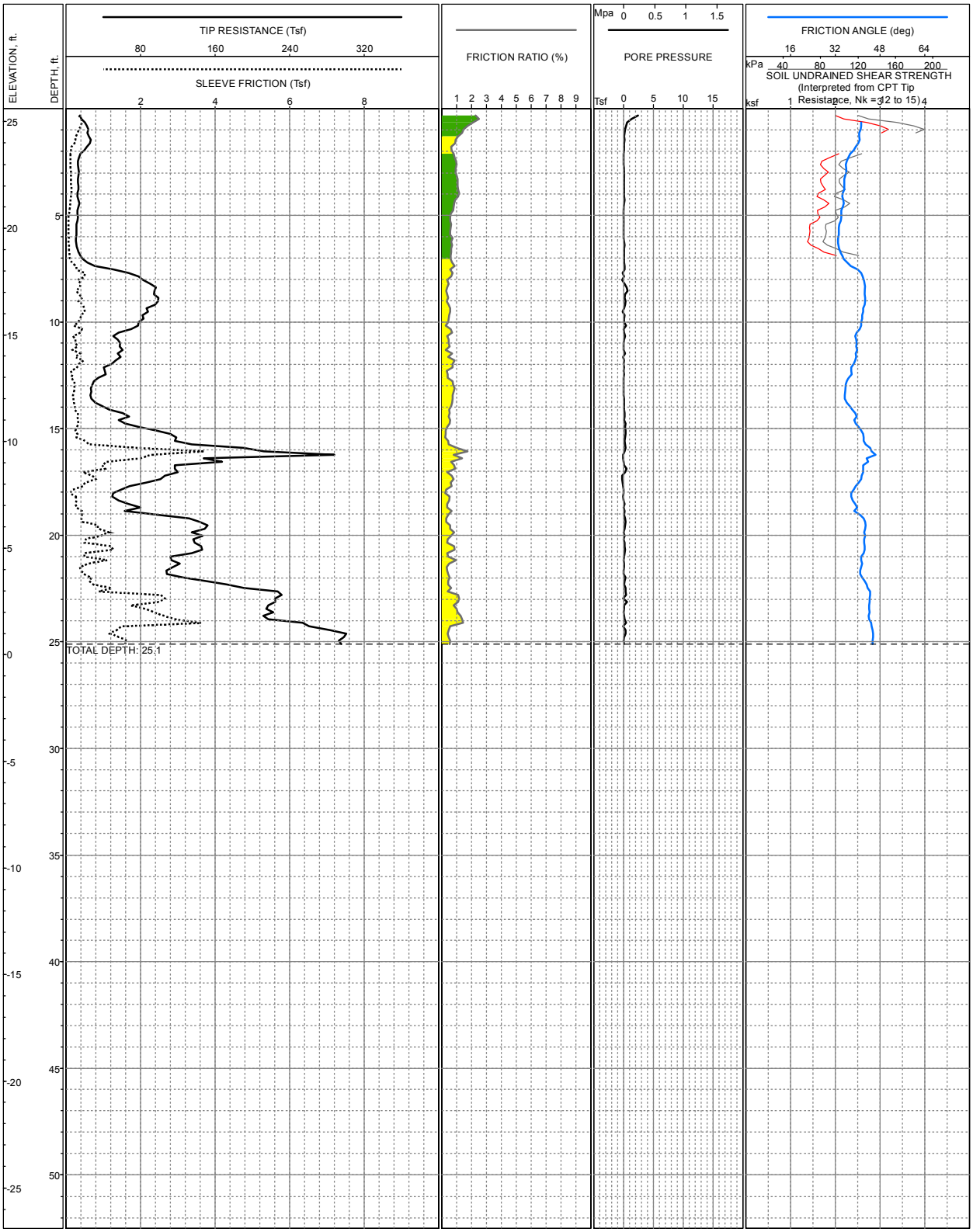
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98LL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-76

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,386, E 5,993,274
SURFACE EL: 25.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

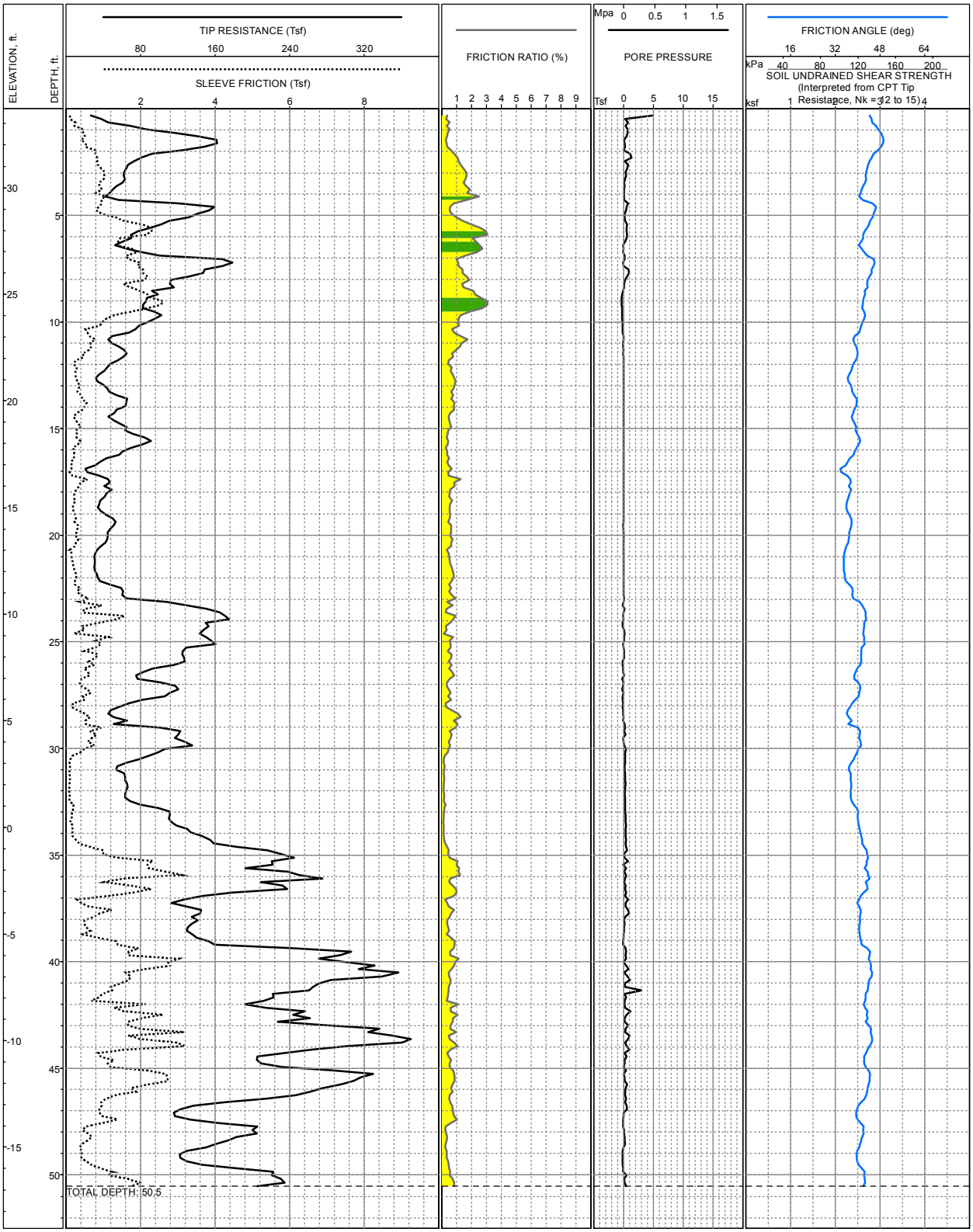
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98LO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-77

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,872, E 5,993,013
SURFACE EL: 33.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.5ft
TESTDATE: 9/21/2010

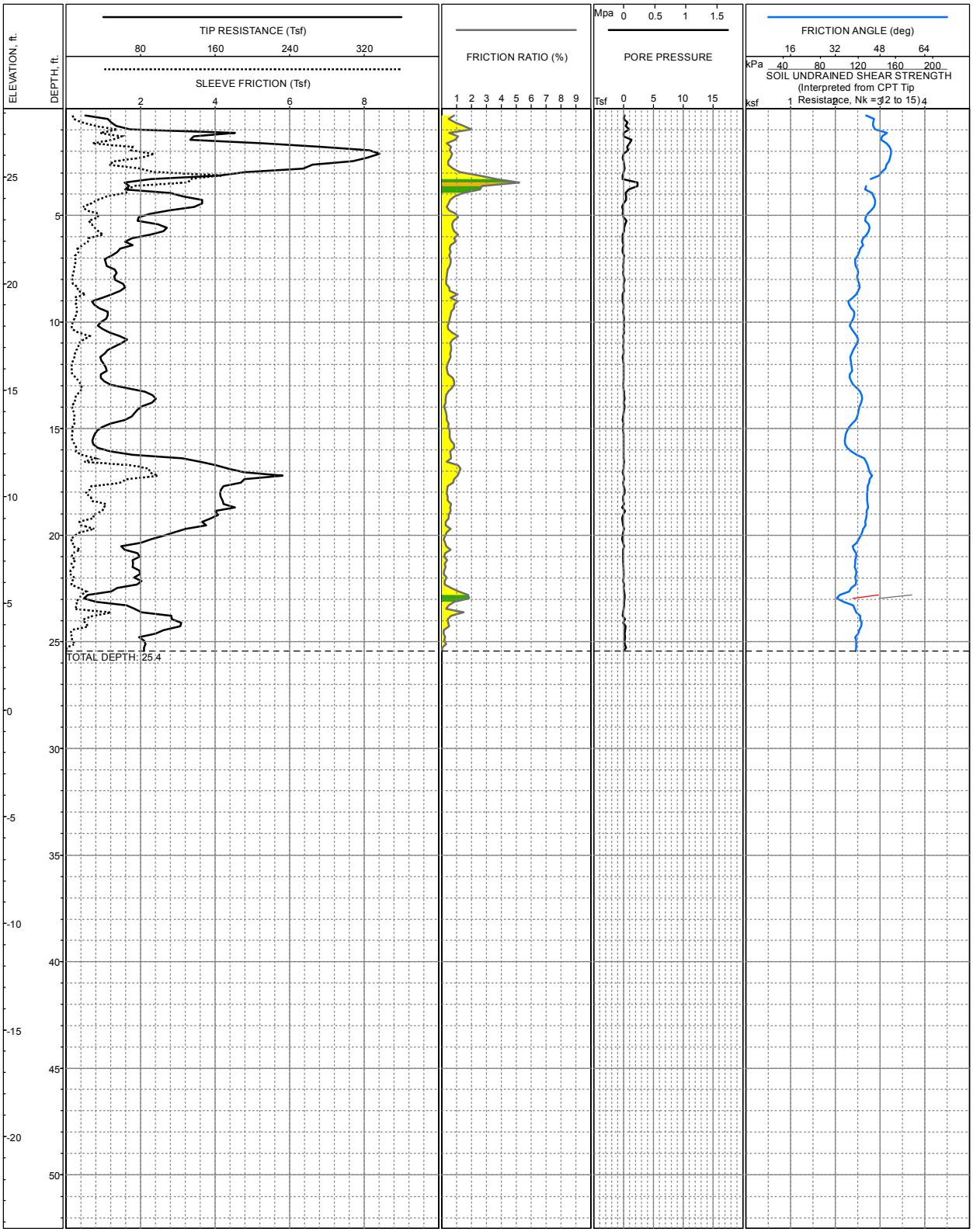
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-78

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,358,899, E 5,993,005
SURFACE EL: 28.2ft +/- (NAVD88)
COMPLETION DEPTH: 25.4ft
TESTDATE: 9/21/2010

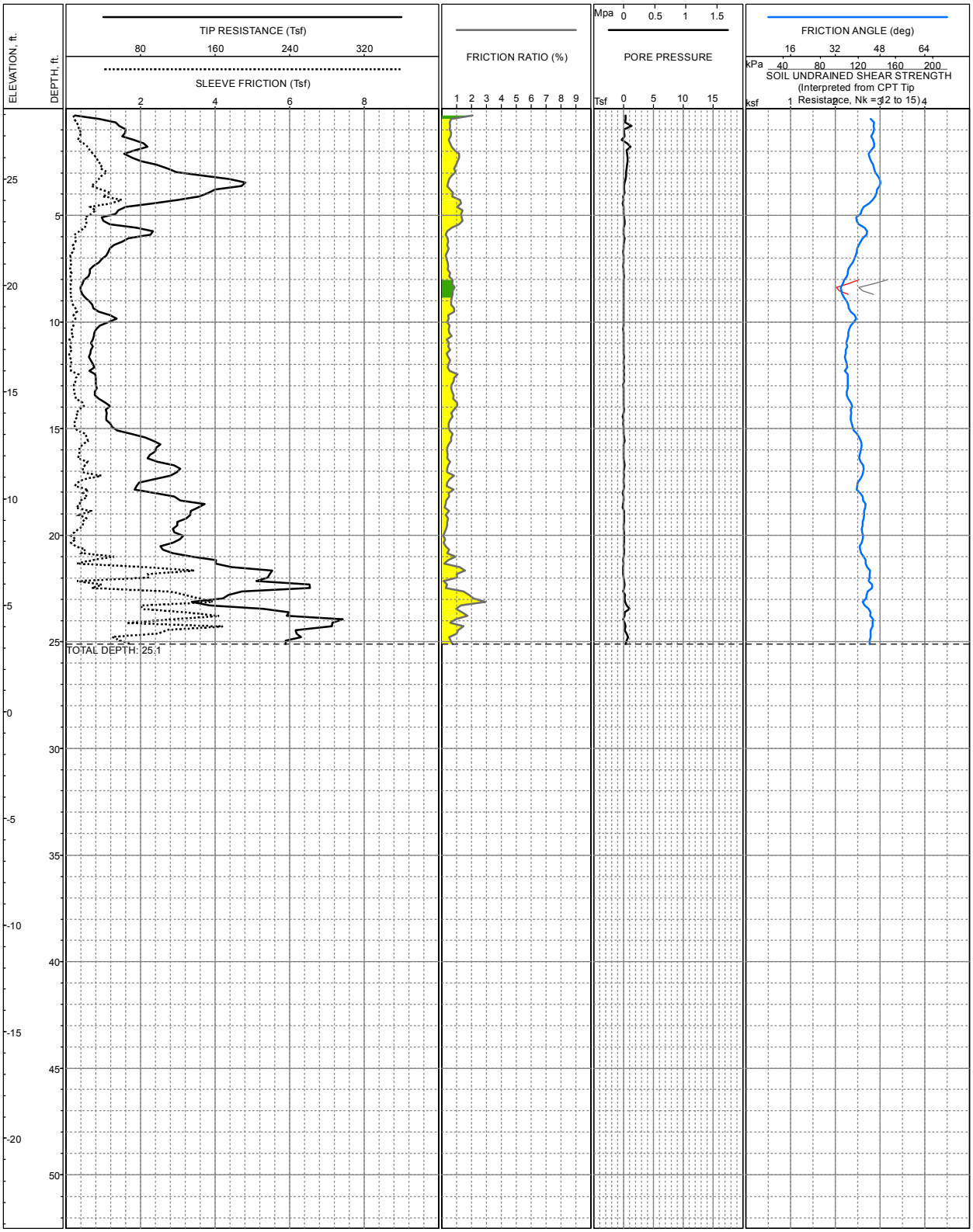
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98RL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-79

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,358,923, E 5,992,999
SURFACE EL: 28.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

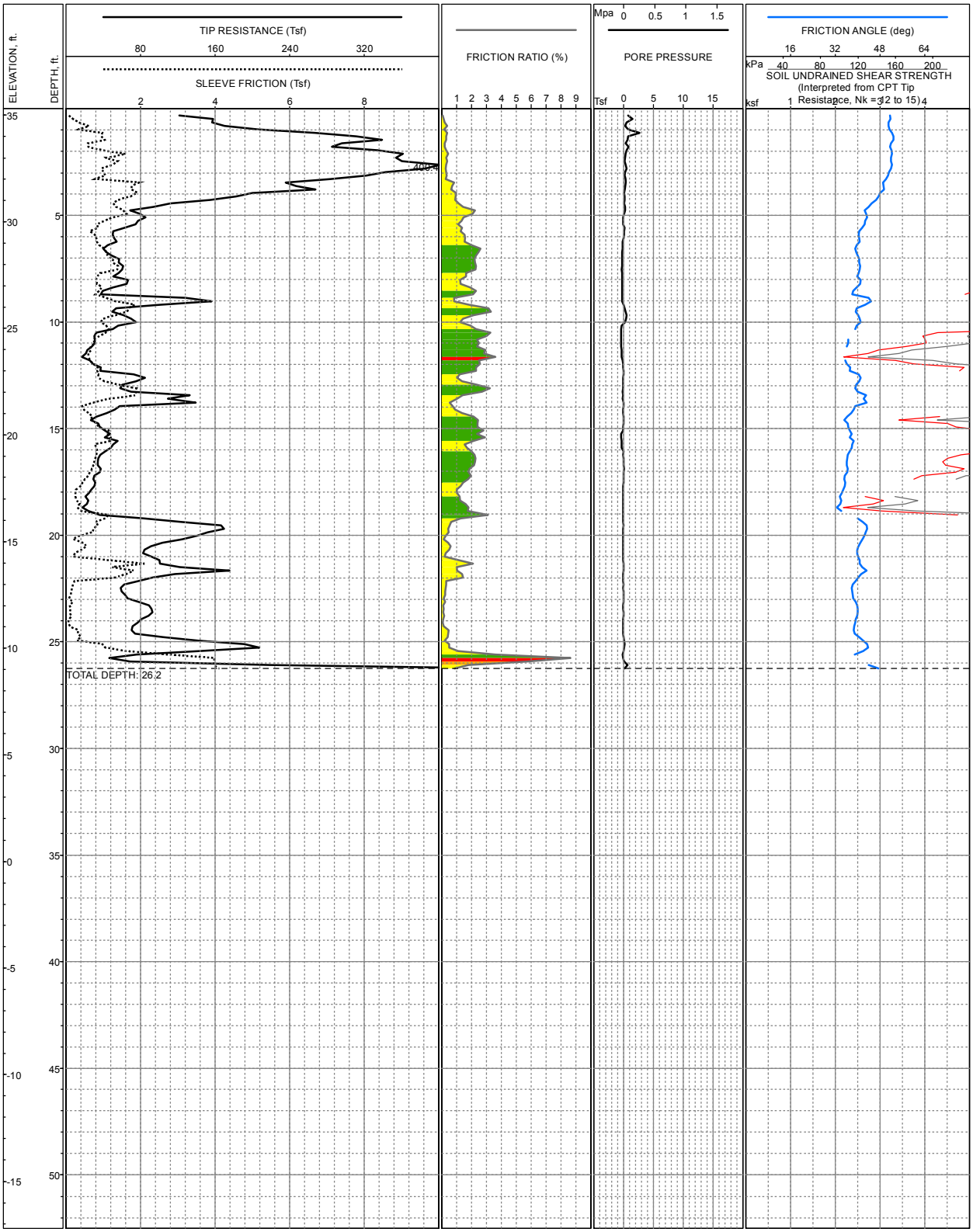
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98RO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-80

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,918, E 5,994,641
SURFACE EL: 35.3ft +/- (NAVD88)
COMPLETION DEPTH: 26.2ft
TESTDATE: 9/24/2010

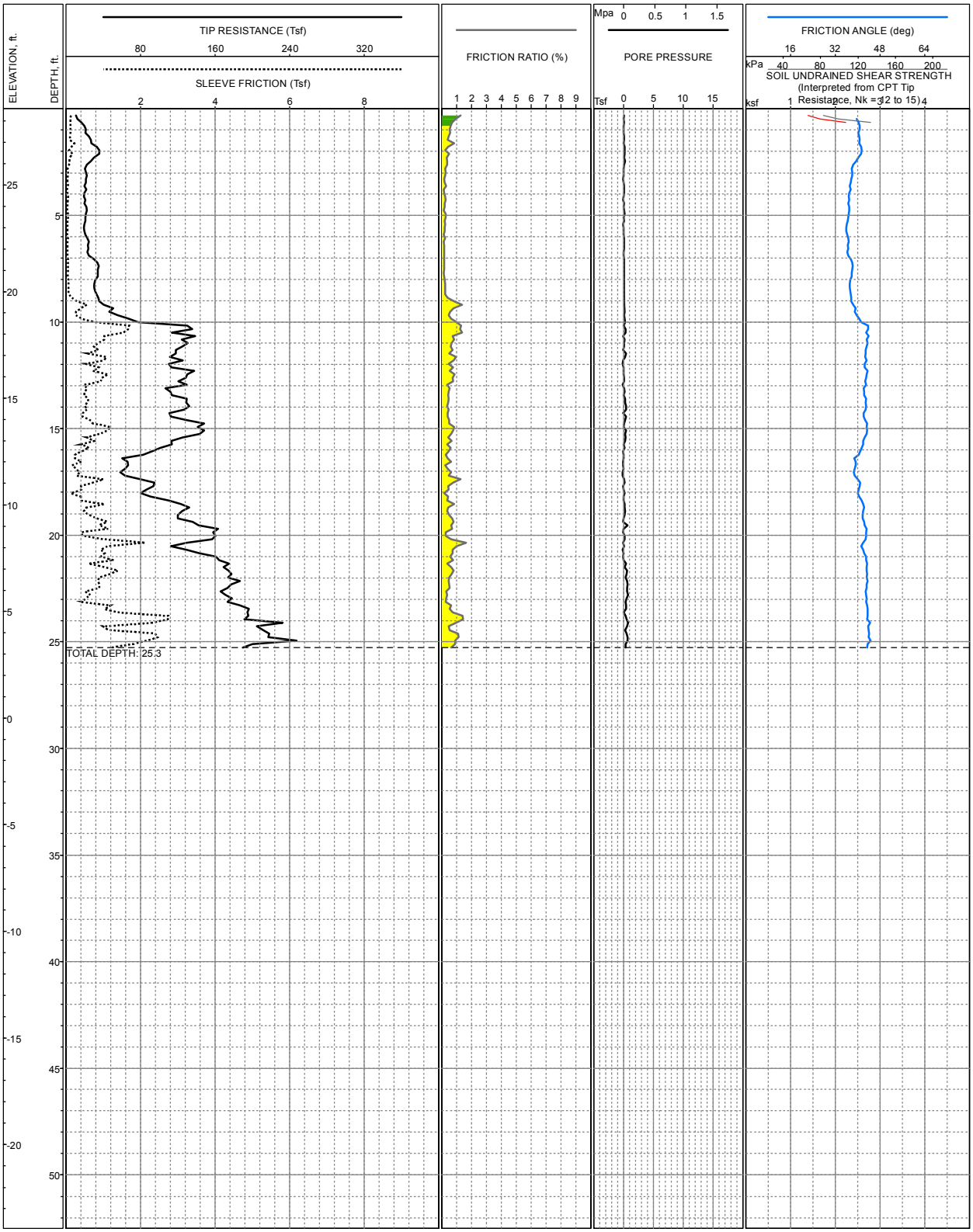
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-81

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,358,841, E 5,994,627
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.3ft
TESTDATE: 9/22/2010

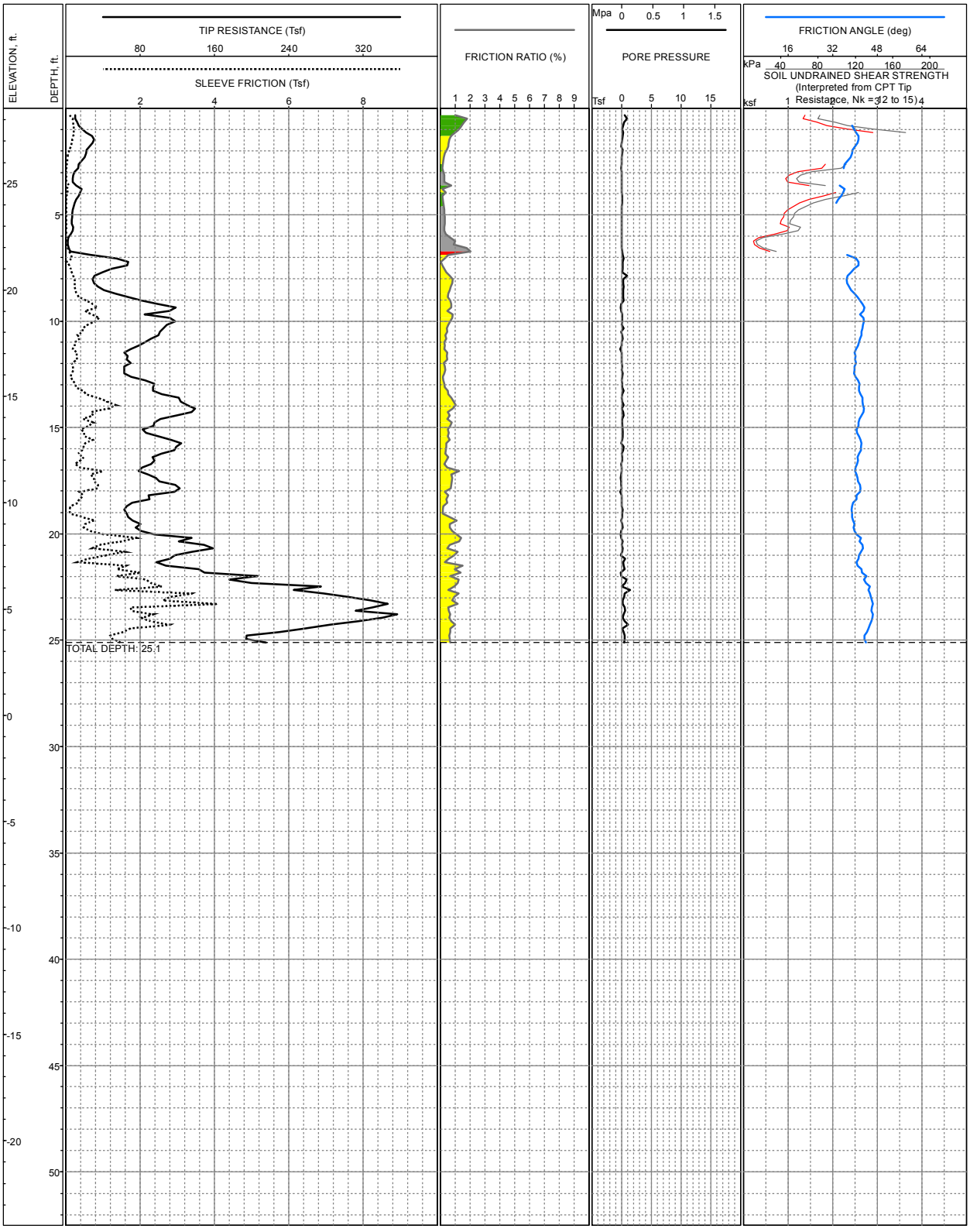
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114LL

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-82

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,358,786, E 5,994,643
SURFACE EL: 28.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

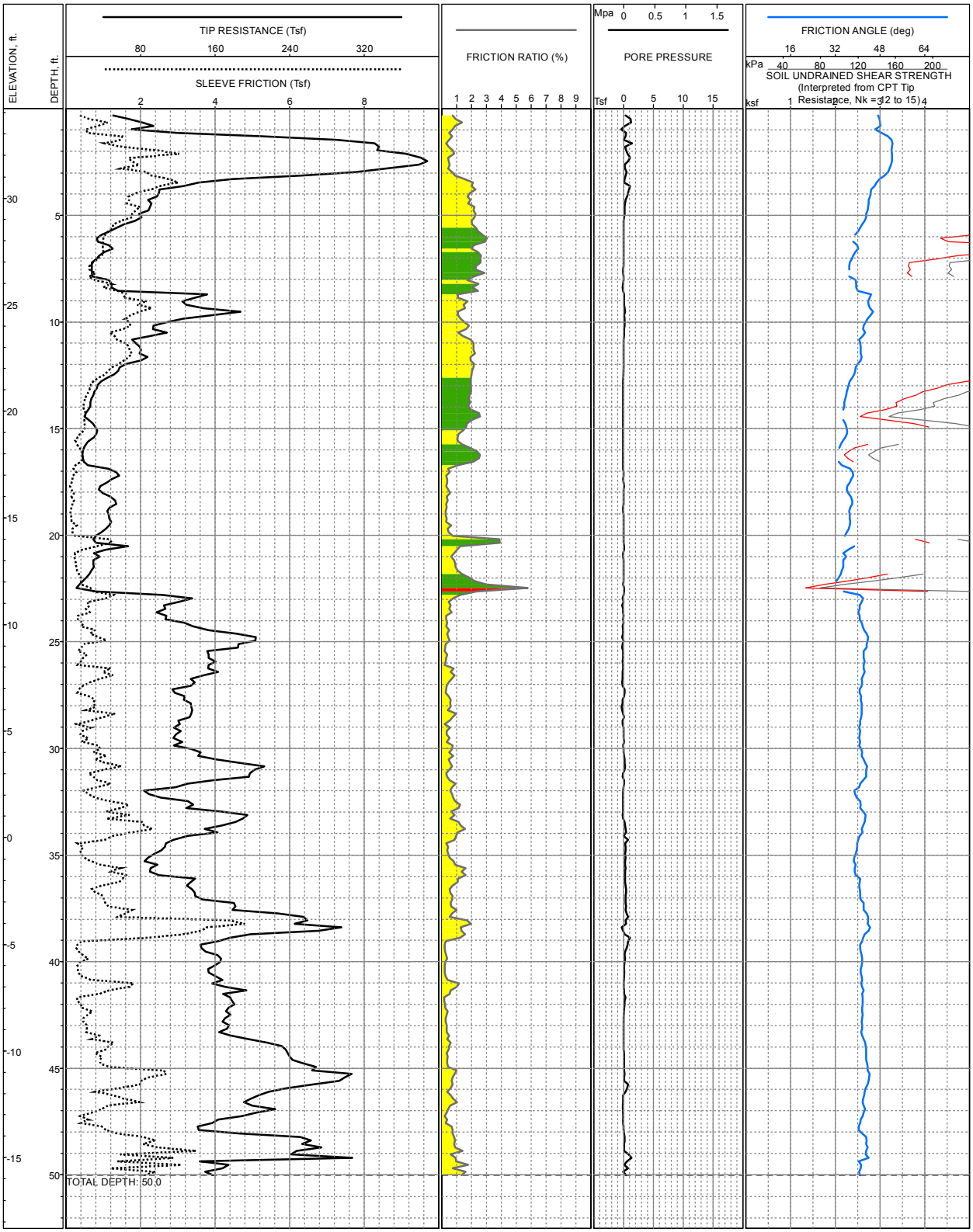
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114LO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-83

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd,05/11/2011,CDean



LOCATION: N2,359,329, E 5,994,587
SURFACE EL: 34.2ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/21/2010

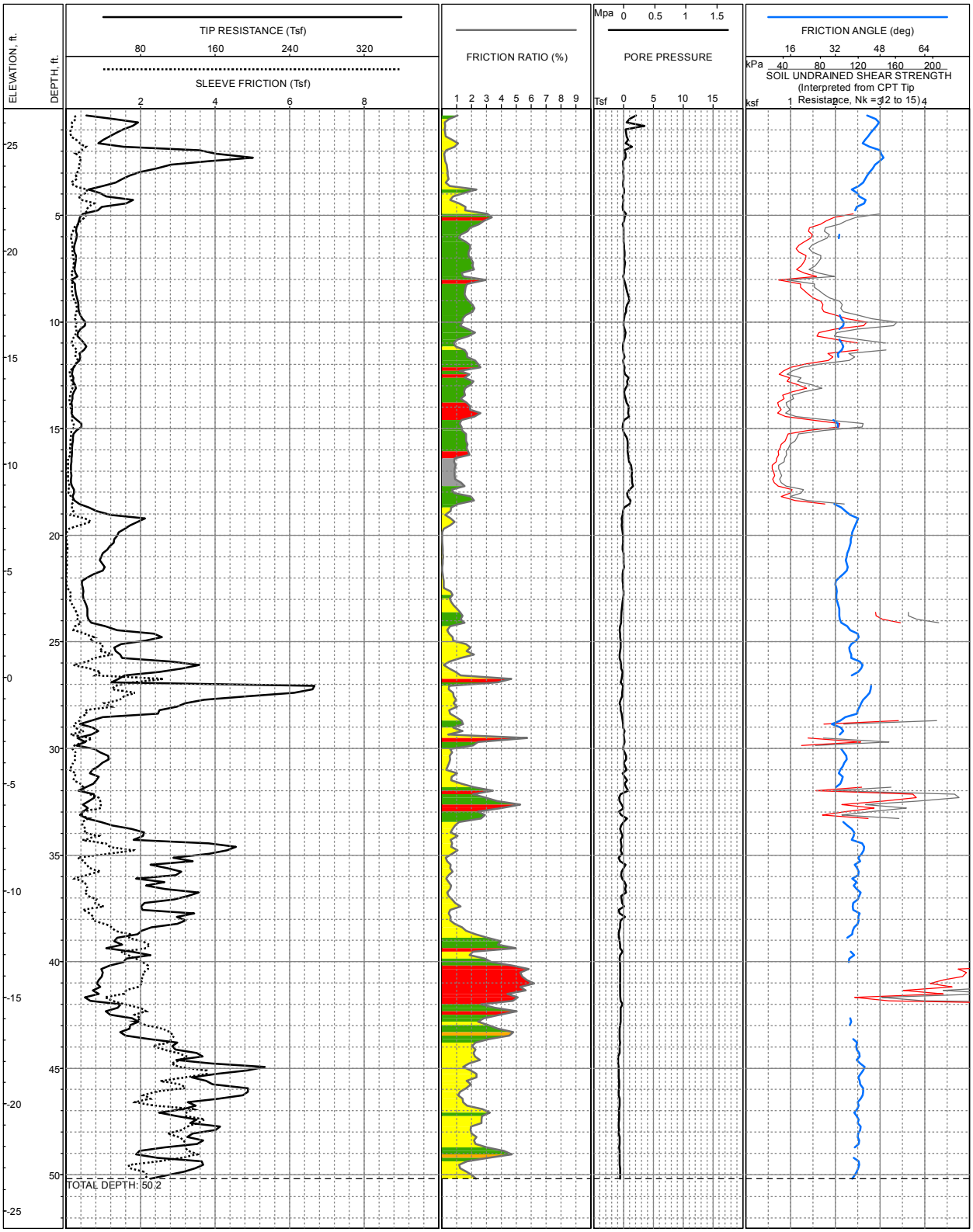
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-84

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,428, E 5,994,591
SURFACE EL: 26.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/24/2010

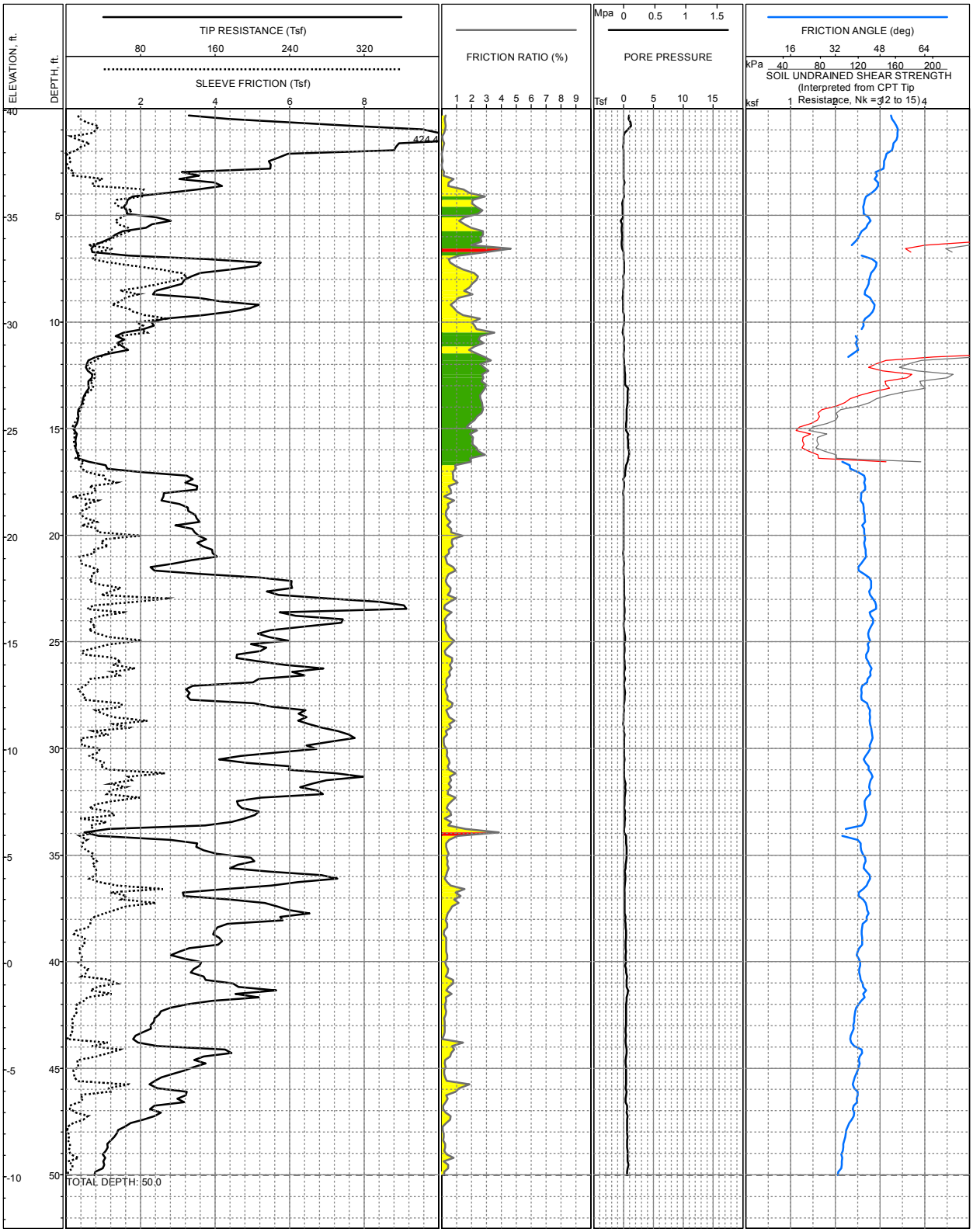
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114RO

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-85

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,243, E 5,996,497
SURFACE EL: 40.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/24/2010

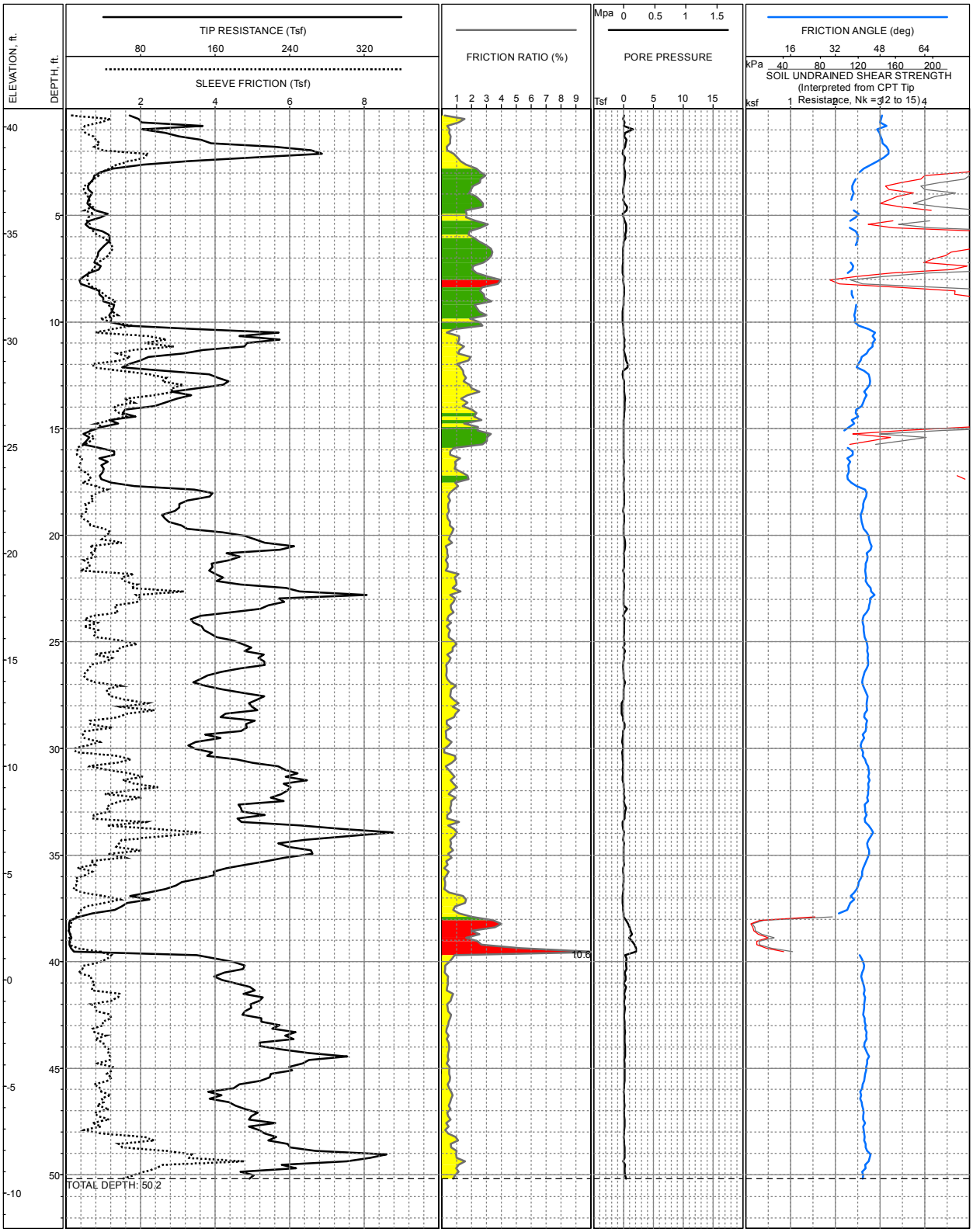
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-132LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-86

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,359,612, E 5,996,278
SURFACE EL: 40.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/20/2010

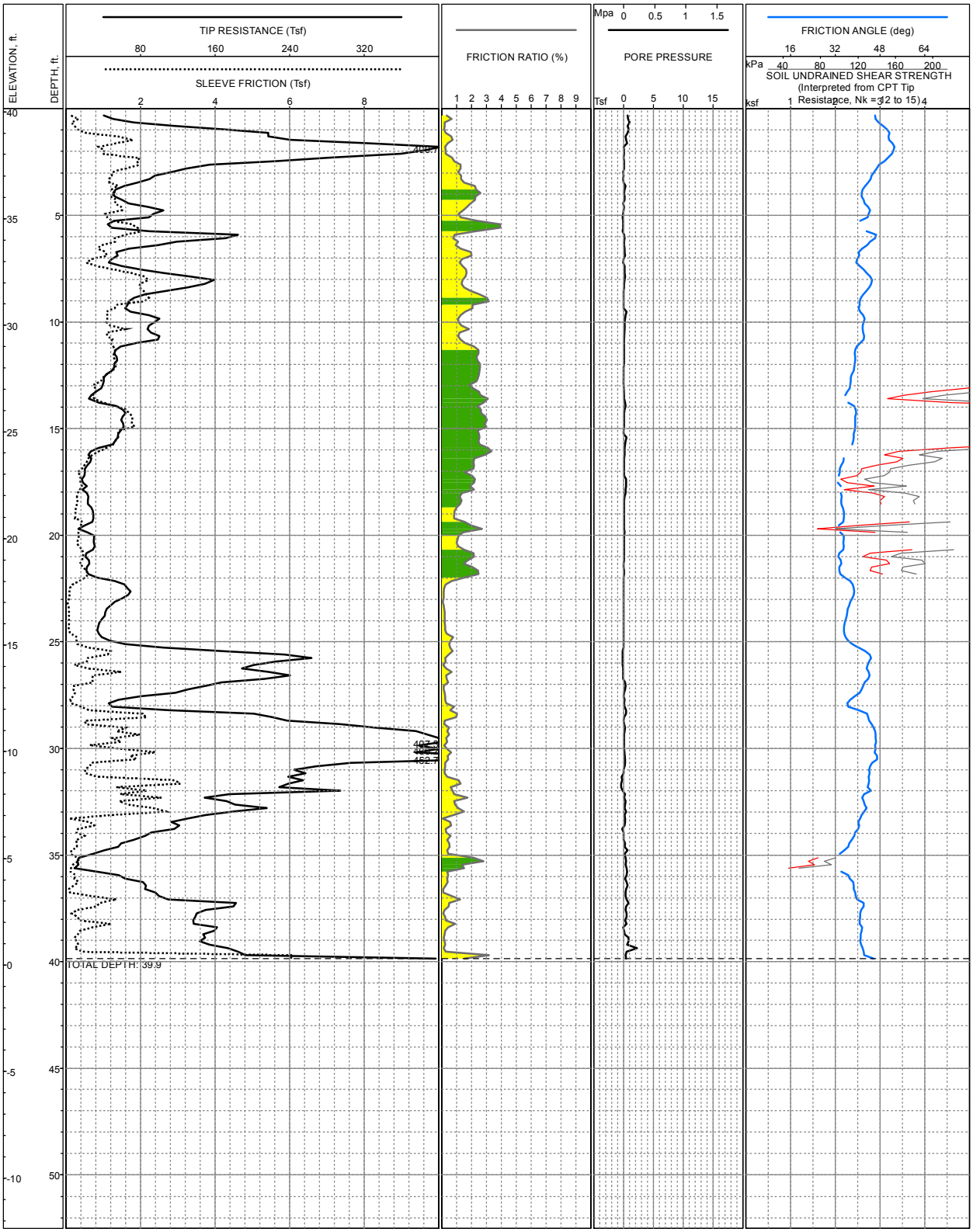
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-132RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-87

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,360,459, E 5,997,183
SURFACE EL: 40.2ft +/- (NAVD88)
COMPLETION DEPTH: 39.9ft
TESTDATE: 9/24/2010

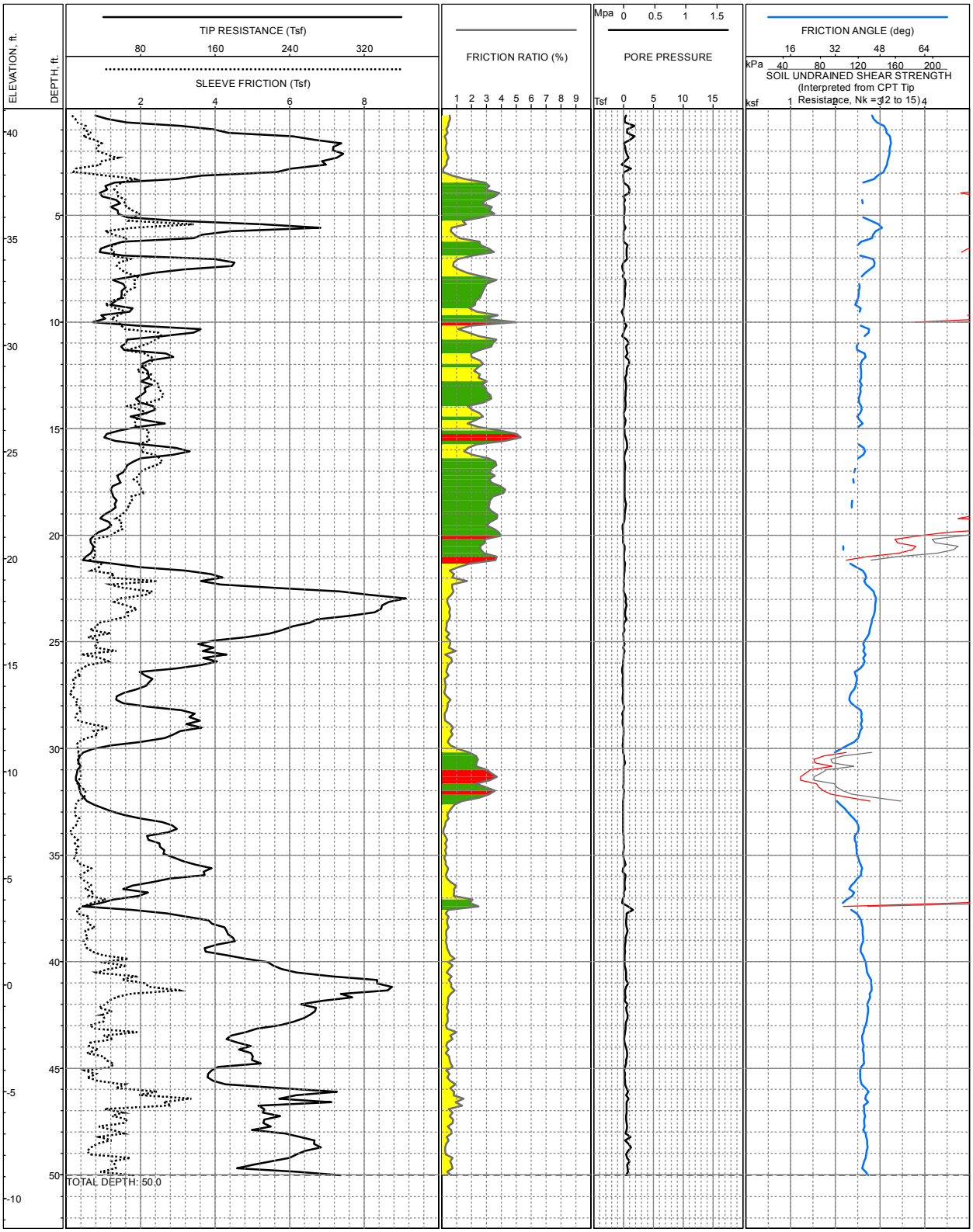
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-146LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-88

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,360,675, E 5,996,804
SURFACE EL: 41.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/20/2010

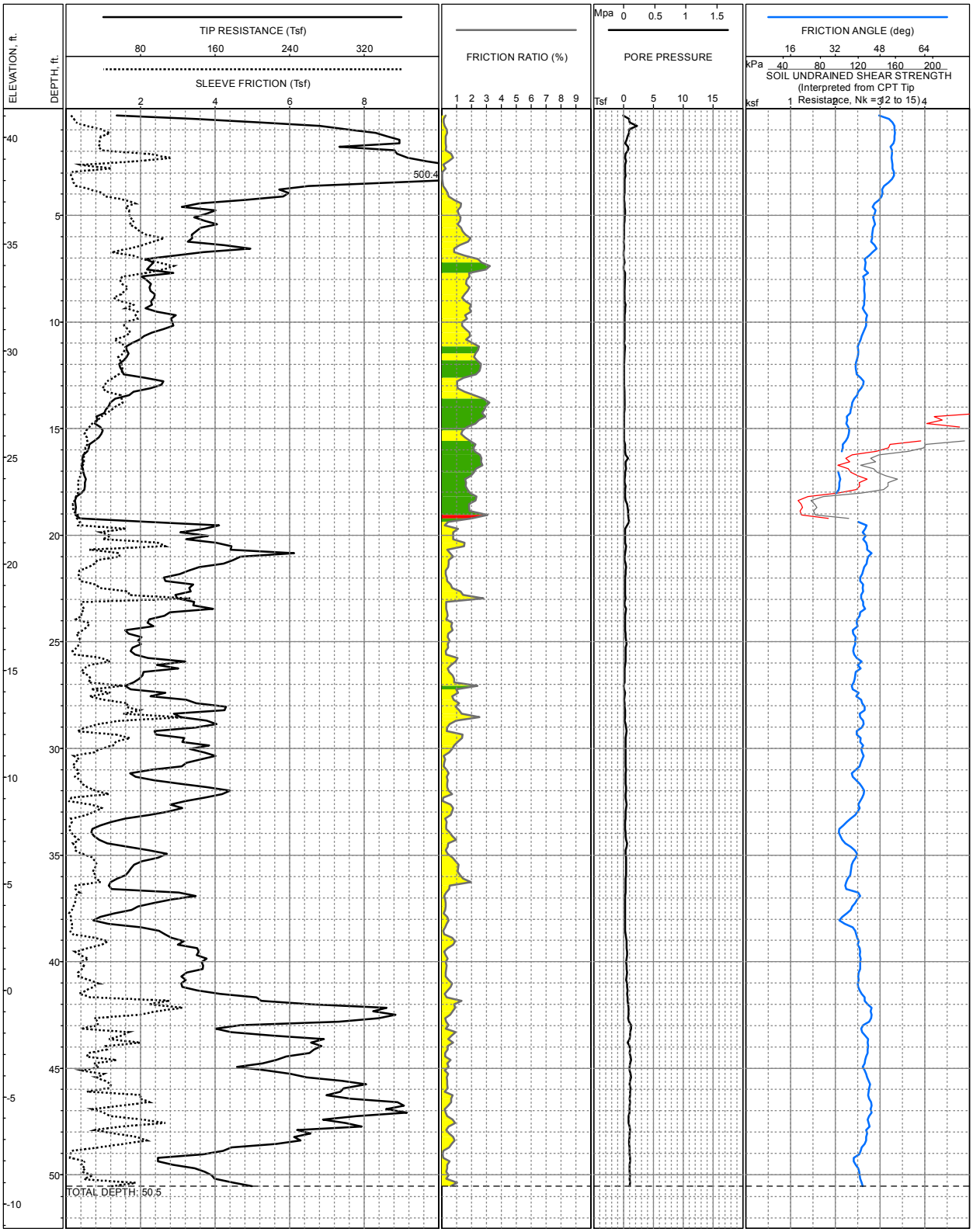
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-146RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-89

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,622, E 5,997,627
SURFACE EL: 41.4ft +/- (NAVD88)
COMPLETION DEPTH: 50.5ft
TESTDATE: 9/24/2010

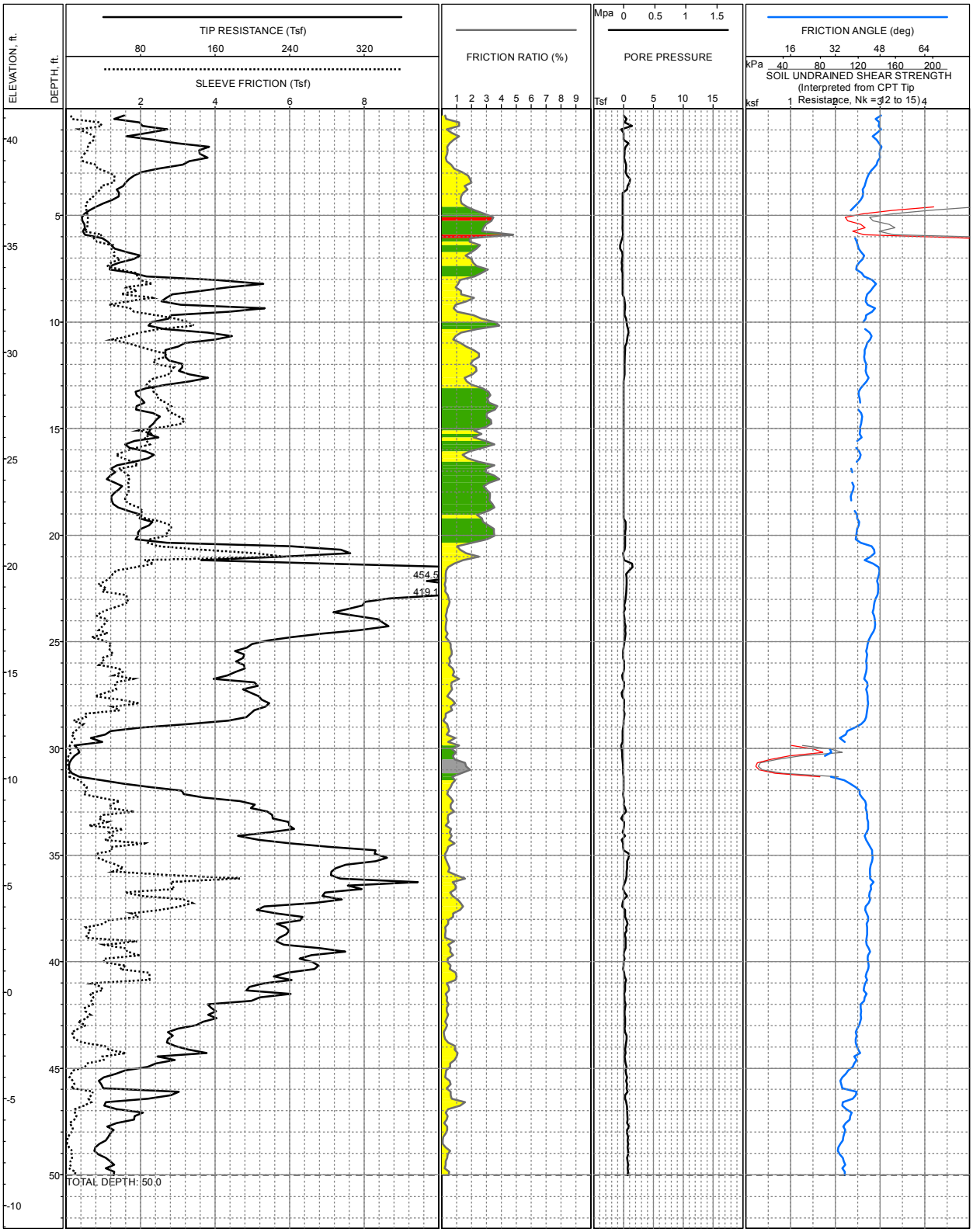
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-158LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-90

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,361,764, E 5,997,202
SURFACE EL: 41.4ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/20/2010

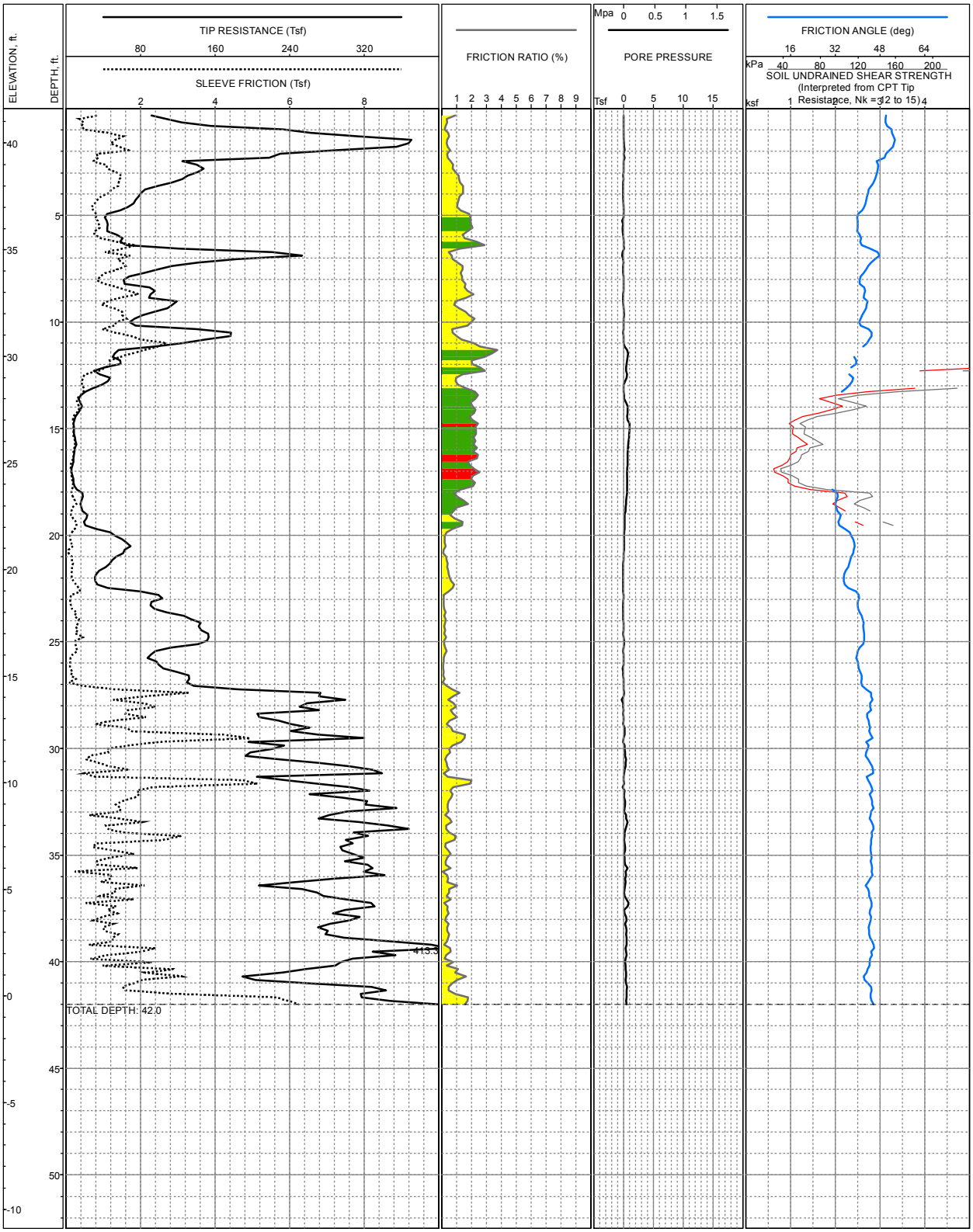
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-158RC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-91

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,362,582, E 5,998,172
SURFACE EL: 41.6ft +/- (NAVD88)
COMPLETION DEPTH: 42.0ft
TESTDATE: 9/23/2010

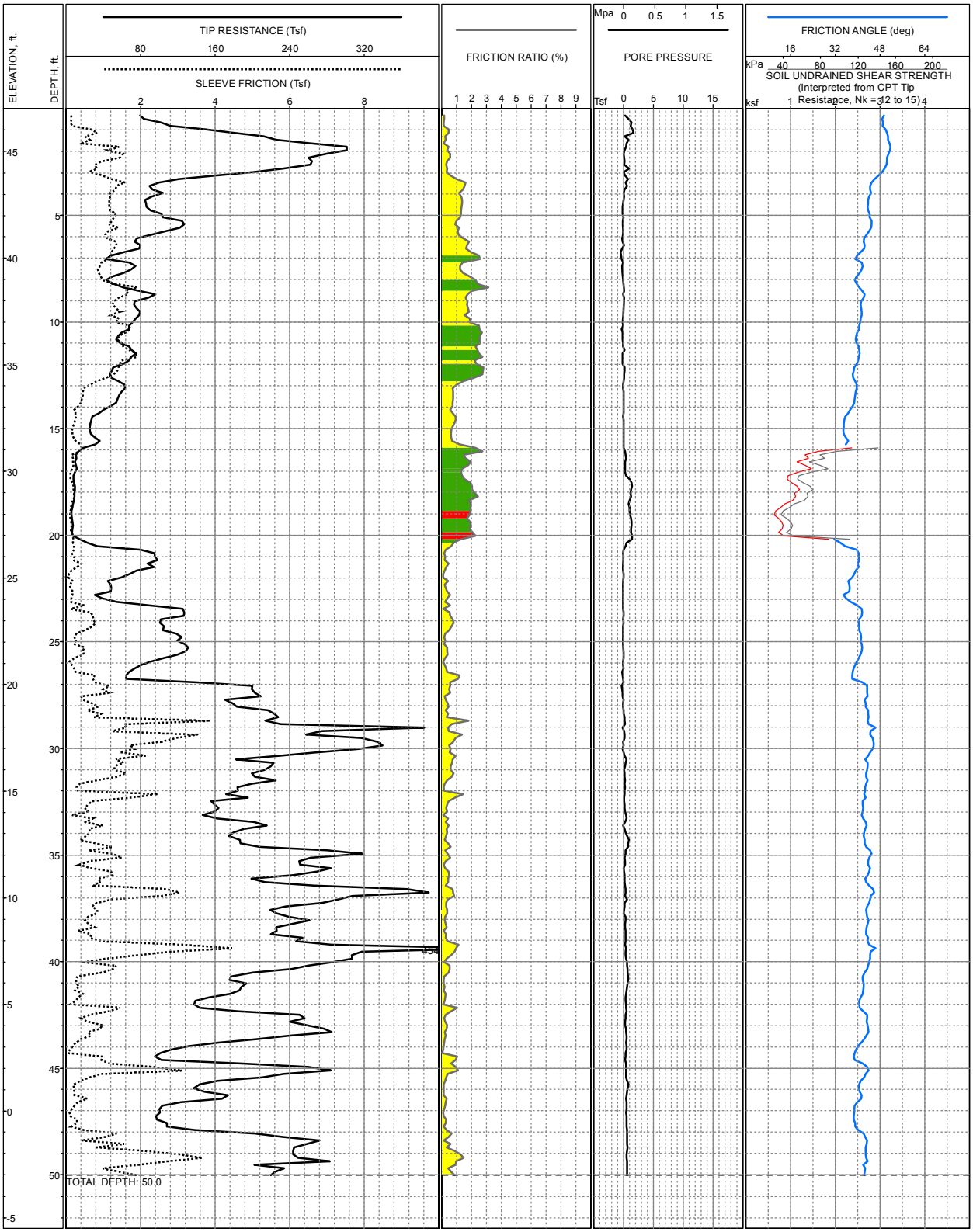
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-171LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-92

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean



LOCATION: N2,362,725, E 5,999,672
SURFACE EL: 47.0ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-185LC

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE B-93

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_10_19_Logs_SuFr\MXD\CPTLog_Fr_Su_CGI10C.mxd.05/11/2011.CDean

APPENDIX C
LABORATORY TESTING

APPENDIX C
LABORATORY TESTING

This appendix discusses the results of the laboratory testing program performed for this geotechnical investigation. Laboratory soil testing was performed subsequent to the field exploration program at Fugro's laboratory in San Luis Obispo, California, and CGI's laboratory in Redding, California. Laboratory tests were performed on selected samples to help classify the soils encountered and to estimate some of their engineering properties.

Push-tube, driven-ring and bulk samples tested in the laboratory testing program were obtained from various locations during the course of the field exploration, as discussed in Appendix B. Each sample is identified by sample number and depth. The various laboratory tests performed are described below. A summary of the laboratory tests performed on selected samples is presented on Plates C-1a to C-1e - Summary of Laboratory Test Results.

The testing programs performed at Fugro's and CGI's laboratories are listed in Tables C-1 and C-2, respectively, and described below. Results of gradation, hydraulic conductivity, shear strength, triaxial, consolidation, and compaction testing are included in this appendix.

Table C-1: Summary of Fugro Laboratory Testing Program

Laboratory Test	Quantity	Testing Standard
Density (in situ)	21	ASTM D2937
Grain Size Distribution	9	ASTM D422
Consolidation	3	ASTM D2435
Atterberg Limits	11	ASTM D4318
Hydraulic Conductivity	15	ASTM 5084 ASTM 2434
Direct Shear	14	ASTM D3080
CU (R) Triaxial	1	ASTM D4767

Table C-2: Summary of CGI Laboratory Testing Program

Laboratory Test	Quantity	Testing Standard
Density (in situ)	27	ASTM D2937 ASTM D7263
Grain Size Distribution	120	ASTM D422
Atterberg Limits	8	ASTM D4318
Compaction (maximum density/optimum moisture content)	2	ASTM D1557

- **Laboratory Moisture Content and Density.** Water content and unit weight tests were performed on selected push-tube and driven samples obtained during the field exploration to evaluate the natural moisture content and dry unit weight of the various materials encountered. The results are presented on Plates C-1a to C-1e and the drill hole logs.
- **Sieve Analyses.** Sieve analyses were performed to determine the gradation of soil grains. Selected samples were tested in accordance with ASTM D422. The results of the sieve analyses are presented on Plates C-2a to C-2k - Grain Size Curves.
- **Atterberg Limit Tests.** Tests for liquid limit, plastic limit, and plasticity index were conducted on selected samples in general accordance with ASTM D4318. The Atterberg limit test results are presented on Plates C-1a to C-1e, Plates C-3a to C-3c Plasticity Chart, and the drill hole logs.
- **Hydraulic Conductivity.** Flexible Wall and constant head hydraulic conductivity tests were performed in accordance with ASTM D5084 and ASTM D2434, respectively, to evaluate saturated permeability of selected samples. The results of the permeability tests are presented on Plates C-4a to C-4p - Hydraulic Conductivity Test Results.
- **Direct Shear Tests.** Direct shear tests were performed on selected driven ring and Shelby tube samples in general accordance with ASTM D3080. The results of the direct shear tests are presented on Plates C-5a to C-5n - Direct Shear Test Results.
- **Isotropically Consolidated, Undrained Triaxial Test with Pore Water Pressure Measurements.** A triaxial compression test with R-pore pressure measurement was performed on one Shelby tube sample in general accordance with ASTM D4767. Results of the triaxial test are presented on Plate C-6, Plate D-3b, and Plate D-4.
- **Consolidation Tests.** One-dimensional consolidation tests were performed on selected driven-ring samples in accordance with ASTM D2435. The samples were incrementally loaded to up to 32 kips per square foot (ksf), with water introduced at a load of 1 ksf. The samples were allowed to consolidate under each load increment. Rebound was measured by unloading the sample. Results of the consolidation tests are presented as Plates C-7a to C-7c - Consolidation Test Results.
- **Modified Proctor Test.** Modified Proctor compaction tests were performed on selected bulk samples to assess compaction characteristics. Bulk samples of surficial material were obtained from locations adjacent to selected drill holes. The tests were performed in general accordance with ASTM D1557. Compaction curves are presented on Plates C-8a to C-8b - Compaction Test Results. Maximum dry densities and optimum moisture contents also are tabulated on Plates C-1a to C-1e.

CGI TECHNICAL SERVICES INC.

FUGRO

SUMMARY OF LABORATORY TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
H057LW	10.0		Well-graded SAND (SW)			20	4																
H057LW	15.0		Poorly graded SAND (SP)			17	5																
H057LW	20.0		Well-graded SAND (SW)			14	4																
H057LW	25.0		Well-graded SAND (SW)			14	3																
H057RO	5.0	T-1	SILT (ML)	122	93	31		42	15														
H057RO	7.0	B-1	SILT (ML)							117.1	12.2												
H057RO	10.0	R-1	SILT with sand (ML)		95	27	60					0.1	39										
H057RO	15.0		Poorly graded SAND with gravel (SP)			14	2	25	6														
H057RO	20.0		Well-graded SAND with gravel (SW)			16	5																
H057RO	25.0		Poorly graded SAND with gravel (SP)			14	3																
H057RW	15.0	T-2	Sandy SILT (ML)		78	33		31	1			0.2	36										
H057RW	20.0		Poorly graded SAND with silt and gravel (SP-SM)			15	5																
H057RW	25.0		Poorly graded SAND with gravel (SP)			12	4																
H073LL	17.0	T-2	Silty SAND (SM)		76	32	25					0.2	36										
H073LL	20.0		Well-graded SAND with gravel (SW)			15	2																
H073LL	25.0		Well-graded SAND with gravel (SW)			14	4																
H073LW	5.0		Well-graded SAND with silt and gravel (SW-SM)			10	6																
H073LW	20.0		Well-graded SAND (SW)			17	4																
H073LW	25.0		Poorly graded SAND (SP)			26	4																
H073RW	10.0		Poorly graded SAND (SP)			20	5																
H073RW	15.0		Poorly graded SAND (SP)			24	4																
H073RW	25.0		Poorly graded SAND with gravel (SP)			17	2																
H087LW	5.0		Well-graded SAND with silt and gravel (SW-SM)			10	7																
H087LW	15.0		Well-graded SAND with gravel (SW)			14	4																
H087LW	20.0		Poorly graded SAND with silt (SP-SM)			17	9																
H087LW	25.0		Poorly graded SAND with silt and gravel (SP-SM)			15	6																
H087RW	5.0		Poorly graded SAND with gravel (SP)			11	4																
H087RW	10.0		Well-graded SAND with gravel (SW)			11	3																
H087RW	15.0		Poorly graded SAND (SP)			19	3																
H087RW	25.0		Well-graded SAND with gravel (SW)			14	4																

PLATE C-1a

CGI TECHNICAL SERVICES INC.

FUGRO

SUMMARY OF LABORATORY TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS LL	ATTERBERG LIMITS PI	COMPACTION TEST MAX DD pcf	COMPACTION TEST OPT MC %	DIRECT SHEAR C ksf	DIRECT SHEAR PHI deg	COMPRESSIVE STRENGTH TESTS Qu, ksf	COMPRESSIVE STRENGTH TESTS S_u (Cell Prs.) ksf	CORROSIVITY TESTS R	CORROSIVITY TESTS pH	CORROSIVITY TESTS Cl	CORROSIVITY TESTS So_4 (%)	R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
H098LW	15.0		Poorly graded SAND with gravel (SP)			13	2																
H098LW	20.0		Well-graded SAND with gravel (SW)			15	2																
H098LW	25.0		Well-graded SAND with gravel (SW)			14	3																
H098RW	10.0		Poorly graded SAND with gravel (SP)			13	3																
H098RW	15.0		Well-graded SAND with gravel (SW)			17	2																
H098RW	20.0		Poorly graded SAND with gravel (SP)			11	3																
H098RW	25.0		Poorly graded SAND with gravel (SP)			14	4																
H114LW	15.0		Well-graded SAND with gravel (SW)			15	2																
H114LW	25.0		Well-graded SAND with gravel (SW)			12	1																
H114RL	15.0		Poorly graded SAND (SP)			18	3																
H114RL	20.0		Poorly graded SAND with silt (SP-SM)			30	8																
H114RL	25.0		Well-graded SAND with silt (SW-SM)			13	6																
H114RW	15.0		Poorly graded SAND with gravel (SP)			14	4																
H114RW	20.0		Well-graded SAND with gravel (SW)			11	3																
H114RW	25.0		Well-graded SAND with gravel (SW)			11	4																
H132LL	5.0	T-1	SILT (ML)	128	103	23		35	9														
H132LL	25.0		Poorly graded SAND with gravel (SP)			13	3																
H132LO	5.0	T-1	SILT (ML)	114	86	33		40	12														
H132LO	10.0	R-1	Silty SAND (SM)		91	13	34					0.1	33										
H132LO	20.0		Poorly graded SAND with gravel (SP)			13	3																
H132LO	25.0		Poorly graded SAND with gravel (SP)			14	3																
H132LW	7.5		Well-graded SAND with gravel (SW)			3	5																
H132LW	10.0		Poorly graded SAND with gravel (SP)			10	3																
H132LW	15.0		Well-graded SAND with gravel (SW)			12	3																
H132LW	20.0		Well-graded SAND with gravel (SW)			8	2																
H132LW	25.0		Poorly graded SAND with gravel (SP)			10	3																
H132RL	5.0		Silty SAND with gravel (SM)			10	13	21	3														
H132RL	10.0		Poorly graded SAND with gravel (SP)			3	2																
H132RL	15.0		Poorly graded SAND with gravel (SP)			12	4																
H132RL	20.0		Well-graded SAND with gravel (SW)			15	3																

PLATE C-1b

Humboldt County Public Works Department
Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

FUGRO

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
H132RL	25.0		Well-graded SAND (SW)			18	3																
H132RO	15.0	R-2	Well-graded SAND with gravel (SW)	111	106	5	4																
H132RO	20.0		Poorly graded SAND with gravel (SP)			15	3																
H132RO	25.0		Poorly graded SAND with gravel (SP)			14	3																
H132RW	5.0	S-1	Poorly graded SAND with silt and gravel (SP-SM)			4	10																
H132RW	10.0		Poorly graded SAND with silt and gravel (SP-SM)			12	10																
H132RW	15.0	S-3	Well-graded SAND with gravel (SW)			18	2																
H132RW	20.0		Well-graded SAND with gravel (SW)			13	4																
H132RW	25.0		Well-graded SAND with gravel (SW)			15	5																
H146LL	5.0		Silty SAND (SM)			26	27	NP	NP														
H146LL	10.0	T-1	SILT (ML)		83	34		34	7			0.2	34										
H146LL	15.0		Poorly graded SAND with silt (SP-SM)			29	8																
H146LL	20.0		Poorly graded SAND with gravel (SP)			12	3																
H146LL	25.0		Poorly graded SAND with gravel (SP)			12	3																
H146LO	10.0	R-1	Poorly graded SAND with silt (SP-SM)		101	5	8					0.3	33										
H146LO	20.0		Well-graded SAND (SW)			14	4																
H146LO	25.0		Well-graded SAND with gravel (SW)			13	4																
H146LW	10.0		Well-graded SAND with gravel (SW)			13	3																
H146LW	15.0		Poorly graded SAND (SP)			19	4																
H146LW	20.0		Poorly graded SAND (SP)			15	1																
H146LW	25.0		Poorly graded SAND with gravel (SP)			14	4																
H146RL	20.0		Well-graded SAND with gravel (SW)			11	3																
H146RL	25.0		Well-graded SAND with silt and gravel (SW-SM)			24	9	NP	NP														
H146RO	10.0	R-2	Poorly graded SAND with silt (SP-SM)	111	108	3	7																
H146RO	25.0		Poorly graded SAND with silt (SP-SM)			29	12	NP	NP														
H146RW	5.0		Poorly graded GRAVEL with silt and sand (GP-GM)			10	12																
H146RW	10.0		Poorly graded SAND (SP)			17	3																
H146RW	15.0		Poorly graded SAND (SP)			14	3																
H146RW	20.0		Well-graded SAND with silt (SW-SM)			15	6																
H146RW	25.0		Well-graded SAND with silt (SW-SM)			15	5																

SUMMARY OF LABORATORY TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-1c

LAB SUMMARY TABLE VENTURA_C:\DOCUMENTS AND SETTINGS\GECKRICH\DESKTOP\3502.002 REDWOOD CREEK LEVEE EVALUATION\GINT\3502-002_2010_CGI10B.GPJ_ 6/22/11 03:06 PM.cab

CGI TECHNICAL SERVICES INC.

FUGRO

SUMMARY OF LABORATORY TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
H158LL	10.0		Poorly graded SAND with silt (SP-SM)			8	6																
H158LL	15.0		Poorly graded SAND with gravel (SP)			22	5																
H158LL	20.0		Poorly graded SAND with gravel (SP)			11	4																
H158LL	25.0		Poorly graded SAND with gravel (SP)			16	2																
H158LO	5.0	T-1	SILT (ML)	118	75	58		34	9														
H158LO	15.0		Silty SAND (SM)			30	26	NP	NP														
H158LO	20.0		Well-graded SAND with gravel (SW)			14	4																
H158LO	25.0		Well-graded SAND with gravel (SW)			14	2																
H158LW	5.0		Silty SAND with gravel (SM)			3	14																
H158LW	10.0		Well-graded SAND with gravel (SW)			3	3																
H158LW	15.0		Poorly graded SAND with gravel (SP)			16	3																
H158LW	20.0		Well-graded SAND with gravel (SW)			14	3																
H158LW	25.0		Well-graded SAND with gravel (SW)			9	4																
H158RL	5.0		Silty SAND with gravel (SM)			10	16	22	3														
H158RL	10.0		Silty SAND (SM)			19	27	NP	NP														
H158RL	15.0		Poorly graded SAND with silt and gravel (SP-SM)			12	6																
H158RL	20.0		Well-graded SAND with silt and gravel (SW-SM)			13	8																
H158RL	25.0		Well-graded SAND with silt and gravel (SW-SM)			14	5																
H158RO	15.0	R-2	Well-graded GRAVEL with sand (GW)		96	3	4					0.0	44										
H158RW	5.0		Silty SAND with gravel (SM)			7	37																
H158RW	15.0		Poorly graded SAND with gravel (SP)			14	1																
H158RW	20.0		Poorly graded SAND (SP)			15	1																
H158RW	25.0		Poorly graded SAND (SP)			14	2																
H171LL	5.0	T-1	SILT (ML)		79	31		33	7			0.1	34										
H171LL	10.0		Silty SAND (SM)			9	13																
H171LL	15.0		Poorly graded SAND with gravel (SP)			3	2																
H171LL	20.0		Well-graded SAND with silt and gravel (SW-SM)			10	6																
H171LL	25.0		Poorly graded SAND with gravel (SP)			13	3																
H171LO	10.0		Silty SAND (SM)			10	16																
H171LO	15.0		Poorly graded SAND (SP)			3	2																

PLATE C-1d

Humboldt County Public Works Department
Project No. 04.B3502002
CGI Project No. 10-1949.01

CGI Technical Services Inc.

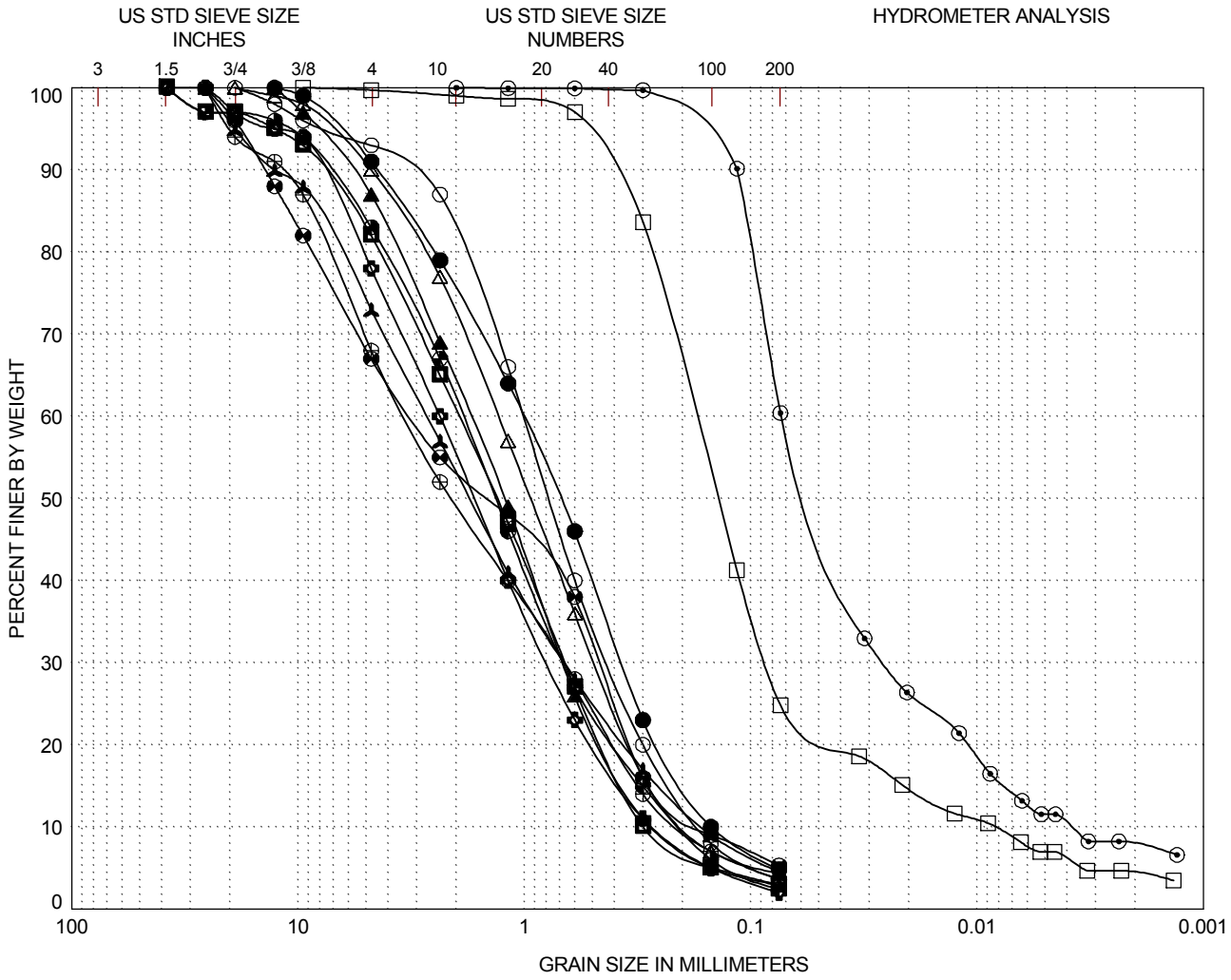
FUGRO

DRILL HOLE	DEPTH, ft	SAMPLE NUMBER	MATERIAL DESCRIPTION	UWW pcf	UDW pcf	MC %	FINES %	ATTERBERG LIMITS		COMPACTION TEST		DIRECT SHEAR		COMPRESSIVE STRENGTH TESTS		CORROSIVITY TESTS				R-VALUE	EXPANSION INDEX	SAND EQUIVALENT (SE)	SPECIFIC GRAVITY
								LL	PI	MAX DD pcf	OPT MC %	C ksf	PHI deg	Qu, ksf	S_u (Cell Prs.) ksf	R	pH	Cl	So_4 (%)				
H171LO	20.0		Poorly graded SAND with gravel (SP)			12	4																
H171LO	25.0		Poorly graded SAND with gravel (SP)			13	2																
H171LW	5.0		Well-graded SAND with gravel (SW)			3	4																
H171LW	10.0		Silty SAND with gravel (SM)			5	25																
H171LW	15.0	T-1	Poorly graded SAND with silt (SP-SM)		101	10	5					0.2	36										
H171LW	20.0		Poorly graded SAND with gravel (SP)			13	3																
H171LW	25.0		Well-graded SAND (SW)			16	2																
H185LL	5.0		Silty SAND (SM)			13	24																
H185LL	10.0		Poorly graded SAND with silt (SP-SM)			11	11																
H185LL	12.0		Lean CLAY (CL)							125.9	10.1												
H185LL	20.0		Poorly graded SAND (SP)			12	4																
H185LL	25.0		Poorly graded SAND (SP)			15	5																
H185LW	5.0		Poorly graded SAND with silt and gravel (SP-SM)			1	6																
H185LW	10.0		Well-graded SAND with silt and gravel (SW-SM)			15	8																
H185LW	15.0		Poorly graded SAND (SP)			16	2																
H185LW	20.0		Well-graded SAND with gravel (SW)			15	2																
H185LW	25.0		Well-graded SAND with gravel (SW)			12	3																
S073LC	3.0		Silty SAND with gravel (SM)		110	8		21	3			0.1	28										
S087LC	3.0		Lean CLAY (CL)	133	117	14																	
S098LC	1.0		Well-graded SAND with silt and gravel (SW-SM)		125	3	10					0.2	36										
S146LC	4.0		Sandy Lean CLAY with gravel (CL)	136	126	8		27	8			0.1	34										
S158LC	1.0		Silty SAND with gravel (SM)	152	144	5	16					0.2	31										
S185LC	8.0		Silty CLAY (CL-ML)	128	111	15		26	5			0.2	30										

SUMMARY OF LABORATORY TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-1e



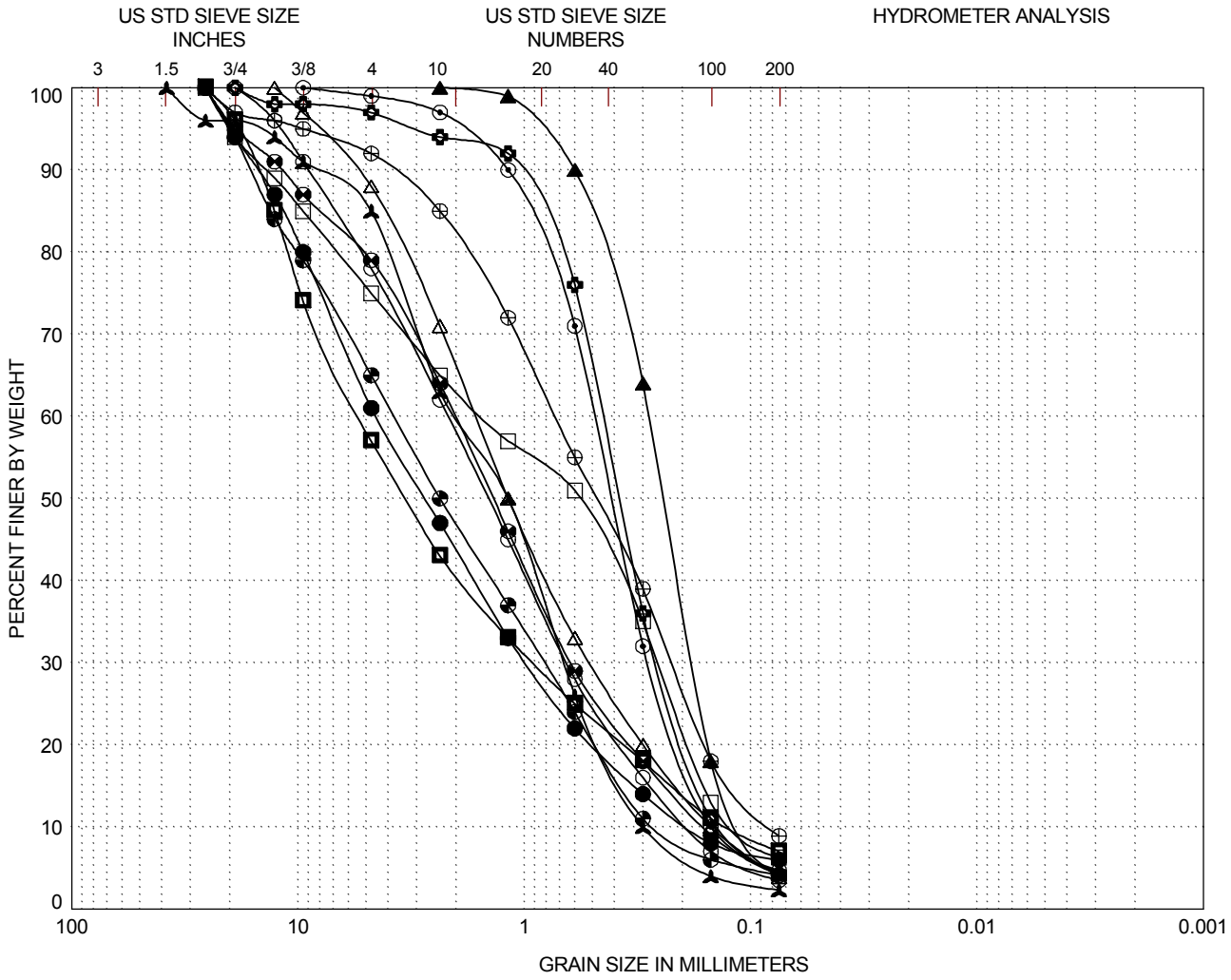
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H057LW	10.0	Well-graded SAND (SW)	1.1	6.0
●	H057LW	15.0	Poorly graded SAND (SP)	0.9	6.8
△	H057LW	20.0	Well-graded SAND (SW)	1.0	6.9
▲	H057LW	25.0	Well-graded SAND (SW)	1.0	6.5
⊙	H057RO	10.0	SILT with sand (ML)	2.4	18.9
✿	H057RO	15.0	Poorly graded SAND with gravel (SP)	2245.0	1.1
⅄	H057RO	20.0	Well-graded SAND with gravel (SW)	1.0	16.4
◘	H057RO	25.0	Poorly graded SAND with gravel (SP)	0.8	6.5
⊗	H057RW	20.0	Poorly graded SAND with silt and gravel (SP-SM)	0.4	19.1
⊕	H057RW	25.0	Poorly graded SAND with gravel (SP)	0.7	16.6
□	H073LL	17.0	Silty SAND (SM)	4.9	21.0
◕	H073LL	20.0	Well-graded SAND with gravel (SW)	1.2	9.2

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2a



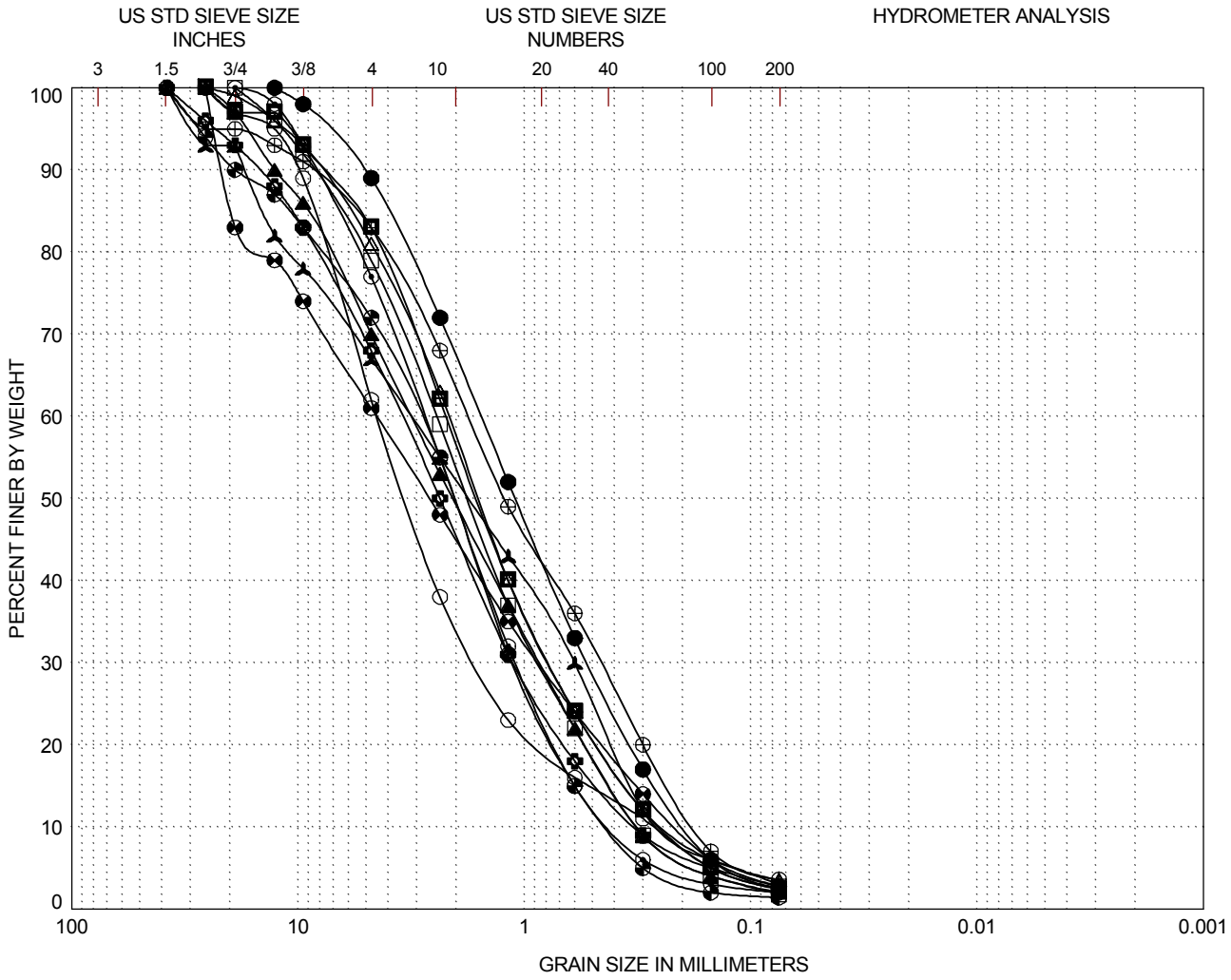
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H073LL	25.0	Well-graded SAND with gravel (SW)	1.0	11.5
●	H073LW	5.0	Well-graded SAND with silt and gravel (SW-SM)	1.1	23.9
△	H073LW	20.0	Well-graded SAND (SW)	1.1	10.9
▲	H073LW	25.0	Poorly graded SAND (SP)	1.1	2.8
⊙	H073RW	10.0	Poorly graded SAND (SP)	1.1	3.3
✿	H073RW	15.0	Poorly graded SAND (SP)	1.1	3.4
⅄	H073RW	25.0	Poorly graded SAND with gravel (SP)	0.7	6.7
◘	H087LW	5.0	Well-graded SAND with silt and gravel (SW-SM)	1.2	42.6
⊗	H087LW	15.0	Well-graded SAND with gravel (SW)	1.2	12.5
⊕	H087LW	20.0	Poorly graded SAND with silt (SP-SM)	0.8	9.0
□	H087LW	25.0	Poorly graded SAND with silt and gravel (SP-SM)	0.4	13.9
◕	H087RW	5.0	Poorly graded SAND with gravel (SP)	0.7	14.4

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2b



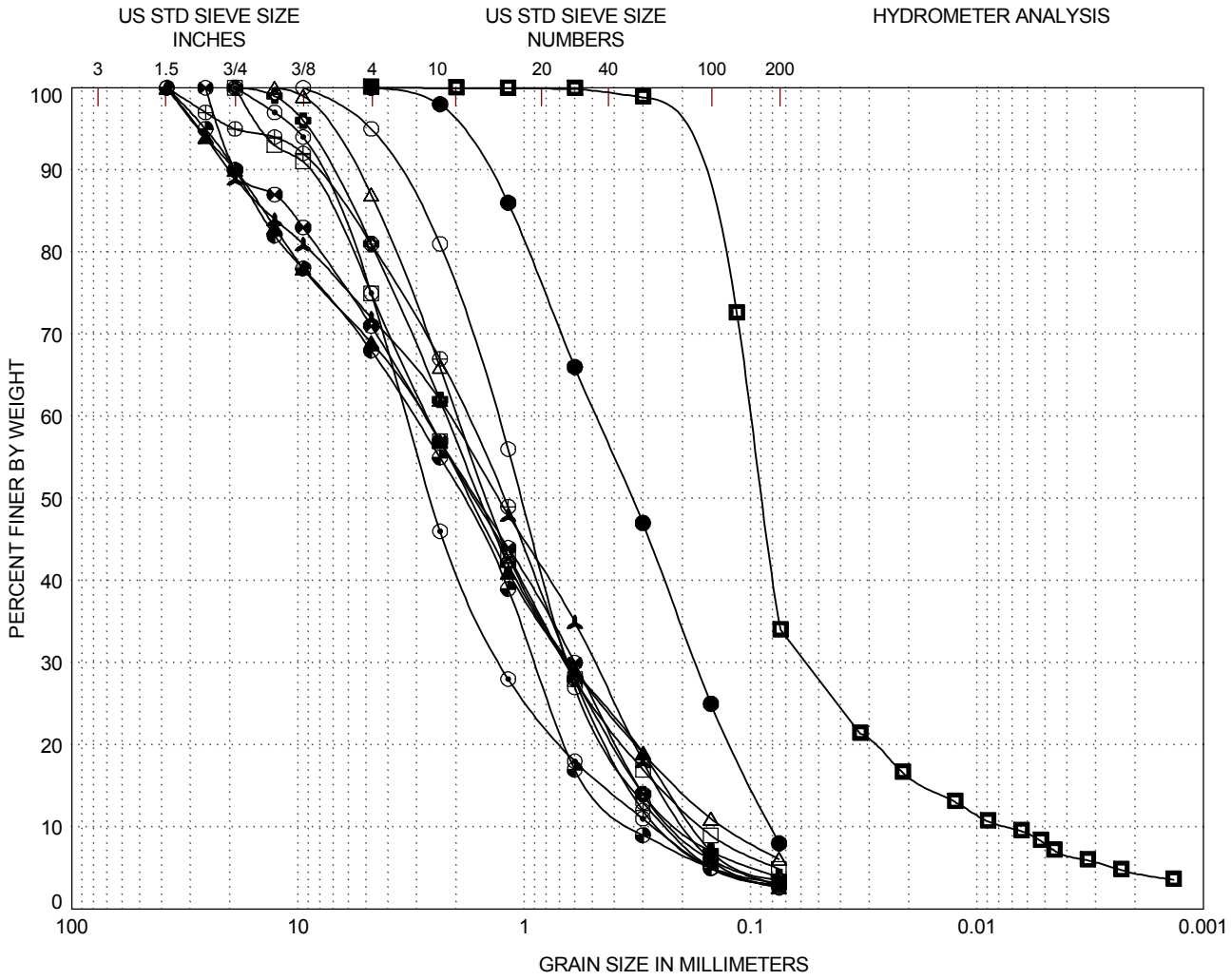
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H087RW	10.0	Well-graded SAND with gravel (SW)	2.2	16.8
●	H087RW	15.0	Poorly graded SAND (SP)	0.9	8.1
△	H087RW	25.0	Well-graded SAND with gravel (SW)	1.2	9.1
▲	H098LW	15.0	Poorly graded SAND with gravel (SP)	0.7	9.9
⊙	H098LW	20.0	Well-graded SAND with gravel (SW)	1.1	6.8
✿	H098LW	25.0	Well-graded SAND with gravel (SW)	1.1	10.7
⅄	H098RW	10.0	Poorly graded SAND with gravel (SP)	0.5	13.3
◘	H098RW	15.0	Well-graded SAND with gravel (SW)	1.1	9.0
⊗	H098RW	20.0	Poorly graded SAND with gravel (SP)	0.8	21.2
⊕	H098RW	25.0	Poorly graded SAND with gravel (SP)	0.7	10.0
□	H114LW	15.0	Well-graded SAND with gravel (SW)	1.0	7.7
◕	H114LW	25.0	Well-graded SAND with gravel (SW)	1.0	6.8

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2c



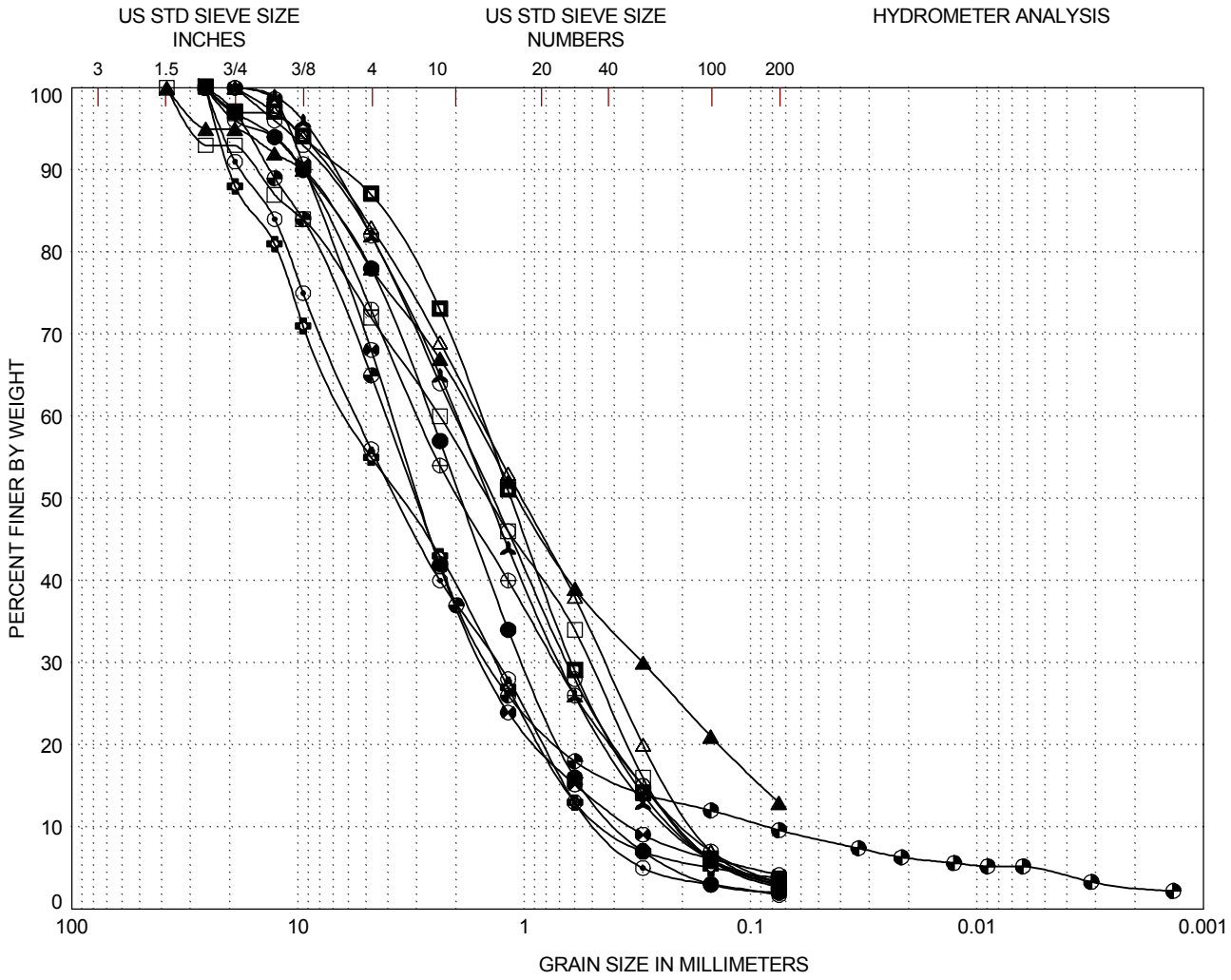
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H114RL	15.0	Poorly graded SAND (SP)	1.4	5.7
●	H114RL	20.0	Poorly graded SAND with silt (SP-SM)	0.8	5.9
△	H114RL	25.0	Well-graded SAND with silt (SW-SM)	1.5	15.1
▲	H114RW	15.0	Poorly graded SAND with gravel (SP)	0.8	15.8
⊙	H114RW	20.0	Well-graded SAND with gravel (SW)	1.8	12.4
✿	H114RW	25.0	Well-graded SAND with gravel (SW)	1.0	10.9
⅄	H132LL	25.0	Poorly graded SAND with gravel (SP)	0.6	11.3
◘	H132LO	10.0	Silty SAND (SM)	4.5	13.5
⊗	H132LO	20.0	Poorly graded SAND with gravel (SP)	0.6	12.9
⊕	H132LO	25.0	Poorly graded SAND with gravel (SP)	0.9	7.3
□	H132LW	7.5	Well-graded SAND with gravel (SW)	1.0	16.2
◕	H132LW	10.0	Poorly graded SAND with gravel (SP)	0.8	9.4

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2d



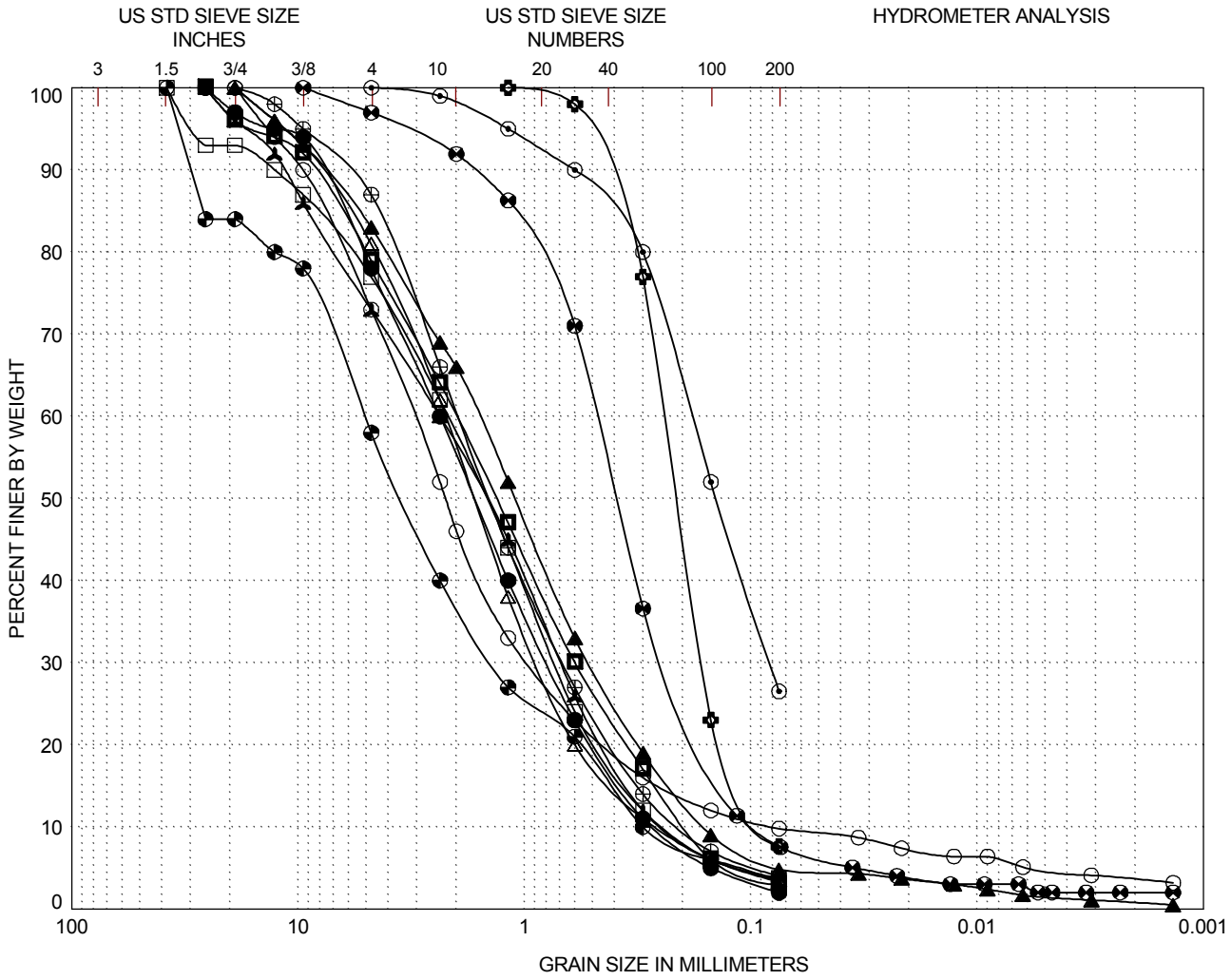
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H132LW	15.0	Well-graded SAND with gravel (SW)	1.1	10.4
●	H132LW	20.0	Well-graded SAND with gravel (SW)	1.0	6.9
△	H132LW	25.0	Poorly graded SAND with gravel (SP)	0.7	9.1
▲	H132RL	5.0	Silty SAND with gravel (SM)		
⊙	H132RL	10.0	Poorly graded SAND with gravel (SP)	0.7	11.9
✿	H132RL	15.0	Poorly graded SAND with gravel (SP)	0.7	13.9
⅄	H132RL	20.0	Well-graded SAND with gravel (SW)	1.1	9.0
◘	H132RL	25.0	Well-graded SAND (SW)	1.2	7.4
⊗	H132RO	15.0	Well-graded SAND with gravel (SW)	1.7	11.5
⊕	H132RO	20.0	Poorly graded SAND with gravel (SP)	0.9	14.4
□	H132RO	25.0	Poorly graded SAND with gravel (SP)	0.6	11.9
◕	H132RW	5.0	Poorly graded SAND with silt and gravel (SP-SM)	6.0	48.5

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2e



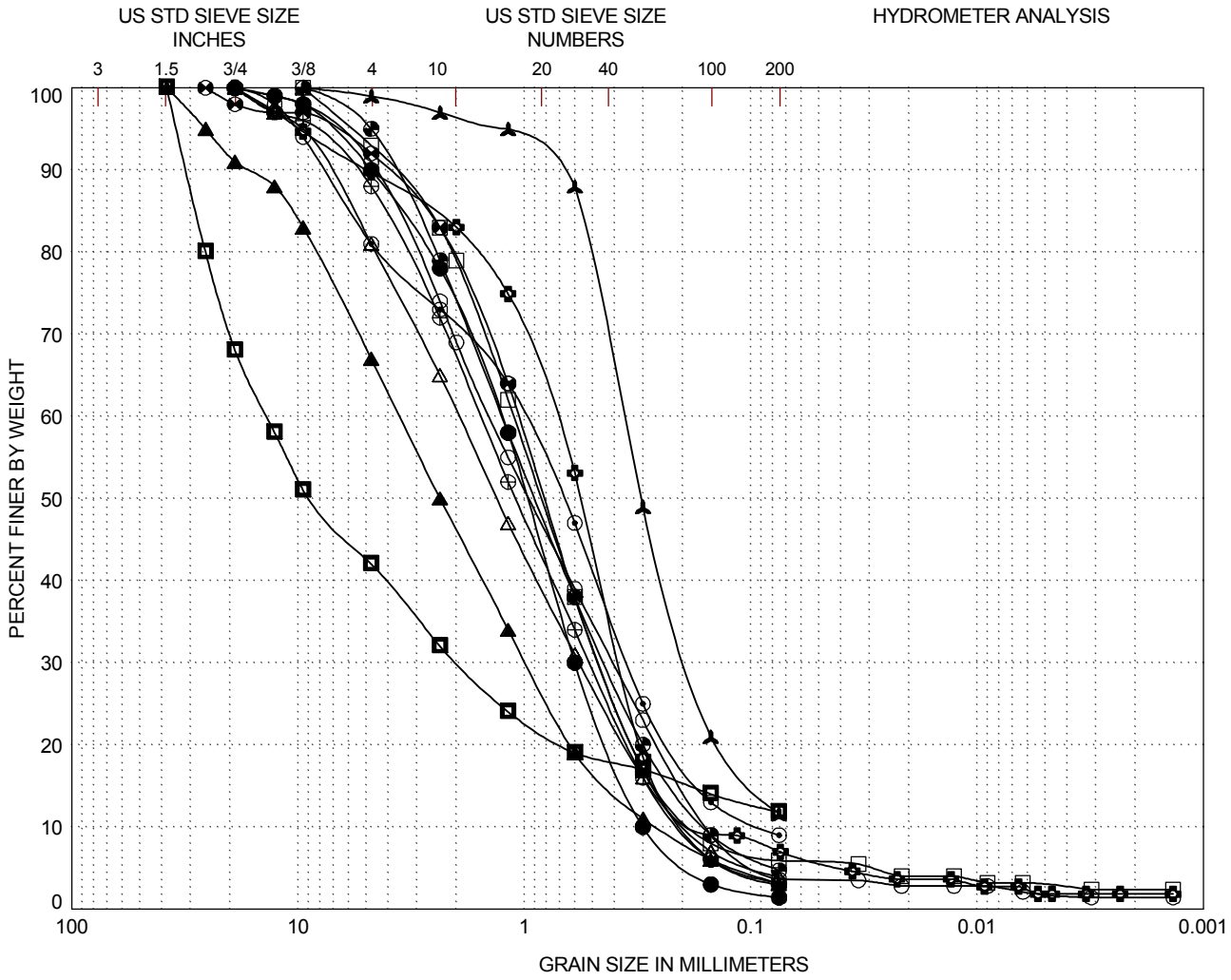
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H132RW	10.0	Poorly graded SAND with silt and gravel (SP-SM)	3.8	38.6
●	H132RW	15.0	Well-graded SAND with gravel (SW)	1.0	8.8
△	H132RW	20.0	Well-graded SAND with gravel (SW)	1.3	8.5
▲	H132RW	25.0	Well-graded SAND with gravel (SW)	1.0	9.9
⊙	H146LL	5.0	Silty SAND (SM)		
✿	H146LL	15.0	Poorly graded SAND with silt (SP-SM)	1.3	2.9
⅄	H146LL	20.0	Poorly graded SAND with gravel (SP)	0.9	9.9
◘	H146LL	25.0	Poorly graded SAND with gravel (SP)	0.9	10.4
⊗	H146LO	10.0	Poorly graded SAND with silt (SP-SM)	1.2	4.9
⊕	H146LO	20.0	Well-graded SAND (SW)	1.2	9.7
□	H146LO	25.0	Well-graded SAND with gravel (SW)	1.0	9.2
◕	H146LW	10.0	Well-graded SAND with gravel (SW)	1.3	17.0

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2f



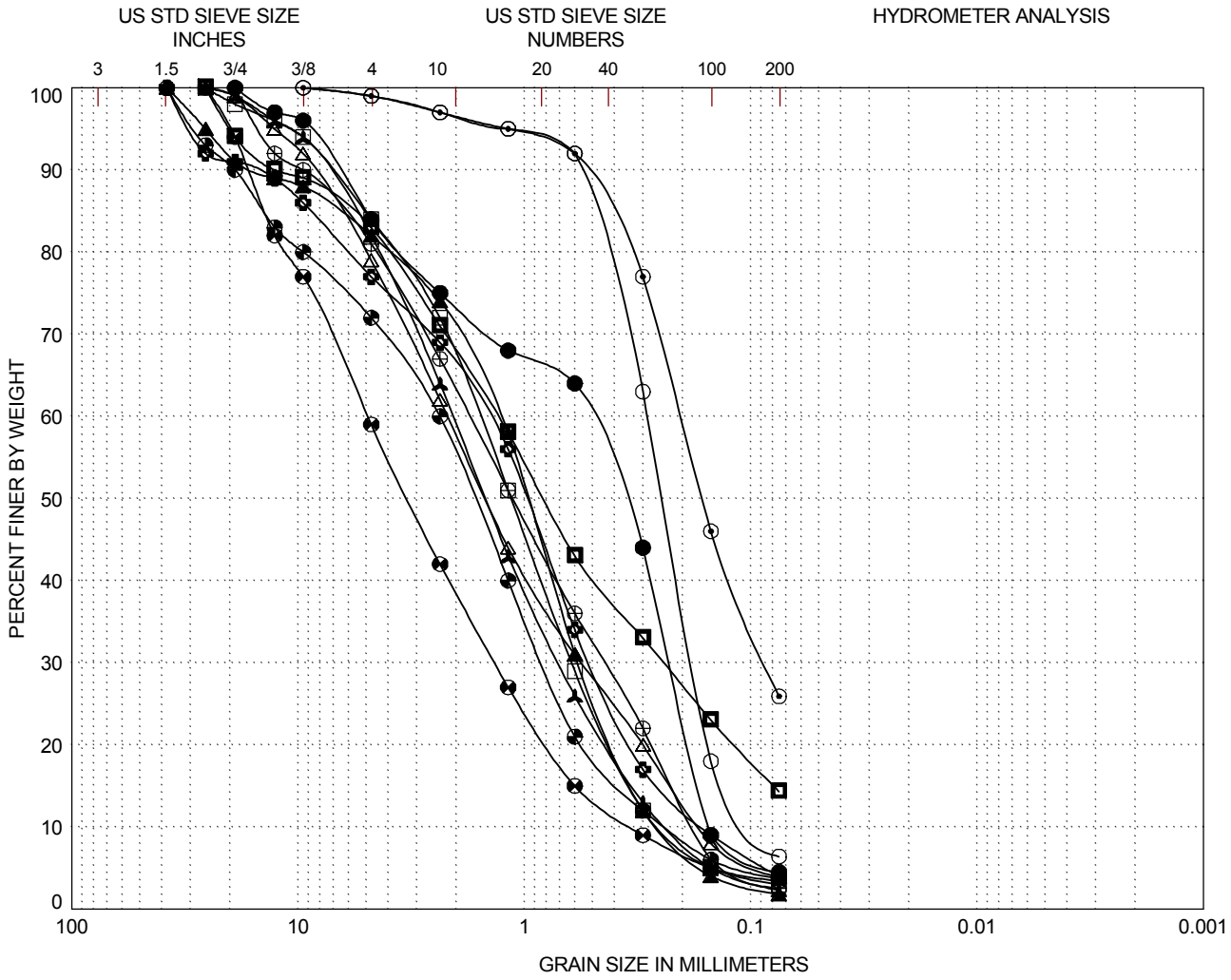
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H146LW	15.0	Poorly graded SAND (SP)	0.7	9.0
●	H146LW	20.0	Poorly graded SAND (SP)	0.9	4.2
△	H146LW	25.0	Poorly graded SAND with gravel (SP)	0.9	10.3
▲	H146RL	20.0	Well-graded SAND with gravel (SW)	1.0	13.6
⊙	H146RL	25.0	Well-graded SAND with silt and gravel (SW-SM)	1.4	11.3
✿	H146RO	10.0	Poorly graded SAND with silt (SP-SM)	1.5	5.8
⅄	H146RO	25.0	Poorly graded SAND with silt (SP-SM)	1.4	5.5
◘	H146RW	5.0	Poorly graded GRAVEL with silt and sand (GP-GM)	6.7	323.6
⊗	H146RW	10.0	Poorly graded SAND (SP)	1.0	5.5
⊕	H146RW	15.0	Poorly graded SAND (SP)	0.9	7.9
□	H146RW	20.0	Well-graded SAND with silt (SW-SM)	1.1	6.4
◕	H146RW	25.0	Well-graded SAND with silt (SW-SM)	1.0	7.9

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2g



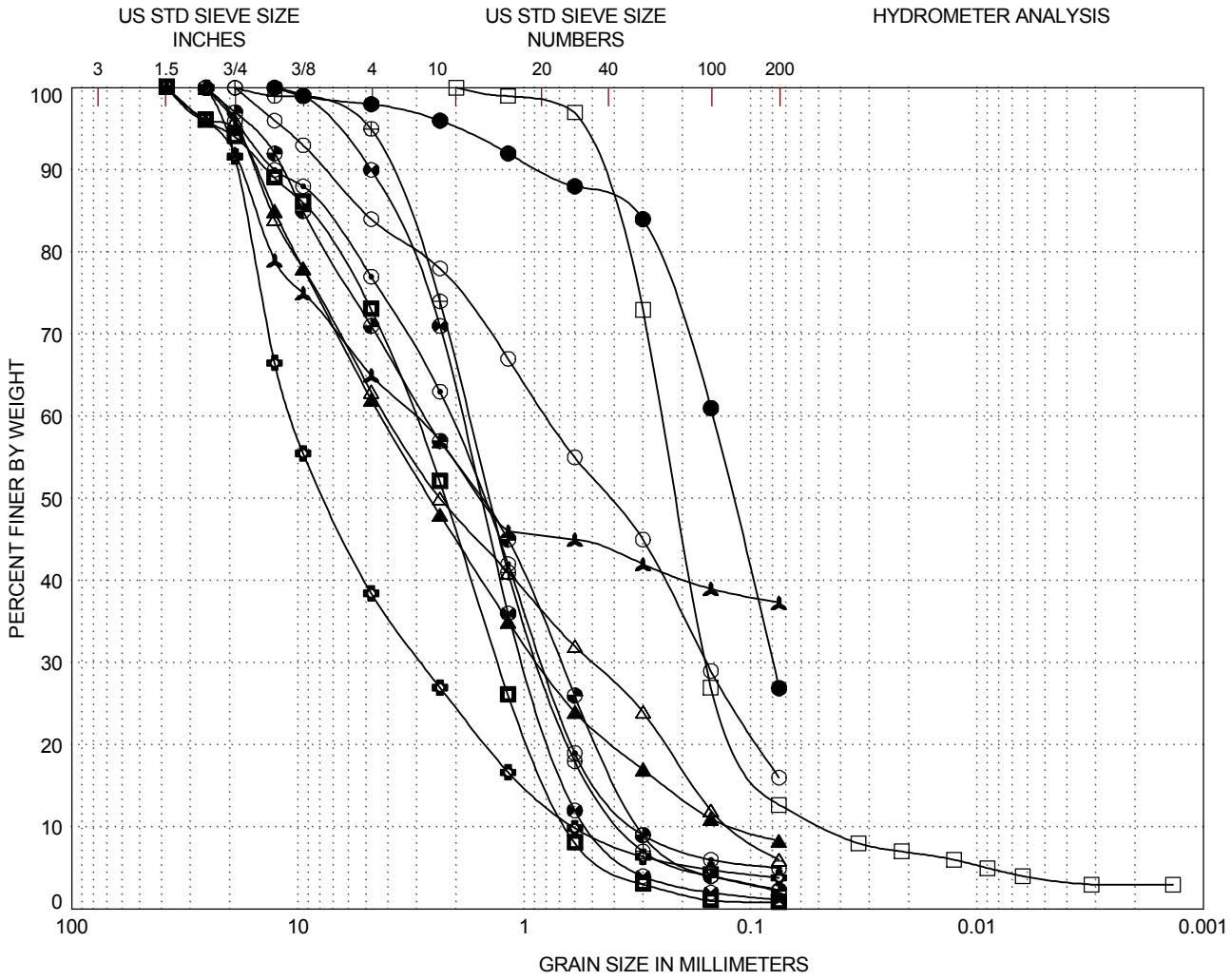
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H158LL	10.0	Poorly graded SAND with silt (SP-SM)	1.2	3.1
●	H158LL	15.0	Poorly graded SAND with gravel (SP)	0.6	3.4
△	H158LL	20.0	Poorly graded SAND with gravel (SP)	0.9	13.0
▲	H158LL	25.0	Poorly graded SAND with gravel (SP)	1.0	5.1
⊙	H158LO	15.0	Silty SAND (SM)		
✿	H158LO	20.0	Well-graded SAND with gravel (SW)	1.1	8.9
⅄	H158LO	25.0	Well-graded SAND with gravel (SW)	1.0	8.9
◘	H158LW	5.0	Silty SAND with gravel (SM)		
⊗	H158LW	10.0	Well-graded SAND with gravel (SW)	1.1	14.7
⊕	H158LW	15.0	Poorly graded SAND with gravel (SP)	0.6	9.8
□	H158LW	20.0	Well-graded SAND with gravel (SW)	1.0	6.5
◕	H158LW	25.0	Well-graded SAND with gravel (SW)	1.2	9.9

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2h



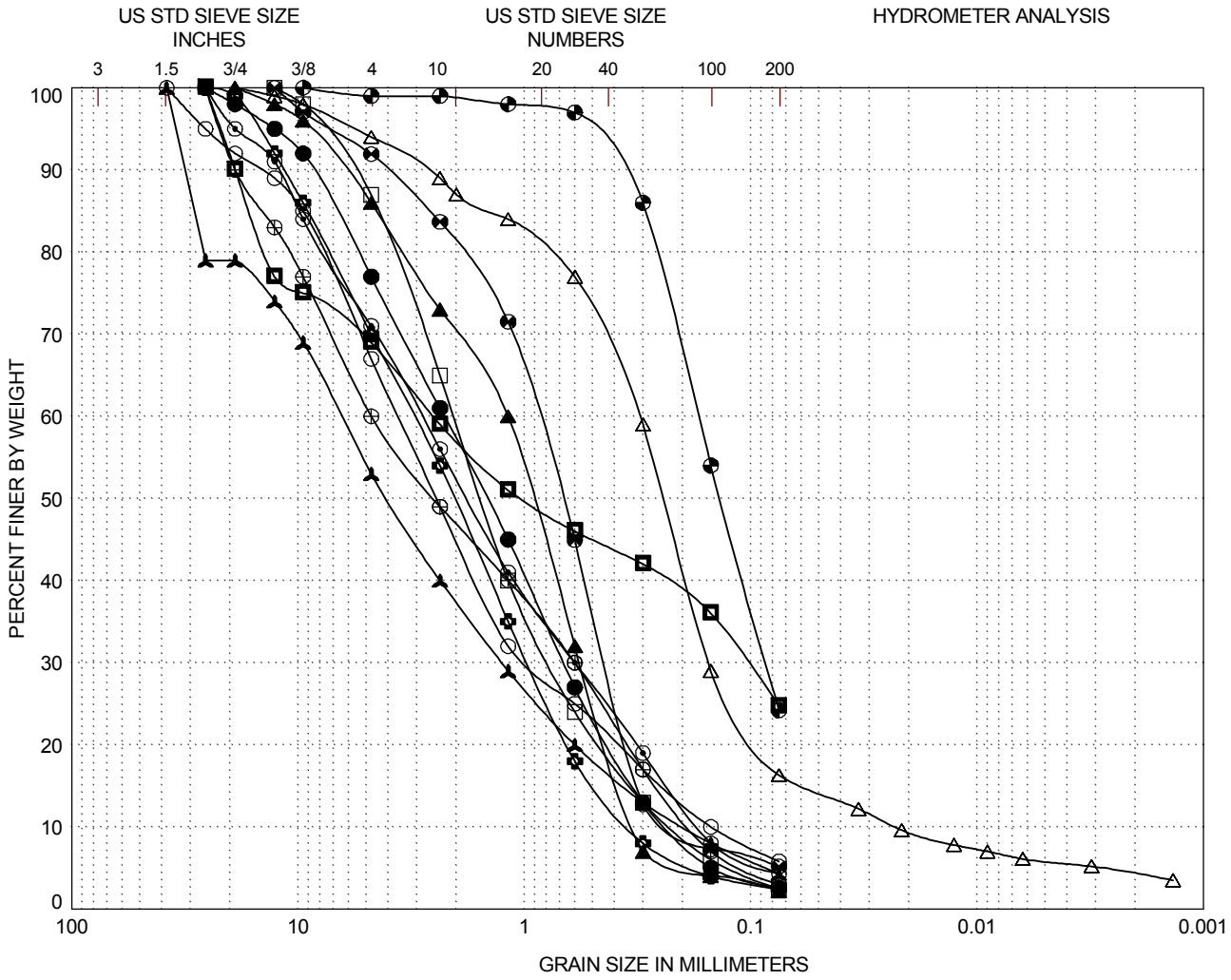
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H158RL	5.0	Silty SAND with gravel (SM)		
●	H158RL	10.0	Silty SAND (SM)		
△	H158RL	15.0	Poorly graded SAND with silt and gravel (SP-SM)	0.5	34.0
▲	H158RL	20.0	Well-graded SAND with silt and gravel (SW-SM)	1.5	37.0
⊙	H158RL	25.0	Well-graded SAND with silt and gravel (SW-SM)	1.0	6.6
✿	H158RO	15.0	Well-graded GRAVEL with sand (GW)	1.2	17.6
⅄	H158RW	5.0	Silty SAND with gravel (SM)		
◘	H158RW	15.0	Poorly graded SAND with gravel (SP)	0.9	4.8
⊗	H158RW	20.0	Poorly graded SAND (SP)	1.0	3.8
⊕	H158RW	25.0	Poorly graded SAND (SP)	1.1	4.9
□	H171LL	10.0	Silty SAND (SM)	2.1	5.2
◕	H171LL	15.0	Poorly graded SAND with gravel (SP)	0.6	8.8

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2i



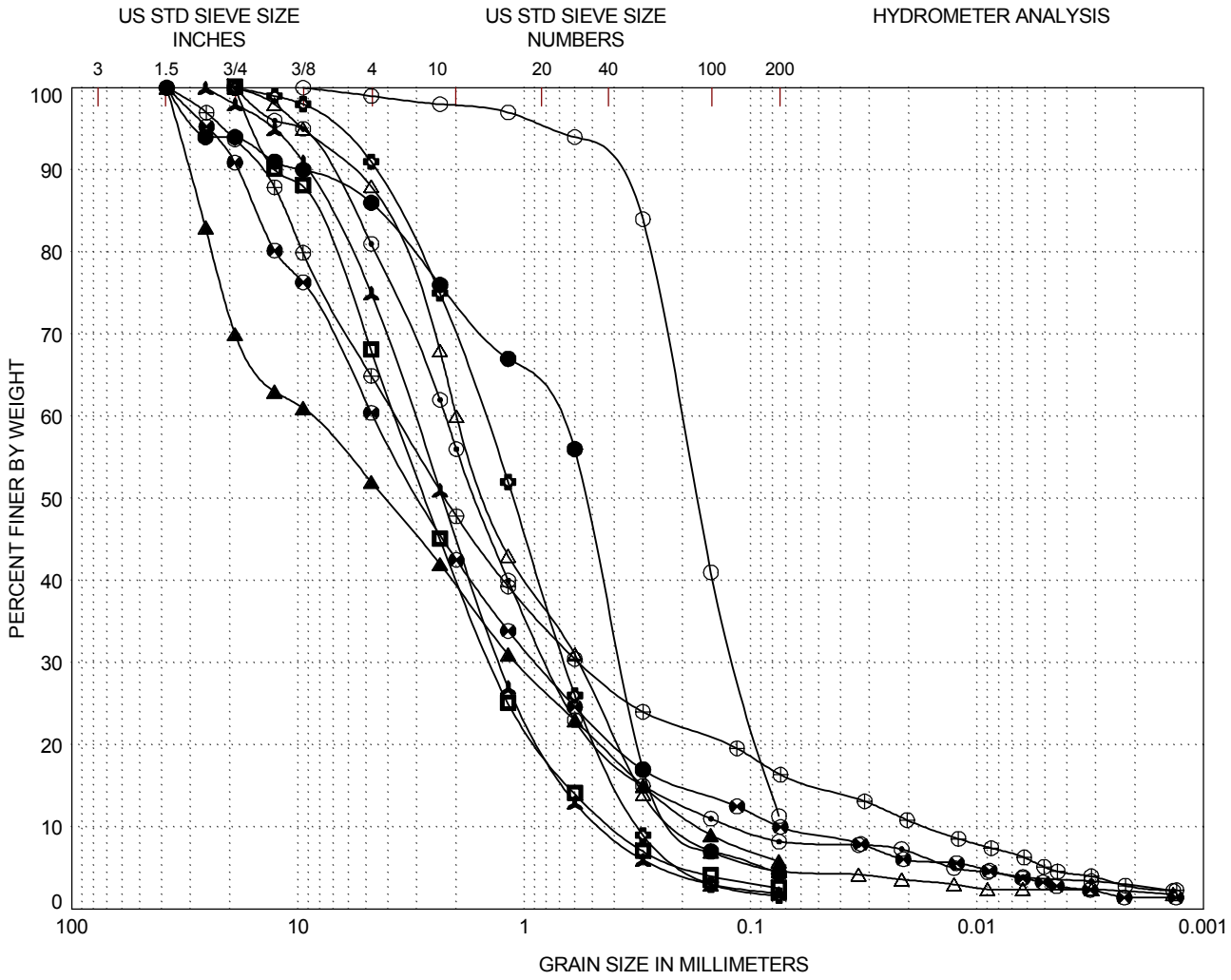
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H171LL	20.0	Well-graded SAND with silt and gravel (SW-SM)	1.7	24.1
●	H171LL	25.0	Poorly graded SAND with gravel (SP)	0.9	9.8
△	H171LO	10.0	Silty SAND (SM)	3.3	13.5
▲	H171LO	15.0	Poorly graded SAND (SP)	0.8	3.6
⊙	H171LO	20.0	Poorly graded SAND with gravel (SP)	0.7	16.7
✿	H171LO	25.0	Poorly graded SAND with gravel (SP)	0.9	8.9
⅄	H171LW	5.0	Well-graded SAND with gravel (SW)	1.2	32.5
◘	H171LW	10.0	Silty SAND with gravel (SM)		
⊗	H171LW	15.0	Poorly graded SAND with silt (SP-SM)	1.0	4.2
⊕	H171LW	20.0	Poorly graded SAND with gravel (SP)	0.4	25.7
□	H171LW	25.0	Well-graded SAND (SW)	1.3	9.2
◕	H185LL	5.0	Silty SAND (SM)		

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2j



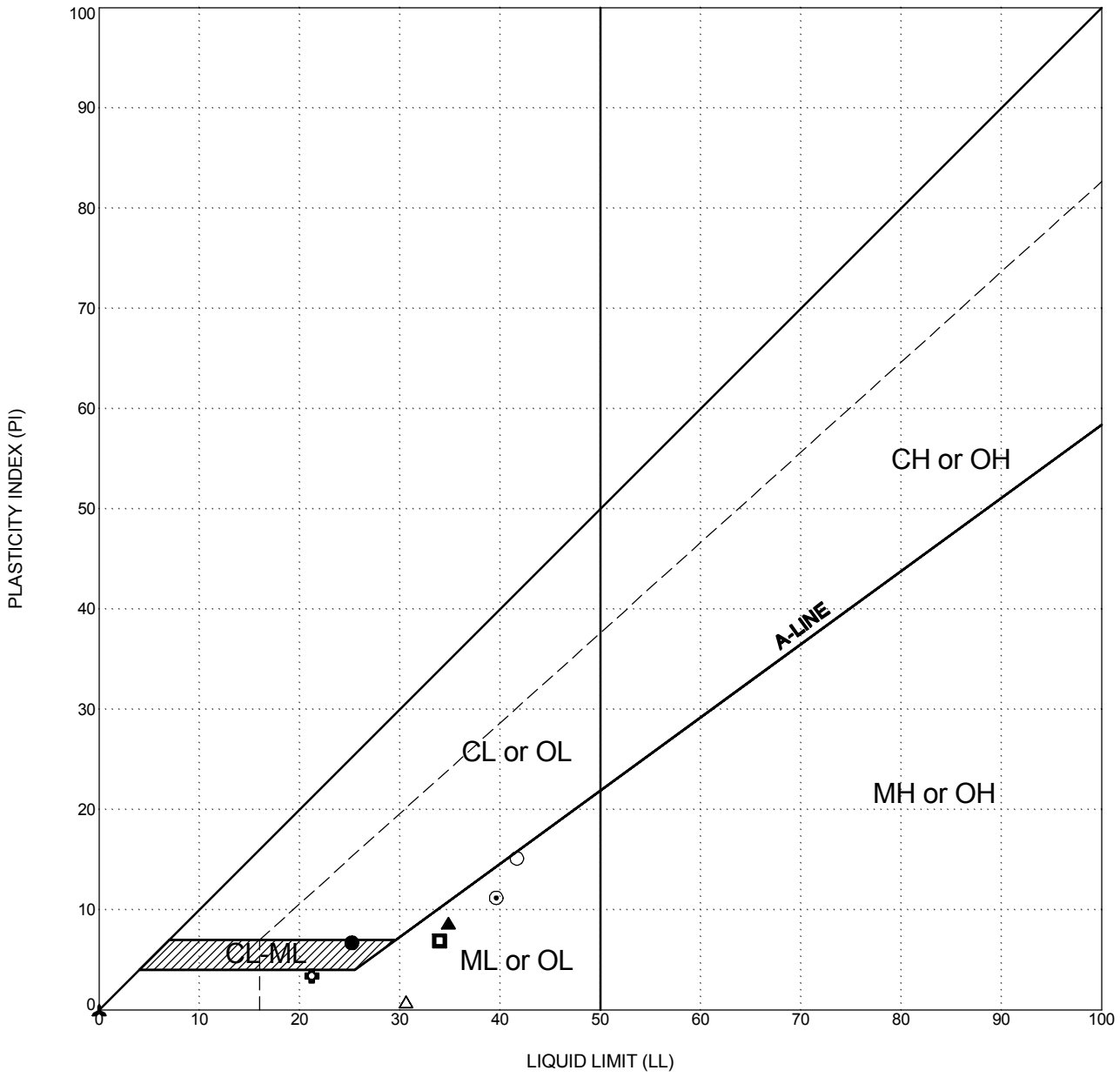
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

LEGEND	(location)	(depth,ft)	CLASSIFICATION	Cc	Cu
○	H185LL	10.0	Poorly graded SAND with silt (SP-SM)	0.9	2.8
●	H185LL	20.0	Poorly graded SAND (SP)	1.0	4.2
△	H185LL	25.0	Poorly graded SAND (SP)	0.8	9.9
▲	H185LW	5.0	Poorly graded SAND with silt and gravel (SP-SM)	0.8	52.2
⊙	H185LW	10.0	Well-graded SAND with silt and gravel (SW-SM)	2.4	19.1
✿	H185LW	15.0	Poorly graded SAND (SP)	0.9	4.8
⅄	H185LW	20.0	Well-graded SAND with gravel (SW)	1.2	6.9
◘	H185LW	25.0	Well-graded SAND with gravel (SW)	1.3	9.2
⊛	S098LC	1.0	Well-graded SAND with silt and gravel (SW-SM)	2.3	62.9
⊕	S158LC	1.0	Silty SAND with gravel (SM)	5.2	220.0

GRAIN SIZE CURVES

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-2k

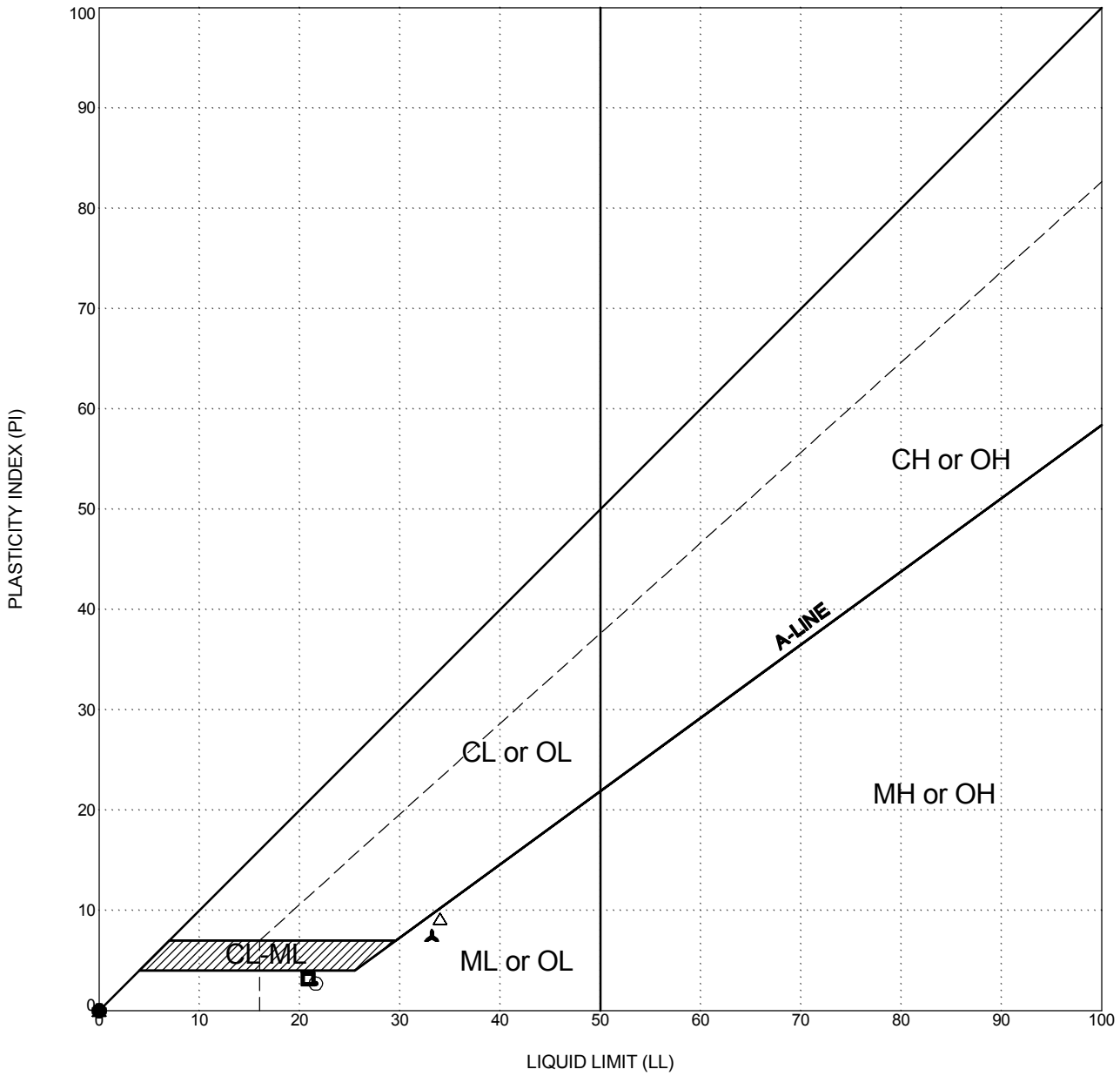


LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
	location	depth, ft		LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
○	H057RO	5.0	SILT (ML)	42	27	15
●	H057RO	15.0	Poorly graded SAND with gravel (SP)	25	19	6
△	H057RW	15.0	Sandy SILT (ML)	31	30	1
▲	H132LL	5.0	SILT (ML)	35	26	9
⊙	H132LO	5.0	SILT (ML)	40	28	12
✿	H132RL	5.0	Silty SAND with gravel (SM)	21	18	3
⅄	H146LL	5.0	Silty SAND (SM)	NP	NP	NP
◘	H146LL	10.0	SILT (ML)	34	27	7

PLASTICITY CHART

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-3a

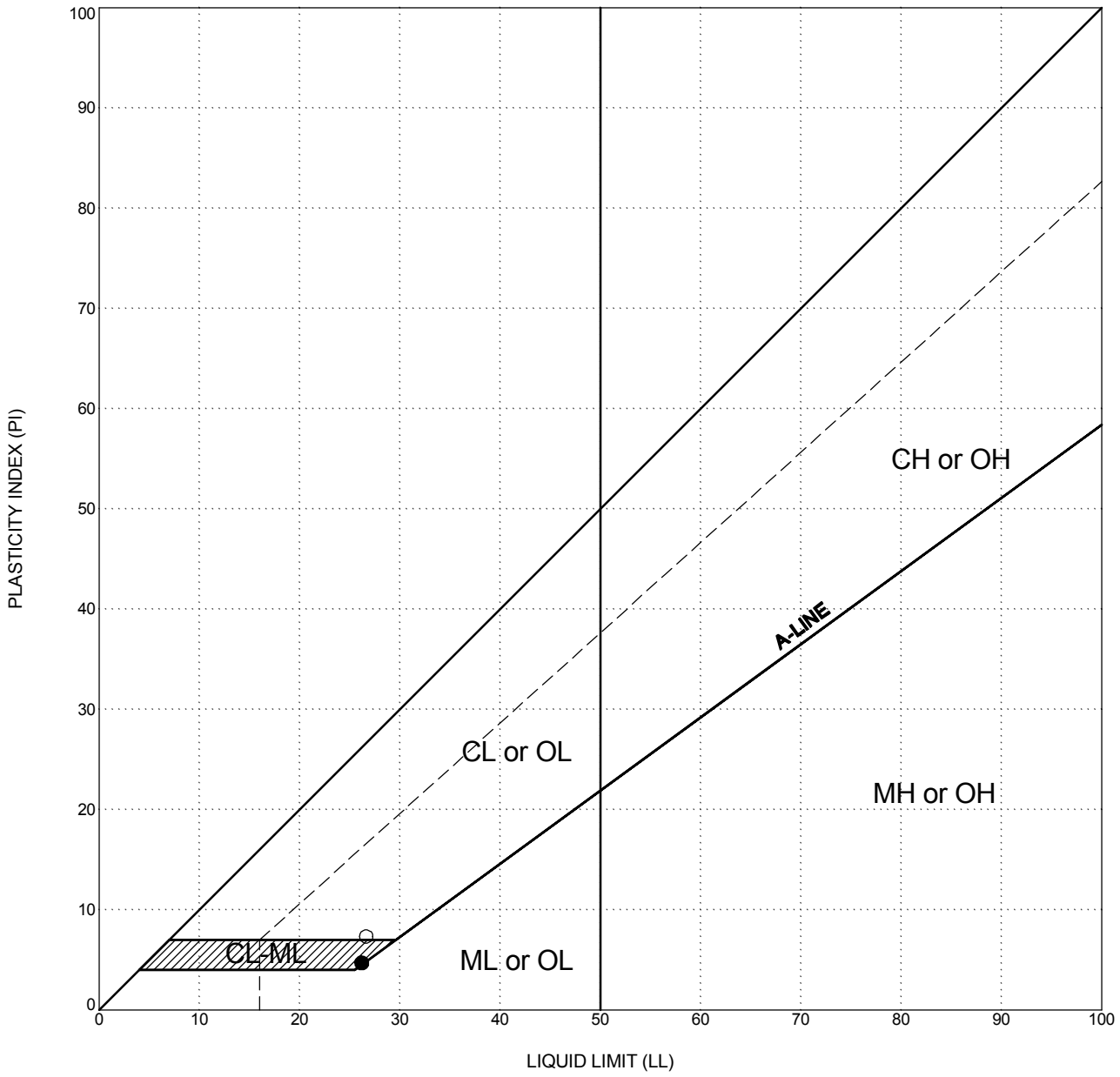


LEGEND	location	depth, ft	CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
○	H146RL	25.0	Well-graded SAND with silt and gravel (SW-SM)	NP	NP	NP
●	H146RO	25.0	Poorly graded SAND with silt (SP-SM)	NP	NP	NP
△	H158LO	5.0	SILT (ML)	34	25	9
▲	H158LO	15.0	Silty SAND (SM)	NP	NP	NP
⊙	H158RL	5.0	Silty SAND with gravel (SM)	22	19	3
✿	H158RL	10.0	Silty SAND (SM)	NP	NP	NP
⅄	H171LL	5.0	SILT (ML)	33	26	7
◘	S073LC	3.0	Silty SAND with gravel (SM)	21	18	3

PLASTICITY CHART

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-3b



LEGEND			CLASSIFICATION	ATTERBERG LIMITS TEST RESULTS		
	location	depth, ft		LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)
○	S146LC	4.0	Sandy Lean CLAY with gravel (CL)	27	19	8
●	S185LC	8.0	Silty CLAY (CL-ML)	26	21	5

PLASTICITY CHART

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-3c

SAMPLE ID

Boring Number	H57RO
Sample Number	R-1
Sample Depth, ft	10
Classification	SILT with sand (ML): olive gray, wet

SAMPLE PROPERTIES

	Intial	Final
Mass, g	182.05	182.27
Water Content, %	25.5%	25.6%
Dry Density, pcf	97.0	99.7
Saturation, %	93%	100%
Void Ratio	0.74	0.69
Diameter, in	2.42	2.42
Height, in	1.24	1.21
Area, in^2	4.60	4.58
Volume, in^3	5.70	5.54

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	21
Plastic Limit	---
Plasticity Index	21
Estimated Gs	2.7

TEST SUMMARY

Sample Type	MCA
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	3.3E-06
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/11/10	111	22.6	1.2	14.4	10.2	2.1	3.5E-06
2	11/11/10	109	22.6	1.2	14.4	10.2	2.1	3.6E-06
3	11/11/10	109	22.6	1.2	14.4	10.2	2.1	3.6E-06
4	11/11/10	112	22.6	1.2	14.4	10.2	2.1	3.5E-06
5	11/11/10	111	22.6	1.2	14.4	10.2	2.1	3.5E-06
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4a

SAMPLE ID

Boring Number	H57RW
Sample Number	R-2
Sample Depth, ft	15
Classification	Sandy SILT (ML): dark gray, wet, w/decaying wood fragments

SAMPLE PROPERTIES

	Intial	Final
Mass, g	212.68	210.20
Water Content, %	32.5%	31.0%
Dry Density, pcf	89.5	91.7
Saturation, %	99%	100%
Void Ratio	0.88	0.84
Diameter, in	2.36	2.38
Height, in	1.56	1.50
Area, in^2	4.39	4.45
Volume, in^3	6.83	6.66

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	31
Plastic Limit	30
Plasticity Index	1
Estimated Gs	2.7

TEST SUMMARY

Sample Type	MCA
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	9.3E-06
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/10/10	56	25.0	1.8	13.0	10.3	1.7	1.0E-05
2	11/10/10	56	25.0	1.8	13.0	10.3	1.7	1.0E-05
3	11/10/10	55	25.0	1.8	13.0	10.3	1.7	1.1E-05
4	11/10/10	55	25.0	1.8	13.0	10.3	1.7	1.1E-05
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4b

SAMPLE ID

Boring Number	H73LL
Sample Number	T-2
Sample Depth, ft	17.00
Classification	Silty SAND (SM): dark gray, wet, w/decaying leaves, roots, & wood fragments

SAMPLE PROPERTIES

	Intial	Final
Mass, g	274.13	266.96
Water Content, %	31.7%	28.2%
Dry Density, pcf	86.2	94.5
Saturation, %	91%	100%
Void Ratio	0.92	0.75
Diameter, in	2.42	2.34
Height, in	2.00	1.95
Area, in^2	4.60	4.30
Volume, in^3	9.20	8.39

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	100
#4 (4.75mm)	100
#16 (1.18mm)	99
#30 (0.6mm)	97
#100 (0.150mm)	41
#200 (0.075mm)	24.8

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.65

TEST SUMMARY

Sample Type	TWT
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	9.2E-04
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/10/10	181	25.0	1.5984	13.0	0.6	0.2	1.1E-03
2	11/10/10	183	25.0	1.5984	13.0	0.6	0.2	1.1E-03
3	11/10/10	189	25.0	1.5984	13.0	0.6	0.2	1.0E-03
4	11/10/10	198	25.0	1.5984	13.0	0.6	0.2	9.9E-04
5	11/10/10	203	25.0	1.5984	13.0	0.6	0.2	9.7E-04
6	11/10/10	185	25.0	1.5984	13.0	0.6	0.2	1.1E-03

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4c

SAMPLE ID

Boring Number	H132LL
Sample Number	ST-1
Sample Depth, ft	5
Classification	SILT (ML): dark grayish brown, moist, clayey

SAMPLE PROPERTIES

	Intial	Final
Mass, g	154.28	155.12
Water Content, %	23.4%	24.1%
Dry Density, pcf	103.4	102.3
Saturation, %	100%	100%
Void Ratio	0.63	0.65
Diameter, in	2.42	2.44
Height, in	1.00	1.00
Area, in^2	4.61	4.68
Volume, in^3	4.61	4.66

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	35
Plastic Limit	26
Plasticity Index	8
Estimated Gs	2.7

TEST SUMMARY

Sample Type	TWT
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	1.8E-06
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/10/10	148	25.0	0.6	8.6	20.2	5.2	1.9E-06
2	11/10/10	157	25.0	0.6	8.6	20.2	4.1	2.0E-06
3	11/10/10	138	25.0	0.6	8.6	20.2	5.2	2.0E-06
4	11/10/10	137	25.0	0.6	8.6	20.2	5.2	2.0E-06
5	11/10/10	156	25.0	0.6	8.6	20.2	4.1	2.1E-06
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4d

SAMPLE ID

Boring Number	H132LO
Sample Number	R-1
Sample Depth, ft	10.00
Classification	Silty SAND (SM): olive gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	154.07	184.52
Water Content, %	12.5%	34.7%
Dry Density, pcf	85.1	86.0
Saturation, %	35%	100%
Void Ratio	0.94	0.92
Diameter, in	2.37	2.39
Height, in	1.39	1.35
Area, in^2	4.41	4.49
Volume, in^3	6.13	6.07

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	100
#4 (4.75mm)	100
#16 (1.18mm)	100
#30 (0.6mm)	100
#100 (0.150mm)	73
#200 (0.075mm)	34.0

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.65

TEST SUMMARY

Sample Type	MCA
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	1.3E-03
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/8/10	88	23.3	1.1952	13.2	0.9	0.3	1.5E-03
2	11/8/10	96	23.2	1.1952	13.2	0.8	0.3	1.4E-03
3	11/8/10	91	23.2	1.1952	13.2	0.8	0.3	1.4E-03
4	11/8/10	93	23.2	1.1952	13.2	0.8	0.3	1.4E-03
5	11/8/10	90	23.2	1.1952	13.2	0.8	0.3	1.4E-03
6	11/8/10	90	23.1	1.1952	13.2	0.8	0.3	1.4E-03

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4e

SAMPLE ID

Boring Number	H132RO
Sample Number	R-2
Sample Depth, ft	15.0
Classification	Well-graded SAND with gravel (SW): gray, moist

SAMPLE PROPERTIES

Mass, g	802.27
Water Content, %	4.5%
Dry Density, pcf	106.0
Void Ratio	0.53
Diameter, in	2.42
Height, in	6.00
Area, in^2	4.60
Volume, in^3	27.60

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	91
#4 (4.75mm)	68
#16 (1.18mm)	24
#30 (0.6mm)	15
#100 (0.150mm)	6
#200 (0.075mm)	4.1

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.6

TEST SUMMARY

Sample Type	MCA
Permeant	Tap Water
Length Across Head Loss, in	3.2
k_{avg} 20ºC, cm/s	3.4E-01
Tested By	ND

REMARKS

Test Method: ASTM D2434

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, ºC	Vol., ml	Head, cm	Tail, cm	Gradient	k_t, cm/s
1	11/10/10	30	24.2	36.5	70.1	69.2	0.1	3.7E-01
2	11/10/10	30	24.2	36.5	70.8	69.9	0.1	3.7E-01
3	11/10/10	30	24.2	38.5	74.0	73.1	0.1	3.9E-01
4	11/10/10	30	24.2	38.0	74.0	73.1	0.1	3.9E-01
5	11/10/10	30	24.2	38.0	74.0	73.1	0.1	3.9E-01
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4f

SAMPLE ID

Boring Number	H146LO
Sample Number	R-1
Sample Depth, ft	10.00
Classification	Poorly-graded SAND with silt (SP-SM): gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	306.73	343.63
Water Content, %	4.5%	17.0%
Dry Density, pcf	108.7	112.4
Saturation, %	24%	100%
Void Ratio	0.49	0.44
Diameter, in	2.37	2.44
Height, in	2.33	2.12
Area, in^2	4.41	4.69
Volume, in^3	10.29	9.95

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	100
#4 (4.75mm)	97
#16 (1.18mm)	86
#30 (0.6mm)	71
#100 (0.150mm)	11
#200 (0.075mm)	7.5

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.6

TEST SUMMARY

Sample Type	MCA
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	6.4E-03
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/10/10	28	24.6	1.1952	13.0	0.5	0.2	7.0E-03
2	11/10/10	29	24.6	1.1952	13.0	0.5	0.2	6.8E-03
3	11/10/10	28	24.6	1.1952	13.0	0.5	0.2	7.0E-03
4	11/10/10	27	24.6	1.1952	13.0	0.5	0.2	7.3E-03
5	11/10/10	27	24.6	1.1952	13.0	0.5	0.2	7.3E-03
6	11/10/10	27	24.6	1.1952	13.0	0.5	0.2	7.3E-03

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4g

SAMPLE ID

Boring Number	H146RO
Sample Number	R-2
Sample Depth, ft	10.00
Classification	Poorly-graded SAND with silt (SP-SM): dark gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	368.97	415.94
Water Content, %	3.2%	16.4%
Dry Density, pcf	107.5	113.8
Saturation, %	17%	100%
Void Ratio	0.51	0.43
Diameter, in	2.37	2.36
Height, in	2.87	2.74
Area, in^2	4.41	4.37
Volume, in^3	12.66	11.97

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	95
#4 (4.75mm)	90
#16 (1.18mm)	75
#30 (0.6mm)	53
#100 (0.150mm)	9
#200 (0.075mm)	6.9

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.6

TEST SUMMARY

Sample Type	MCA
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	1.3E-02
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/11/10	20	23.2	1.1952	14.4	0.4	0.1	1.4E-02
2	11/11/10	20	23.2	1.1952	14.4	0.4	0.1	1.4E-02
3	11/11/10	19	23.2	1.1952	14.4	0.4	0.1	1.4E-02
4	11/11/10	20	23.2	1.1952	14.4	0.4	0.1	1.4E-02
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4h

SAMPLE ID

Boring Number	H171LL
Sample Number	T-1
Sample Depth, ft	5.00
Classification	SILT (ML): olive gray, moist, clayey, with pinhole voids

SAMPLE PROPERTIES

	Intial	Final
Mass, g	128.64	136.19
Water Content, %	30.9%	38.5%
Dry Density, pcf	81.4	82.7
Saturation, %	78%	100%
Void Ratio	1.07	1.04
Diameter, in	2.42	2.42
Height, in	1.00	0.98
Area, in^2	4.60	4.60
Volume, in^3	4.60	4.53

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	33
Plastic Limit	26
Plasticity Index	7
Estimated Gs	2.70

TEST SUMMARY

Sample Type	TWT
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	8.1E-04
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/8/10	106	23.1	0.6048	7.2	1.2	0.4	8.7E-04
2	11/8/10	108	23.1	0.6048	7.2	1.2	0.4	8.6E-04
3	11/8/10	106	23.1	0.6048	7.2	1.2	0.4	8.7E-04
4	11/8/10	107	23.1	0.6048	7.2	1.2	0.4	8.6E-04
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4i

SAMPLE ID

Boring Number	H171LW
Sample Number	T-1
Sample Depth, ft	15.00
Classification	Poorly-graded SAND with silt (SP-SM): dark gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	249.30	266.99
Water Content, %	9.7%	17.5%
Dry Density, pcf	108.5	111.5
Saturation, %	51%	100%
Void Ratio	0.50	0.46
Diameter, in	2.41	2.38
Height, in	1.75	1.75
Area, in^2	4.56	4.45
Volume, in^3	7.98	7.77

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	97.1
#4 (4.75mm)	91.9
#16 (1.18mm)	71.5
#30 (0.6mm)	44.9
#100 (0.150mm)	7.3
#200 (0.075mm)	5.2

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.6

TEST SUMMARY

Sample Type	TWT
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	7.9E-03
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/8/10	20	23.0	1.8	12.6	0.7	0.2	8.5E-03
2	11/8/10	20	23.0	1.8	12.6	0.7	0.2	8.5E-03
3	11/8/10	20	23.0	1.8	12.6	0.7	0.2	8.5E-03
4	11/8/10	20	23.0	1.8	12.6	0.7	0.2	8.5E-03
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4j

SAMPLE ID

Boring Number	S73LC
Sample Number	---
Sample Depth, ft	3.00
Classification	Silty SAND with gravel (SM): dark olive gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	141.35	156.56
Water Content, %	7.7%	19.3%
Dry Density, pcf	108.7	110.9
Saturation, %	38%	100%
Void Ratio	0.55	0.52
Diameter, in	2.42	2.45
Height, in	1.00	0.96
Area, in^2	4.60	4.70
Volume, in^3	4.60	4.51

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	21
Plastic Limit	18
Plasticity Index	3
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Remold
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	1.6E-04
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/17/10	534	23.8	0.4032	11.5	1.2	0.4	1.7E-04
2	11/17/10	526	23.9	0.4032	11.5	1.2	0.4	1.7E-04
3	11/17/10	501	24.0	0.4032	11.5	1.2	0.4	1.8E-04
4	11/17/10	518	24.1	0.4032	11.5	1.2	0.4	1.7E-04
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

SAMPLE ID

Boring Number	S87LC
Sample Number	---
Sample Depth, ft	3
Classification	Lean CLAY (CL): gray, moist, w/fine sand pockets

SAMPLE PROPERTIES

	Intial	Final
Mass, g	158.15	165.19
Water Content, %	13.9%	19.0%
Dry Density, pcf	115.0	111.5
Saturation, %	81%	100%
Void Ratio	0.47	0.51
Diameter, in	2.42	2.44
Height, in	1.00	1.01
Area, in^2	4.60	4.68
Volume, in^3	4.60	4.74

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Sonic Core
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	3.0E-07
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/24/10	601	24.4	0.4	13.0	19.8	7.6	3.3E-07
2	11/24/10	606	24.2	0.4	13.0	19.8	7.6	3.3E-07
3	11/24/10	702	23.8	0.4	13.0	19.8	6.6	3.3E-07
4	11/24/10	614	23.5	0.4	13.0	19.8	7.6	3.3E-07
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4I

SAMPLE ID

Boring Number	S146LC
Sample Number	---
Sample Depth, ft	4.00
Classification	Sandy lean CLAY with gravel (CL): dark olive gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	141.93	156.95
Water Content, %	8.2%	19.6%
Dry Density, pcf	109.6	110.3
Saturation, %	41%	100%
Void Ratio	0.54	0.53
Diameter, in	2.41	2.40
Height, in	1.00	1.00
Area, in^2	4.56	4.53
Volume, in^3	4.56	4.53

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	27
Plastic Limit	19
Plasticity Index	8
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Remold
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	2.8E-05
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/18/10	3172	22.3	0.504	14.4	1.2	0.4	3.0E-05
2	11/18/10	3179	22.7	0.504	14.4	1.2	0.4	3.0E-05
3	11/18/10	3164	23.2	0.504	14.4	1.2	0.4	3.0E-05
4	11/18/10	3170	23.6	0.504	14.4	1.2	0.4	3.0E-05
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4m

SAMPLE ID

Boring Number	S158LC
Sample Number	---
Sample Depth, ft	1.00
Classification	Silty SAND with gravel (SM): dark olive gray, moist

SAMPLE PROPERTIES

	Intial	Final
Mass, g	157.03	166.49
Water Content, %	5.2%	11.5%
Dry Density, pcf	124.7	128.5
Saturation, %	40%	100%
Void Ratio	0.35	0.31
Diameter, in	2.41	2.38
Height, in	1.00	0.99
Area, in^2	4.56	4.46
Volume, in^3	4.56	4.42

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	79.9
#4 (4.75mm)	64.9
#16 (1.18mm)	39.3
#30 (0.6mm)	30.4
#100 (0.150mm)	19.6
#200 (0.075mm)	16.4

Other Parameters	
Liquid Limit	---
Plastic Limit	---
Plasticity Index	---
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Remold
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.971
k_{avg} 20°C, cm/s	1.3E-03
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method C)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/18/10	70	22.6	0.2016	8.6	1.2	0.4	1.4E-03
2	11/18/10	73	22.6	0.2016	8.6	1.2	0.4	1.3E-03
3	11/18/10	72	22.6	0.2016	8.6	1.2	0.4	1.3E-03
4	11/18/10	71	22.6	0.2016	8.6	1.2	0.4	1.4E-03
5	11/18/10	73	22.6	0.2016	8.6	1.2	0.4	1.3E-03
6	11/18/10	72	22.6	0.2016	8.6	1.2	0.4	1.3E-03

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4n

SAMPLE ID

Boring Number	S185LC
Sample Number	---
Sample Depth, ft	8
Classification	Silty CLAY (CL-ML): gray, moist, vertically trimmed sample

SAMPLE PROPERTIES

	Intial	Final
Mass, g	103.51	109.80
Water Content, %	13.8%	20.8%
Dry Density, pcf	110.5	108.1
Saturation, %	71%	100%
Void Ratio	0.52	0.56
Diameter, in	2.00	2.01
Height, in	1.00	1.01
Area, in^2	3.14	3.18
Volume, in^3	3.14	3.20

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	26
Plastic Limit	21
Plasticity Index	5
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Sonic Core
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	1.1E-06
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/17/10	339	23.7	1.0	14.4	20.0	5.1	1.2E-06
2	11/17/10	338	23.7	1.0	14.4	20.0	5.1	1.2E-06
3	11/17/10	343	23.7	1.0	14.4	20.0	5.1	1.2E-06
4	11/17/10	339	23.7	1.0	14.4	20.0	5.1	1.2E-06
5								
6								

SAMPLE IMAGES

HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4o

SAMPLE ID

Boring Number	S185LC
Sample Number	---
Sample Depth, ft	8
Classification	Silty CLAY (CL-ML): gray, moist, horizontally trimmed sample

SAMPLE PROPERTIES

	Intial	Final
Mass, g	101.88	108.62
Water Content, %	13.8%	21.4%
Dry Density, pcf	108.7	106.9
Saturation, %	68%	100%
Void Ratio	0.55	0.58
Diameter, in	2.00	2.01
Height, in	1.00	1.01
Area, in^2	3.14	3.16
Volume, in^3	3.14	3.19

CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Other Parameters	
Liquid Limit	26
Plastic Limit	21
Plasticity Index	5
Estimated Gs	2.7

TEST SUMMARY

Sample Type	Sonic Core
Permeant	Deaired Tap-Water
Pipette Area, cm^2	0.0314
Annulus Area, cm^2	0.7671
k_{avg} 20°C, cm/s	3.3E-06
Tested By	JC

REMARKS

Test Method: ASTM D5084 (Method F)

PERMEATION DATA

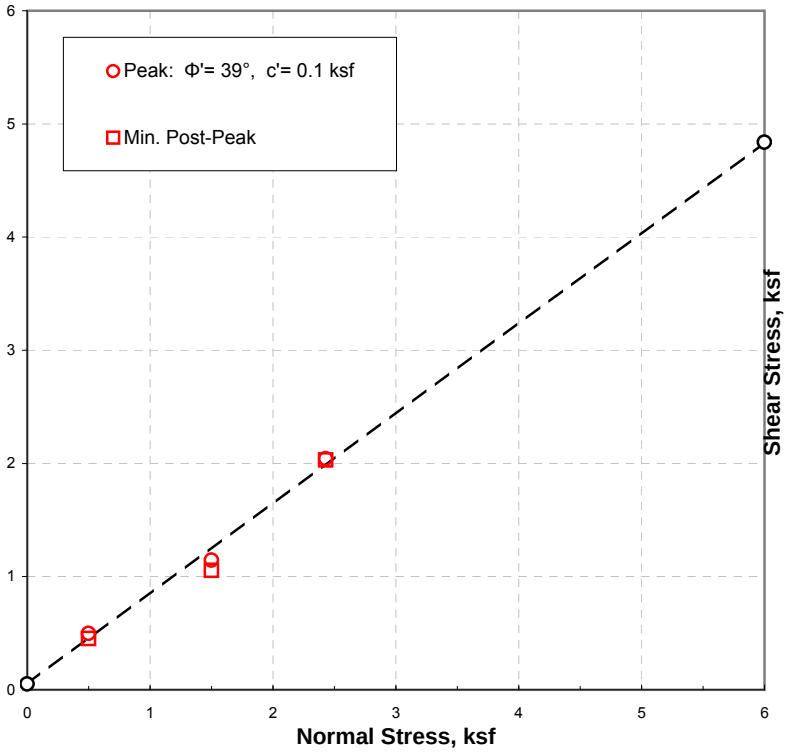
Trial	Date	Time, sec	$Temp_{Avg}$, °C	σ', ksf	μ, ksf	i_o	i_f	k_t, cm/s
1	11/16/10	174	25.4	1.0	10.2	19.9	2.6	3.7E-06
2	11/16/10	173	25.4	1.0	10.2	19.9	2.6	3.8E-06
3	11/16/10	173	25.4	1.0	10.2	19.9	2.6	3.8E-06
4	11/16/10	173	25.4	1.0	10.2	19.9	2.6	3.8E-06
5								
6								

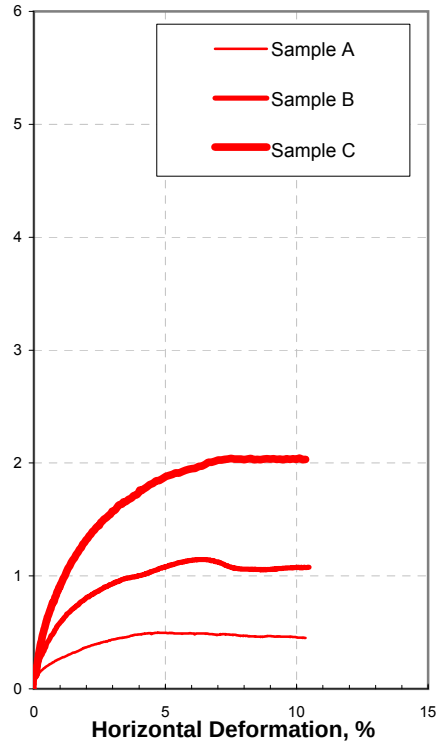
SAMPLE IMAGES

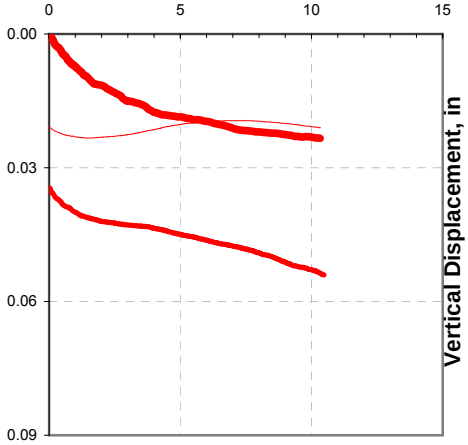
HYDRAULIC CONDUCTIVITY

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-4p







SAMPLE ID

Boring Number:	H57R0
Sample Number:	R-1
Sample Depth:	10.0 ft
USCS Classification:	SILT with sand (ML): olive gray, wet

	Sample No.	A	B	C	D
INITIAL	Water Content, %	26.7%	26.7%	26.7%	
	Dry Unit Weight, pcf	93.1	95.0	97.2	
	Saturation, %	89%	93%	98%	
	Void Ratio	0.81	0.77	0.73	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	27.3%	25.9%	23.7%	
	Dry Unit Weight, pcf	96.3	99.8	103.5	
	Void Ratio	0.75	0.69	0.63	
TEST SUMMARY	Deformation at Peak, %	4.74	6.38	10.11	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.4	
	Peak Shear Stress, ksf	0.50	1.15	2.04	
	Min. Post-Peak Stress, ksf	0.45	1.05	2.03	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

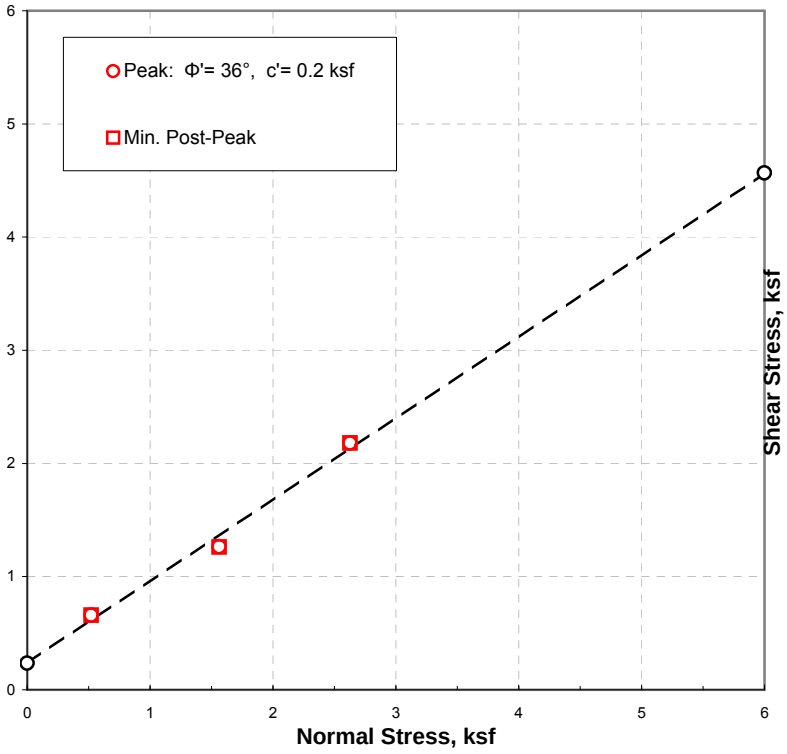
Sieve Size	% Passing
3/8-in. (9.5mm)	---
No. 4 (4.75mm)	---
No. 10 (2.0mm)	---
No. 30 (0.6mm)	---
No. 100 (0.150mm)	---
No. 200 (0.075mm)	---

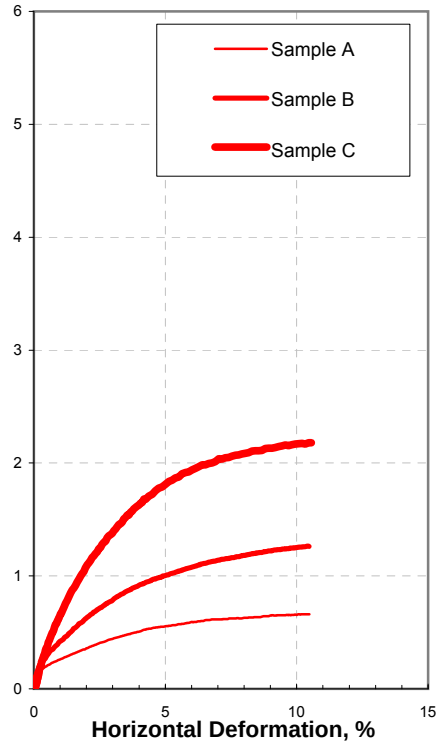
Atterberg Limits	
Liquid Limit, %	21
Plastic Limit, %	---
Plasticity Index, %	21
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	3.3×10^{-6}

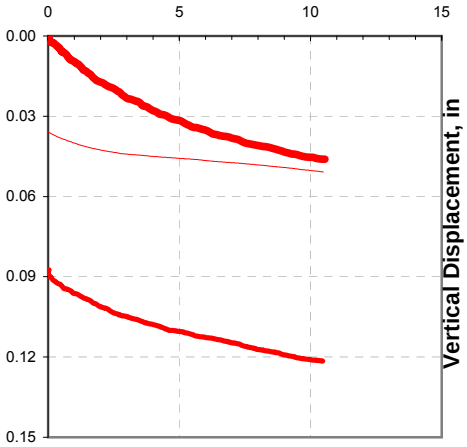
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5a







SAMPLE ID	Boring Number:	H57RW			
	Sample Number:	R-2			
	Sample Depth:	15.0 ft			
	USCS Classification:	Sandy SILT (ML): dark gray, wet, w/decaying wood fragments			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	32.5%	32.5%	32.5%	
	Dry Unit Weight, pcf	79.0	76.0	79.9	
	Saturation, %	78%	72%	79%	
	Void Ratio	1.13	1.22	1.11	
	Diameter, in	2.37	2.37	2.37	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	55.9%	60.9%	55.2%	
	Dry Unit Weight, pcf	69.1	65.6	70.0	
	Void Ratio	1.44	1.57	1.41	
TEST SUMMARY	Deformation at Peak, %	10.08	10.42	10.55	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.6	2.6	
	Peak Shear Stress, ksf	0.66	1.26	2.18	
	Min. Post-Peak Stress, ksf	0.66	1.26	2.18	
REMARKS	Test Method: ASTM D3080				

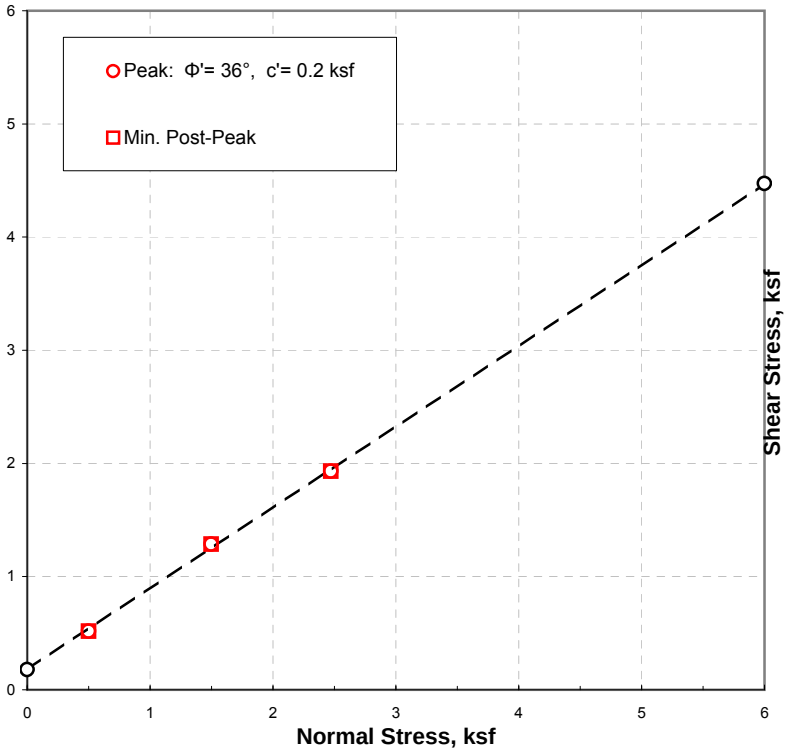
CLASSIFICATION

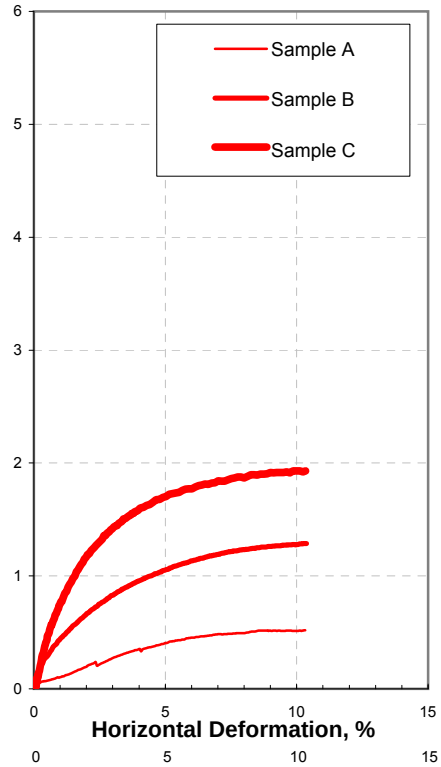
Sieve Size	% Passing
3/8-in. (9.5mm)	---
No. 4 (4.75mm)	---
No. 10 (2.0mm)	---
No. 30 (0.6mm)	---
No. 100 (0.150mm)	---
No. 200 (0.075mm)	---

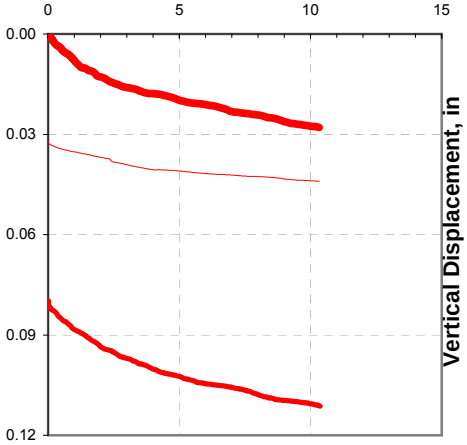
Atterberg Limits	
Liquid Limit, %	31
Plastic Limit, %	30
Plasticity Index, %	1
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	9.3×10^{-6}

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5b







SAMPLE ID

Boring Number:	H73LL
Sample Number:	T-2
Sample Depth:	17.0 ft
USCS Classification:	Silty SAND (SM): dark gray, wet, w/decaying leaves, roots, & wood fragments

	Sample No.	A	B	C	D
INITIAL	Water Content, %	31.7%	31.7%	31.7%	
	Dry Unit Weight, pcf	76.2	73.5	77.0	
	Saturation, %	72%	67%	73%	
	Void Ratio	1.17	1.25	1.15	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	48.7%	52.1%	44.2%	
	Dry Unit Weight, pcf	70.7	69.2	77.8	
	Void Ratio	1.34	1.39	1.13	
TEST SUMMARY	Deformation at Peak, %	10.30	10.37	10.33	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.52	1.29	1.93	
	Min. Post-Peak Stress, ksf	0.52	1.29	1.93	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

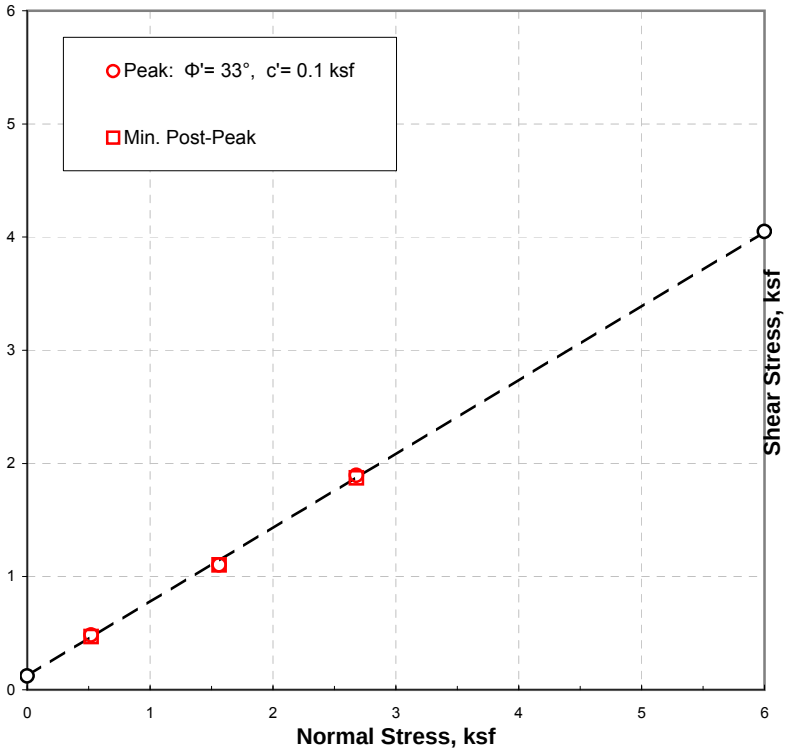
Sieve Size	% Passing
3/8-in. (9.5mm)	100
No. 4 (4.75mm)	100
No. 10 (2.0mm)	99
No. 30 (0.6mm)	97
No. 100 (0.150mm)	41
No. 200 (0.075mm)	24.8

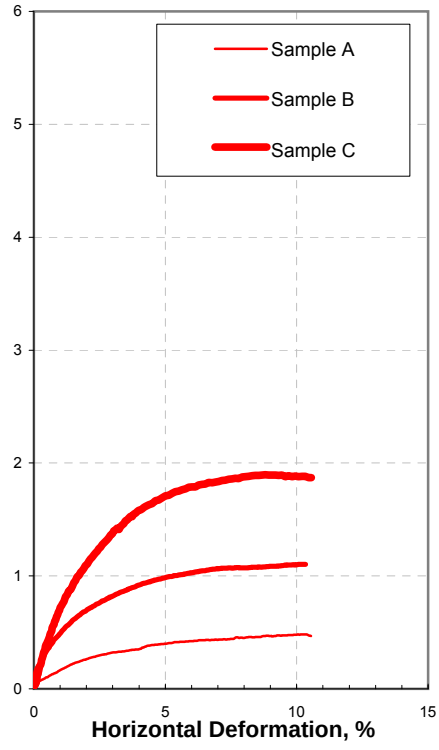
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.65
k_{avg} 20°C, $^{cm}/_{sec}$	9.2×10^{-4}

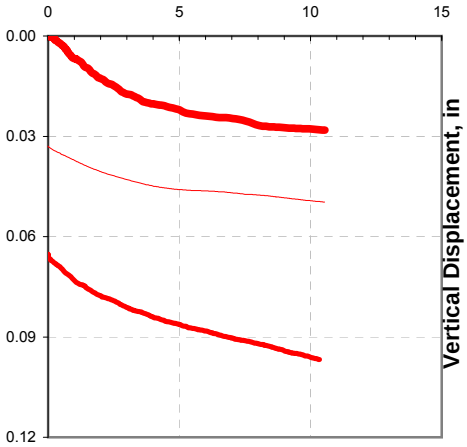
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5c







SAMPLE ID

Boring Number:	H132LO
Sample Number:	R-1
Sample Depth:	10.0 ft
USCS Classification:	Silty SAND (SM): olive gray, moist

	Sample No.	A	B	C	D
INITIAL	Water Content, %	12.5%	12.5%	12.5%	
	Dry Unit Weight, pcf	91.8	94.6	85.4	
	Saturation, %	41%	44%	35%	
	Void Ratio	0.80	0.75	0.94	
	Diameter, in	2.37	2.37	2.37	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	30.9%	28.4%	29.4%	
	Dry Unit Weight, pcf	92.3	95.8	96.6	
	Void Ratio	0.79	0.73	0.71	
TEST SUMMARY	Deformation at Peak, %	10.19	10.22	8.81	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.6	2.7	
	Peak Shear Stress, ksf	0.48	1.10	1.90	
	Min. Post-Peak Stress, ksf	0.47	1.10	1.87	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

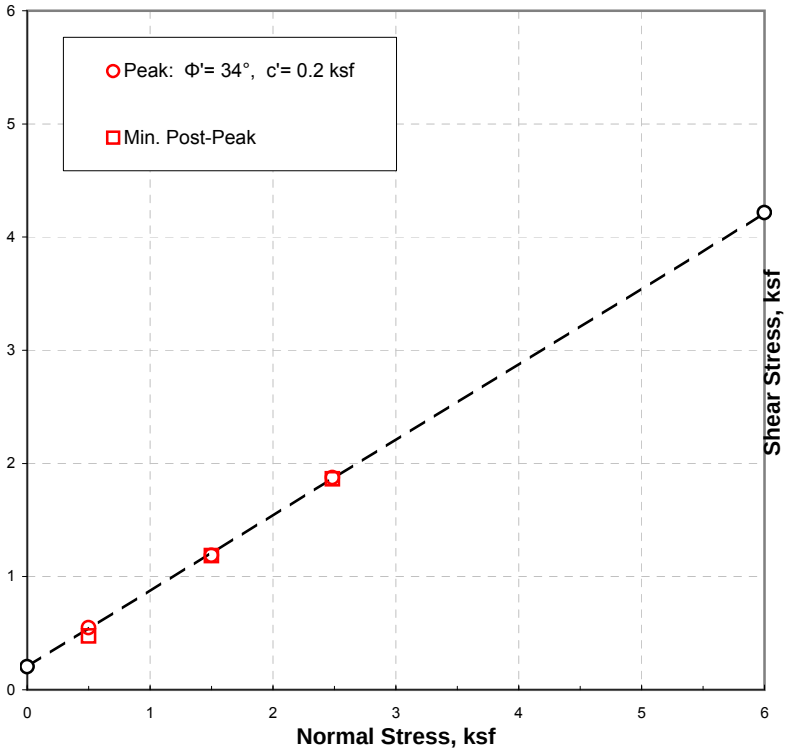
Sieve Size	% Passing
3/8-in. (9.5mm)	100
No. 4 (4.75mm)	100
No. 10 (2.0mm)	100
No. 30 (0.6mm)	100
No. 100 (0.150mm)	73
No. 200 (0.075mm)	34.0

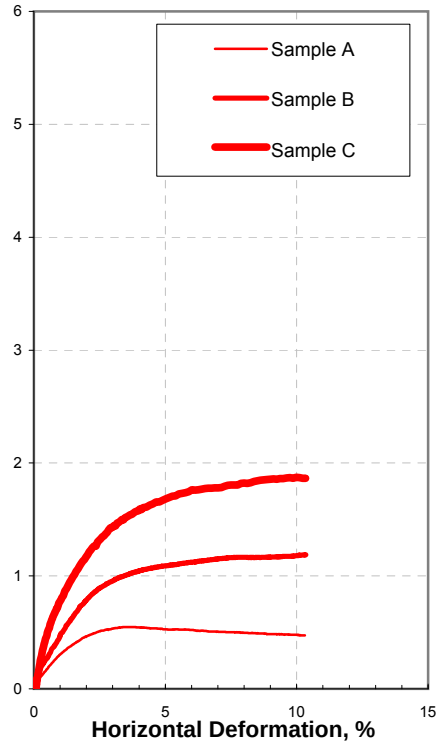
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.65
k_{avg} 20°C, cm/sec	1.3×10^{-3}

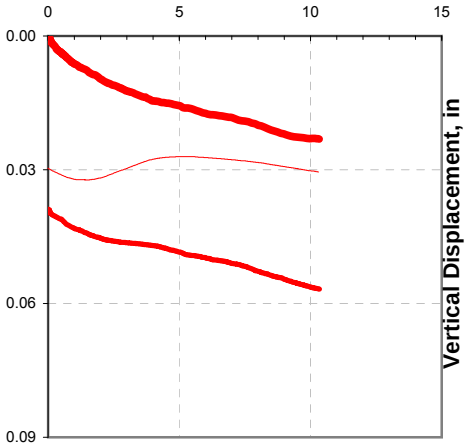
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5d







SAMPLE ID	Boring Number:	H146LL			
	Sample Number:	T-1			
	Sample Depth:	10.0 ft			
	USCS Classification:	SILT (ML): very dark gray, moist, with rootlets			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	34.3%	34.3%	34.3%	
	Dry Unit Weight, pcf	83.6	81.0	83.3	
	Saturation, %	91%	86%	91%	
	Void Ratio	1.01	1.08	1.02	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	33.0%	32.0%	31.3%	
	Dry Unit Weight, pcf	87.4	87.1	89.1	
	Void Ratio	0.93	0.93	0.89	
TEST SUMMARY	Deformation at Peak, %	3.63	10.30	9.98	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.55	1.19	1.87	
	Min. Post-Peak Stress, ksf	0.47	1.19	1.86	
REMARKS	Test Method: ASTM D3080				

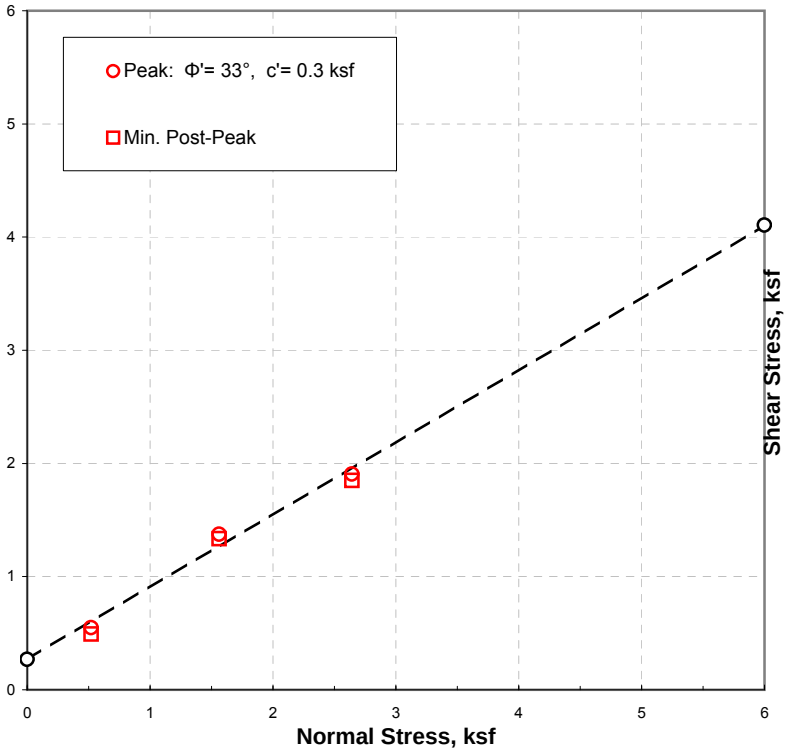
CLASSIFICATION

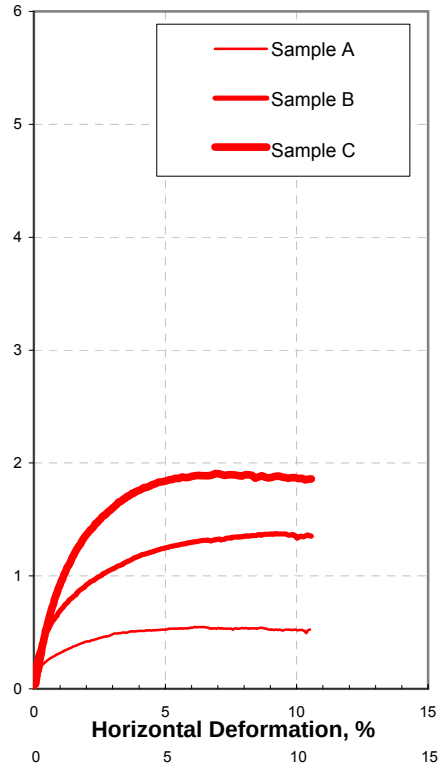
Sieve Size	% Passing
3/8-in. (9.5mm)	---
No. 4 (4.75mm)	---
No. 16 (1.18mm)	---
No. 30 (0.6mm)	---
No. 100 (0.150mm)	---
No. 200 (0.075mm)	---

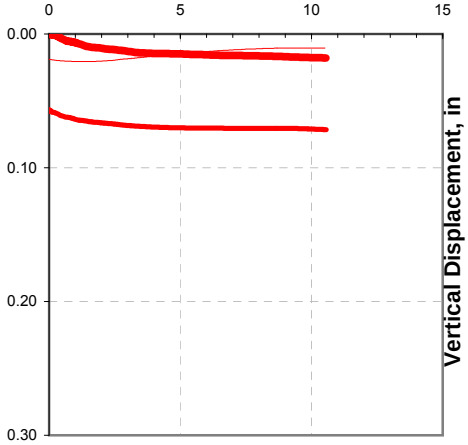
Atterberg Limits	
Liquid Limit, %	34
Plastic Limit, %	27
Plasticity Index, %	7
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	---

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5e







SAMPLE ID	Boring Number:	H146LO			
	Sample Number:	R-1			
	Sample Depth:	10.0 ft			
	USCS Classification:	Poorly-graded SAND with silt (SP-SM): gray, moist			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	4.6%	4.6%	4.6%	
	Dry Unit Weight, pcf	104.2	101.0	96.4	
	Saturation, %	22%	20%	18%	
	Void Ratio	0.56	0.61	0.68	
	Diameter, in	2.37	2.37	2.37	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	22.1%	22.3%	23.8%	
	Dry Unit Weight, pcf	101.1	102.8	95.6	
	Void Ratio	0.61	0.58	0.70	
TEST SUMMARY	Deformation at Peak, %	6.30	9.23	6.91	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.6	2.6	
	Peak Shear Stress, ksf	0.55	1.37	1.91	
	Min. Post-Peak Stress, ksf	0.49	1.34	1.85	
REMARKS	Test Method: ASTM D3080				

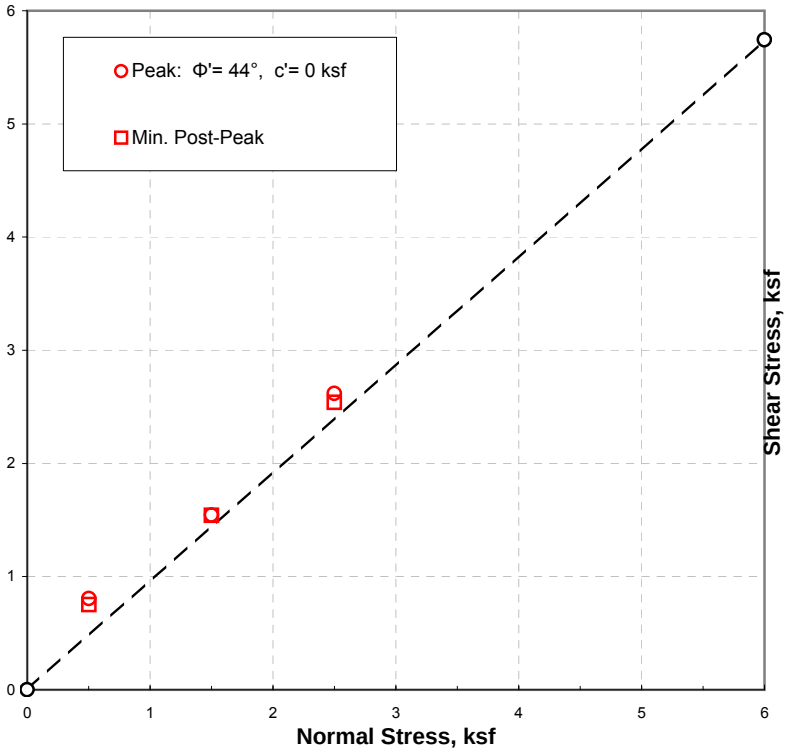
CLASSIFICATION

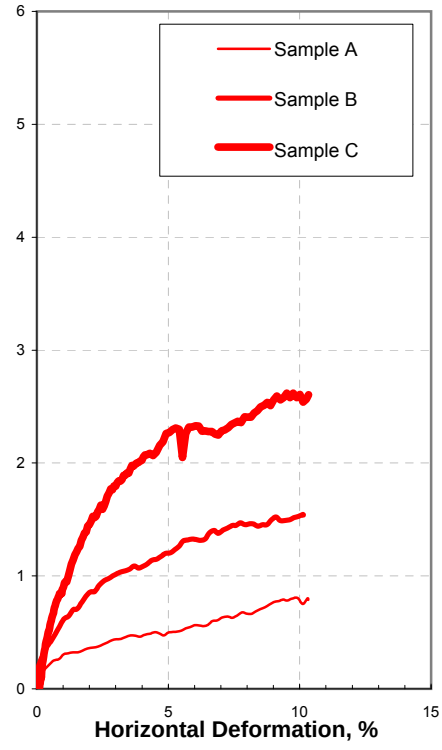
Sieve Size	% Passing
3/8-in. (9.5mm)	100
No. 4 (4.75mm)	97
No. 10 (2.0mm)	92
No. 30 (0.6mm)	71
No. 100 (0.150mm)	11
No. 200 (0.075mm)	7.5

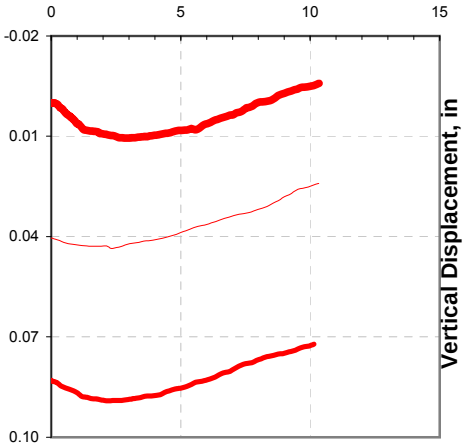
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.6
k_{avg} 20°C, cm/sec	6.4×10^{-3}

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5f







SAMPLE ID	Boring Number:	H158RO			
	Sample Number:	R-2			
	Sample Depth:	15.0 ft			
	USCS Classification:	Well-graded GRAVEL with sand (GW): dark gray, moist, very loose			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	3.2%	3.2%	3.2%	
	Dry Unit Weight, pcf	96.6	93.7	96.7	
	Saturation, %	12%	11%	12%	
	Void Ratio	0.68	0.73	0.68	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	14.1%	16.7%	13.7%	
	Dry Unit Weight, pcf	93.4	96.7	92.9	
	Void Ratio	0.74	0.68	0.75	
TEST SUMMARY	Deformation at Peak, %	9.92	10.12	9.51	
	Displacement Rate, in/min	0.004	0.004	0.004	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.80	1.54	2.62	
	Min. Post-Peak Stress, ksf	0.75	1.54	2.54	
REMARKS	Test Method: ASTM D3080				

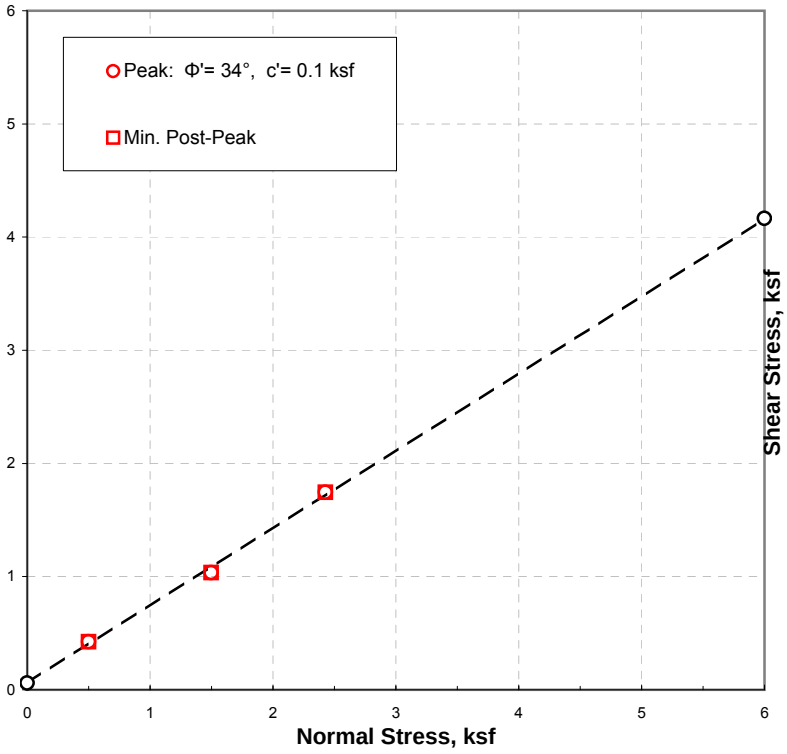
CLASSIFICATION

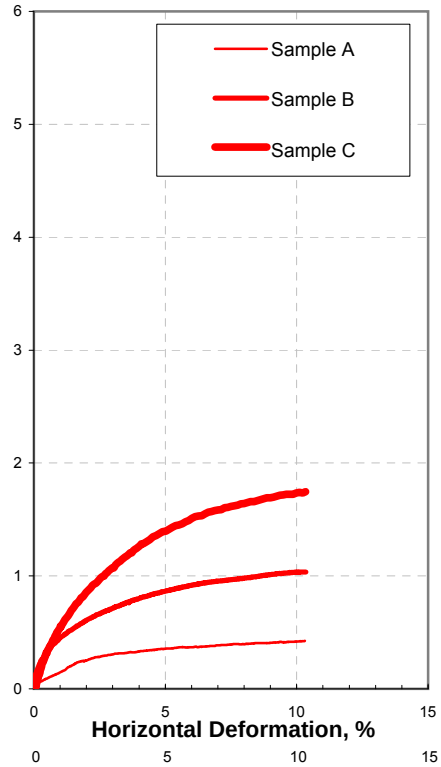
Sieve Size	% Passing
3/8-in. (9.5mm)	55.5
No. 4 (4.75mm)	38.4
No. 16 (1.18mm)	16.6
No. 30 (0.6mm)	9.9
No. 100 (0.150mm)	4.8
No. 200 (0.075mm)	3.8

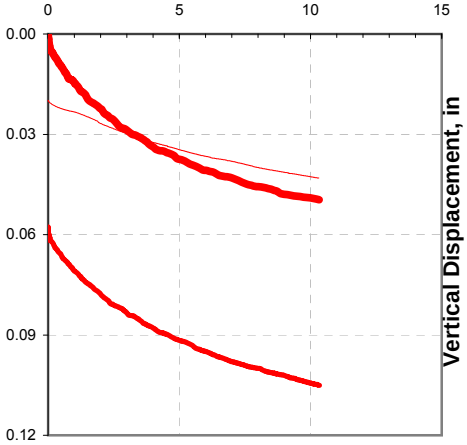
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.6
k_{avg} 20°C, cm/sec	---

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5g







SAMPLE ID

Boring Number:	H171LL
Sample Number:	T-1
Sample Depth:	5.0 ft
USCS Classification:	SILT (ML): olive gray, moist, clayey

	Sample No.	A	B	C	D
INITIAL	Water Content, %	30.9%	30.9%	30.9%	
	Dry Unit Weight, pcf	77.7	80.2	79.9	
	Saturation, %	71%	76%	75%	
	Void Ratio	1.17	1.10	1.11	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	37.8%	35.3%	32.8%	
	Dry Unit Weight, pcf	81.1	86.2	88.3	
	Void Ratio	1.08	0.96	0.91	
TEST SUMMARY	Deformation at Peak, %	10.31	10.27	10.33	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.4	
	Peak Shear Stress, ksf	0.43	1.04	1.75	
	Min. Post-Peak Stress, ksf	0.43	1.03	1.75	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

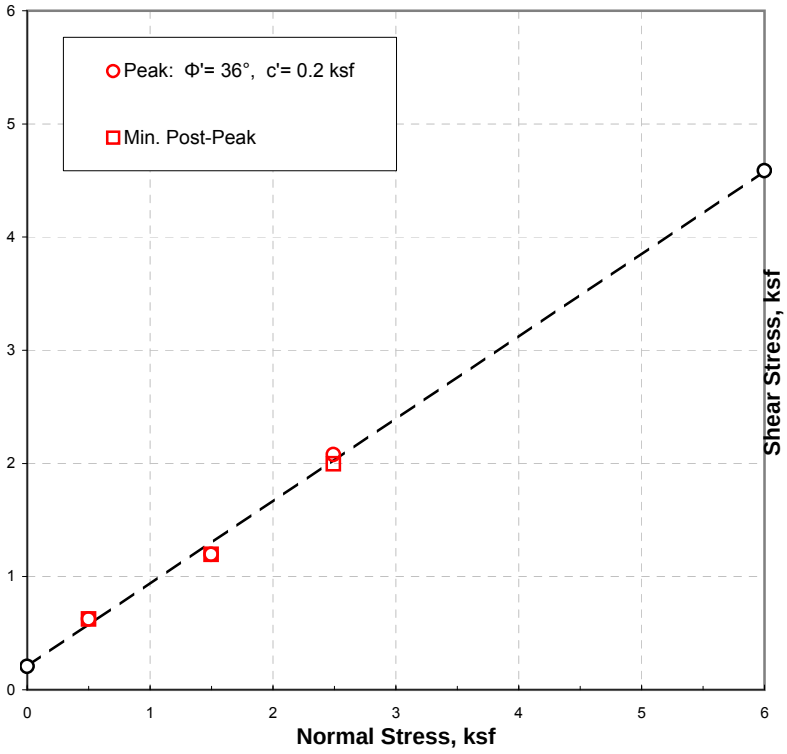
Sieve Size	% Passing
3/8-in. (9.5mm)	---
No. 4 (4.75mm)	---
No. 10 (2.0mm)	---
No. 30 (0.6mm)	---
No. 100 (0.150mm)	---
No. 200 (0.075mm)	---

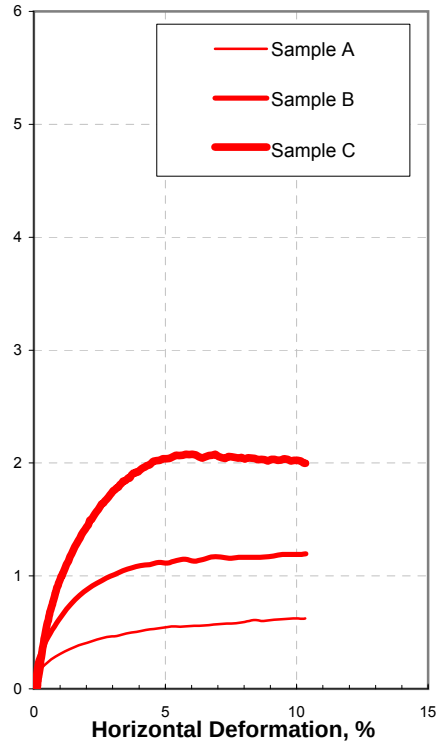
Atterberg Limits	
Liquid Limit, %	33
Plastic Limit, %	26
Plasticity Index, %	7
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	8.3×10^{-4}

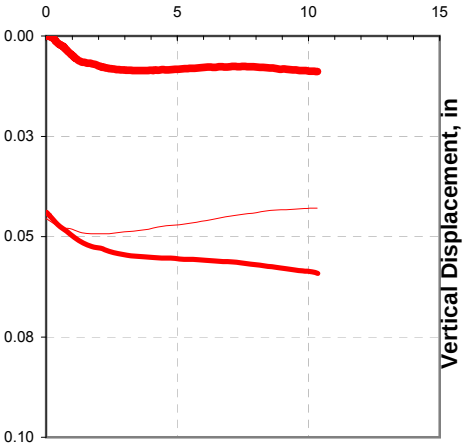
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5h







SAMPLE ID	Boring Number:	H171LW			
	Sample Number:	T-1			
	Sample Depth:	15.0 ft			
	USCS Classification:	Poorly-graded SAND with silt (SP-SM): dark gray, moist			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	9.7%	9.7%	9.7%	
	Dry Unit Weight, pcf	100.6	97.3	105.1	
	Saturation, %	41%	38%	46%	
	Void Ratio	0.61	0.67	0.54	
	Diameter, in	2.42	2.42	2.42	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	21.1%	19.7%	17.6%	
	Dry Unit Weight, pcf	95.1	97.5	99.6	
	Void Ratio	0.71	0.66	0.63	
TEST SUMMARY	Deformation at Peak, %	10.33	10.35	6.03	
	Displacement Rate, in/min	0.008	0.008	0.008	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.62	1.19	2.08	
	Min. Post-Peak Stress, ksf	0.62	1.19	2.00	
REMARKS	Test Method: ASTM D3080				

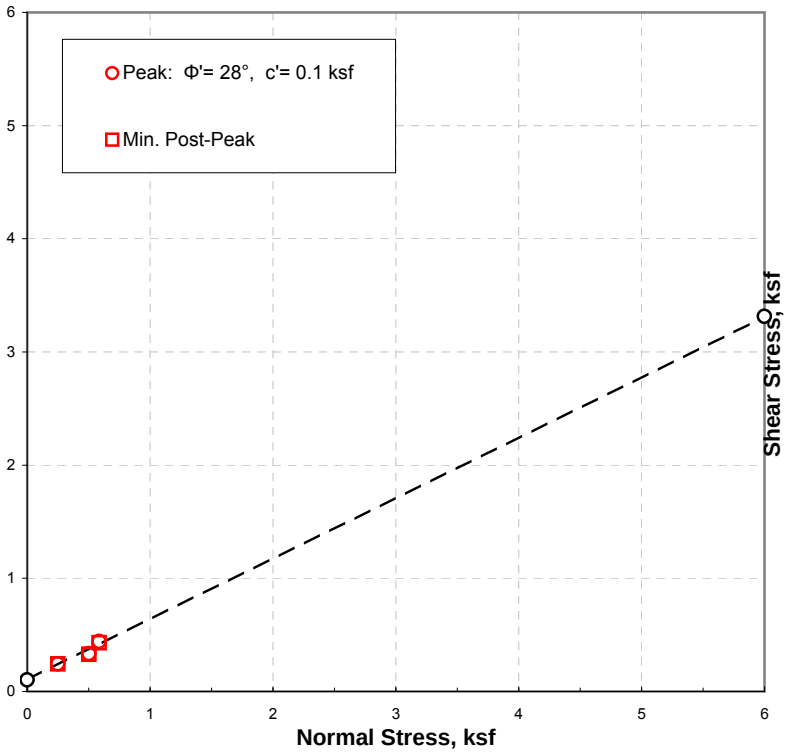
CLASSIFICATION

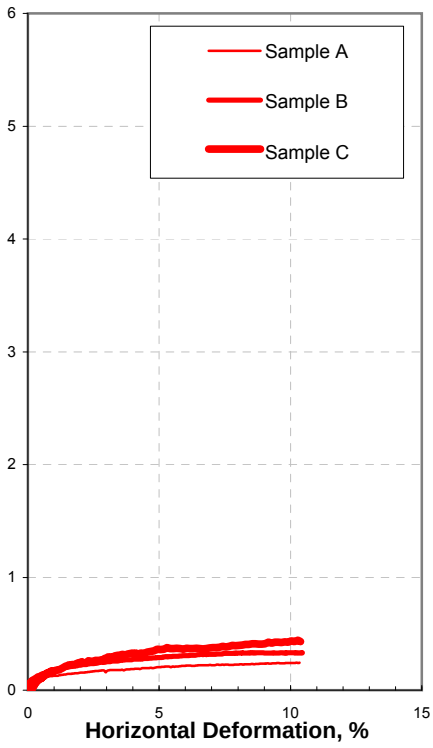
Sieve Size	% Passing
3/8-in. (9.5mm)	97.1
No. 4 (4.75mm)	91.9
No. 16 (1.18mm)	75.1
No. 30 (0.6mm)	44.9
No. 100 (0.150mm)	7.3
No. 200 (0.075mm)	5.2

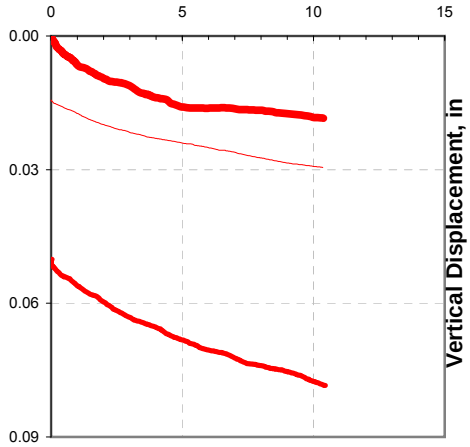
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.6
k_{avg} 20°C, cm/sec	7.7×10^{-3}

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5i







SAMPLE ID	Boring Number:	S73LC			
	Sample Number:	---			
	Sample Depth:	3.0 ft			
	USCS Classification:	Silty SAND with gravel (SM): dark olive gray, moist			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	7.7%	7.7%	7.7%	
	Dry Unit Weight, pcf	109.8	109.8	109.9	
	Saturation, %	39%	39%	39%	
	Void Ratio	0.53	0.53	0.53	
	Diameter, in	2.41	2.41	2.41	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	18.3%	18.3%	17.7%	
	Dry Unit Weight, pcf	107.5	111.8	107.3	
	Void Ratio	0.57	0.51	0.57	
TEST SUMMARY	Deformation at Peak, %	10.23	8.74	10.28	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.3	0.5	0.6	
	Peak Shear Stress, ksf	0.24	0.33	0.44	
	Min. Post-Peak Stress, ksf	0.24	0.33	0.43	
REMARKS	Test Method: ASTM D3080				

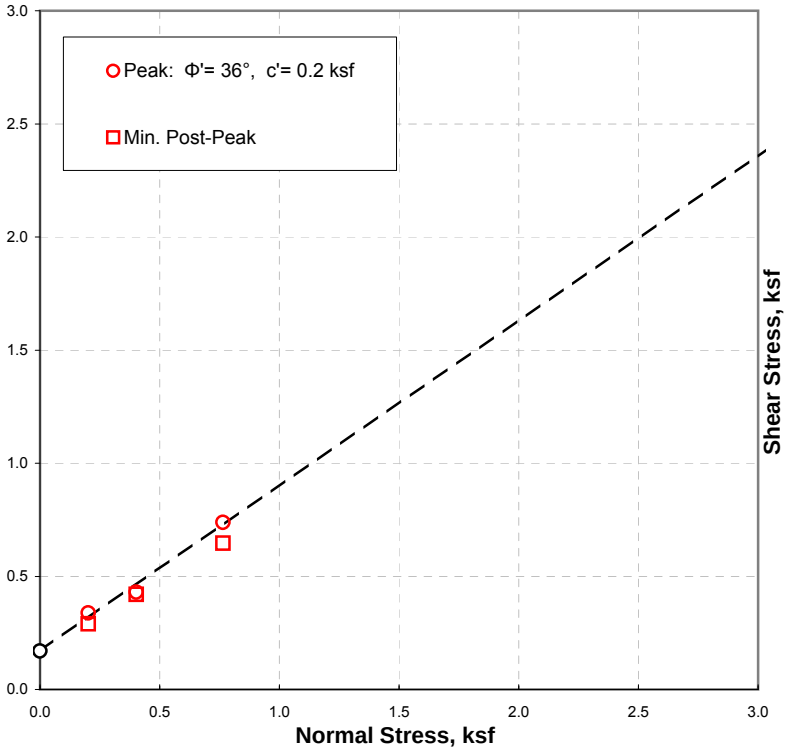
CLASSIFICATION

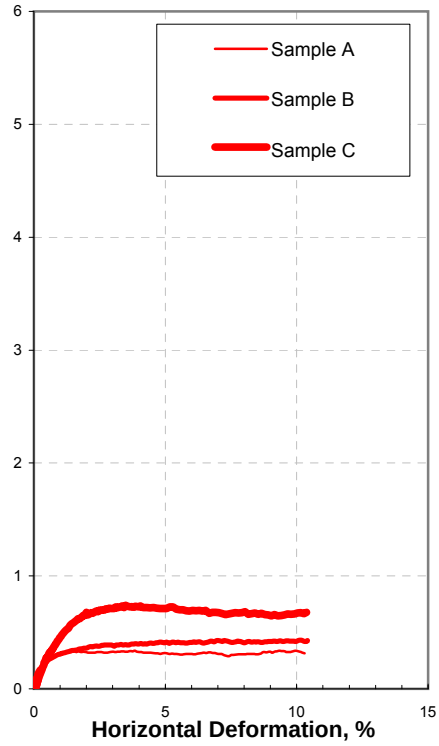
Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

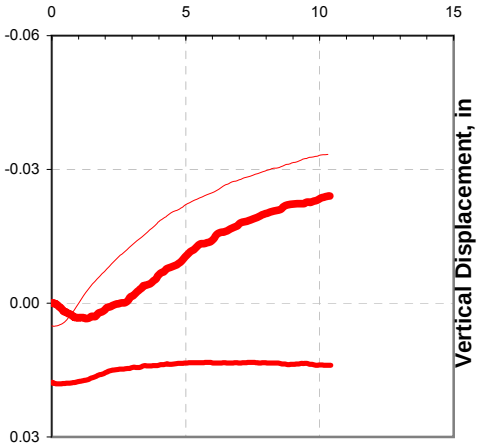
Atterberg Limits	
Liquid Limit, %	21
Plastic Limit, %	18
Plasticity Index, %	3
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	1.6×10^{-4}

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5j







SAMPLE ID

Boring Number:	S98LC
Sample Number:	---
Sample Depth:	1.0 ft
USCS Classification:	Well-graded SAND with silt and gravel (SW-SM): dark olive gray, moist

	Sample No.	A	B	C	D
INITIAL	Water Content, %	3.2%	3.2%	3.2%	
	Dry Unit Weight, pcf	124.6	124.5	124.5	
	Saturation, %	25%	24%	24%	
	Void Ratio	0.35	0.35	0.35	
	Diameter, in	2.41	2.41	2.41	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	12.0%	11.7%	11.9%	
	Dry Unit Weight, pcf	116.7	121.2	120.1	
	Void Ratio	0.44	0.39	0.40	
TEST SUMMARY	Deformation at Peak, %	3.84	10.15	3.49	
	Displacement Rate, in/min	0.002	0.002	0.002	
	Normal Stress, ksf	0.2	0.4	0.8	
	Peak Shear Stress, ksf	0.34	0.43	0.74	
	Min. Post-Peak Stress, ksf	0.29	0.42	0.65	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

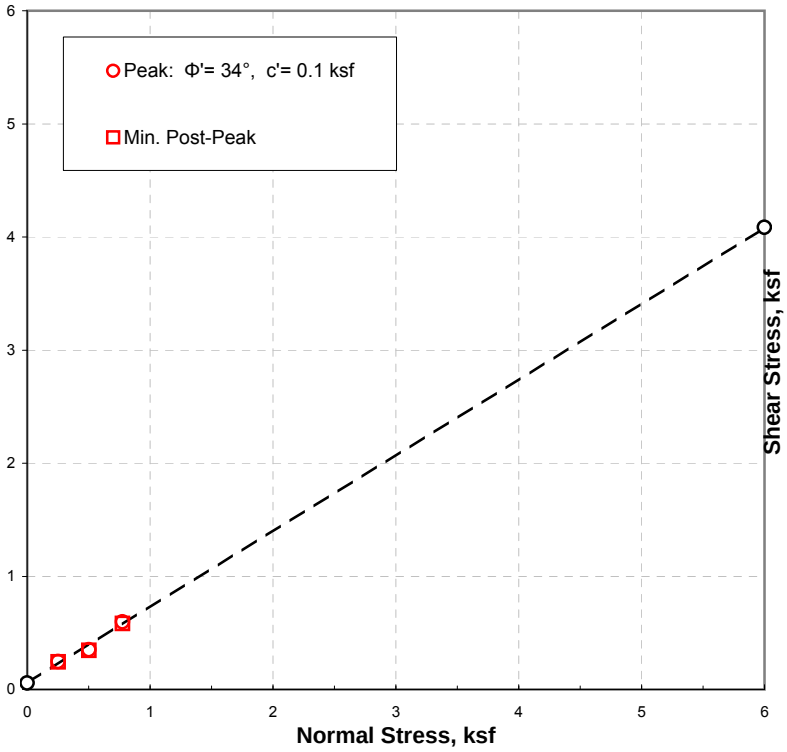
Sieve Size	% Passing
3/8-in. (9.5mm)	76.3
#4 (4.75mm)	60.4
#16 (1.18mm)	33.9
#30 (0.6mm)	24.6
#100 (0.150mm)	12.5
#200 (0.075mm)	10

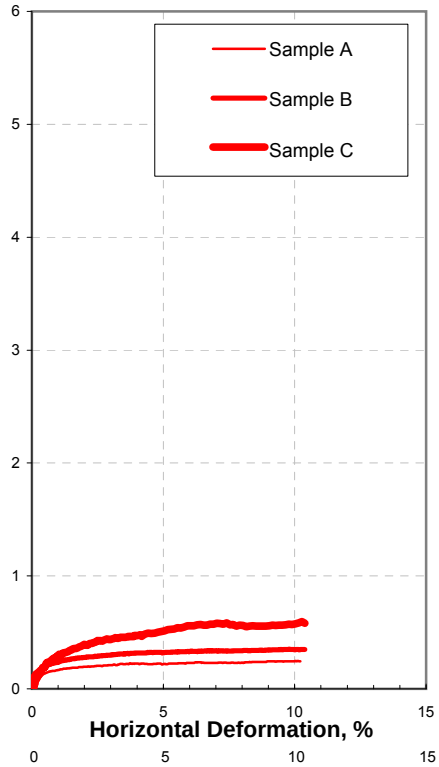
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.7

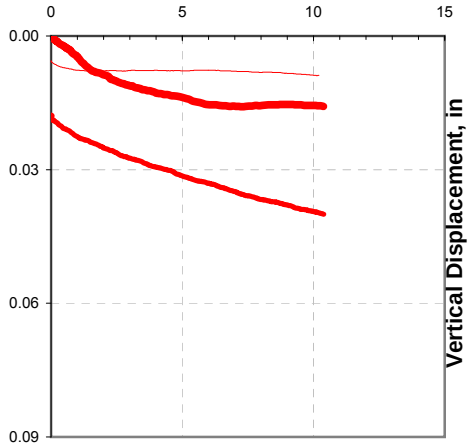
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5k







SAMPLE ID	Boring Number:	S146LC			
	Sample Number:	---			
	Sample Depth:	4.0 ft			
	USCS Classification:	Sandy lean CLAY with gravel (CL): dark olive gray, moist			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	8.2%	8.2%	8.2%	
	Dry Unit Weight, pcf	109.7	109.6	109.7	
	Saturation, %	41%	41%	41%	
	Void Ratio	0.54	0.54	0.54	
	Diameter, in	2.41	2.41	2.41	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	19.7%	19.1%	18.6%	
	Dry Unit Weight, pcf	108.8	109.3	108.3	
	Void Ratio	0.55	0.54	0.55	
TEST SUMMARY	Deformation at Peak, %	10.03	9.78	10.27	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.3	0.5	0.8	
	Peak Shear Stress, ksf	0.25	0.35	0.60	
	Min. Post-Peak Stress, ksf	0.24	0.35	0.58	
REMARKS	Test Method: ASTM D3080				

CLASSIFICATION

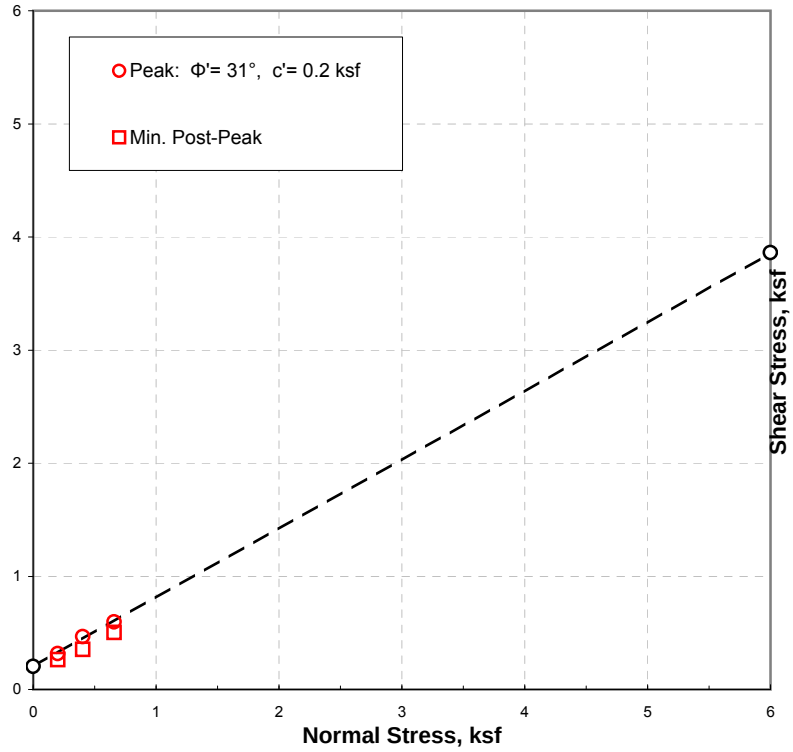
Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

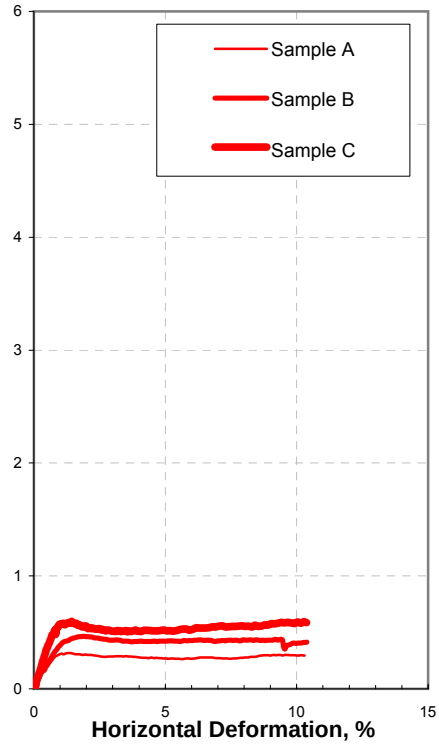
Atterberg Limits	
Liquid Limit, %	27
Plastic Limit, %	19
Plasticity Index, %	8
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	$2.8X10^{-5}$

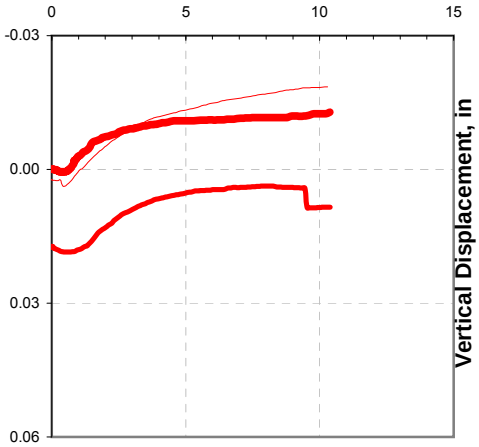
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5l







SAMPLE ID

Boring Number:	S158LC
Sample Number:	---
Sample Depth:	1.0 ft
USCS Classification:	Silty SAND with gravel (SM): dark olive gray, moist

	Sample No.	A	B	C	D
INITIAL	Water Content, %	5.2%	5.2%	5.2%	
	Dry Unit Weight, pcf	124.7	124.8	124.5	
	Saturation, %	40%	40%	40%	
	Void Ratio	0.35	0.35	0.35	
	Diameter, in	2.41	2.41	2.41	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	11.9%	11.5%	11.0%	
	Dry Unit Weight, pcf	119.9	121.1	120.5	
	Void Ratio	0.41	0.39	0.40	
TEST SUMMARY	Deformation at Peak, %	1.30	1.90	1.44	
	Displacement Rate, in/min	0.002	0.002	0.002	
	Normal Stress, ksf	0.2	0.4	0.7	
	Peak Shear Stress, ksf	0.32	0.47	0.60	
	Min. Post-Peak Stress, ksf	0.26	0.35	0.50	

REMARKS

Test Method: ASTM D3080

CLASSIFICATION

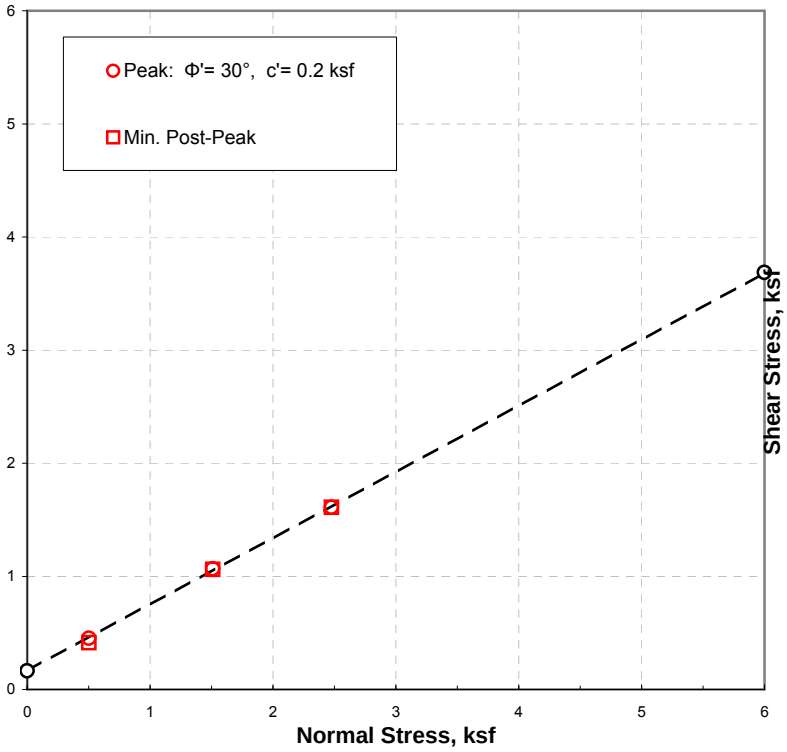
Sieve Size	% Passing
3/8-in. (9.5mm)	79.9
#4 (4.75mm)	64.9
#16 (1.18mm)	39.3
#30 (0.6mm)	30.4
#100 (0.150mm)	19.6
#200 (0.075mm)	16.4

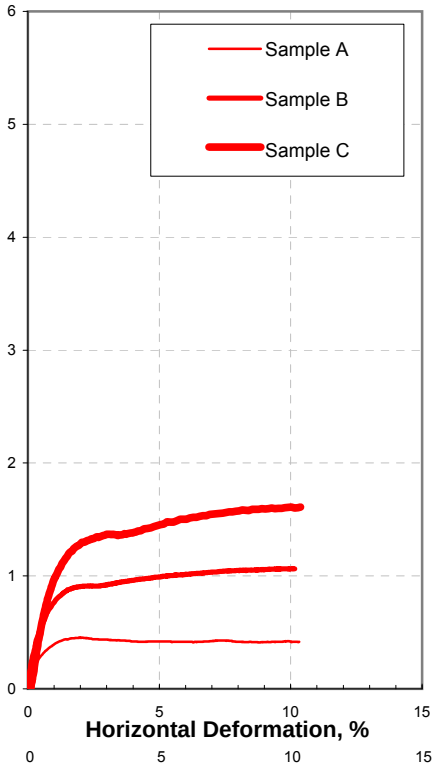
Atterberg Limits	
Liquid Limit, %	---
Plastic Limit, %	---
Plasticity Index, %	---
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	1.3×10^{-3}

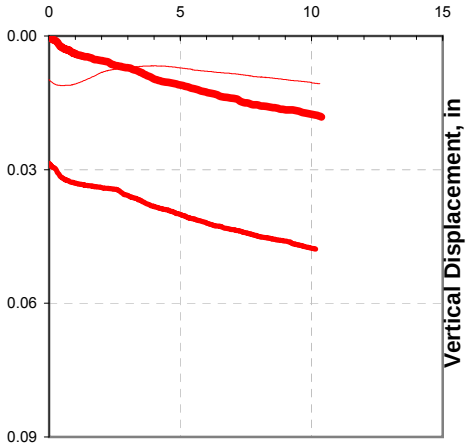
DIRECT SHEAR TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5m







SAMPLE ID	Boring Number:	S185LC			
	Sample Number:	---			
	Sample Depth:	8.0 ft			
	USCS Classification:	Silty CLAY (CL-ML): dark olive gray, moist			
INITIAL	Sample No.	A	B	C	D
	Water Content, %	15.4%	15.4%	15.4%	
	Dry Unit Weight, pcf	109.8	109.8	109.8	
	Saturation, %	78%	78%	78%	
	Void Ratio	0.53	0.53	0.53	
	Diameter, in	2.41	2.41	2.41	
	Height, in	1.00	1.00	1.00	
FINAL	Water Content, %	21.6%	21.3%	20.5%	
	Dry Unit Weight, pcf	105.7	105.3	107.0	
	Void Ratio	0.59	0.60	0.57	
TEST SUMMARY	Deformation at Peak, %	1.97	10.08	10.37	
	Displacement Rate, in/min	0.001	0.001	0.001	
	Normal Stress, ksf	0.5	1.5	2.5	
	Peak Shear Stress, ksf	0.45	1.07	1.61	
	Min. Post-Peak Stress, ksf	0.41	1.06	1.61	
REMARKS	Test Method: ASTM D3080				

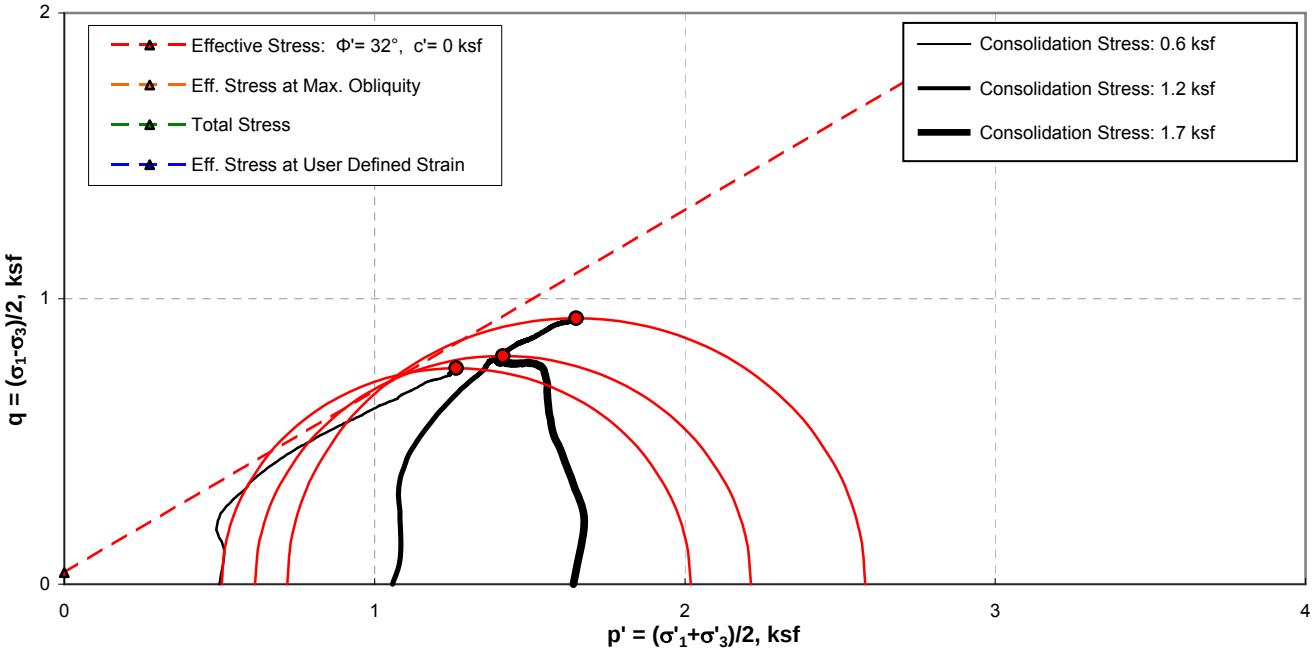
CLASSIFICATION

Sieve Size	% Passing
3/8-in. (9.5mm)	---
#4 (4.75mm)	---
#16 (1.18mm)	---
#30 (0.6mm)	---
#100 (0.150mm)	---
#200 (0.075mm)	---

Atterberg Limits	
Liquid Limit, %	26
Plastic Limit, %	21
Plasticity Index, %	5
Estimated Gs	2.7
k_{avg} 20°C, cm/sec	3.3×10^{-6}

DIRECT SHEAR TEST RESULTS
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-5n



SAMPLE ID

Boring Number.:	H132LO	H132LO	H132LO
Sample Number.:	T-1	T-1	T-1
Sample Depth:	5.0	5.0	5.0
USCS Classification:	Lean CLAY (CL): olive, moist, silty	Lean CLAY (CL): olive, moist, silty	Lean CLAY (CL): olive, moist, silty

INITIAL

Sample No.	A	B	C
Water Content, %	33.8%	33.8%	33.8%
Dry Unit Weight, pcf	83.0	85.1	82.0
Saturation, %	90%	92%	86%
Void Ratio	1.00	1.01	1.05
Diameter, in	2.84	2.83	2.83
Height, in	5.69	5.63	5.74

PRE-SHEAR

Water Content, %	38.7%	36.6%	37.8%
Dry Unit Weight, pcf	81.6	85.5	83.5
Saturation, %	100%	100%	100%
Void Ratio	1.03	1.00	1.02

REMARKS

Test Method: ASTM 4767

CLASSIFICATION

Sample No.	A	B	C
Liquid Limit	---	---	---
Plastic Limit	---	---	---
Plastic Index	---	---	---
Passing #4 (4.75 mm)	---	---	---
Passing #200 (0.075 mm)	---	---	---
Estimated Gs	2.66	2.74	2.70

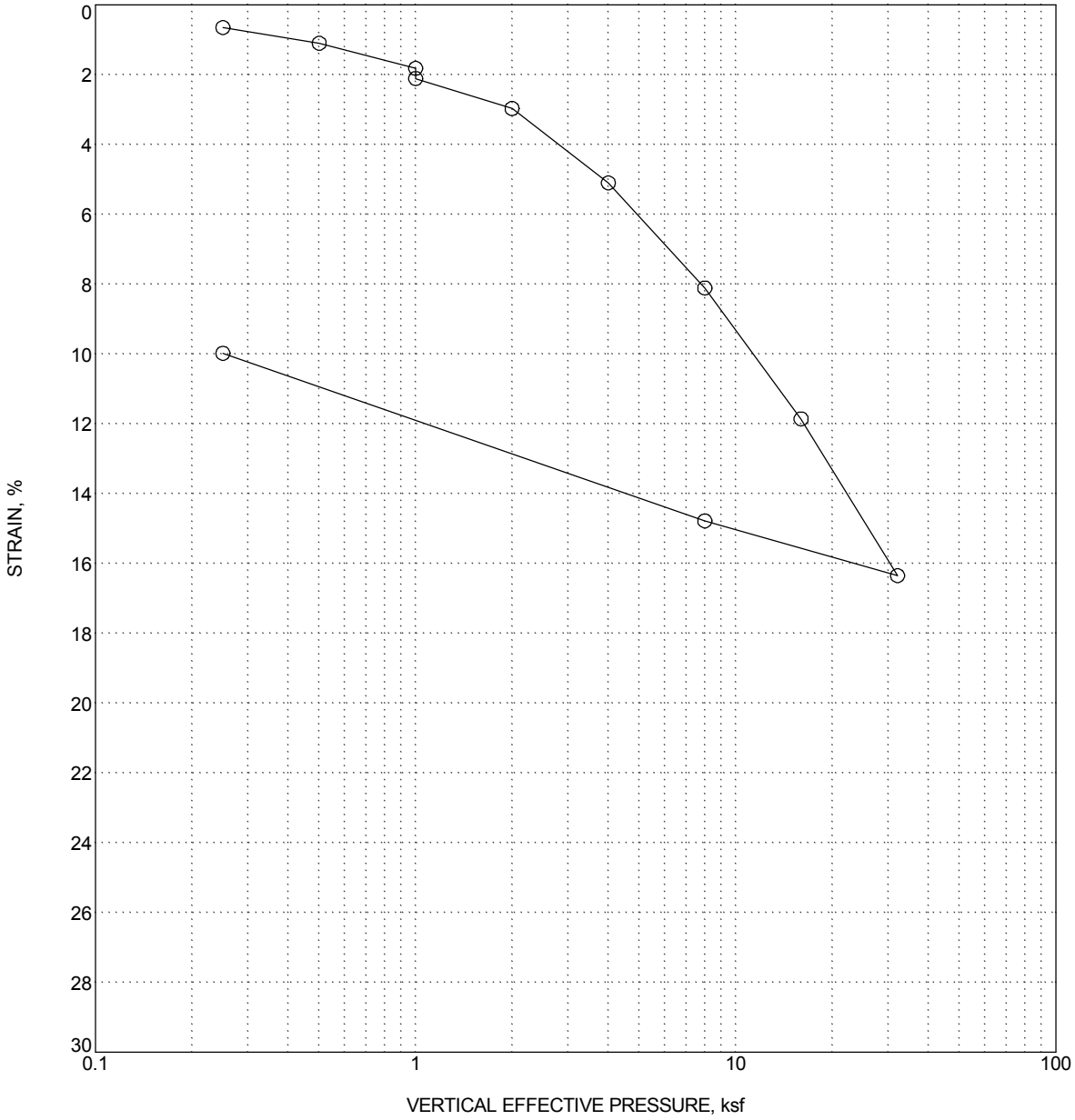
TEST SUMMARY

Sample No.	A	B	C
B-Parameter	0.98	0.99	1.00
t_{50}, minutes	N/A	N/A	0.1
Strain Rate, %/min	0.5	0.5	0.5
Cell Pressure, ksf	12.1	12.7	13.2
Back Pressure, ksf	11.5	11.5	11.5
Consolidation Stress, ksf	0.6	1.2	1.7
Deviator Stress @ Failure, ksf	1.5	1.8	1.6
Axial Strain @ Failure, %	14.9	15.0	13.3
σ'_{1F}, ksf	2.0	2.6	2.2
σ'_{3F}, ksf	0.5	0.7	0.6
Tested By:	JC	JC	JC
Date Tested:	10/18/10	10/18/10	10/18/10

ISOTROPICALLY CONSOLIDATED, UNDRAINED TRIAXIAL TEST WITH PORE WATER PRESSURE MEASUREMENTS

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE C-6

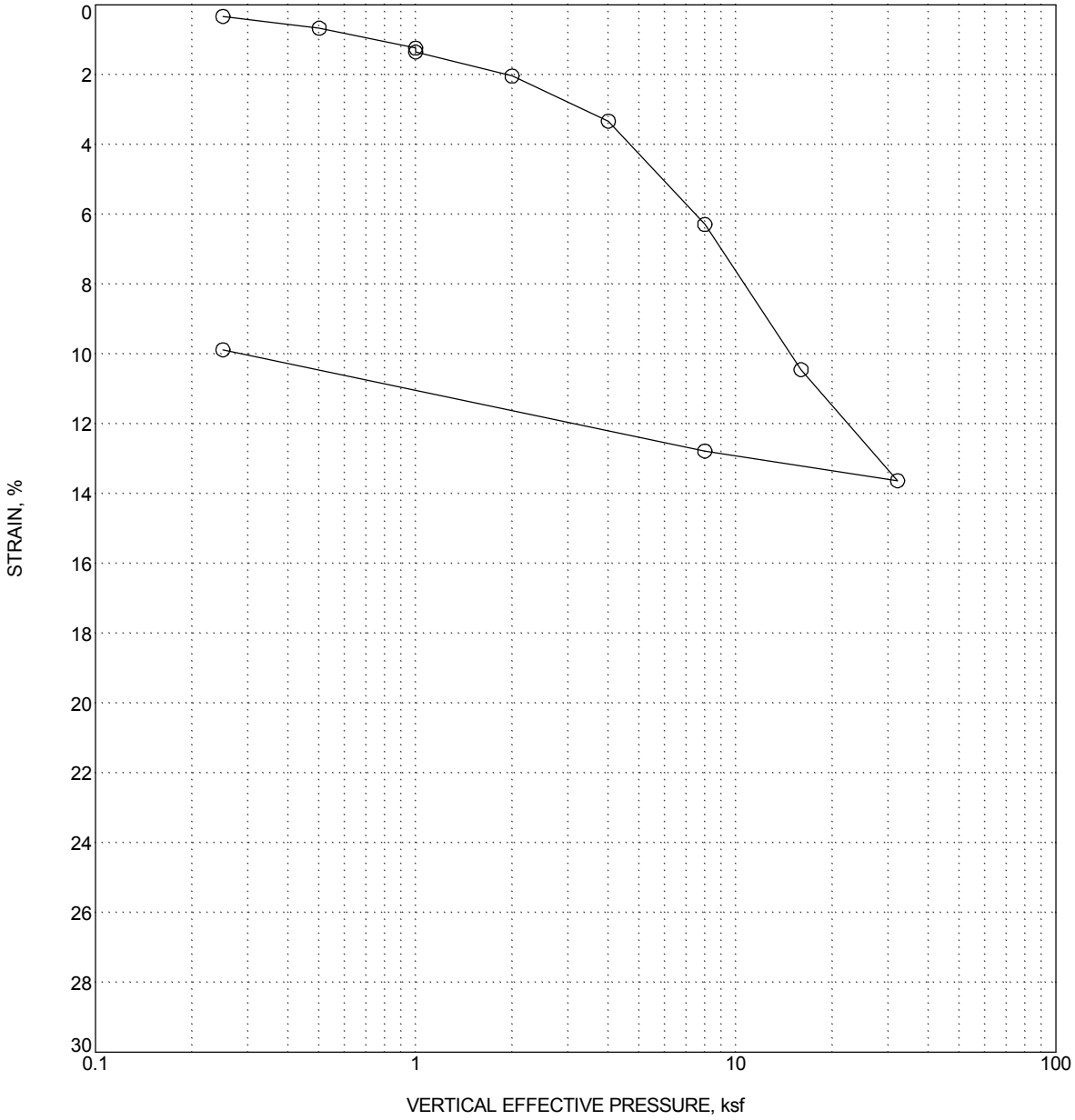


LOCATION	H057RO
DEPTH, ft	5
INITIAL MOISTURE CONTENT, %	31
UNIT DRY WEIGHT, pcf	93
MATERIAL DESCRIPTION	SILT (ML)
SAMPLE CONDITION	TWT

CONSOLIDATION TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-7a

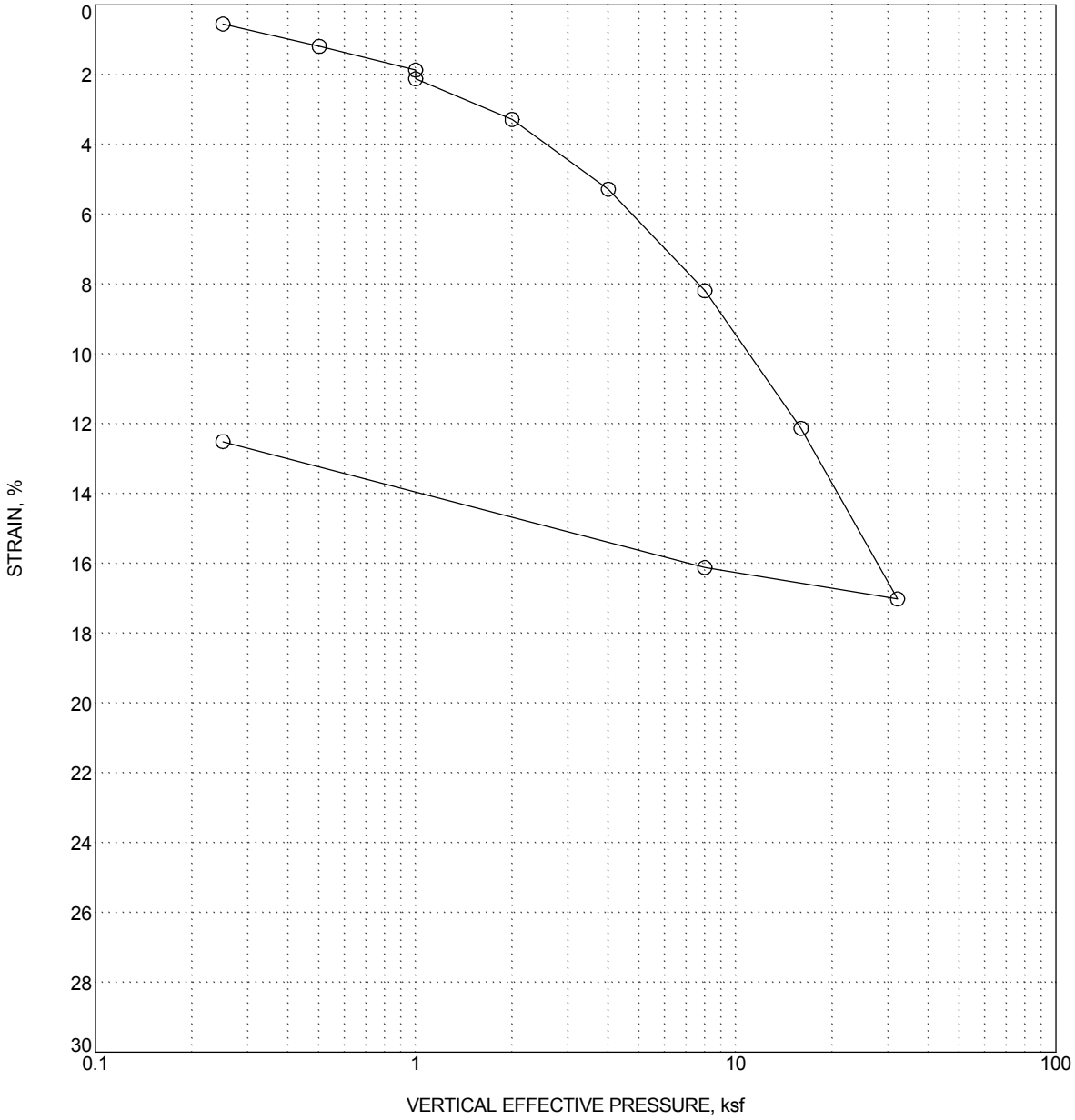


LOCATION	H132LO
DEPTH, ft	5
INITIAL MOISTURE CONTENT, %	33
UNIT DRY WEIGHT, pcf	86
MATERIAL DESCRIPTION	SILT (ML)
SAMPLE CONDITION	

CONSOLIDATION TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-7b



LOCATION	H158LO
DEPTH, ft	5
INITIAL MOISTURE CONTENT, %	58
UNIT DRY WEIGHT, pcf	75
MATERIAL DESCRIPTION	SILT (ML)
SAMPLE CONDITION	

CONSOLIDATION TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

PLATE C-7c

CGI Technical Services Inc.

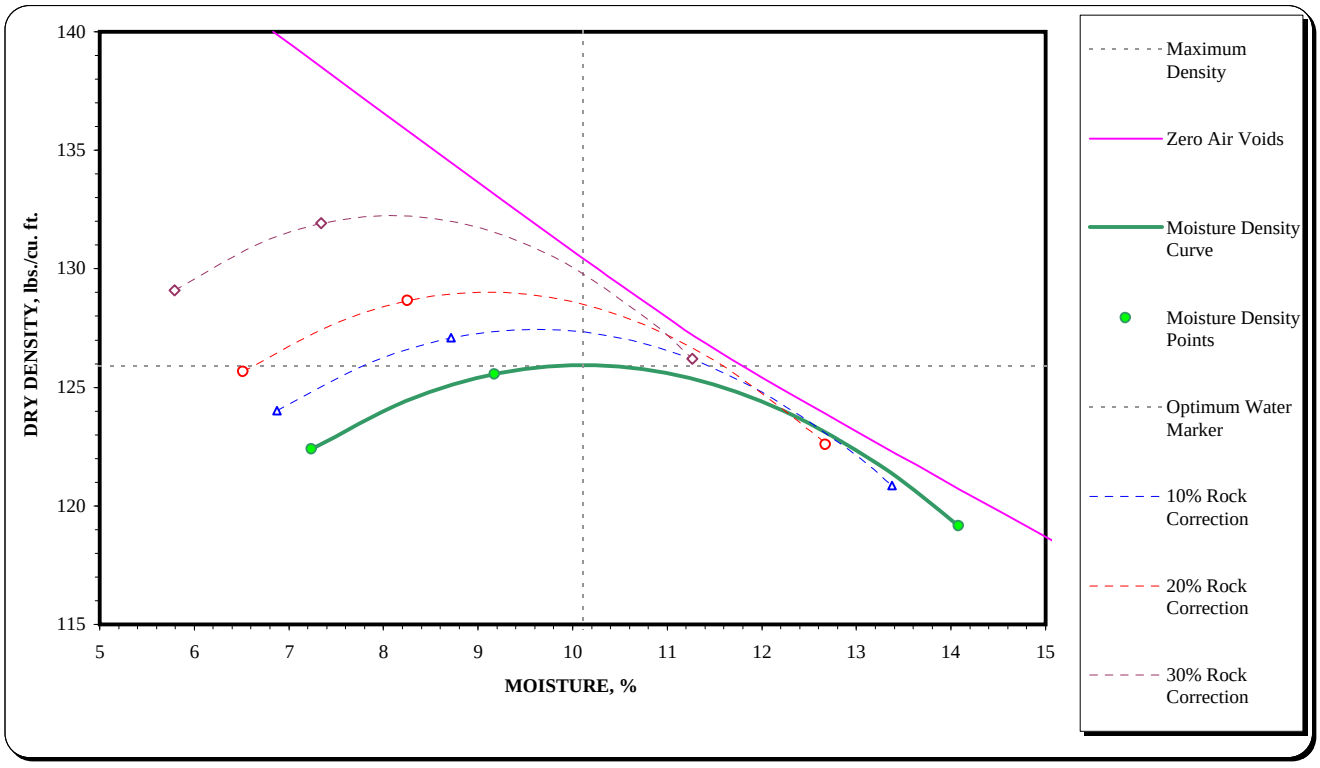
1612 Wedding Way
Redding, California 96003
530-244-6277
530-244-6276 FAX
www.CurryGroup.com

MOISTURE DENSITY RELATIONSHIP

Client:	Humboldt County Department of Public Works	**Job No.:**	10-1949.01
Project:	Redwood Creek Levee Geotechnical Evaluation Program	**Lab No.:**	4279
Location:	Orick, Humboldt County, California		
Material Type:	Native	**CURVE NO.:**	1
Sample Location:	H185LL @ 12' - 14'		
Material Description:	Dark gray sandy clay		
Material Supplier:	NA		
Sampled By:	WP	**Date Sampled:**	30-Sep-10
Received By:	JS	**Date Received:**	1-Oct-10
Tested By:	BW	**Date Tested:**	29-Oct-10
Reviewed By:	JAB	**Date Reviewed:**	29-Oct-10
Test Procedure:	ASTM	**Method:**	D-1557

Oversized Material (%), +3/4": 0%

Correction Required: [ ] YES [X] NO



SPECIMEN	A	B	C
DRY DENSITY	122.4	125.6	119.2
MOISTURE AT TEST, %	7.2	9.2	14.1

Maximum Dry Density, PCF 125.9 **@ Optimum Moisture, %** 10.1

COMPACTION TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

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CGI Technical Services Inc.

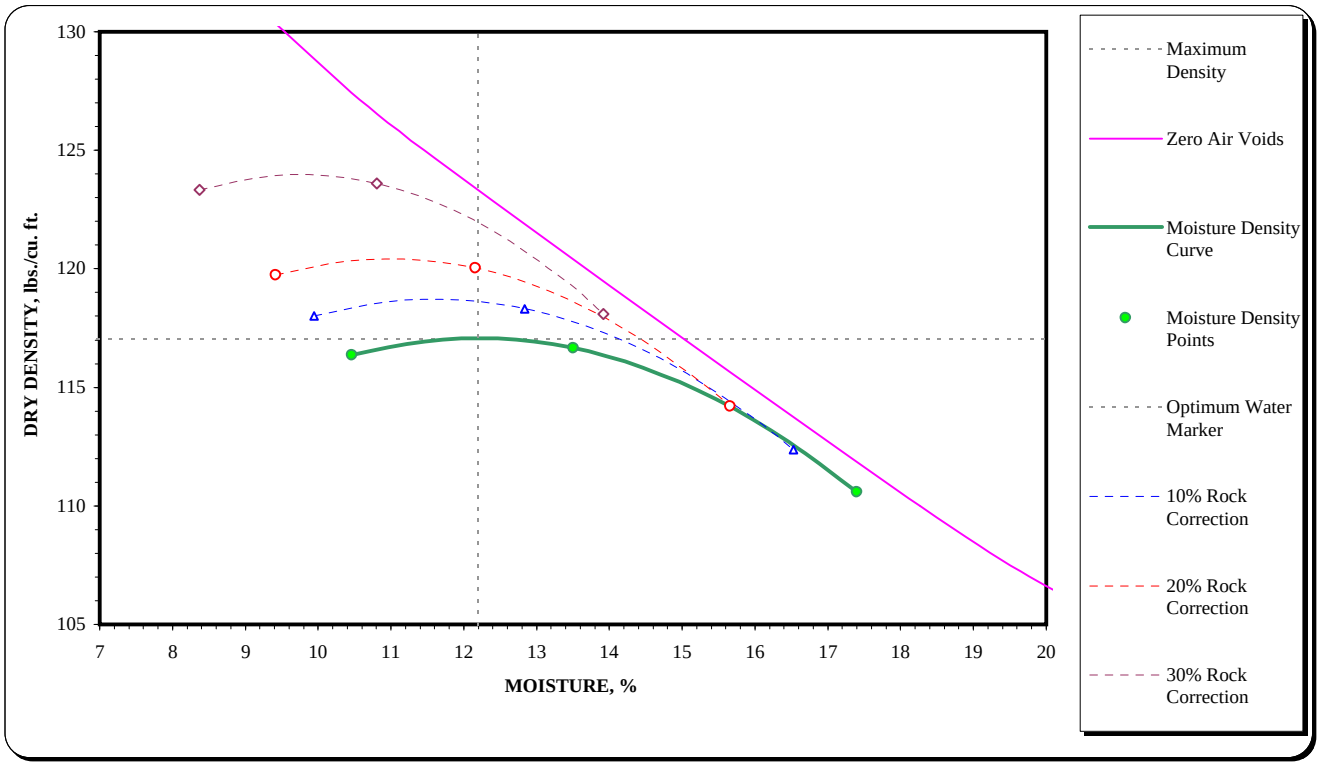
1612 Wedding Way
Redding, California 96003
530-244-6277
530-244-6276 FAX
www.CurryGroup.com

MOISTURE DENSITY RELATIONSHIP

Client:	Humboldt County Department of Public Works	**Job No.:**	10-1949.01
Project:	Redwood Creek Levee Geotechnical Evaluation Program	**Lab No.:**	4279
Location:	Orick, Humboldt County, California		
Material Type:	Native	**CURVE NO.:**	2
Sample Location:	H57RO @ 7'		
Material Description:	Dark gray sandy clay		
Material Supplier:	NA		
Sampled By:	WP	**Date Sampled:**	13-Oct-10
Received By:	JS	**Date Received:**	15-Oct-10
Tested By:	JS	**Date Tested:**	2-Dec-10
Reviewed By:	JAB	**Date Reviewed:**	2-Dec-10
Test Procedure:	ASTM	**Method:**	D-1557

Oversized Material (%), +3/4": 0%

Correction Required: [ ] YES [X] NO



SPECIMEN	A	B	C
DRY DENSITY	116.4	116.7	110.6
MOISTURE AT TEST, %	10.5	13.5	17.4

Maximum Dry Density, PCF 117.1 **@ Optimum Moisture, %** 12.2

COMPACTION TEST RESULTS

Redwood Creek Levee Geotechnical Evaluation
Orick, Humboldt County, California

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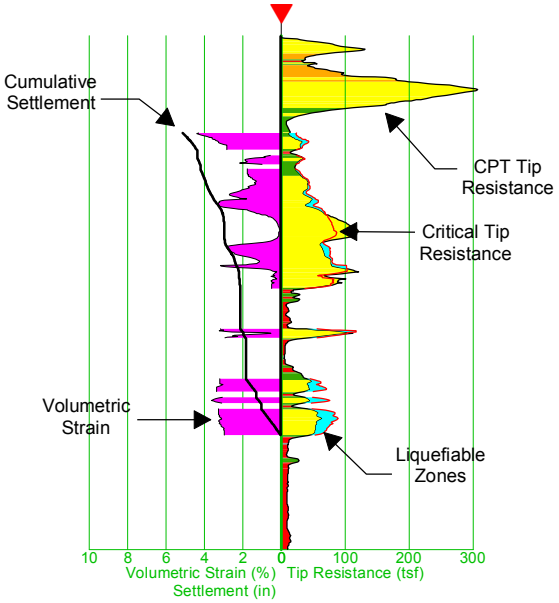
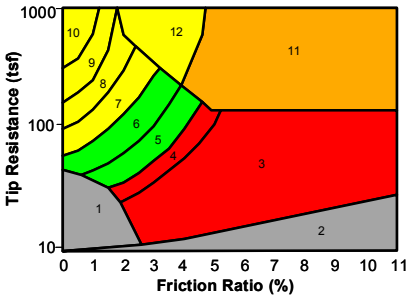
APPENDIX D
GEOTECHNICAL ANALYSES AND CALCULATIONS



CPT SOUNDING WITH LIQUEFACTION EVALUATION



Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

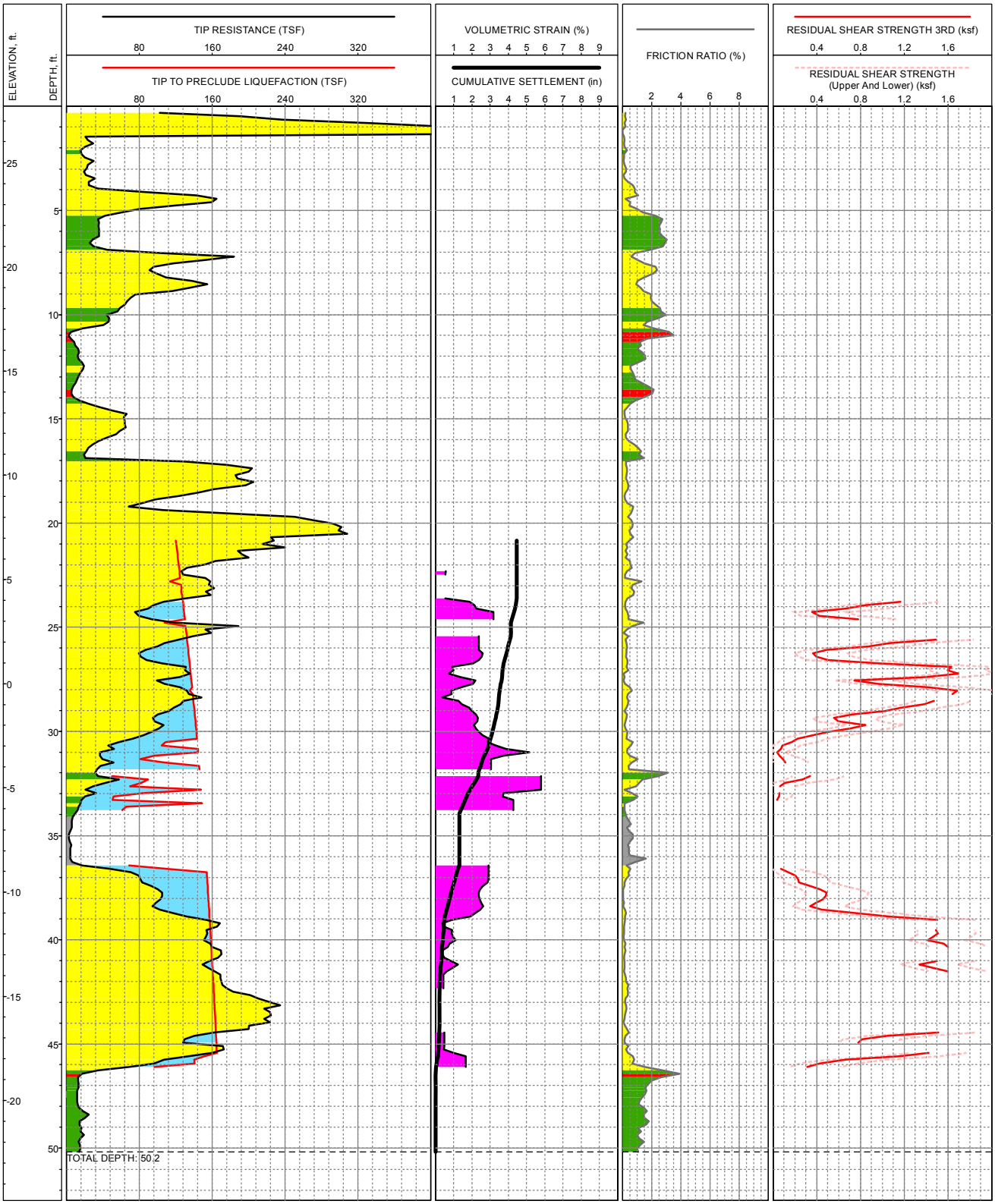
(Robertson and Campanella, 1988)

KEY TO CPT LIQUEFACTION LOGS

Redwood Creek Levee
Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-1

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Outputs\2011_05_21_GeotechEval\mxd\Plate_D-01_KeytoCPT-Liqu.mxd, 05/11/11, CDean



LOCATION: N2,361,026.35, E5,991,192.46
SURFACE EL: 27.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

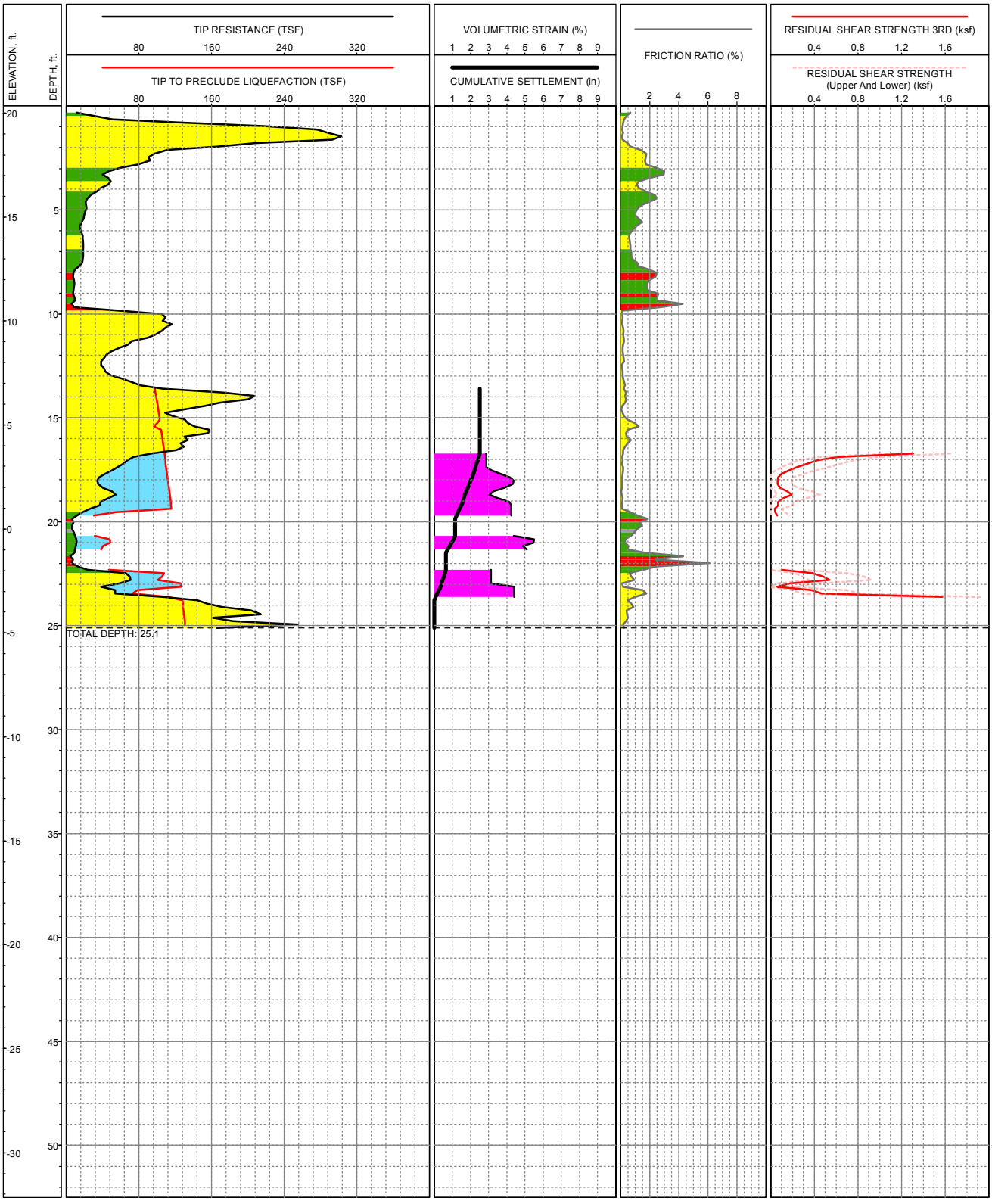
LOG OF CPT NO: C-57LC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-2

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,360,998.61, E5,991,145.07
SURFACE EL: 20.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57LL

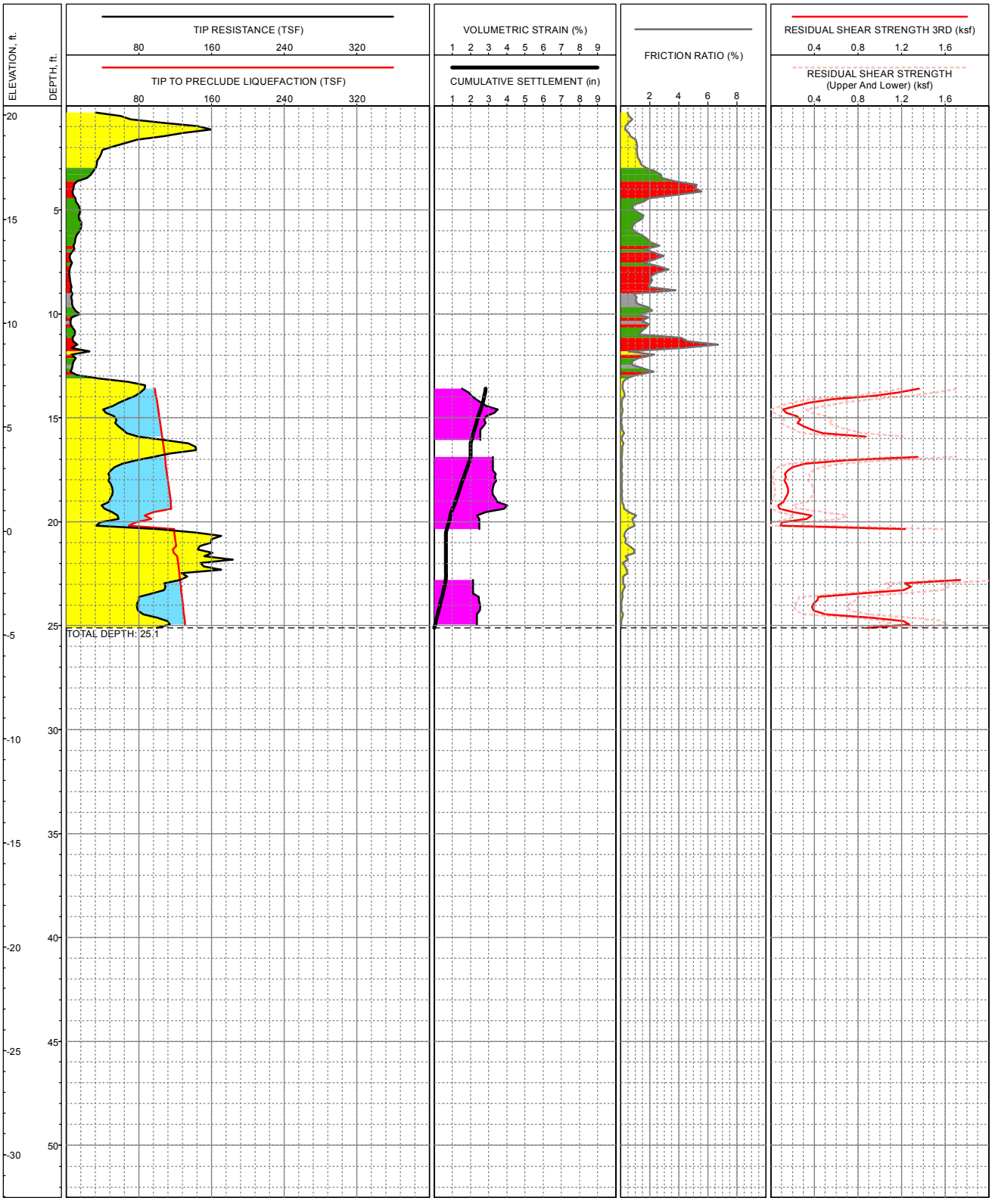
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-3

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,016.82, E5,991,145.50
SURFACE EL: 20.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

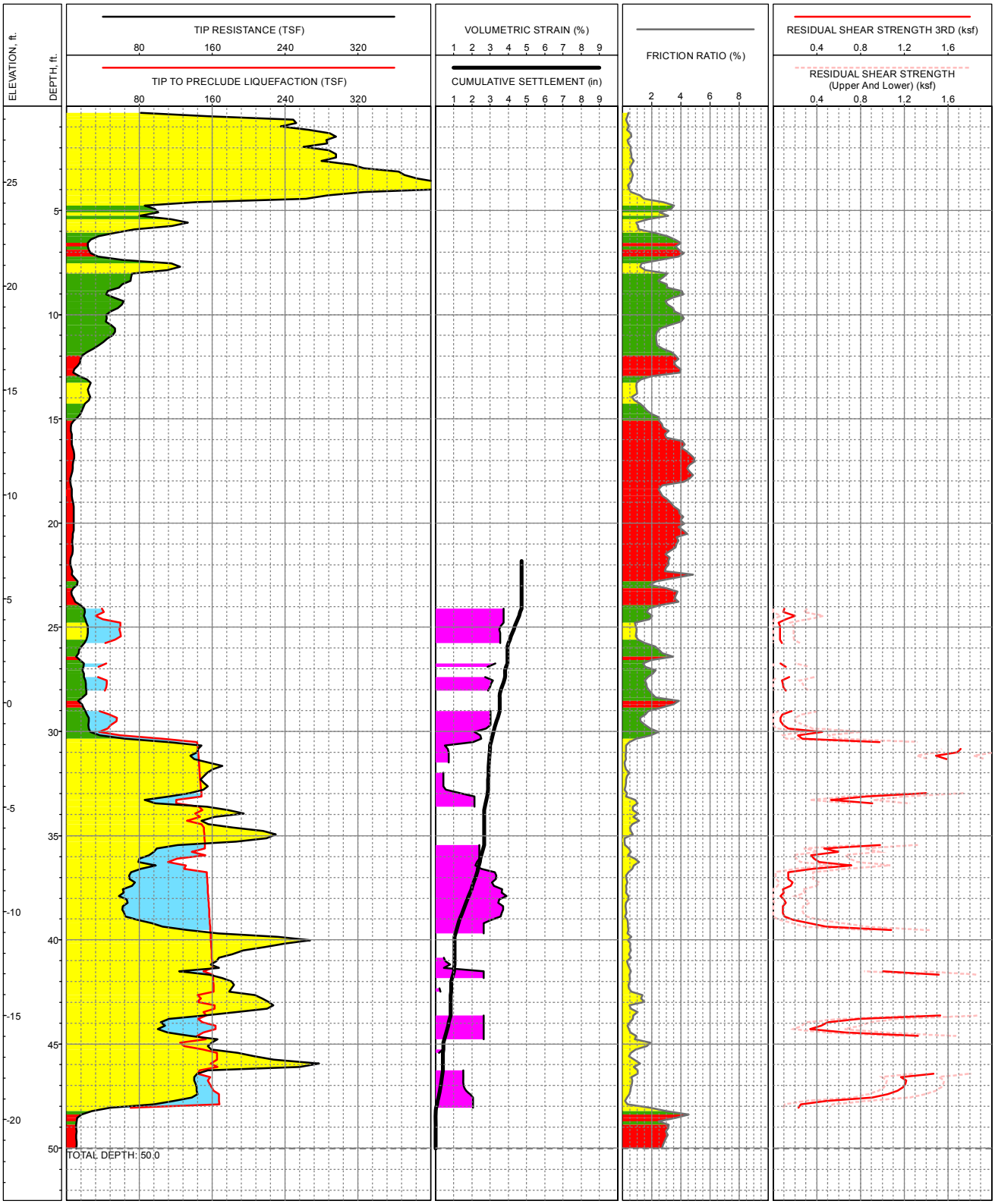
LOG OF CPT NO: C-57LO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-4

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,403.04, E5,991,434.81
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

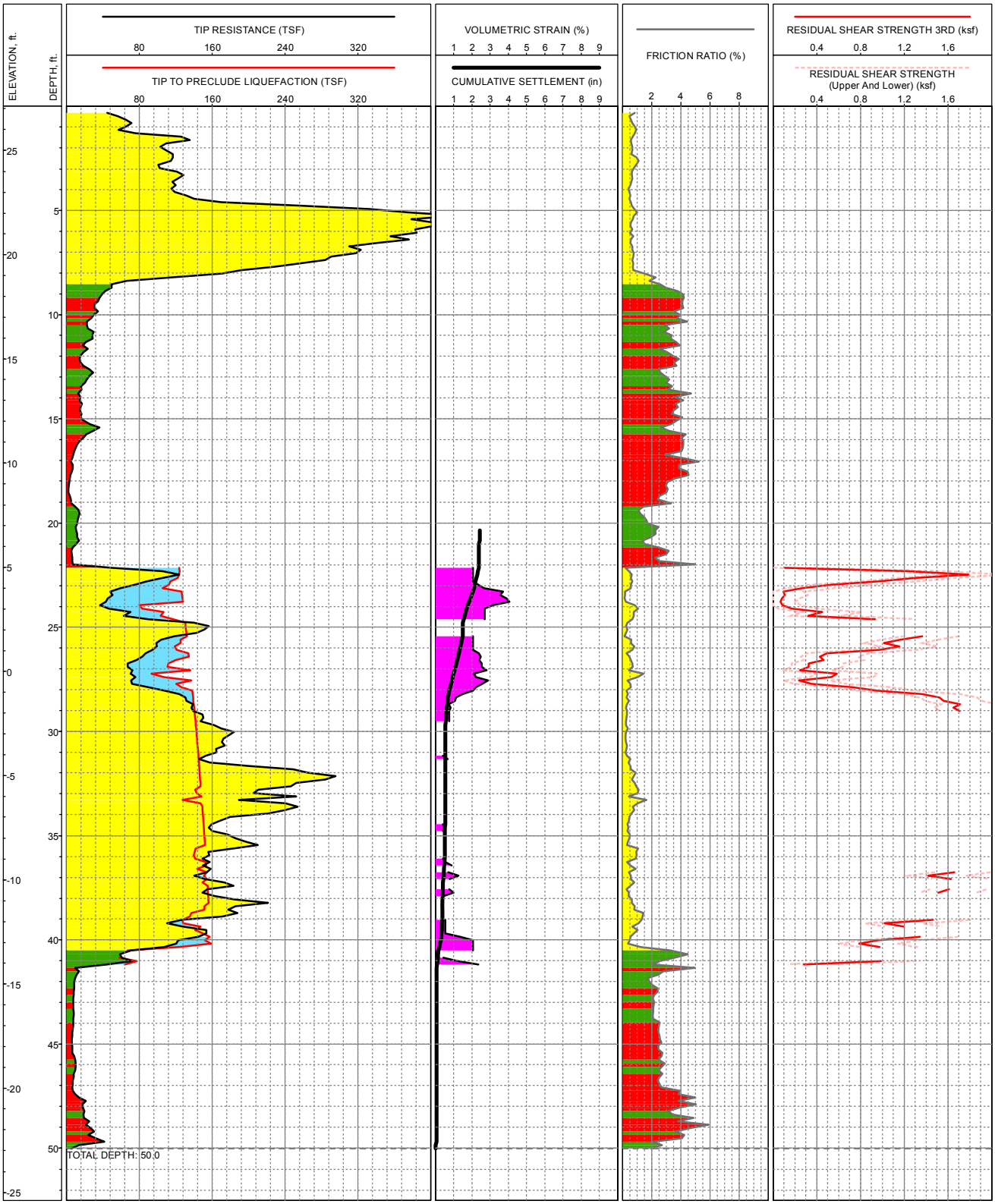
LOG OF CPT NO: C-57RC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-5

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,422.53, E5,991,485.50
SURFACE EL: 27.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57RL

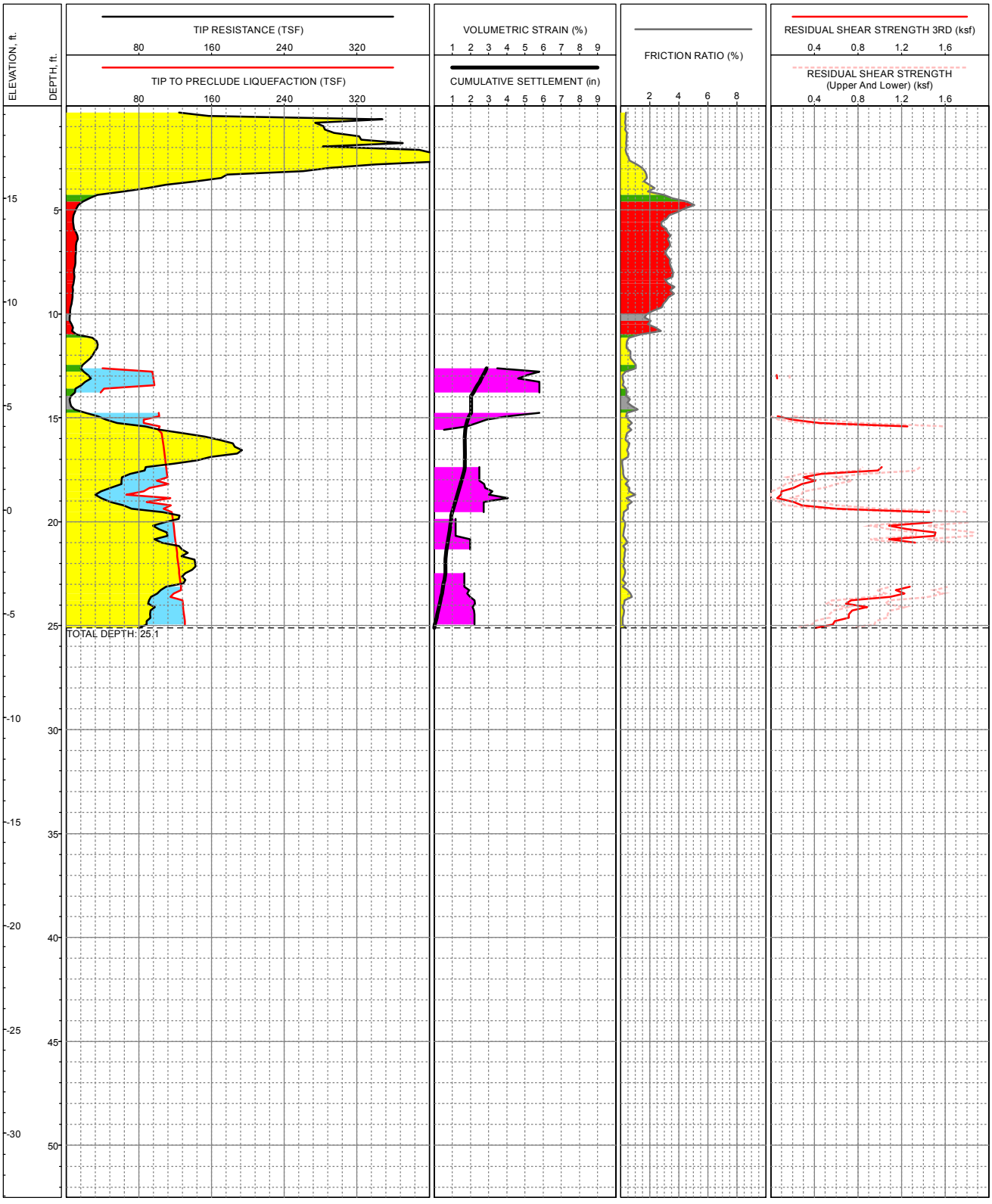
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-6

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,467.42, E5,991,571.88
SURFACE EL: 19.4ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-57RO

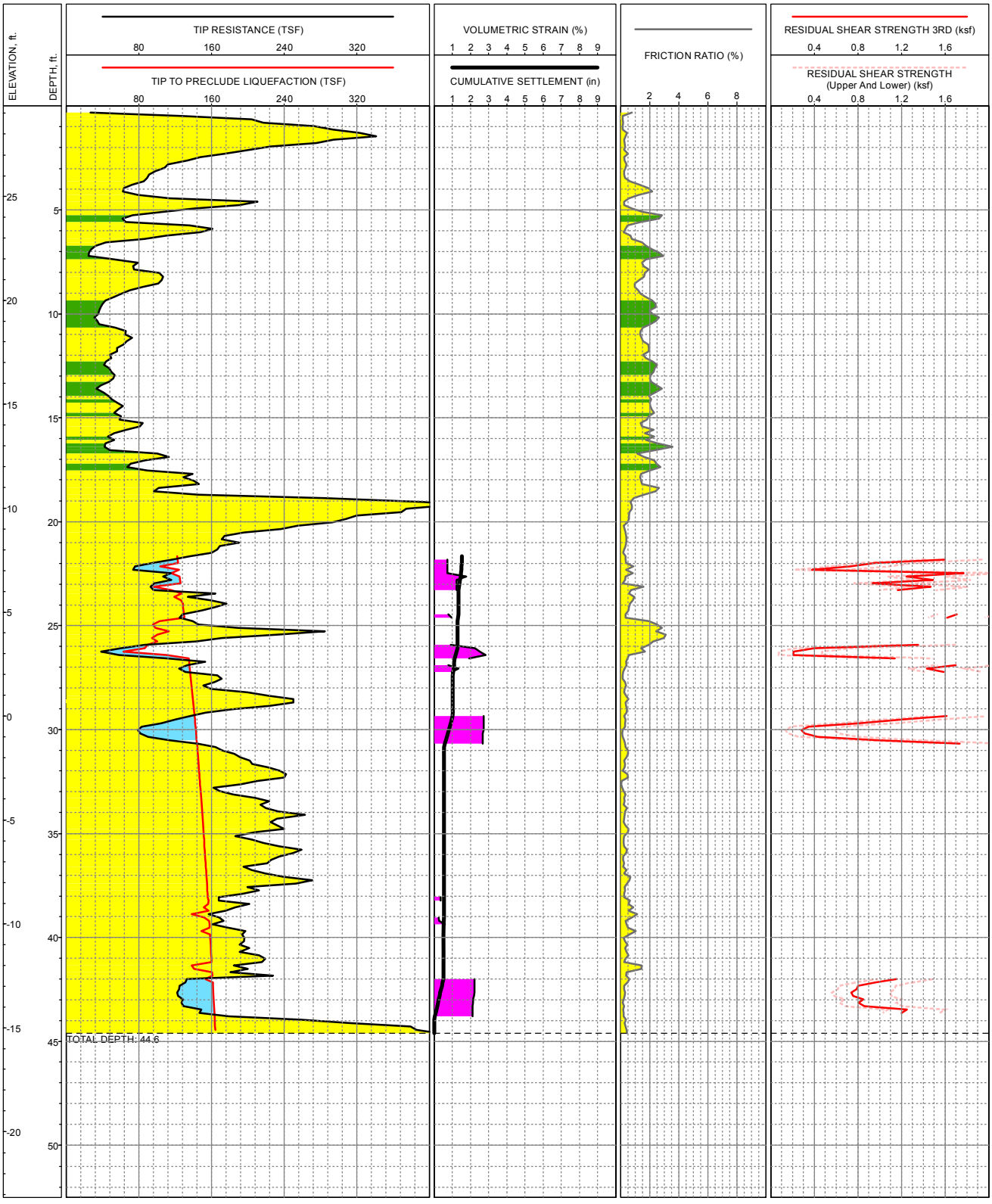
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-7

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,820.45, E5,991,193.85
SURFACE EL: 29.3ft +/- (NAVD88)
COMPLETION DEPTH: 44.6ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

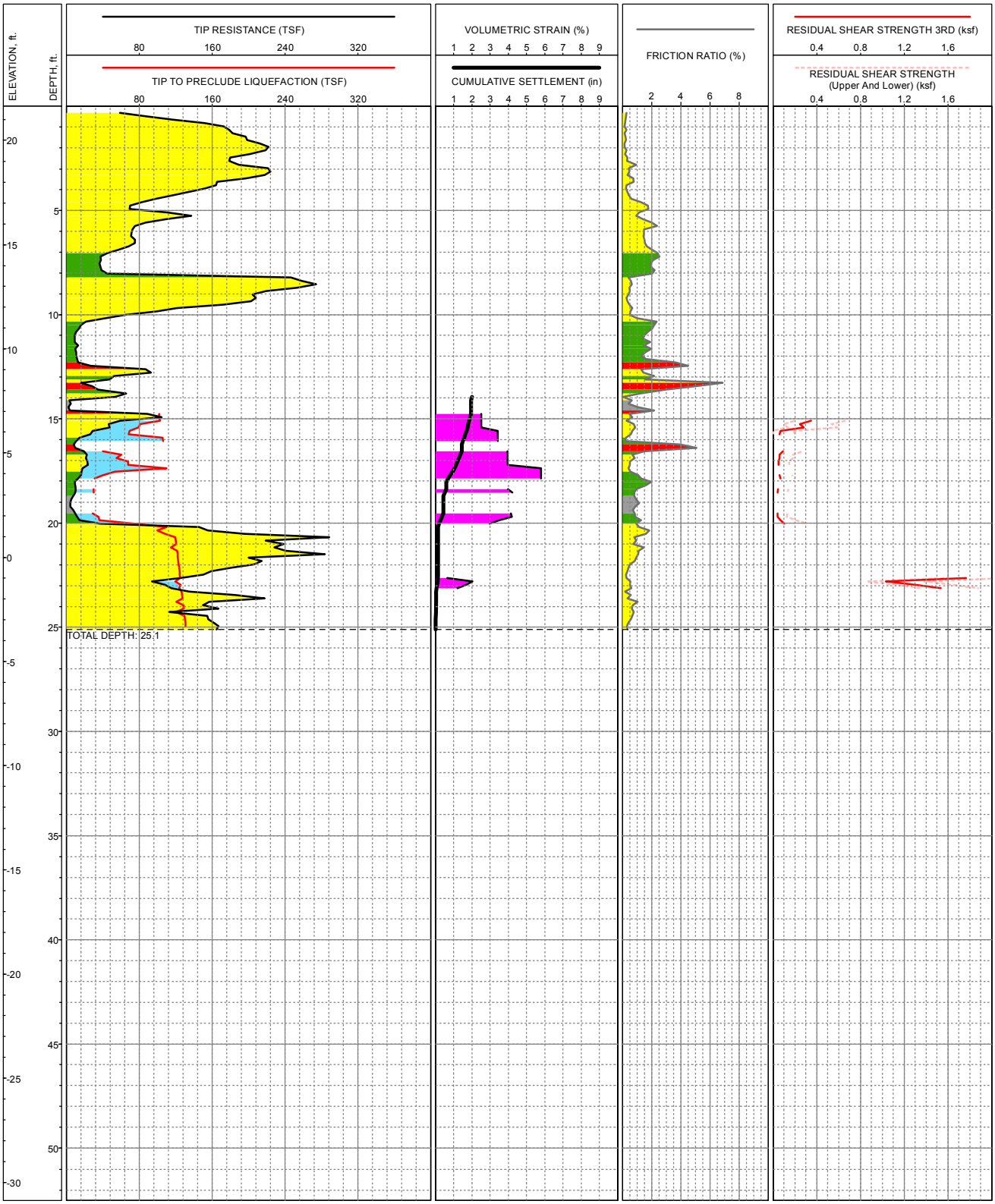
LOG OF CPT NO: C-73LC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-8

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,816.97, E5,991,166.08
SURFACE EL: 21.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73LL

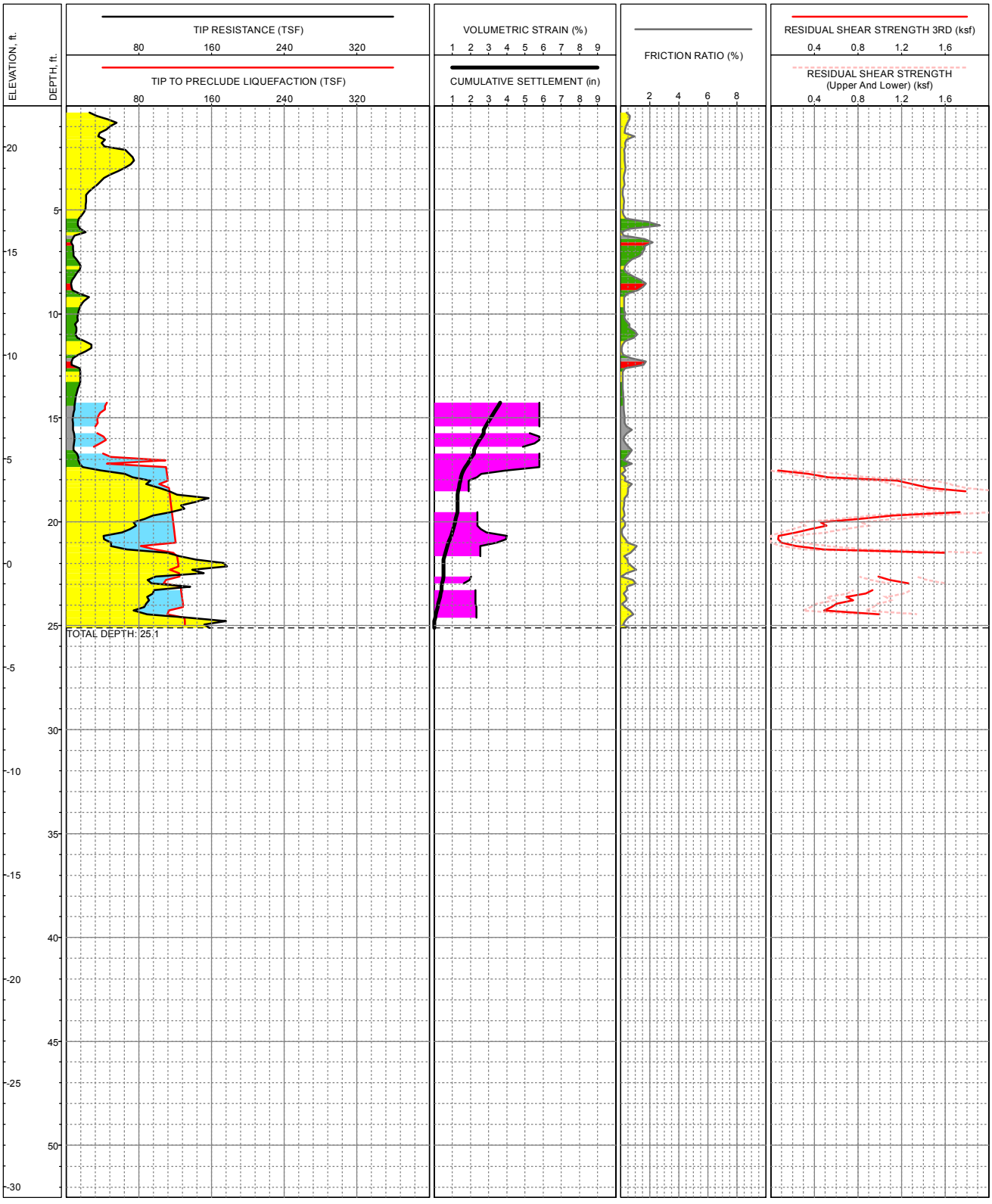
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-9

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,816.46, E5,991,144.43
SURFACE EL: 22.0ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

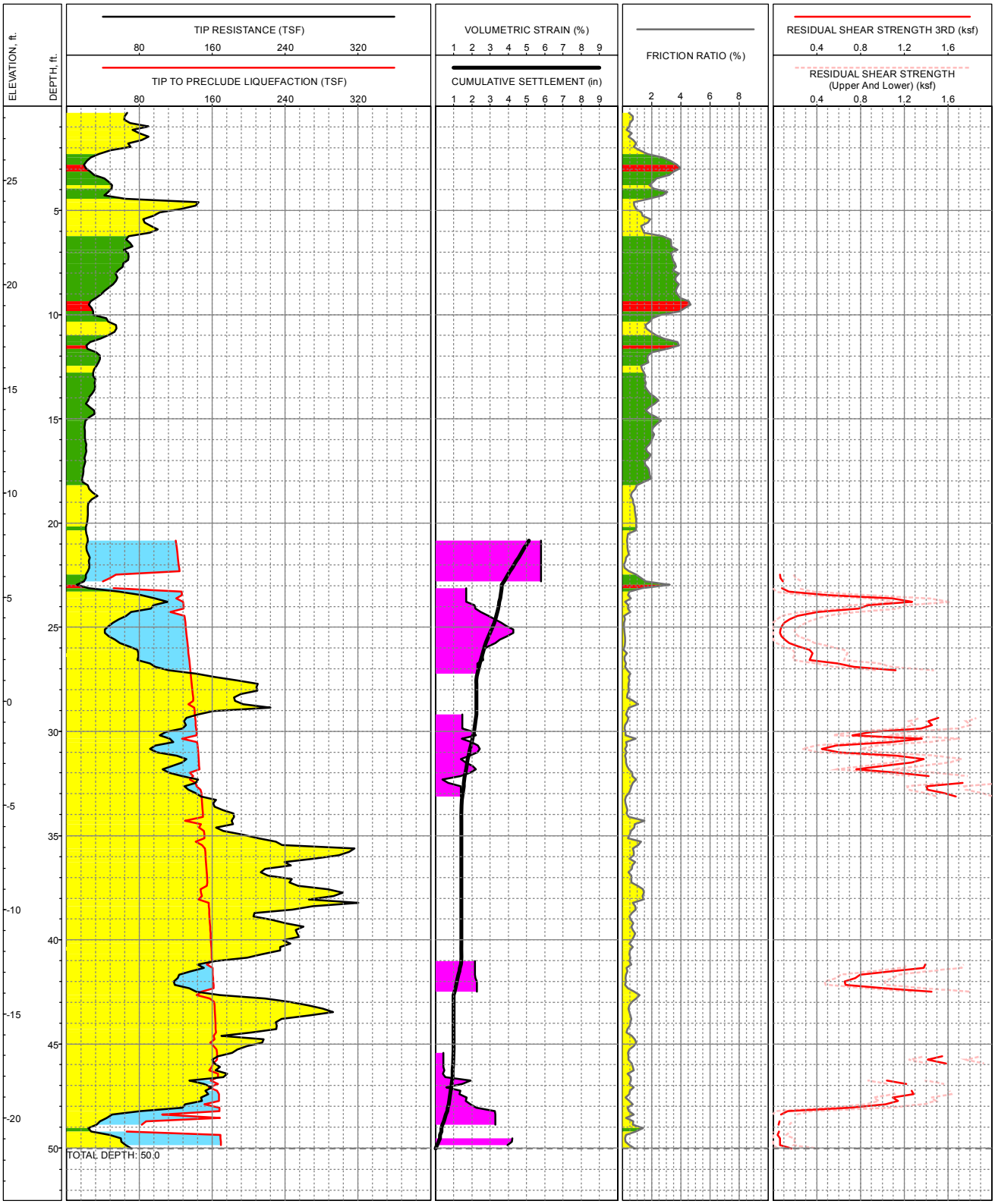
LOG OF CPT NO: C-73LO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-10

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,828.24, E5,991,604.56
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73RC

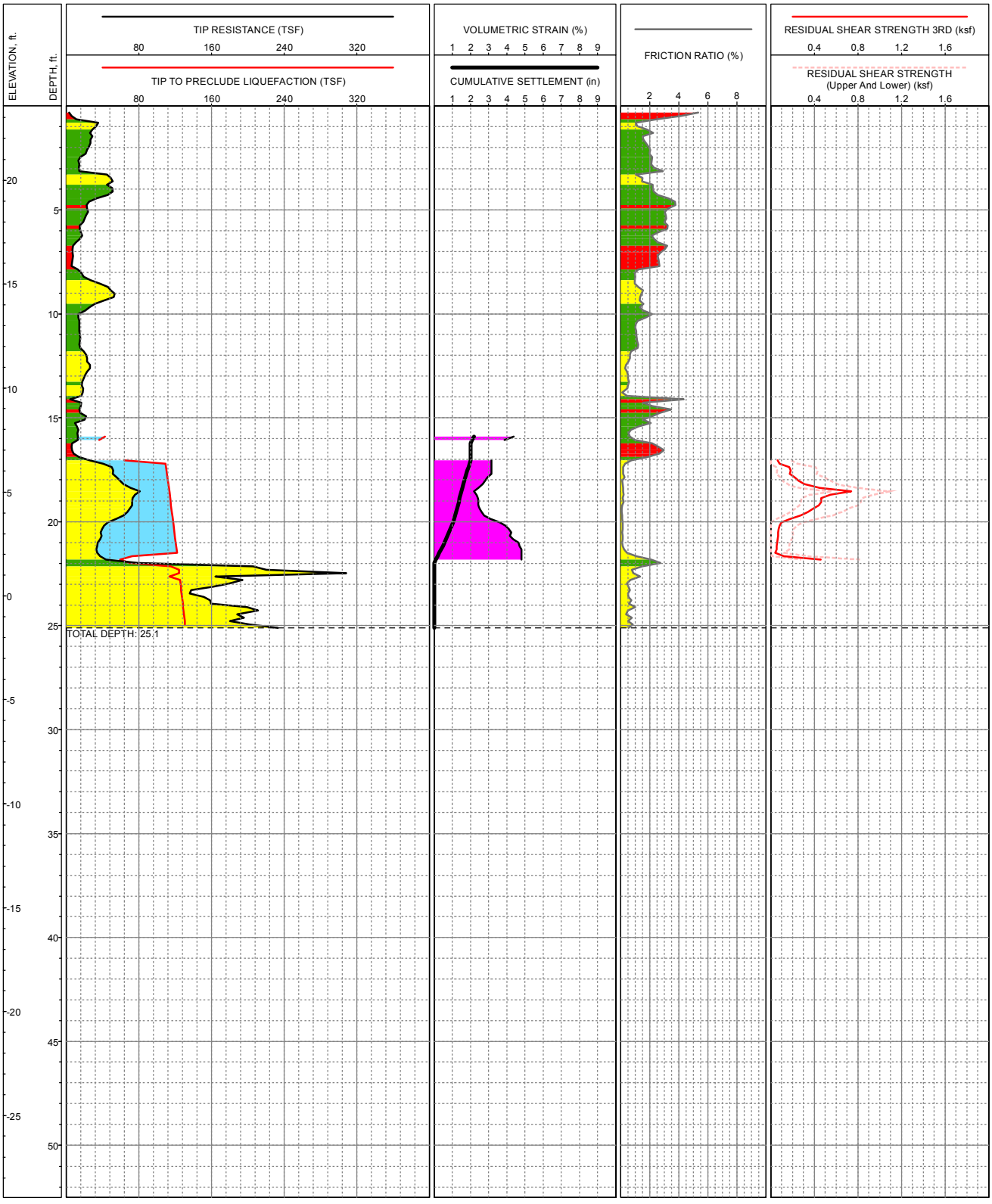
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-11

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,822.71, E5,991,634.17
SURFACE EL: 23.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-73RL

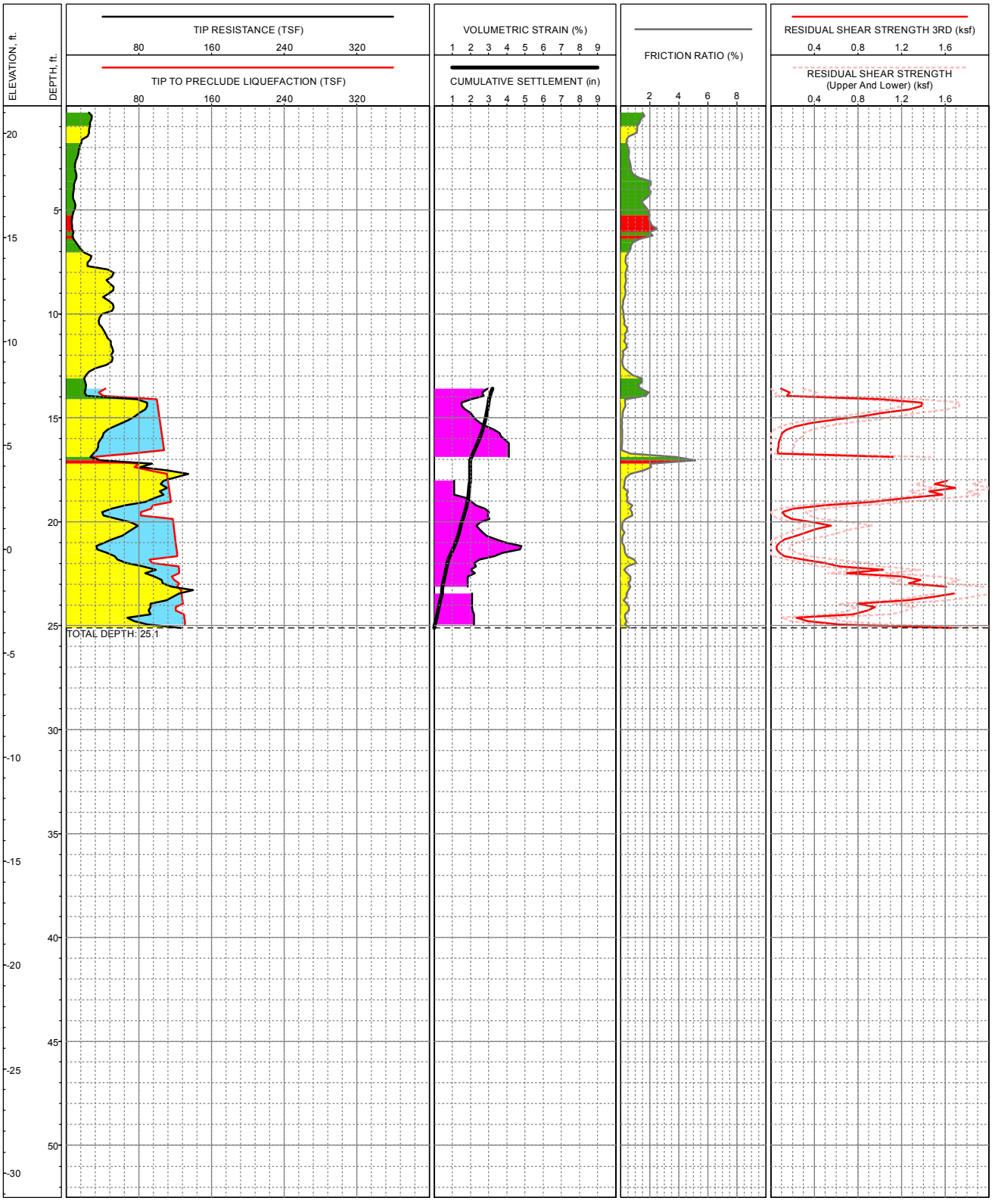
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-12

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,826.26, E5,991,658.15
SURFACE EL: 21.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

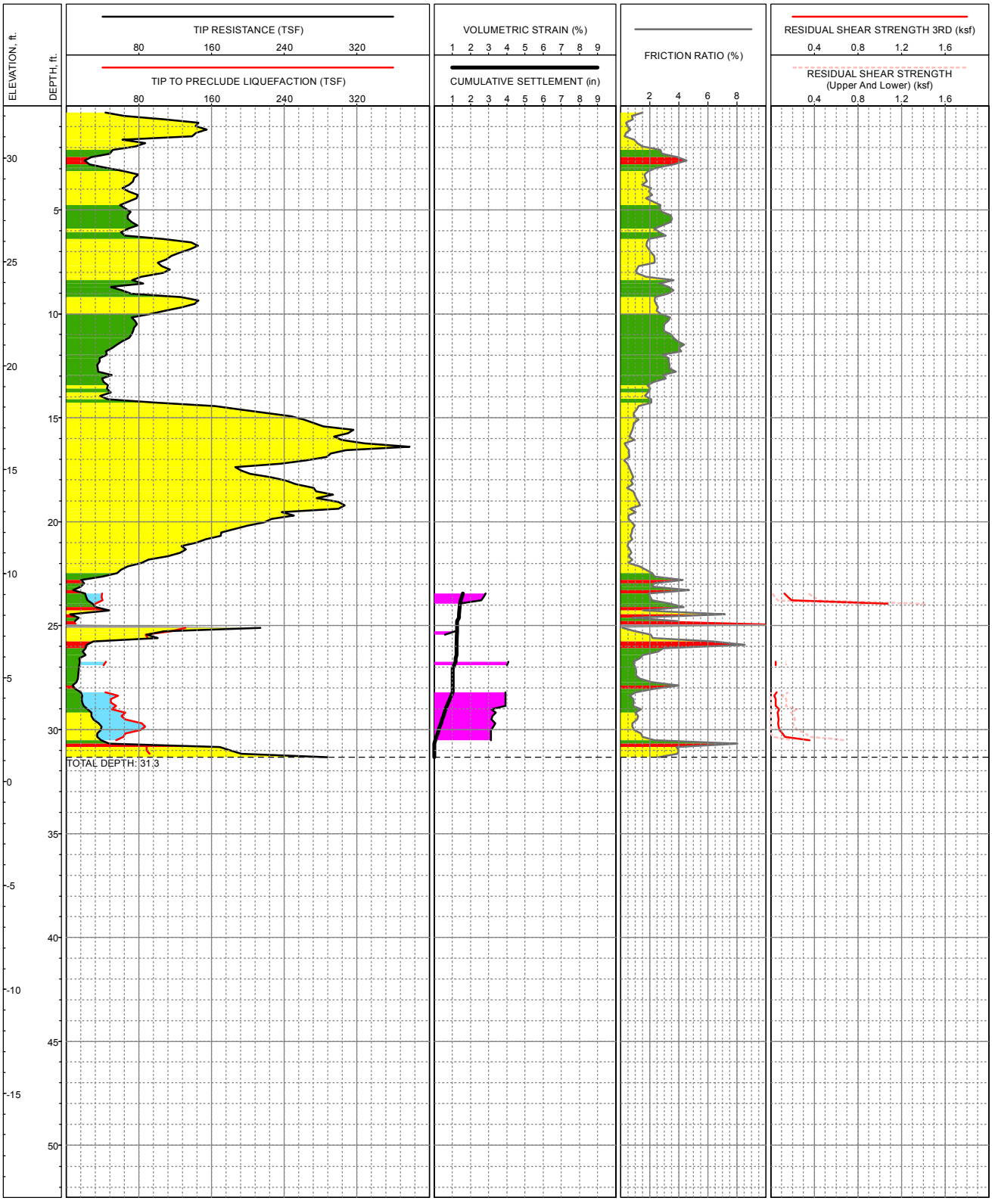
LOG OF CPT NO: C-73RO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-13

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,357.43, E5,991,843.58
SURFACE EL: 32.5ft +/- (NAVD88)
COMPLETION DEPTH: 31.3ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

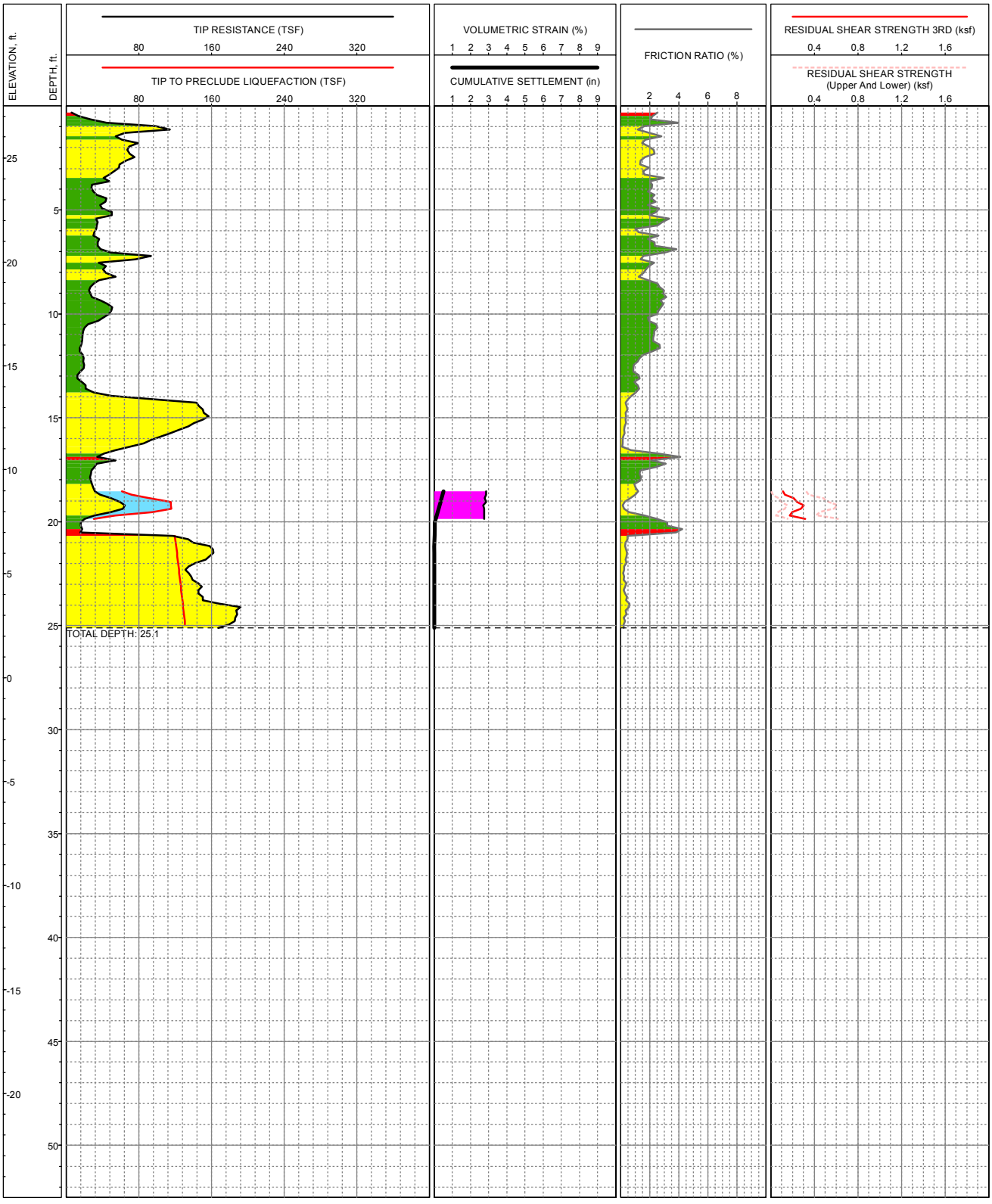
LOG OF CPT NO: C-87LC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-14

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,322.36, E5,991,832.72
SURFACE EL: 27.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

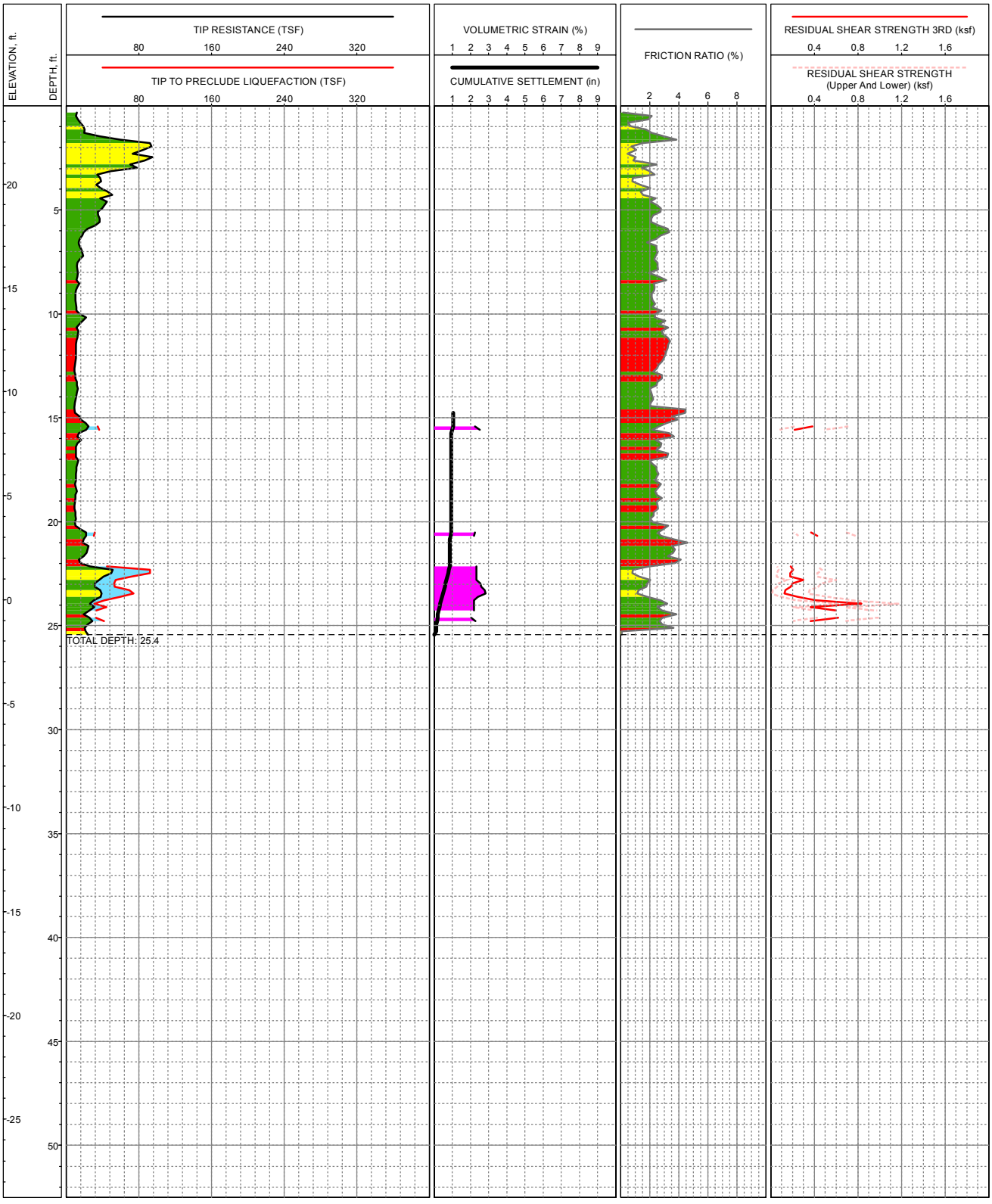
LOG OF CPT NO: C-87LL

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-15

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,274.86, E5,991,805.35
SURFACE EL: 23.7ft +/- (NAVD88)
COMPLETION DEPTH: 25.4ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

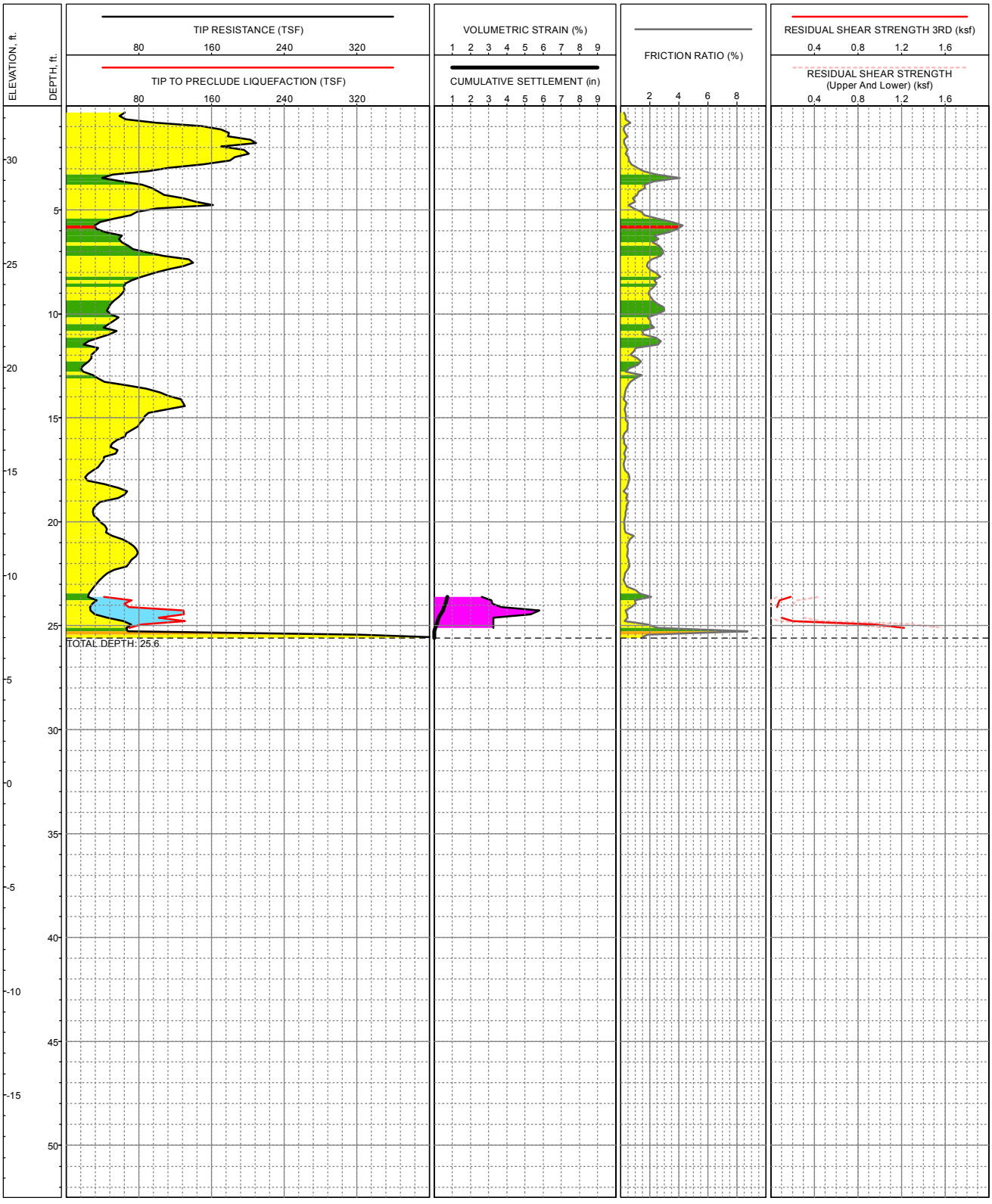
LOG OF CPT NO: C-87LO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-16

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,710.05, E5,992,106.78
SURFACE EL: 32.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.6ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

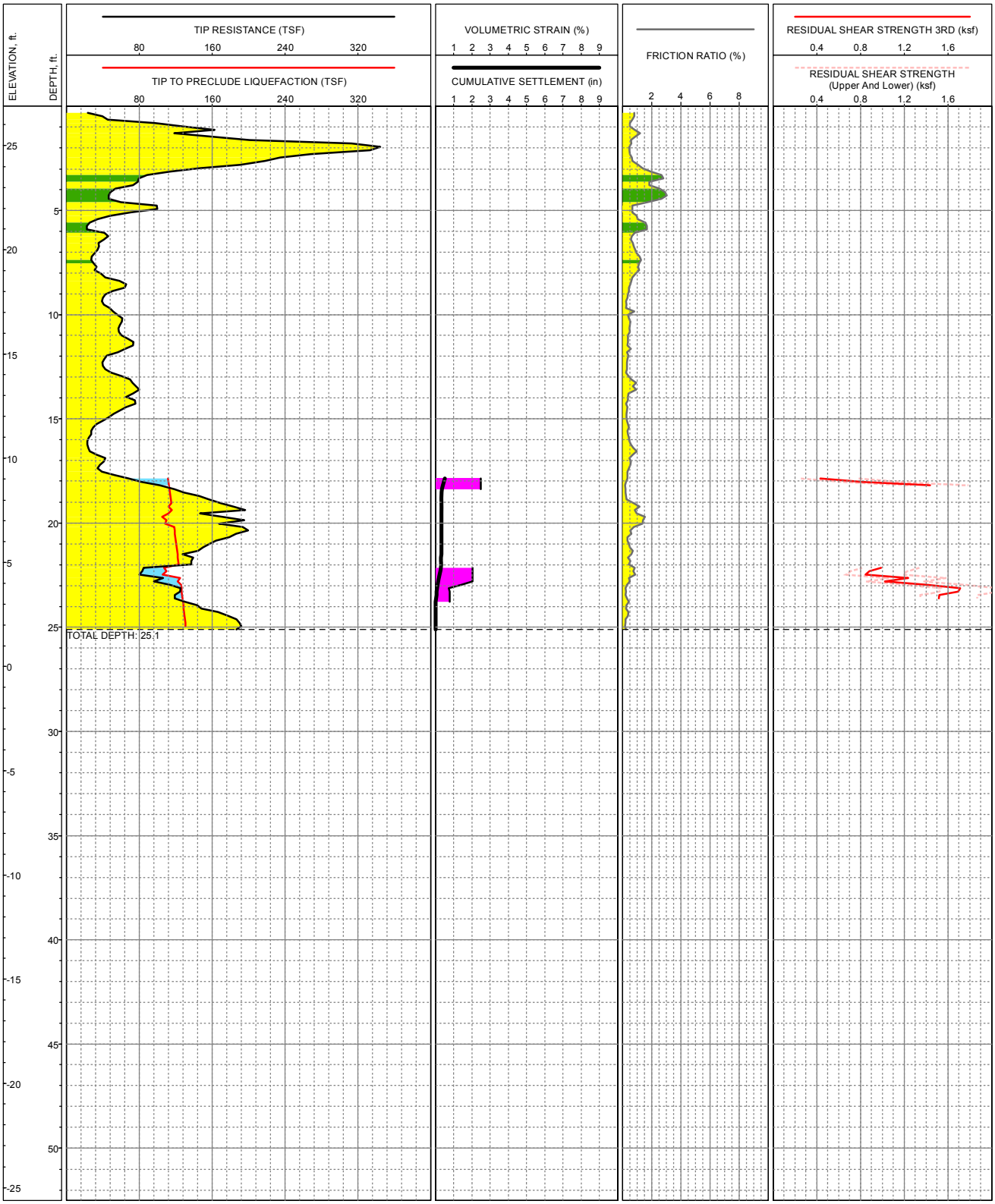
LOG OF CPT NO: C-87RC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-17

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,730.76, E5,992,123.84
SURFACE EL: 26.9ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

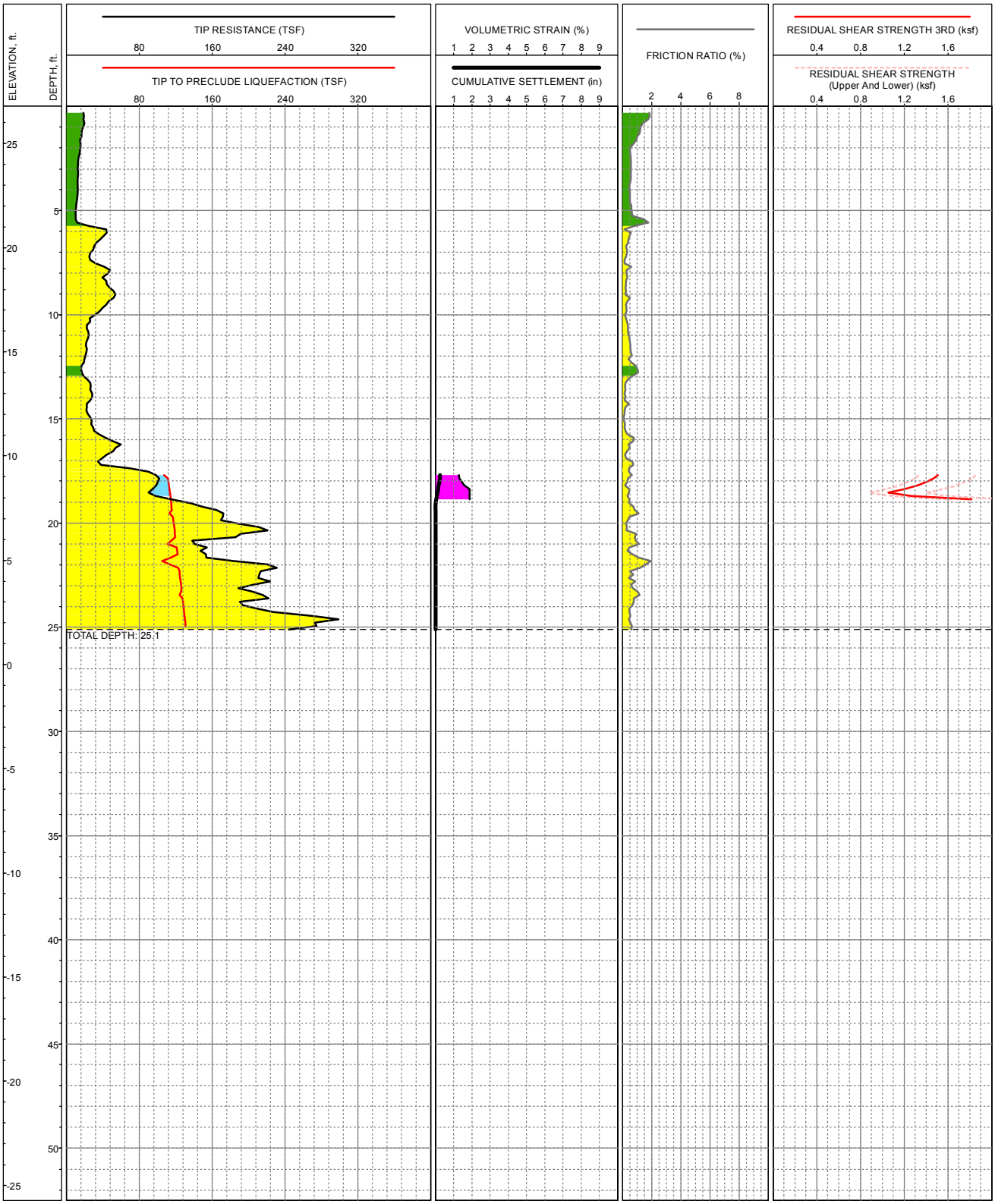
LOG OF CPT NO: C-87RL

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-18

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,740.47, E5,992,128.13
SURFACE EL: 26.8ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

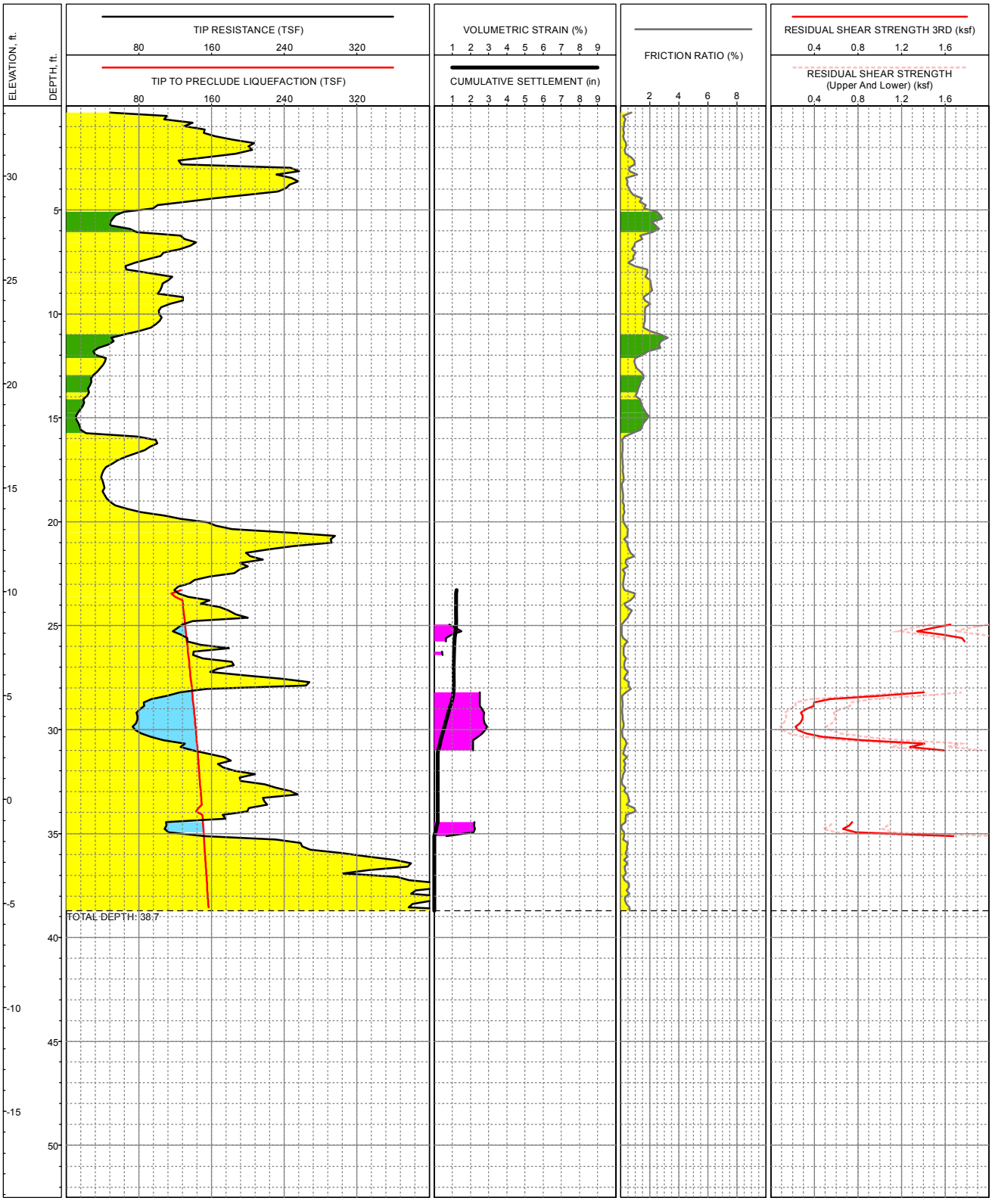
LOG OF CPT NO: C-87RO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-19

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,517.20, E5,993,201.68
SURFACE EL: 33.4ft +/- (NAVD88)
COMPLETION DEPTH: 38.7ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98LC

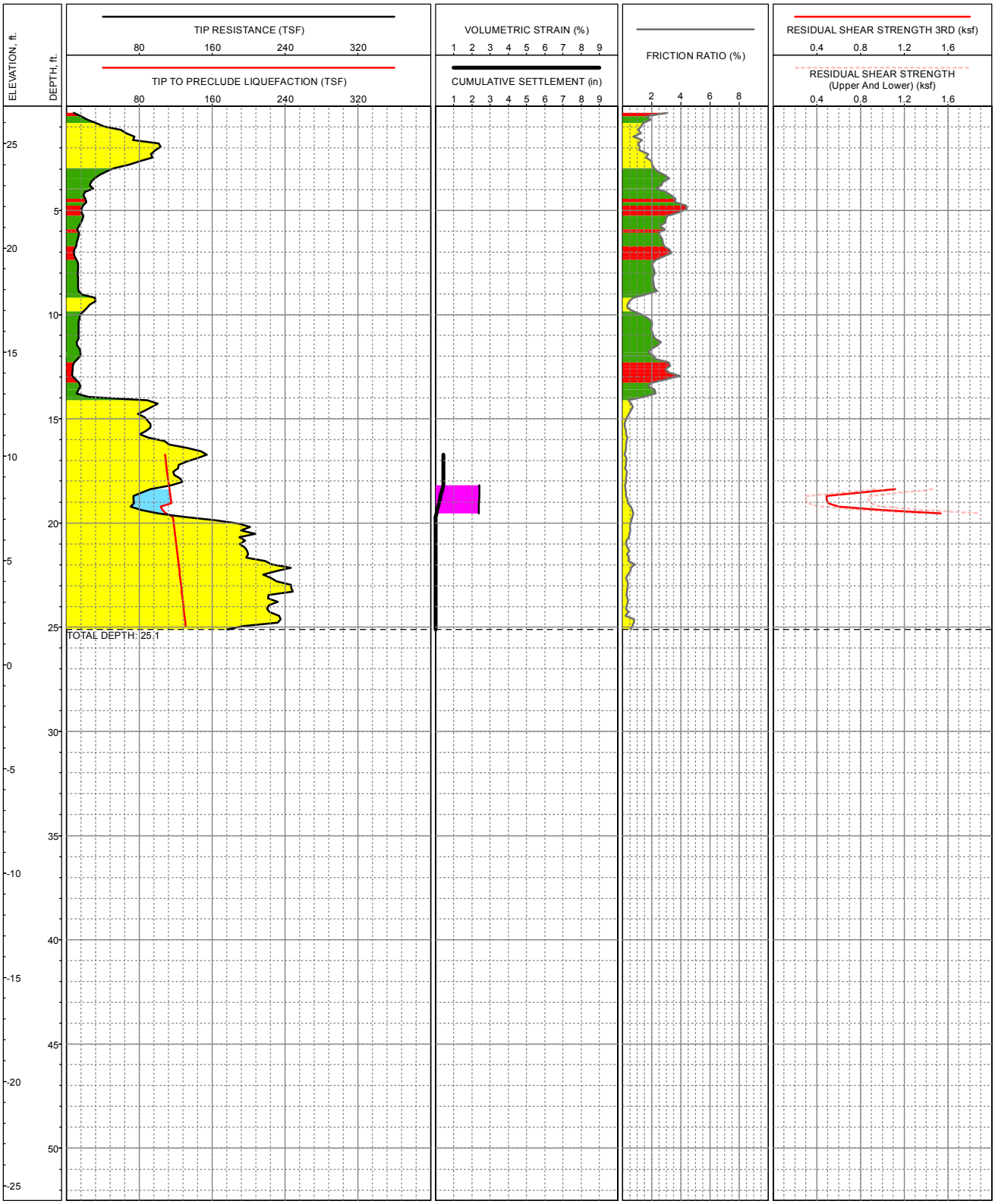
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-20

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,470.50, E5,993,221.24
SURFACE EL: 26.8ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

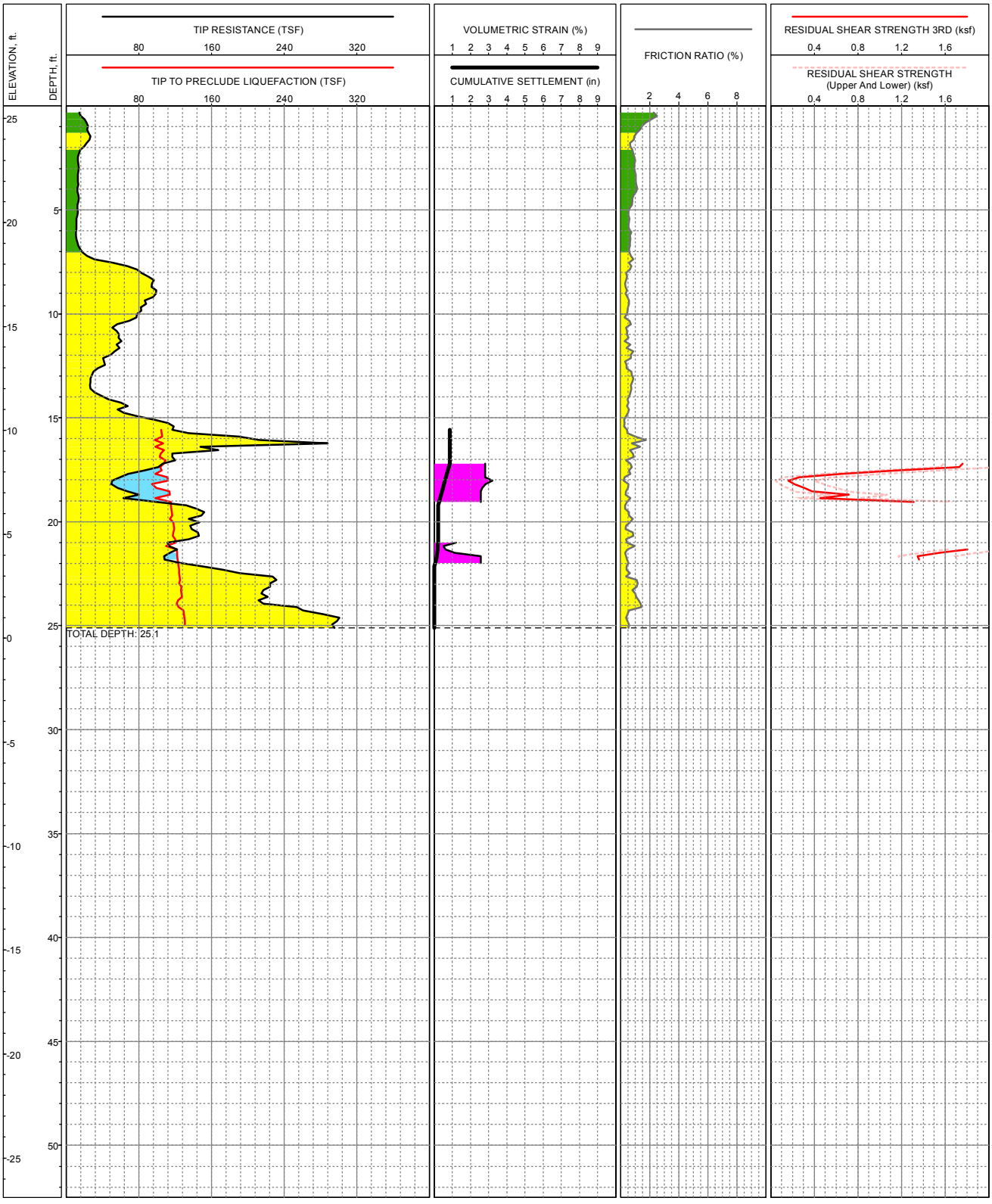
LOG OF CPT NO: C-98LL

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-21

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,385.84, E5,993,273.78
SURFACE EL: 25.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-98LO

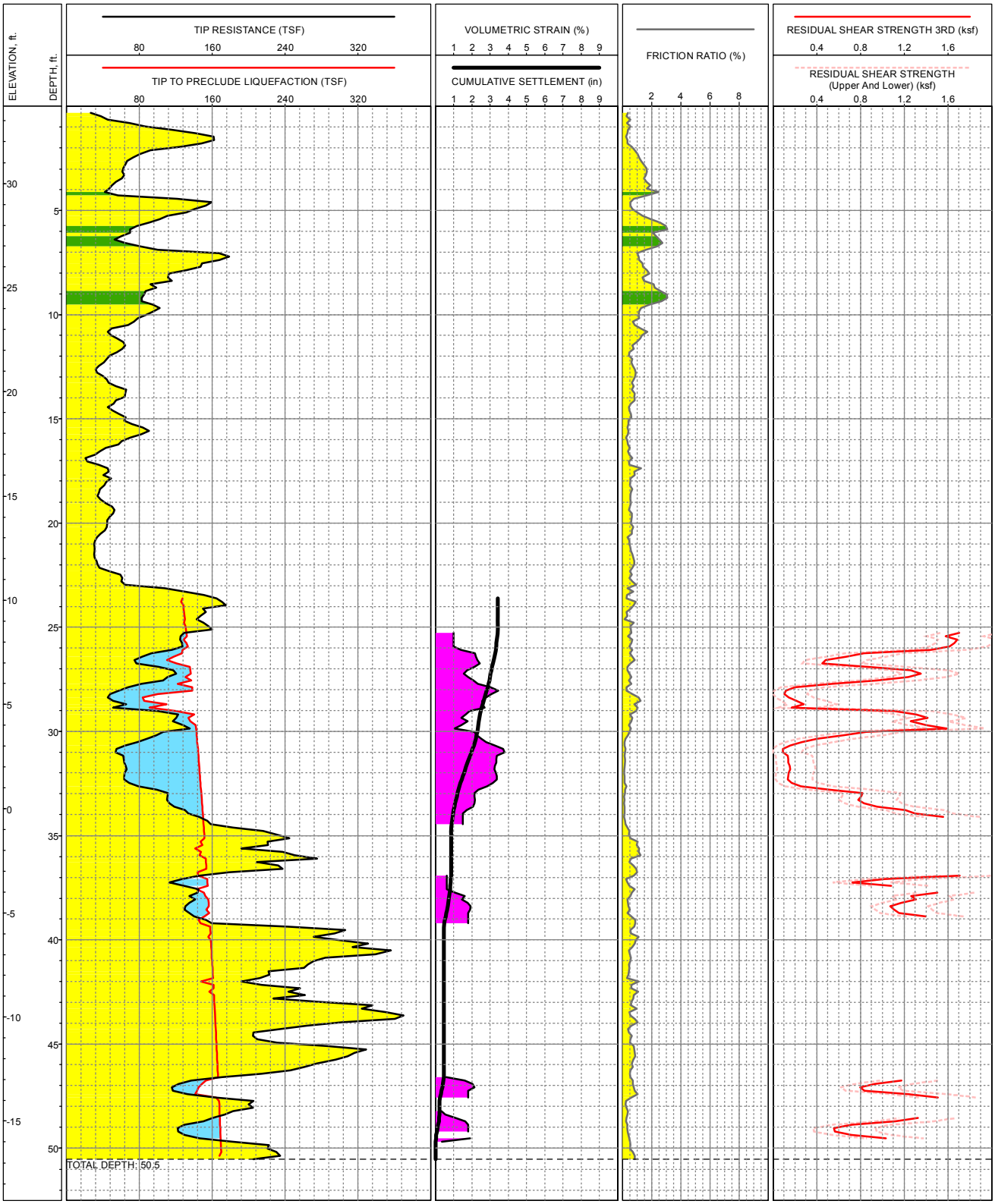
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-22

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,872.28, E5,993,013.32
SURFACE EL: 33.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.5ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

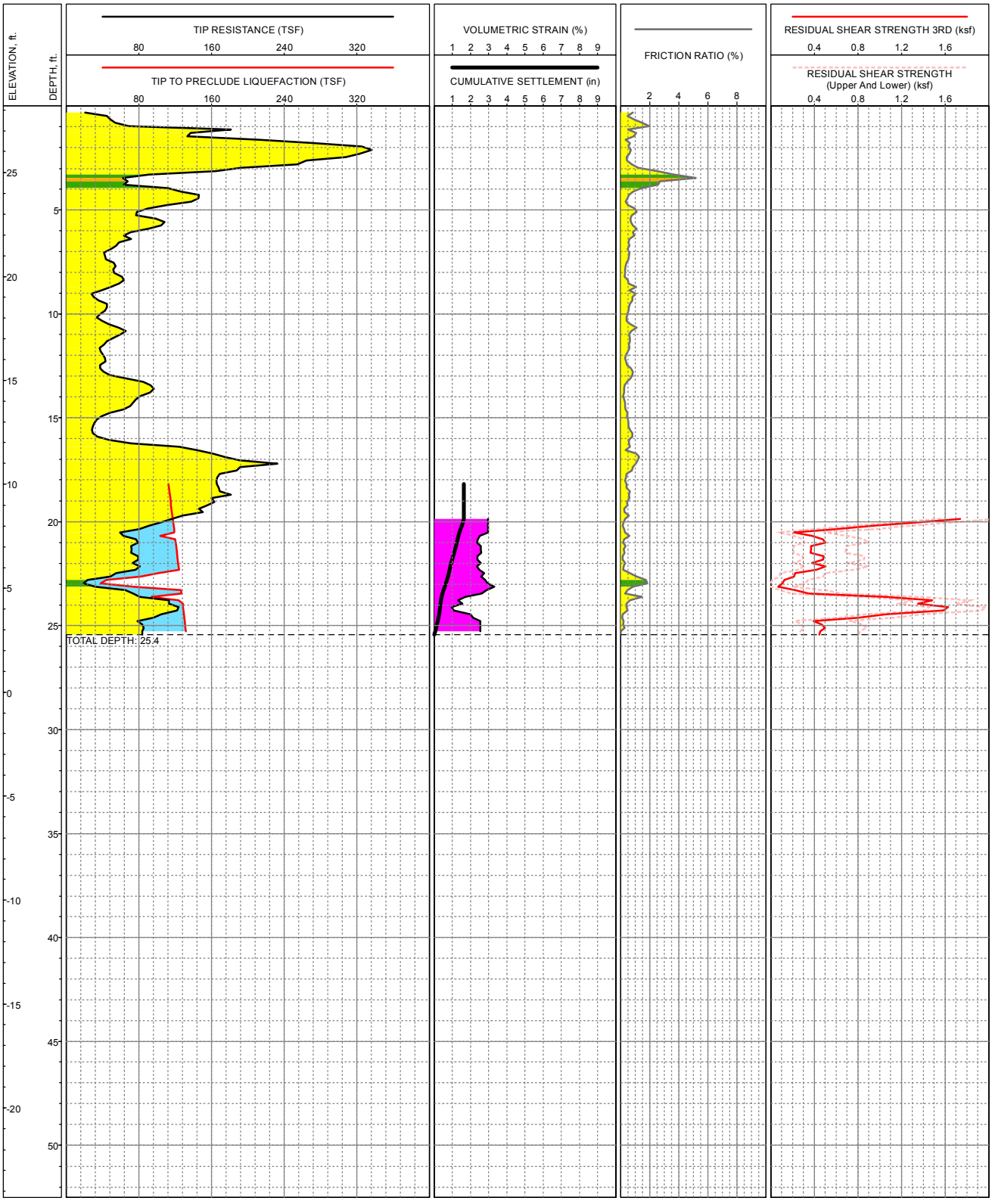
LOG OF CPT NO: C-98RC

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-23

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,898.93, E5,993,005.18
SURFACE EL: 28.2ft +/- (NAVD88)
COMPLETION DEPTH: 25.4ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

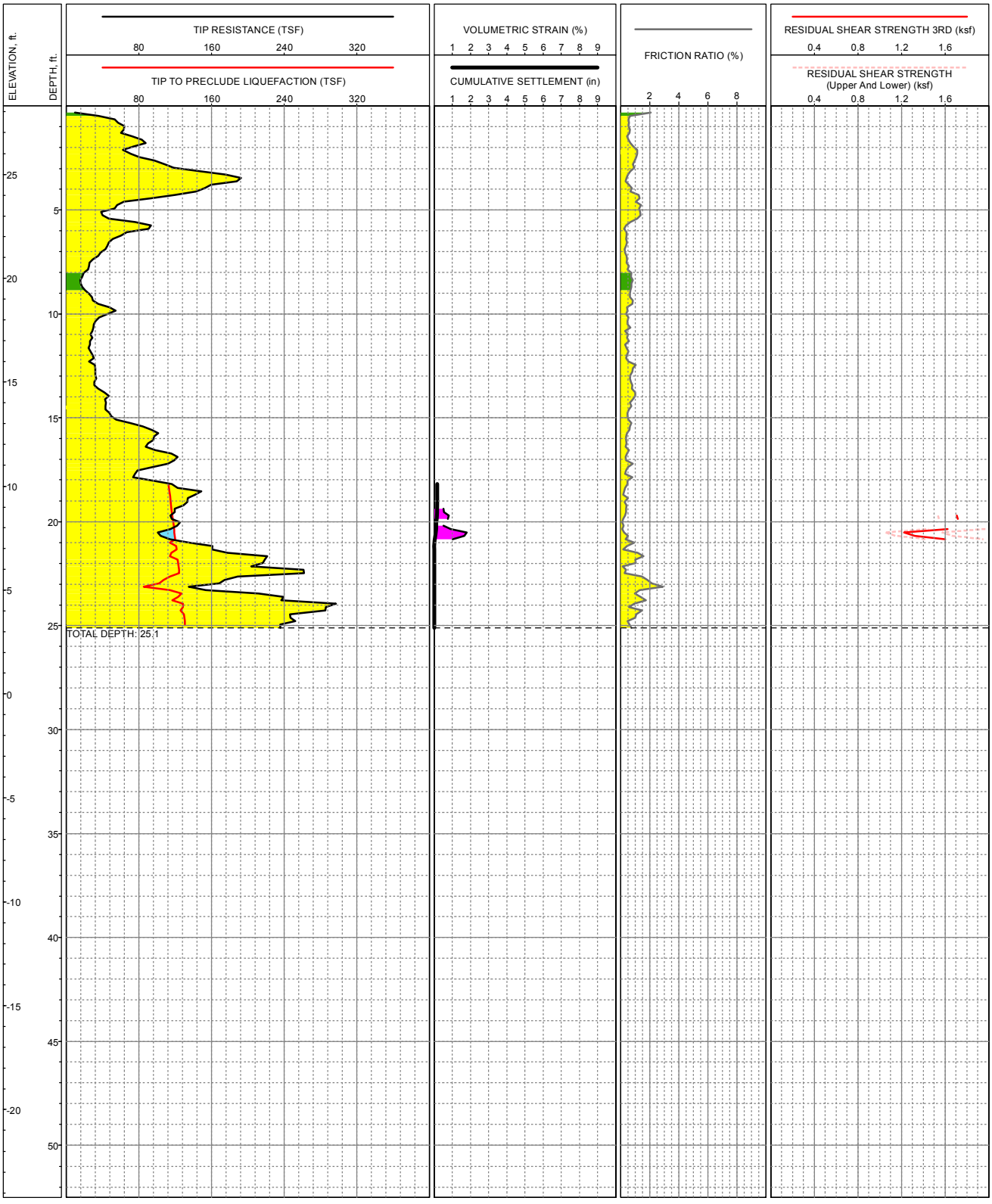
LOG OF CPT NO: C-98RL

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-24

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,922.75, E5,992,998.65
SURFACE EL: 28.3ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

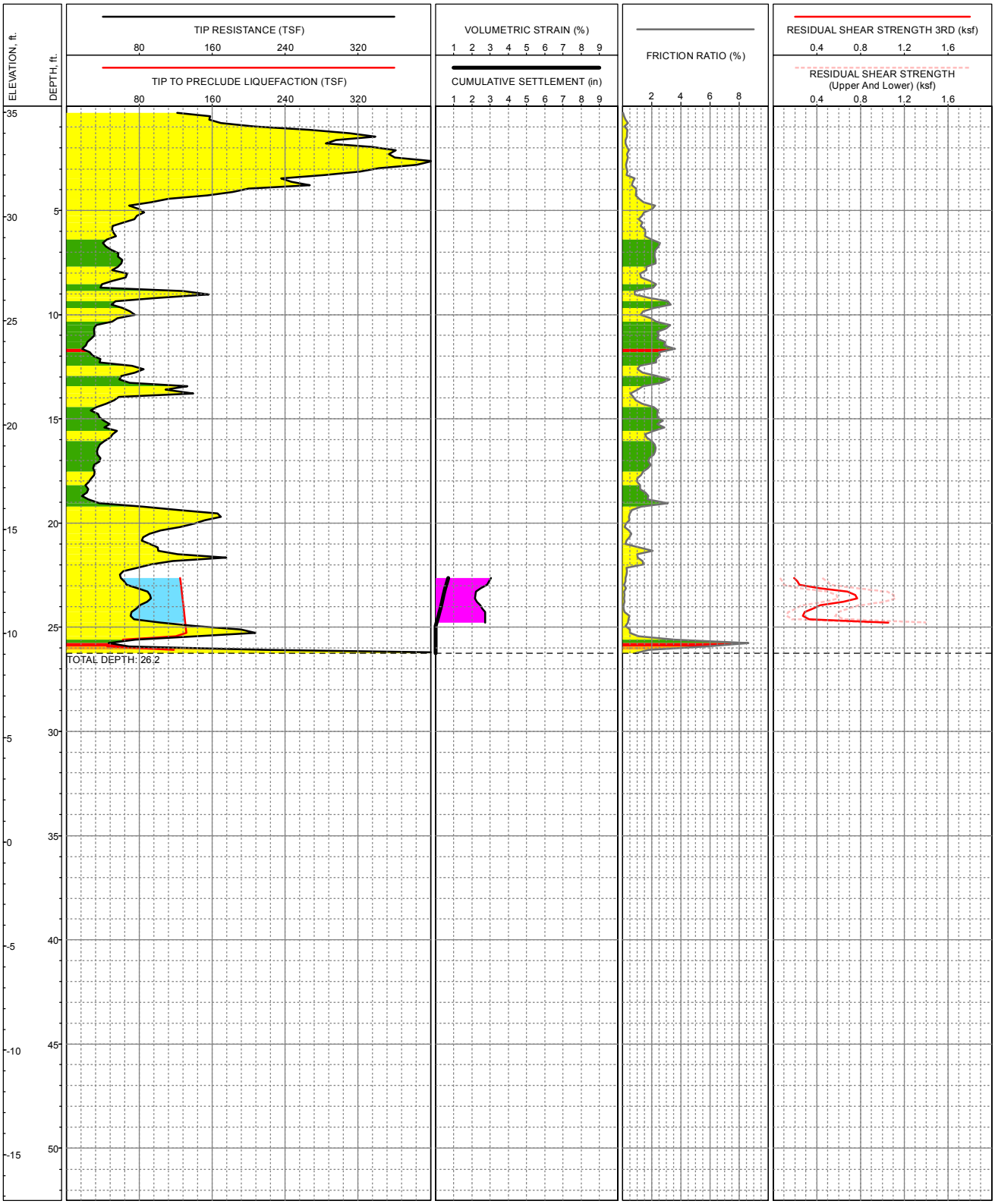
LOG OF CPT NO: C-98RO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-25

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,917.76, E5,994,641.22
SURFACE EL: 35.3ft +/- (NAVD88)
COMPLETION DEPTH: 26.2ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114LC

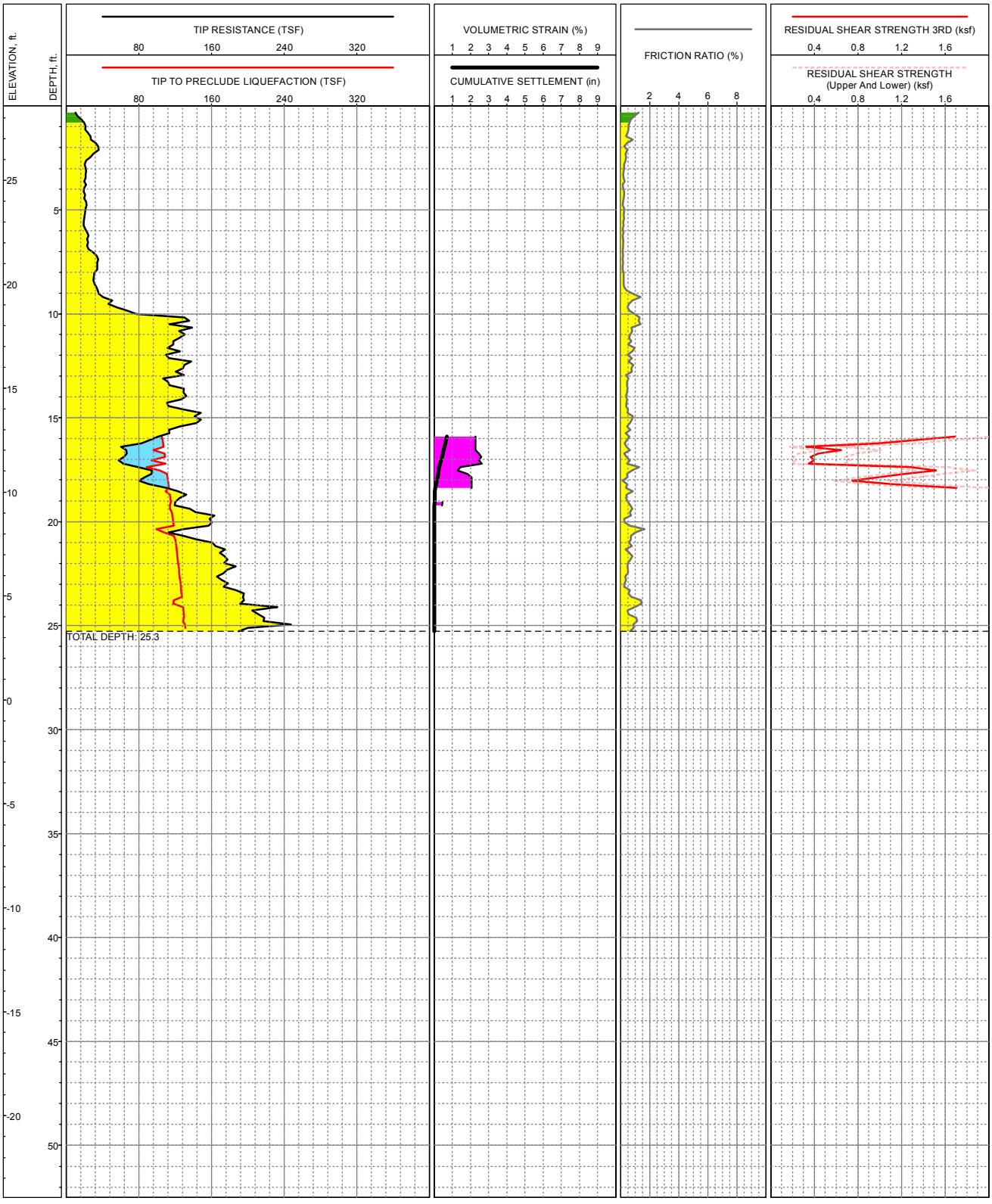
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-26

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,841.37, E5,994,627.01
SURFACE EL: 28.6ft +/- (NAVD88)
COMPLETION DEPTH: 25.3ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

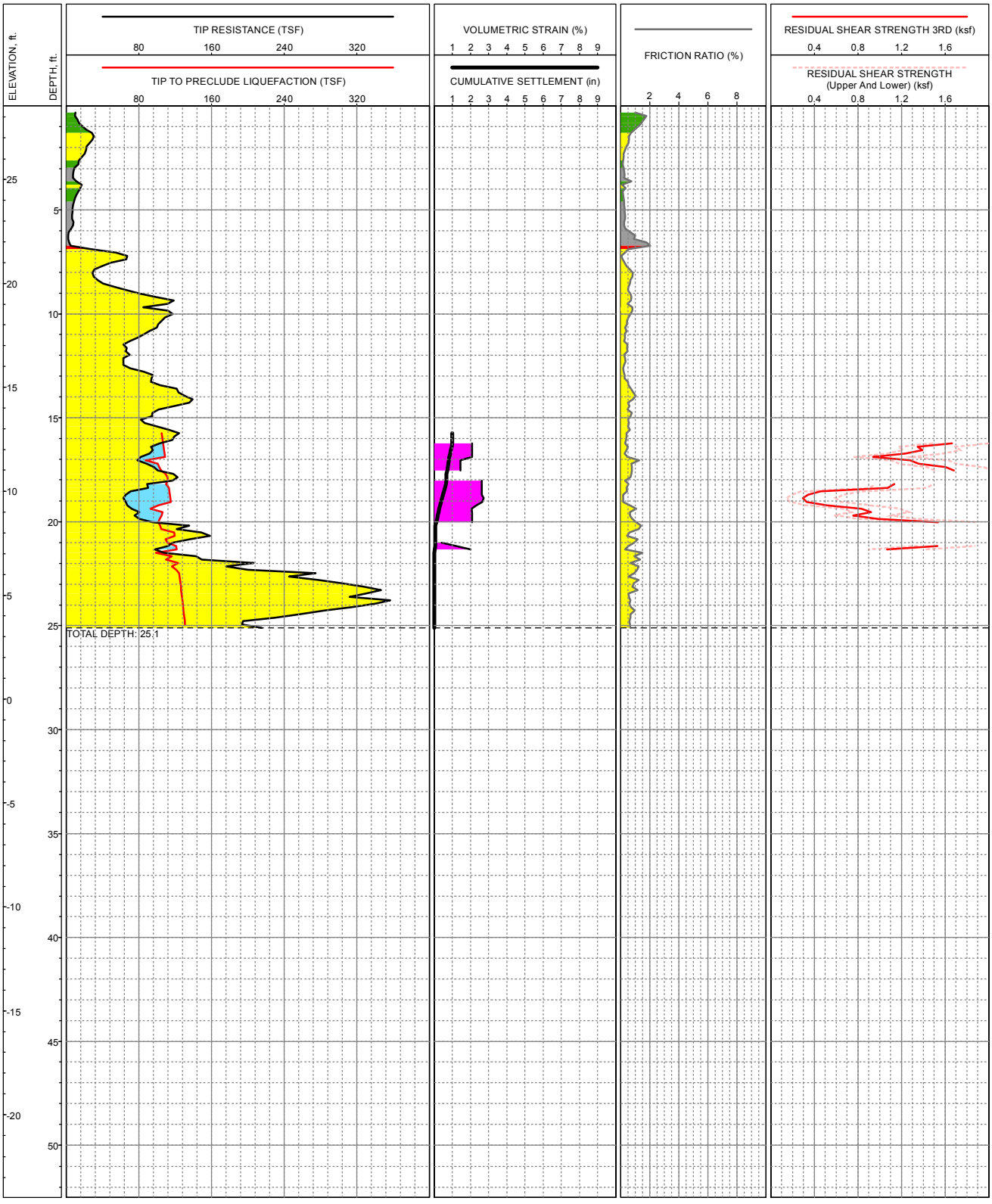
LOG OF CPT NO: C-114LL

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-27

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLeveeExplorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,358,786.16, E5,994,642.57
SURFACE EL: 28.5ft +/- (NAVD88)
COMPLETION DEPTH: 25.1ft
TESTDATE: 9/22/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

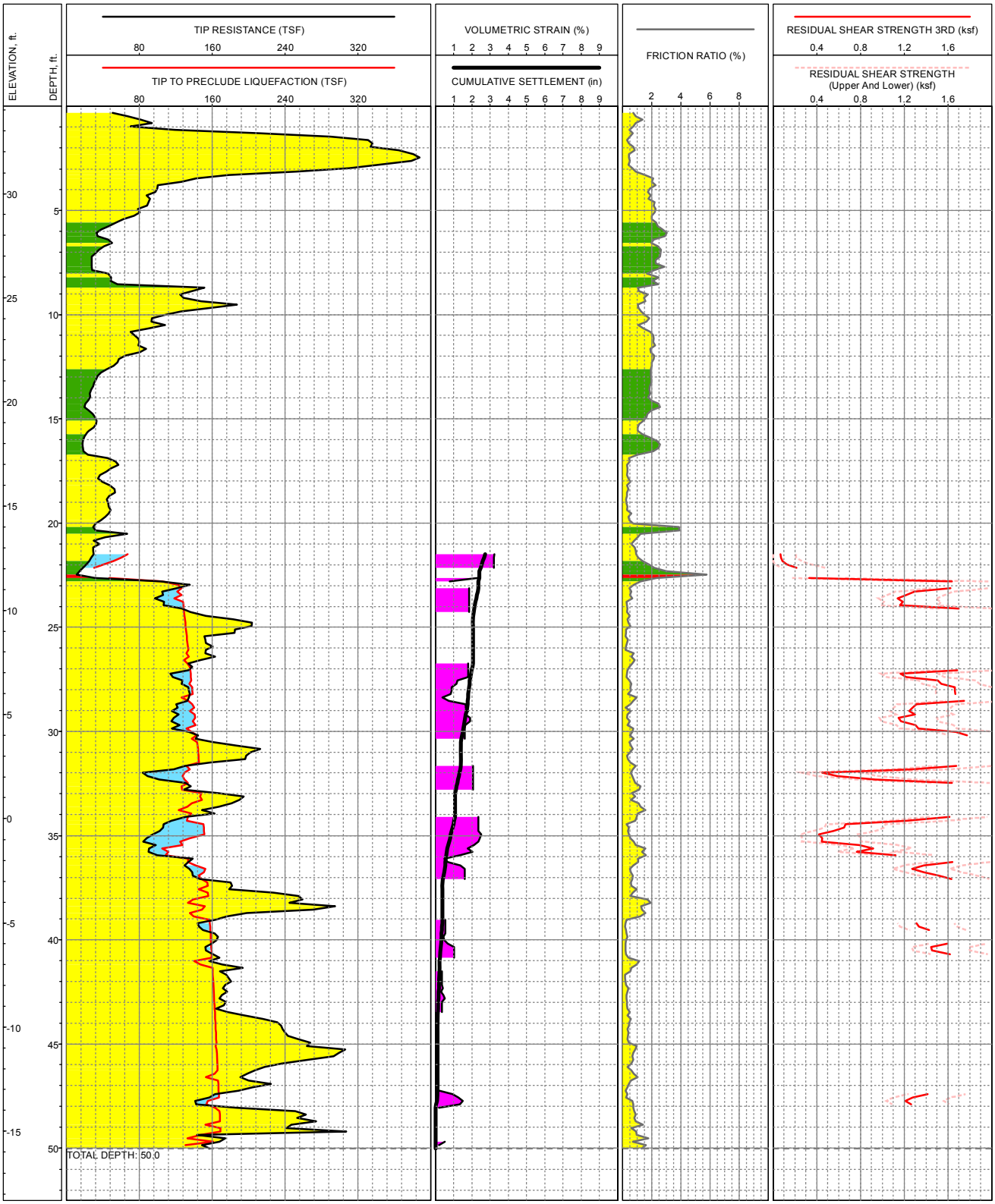
LOG OF CPT NO: C-114LO

M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-28

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,328.93, E5,994,586.94
SURFACE EL: 34.2ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/21/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114RC

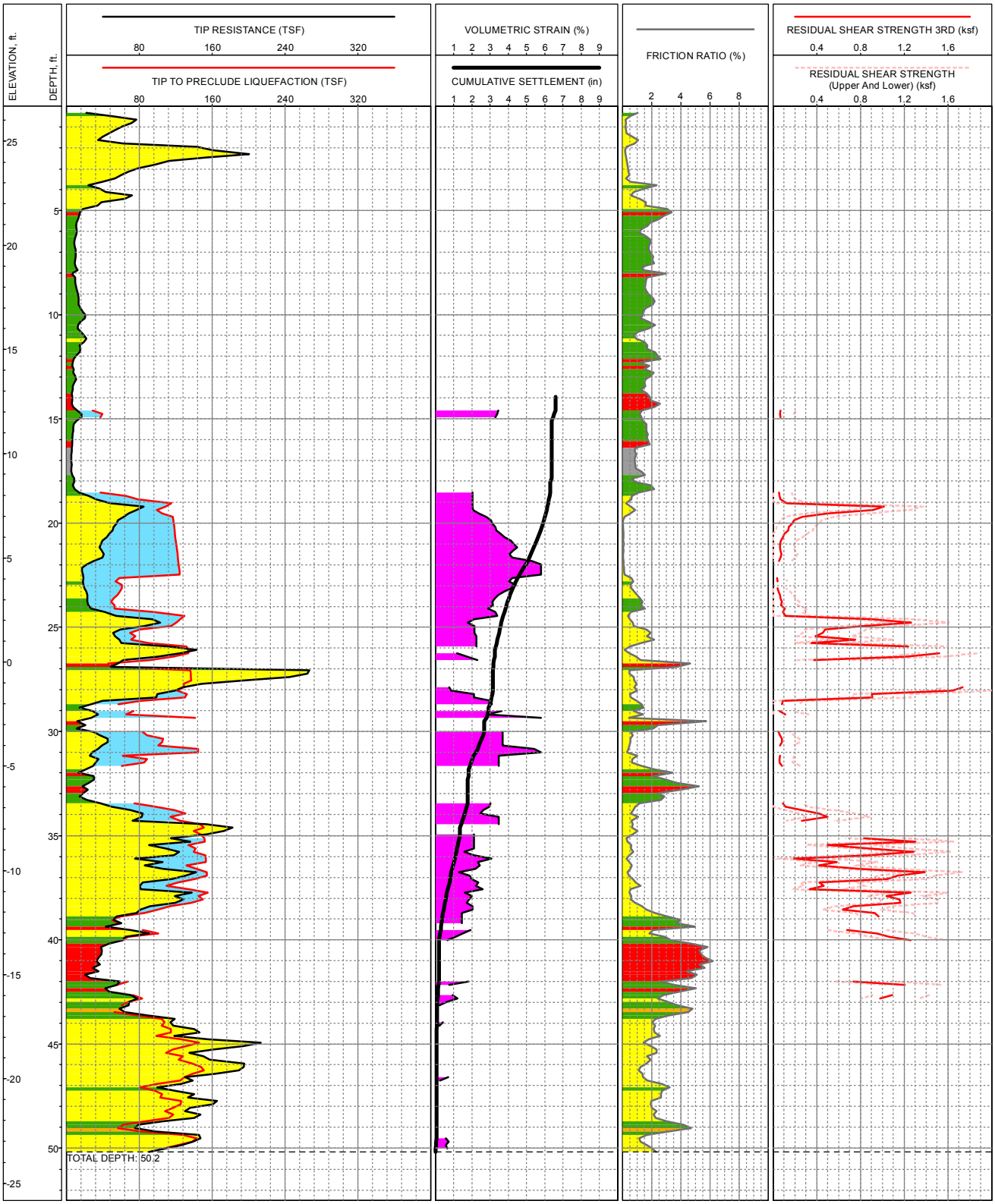
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-29

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,428.42, E5,994,590.67
SURFACE EL: 26.7ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-114RO

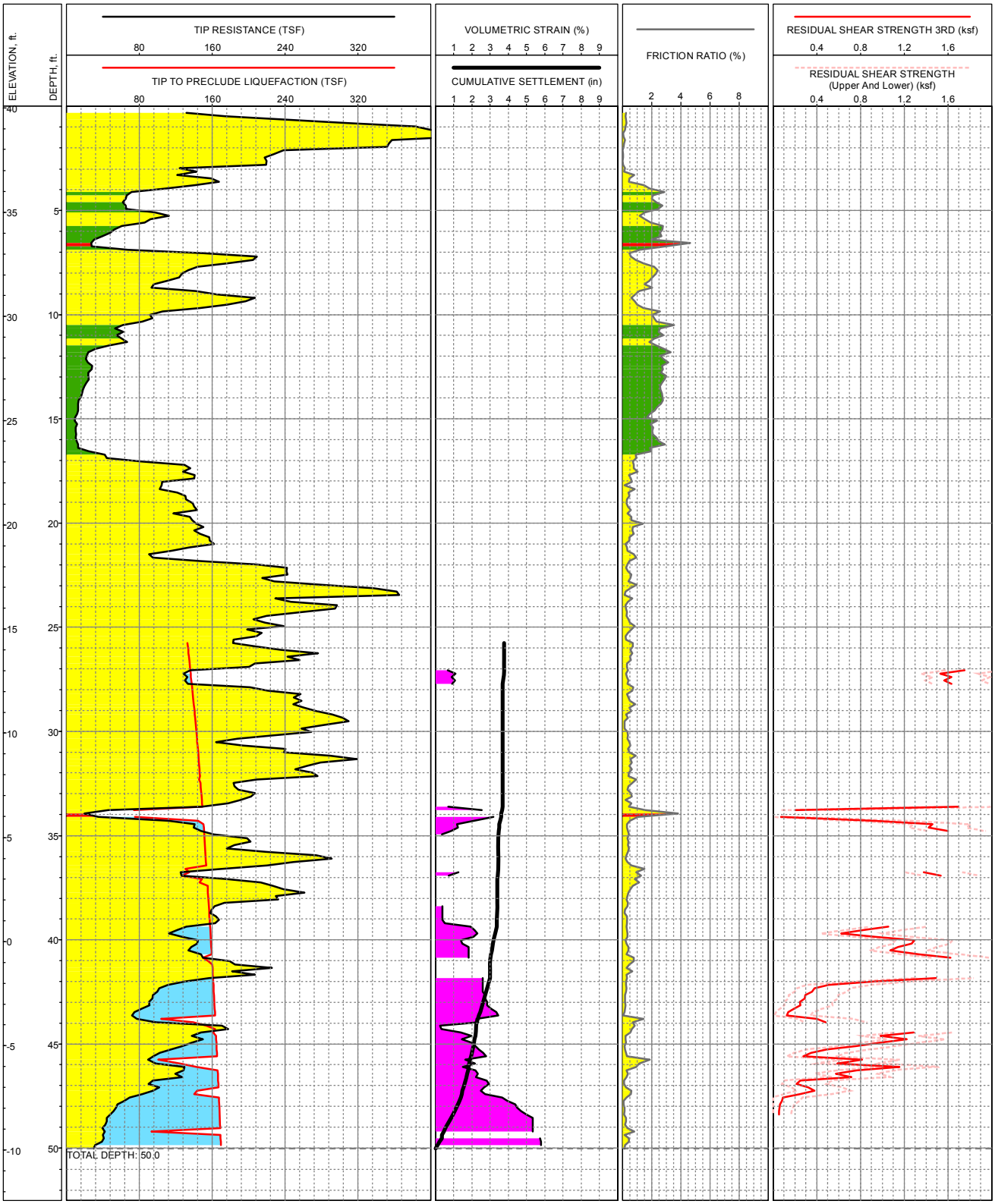
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-30

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,242.72, E5,996,496.69
SURFACE EL: 40.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-132LC

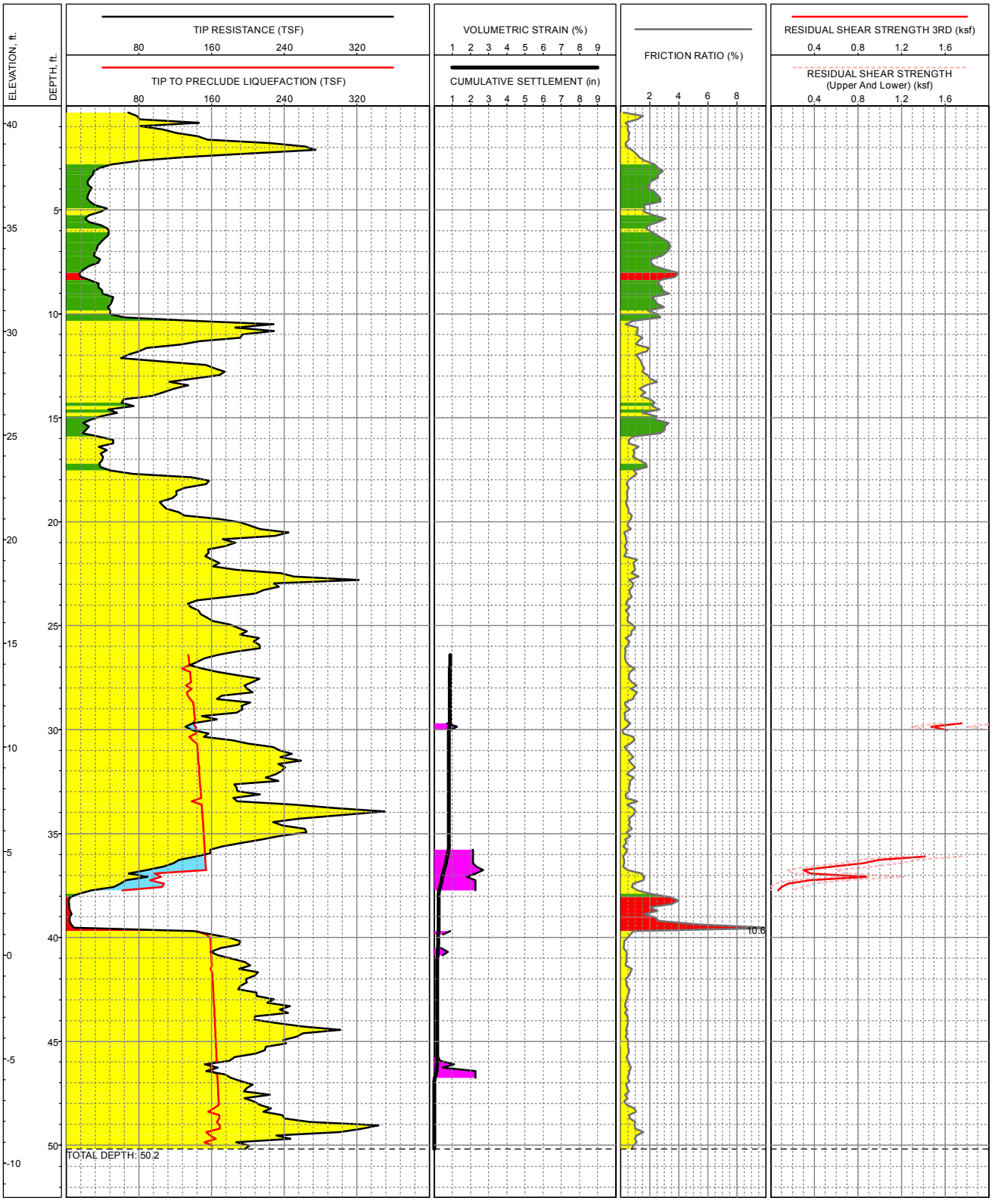
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-31

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,359,611.97, E5,996,278.46
SURFACE EL: 40.9ft +/- (NAVD88)
COMPLETION DEPTH: 50.2ft
TESTDATE: 9/20/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-132RC

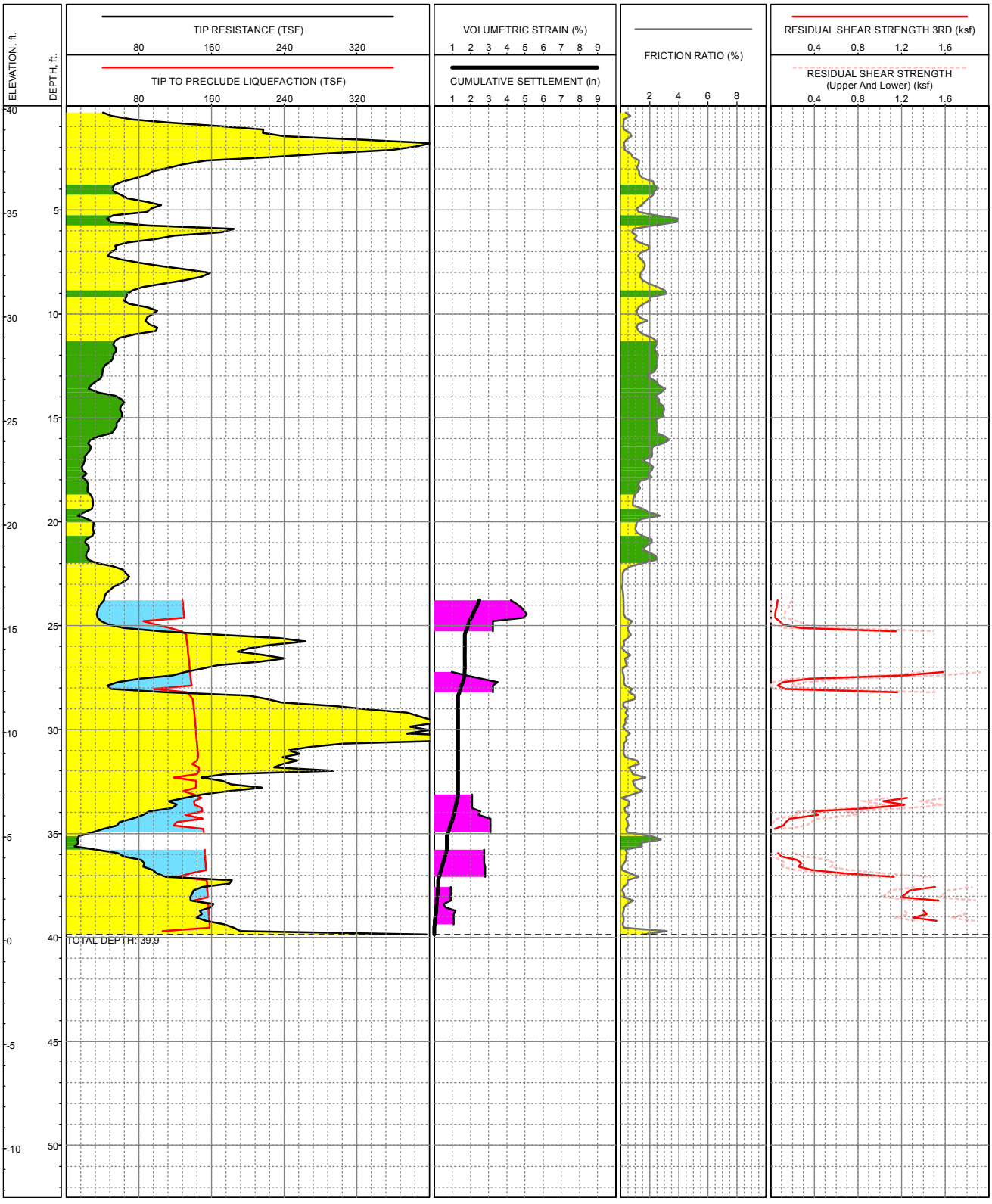
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-32

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,360,459.00, E5,997,182.56
SURFACE EL: 40.2ft +/- (NAVD88)
COMPLETION DEPTH: 39.9ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-146LC

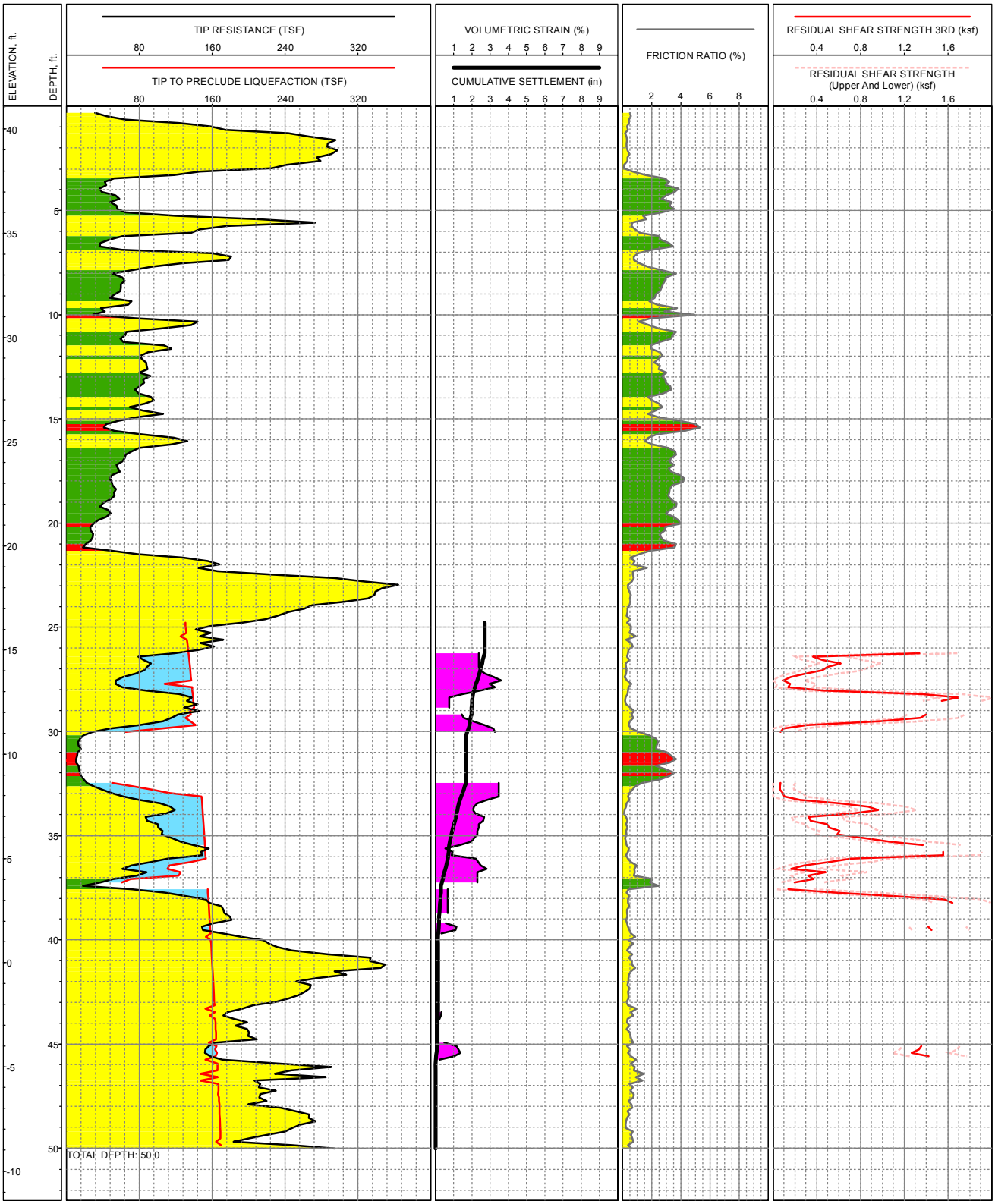
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-33

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,360,674.68, E5,996,803.74
SURFACE EL: 41.1ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/20/2010

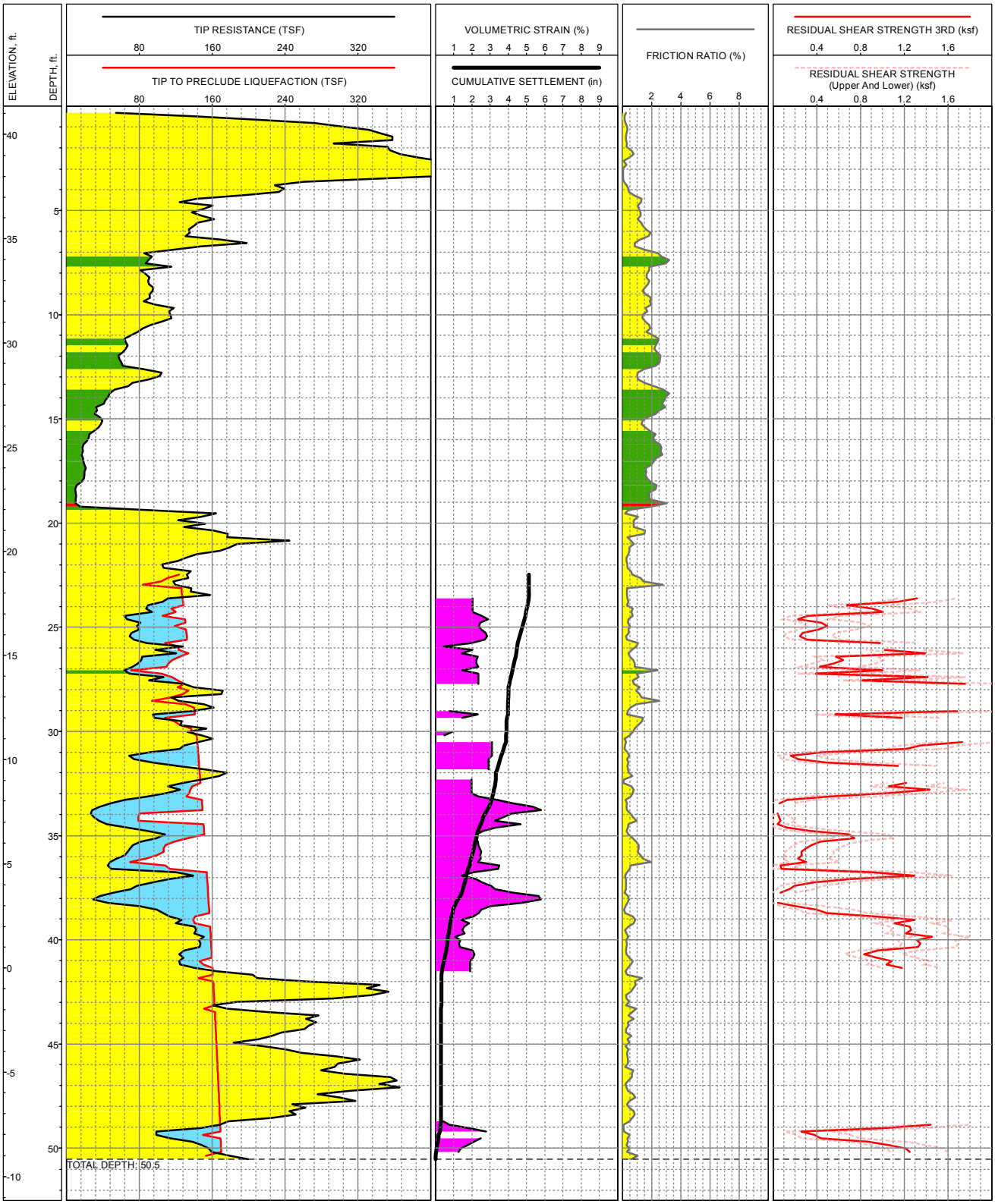
EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-146RC

M = 9.0, P.G.A. = 0.2 g
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-34

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,622.45, E5,997,626.65
SURFACE EL: 41.4ft +/- (NAVD88)
COMPLETION DEPTH: 50.5ft
TESTDATE: 9/24/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-158LC

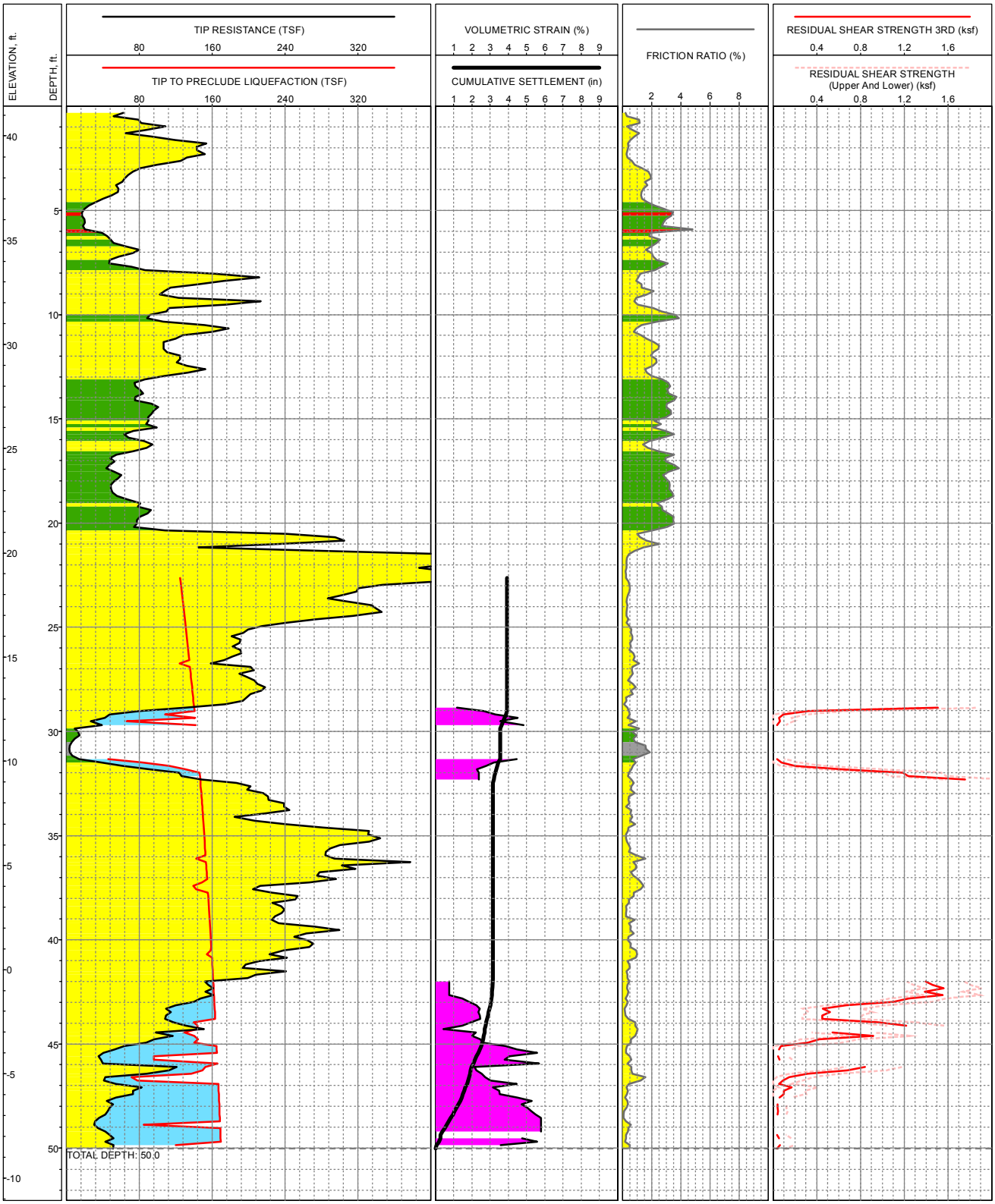
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-35

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,361,764.32, E5,997,201.95
SURFACE EL: 41.4ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/20/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-158RC

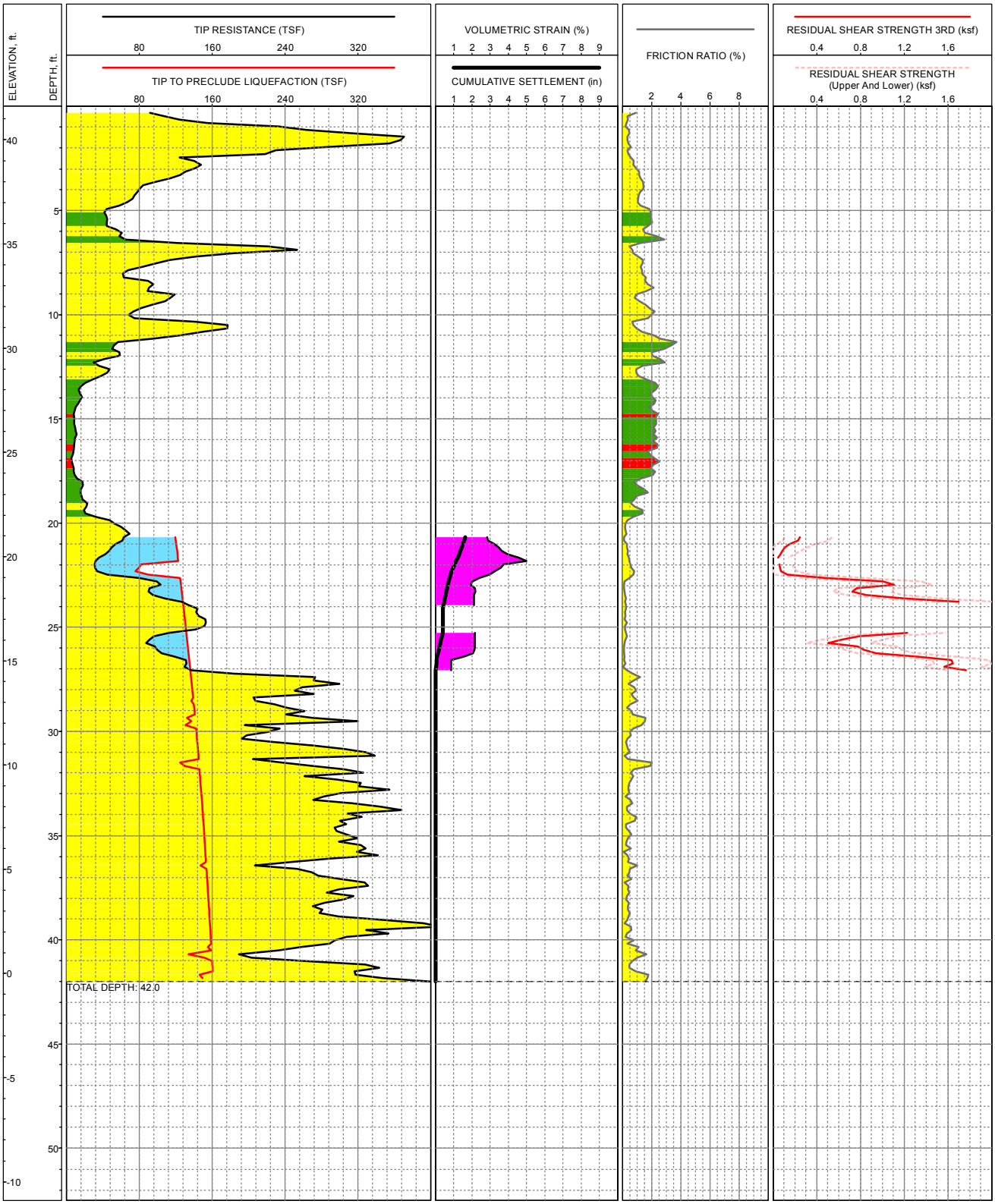
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-36

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,362,582.00, E5,998,172.00
SURFACE EL: 41.6ft +/- (NAVD88)
COMPLETION DEPTH: 42.0ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-171LC

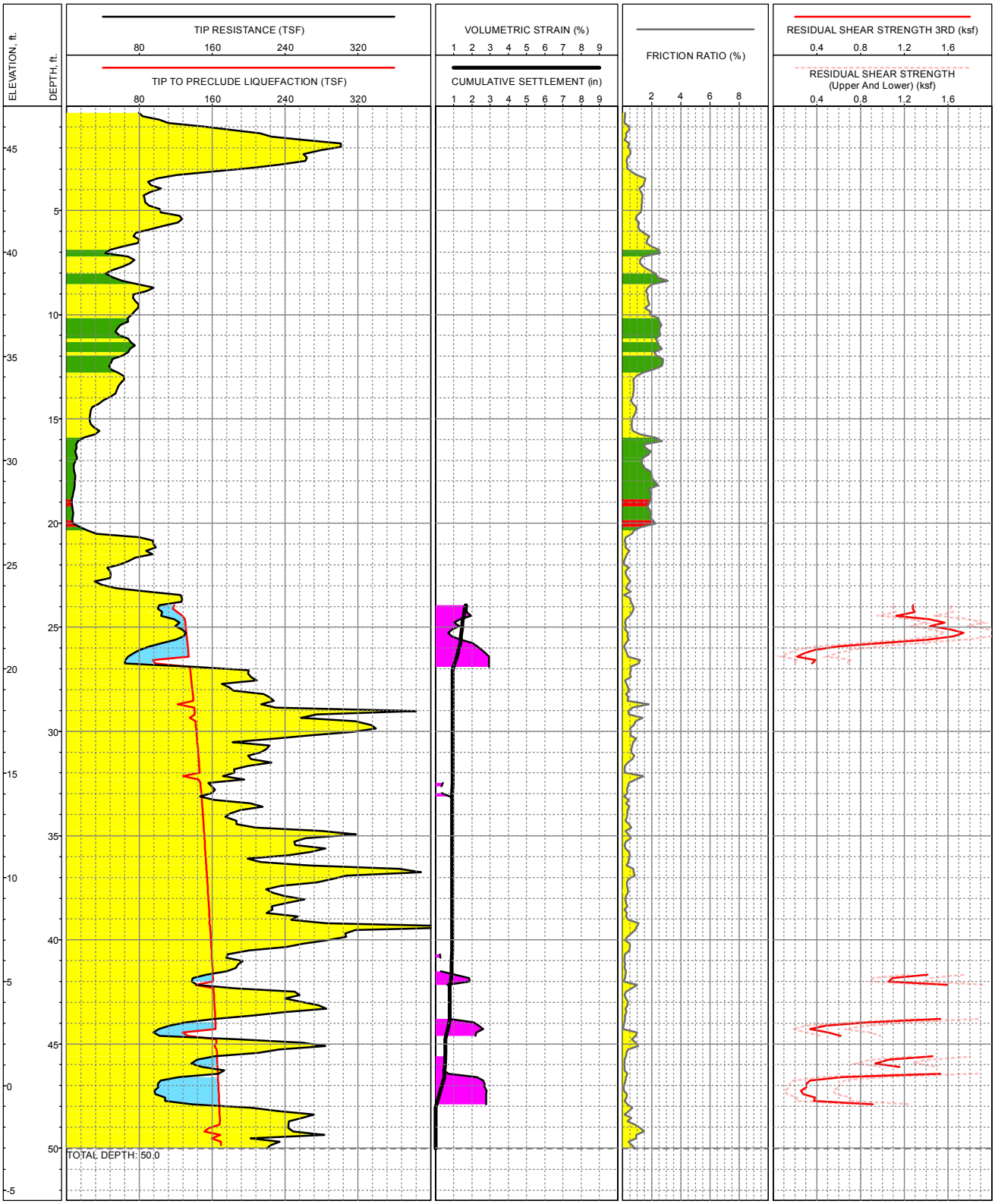
M = 9.0, P.G.A. = 0.2 g

Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

PLATE D-37

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean



LOCATION: N2,362,724.71, E5,999,672.32
SURFACE EL: 47.0ft +/- (NAVD88)
COMPLETION DEPTH: 50.0ft
TESTDATE: 9/23/2010

EXPLORATION METHOD: Cone Penetrometer
PERFORMED BY: Gregg Drilling
REVIEWED BY: G Eckrich
CONE AREA RATIO: 0.85

LOG OF CPT NO: C-185LC

M = 9.0, P.G.A. = 0.2 g

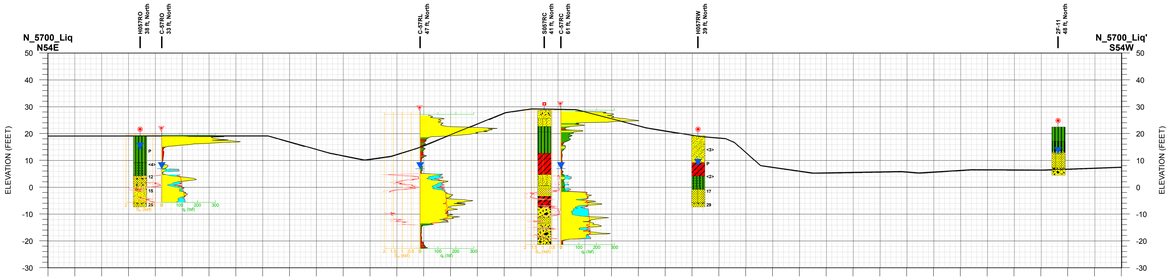
Redwood Creek Levee Geotechnical Evaluation Project

Orick, Humboldt County, California

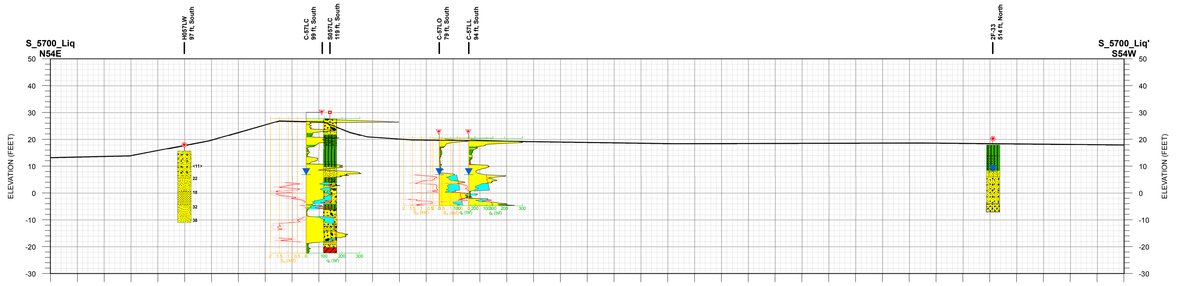
PLATE D-38

N:\Projects\3502_CurryGroup\3502-002_RedwoodCRLevee\Explorations\CPT\2010\Logs\2010_12_02_Logs_M9_a0_2_wRes\MXD\Logs_M9_a0_2_CGI10C_wRes.mxd,05/11/2011,CDean

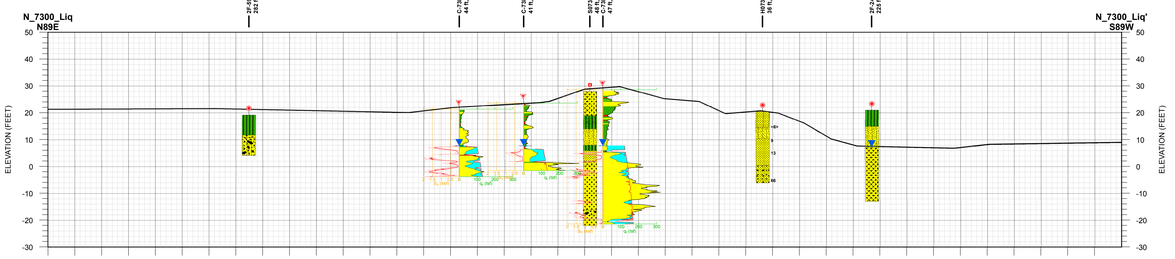
57+00 North



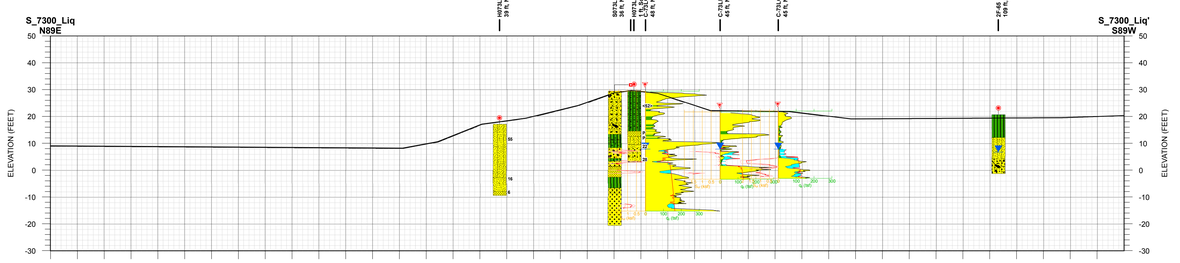
57+00 South



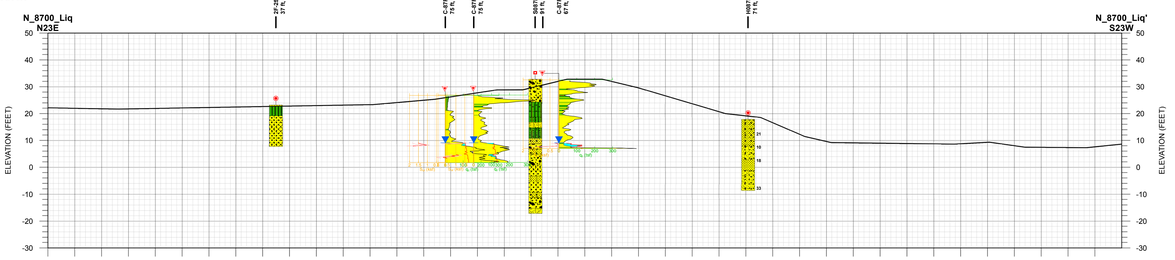
73+00 North



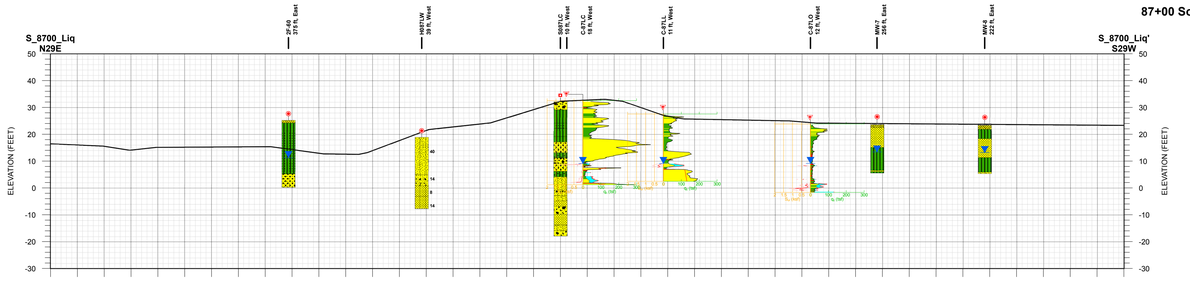
73+00 South



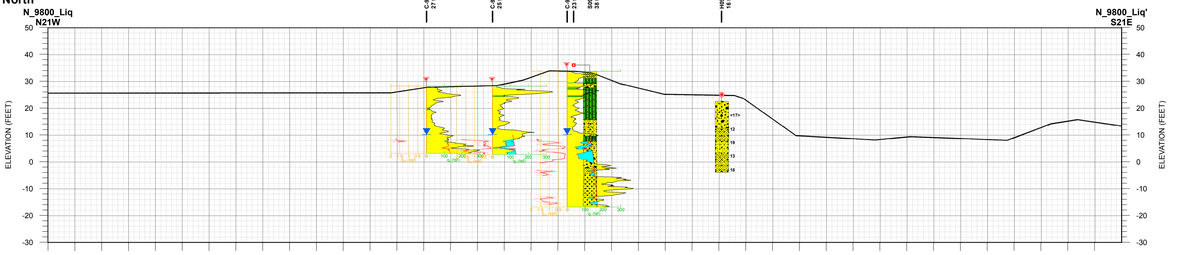
87+00 North



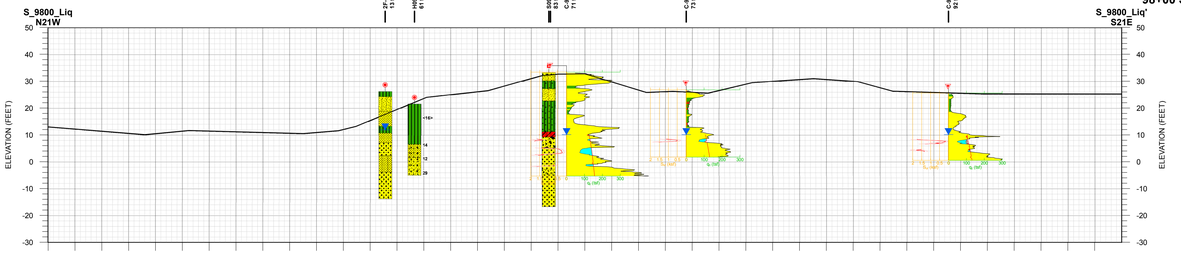
87+00 South



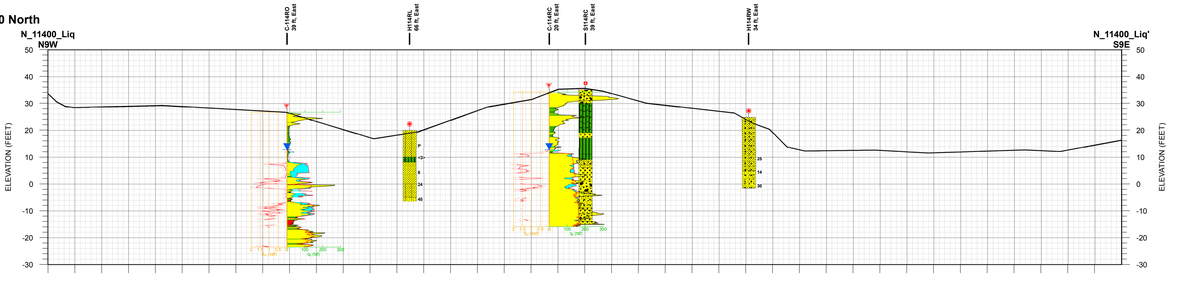
98+00 North



98+00 South



114+00 North



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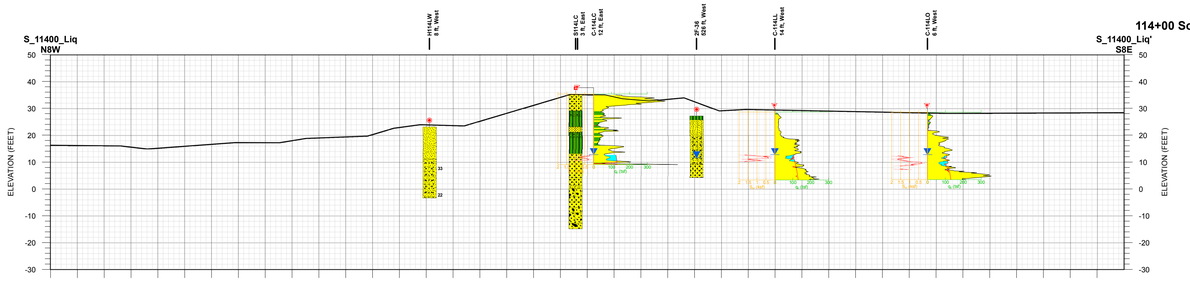
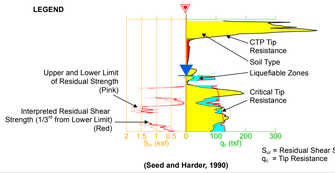


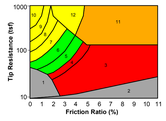
LEGEND



S_{ur} = Residual Shear Strength
q_c = Tip Resistance

(Seed and Harder, 1990)

COLOR LEGEND FOR FRICTION RATIO TRACES

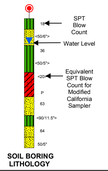


Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-OH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART

(Robertson and Campanella, 1988)



SOIL BORING LITHOLOGY

- Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Sandy Lean Clay (CL)
- Gravelly Lean CLAY (CL)
- Fat CLAY (CH)
- Silt (ML)
- Clayey SILT (ML)
- Sandy, Gravelly SILT (ML)
- Sandy SILT (ML)
- Gravelly SILT (ML)
- Elastic Silt (MH)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND (SP)
- Well-Graded SAND (SW)
- Well-Graded SAND with Silt (SW-SM)
- Gravelly Well-Graded SAND (SW)
- Clayey SAND (SC)
- Silty SAND (SM)
- Gravelly Silty SAND (SM)
- Poorly-Graded GRAVEL (GP)
- Poorly-Graded GRAVEL with Clay (GP-GC)
- Poorly-Graded GRAVEL with Silt (GP-GM)
- Sandy GRAVEL (GP)
- Well-Graded GRAVEL (GW)
- Well-Graded GRAVEL with Clay (GW-GC)
- Well-Graded GRAVEL with Silt (GW-GM)
- Sandy Well-Graded GRAVEL (GW)
- Clayey GRAVEL (GC)
- Sandy, Clayey GRAVEL (GC)
- Silty Gravel (GM)
- Sandy, Silty GRAVEL (GM)
- Fill
- Asphaltic Concrete

20 ft
20 ft
Vertical Exaggeration = 1

Humboldt County Public Works Department
Fugro Project No. 04.83502002
CGI Project No. 10-1949.01

CGI Technical Services Inc. | Fugro

LIQUEFACTION CROSS SECTIONS
STATION 57+00, 73+00, 87+00, 98+00 AND 114+00
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2011	Levee Cross Sections	DRP	CBD	GE

PLATE D-39

K:\Projects\2502_Curt\Final\2502.004_RedwoodWaterLevels\2011_04_21_UpdatedEvaluation\Plate_D-39_LiquefactionCrossSections.mxd, 5/31/11, DRaw

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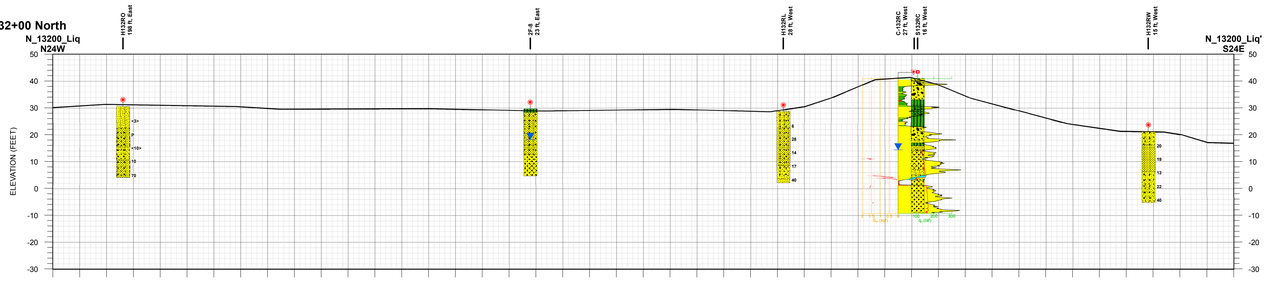
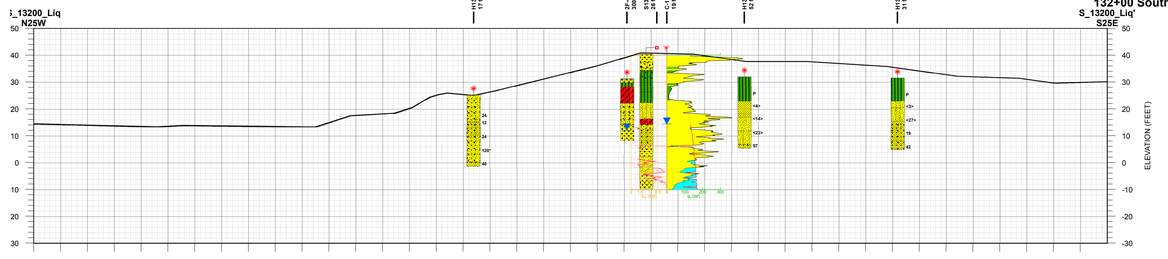
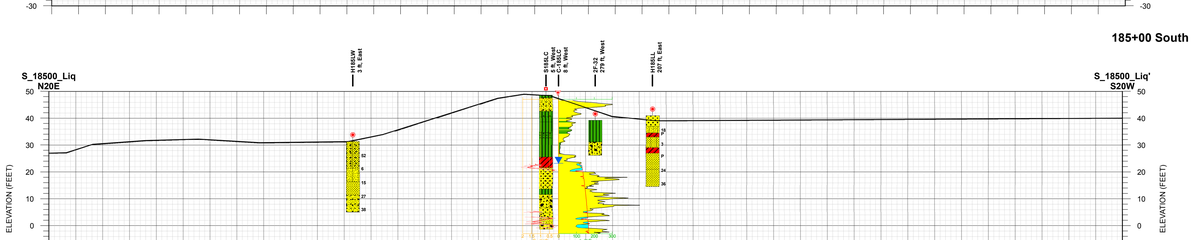


132+00 South



146+00 North

146+00 South



158+00 North

158+00 South

171+00 South

185+00 South

LEGEND

(Seed and Harder, 1990)

S_u = Residual Shear Strength
q_c = Tip Resistance

COLOR LEGEND FOR FRICTION RATIO TRACES

Zone	Soil Behavior Type	U.S.C.S.
1	Sensitive Fine-grained	OL-CH
2	Organic Material	OL-CH
3	Clay	CH
4	Silty Clay to Clay	CL-CH
5	Clayey Silt to Silty Clay	MH-CL
6	Sandy Silt to Clayey Silt	ML-MH
7	Silty Sand to Sandy Silt	SM-ML
8	Sand to Silty Sand	SM-SP
9	Sand	SW-SP
10	Gravelly Sand to Sand	SW-GW
11	Very Stiff Fine-grained *	CH-CL
12	Sand to Clayey Sand *	SC-SM

*overconsolidated or cemented

CPT CORRELATION CHART
(Robertson and Campanella, 1988)

SOIL BORING LITHOLOGY

- Lean CLAY (CL)
- Silty CLAY (CL-ML)
- Sandy Lean Clay (CL)
- Sandy, Gravelly Lean CLAY (CL)
- Gravelly Lean CLAY (CL)
- Silt (ML)
- Sandy, Gravelly SILT (ML)
- Sandy SILT (ML)
- Gravelly SILT (ML)
- Poorly-Graded SAND (SP)
- Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND with Silt (SP-SM)
- Gravelly Poorly-Graded SAND (SP)
- Well-Graded SAND (SW)
- Well-Graded SAND with Clay (SW)
- Well-Graded SAND with Silt (SW-SM)
- Gravelly Well-Graded SAND (SW)
- Clayey SAND (SC)
- Gravelly, Clayey SAND (SC)
- Silty SAND (SM)
- Gravelly Silty SAND (SM)
- Poorly-Graded GRAVEL (GP)
- Poorly-Graded GRAVEL with Clay (GP-GC)
- Poorly-Graded GRAVEL with Silt (GP-GM)
- Sandy GRAVEL with Silt (GP-GM)
- Sandy GRAVEL (GP)
- Well-Graded GRAVEL with Clay (GW-GC)
- Well-Graded GRAVEL with Silt (GW-GM)
- Sandy Well-Graded GRAVEL (GW)
- Sandy, Clayey GRAVEL (GC)
- Silty Gravel (GM)
- Sandy, Silty GRAVEL (GM)
- Fill
- Asphaltic Concrete

20 ft
20 ft
Vertical Exaggeration = 1

Humboldt County Public Works Department
Fugro Project No. 04.B3502002
CGI Project No. 10-1949.01

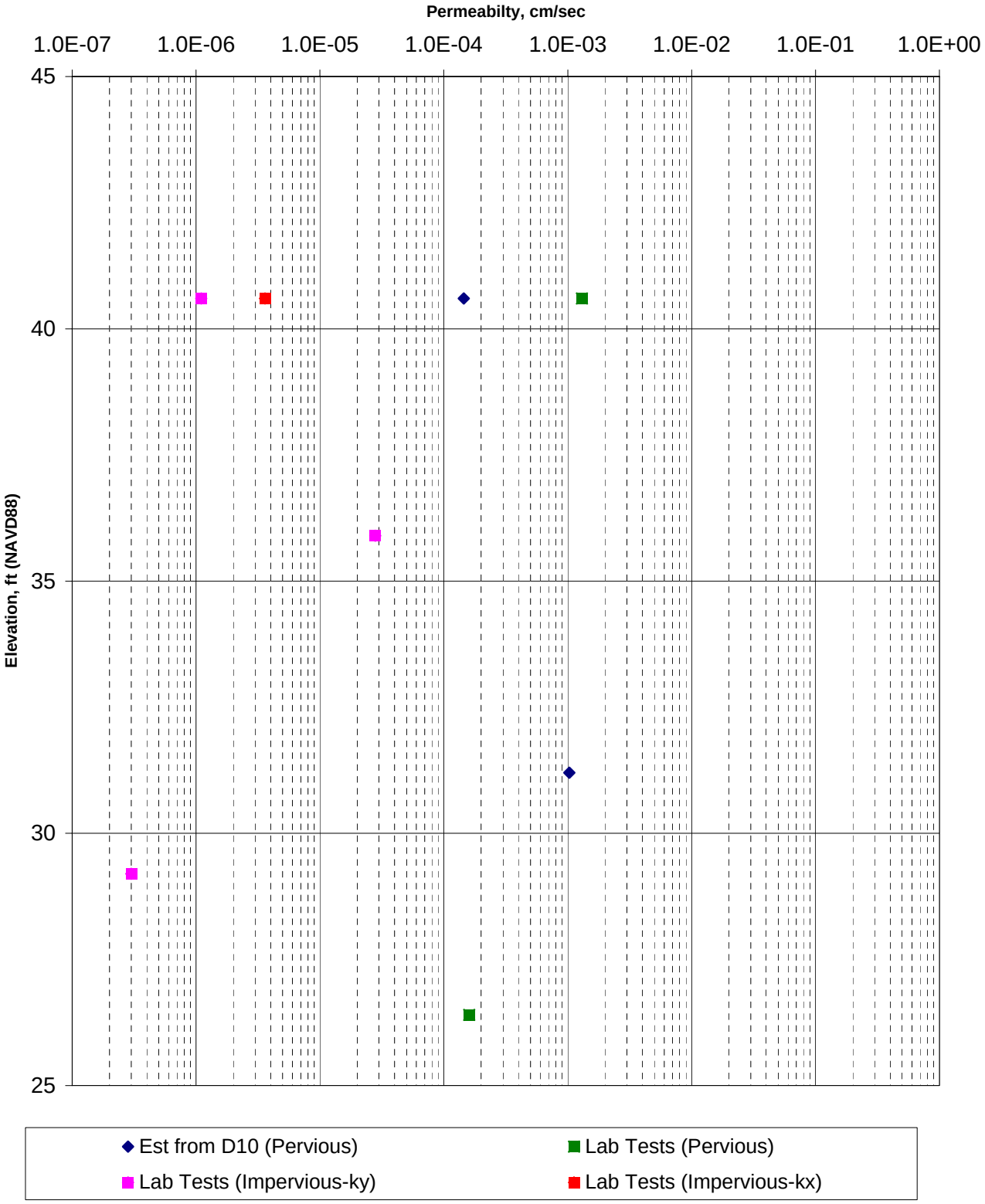
CGI Technical Services Inc. | Fugro

LIQUEFACTION CROSS SECTIONS
STATION 132+00, 146+00, 158+00, 171+00 AND 185+00
Redwood Creek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

NO:	DATE:	DESCRIPTION:	DRAWN:	CHKD:	APPR:
1	May 2011	Levee Cross Sections	DRP	CBD	GE

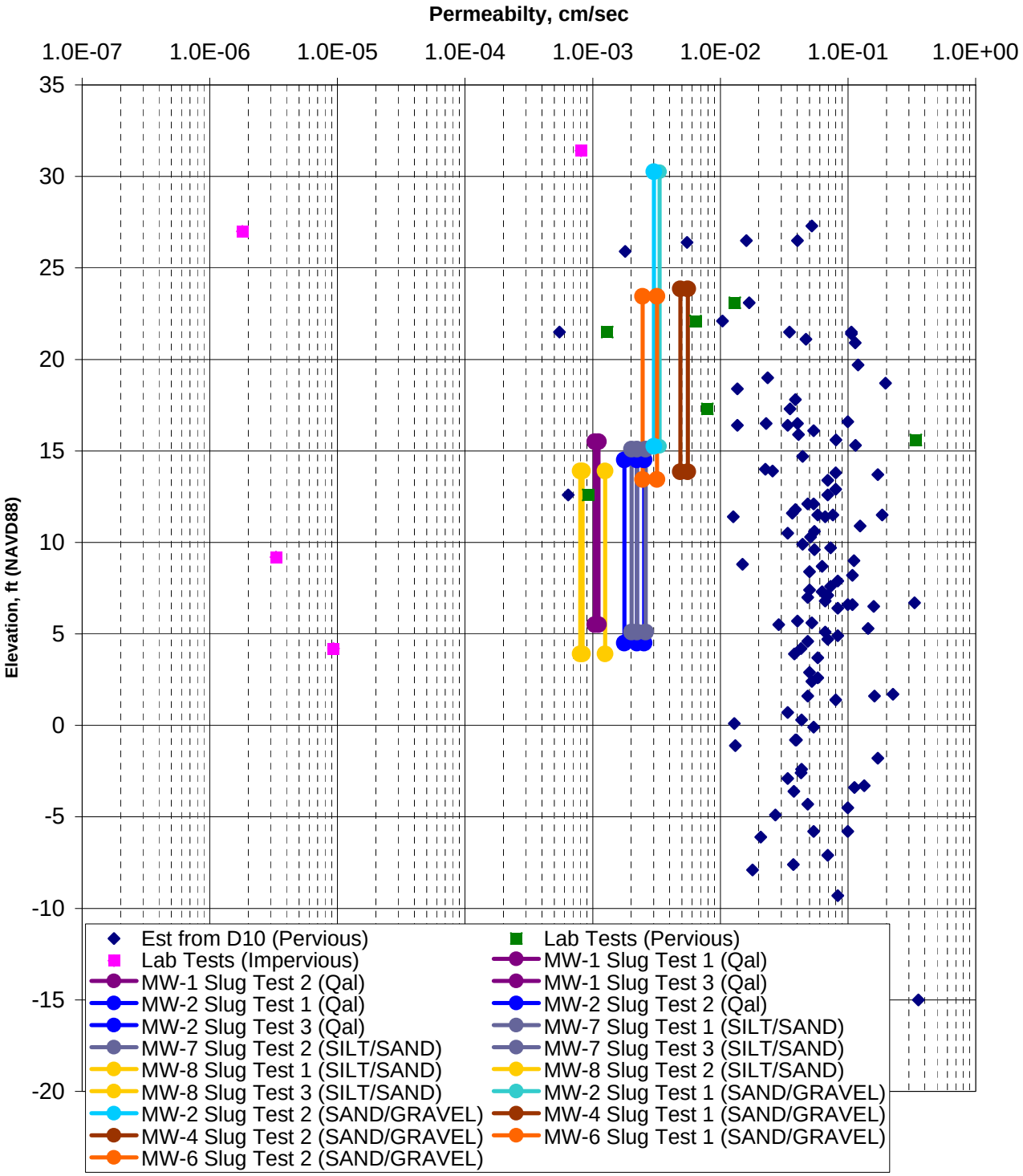
PLATE D-40

G:\Projects\B502_Cost\Cad\2502-002 Redwood\Drawings\Liquefaction\Plate_D-40_LiquefactionCrossSections.mxd, 05/11/11, Oliver



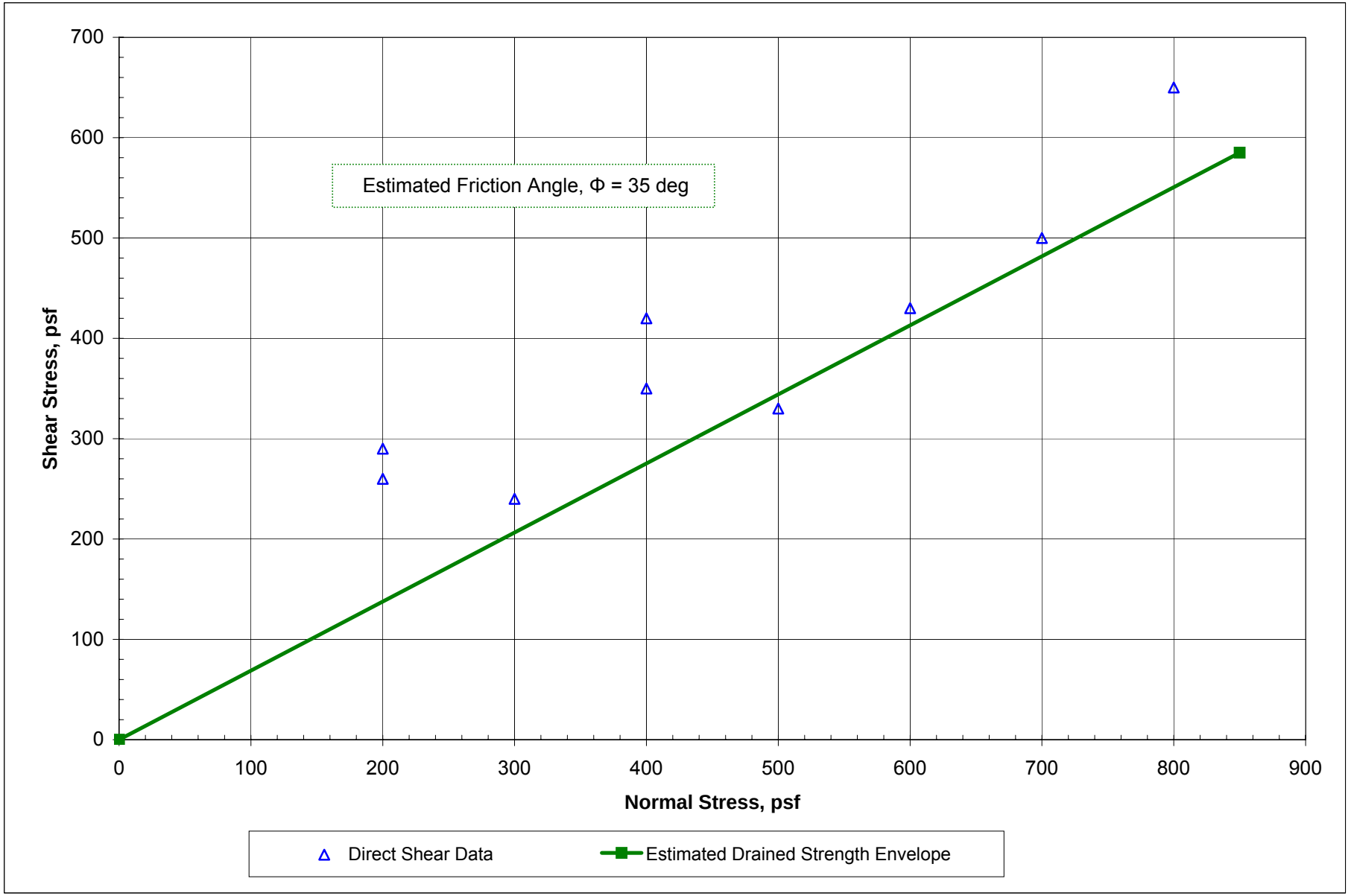
LEVEE FILL PERMEABILITY ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-41



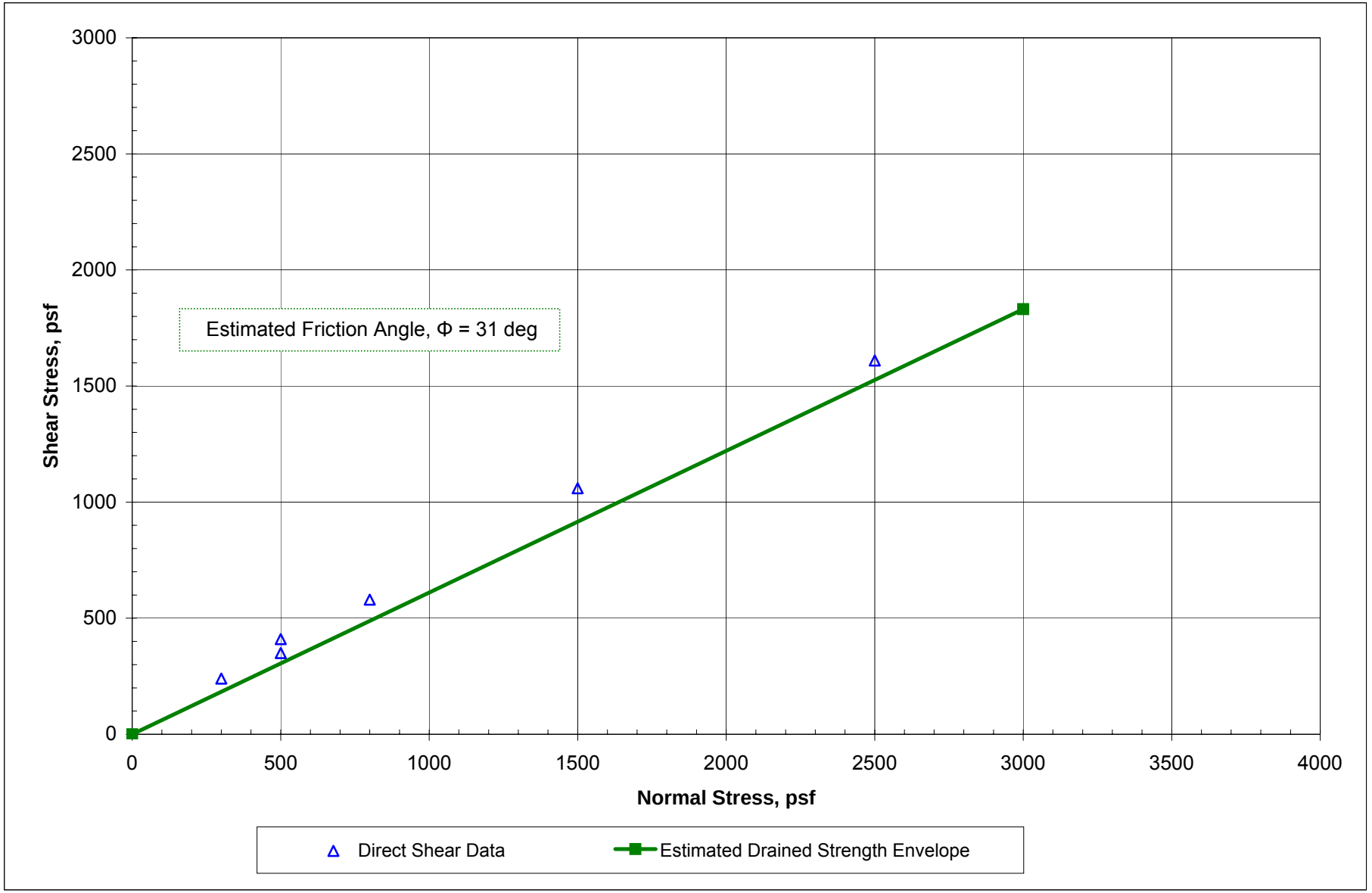
FOUNDATION PERMEABILITY ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-42



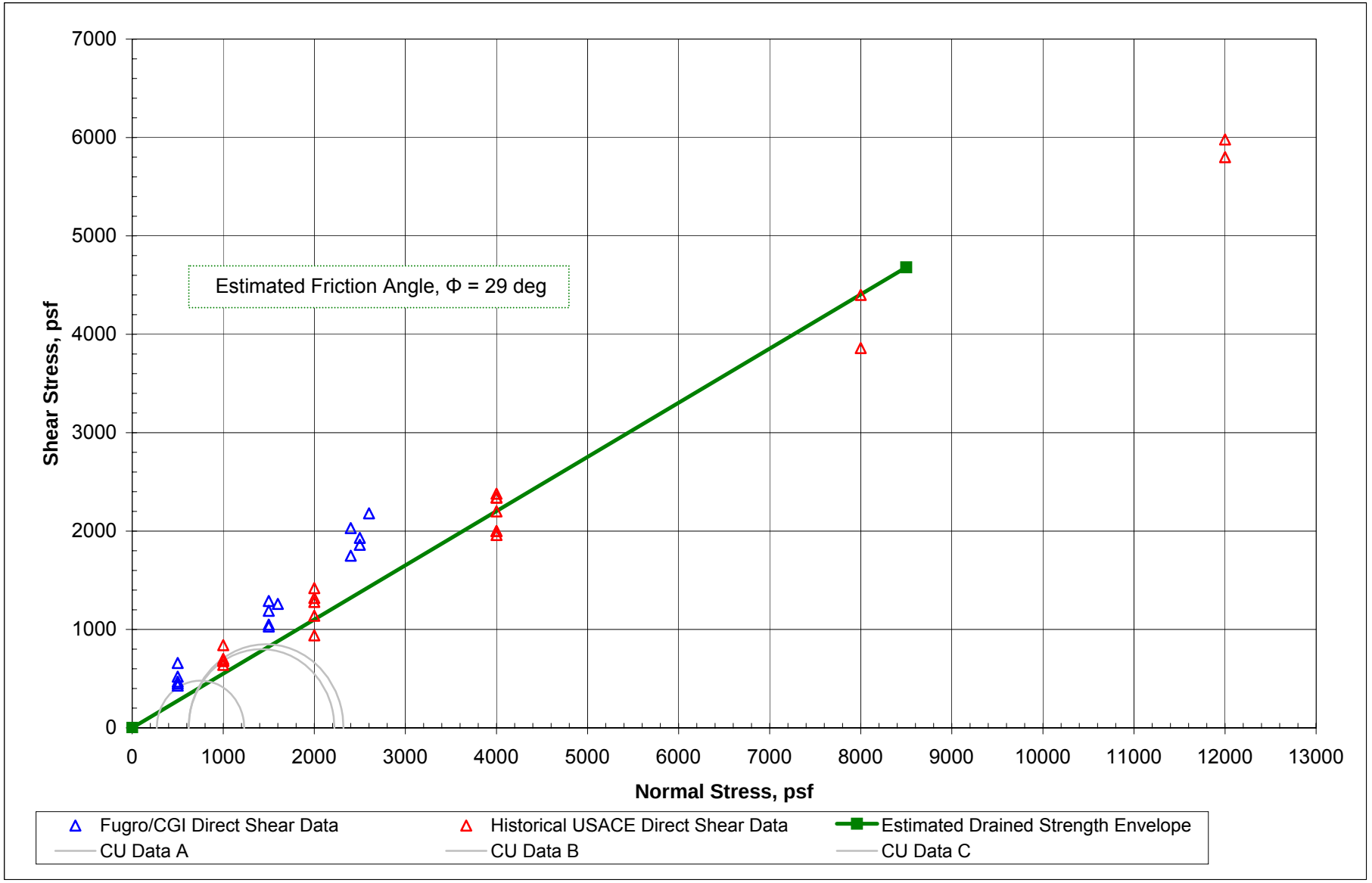
PERVIOUS LEVEE FILL DRAINED STRENGTH ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-43



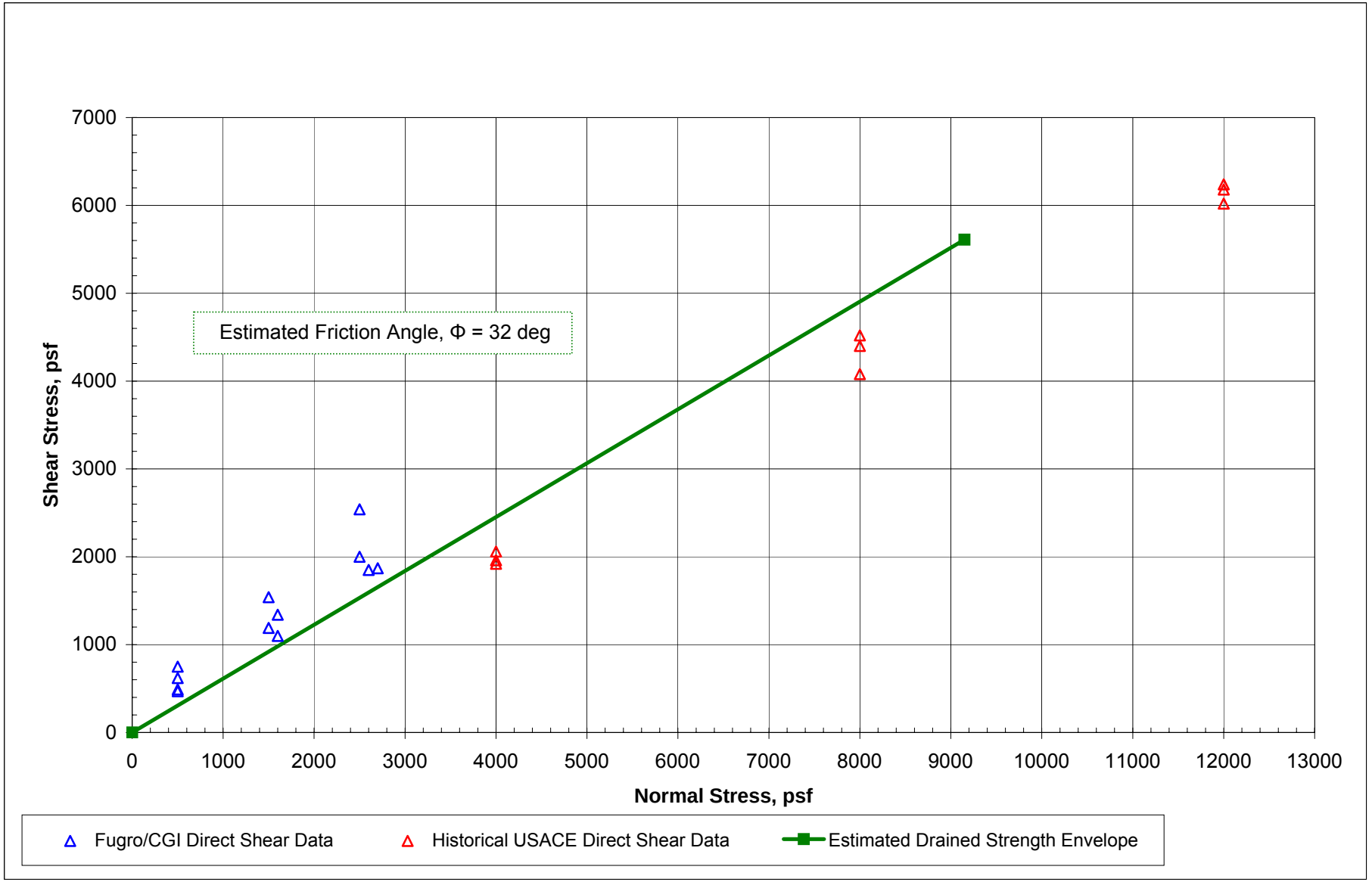
IMPERVIOUS LEVEE FILL DRAINED STRENGTH ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-44



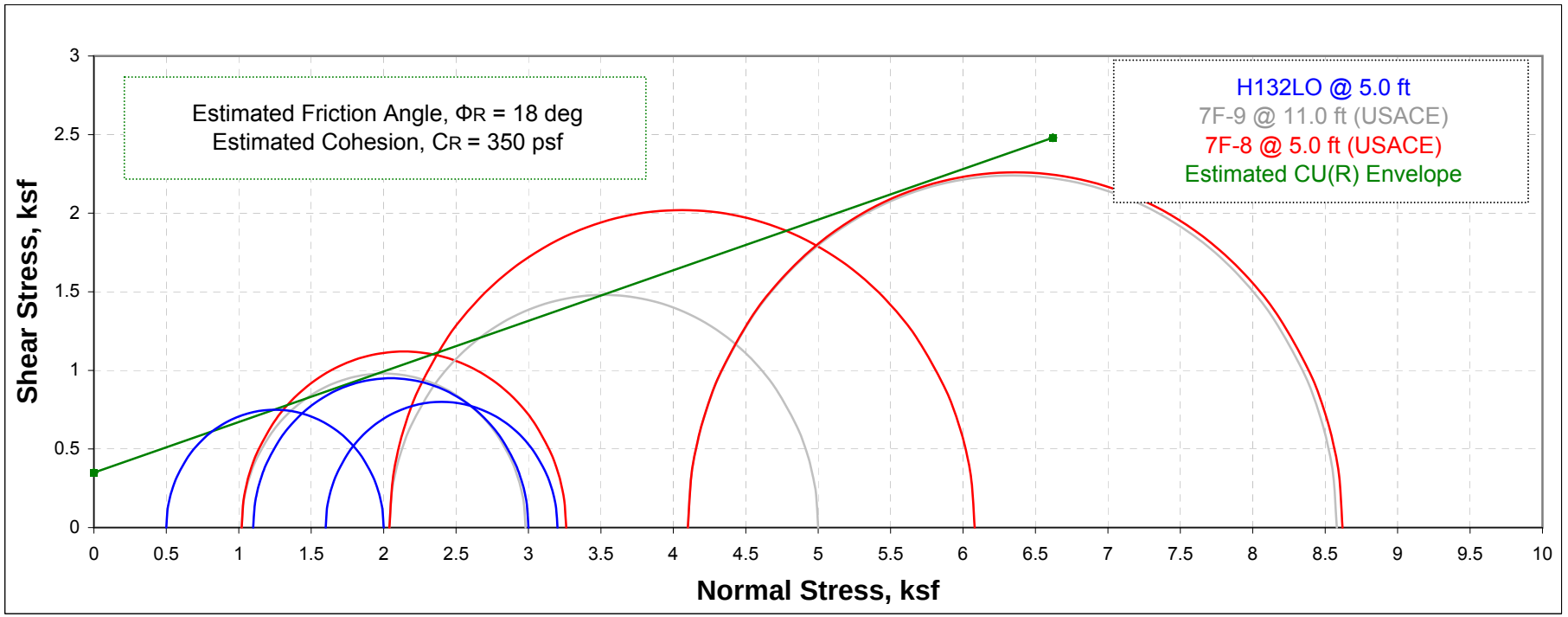
IMPERVIOUS FOUNDATION DRAINED STRENGTH ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-45



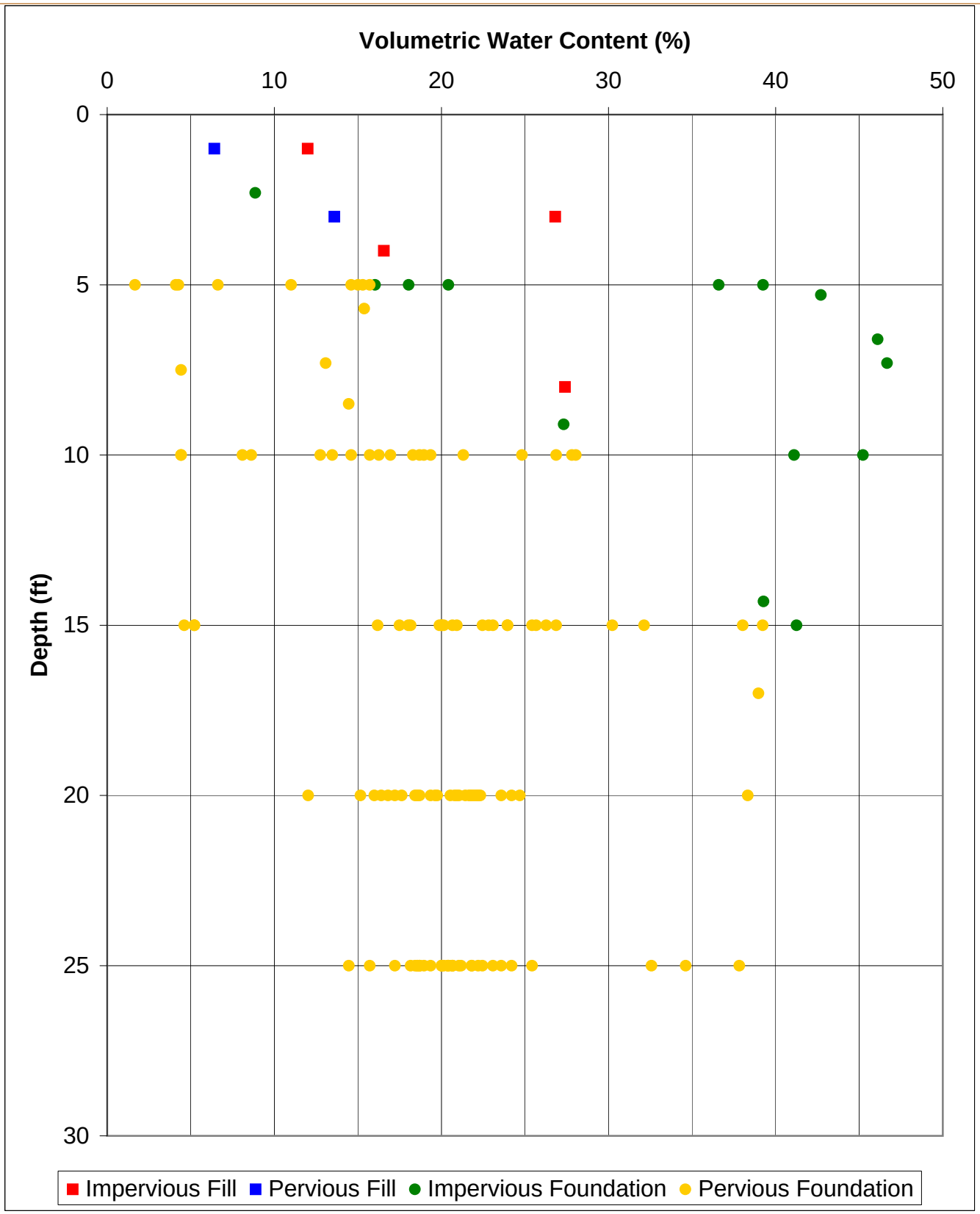
PERVIOUS FOUNDATION DRAINED STRENGTH ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-46



IMPERVIOUS MATERIAL CONSOLIDATED UNDRAINED [CU(R)] STRENGTH ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-47



VOLUMETRIC WATER CONTENT ESTIMATES
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

PLATE D-48

Simplified Procedure for Estimating Earthquake Induced Deviatoric Slope Displacements
by Jonathan D. Bray and Thaleia Travasarou
Journal of Geotechnical and Geonvironmental Engineering, ASCE, V. 133(4), pp. 381-392, April 2007

SEE NOTES BELOW FOR GUIDANCE IN THE USE OF SPREADSHEET

Input Parameters			
Yield Coefficient (ky)	0.022		Based on pseudostatic analysis
Initial Fundamental Period (Ts)	0.10	seconds	1D: Ts=4H/Vs 2D: Ts=2.6H/Vs
Degraded Period (1.5Ts)	0.15	seconds	
Moment Magnitude (Mw)	9.0		
Spectral Acceleration (Sa(1.5Ts))	0.39	g	

Additional Input Parameters		
Probability of Exceedance #1 (P1)	84	%
Probability of Exceedance #2 (P2)	50	%
Probability of Exceedance #3 (P3)	16	%
Displacement Threshold (d_threshold)	5	cm

Intermediate Calculated Parameters			
Non-Zero Seismic Displacement Est (D)	91.07	cm	eq. (5) or (6)
Standard Deviation of Non-Zero Seismic D	0.66		

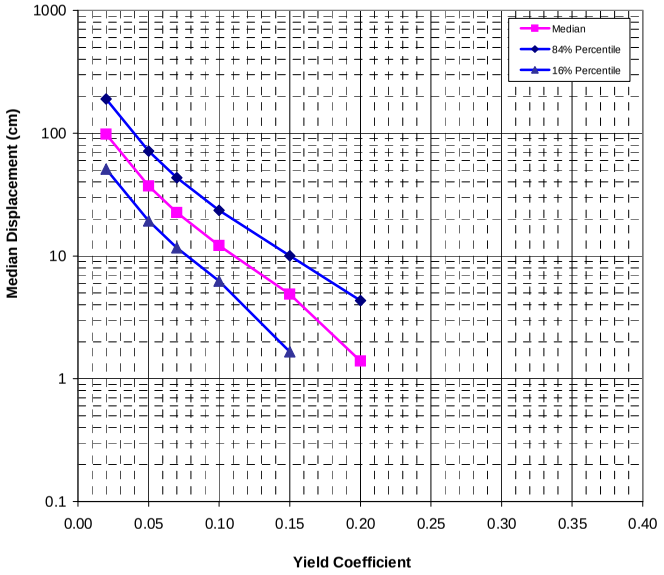
Results			
Probability of Negligible Displ. (P(D=0))	0.000		eq. (3)
D1	47.24	cm	calc. using eq. (7)
D2	91.07	cm	calc. using eq. (7)
D3	175.57	cm	calc. using eq. (7)
P(D>d_threshold)	1.000		eq. (7)

Notes

1. Values highlighted in blue are input parameters
2. Probability of Exceedance is the desired probability of exceeding a particular displacement value.
3. Displacements D1, D2, and D3 correspond to P1, P2, and P3, respectively.
   (e.g., the probability of exceeding displacement D1 is P1)
4. Calculated seismic displacements are due to deviatoric deformation only (add in volumetrically induced movement).
5. ky may range between 0.01 and 0.5, Ts between 0 and 2 s, Sa between 0.002 and 2.7 g, M between 4.5 and 9
6. Rigid slope is assumed for Ts < 0.05 s
7. When a value for D is not calculated, D is < 1cm
8. ky may be estimated using the simplified equations shown below.
9. Examples of how Ts is estimated are shown below.
10. Vs = weighted avg. shear wave velocity for the sliding mass, e.g., for 2 layers, Vs = [(h1)(Vs1) + (h2)(Vs2)]/(h1 + h2)

Dependence on ky

ky	P(D="0")	D (cm)	Dmedian (cm)	D1 (cm)	D3 (cm)
0.020	0.00	98.2	98.2	189.3	50.9
0.05	0.00	37.1	37.1	71.5	19.2
0.07	0.00	22.5	22.5	43.4	11.7
0.1	0.01	12.2	12.2	23.5	6.2
0.15	0.13	5.5	4.9	10.0	1.7
0.2	0.43	2.9	1.4	4.3	<1
0.3	0.87	1.1	<1	<1	<1
0.4	0.98	0.5	<1	<1	<1



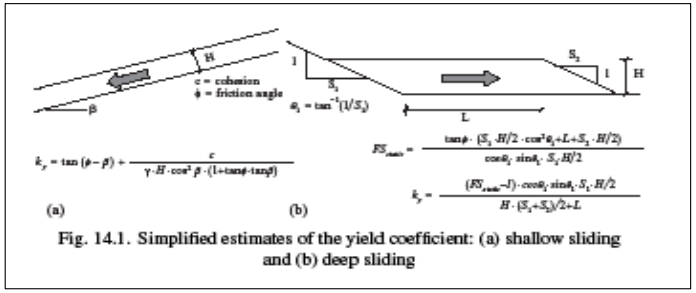


Fig. 14.1. Simplified estimates of the yield coefficient: (a) shallow sliding and (b) deep sliding

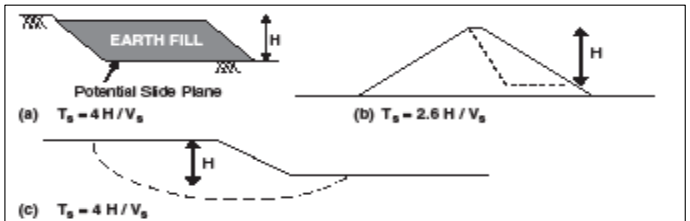


Fig. 14.4. Estimating the initial fundamental period of potential sliding blocks

Simplified Procedure for Estimating Earthquake Induced Deviatoric Slope Displacements
by Jonathan D. Bray and Thaleia Travasarou
Journal of Geotechnical and Geonvironmental Engineering, ASCE, V. 133(4), pp. 381-392, April 2007

SEE NOTES BELOW FOR GUIDANCE IN THE USE OF SPREADSHEET

Input Parameters			
Yield Coefficient (ky)	0.025		Based on pseudostatic analysis
Initial Fundamental Period (Ts)	0.21	seconds	1D: Ts=4H/Vs 2D: Ts=2.6H/Vs
Degraded Period (1.5Ts)	0.32	seconds	
Moment Magnitude (Mw)	9.0		
Spectral Acceleration (Sa(1.5Ts))	0.44	g	

Additional Input Parameters		
Probability of Exceedance #1 (P1)	84	%
Probability of Exceedance #2 (P2)	50	%
Probability of Exceedance #3 (P3)	16	%
Displacement Threshold (d_threshold)	15	cm

Intermediate Calculated Parameters			
Non-Zero Seismic Displacement Est (D)	114.32	cm	eq. (5) or (6)
Standard Deviation of Non-Zero Seismic D	0.66		

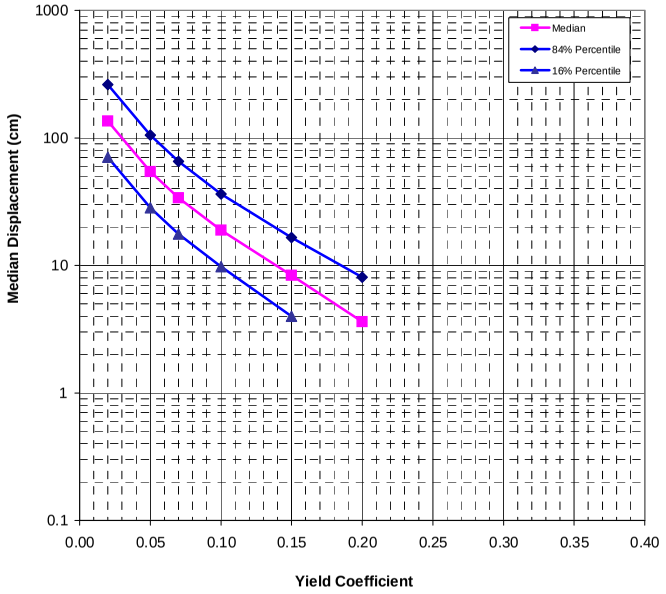
Results			
Probability of Negligible Displ. (P(D=0))	0.00		eq. (3)
D1	59.3	cm	calc. using eq. (7)
D2	114.3	cm	calc. using eq. (7)
D3	220.4	cm	calc. using eq. (7)
P(D>d_threshold)	1.00		eq. (7)

Notes

1. Values highlighted in blue are input parameters, and results are presented in the table with the yellow heading.
2. Probability of Exceedance is the desired probability of exceeding a particular displacement value.
3. Displacements D1, D2, and D3 correspond to P1, P2, and P3, respectively.
   (e.g., the probability of exceeding displacement D1 is P1)
4. The 16%, 50%, and 84% percentile displacement values at selected ky values are shown to the right.
5. Calculated seismic displacements are due to deviatoric deformation only (add in volumetrically induced movement).
6. ky may range between 0.01 and 0.5, Ts between 0 and 2 s, Sa between 0.002 and 2.7 g, M between 4.5 and 9
7. Rigid slope is assumed for Ts < 0.05 s
8. When a value for D is not calculated, D is < 1cm
9. ky may be estimated using the simplified equations shown below.
10. Examples of how Ts is estimated are shown below.
11. Vs = weighted avg. shear wave velocity for the sliding mass, e.g., for 2 layers, Vs = [(h1)(Vs1) + (h2)(Vs2)]/(h1 + h2)

Dependence on ky

ky	P(D="0")	D (cm)	Dmedian (cm)	D-84% (cm)	D-16% (cm)
0.020	0.00	135.6	135.6	261.3	70.3
0.05	0.00	54.5	54.5	105.1	28.3
0.07	0.00	33.9	33.9	65.3	17.6
0.1	0.00	18.9	18.8	36.4	9.8
0.15	0.05	8.7	8.4	16.5	4.0
0.2	0.24	4.7	3.6	8.1	<1
0.3	0.74	1.8	<1	1.5	<1
0.4	0.95	0.9	<1	<1	<1



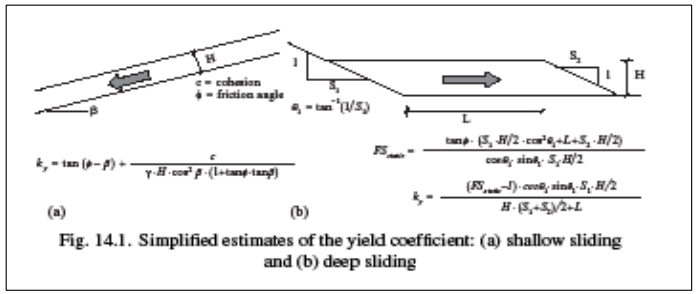


Fig. 14.1. Simplified estimates of the yield coefficient: (a) shallow sliding and (b) deep sliding

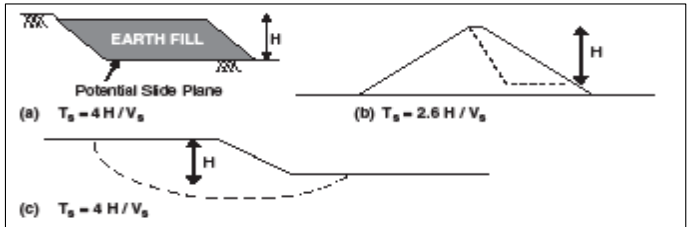


Fig. 14.4. Estimating the initial fundamental period of potential sliding blocks

SEISMIC DEFORMATION ANALYSIS - SECTION 132+00 LEFT
Redwood Creeek Levee Geotechnical Evaluation Project
Orick, Humboldt County, California

CGI Technical Services Inc.
FUGRO

Simplified Procedure for Estimating Earthquake Induced Deviatoric Slope Displacements
by Jonathan D. Bray and Thaleia Travasarou
Journal of Geotechnical and Geonvironmental Engineering, ASCE, V. 133(4), pp. 381-392, April 2007

SEE NOTES BELOW FOR GUIDANCE IN THE USE OF SPREADSHEET

Input Parameters			
Yield Coefficient (ky)	0.035		Based on pseudostatic analysis
Initial Fundamental Period (Ts)	0.18	seconds	1D: Ts=4H/Vs 2D: Ts=2.6H/Vs
Degraded Period (1.5Ts)	0.26	seconds	
Moment Magnitude (Mw)	9.0		
Spectral Acceleration (Sa(1.5Ts))	0.45	g	

Additional Input Parameters		
Probability of Exceedance #1 (P1)	84	%
Probability of Exceedance #2 (P2)	50	%
Probability of Exceedance #3 (P3)	16	%
Displacement Threshold (d_threshold)	15	cm

Intermediate Calculated Parameters			
Non-Zero Seismic Displacement Est (D)	81.20	cm	eq. (5) or (6)
Standard Deviation of Non-Zero Seismic D	0.66		

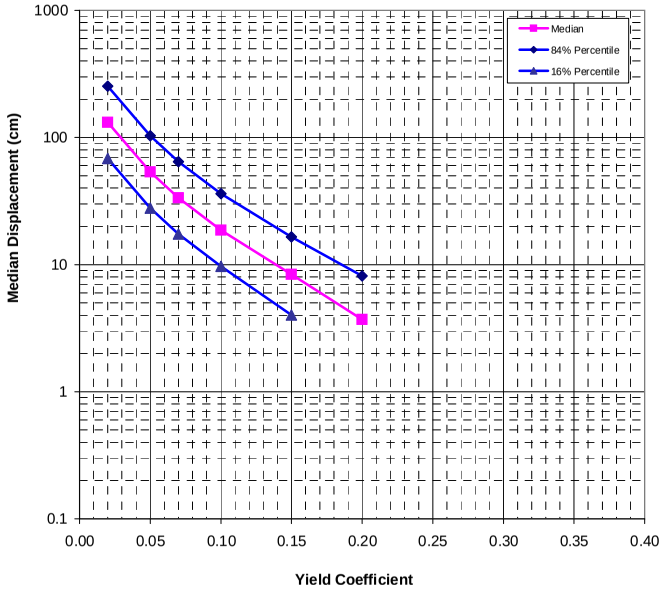
Results			
Probability of Negligible Displ. (P(D=0))	0.00		eq. (3)
D1	42.1	cm	calc. using eq. (7)
D2	81.2	cm	calc. using eq. (7)
D3	156.5	cm	calc. using eq. (7)
P(D>d_threshold)	0.99		eq. (7)

Notes

1. Values highlighted in blue are input parameters, and results are presented in the table with the yellow heading.
2. Probability of Exceedance is the desired probability of exceeding a particular displacement value.
3. Displacements D1, D2, and D3 correspond to P1, P2, and P3, respectively.
   (e.g., the probability of exceeding displacement D1 is P1)
4. The 16%, 50%, and 84% percentile displacement values at selected ky values are shown to the right.
5. Calculated seismic displacements are due to deviatoric deformation only (add in volumetrically induced movement).
6. ky may range between 0.01 and 0.5, Ts between 0 and 2 s, Sa between 0.002 and 2.7 g, M between 4.5 and 9
7. Rigid slope is assumed for Ts < 0.05 s
8. When a value for D is not calculated, D is < 1cm
9. ky may be estimated using the simplified equations shown below.
10. Examples of how Ts is estimated are shown below.
11. Vs = weighted avg. shear wave velocity for the sliding mass, e.g., for 2 layers, Vs = [(h1)(Vs1) + (h2)(Vs2)]/(h1 + h2)

Dependence on ky

ky	P(D="0")	D (cm)	Dmedian (cm)	D-84% (cm)	D-16% (cm)
0.020	0.00	131.6	131.6	253.7	68.3
0.05	0.00	53.5	53.5	103.2	27.8
0.07	0.00	33.4	33.4	64.5	17.3
0.1	0.00	18.7	18.7	36.0	9.7
0.15	0.04	8.7	8.4	16.5	4.0
0.2	0.23	4.7	3.7	8.1	<1
0.3	0.72	1.8	<1	1.6	<1
0.4	0.94	0.9	<1	<1	<1



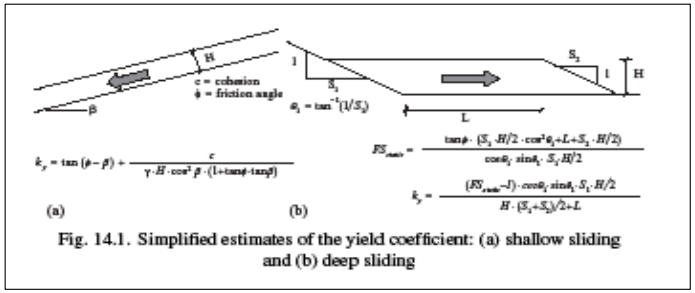


Fig. 14.1. Simplified estimates of the yield coefficient: (a) shallow sliding and (b) deep sliding

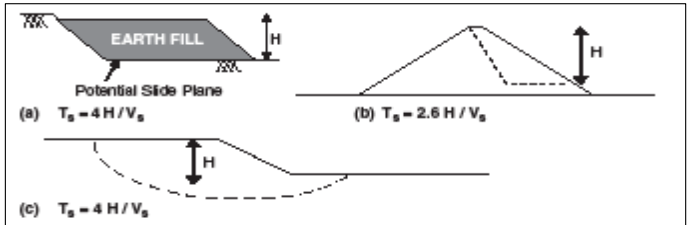


Fig. 14.4. Estimating the initial fundamental period of potential sliding blocks

APPENDIX E
SLIDE OUTPUT

SECTION 57L

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineS_5700 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 57S Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Invalid Surfaces
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	7.5
500	7.5

External Boundary

X	Y
322.96	20.86
319.69	21.82
309.85	25.98
306.55	26.73
302.298	26.6114

296.74	26.73
293.44	26.06
280.33	21.82
275.99	20.86
267.22	18.92
257.38	16.14
247.54	15.26
234.437	14.16
227.89	14.16
226.752	11.85
217.509	11.85
212.556	11.84
208.21	11.84
198.37	11.76
191.83	11.88
188.53	12
181.99	12.54
178.69	12.6
172.15	12.26
168.85	12.35
165.58	12.16
162.31	11.72
155.74	11.19
145.9	9.35
142.299	8.86
139.36	8.46
136.09	8.73
132.79	8.82
122.95	8.32
119.68	7.97
106.57	7.37
100	7.43
100	-50
500	-50
500	8.86
500	18.25
490.18	18.19
483.61	17.98
467.23	18.3
454.12	18.23
447.55	18.47
431.17	18.4
421.33	18.5
414.76	18.81

411.49	18.67
398.38	18.93
388.54	18.91
372.13	19.22
355.75	19.26
352.48	19.36
349.18	19.65
342.64	19.48
332.8	20.32
326.23	20.57

Material Boundary

X	Y
275.99	20.86
289.327	20.86
290.886	20.86
312.55	20.86
315.329	20.86
322.96	20.86

Material Boundary

X	Y
302.298	23.6114
302.298	26.6114

Material Boundary

X	Y
290.886	20.8595
290.886	20.86
294.798	23.6114
302.298	23.6114
309.798	23.6114
315.329	20.86
315.333	20.858

Material Boundary

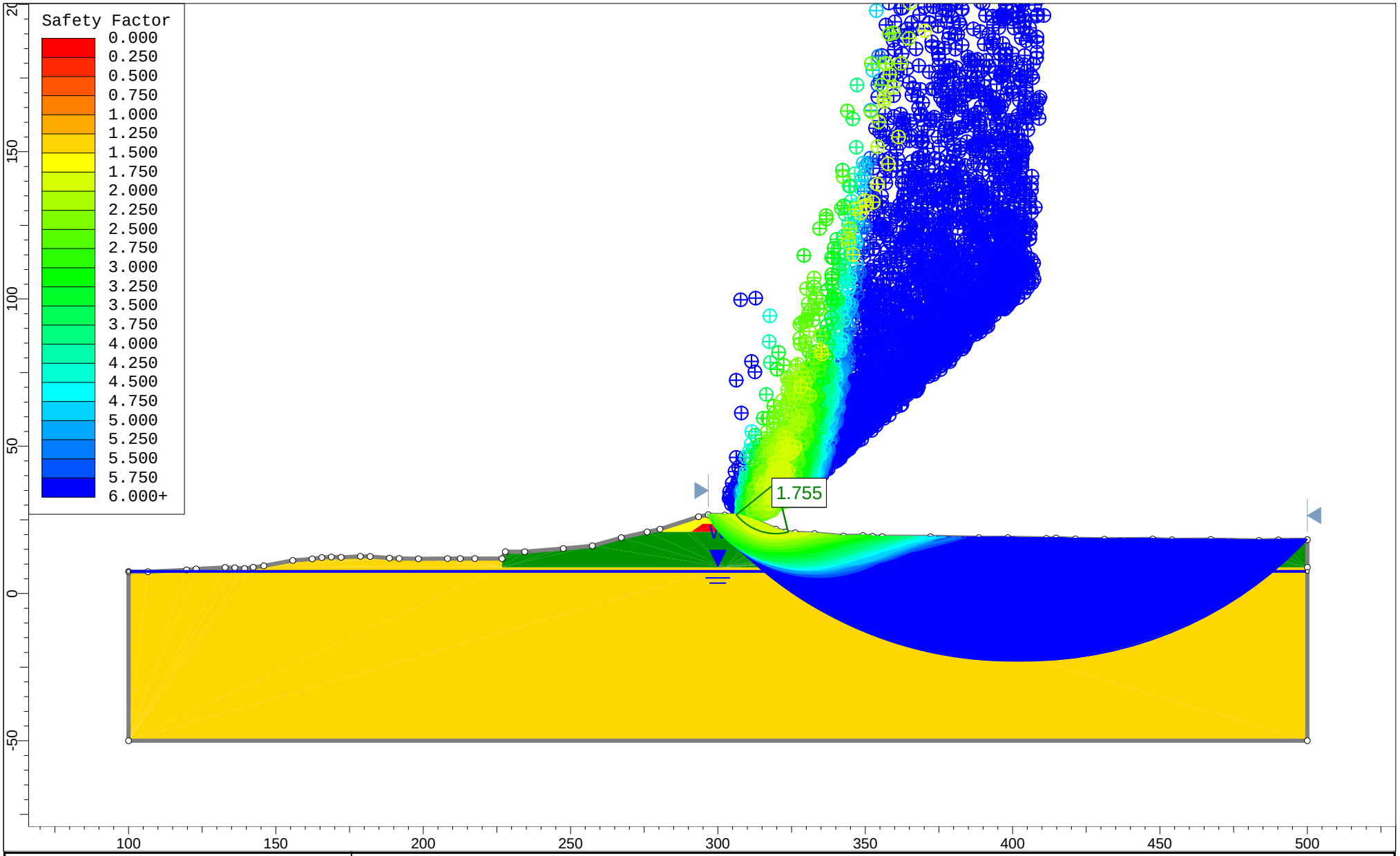
X	Y
302.593	8.86
500	8.86

Material Boundary

X	Y
142.299	8.86
226.752	8.86
302.593	8.86

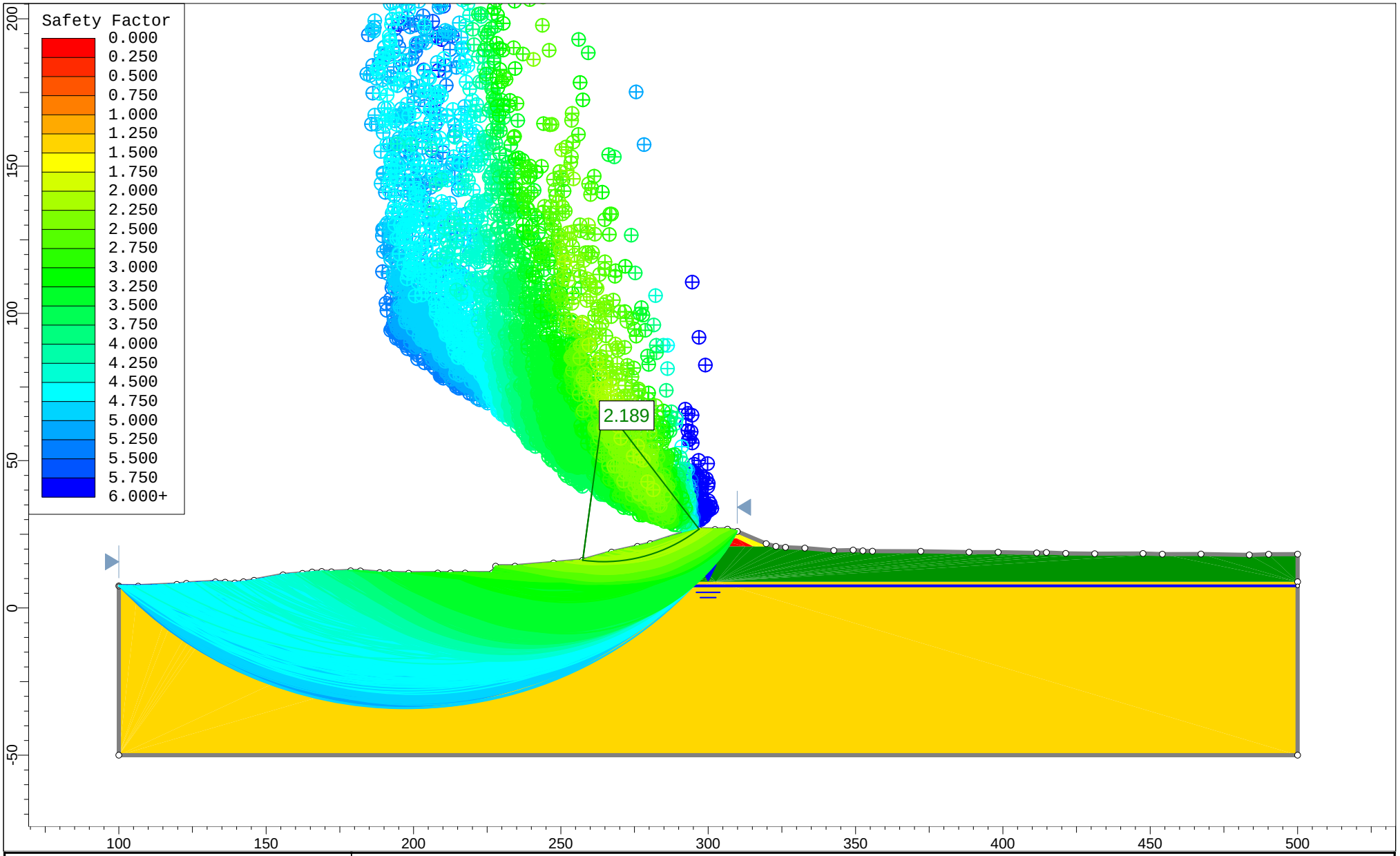
Material Boundary

X	Y
226.752	8.86
226.752	11.85



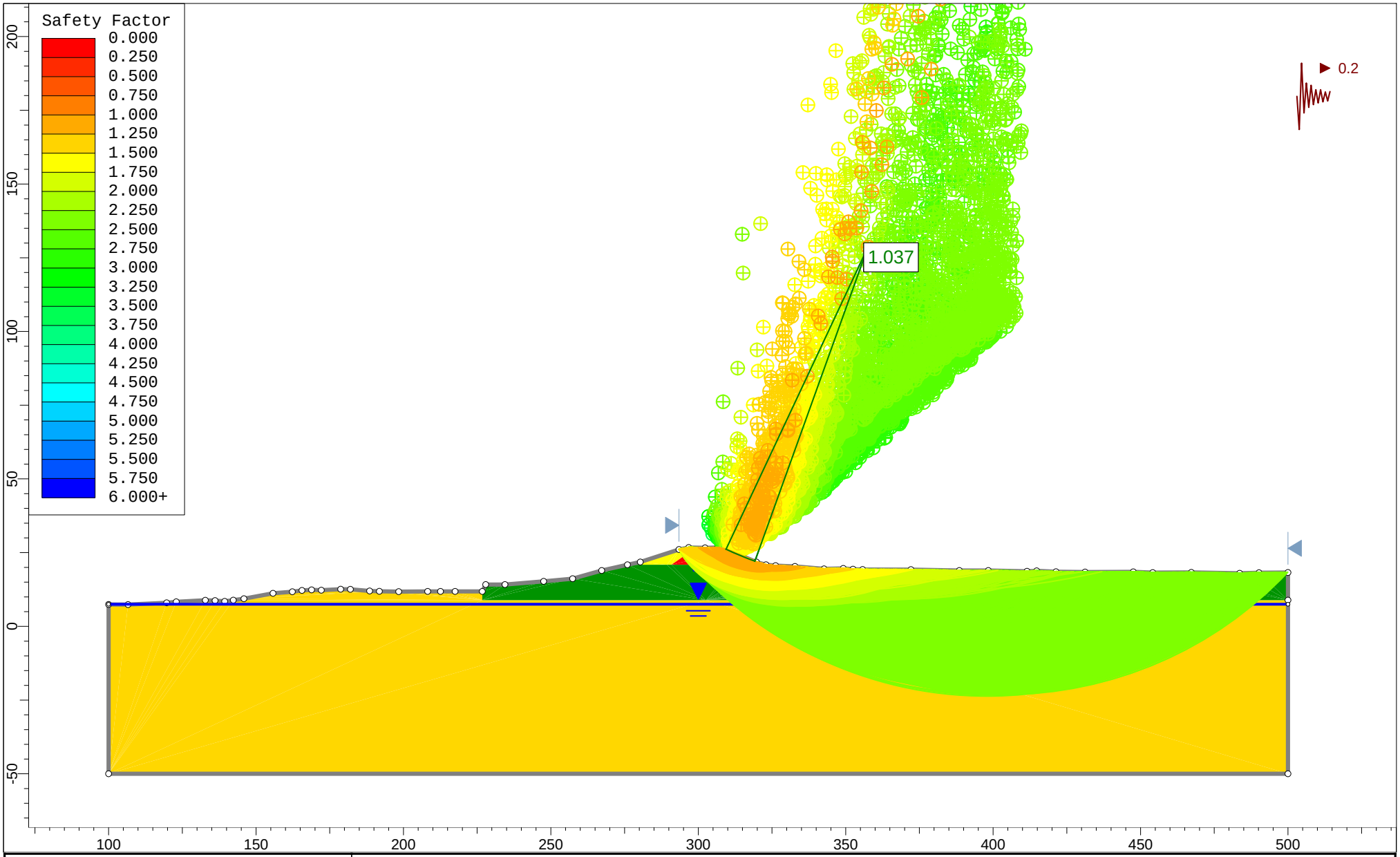
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_5700.slim EL.slim

SLIDEINTERPRET 6.011



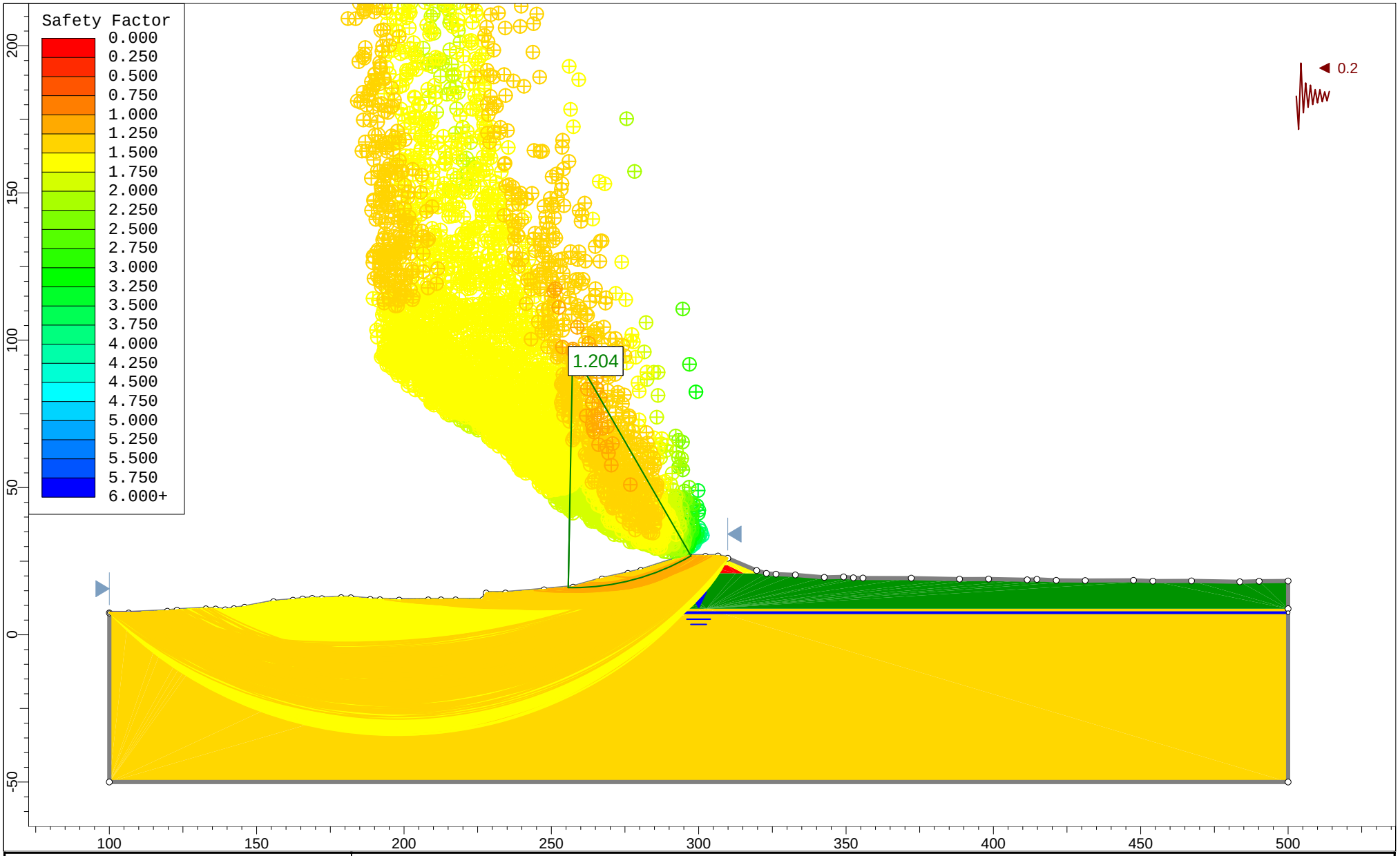
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_5700 EW.slim

SLIDEINTERPRET 6.011



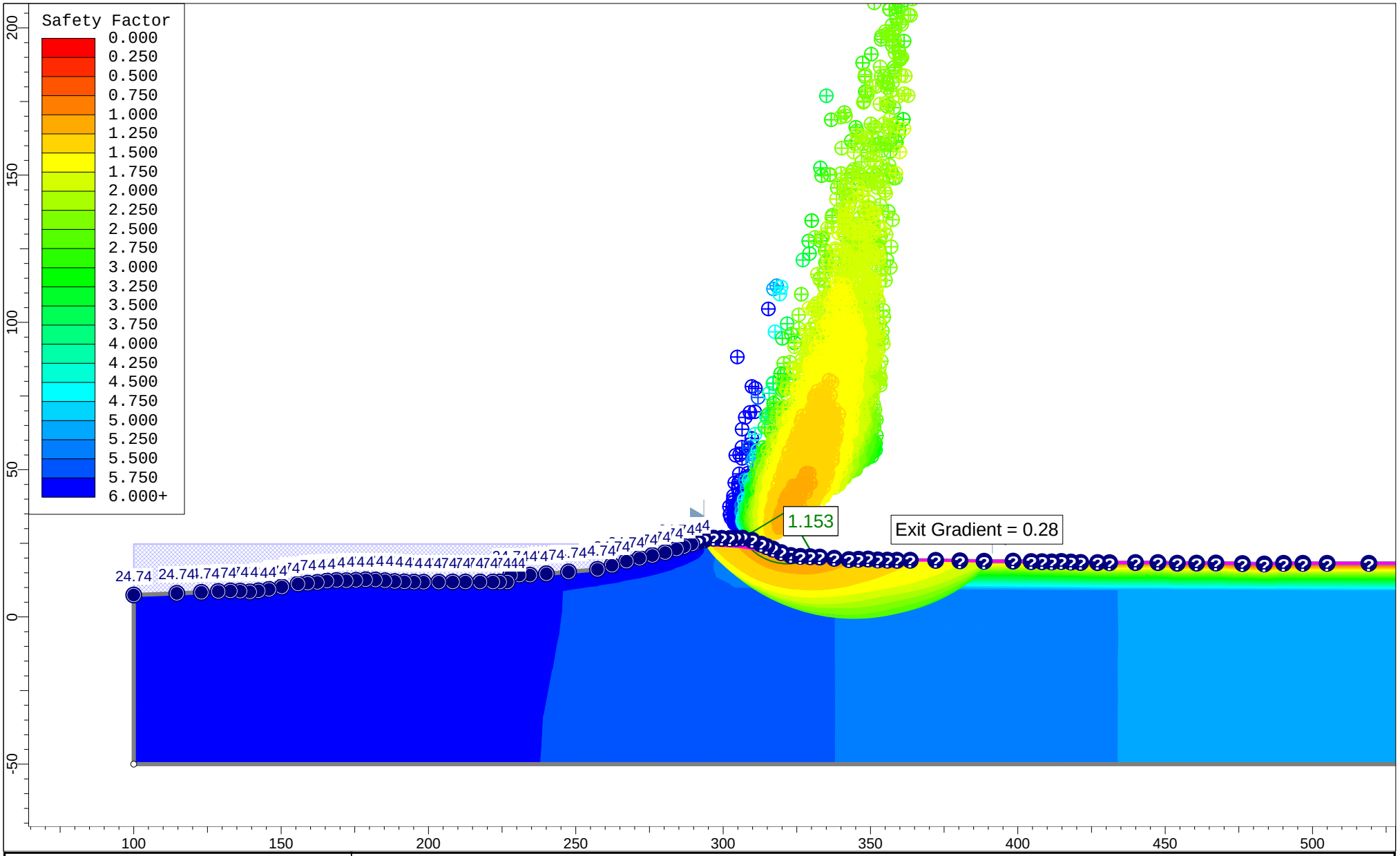
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_5700 PL.slim

SLIDEINTERPRET 6.011



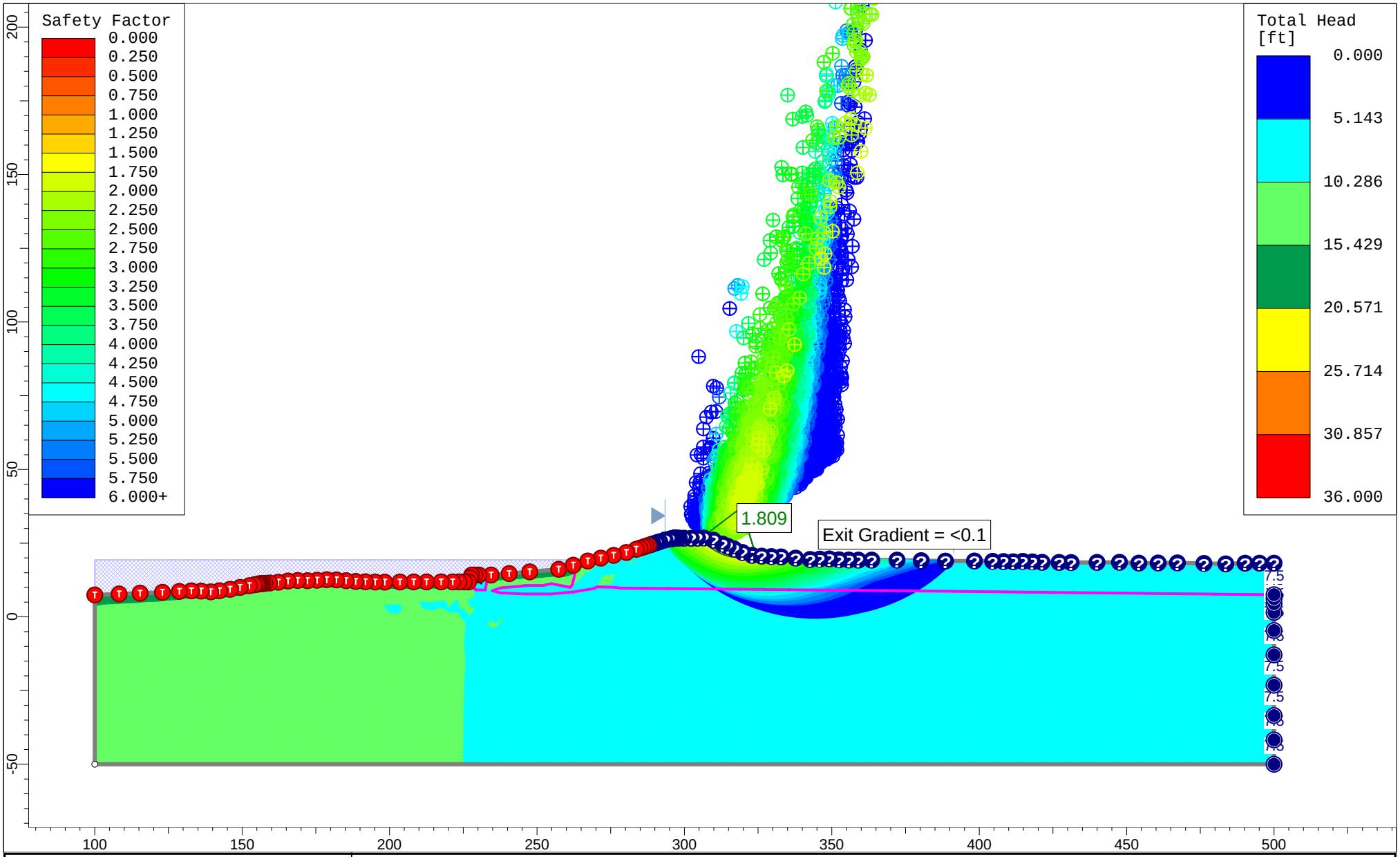
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_5700 PW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Flood Stage Conditions 100-yr WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_5700 FL.slim

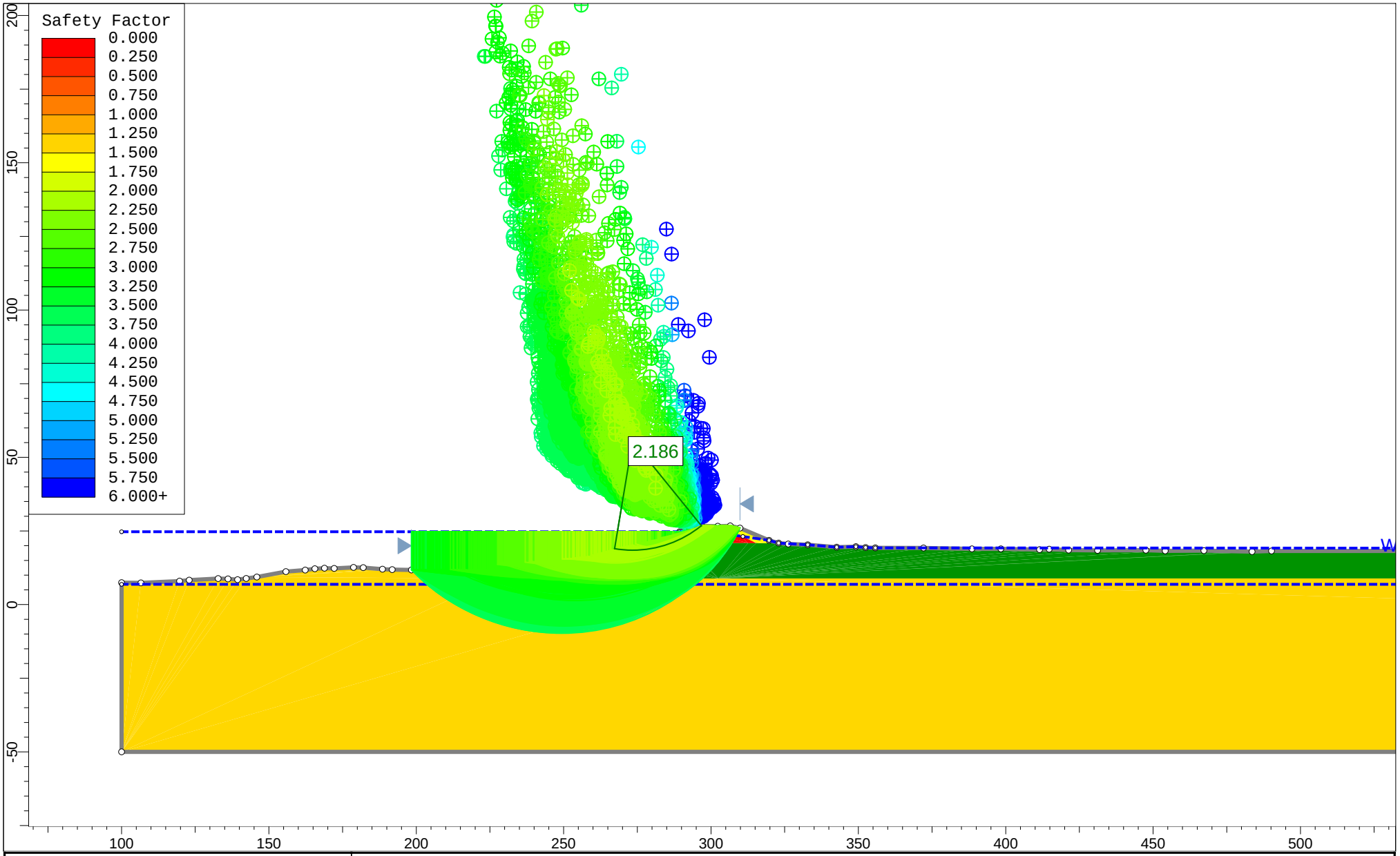
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

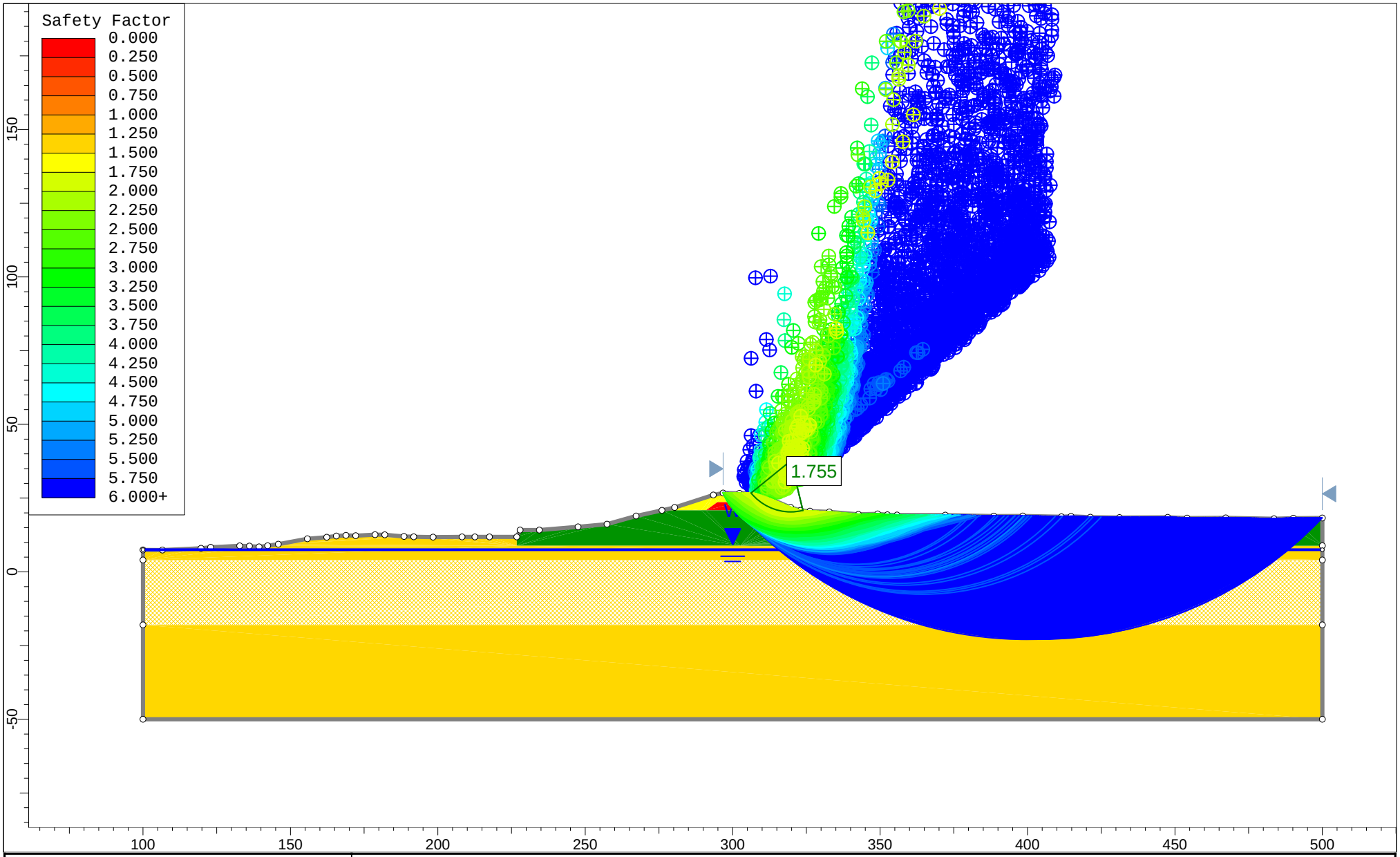
SLIDEINTERPRET 6.011

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 57S Flood Stage Conditions (Transient) 100-yr Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_5700 FLT.slim



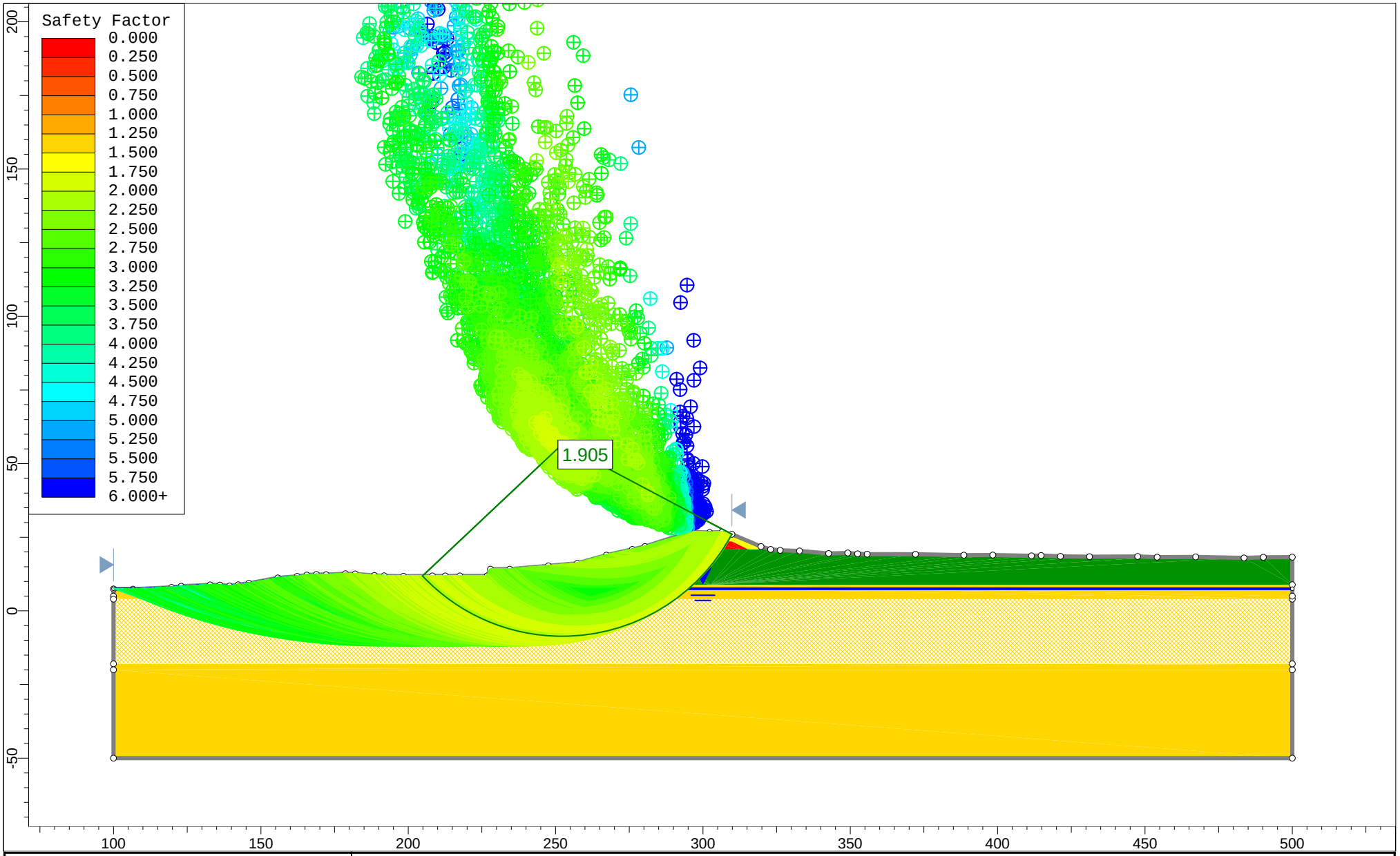
	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_5700 RW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_5700 PEL.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57S Post Earthquake Conditions Median Annual WSE Waterside slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_5700 PEW.slim

SLIDEINTERPRET 6.011

SECTION 57R

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineN_5700 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 57N Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	9
500	9

External Boundary

X	Y
300.01	28.4
293.44	28.75
290.17	28.73
280.33	27.36
273.79	27.61

270.49	27.48
267.22	26.99
247.54	21.48
237.73	21.48
224.59	20.88
221.32	20.94
218.05	21.48
204.94	24.69
195.1	26.46
188.53	25.7
185.26	25.58
175.42	24.12
172.15	24.2
165.58	24.76
162.31	24.86
159.04	24.78
152.47	24.27
145.9	24.14
136.09	22.95
126.25	21.45
119.68	21.09
113.14	21.08
109.84	20.94
106.57	20.6
100	20.35
100	6.56422
100	5.4
100	-50
500	-50
500	7
493.45	7.04
486.91	6.53
477.07	6.29
470.5	6.56
447.55	6.76
444.28	6.53
441.01	5.76
437.71	5.59
434.44	5.88
431.17	5.98
424.6	5.64
418.03	5.76
414.76	5.42
404.92	5.96

398.38	6.1
391.81	5.94
385.27	6.41
384.847	6.56422
375.43	10
363.92	10.5
362.32	16.3
355.75	18.5
352.48	20.28
342.668	21.63
336.318	21.63
329.53	21.63
326.23	22.92
312.442	25.7166
310.362	25.7166
310.223	25.7462
307.076	26.4171

Material Boundary

X	Y
247.54	21.48
277.837	21.551

Material Boundary

X	Y
293.576	6.56422
384.847	6.56422

Material Boundary

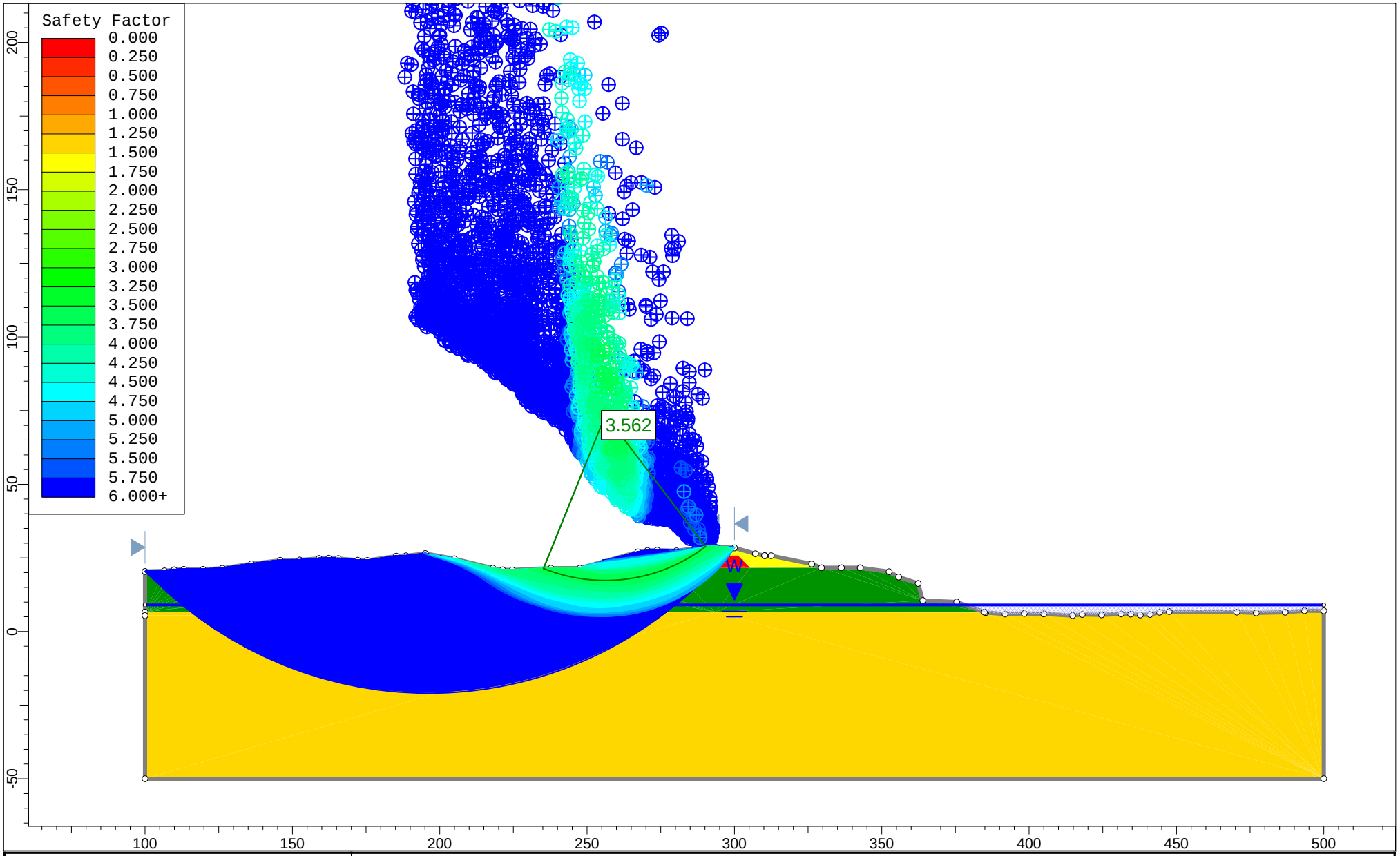
X	Y
100	6.56422
293.576	6.56422

Material Boundary

X	Y
277.837	21.551
286.227	25.7462
301.227	25.7462
305.315	21.5857
277.837	21.551

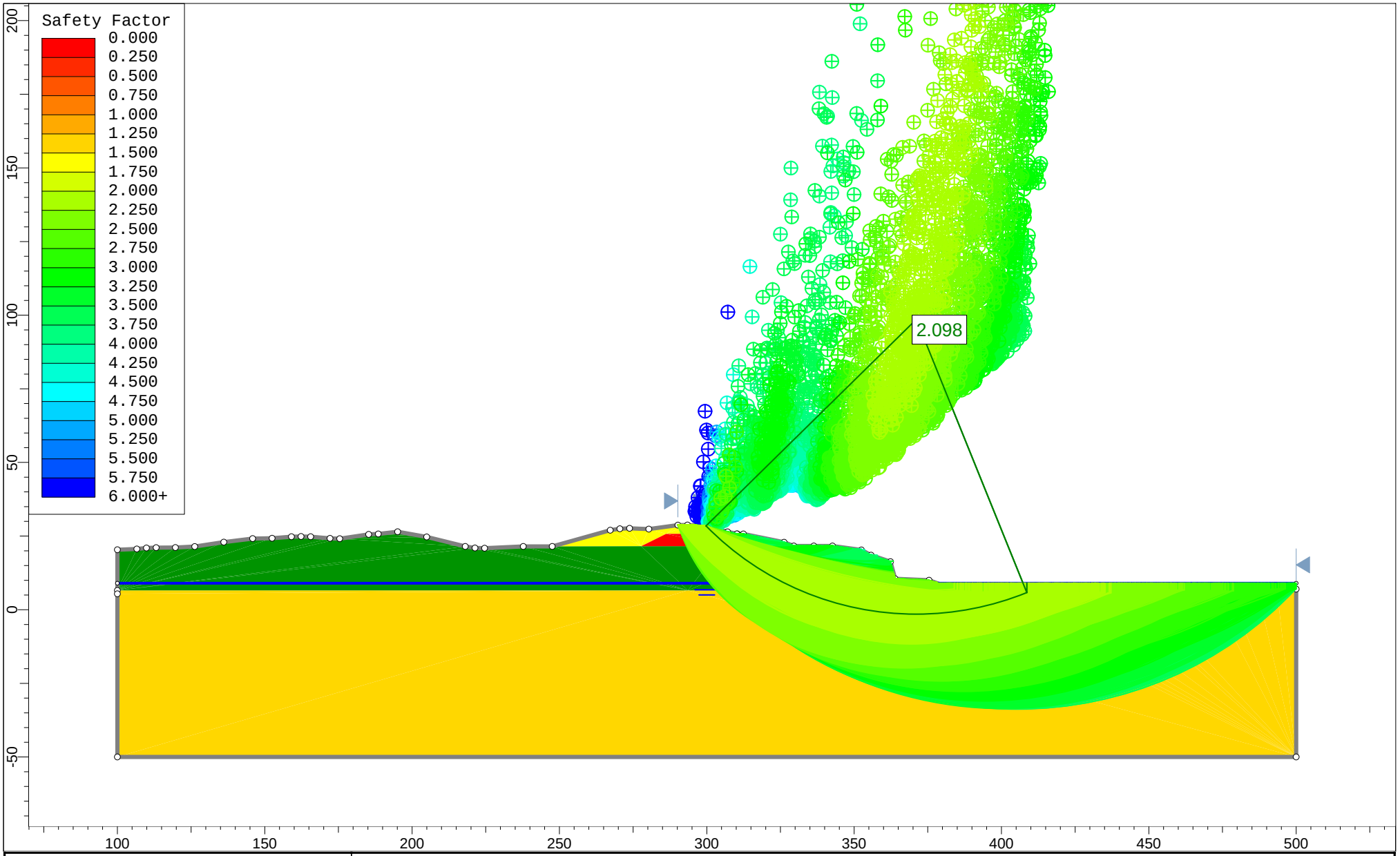
Material Boundary

X	Y
305.315	21.5857
329.53	21.63



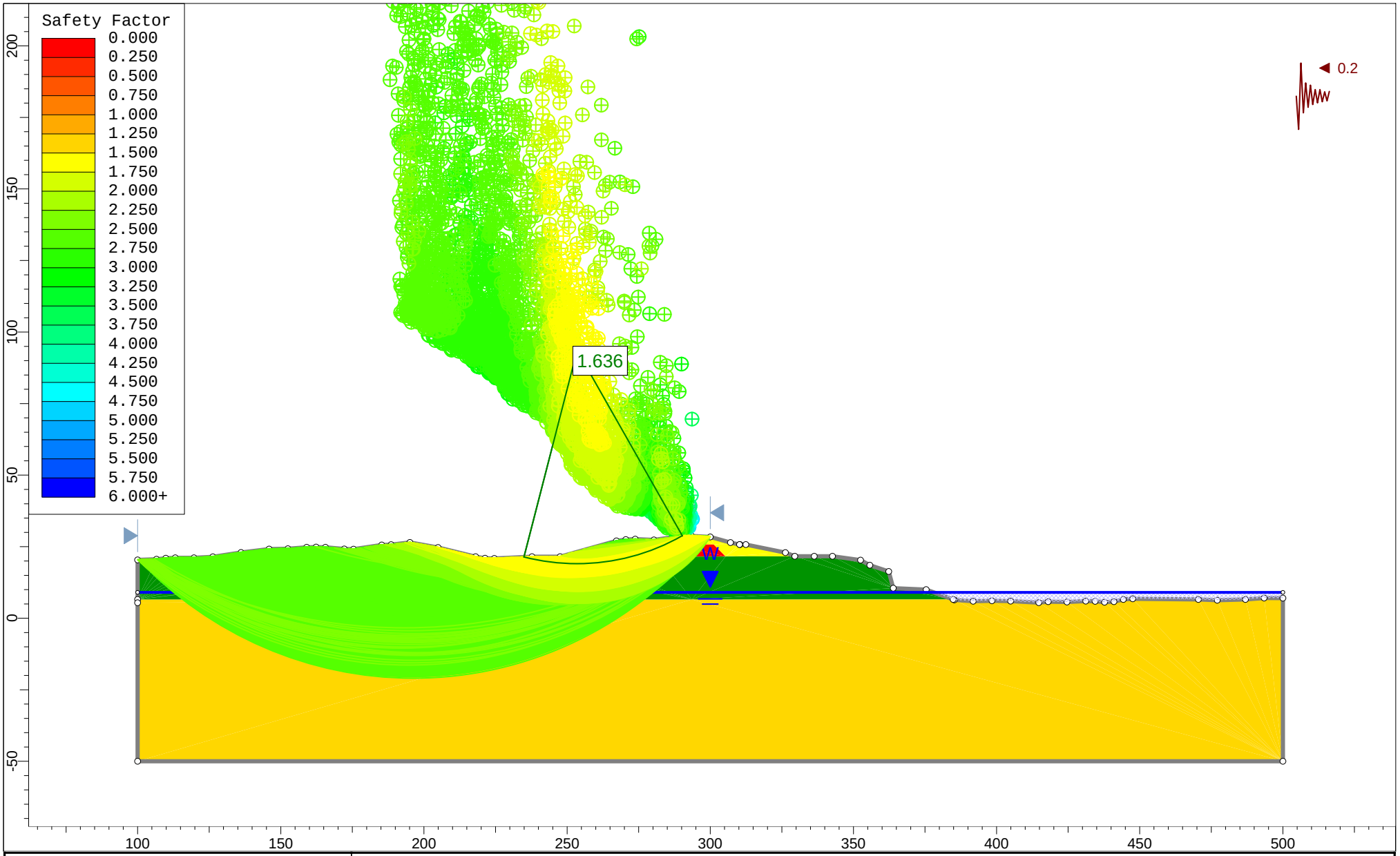
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Flood Stage Conditions (Transient) 100-yr Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_5700 EL.slim

SLIDEINTERPRET 6.011



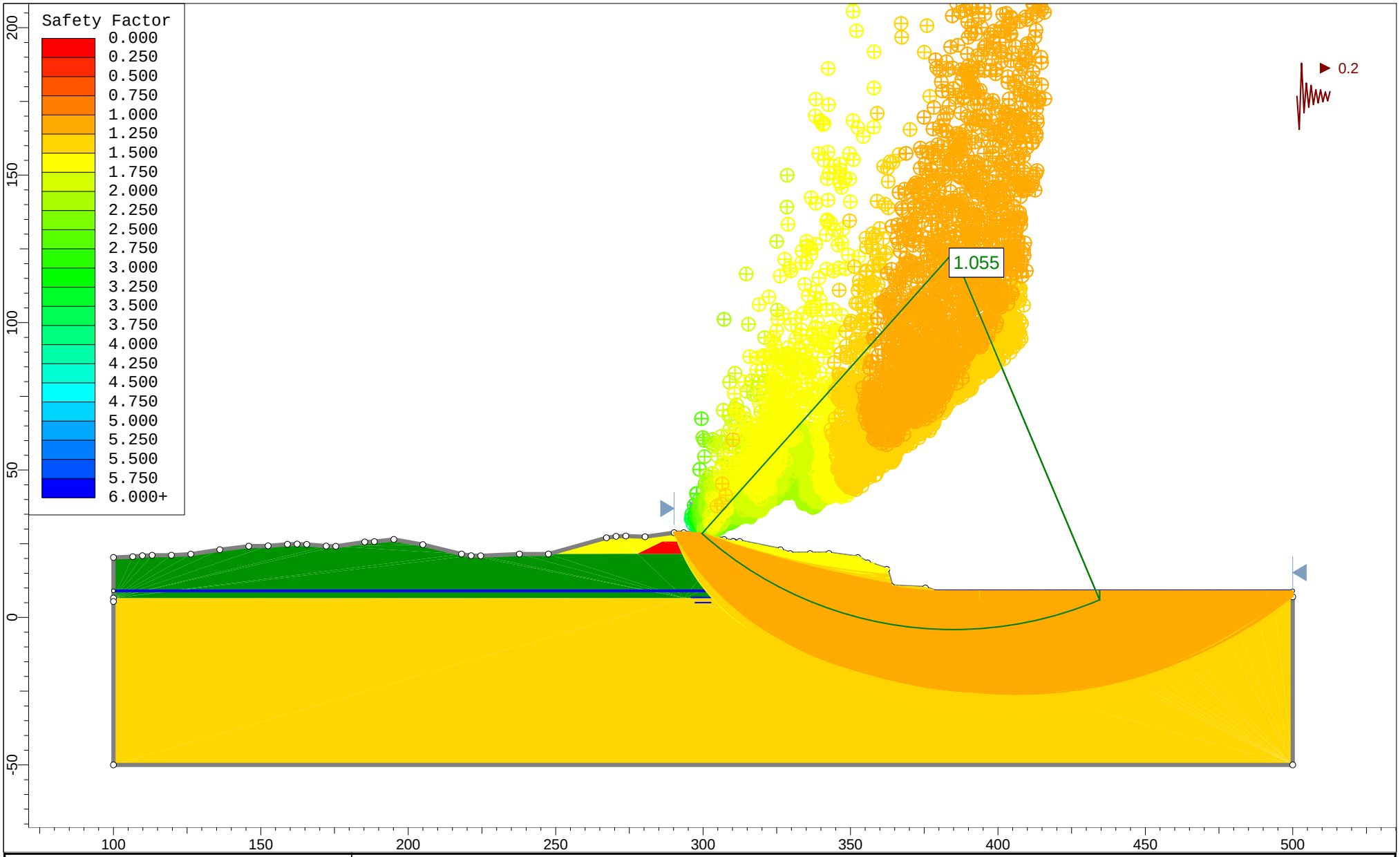
	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_5700 EW.slim

SLIDEINTERPRET 6.011



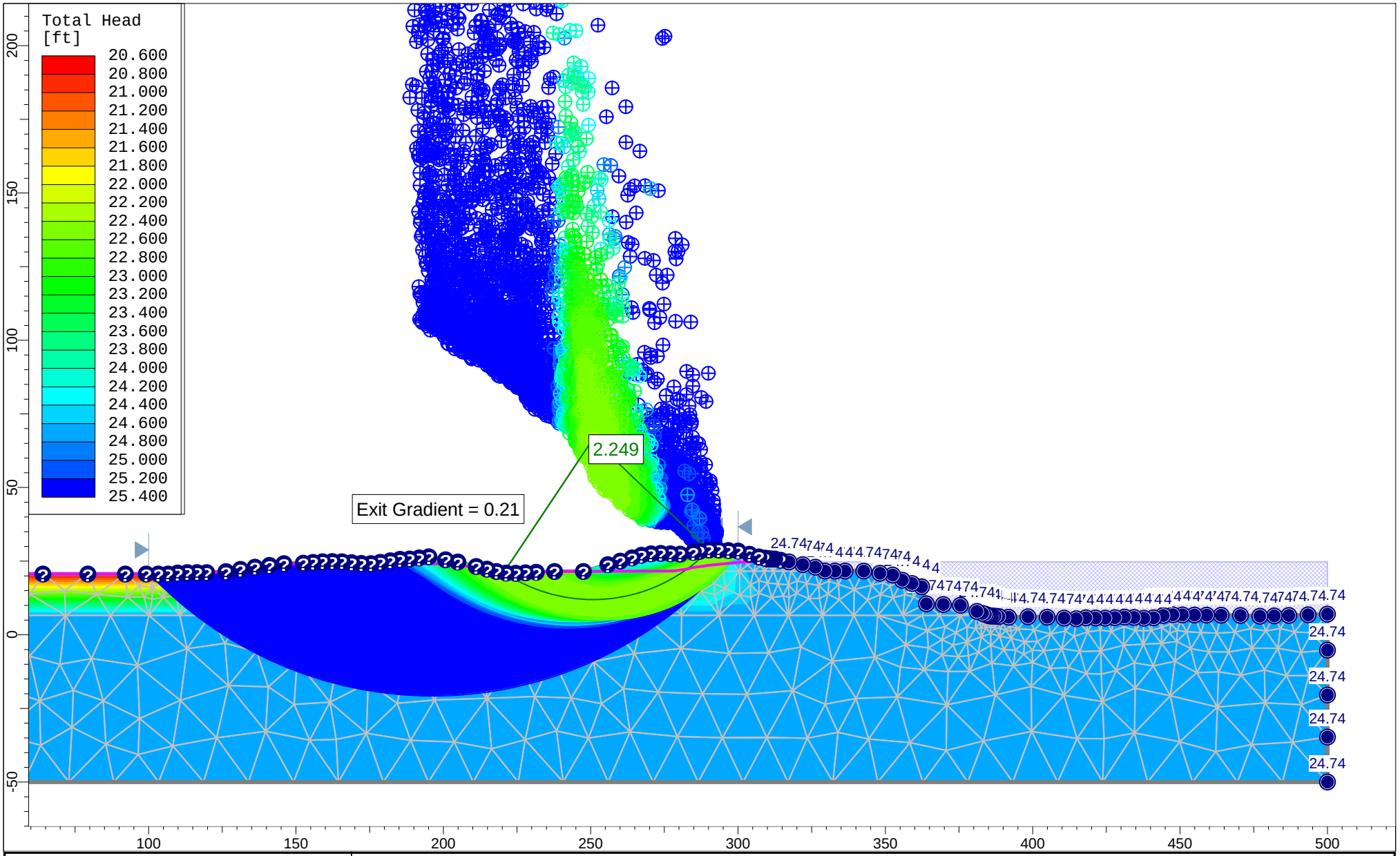
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:556	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_5700 PL.slim

SLIDEINTERPRET 6.011



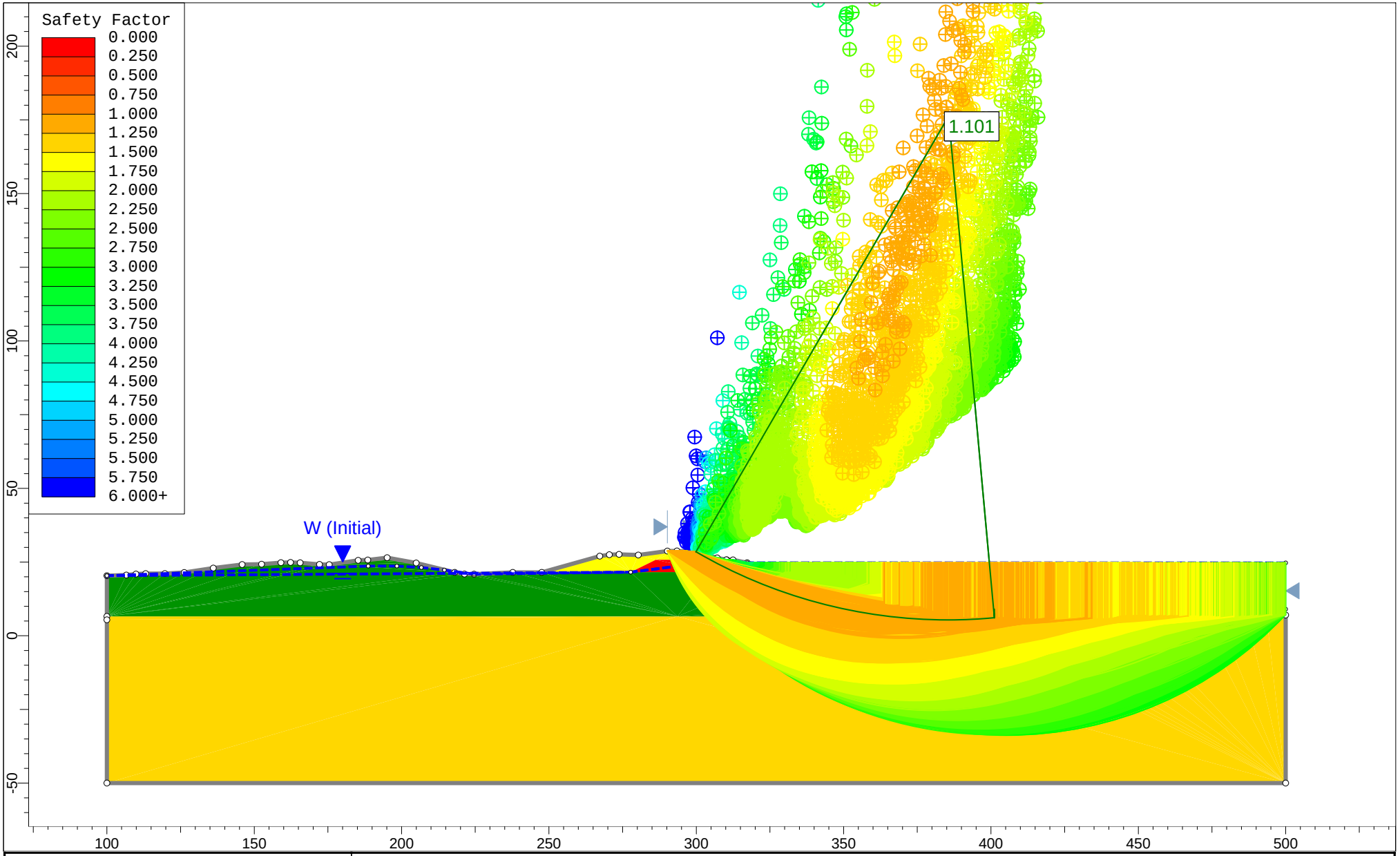
	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_5700 PW.slim

SLIDEINTERPRET 6.011



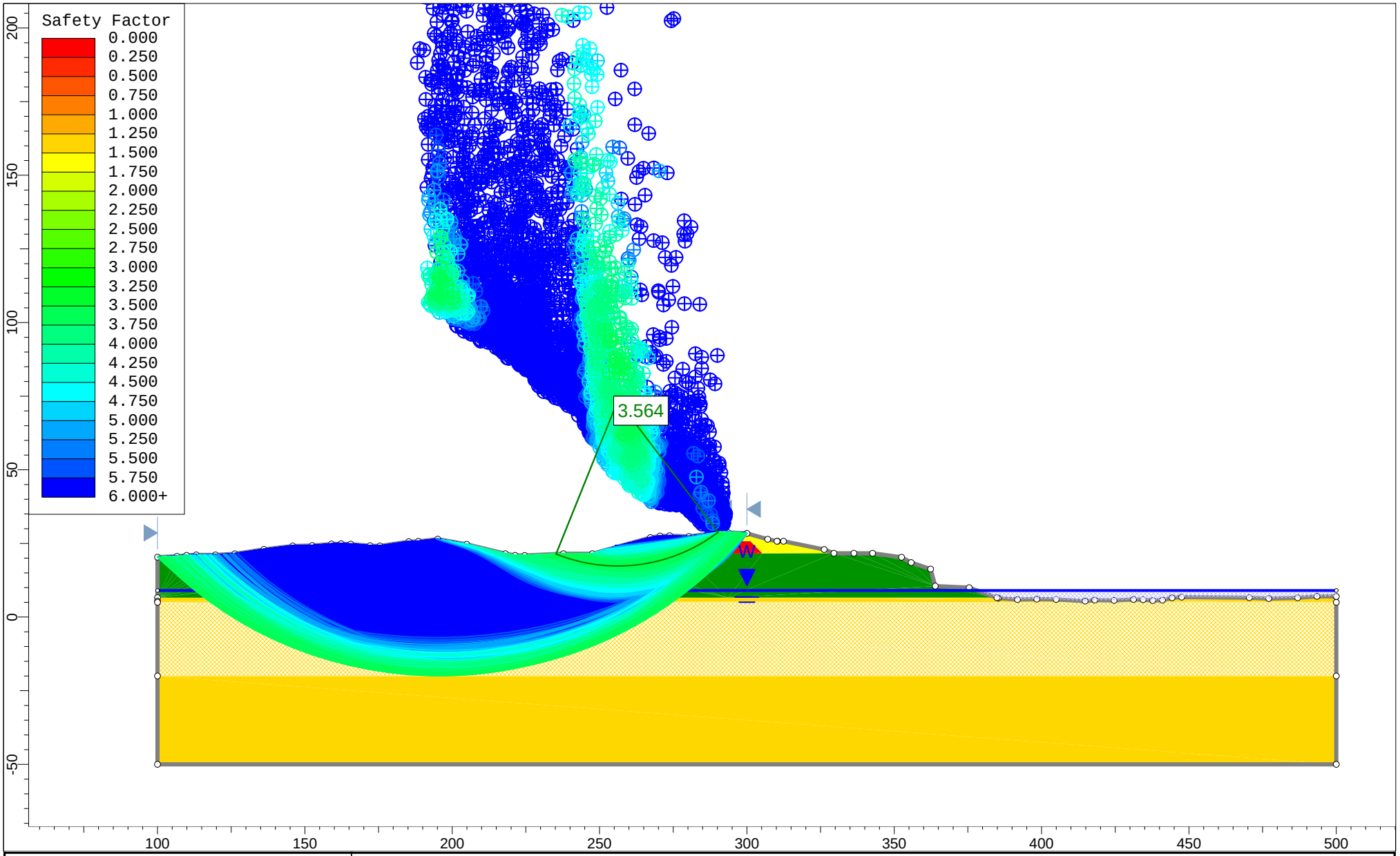
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Flood Stage Conditions 100-yr WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_5700 FL.slim

SLIDEINTERPRET 6.011



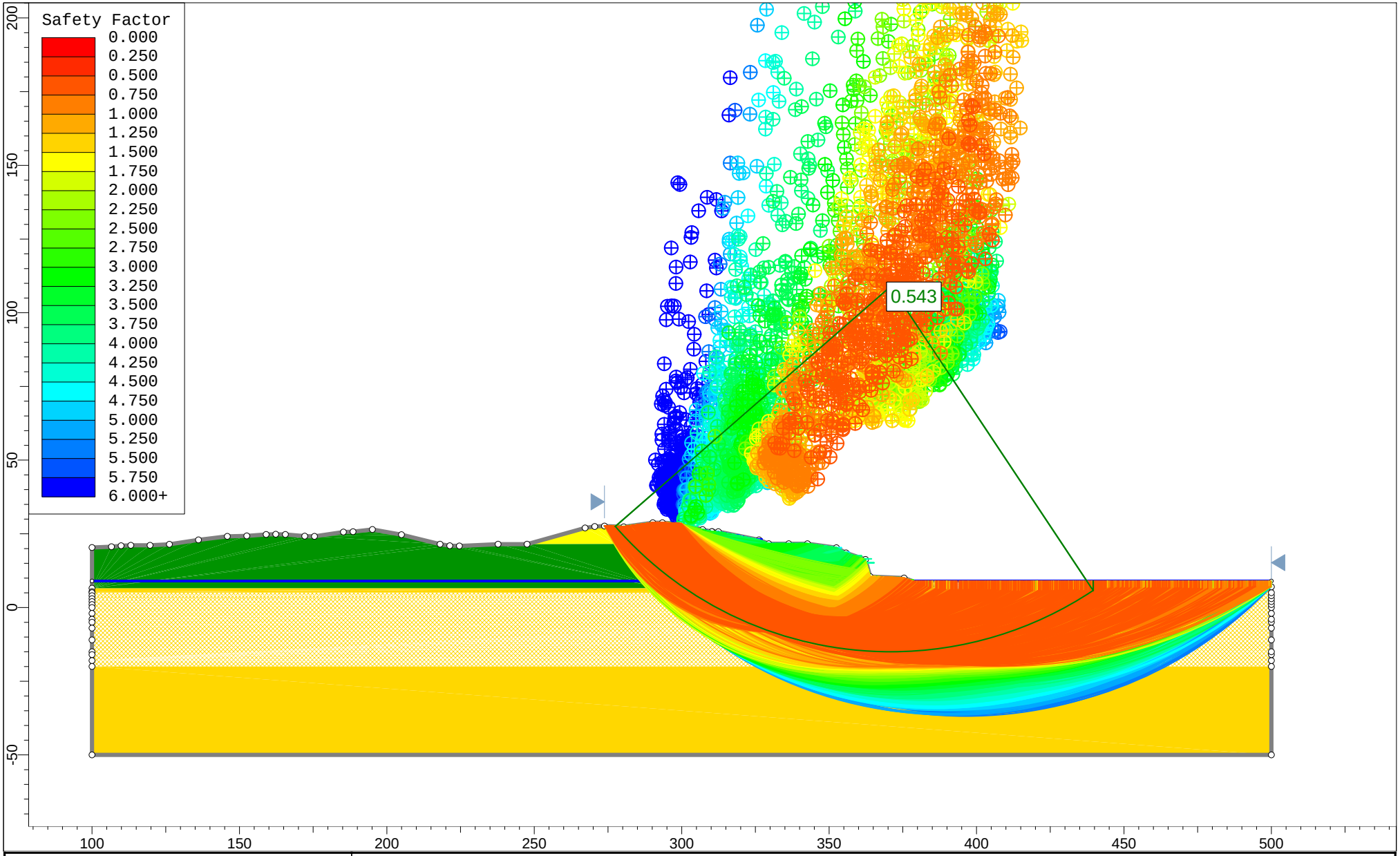
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_5700 RW.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Post Earthquake Conditions, Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_5700 PEL.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 57N Post Earthquake Conditions Median Annual WSE Waterside slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_5700 PEW.slim

SLIDEINTERPRET 6.011

SECTION 73L

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineS_7300 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 73S Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/year
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
362.32	22.21
342.64	22.31
332.8	22.91
329.53	23.3
326.23	23.94

319.69	25.75
309.85	29.54
306.58	30.06
300.01	30.07
296.74	29.66
283.63	25.29
272.566	22.31
267.22	20.87
263.95	20.24
255.471	17.754
249.193	17.254
245.25	17.254
240.612	16.597
234.43	15.43
227.89	10.5
218.05	8.97
211.48	8.6
204.94	8.5
191.83	7.93
168.85	8.87
155.74	8.95
149.2	9.16
129.52	8.79
119.68	8.85
100	8.69
100	7.31
100	-50
500	-50
500	7.31
500	18.97
490.18	19.09
480.34	19.02
467.23	19.49
457.39	19.48
447.55	19.66
427.87	19.49
398.38	19.46
385.27	19.14
381.97	19.37
365.59	22

Material Boundary

X	Y

272.566	22.31
292.433	22.31
318.804	22.31
342.64	22.31

Material Boundary

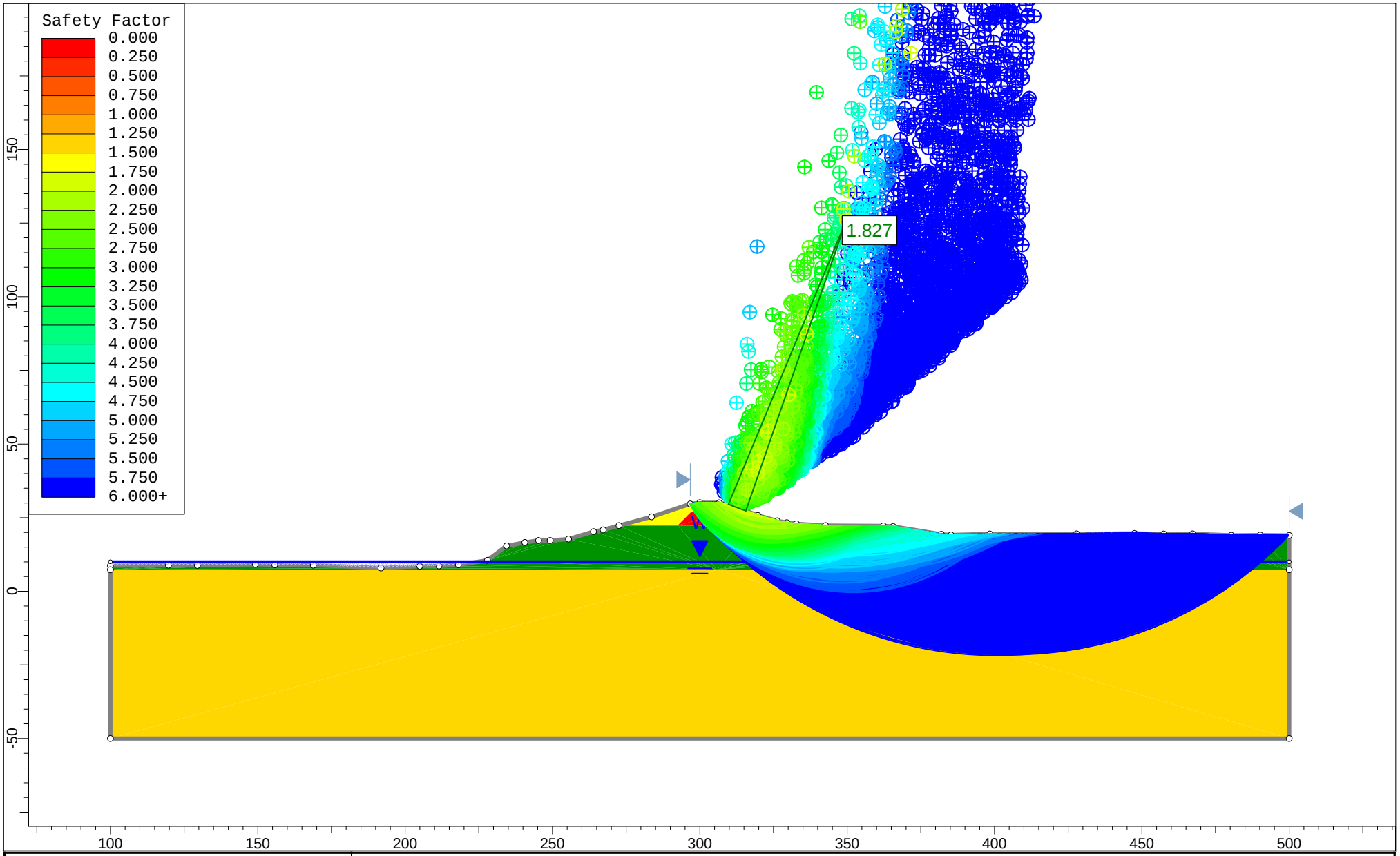
X	Y
292.433	22.31
297.176	27.0652
309.176	27.0997
318.804	22.31

Material Boundary

X	Y
305.853	7.31
500	7.31

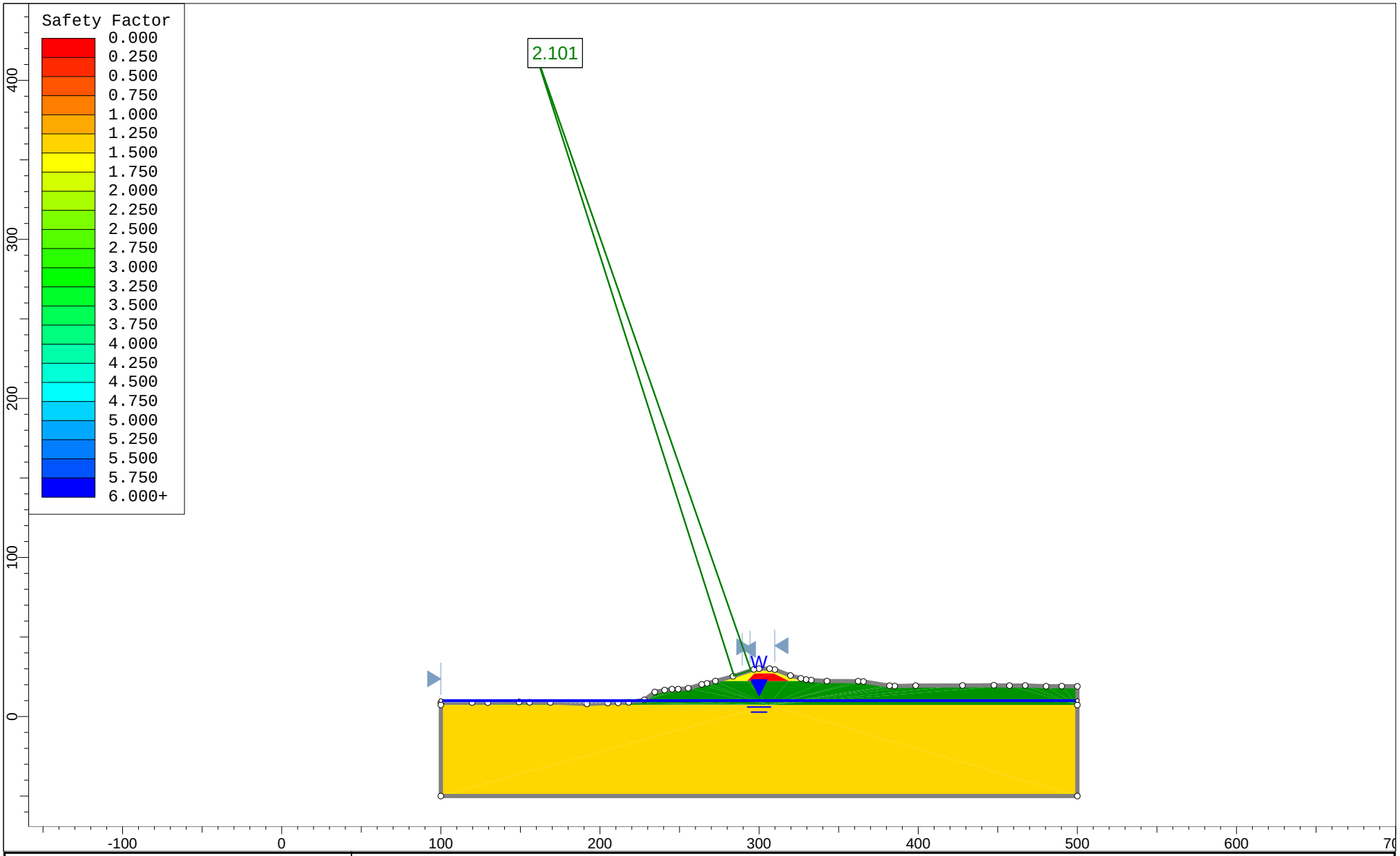
Material Boundary

X	Y
100	7.31
305.853	7.31



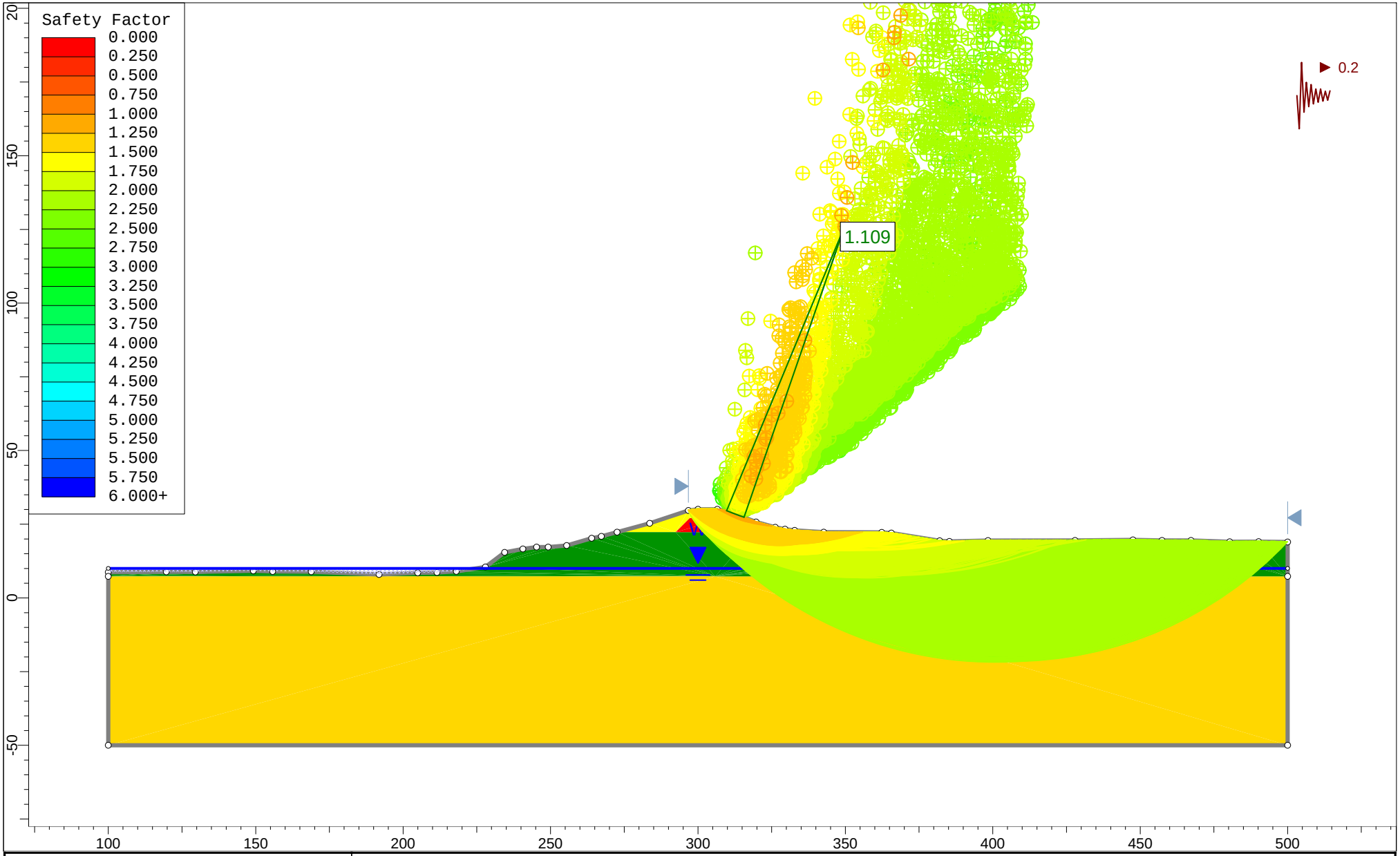
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_7300 EL.slim

SLIDEINTERPRET 6.011



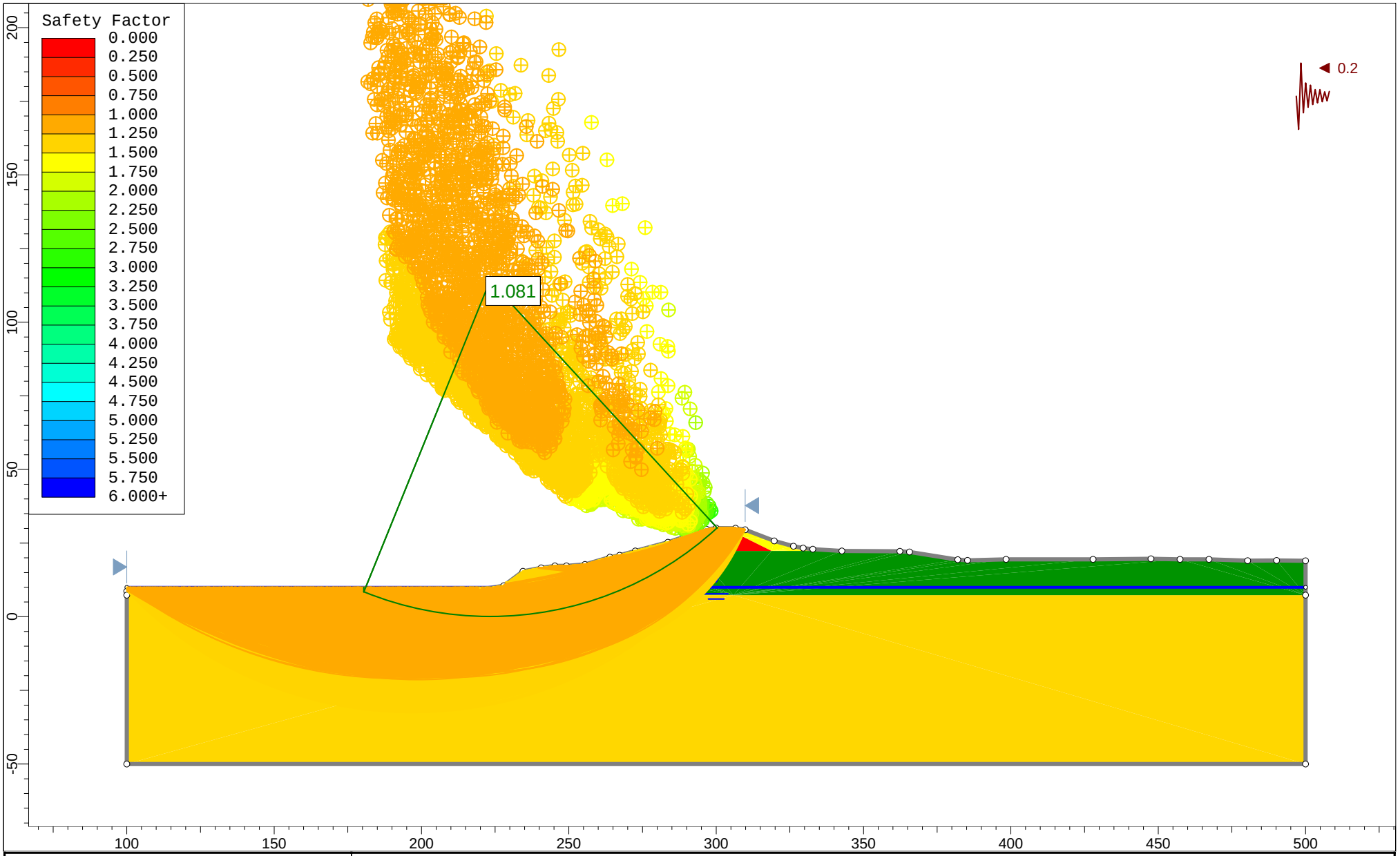
Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 73S Existing Conditions Median Annual WSE Waterside Slope		
Drawn By: AB	Scale: 1:1000	Company: CGI/FWI	
Date: May 2011		File Name: SlopeW_lineS_7300 EW.slim	

SLIDEINTERPRET 6.011



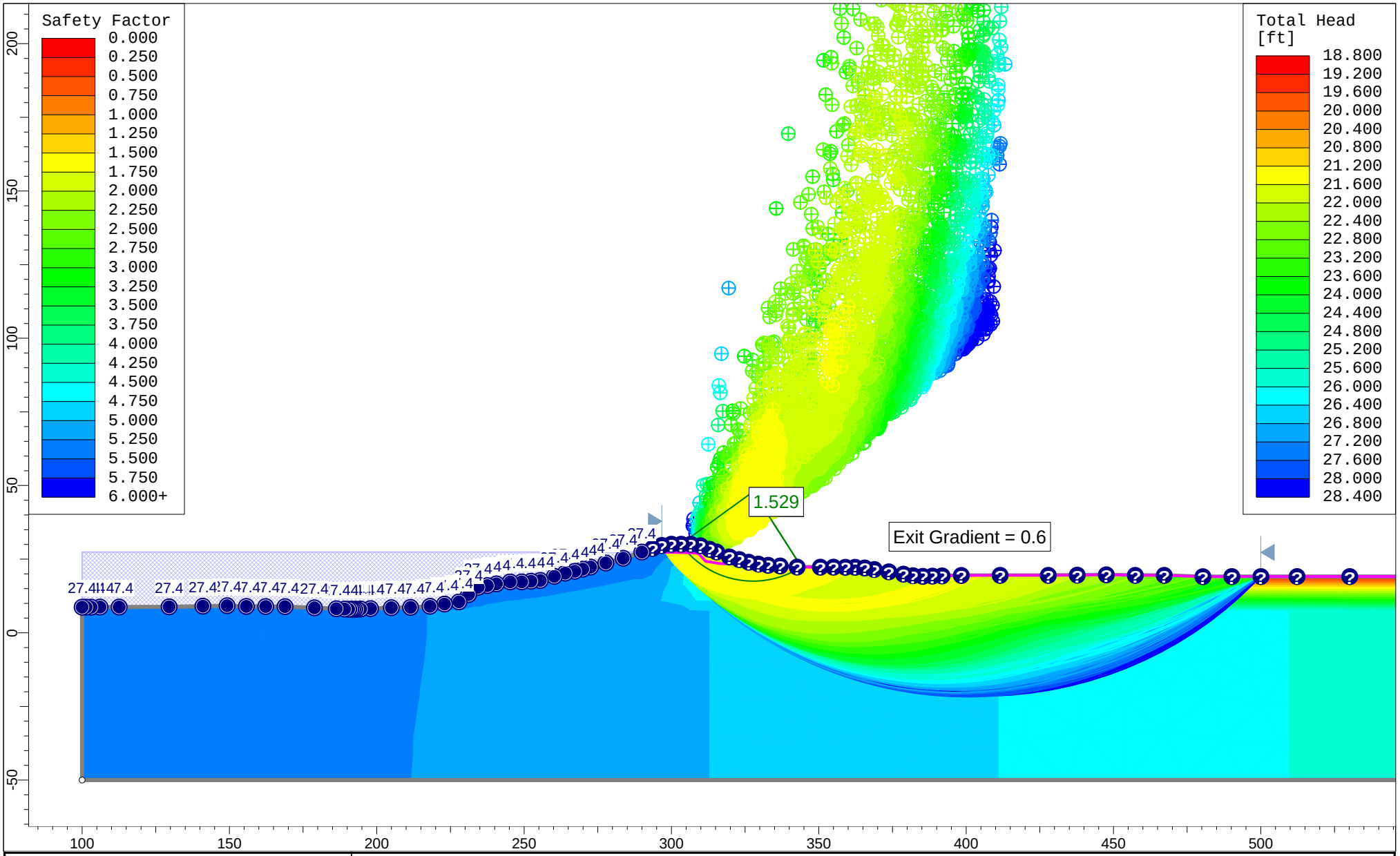
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_7300 PL.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_7300 PW.slim

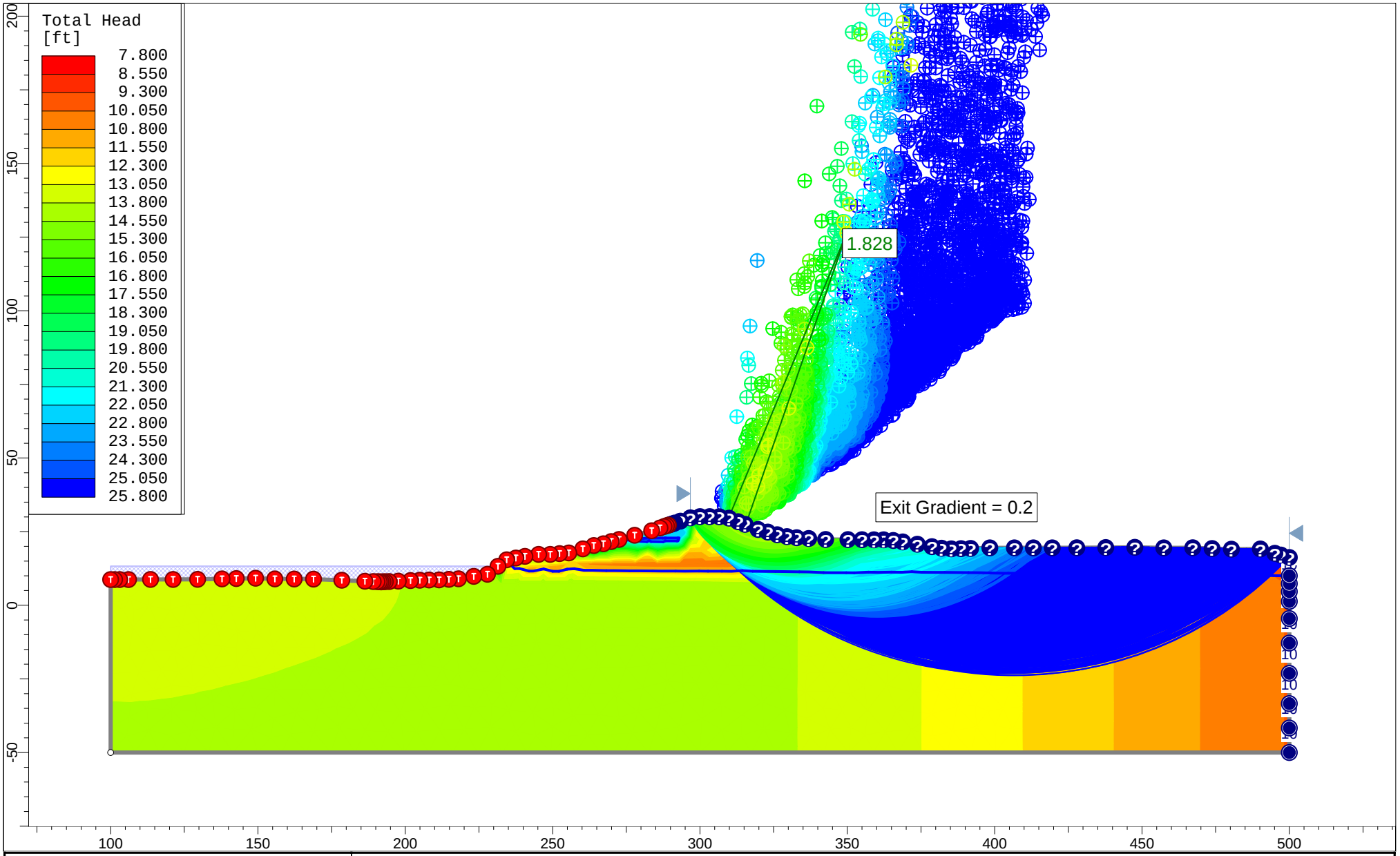
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 73S Flood Stage Conditions 100-yr WSE Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_7300 FL.slim

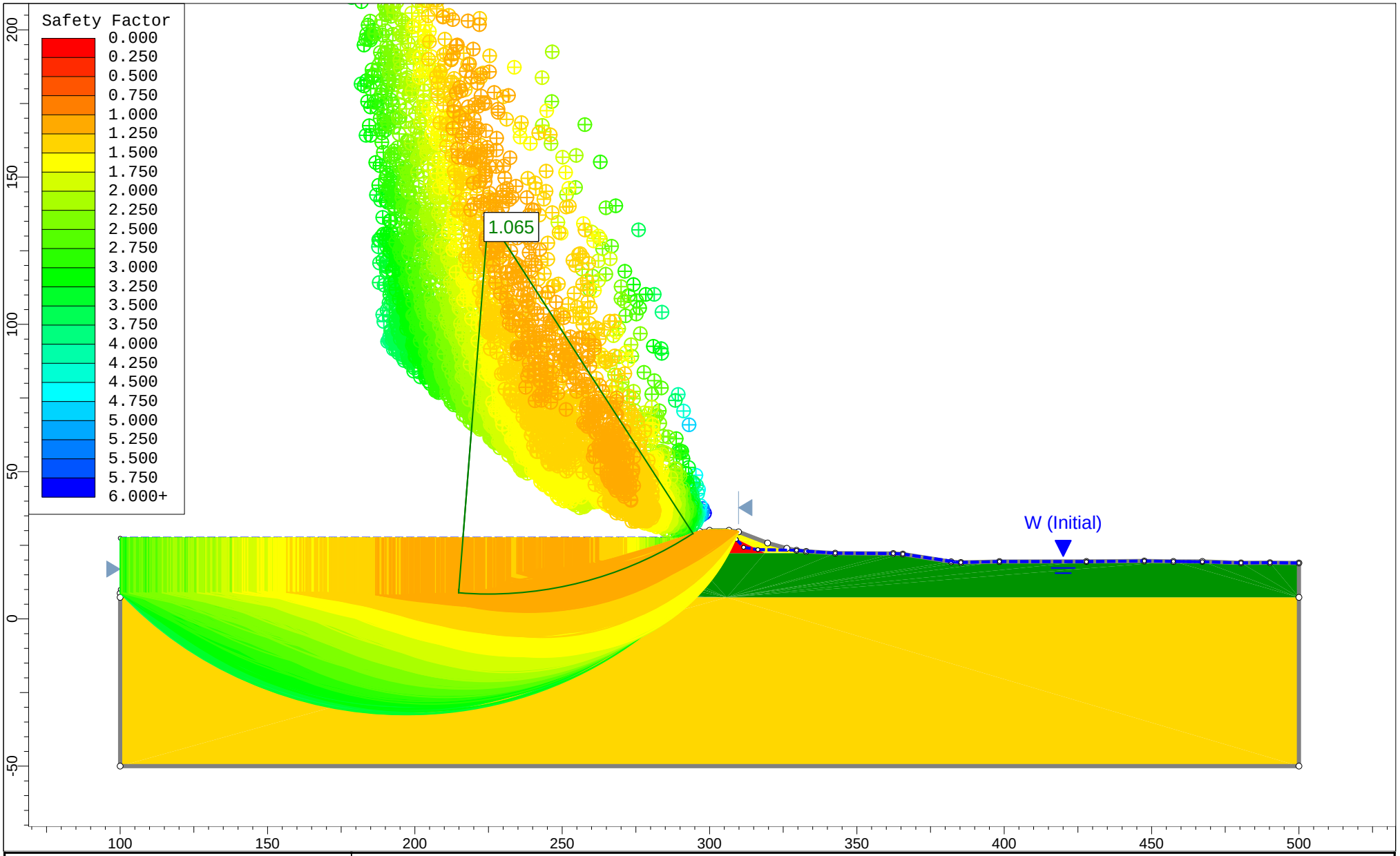
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

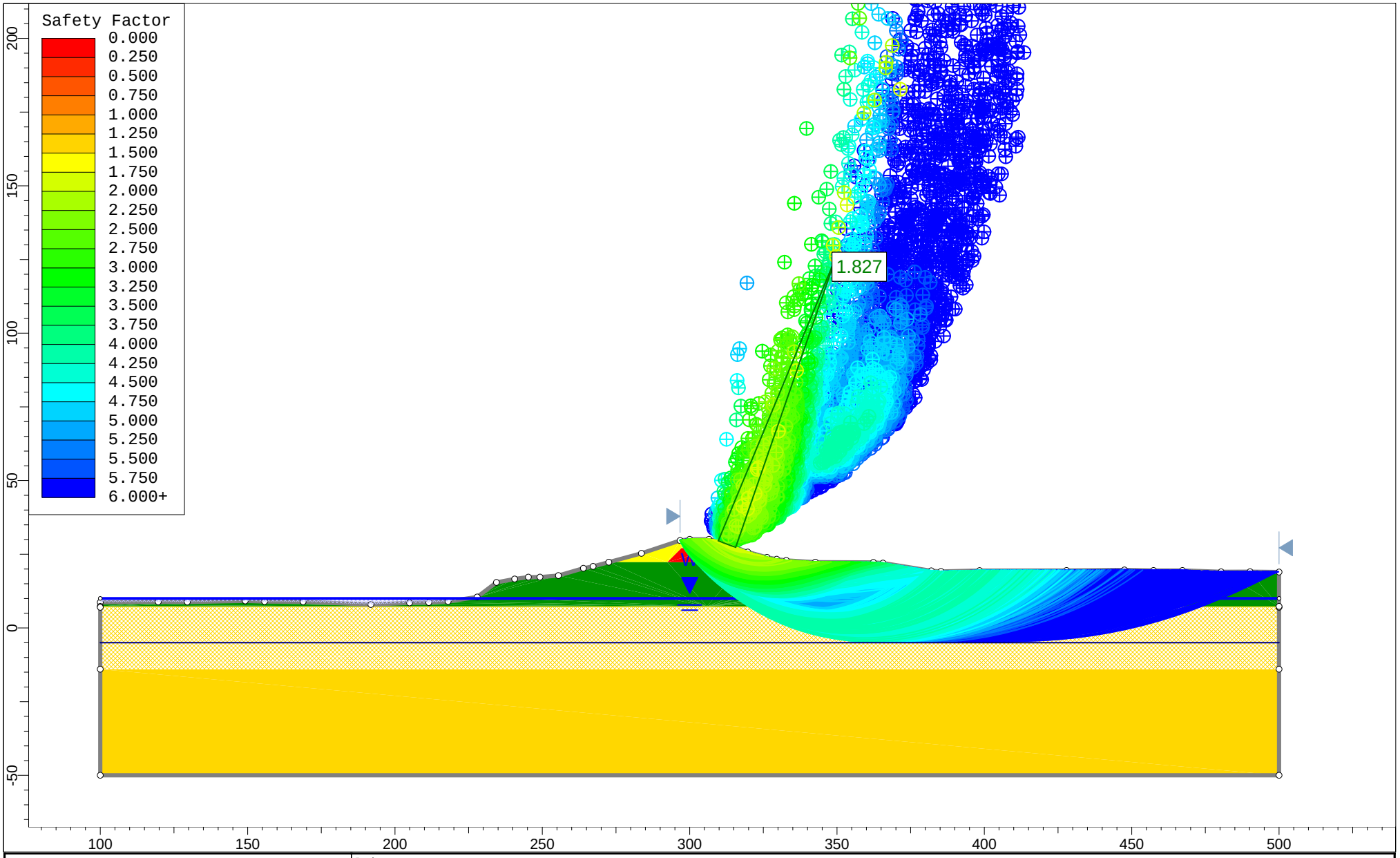
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-Section 73S, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
Drawn By	AB	Scale	1:540
Company	CGI/FWI		
Date	May, 2011	File Name	SlopeW_lineS_7300 FLT.slim

SLIDEINTERPRET 6.011



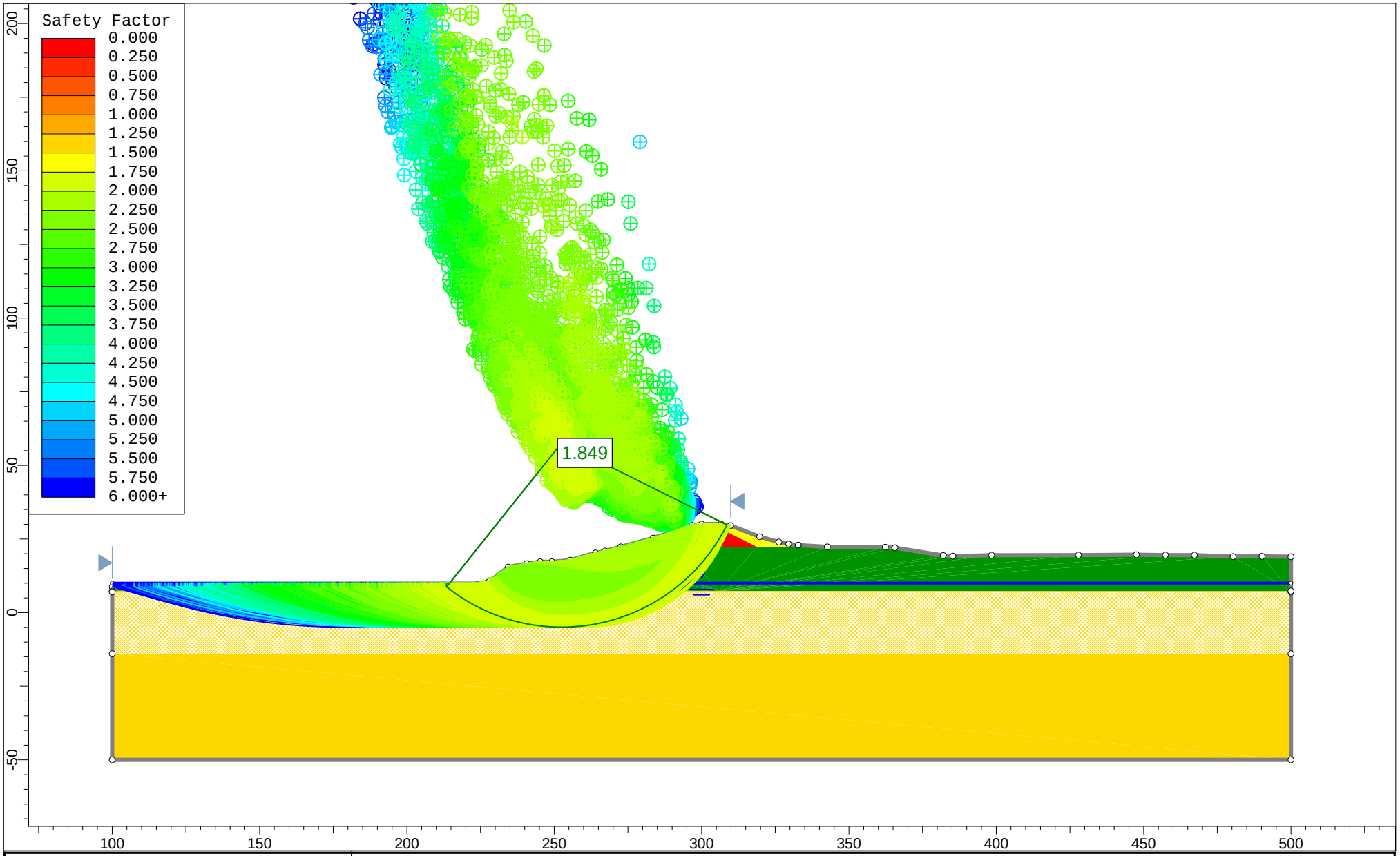
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_7300 RW.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_7300 PEL.slim

SLIDEINTERPRET 6.011



	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73S Post Earthquake Conditions Median Annual WSE Waterside slope		
SLIDEINTERPRET 6.011	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_7300 PEW.slim

SECTION 73R

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineN_7300 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 73N Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: -20
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
300.01	29.54
296.74	29.81
286.9	29.57
283.63	28.84
277.06	26.43

267.22	24.2
263.95	23.86
250.84	23.3
247.54	23.26
234.43	23.71
227.89	23.52
224.59	23.27
208.21	20.5
204.94	20.11
181.99	18.78
175.42	18.64
172.15	18.75
162.31	19.2
152.47	19.87
139.36	20.44
132.79	20.35
113.14	20.51
100	20.46
100	11.9895
100	-50
500	-50
500	8.74
490.18	8.72
480.34	8.29
470.5	8.13
460.66	8.57
431.17	7.68
424.6	6.85
421.33	6.75
411.49	7.41
401.65	7.55
385.27	7.36
381.97	7.47
378.7	7.77
374.051	7.48
364.12	7.48
362.926	11.9895
362.32	14.28
349.18	19.24
342.64	22.26
339.37	23.3
336.07	24.01
332.8	24.36
329.53	24.29

322.96	25.69
319.69	25.88
316.42	25.69
313.12	25.77
303.28	28.74

Material Boundary

X	Y
267.22	24.2
283.117	24.6814
300.795	25.2168
316.42	25.69

Material Boundary

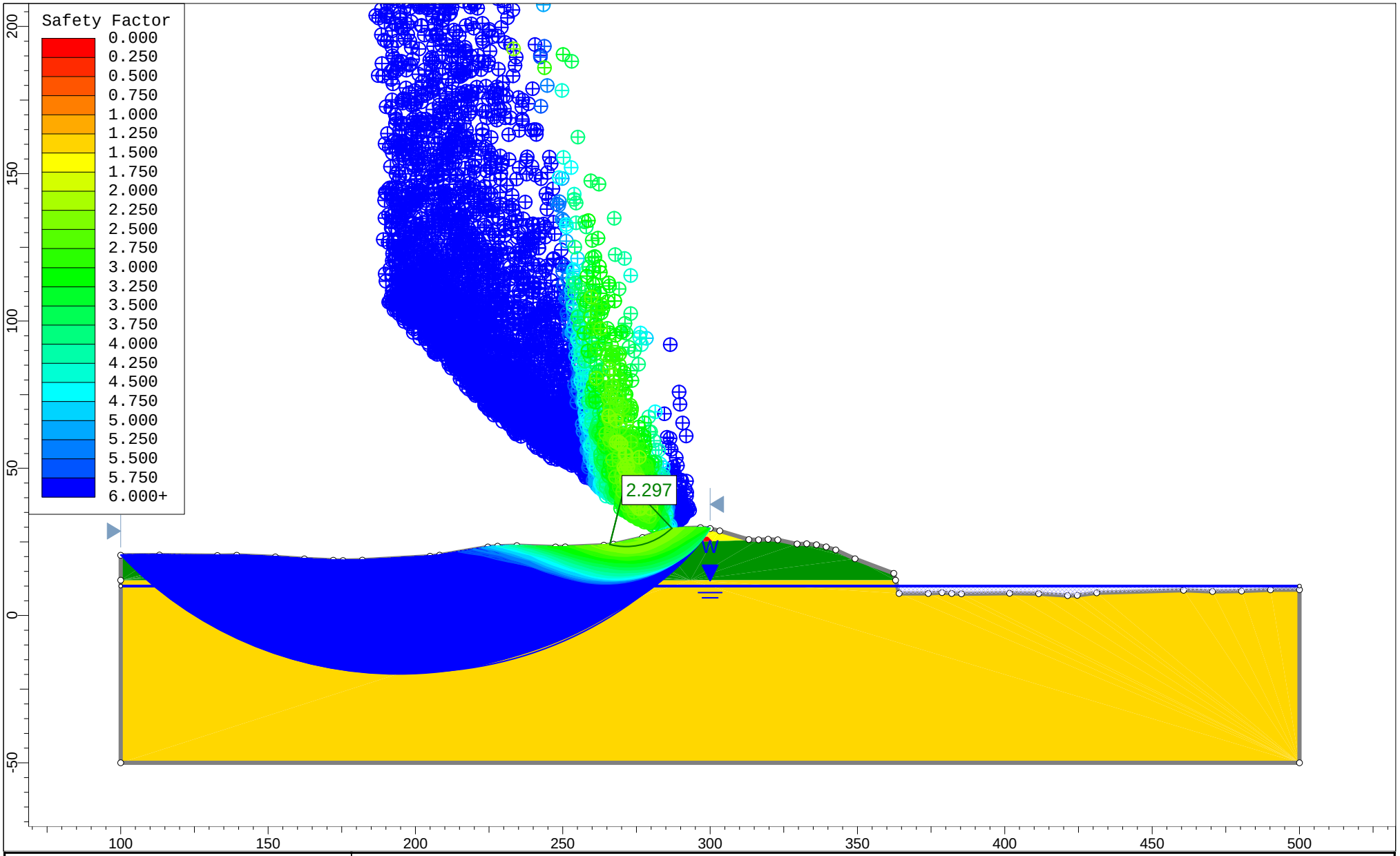
X	Y
283.117	24.6814
287.257	26.7545
299.257	26.7545
300.795	25.2168
300.818	25.1933

Material Boundary

X	Y
293.29	11.9895
362.926	11.9895

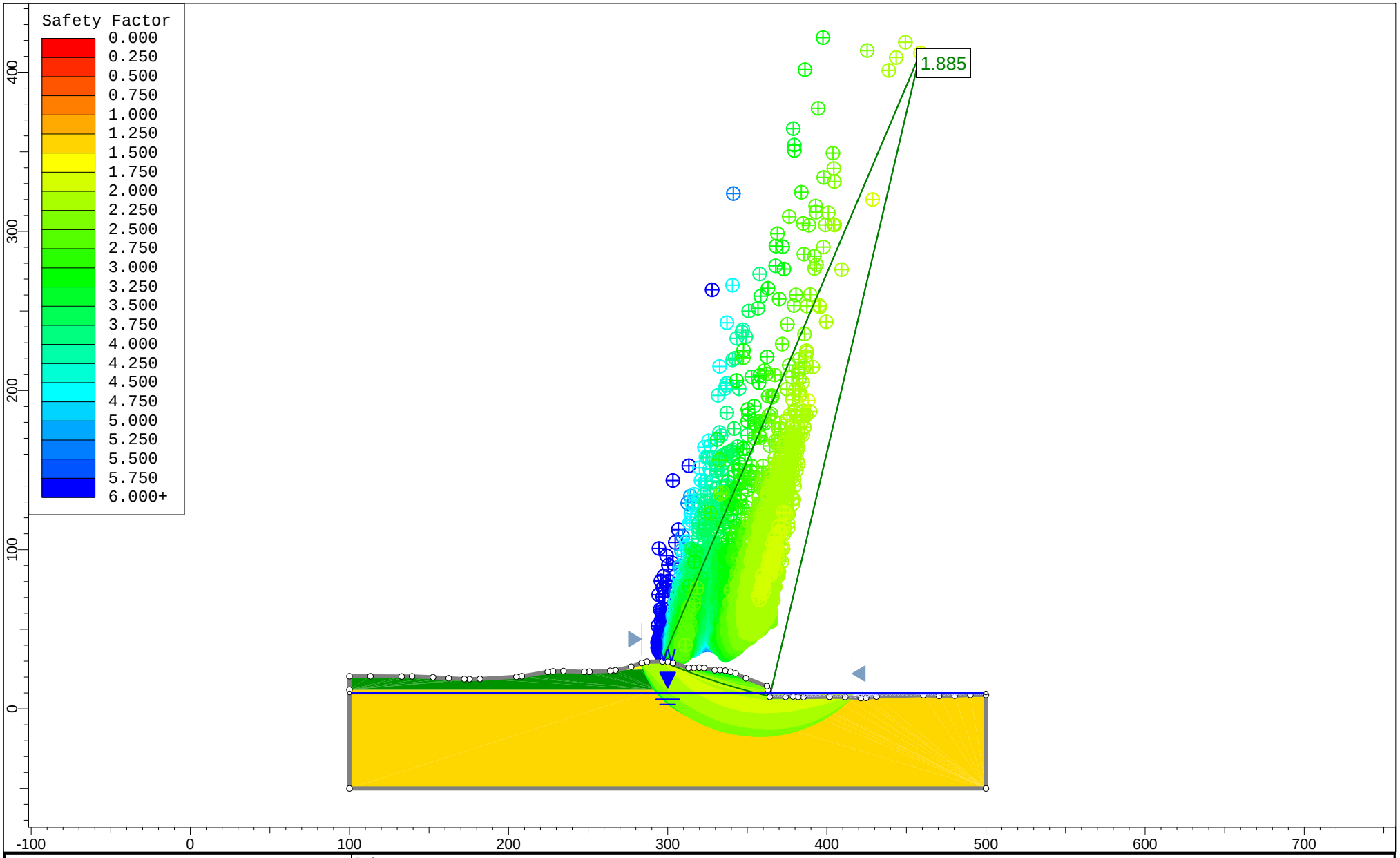
Material Boundary

X	Y
100	11.9895
293.29	11.9895



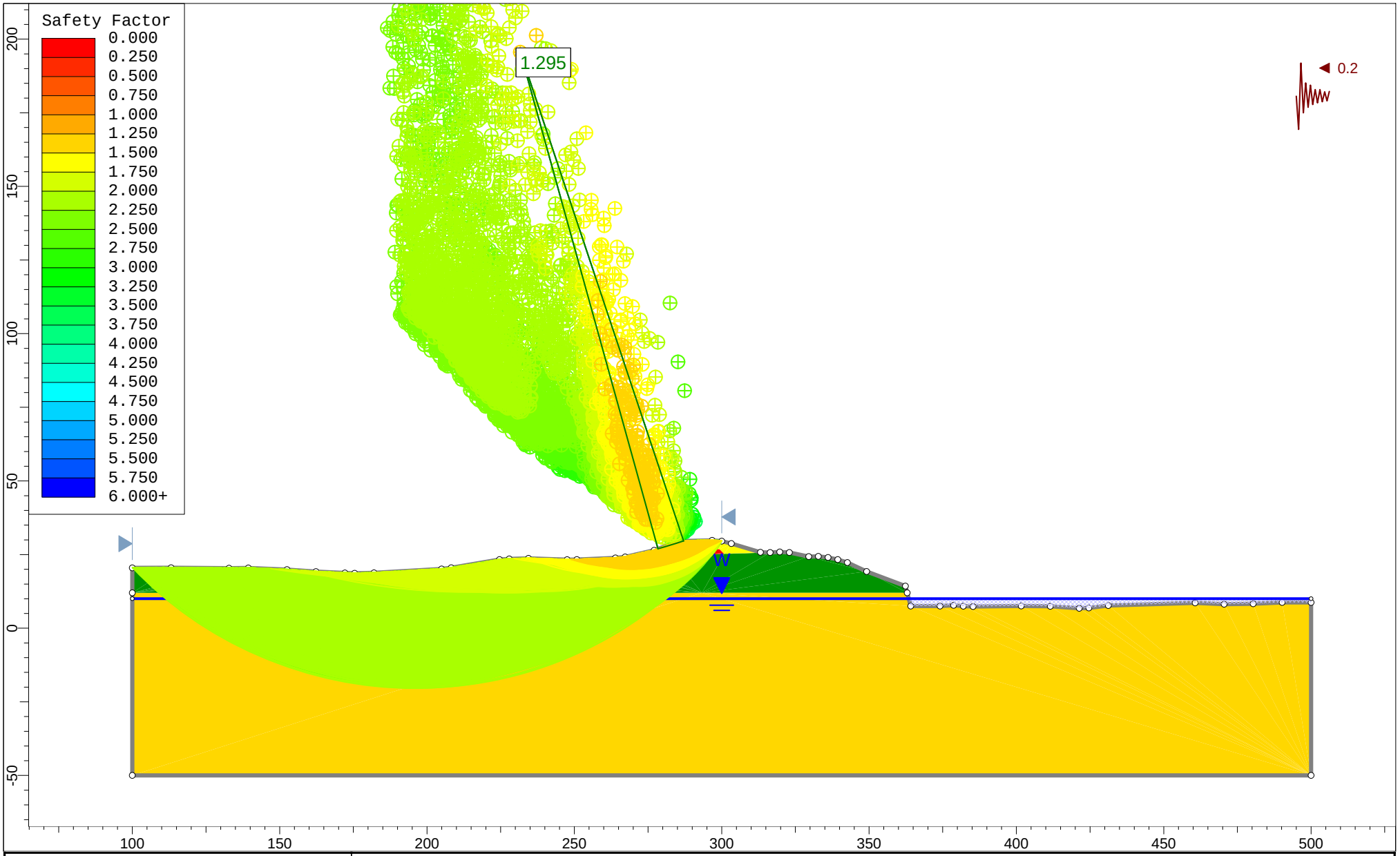
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_7300 EL.slim

SLIDEINTERPRET 6.011



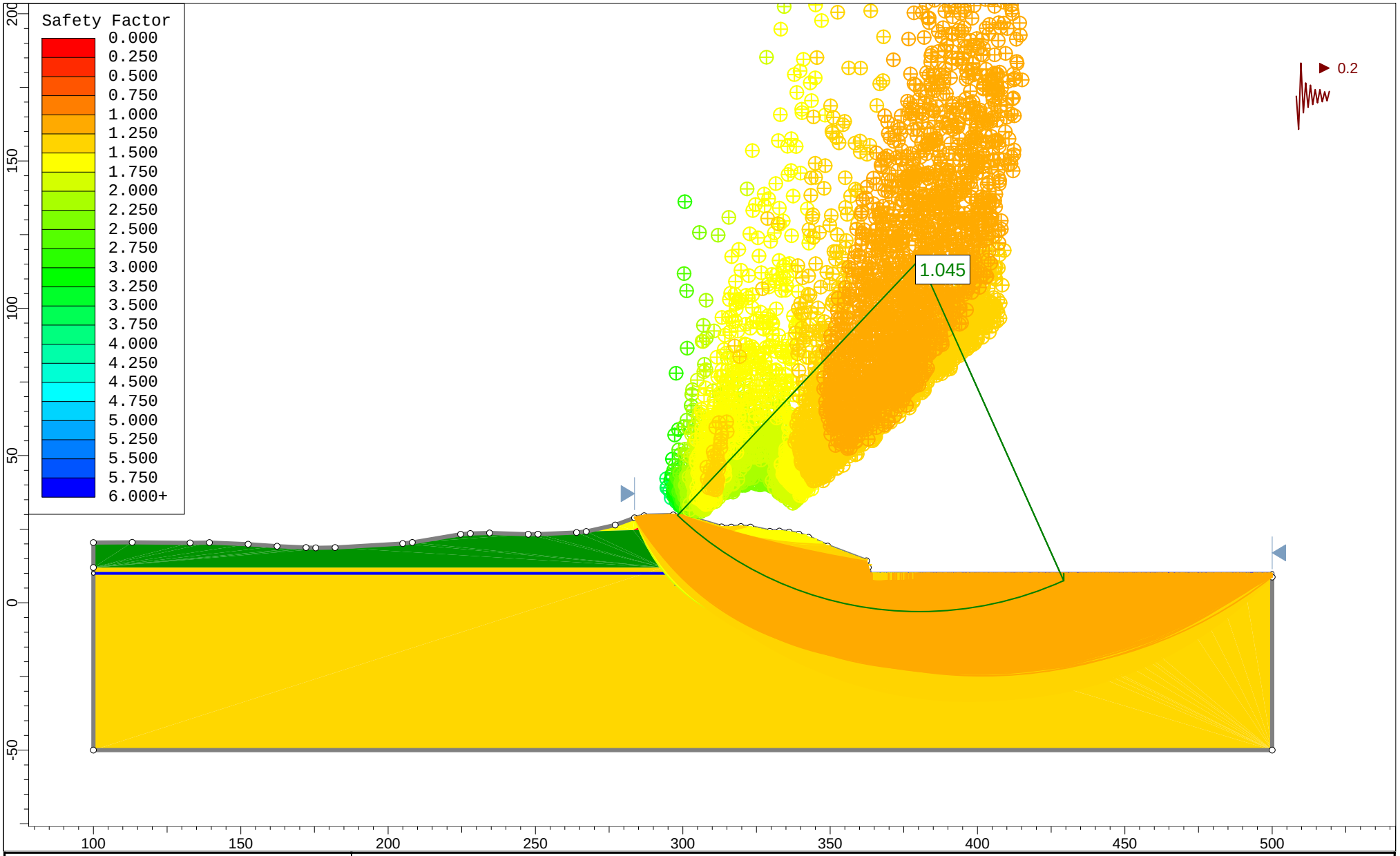
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:1000	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_7300 EW.slim

SLIDEINTERPRET 6.011



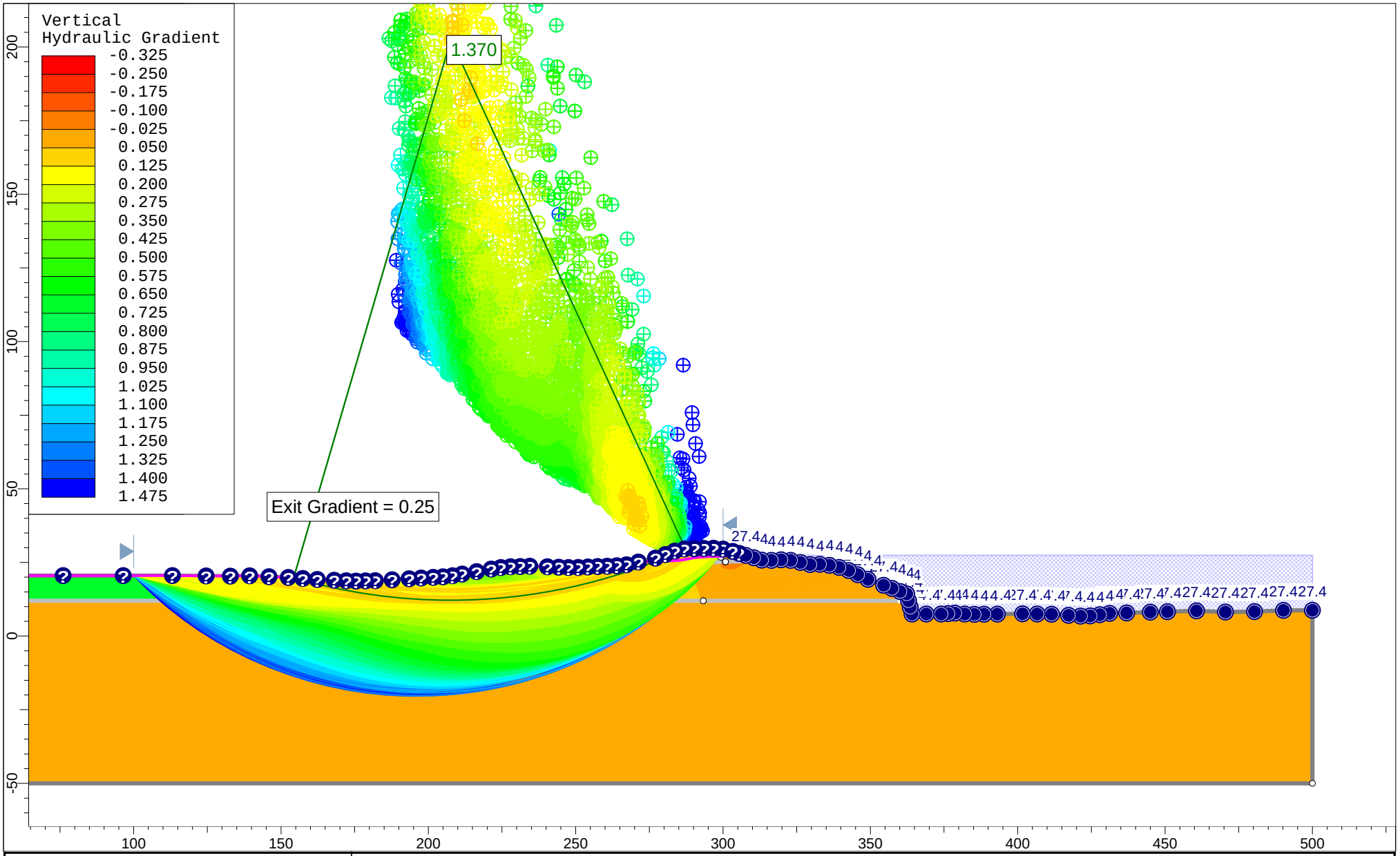
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_7300 PL.slim

SLIDEINTERPRET 6.011

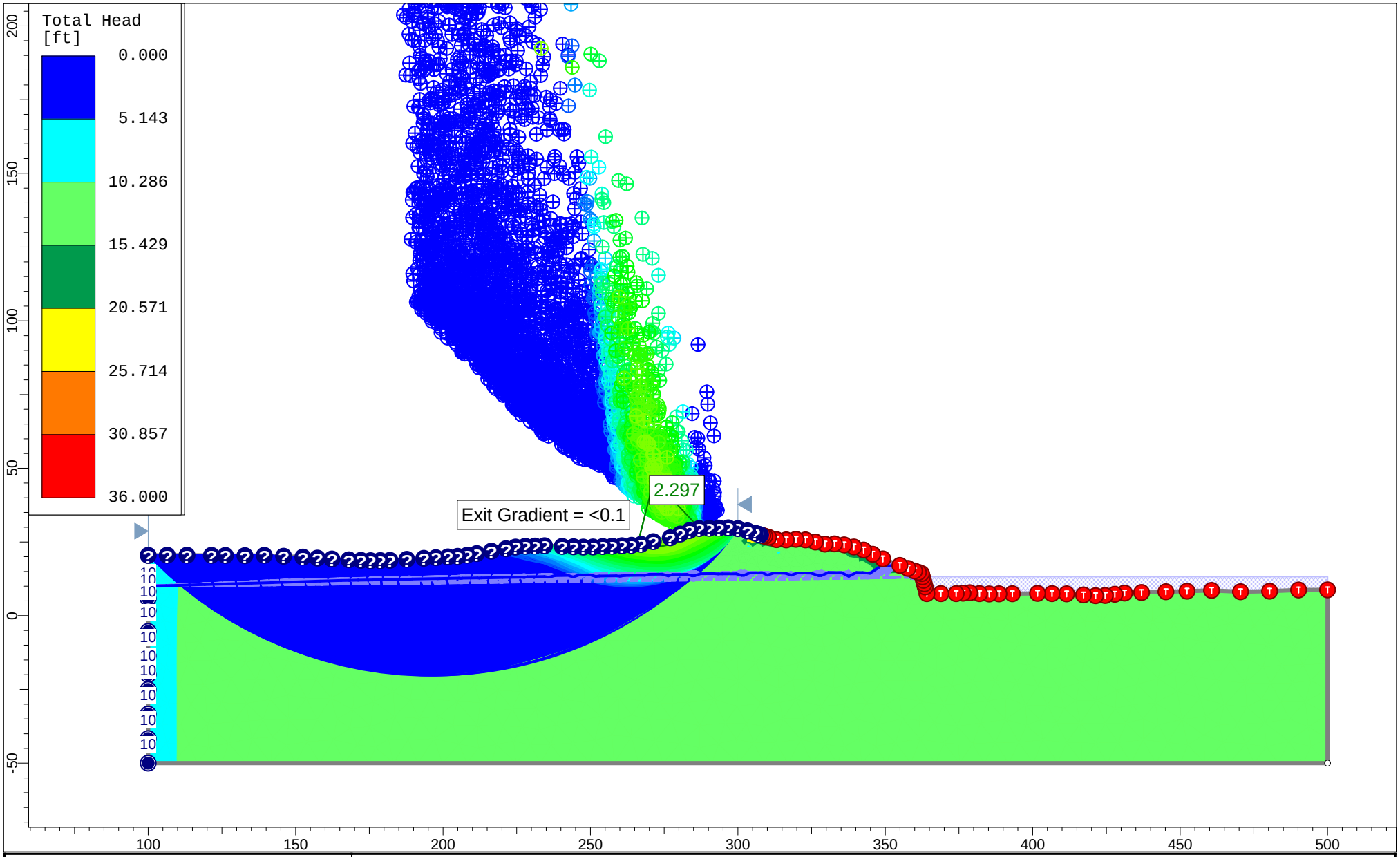


rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_7300 PW.slim

SLIDEINTERPRET 6.011



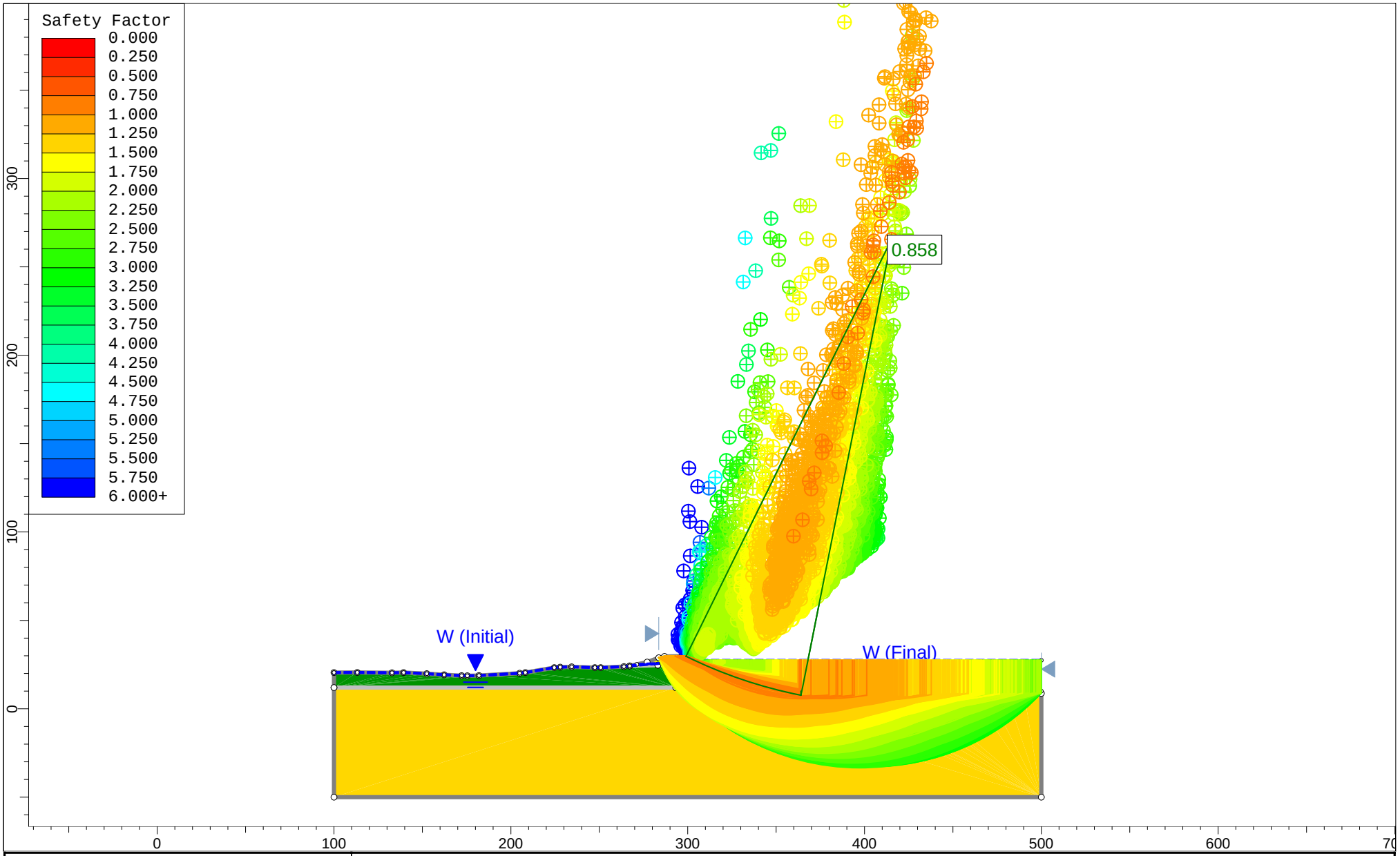
SLIDEINTERPRET 6.011	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Flood Stage Conditions 100-yr WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_7300 FL.slim



CGI Technical Services Inc.

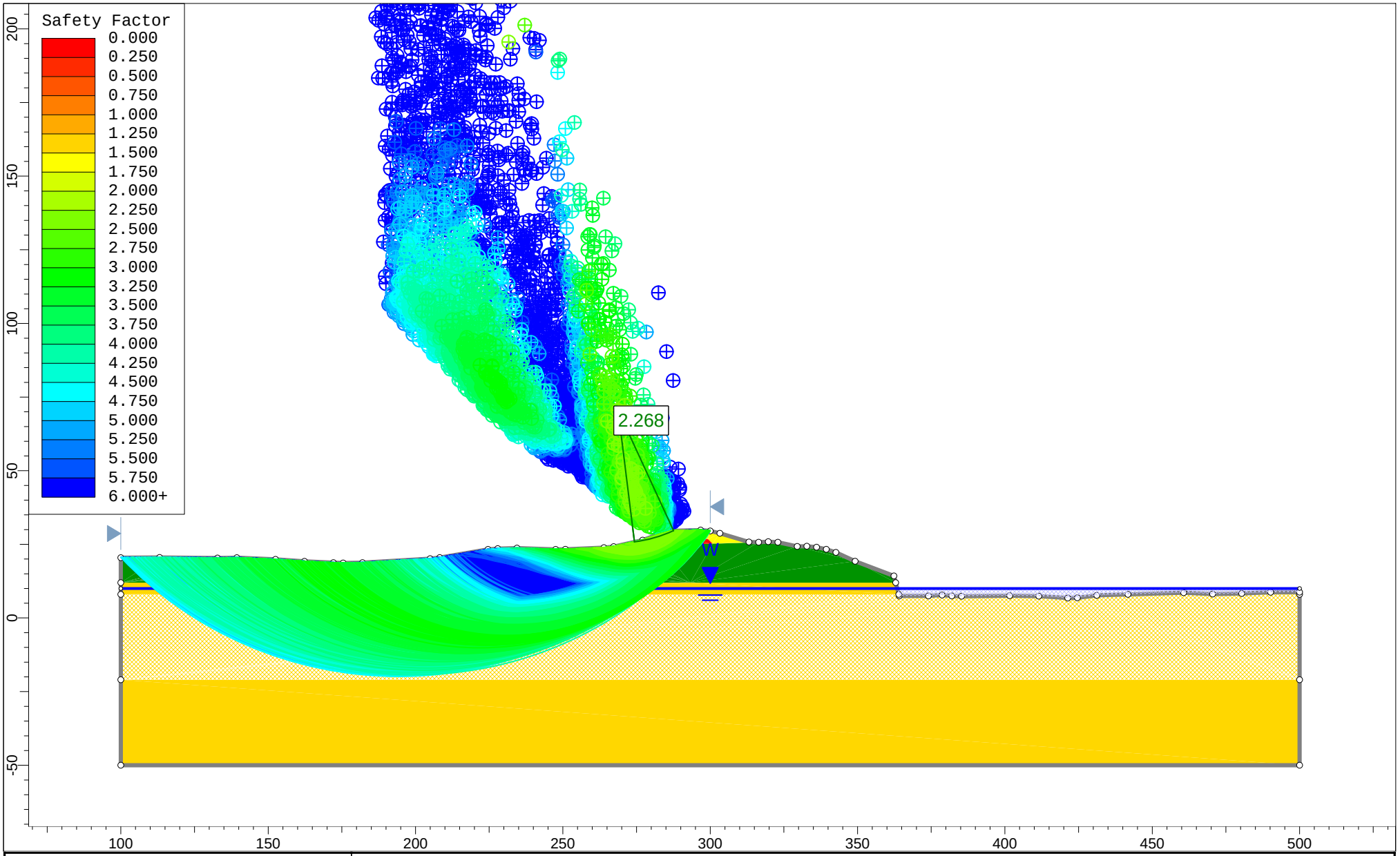
SLIDEINTERPRET 6.011

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 73N Flood Stage Conditions (Transient) 100-yr Landside Slope		
Drawn By	AB	Scale	1:540
Company	CGI/FWI		
Date	May 2011	File Name	SlopeW_lineN_7300 FLT.slim



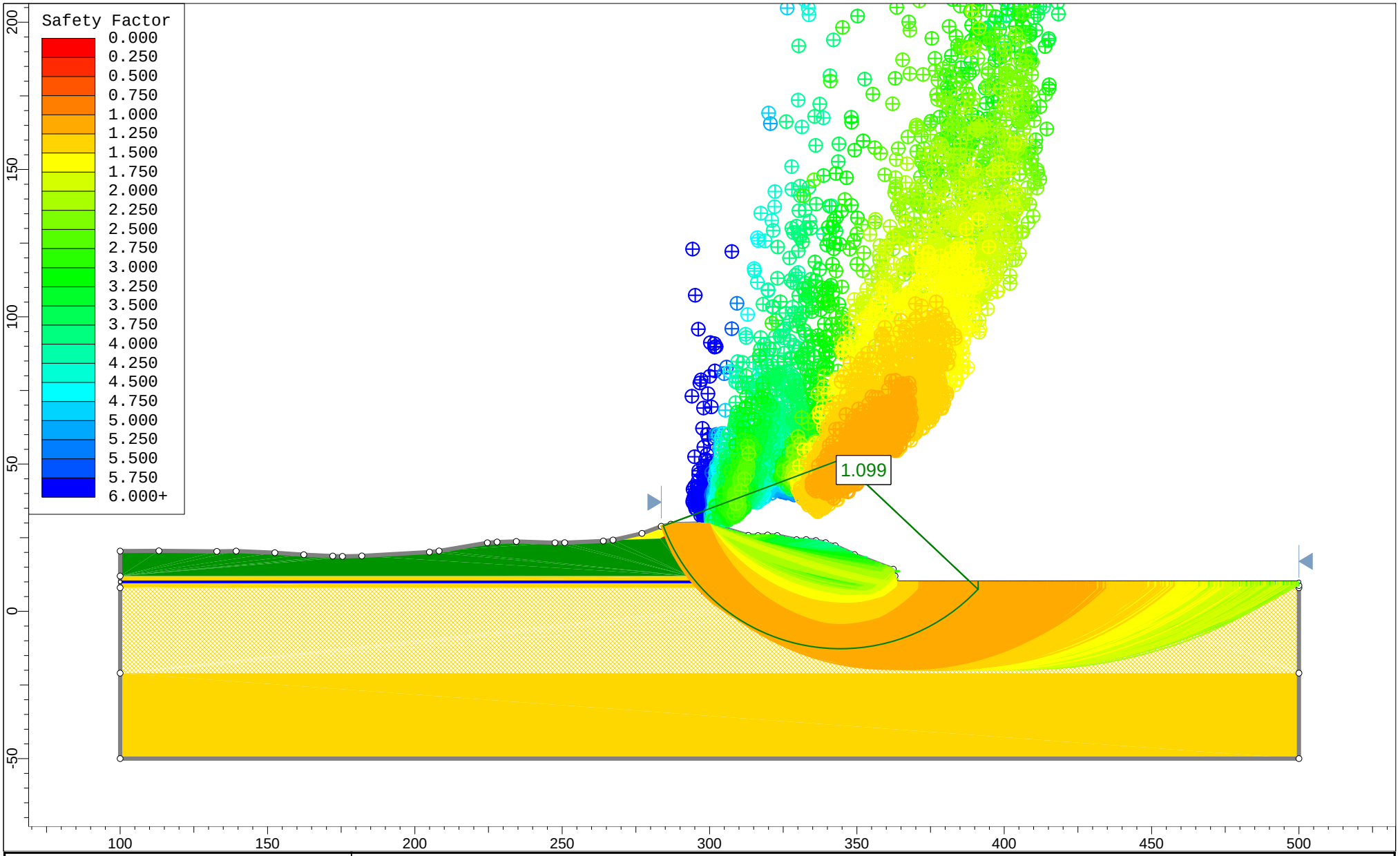
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Rapid Drawdown Waterside Slope		
	Drawn By	AB	*Scale* 1:900	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_7300 RW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 73N Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_7300 PEL.slim

SLIDEINTERPRET 6.011



Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 73N Post Earthquake Conditions Median Annual WSE Waterside slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineN_7300 PEW.slim

SLIDEINTERPRET 6.011

SECTION 87L

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineS_8700 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 87S Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
300.01	32.64
293.44	32.72
290.17	32.3
273.79	27.05
268.975	25.67

263.95	24.23
248.928	19.111
242.481	17.796
234.936	16.701
229.084	15.9268
227.999	12.939
214.78	12.53
211.48	12.36
204.94	12.47
201.64	12.71
198.37	13.1
188.53	14.72
181.99	15.39
178.69	15.43
172.15	15.03
159.04	15.39
152.47	15.27
145.9	14.84
139.36	15.13
136.09	14.86
132.79	14.23
129.52	14.01
119.68	15.6
116.41	15.85
109.84	16.01
103.3	16.59
100	16.44
100	4.67
100	-50
500	-50
500	4.67
500	23.33
486.91	23.54
470.5	23.22
463.96	23.54
454.12	23.65
441.01	23.39
427.87	23.78
408.22	23.94
395.08	24.39
385.27	24.19
375.43	24.99
372.13	24.7
368.86	24.62

359.02	24.97
352.48	24.93
336.07	25.67
332.8	26
329.53	26.66
313.12	32.32
309.85	32.91
306.58	33.03

Material Boundary

X	Y
268.975	25.67
290.374	25.67
318.1	25.67
336.07	25.67

Material Boundary

X	Y
290.359	25.6543
290.374	25.67
294.264	29.56
310.264	29.56
318.1	25.67

Material Boundary

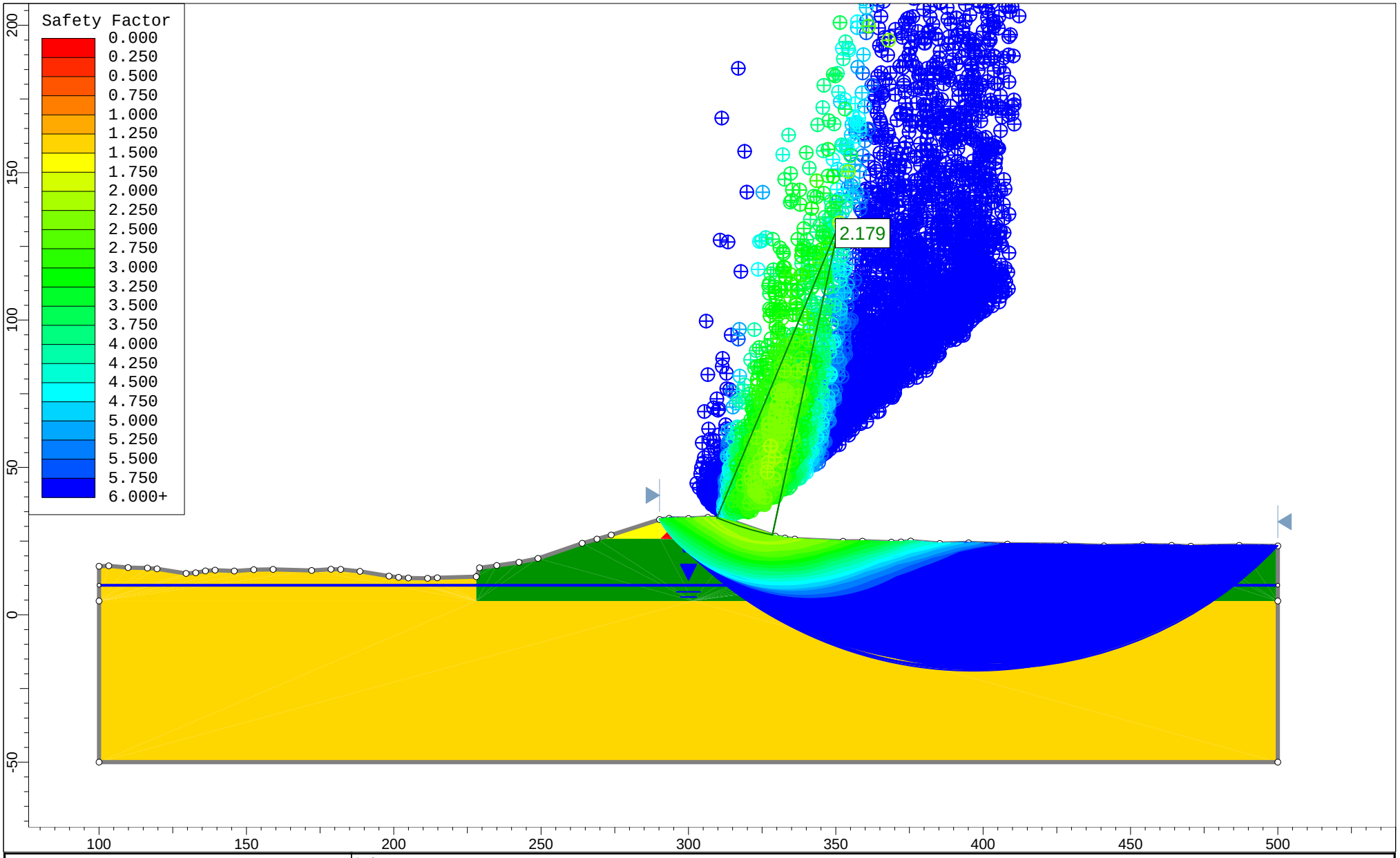
X	Y
301.517	4.67
500	4.67

Material Boundary

X	Y
100	4.67
227.999	4.67
301.517	4.67

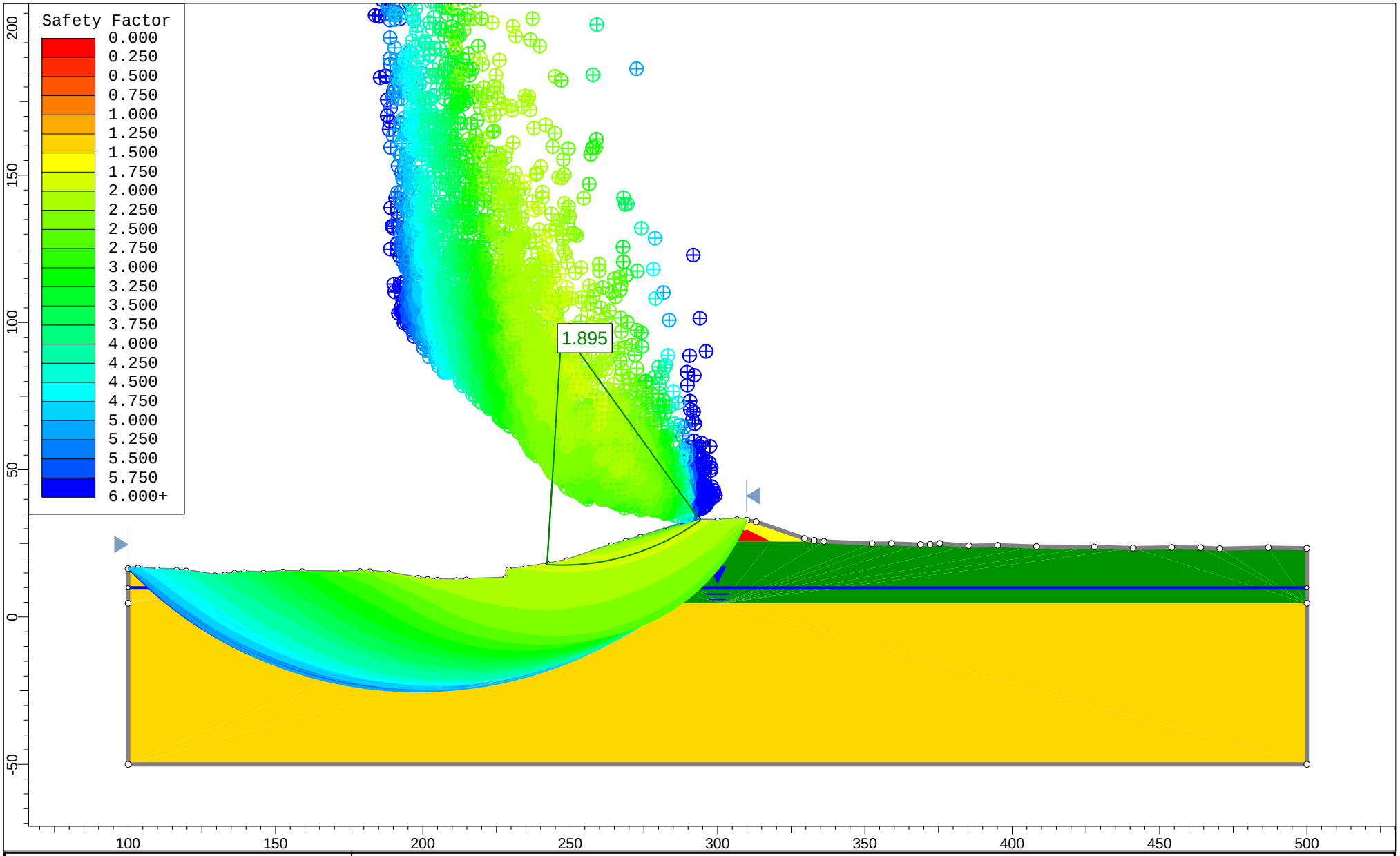
Material Boundary

X	Y
227.999	4.67
227.999	12.939



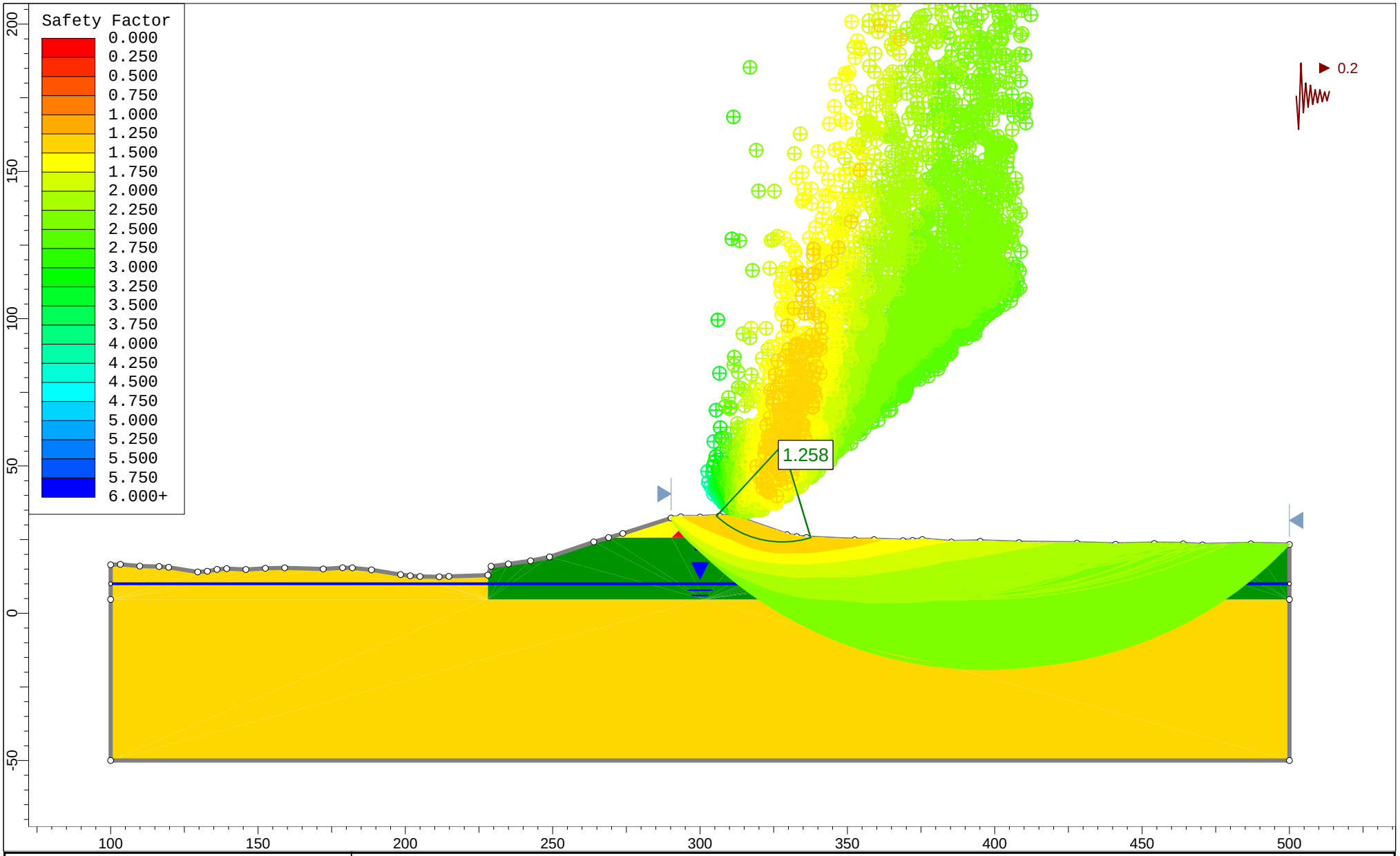
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87S Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_8700 EL.slim

SLIDEINTERPRET 6.011



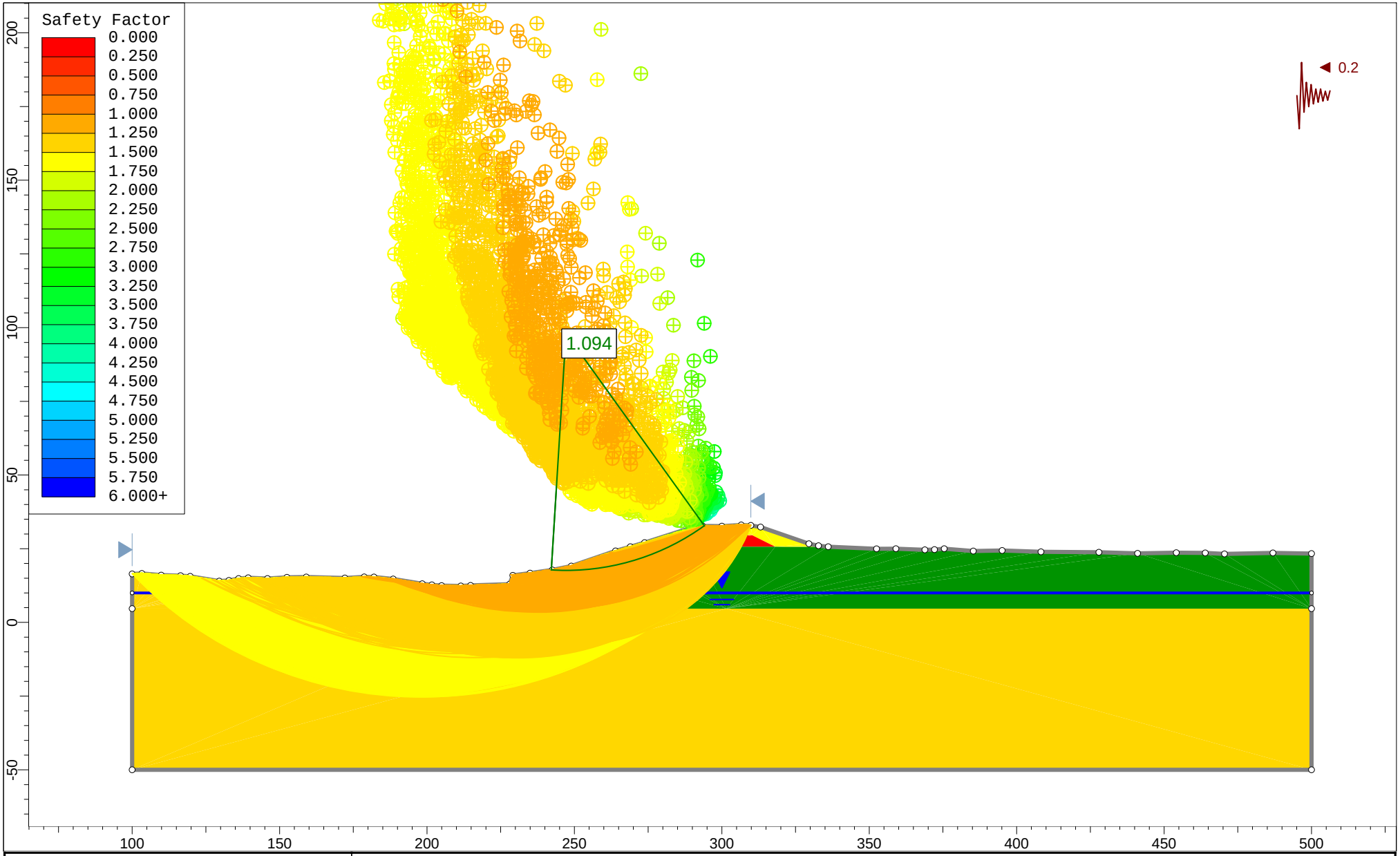
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87S Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_8700 EW.slim

SLIDEINTERPRET 6.011



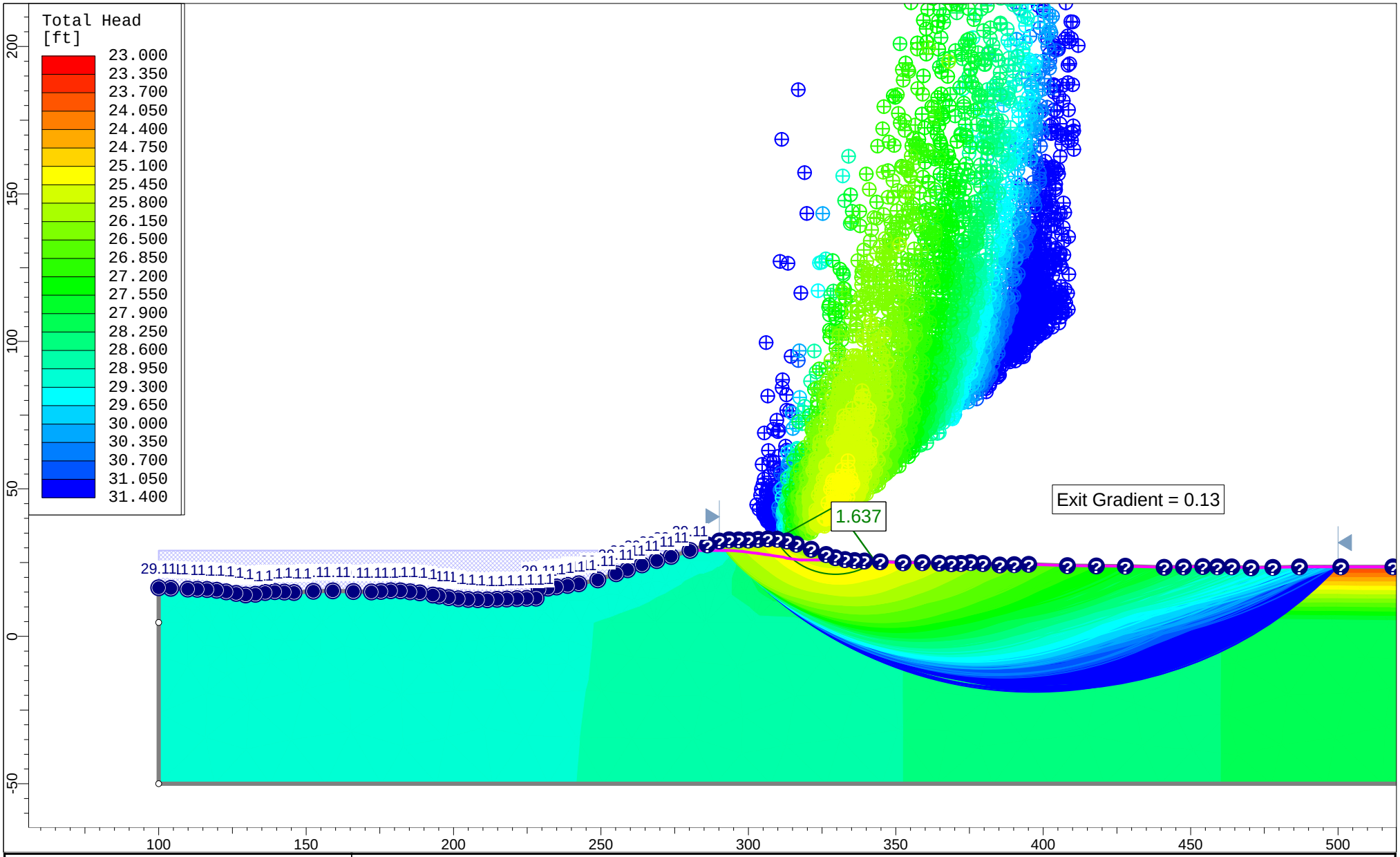
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87S Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_8700 PL.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87S Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_8700 PW.slim

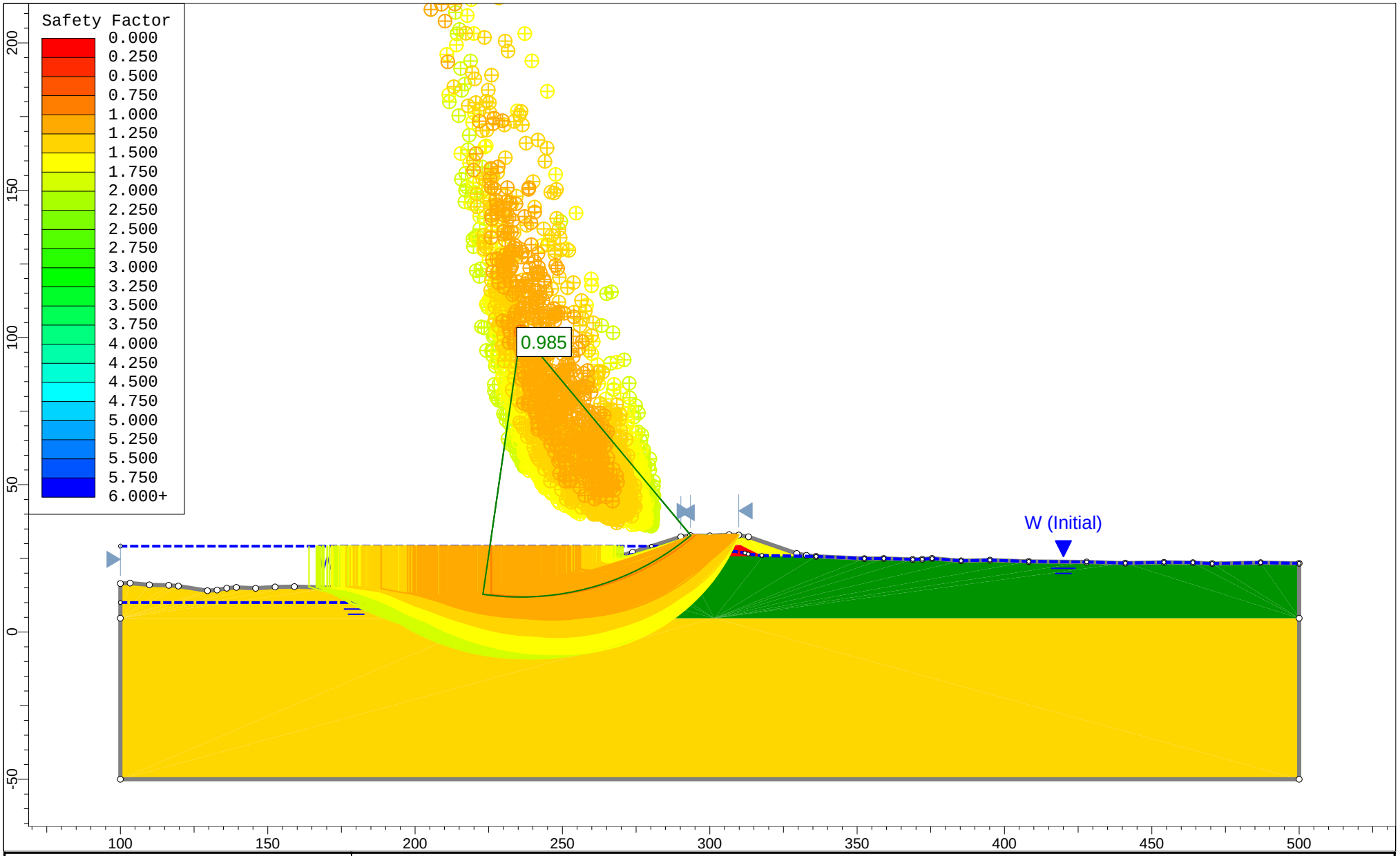
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

SLIDEINTERPRET 6.011

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 87S Flood Stage Conditions 100-yr WSE Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_8700 FL.slim



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87S Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_8700 RW.slim

SLIDEINTERPRET 6.011

SECTION 87R

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineN_8700 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 87N Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	132
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	35
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	0	0	0	0

List Of Coordinates

Water Table

X	Y
100	9
500	9

External Boundary

X	Y
313.12	31.96
309.85	32.69
306.58	32.99
293.44	32.77
290.17	32.04

286.9	30.95
280.33	29.92
273.79	29.34
267.22	29.19
260.68	28.27
247.54	25.9
244.27	25.47
237.73	24.99
227.89	23.8
221.32	23.37
211.48	23.04
204.94	22.56
201.64	22.52
198.37	22.78
188.53	22.99
175.42	22.71
172.15	22.51
162.31	22.71
155.74	22.32
149.2	22.2
142.63	22.26
126.25	21.71
100	22.18
100	19.8
100	-50
500	-50
500	8.42
496.72	8.42
493.45	8.08
480.34	7.32
470.5	8.07
463.96	8.29
454.12	9.54
450.82	9.63
441.01	8.97
437.71	8.93
427.87	9.18
421.33	9.08
408.22	10.05
404.92	10.12
395.08	10
391.81	9.73
388.54	9.81
383.086	10.518

382.178	15.4089
368.86	17.46
357.061	19.8
355.75	20.06
352.48	20.88
349.18	22
342.173	23.8
339.37	24.52
322.96	28.28

Material Boundary

X	Y
227.89	23.8
282.376	23.8
316.088	23.8
342.173	23.8

Material Boundary

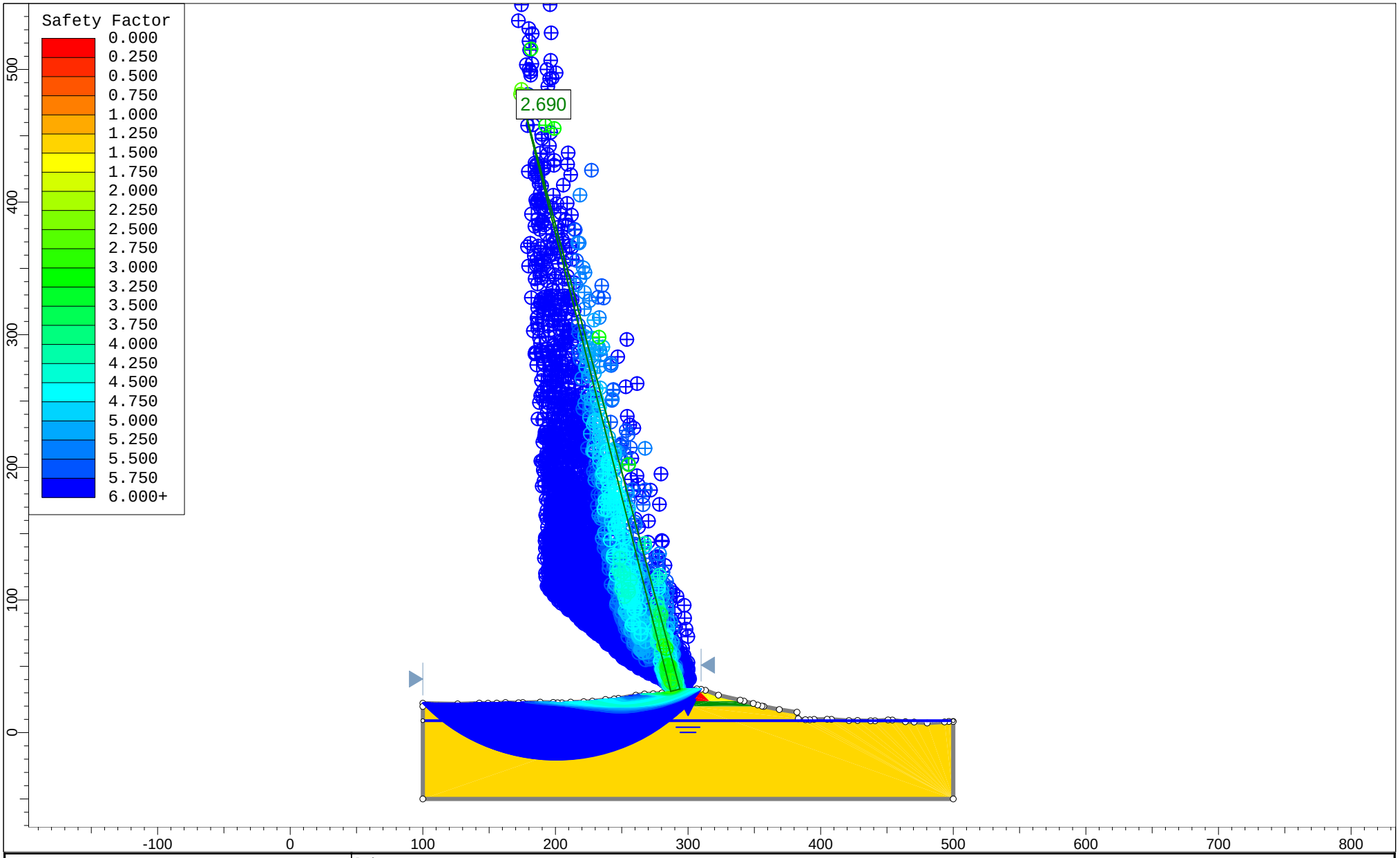
X	Y
282.33	23.7777
282.376	23.8
294.967	29.9204
309.967	29.9204
316.088	23.8
316.15	23.7377

Material Boundary

X	Y
302.686	19.8
357.061	19.8

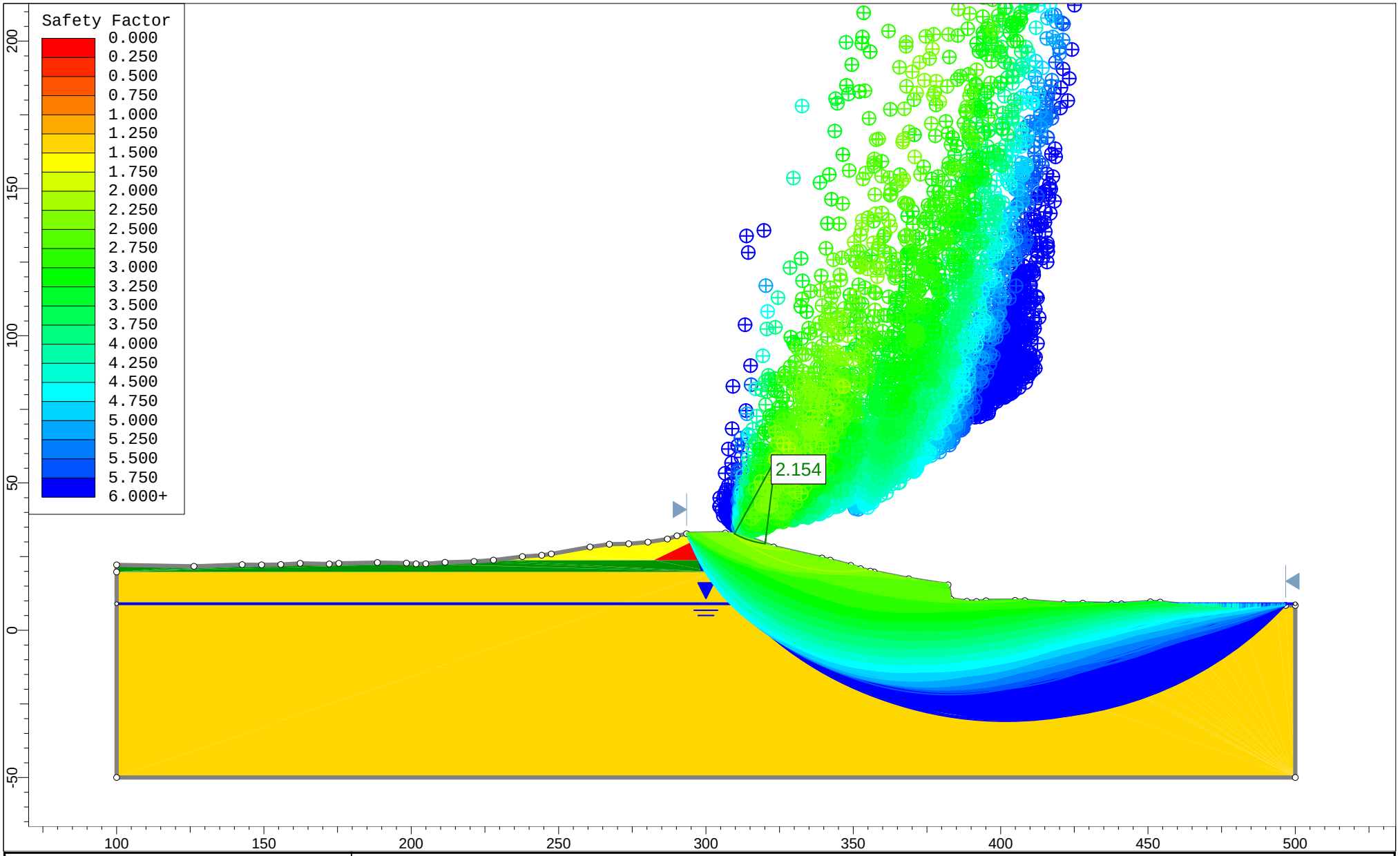
Material Boundary

X	Y
100	19.8
302.686	19.8



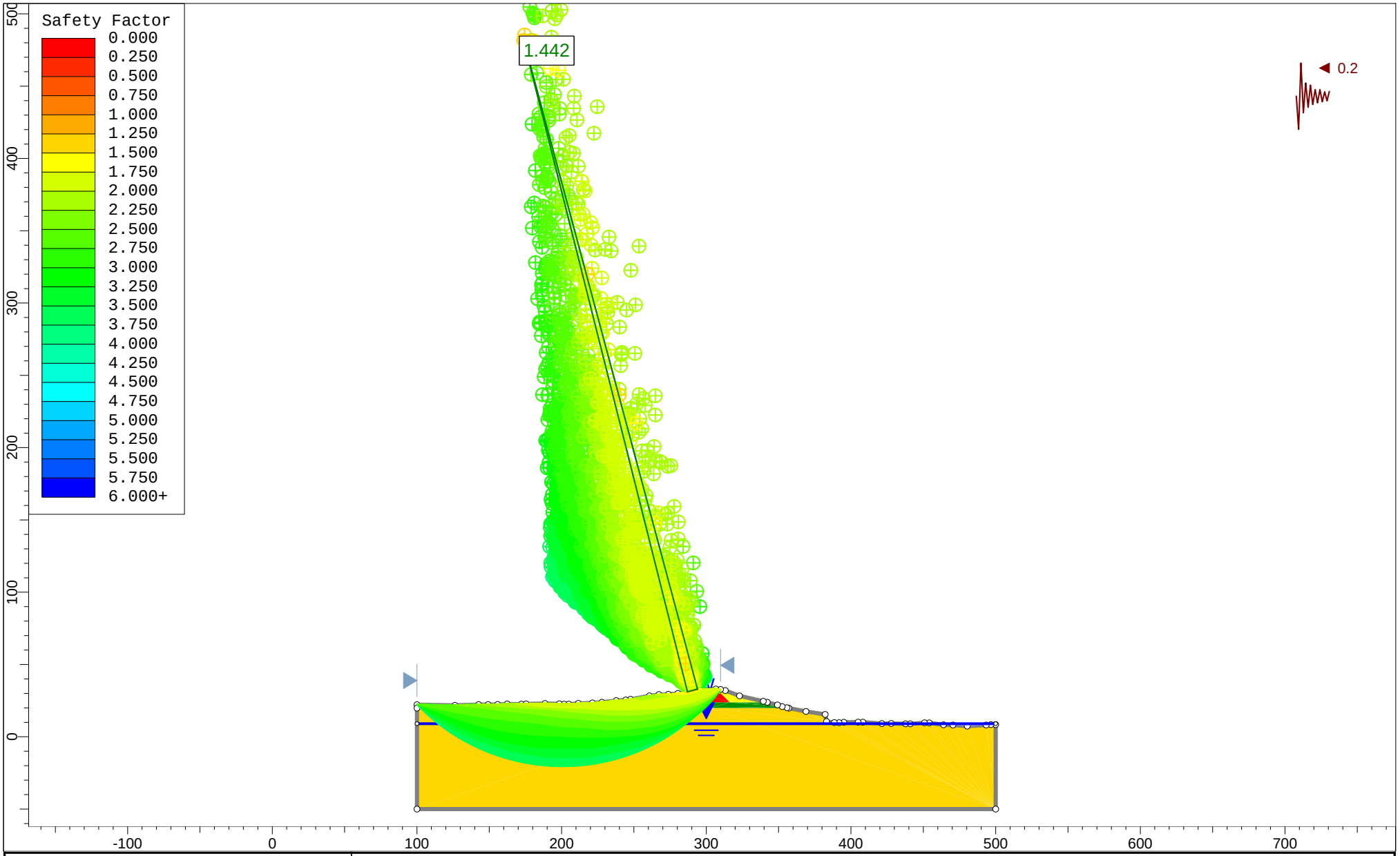
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:1200	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_8700 EL.slim

SLIDEINTERPRET 6.011



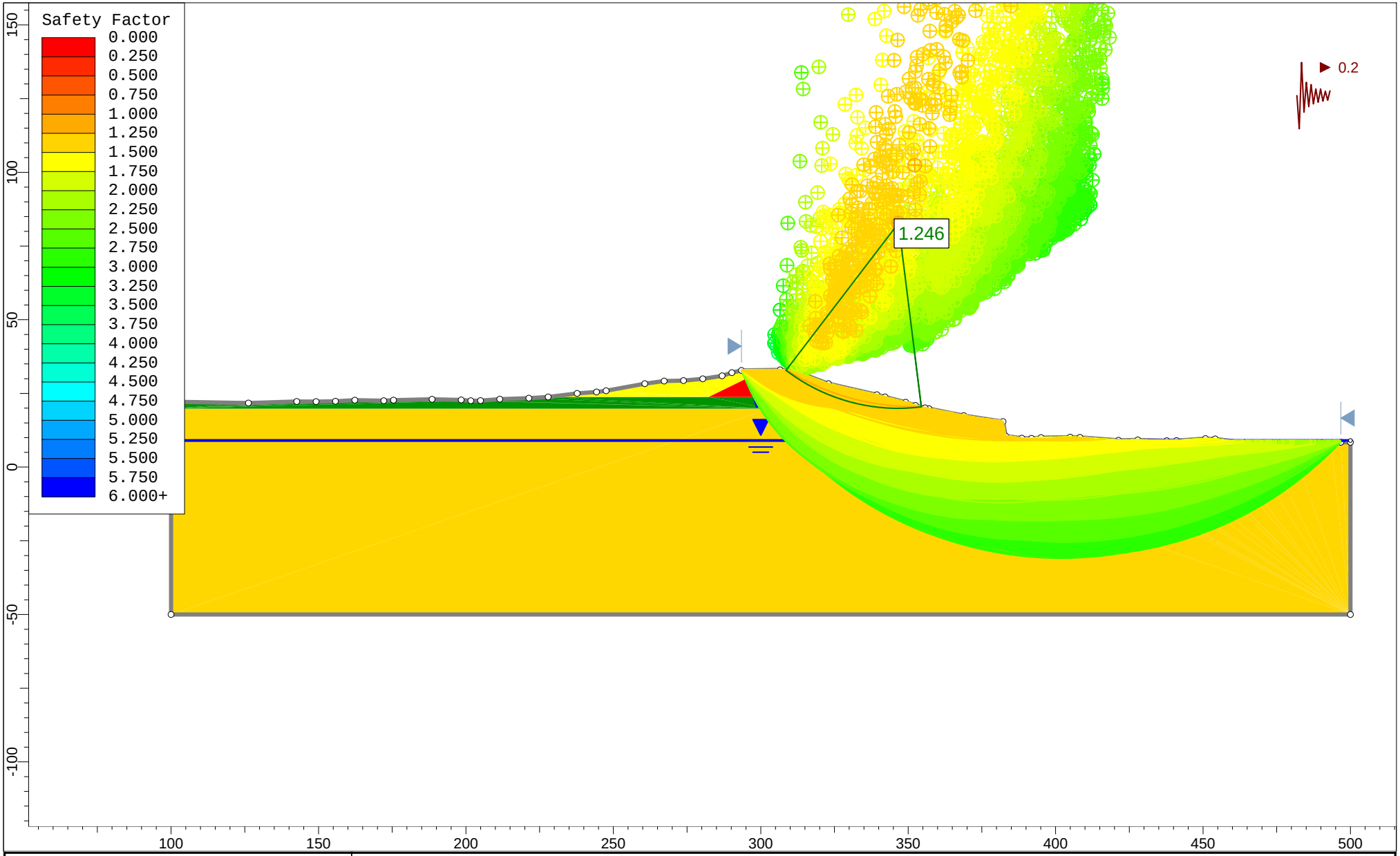
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_8700 EW.slim

SLIDEINTERPRET 6.011



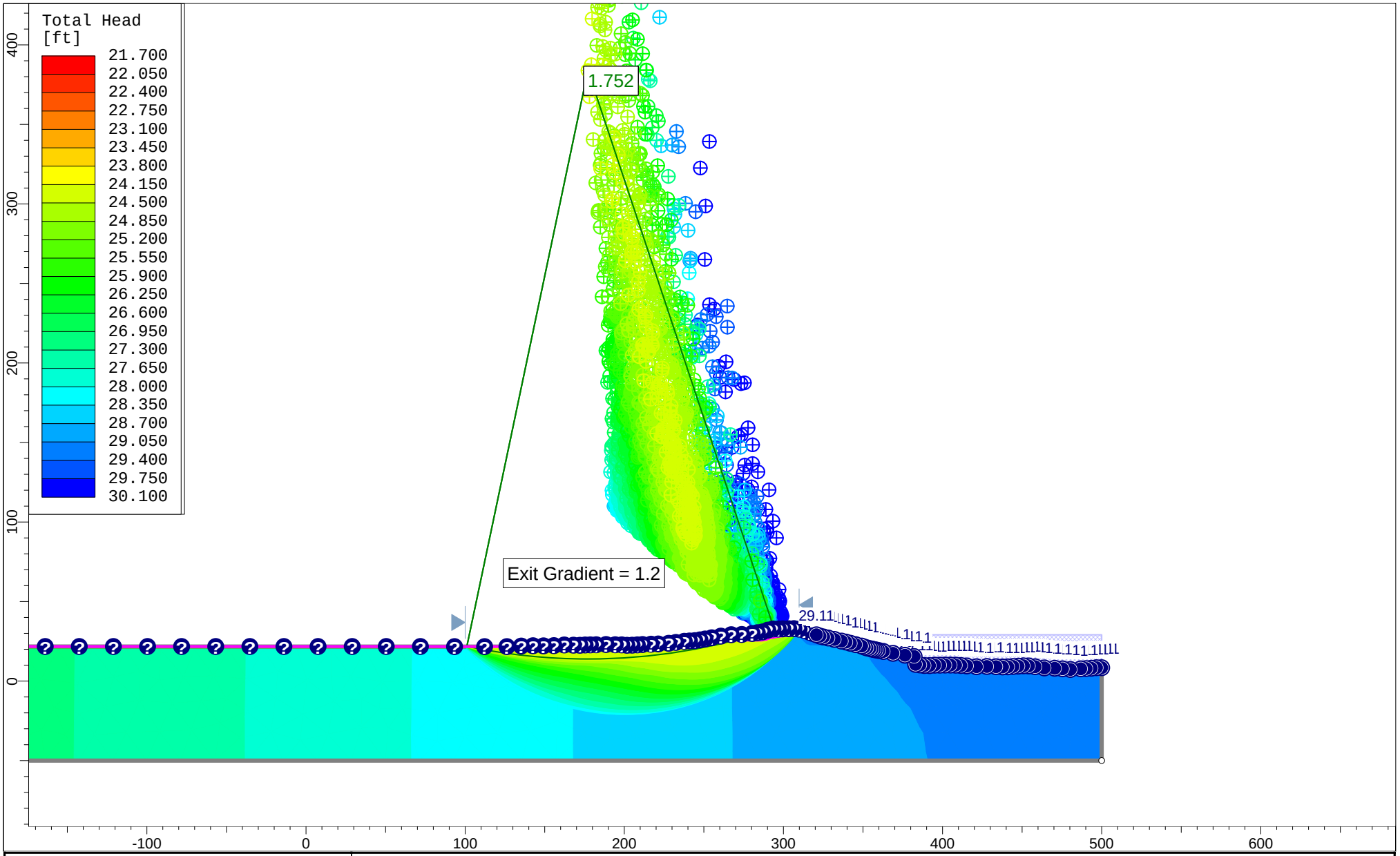
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:1100	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_8700 PL.slim

SLIDEINTERPRET 6.011



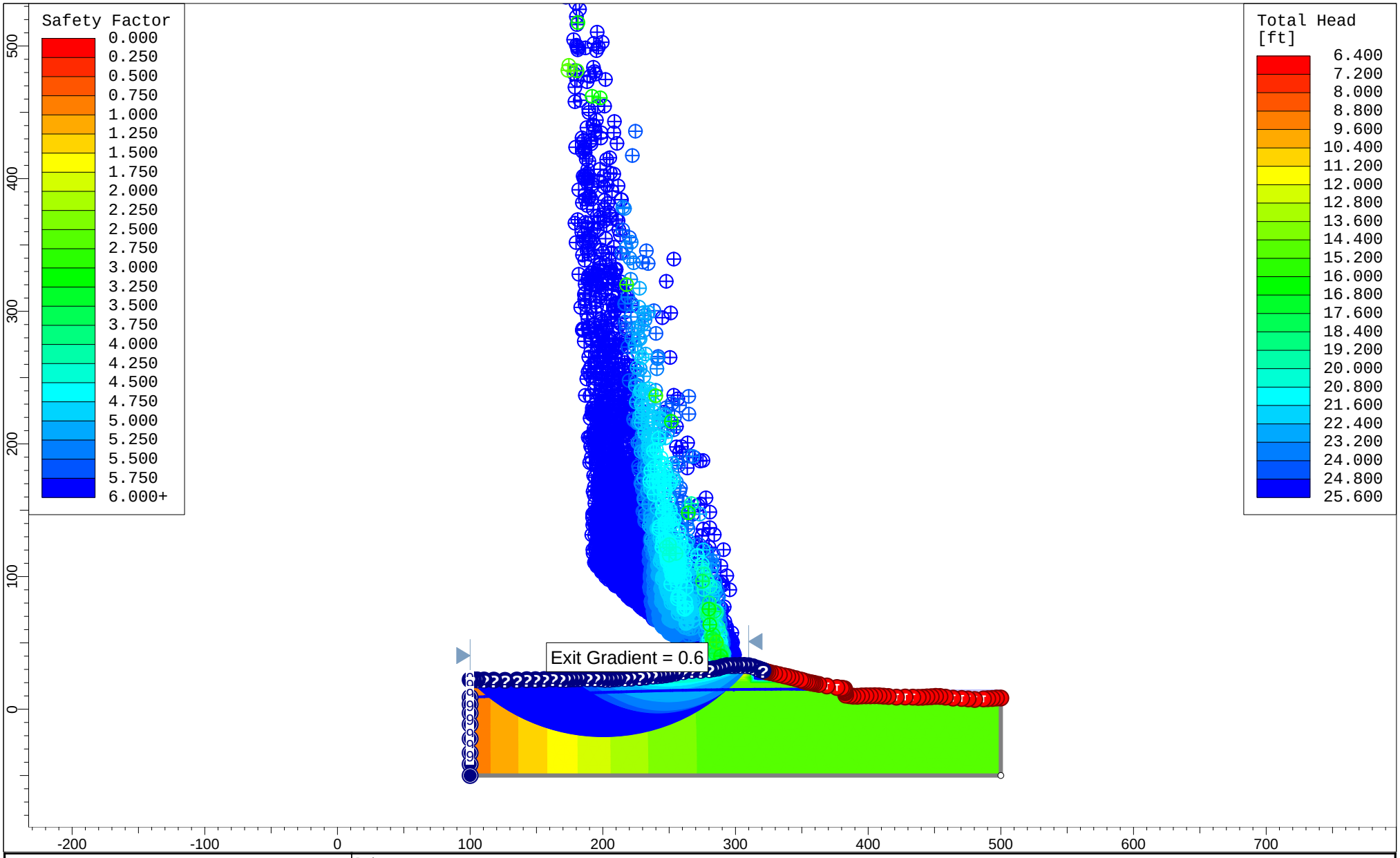
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_8700 PW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Flood Stage Conditions 100-yr WSE Landside Slope		
	Drawn By	AB	Scale 1:1000	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_8700 FL.slim

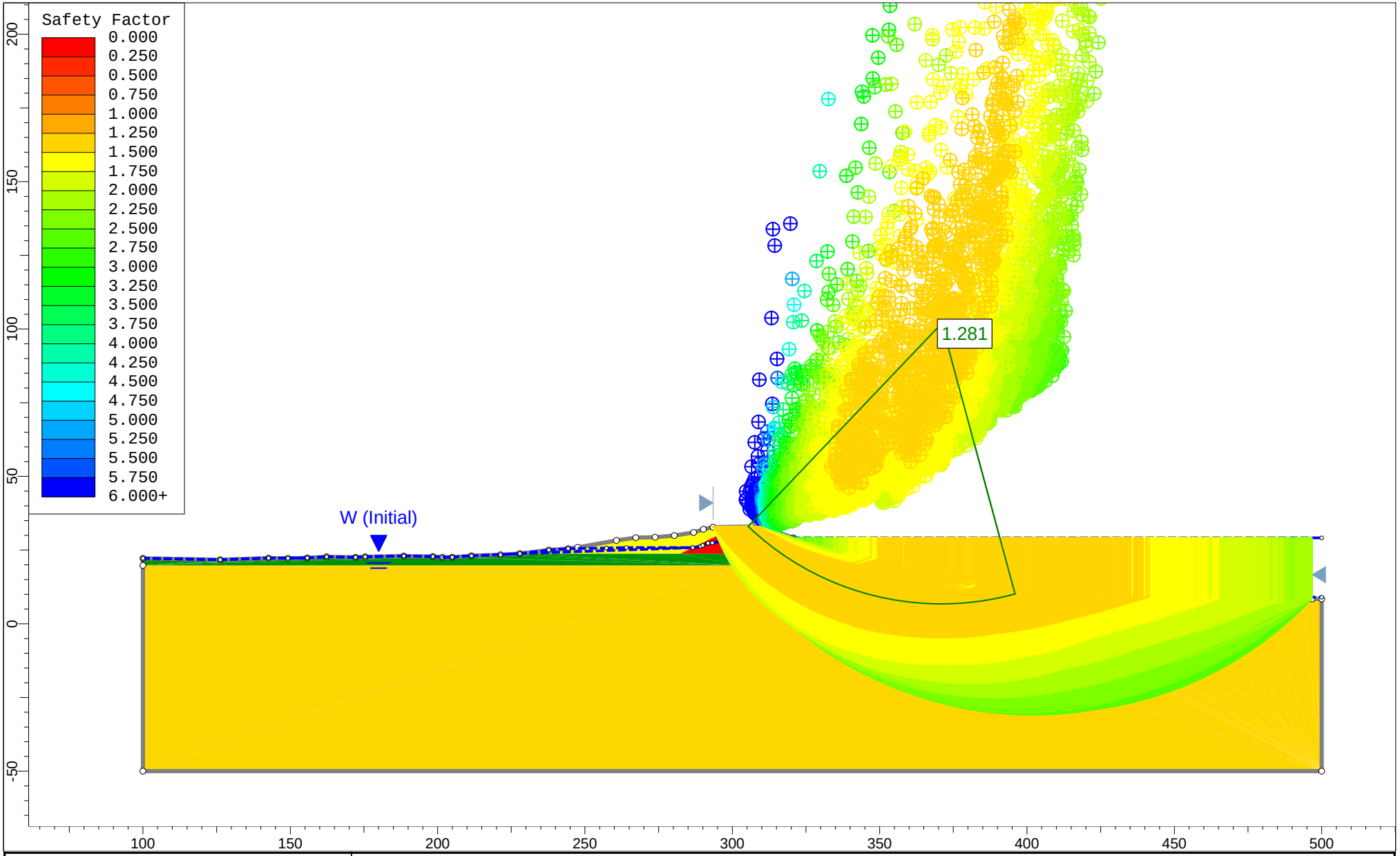
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

SLIDEINTERPRET 6.011

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 87N Flood Stage Conditions (Transient) 100-yr Landside Slope		
Drawn By	AB	*Scale* 1:1200	*Company* CGI/FWI
Date	May 2011		*File Name* SlopeW_lineN_8700 FLT.slim



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 87N Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_8700 RW.slim

SLIDEINTERPRET 6.011

SECTION 98L

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineS_9800 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 98S Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
291.373	31.147
289.816	30.5201
283.63	28.03
276.544	25.91
269.271	24.549

261.369	23.187
257.688	21.586
247.632	20.598
241.526	19.161
237.844	17.904
236.357	13.224
225	12.3867
211.48	11.39
208.21	10.97
204.94	10.84
201.64	10.97
198.37	11.34
195.1	11.52
188.53	11.18
178.69	10.96
172.15	10.51
162.31	10.86
159.04	10.66
152.47	9.85
149.2	9.85
136.09	11.47
129.52	11.6
126.25	11.22
119.68	12.45
116.41	12.61
100	13.65
100	-50
500	-50
500	12.387
500	24.6
336.07	24.6
329.53	24.84
326.23	25.26
311.975	32.48
303.28	32.48
300.01	32.69
293.44	32.69

Material Boundary

X	Y
276.544	25.91
320.718	25.018
329.53	24.84

Material Boundary

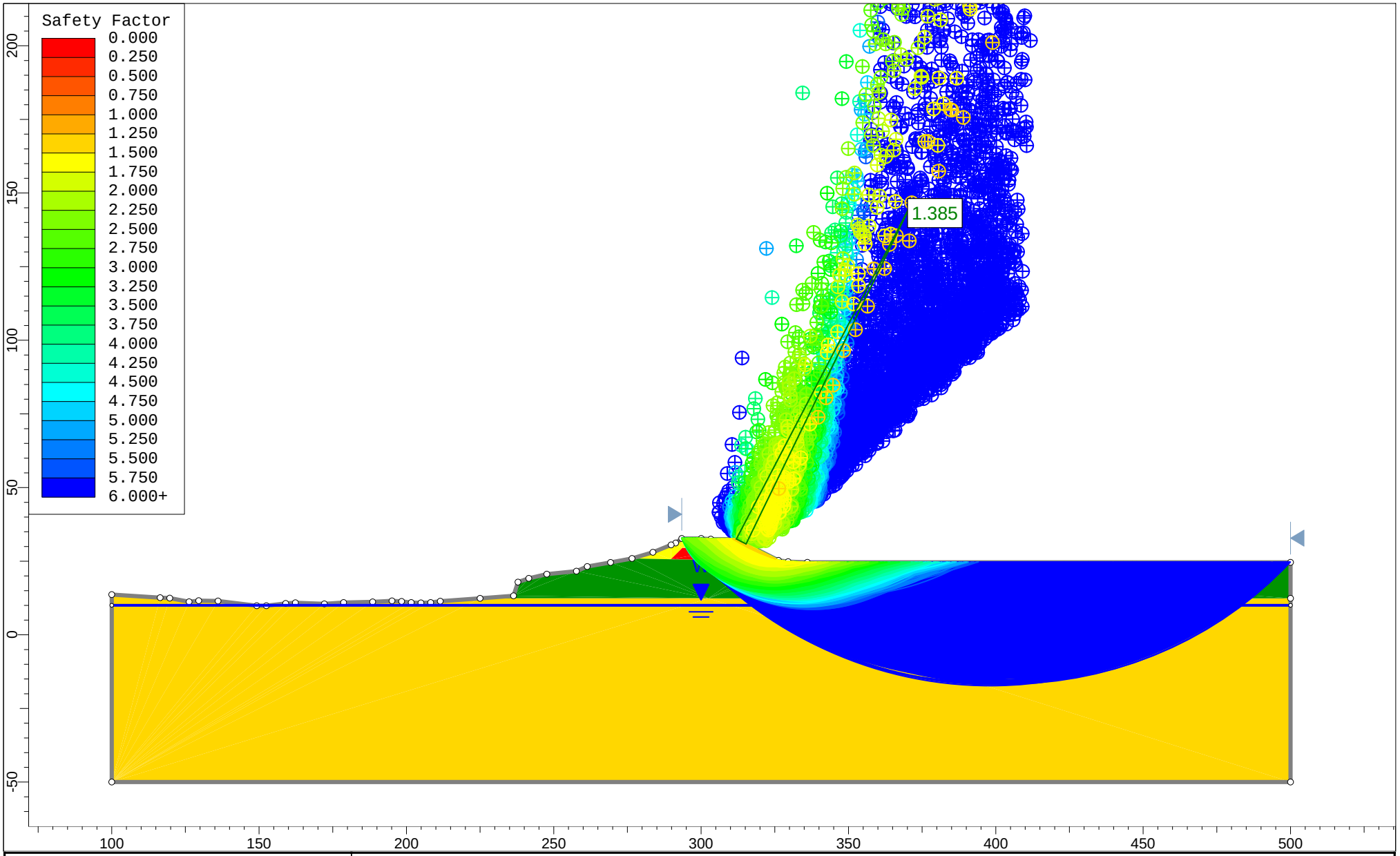
X	Y
289.756	25.6432
293.631	29.5185
311.631	29.5185
320.718	25.018
289.756	25.6432

Material Boundary

X	Y
302.456	12.3867
500	12.387

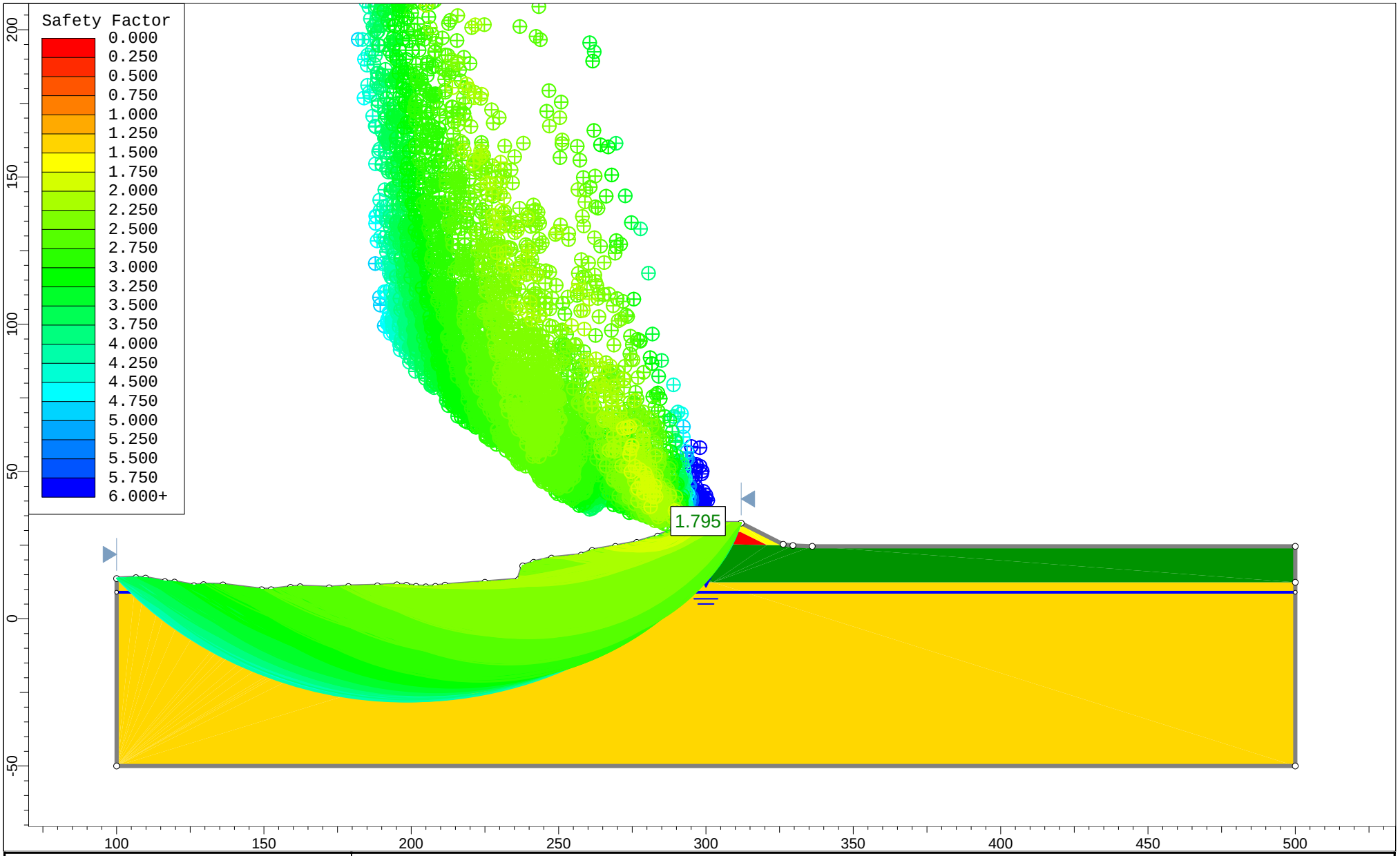
Material Boundary

X	Y
225	12.3867
302.456	12.3867



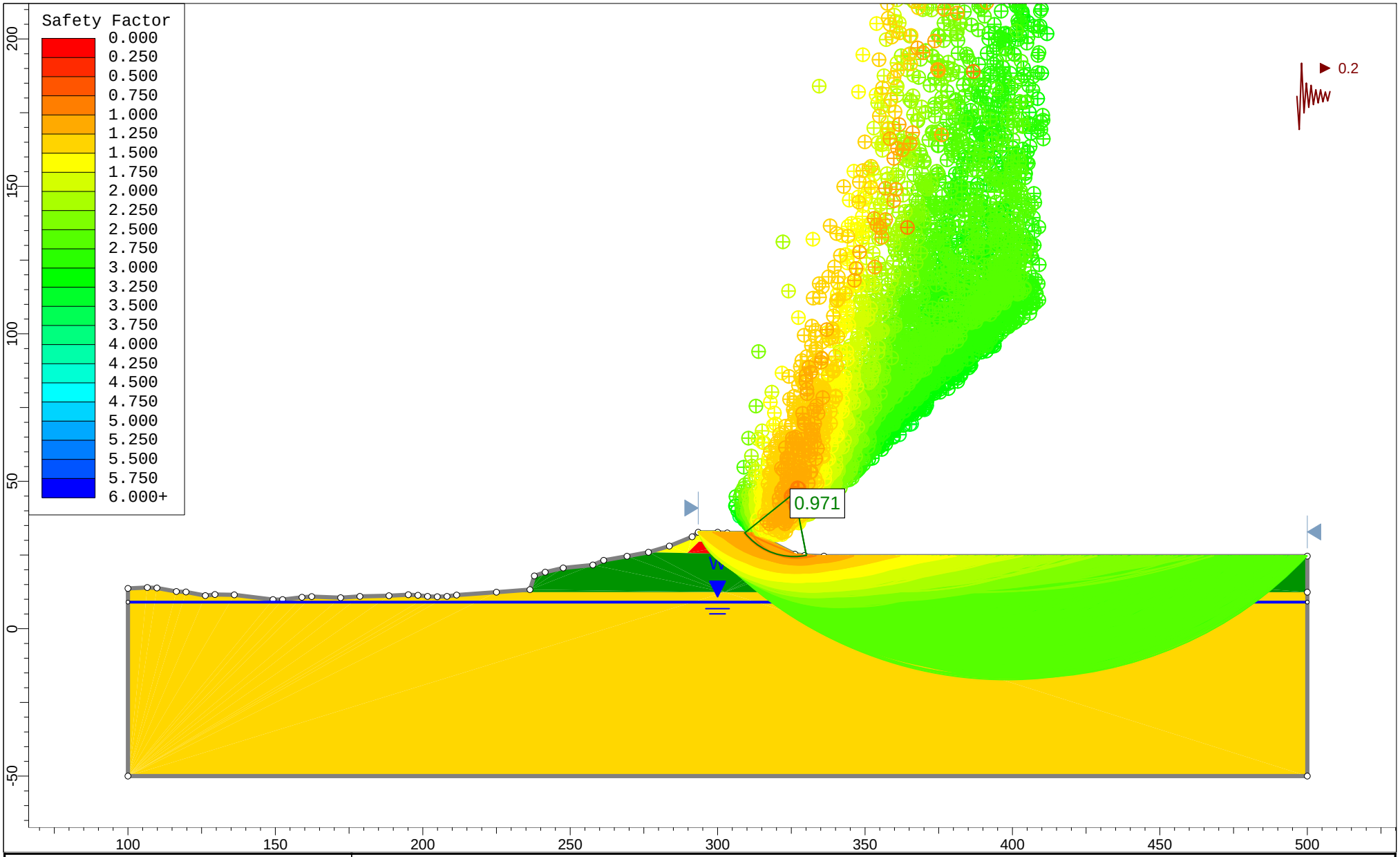
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_9800 EL.slim

SLIDEINTERPRET 6.011



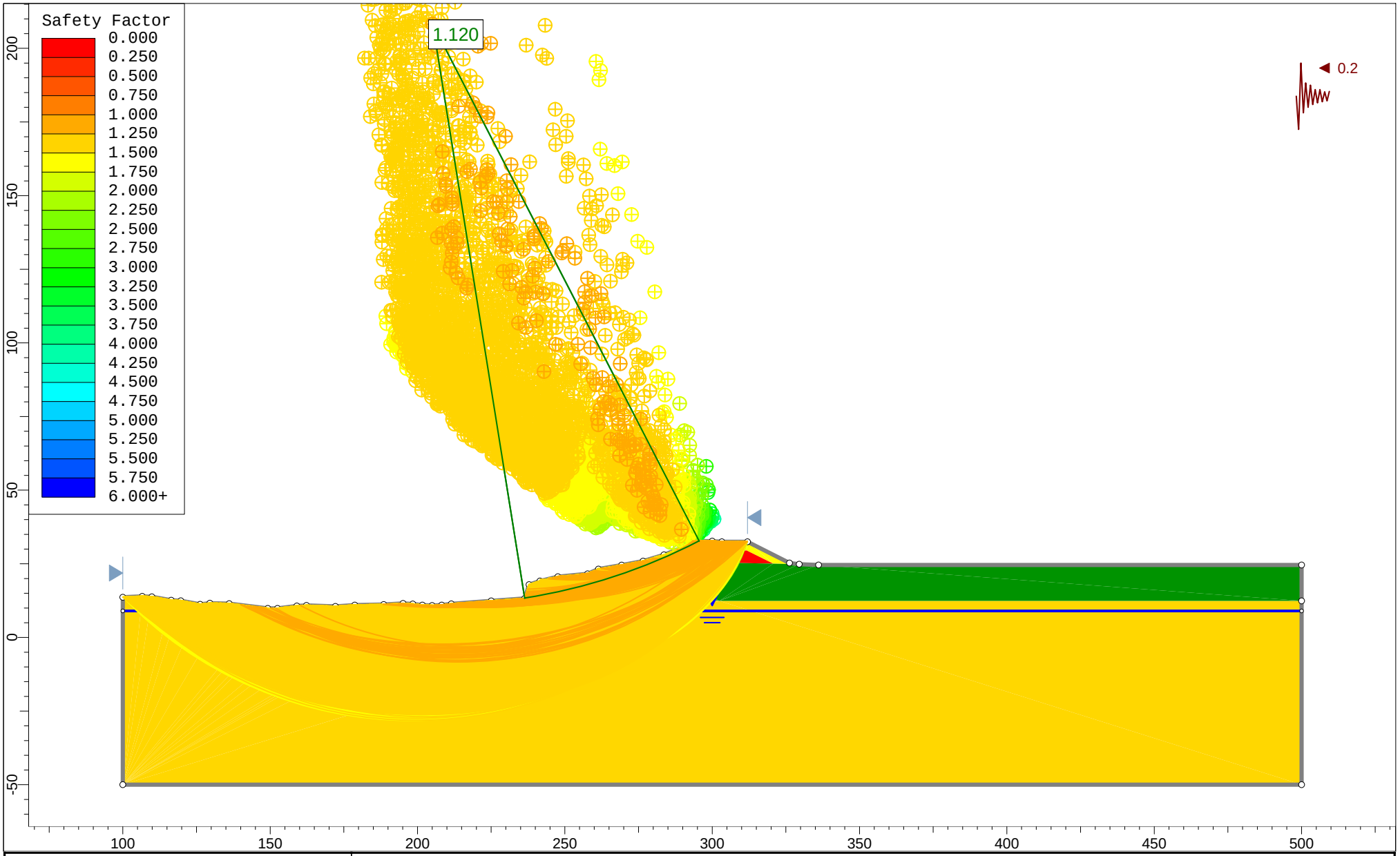
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_9800 EW.slim

SLIDEINTERPRET 6.011



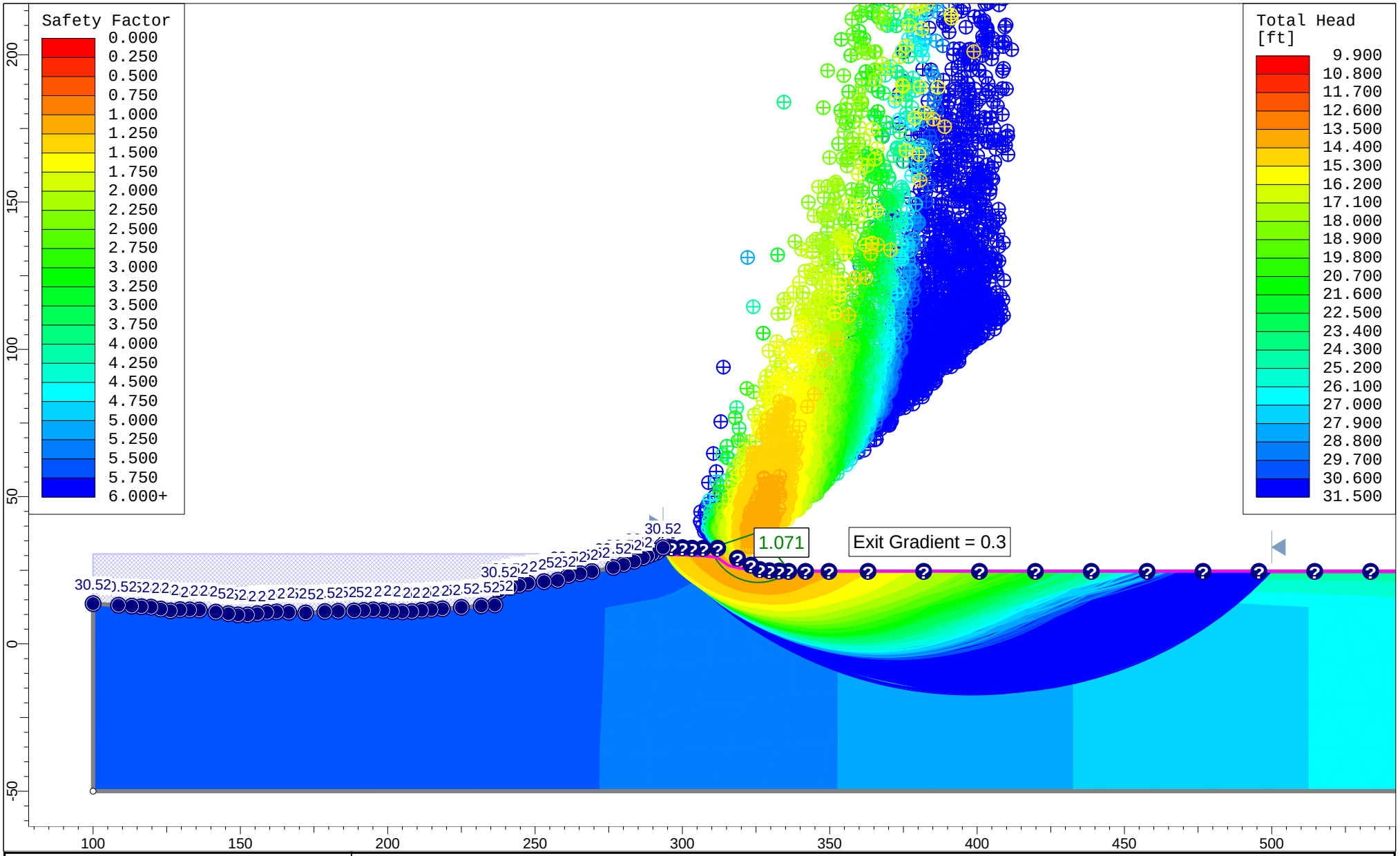
Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98S Pseudo-Static Conditions Median Annual WSE Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_9800 PL.slim

SLIDEINTERPRET 6.011



rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_9800 PW.slim

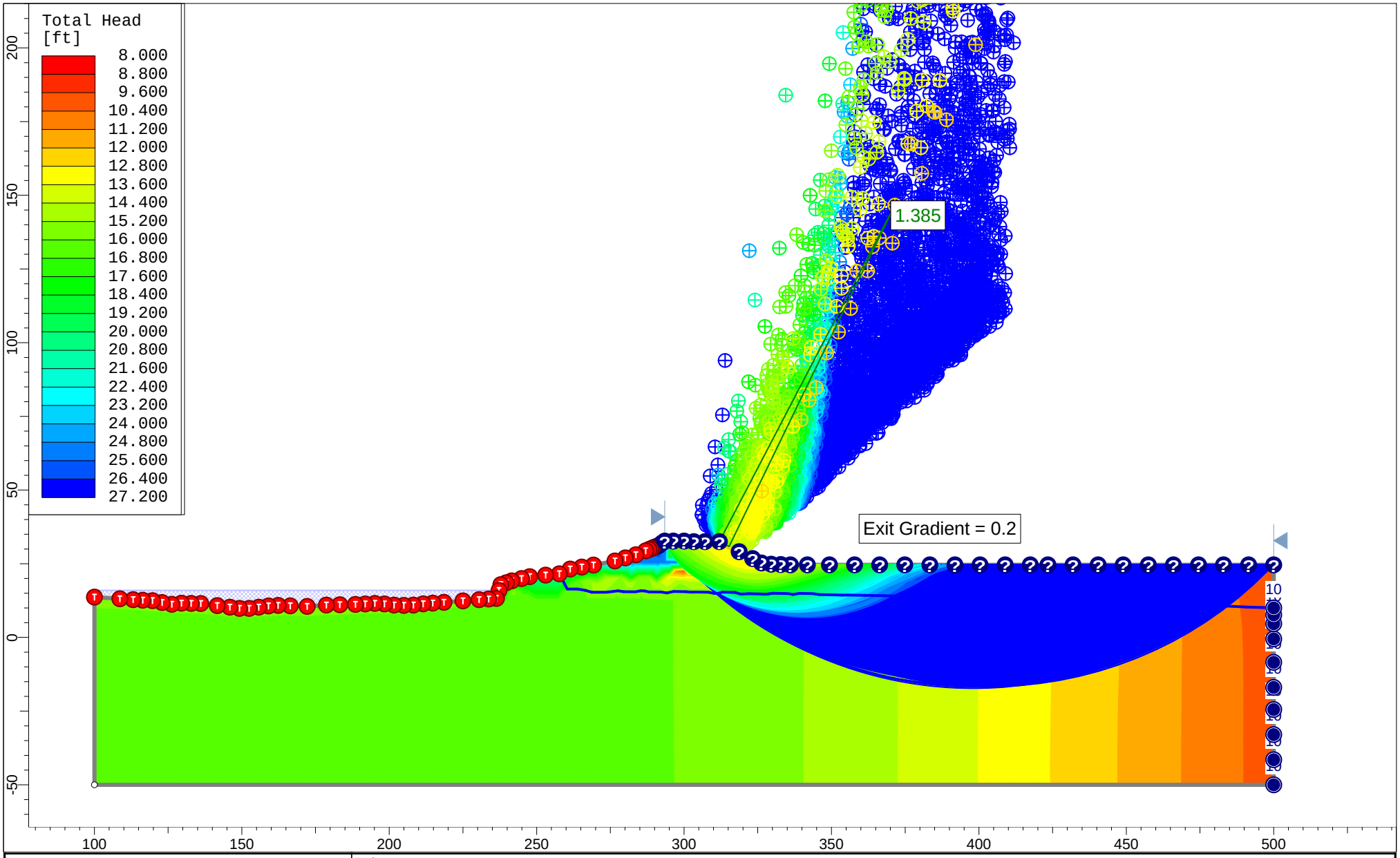
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

SLIDEINTERPRET 6.011

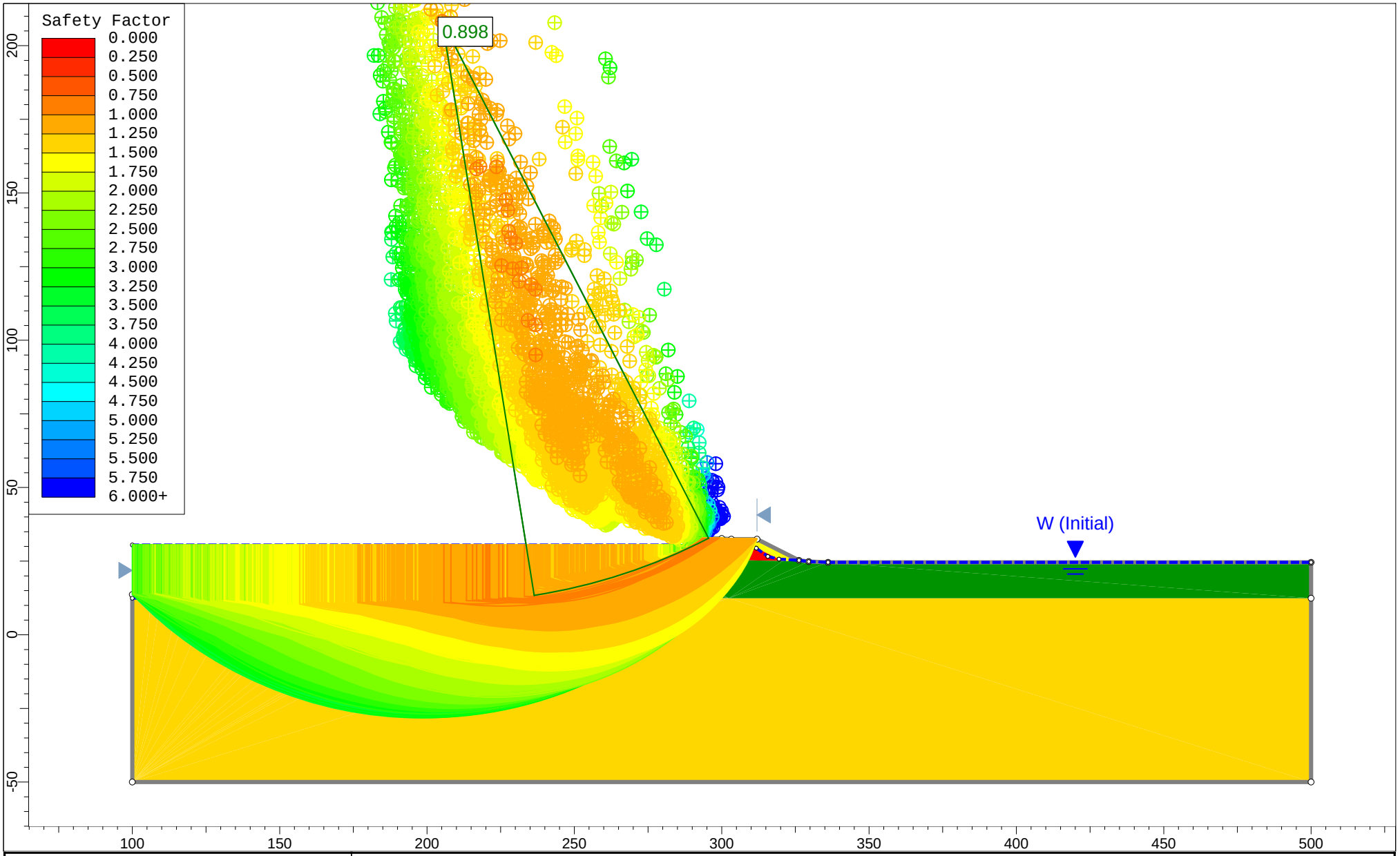
Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98S Flood Stage Conditions 100-yr WSE Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_9800 FL.slim



CGI Technical Services Inc.

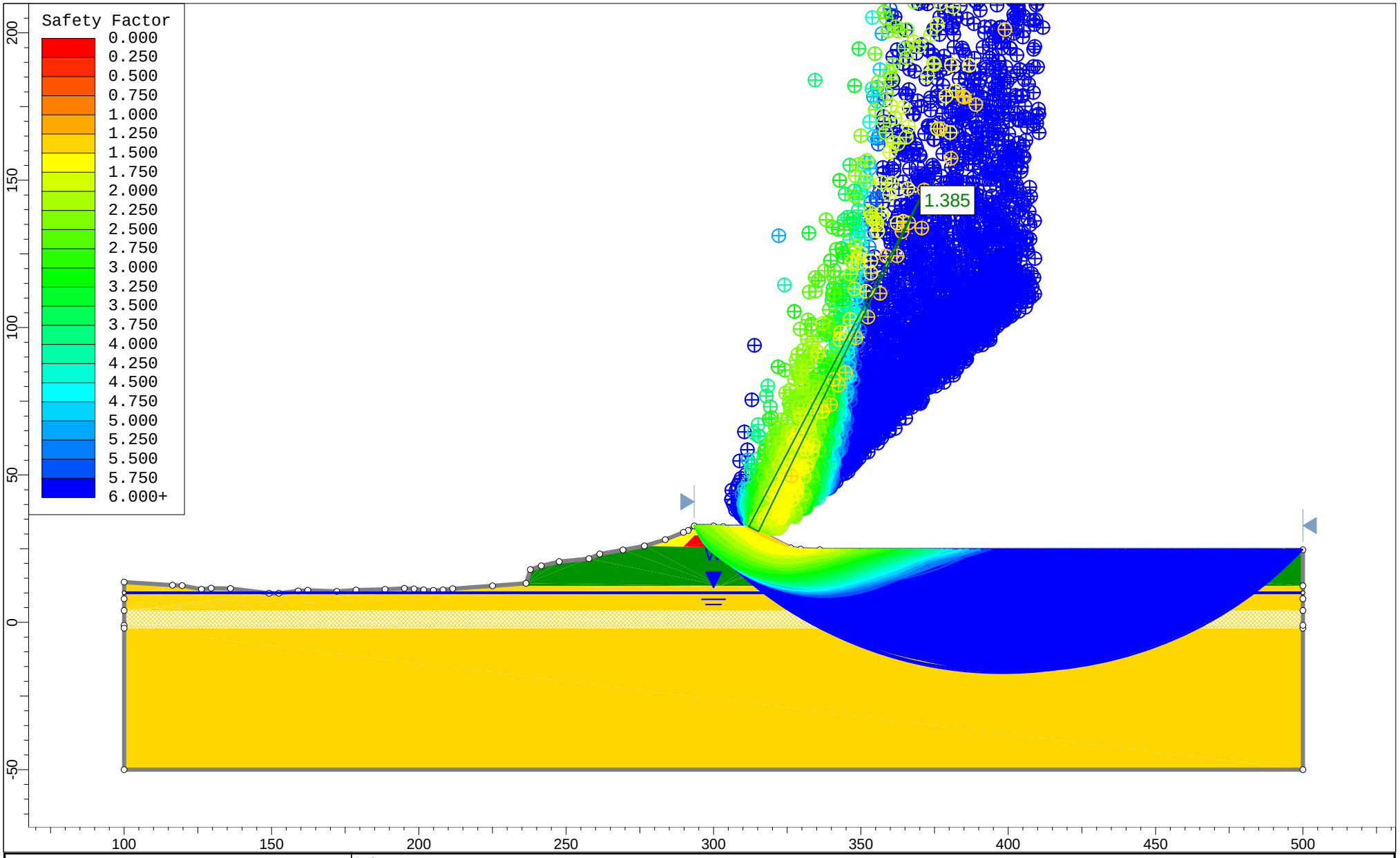
Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98S Flood Stage Conditions (Transient) 100-yr Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineS_9800 FLT.slim

SLIDEINTERPRET 6.011



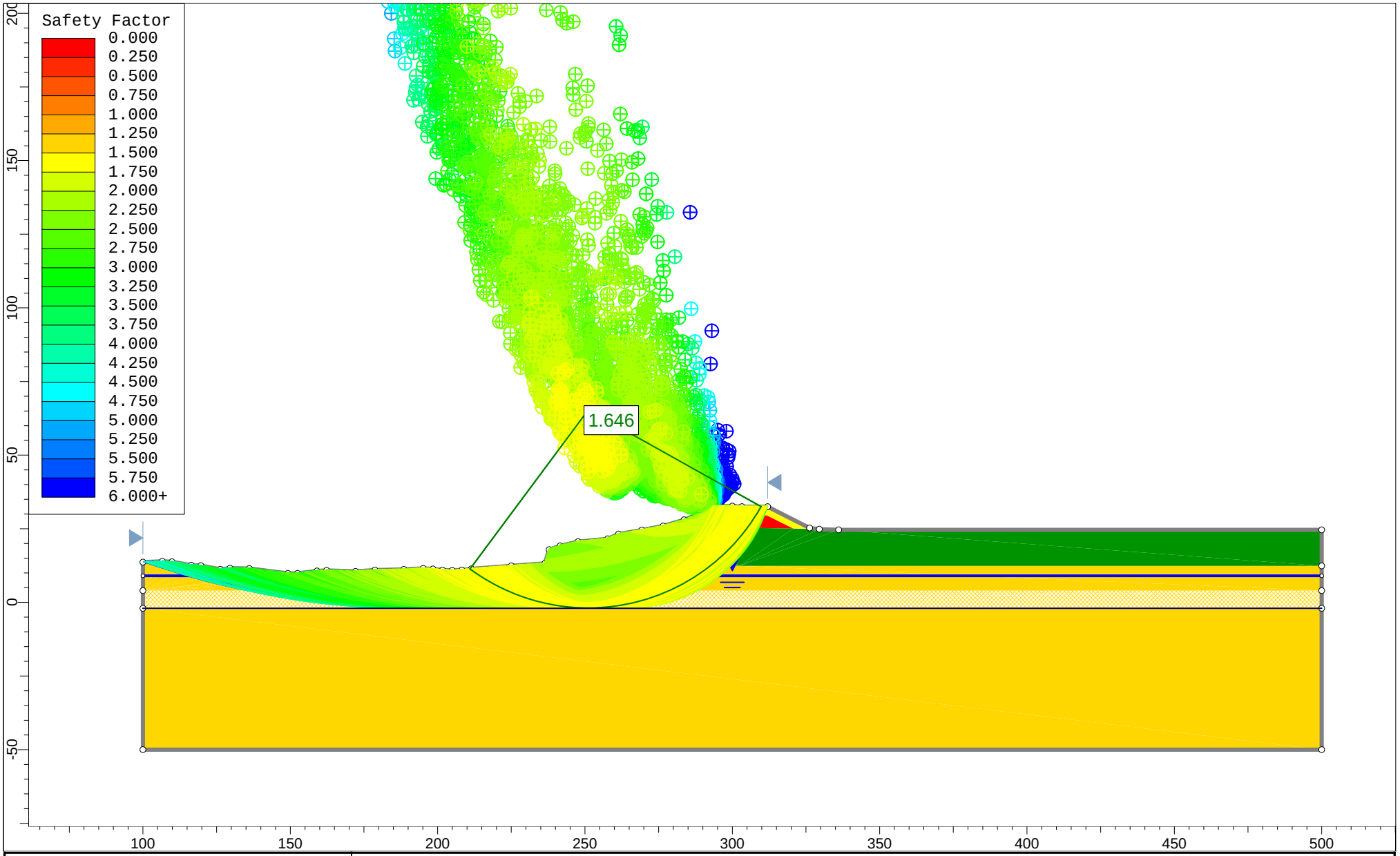
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Rapid Drawdown Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_9800 RW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_9800 PEL.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98S Post Earthquake Conditions Median Annual WSE Waterside slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_9800 PEW.slim

SLIDEINTERPRET 6.011

SECTION 98R

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineN_9800 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 98N Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: -15
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	1	1	1	1

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
309.154	33.94
306.58	33.94
303.28	34.07
300.01	34.14
296.74	33.98

293.44	33.26
290.17	32.2
277.06	29.3
270.49	29.23
263.95	28.8
260.68	28.77
250.84	30.41
247.54	30.57
244.27	29.96
237.73	26.02
234.43	25.73
231.16	25.72
227.89	25.91
208.21	25.26
198.37	25.47
185.26	25.3
168.85	25.6
159.04	25.55
152.47	25.73
139.36	25.53
132.79	25.19
129.52	25.23
109.84	24.65
100	24.6
100	21.02
100	-50
500	-50
500	14.81
496.72	14.81
486.91	14.94
483.61	14.75
480.34	13.89
473.77	13.6
470.5	12.94
467.23	12.58
457.39	12.29
454.12	12
447.55	10.91
437.71	8.27
434.44	8.43
431.17	9.06
427.87	9.44
424.6	9.6
411.49	9.6

401.65	9.21
398.38	9.21
391.81	9.49
379.118	9.49
377.318	14.909
374.053	15.389
370.045	16.055
364.658	17.153
356.409	18.404
348.932	20.1593
346.414	21.02
345.76	21.2434
342.537	22.3456
339.37	23.84
332.314	26.02
329.53	26.88
319.69	30.23
316.42	31.06

Material Boundary

X	Y
237.73	26.02
285.283	26.02

Material Boundary

X	Y
295.373	31.1085
308.373	31.1085
313.56	26.02
285.283	26.02
295.373	31.1085

Material Boundary

X	Y
313.56	26.02
332.314	26.02

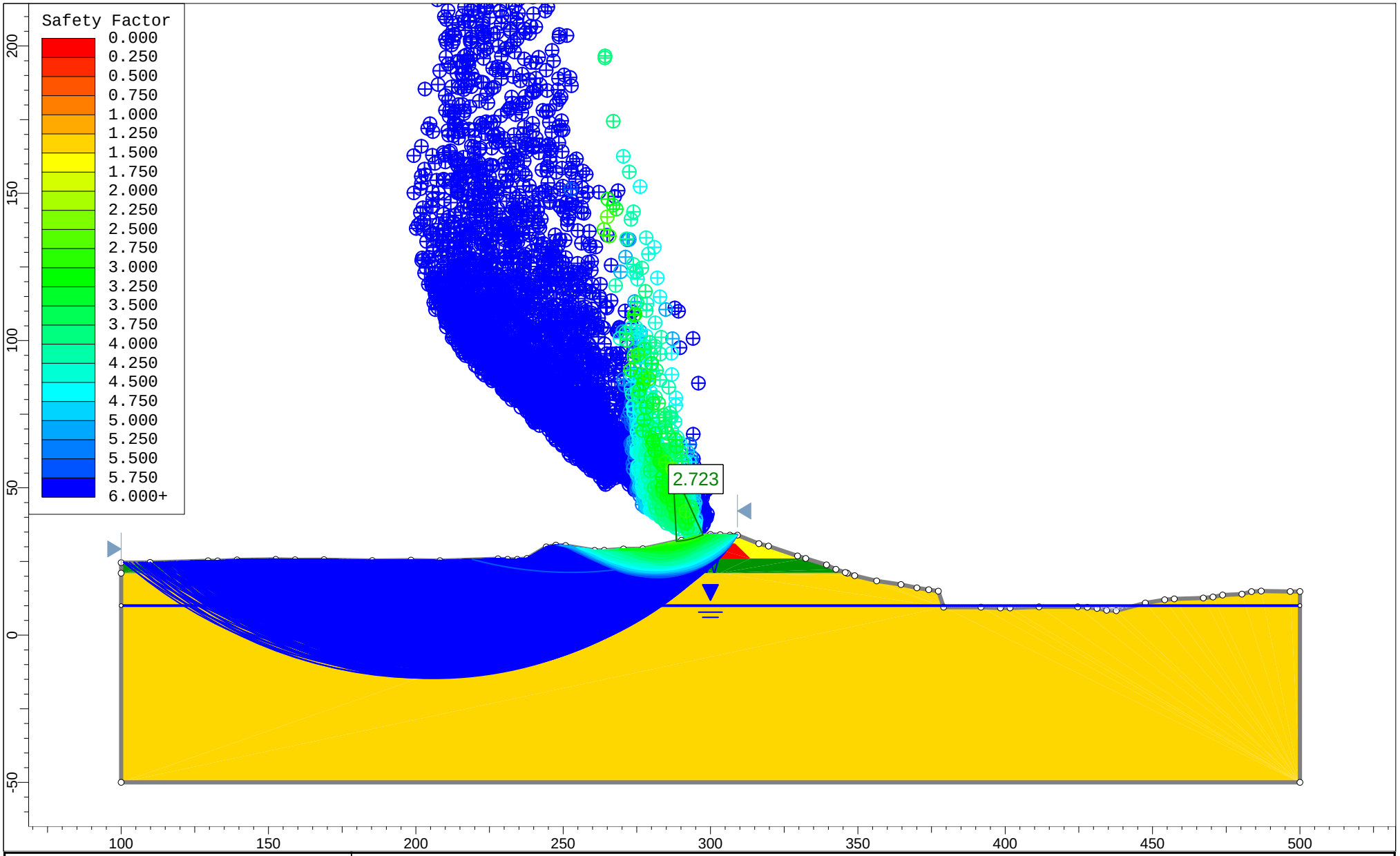
Material Boundary

X	Y
303.067	21.02

346.414	21.02

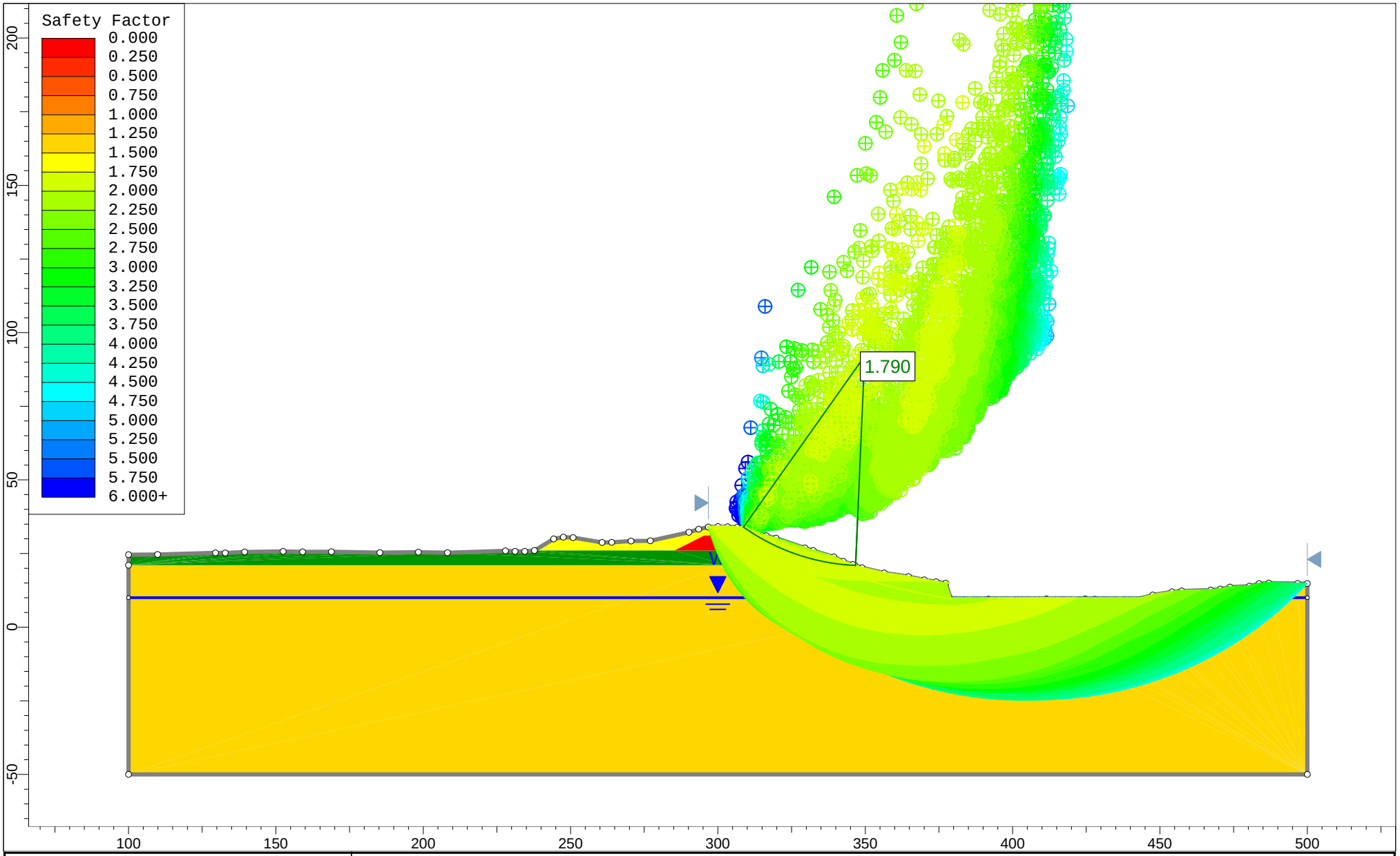
Material Boundary

X	Y
100	21.02
303.067	21.02



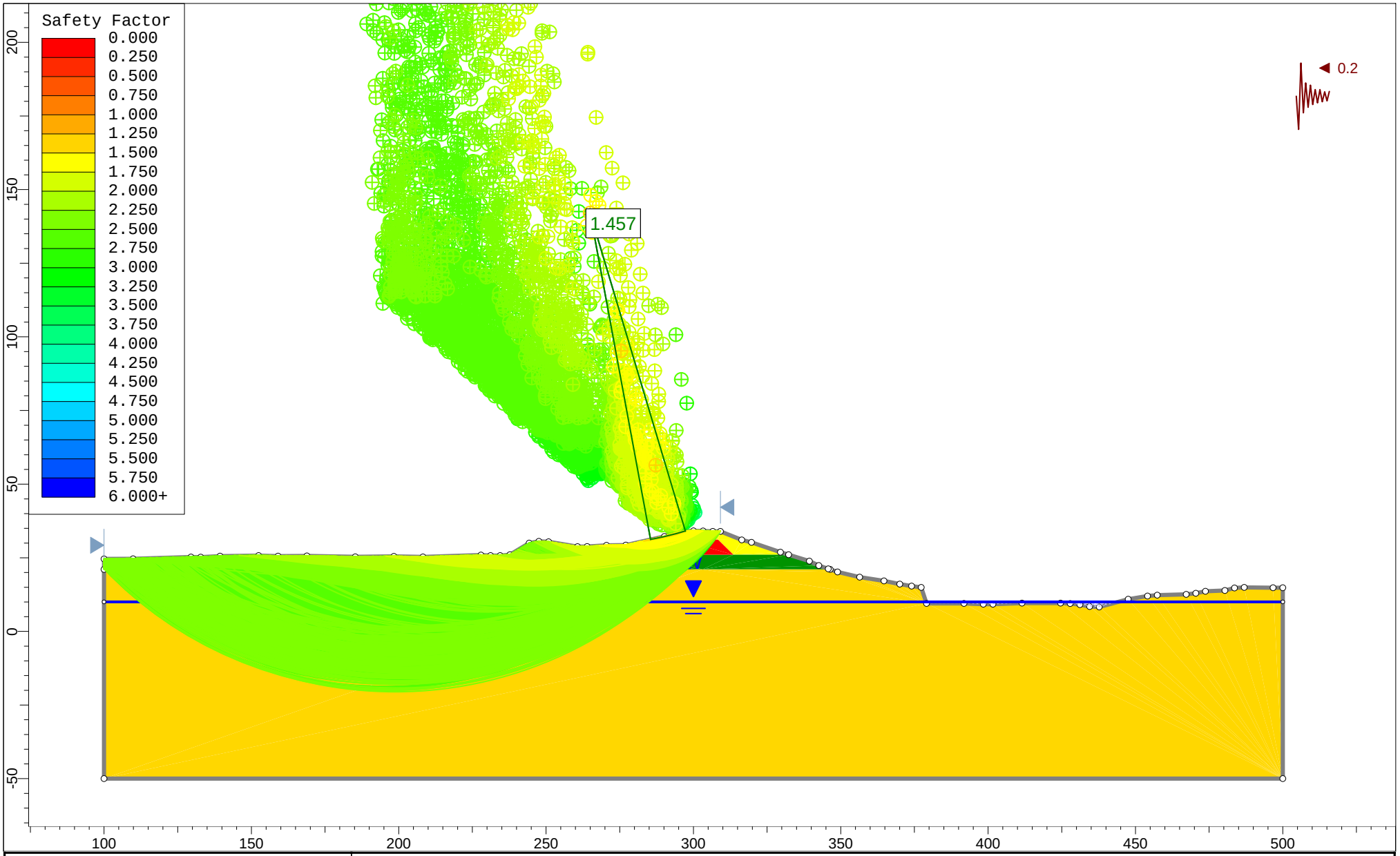
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98N Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_9800 EL.slim

SLIDEINTERPRET 6.011



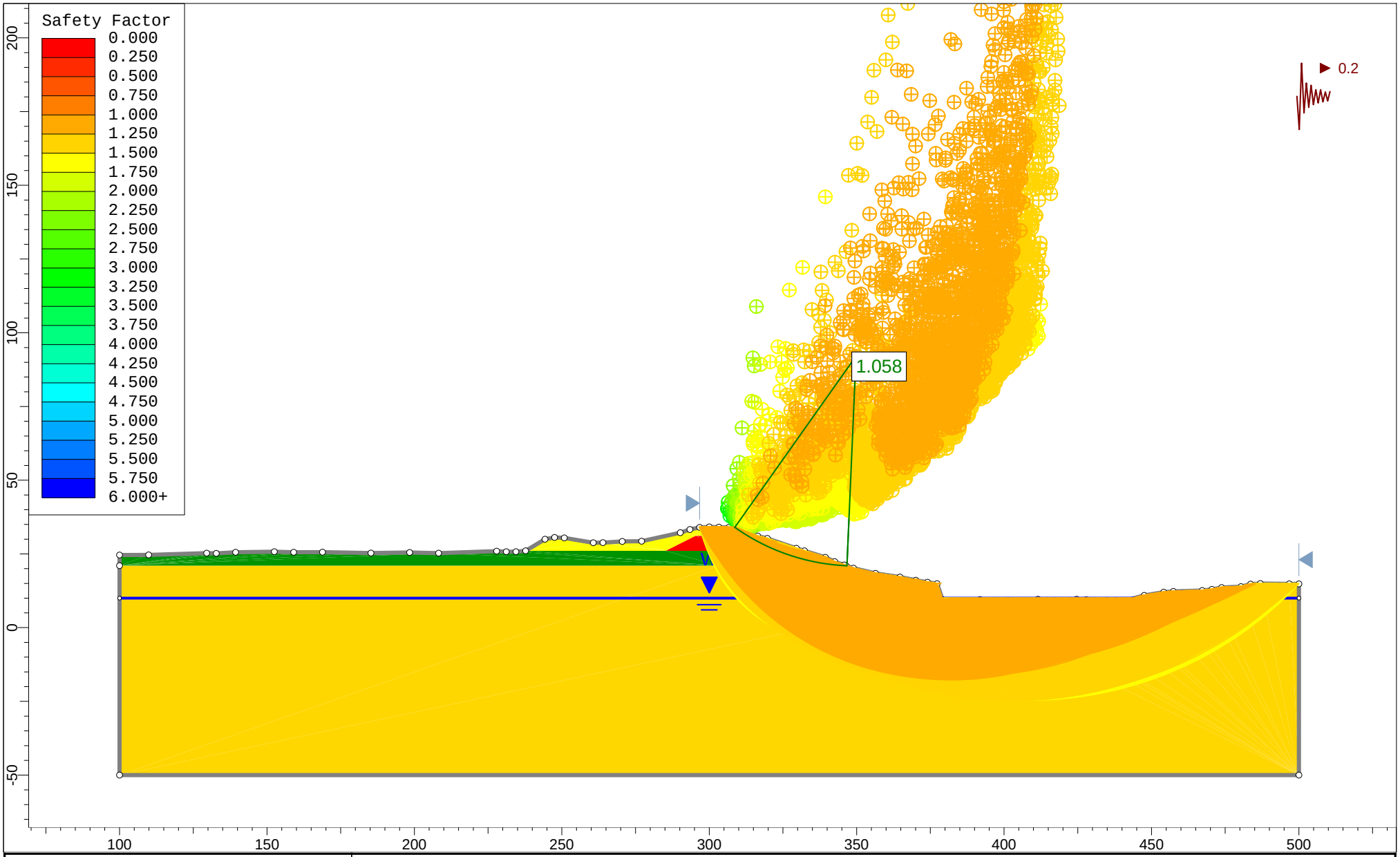
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98N Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_9800 EW.slim

SLIDEINTERPRET 6.011



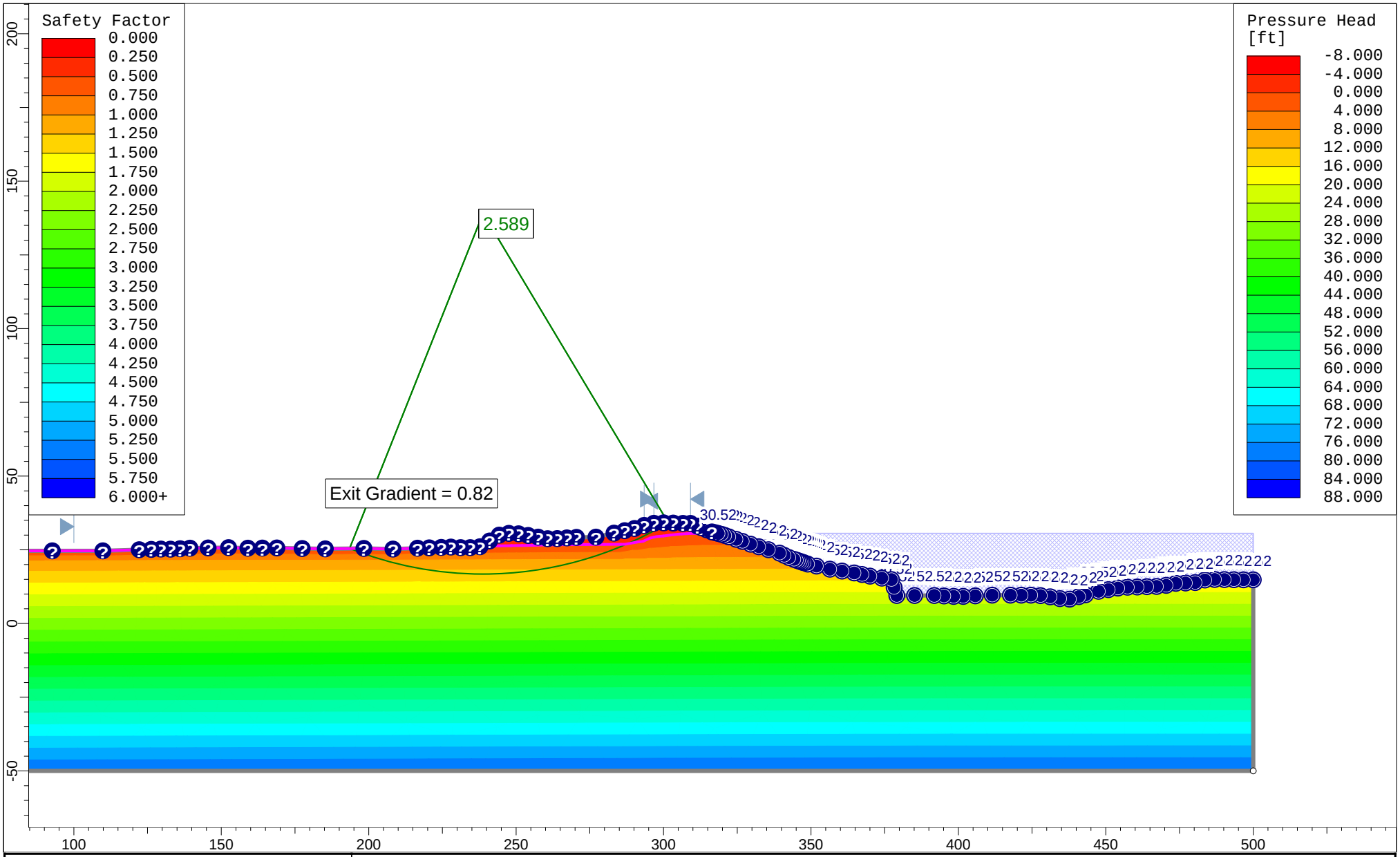
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98N Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_9800 PL.slim

SLIDEINTERPRET 6.011



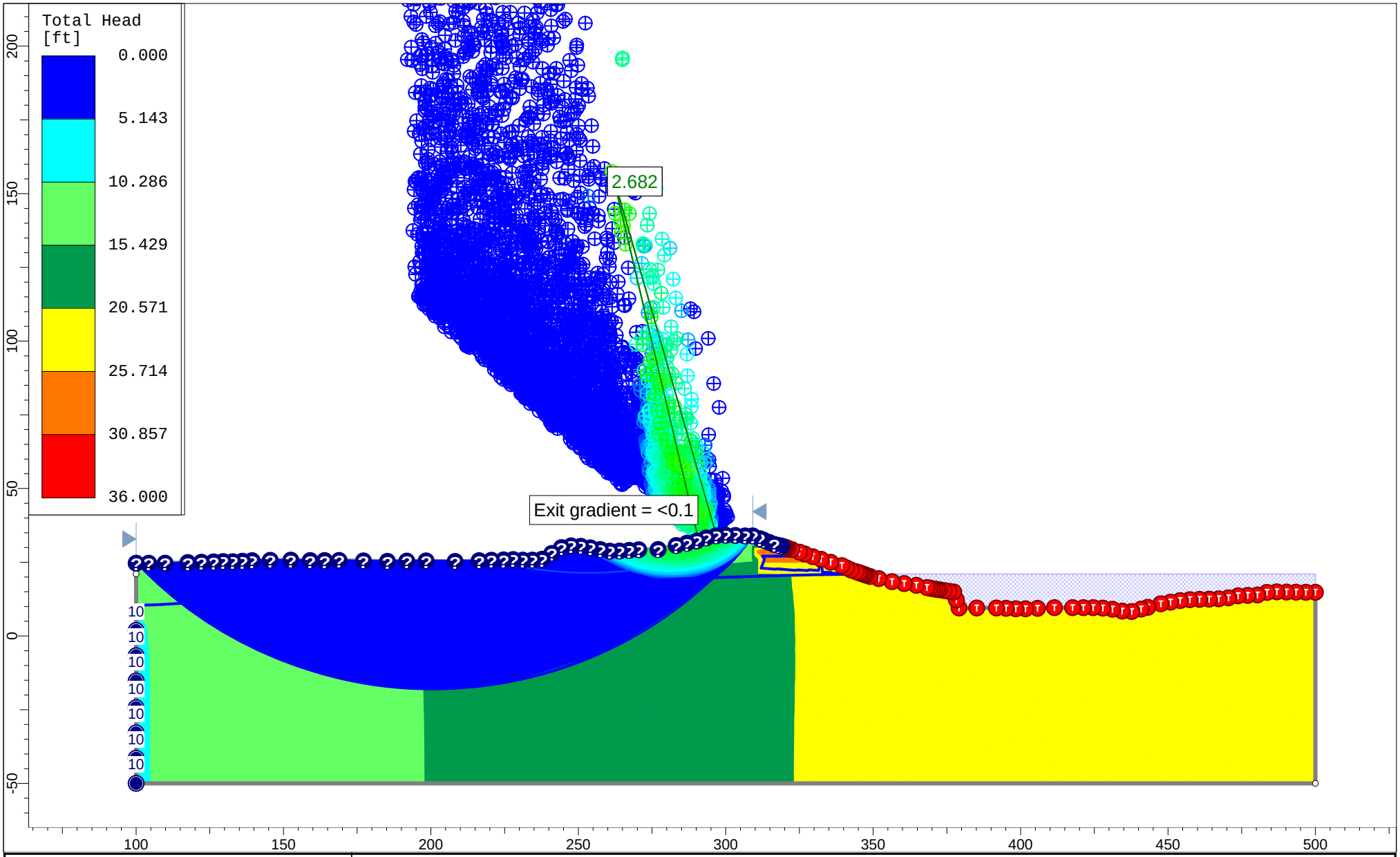
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98N Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineN_9800 PW.slim

SLIDEINTERPRET 6.011



Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98N Flood Stage Conditions 100-yr WSE Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineN_9800 FL.slim

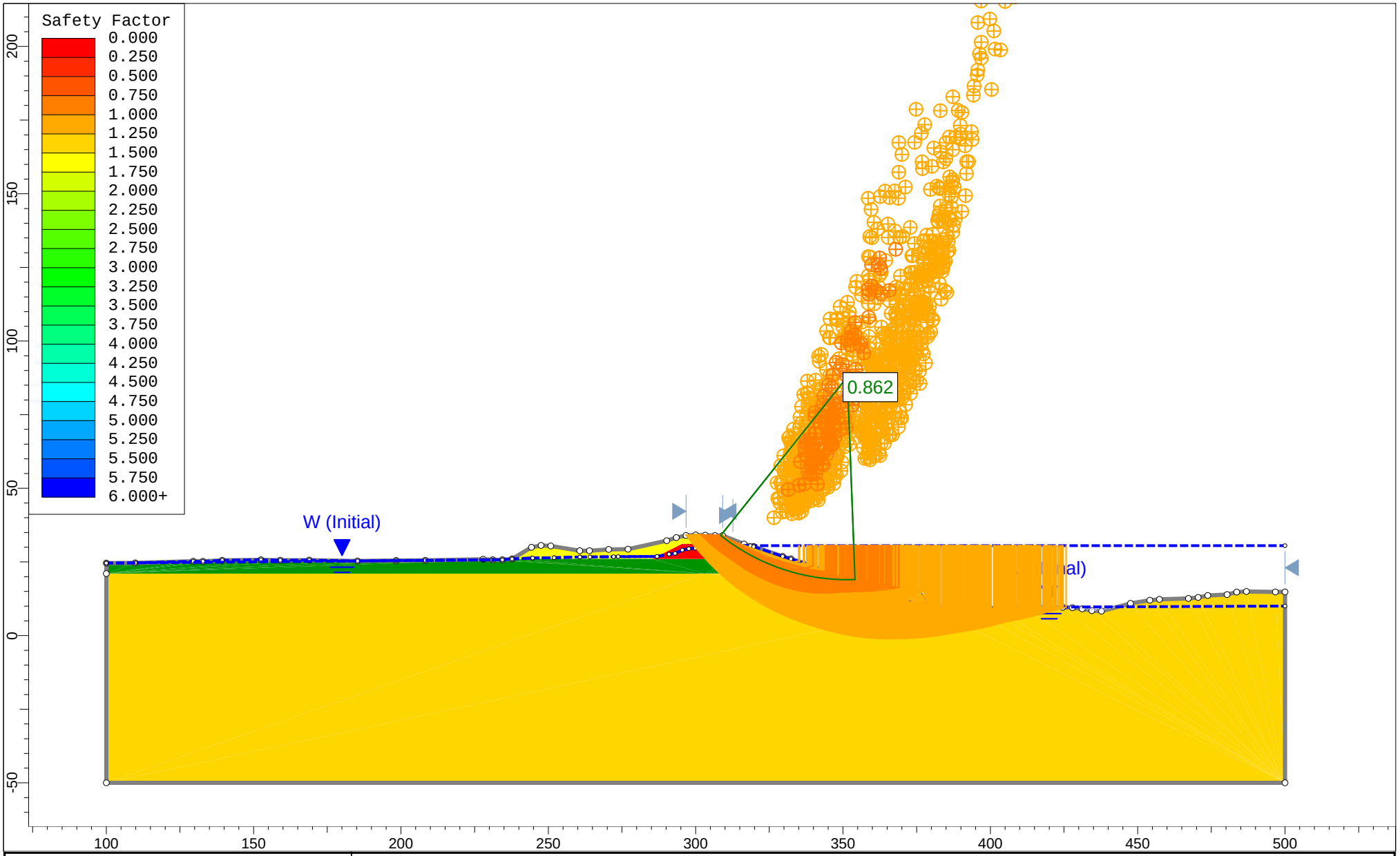
SLIDEINTERPRET 6.011



CGI Technical Services Inc.

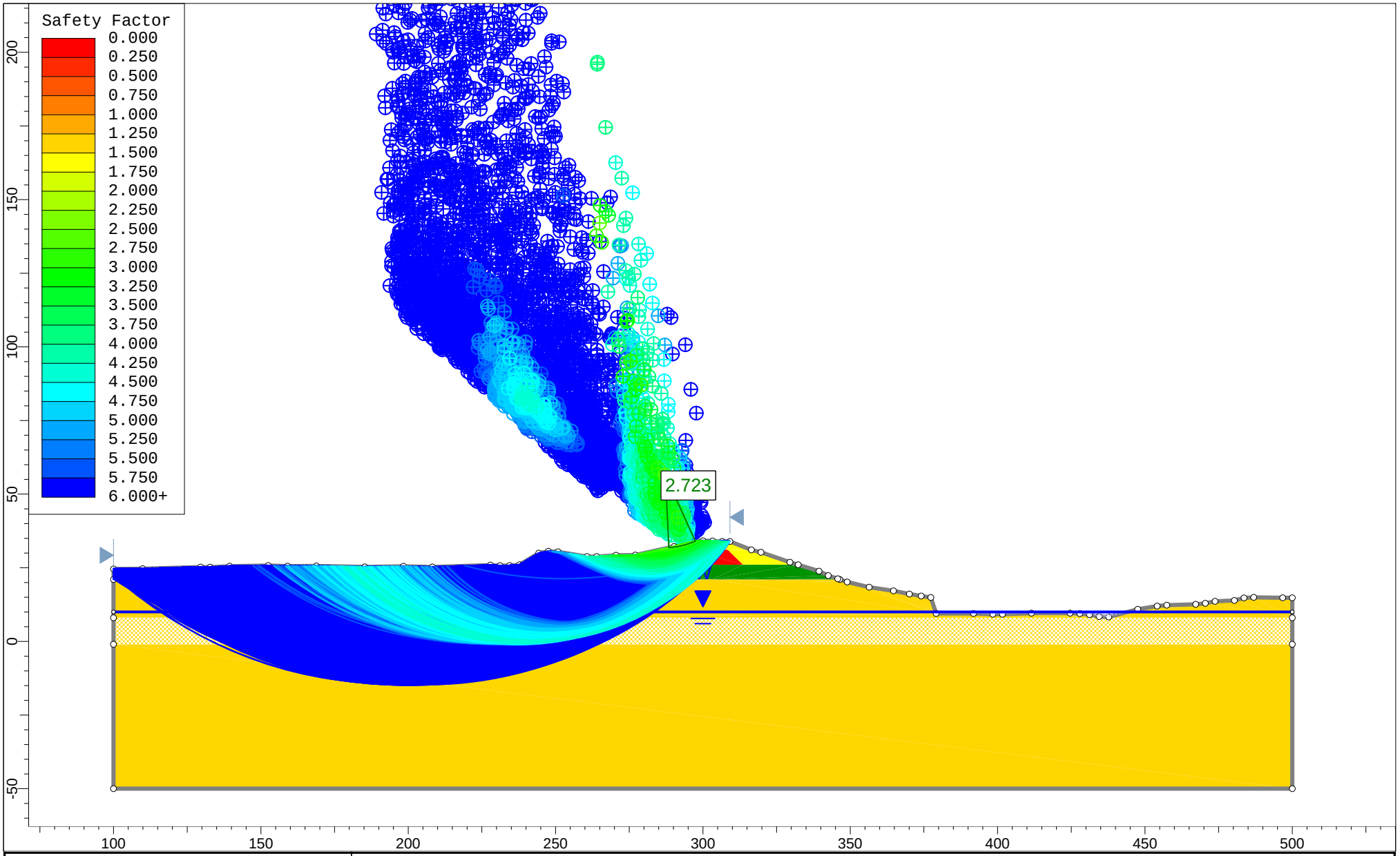
SLIDEINTERPRET 6.011

Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98N Flood Stage Conditions (Transient) 100-yr Landside Slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineN_9800 FLT.slim



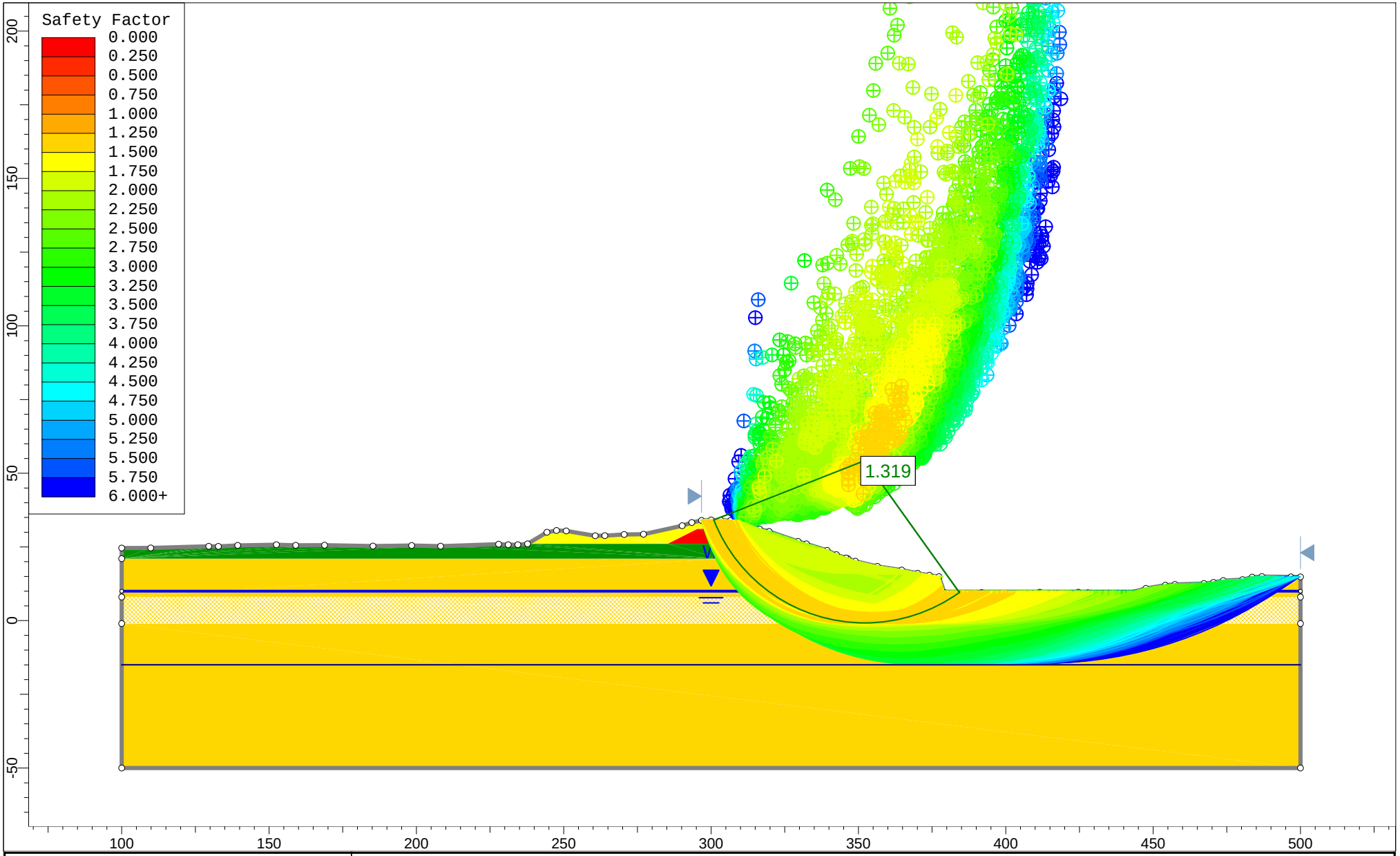
Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98N Rapid Drawdown Waterside Slope		
Drawn By: AB	Scale: 1:540	Company: CGI/FWI	
Date: May 2011		File Name: SlopeW_lineN_9800 RW.slim	

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 98N Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineN_9800 PEL.slim

SLIDEINTERPRET 6.011



Project	Redwood Creek Levee Evaluation Orick California		
Analysis Description	Cross-Section 98N Post Earthquake Conditions Median Annual WSE Waterside slope		
Drawn By	AB	Scale 1:540	Company CGI/FWI
Date	May 2011		File Name SlopeW_lineN_9800 PEW.slim

SLIDEINTERPRET 6.011

SECTION 114L

Slide Analysis Information

Redwood Creek Levee Evaluation Orick California

Project Summary

File Name: SlopeW_lineS_11400 EL
Last saved with Slide version: 6.011
Project Title: Redwood Creek Levee Evaluation Orick California
Analysis: Cross-Section 114S Existing Conditions Median Annual WSE Landside Slope
Author: AB
Company: CGI/FWI
Date Created: May 2011

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Water Surfaces
Pore Fluid Unit Weight: 62.4 lbs/ft3
Advanced Groundwater Method: None

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	132
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	35
Water Surface	Water Table	Water Table	Water Table	Water Table
Hu Value	0	0	0	0

List Of Coordinates

Water Table

X	Y
100	10
500	10

External Boundary

X	Y
313.215	34.35
306.58	34.35
300.369	34.623
296.74	34.15
291.852	32.45

283.63	29.59
280.33	28.83
270.49	27.36
260.68	24.06
255.244	23.88
248.972	23.2099
238.063	22.4177
231.472	21.9391
221.394	21.38
207.019	20.13
204.622	18.7
188.53	18.7
181.99	18.87
172.15	19.72
165.58	19.99
159.04	19.48
152.47	18.31
149.2	17.55
145.694	16.4917
139.36	14.58
136.09	14.19
129.52	14.47
126.25	14.41
119.68	13.58
113.14	13.48
106.57	13.76
100	13.65
100	-50
500	-50
500	16.492
500	28.11
493.45	27.99
486.91	28.23
470.5	27.25
454.12	26.96
444.28	27.09
437.71	27.51
434.44	27.54
431.17	27.29
427.87	27.25
414.76	27.64
398.38	27.15
391.81	27.27
388.54	27.21

381.97	27.54
375.43	27.53
368.86	28.4
341.522	27.35
338.719	27.35
333.77	27.35
333.714	27.3647
327.442	30.85
323.704	32.219
320.816	32.85

Material Boundary

X	Y
283.63	29.59
297.735	28.9633
320.794	27.9388
333.714	27.3647

Material Boundary

X	Y
308.349	16.4917
500	16.492

Material Boundary

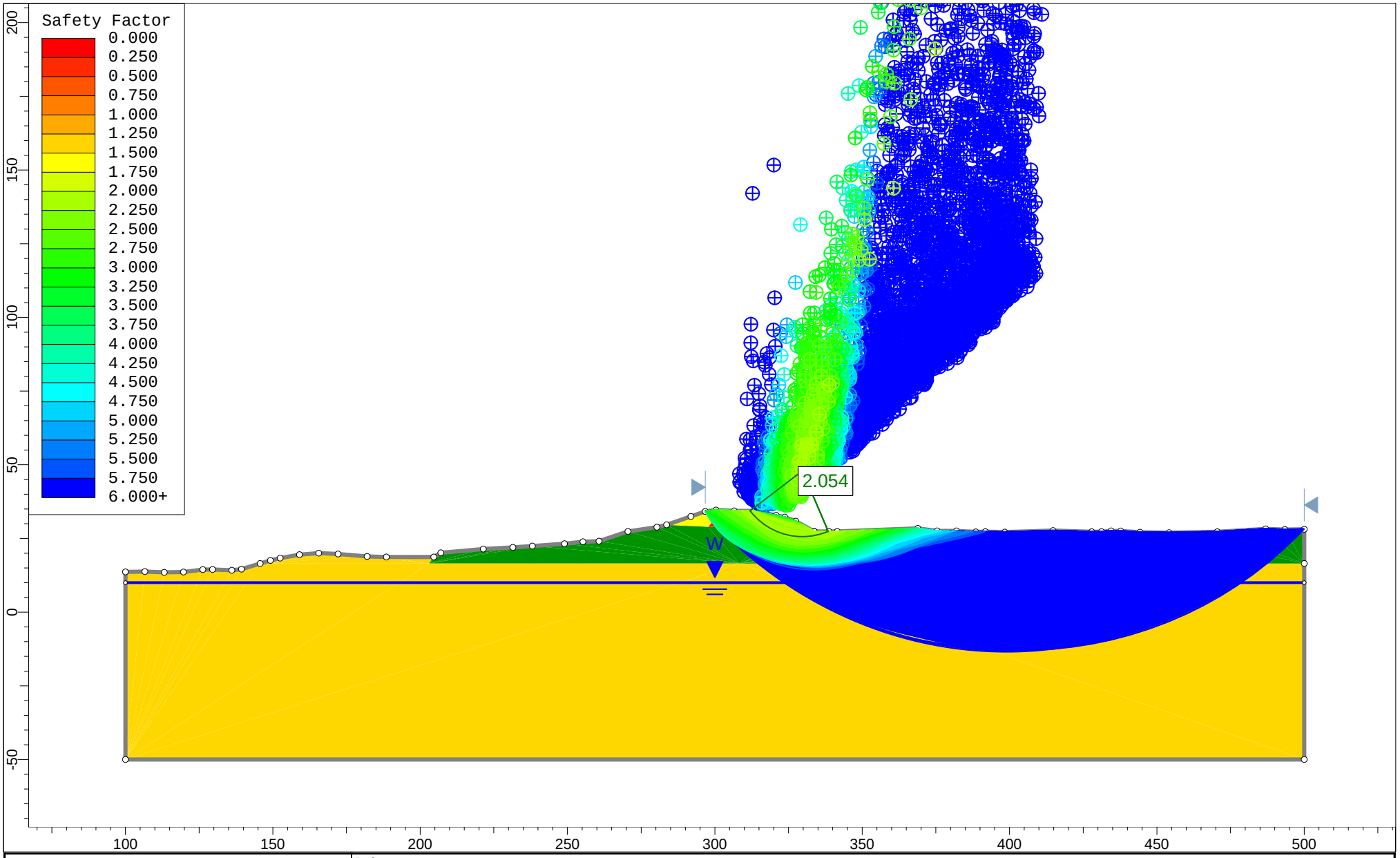
X	Y
145.694	16.4917
202.997	16.4917
308.349	16.4917

Material Boundary

X	Y
297.699	28.9269
297.735	28.9633
300.091	31.3186
314.091	31.3186
320.794	27.9388
297.699	28.9269

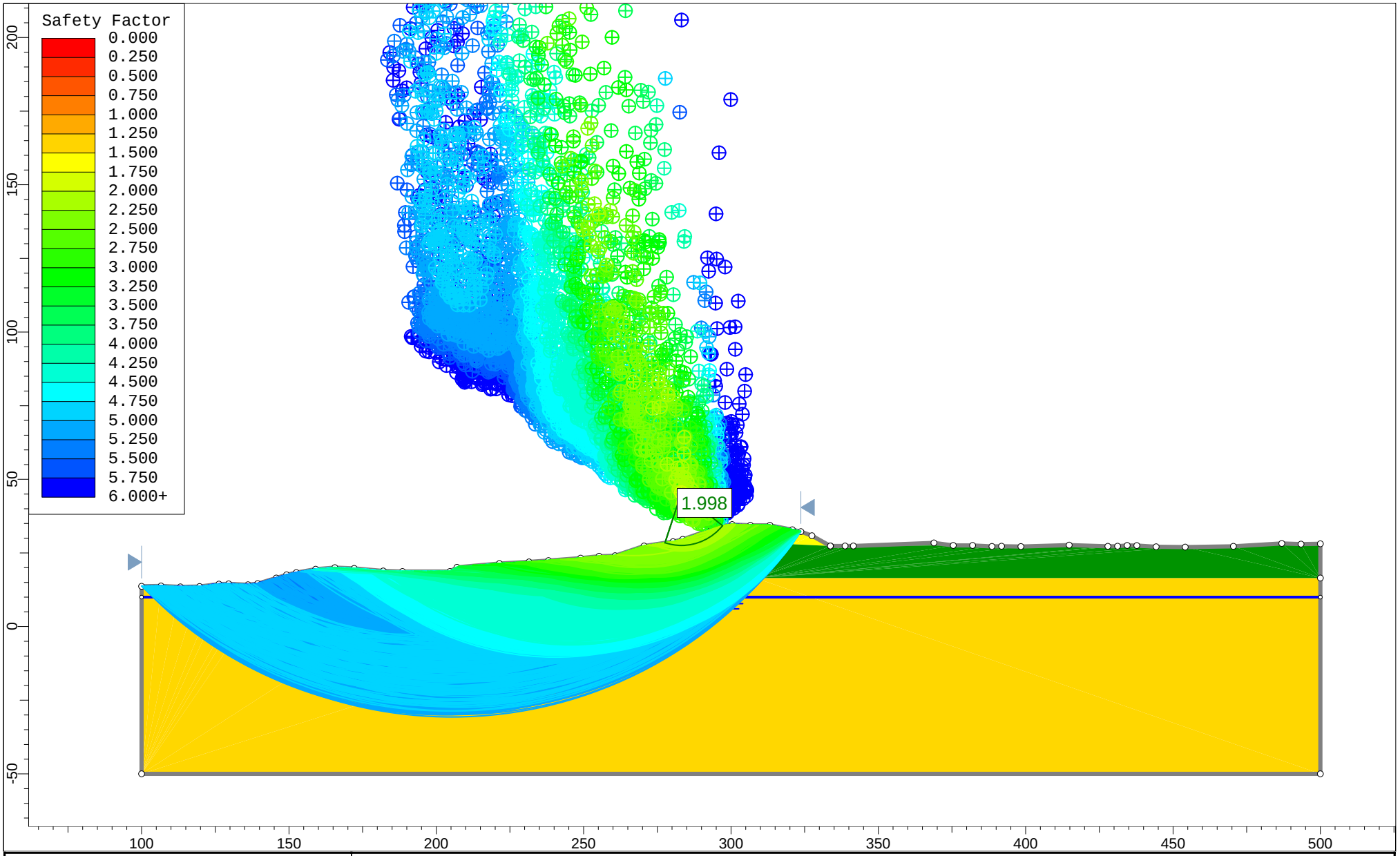
Material Boundary

X	Y
202.997	16.4917
204.622	18.7



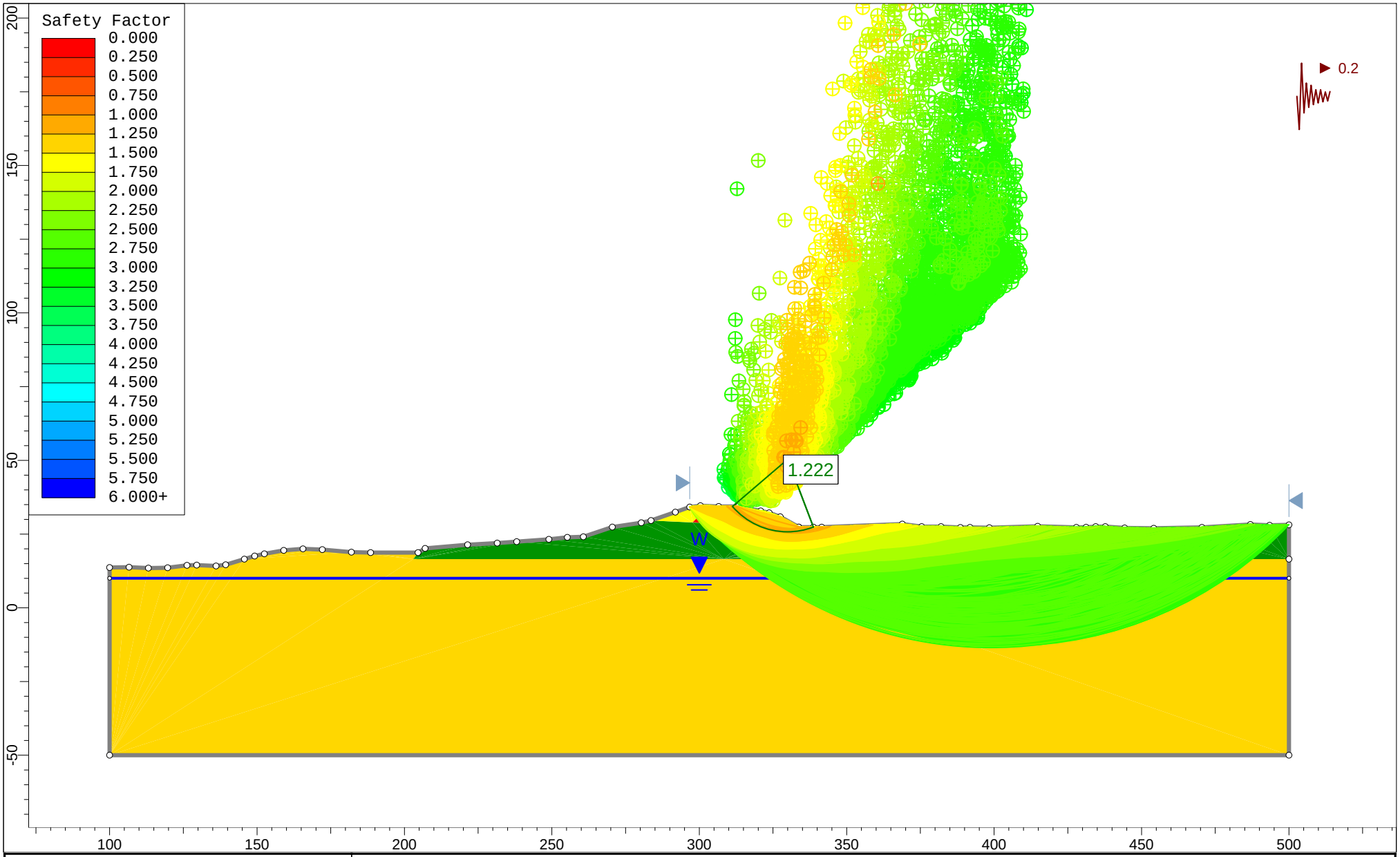
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Existing Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_11400 EL.slim

SLIDEINTERPRET 6.011



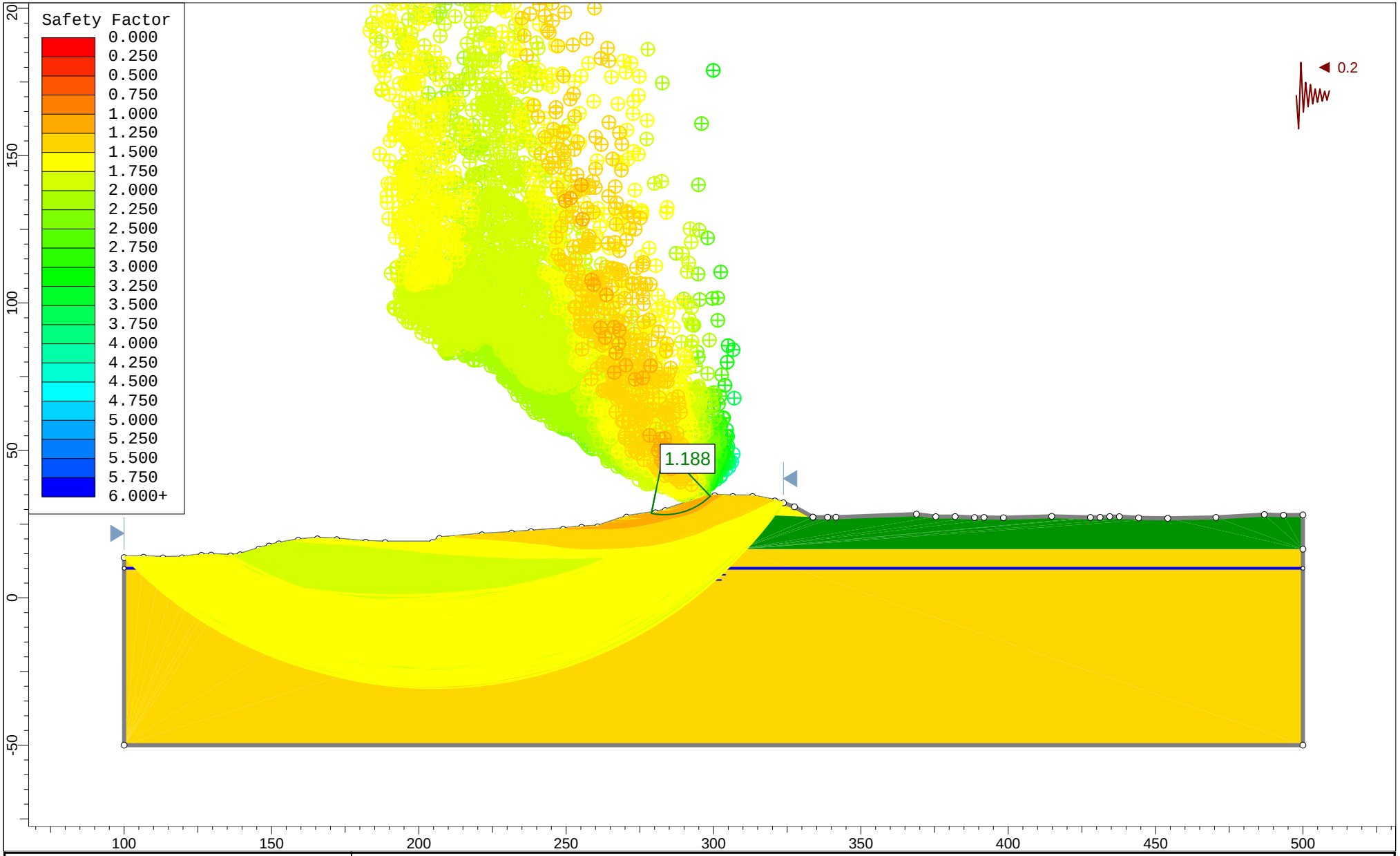
rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Existing Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_11400 EW.slim

SLIDEINTERPRET 6.011



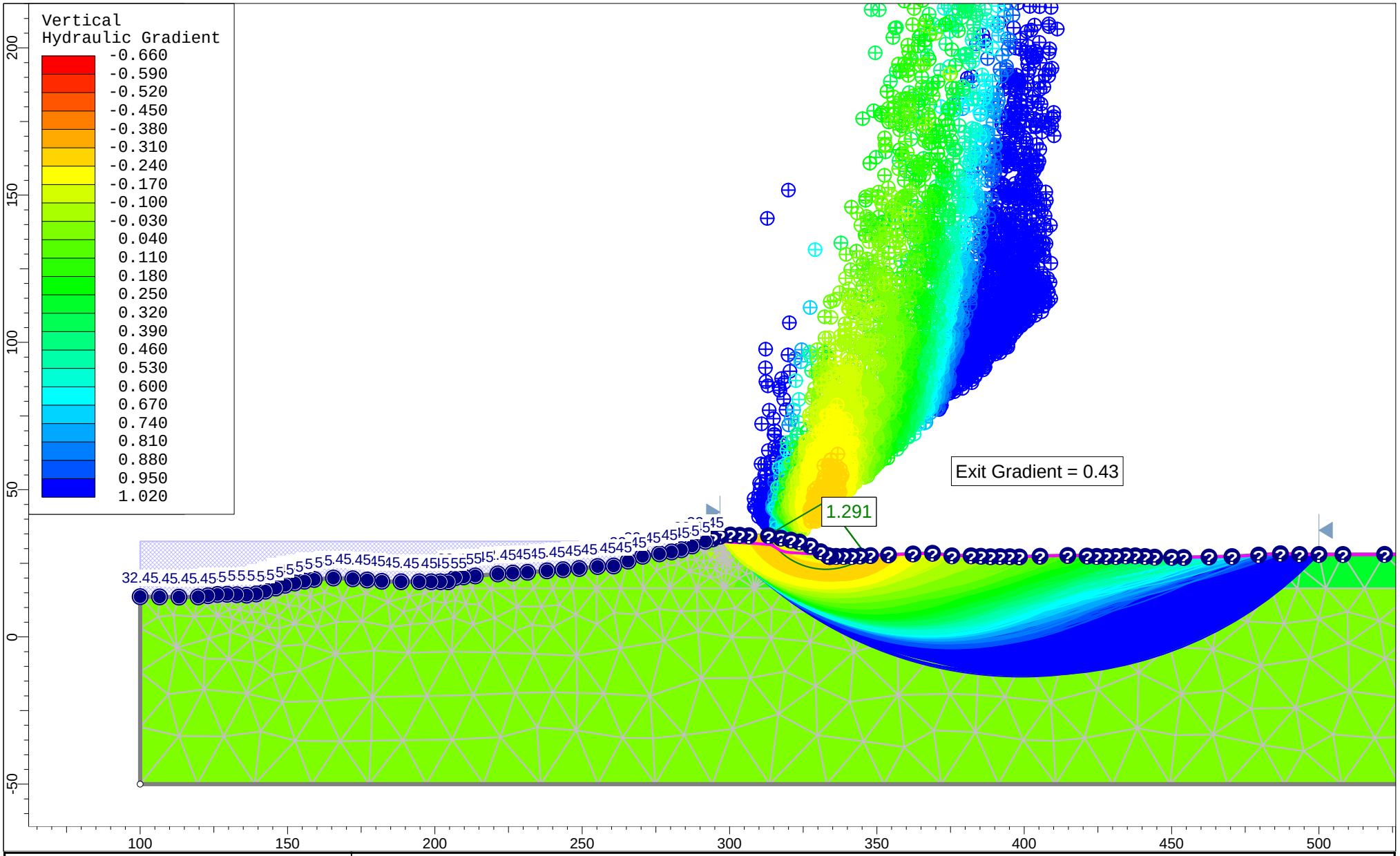
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Pseudo-Static Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_11400 PL.slim

SLIDEINTERPRET 6.011

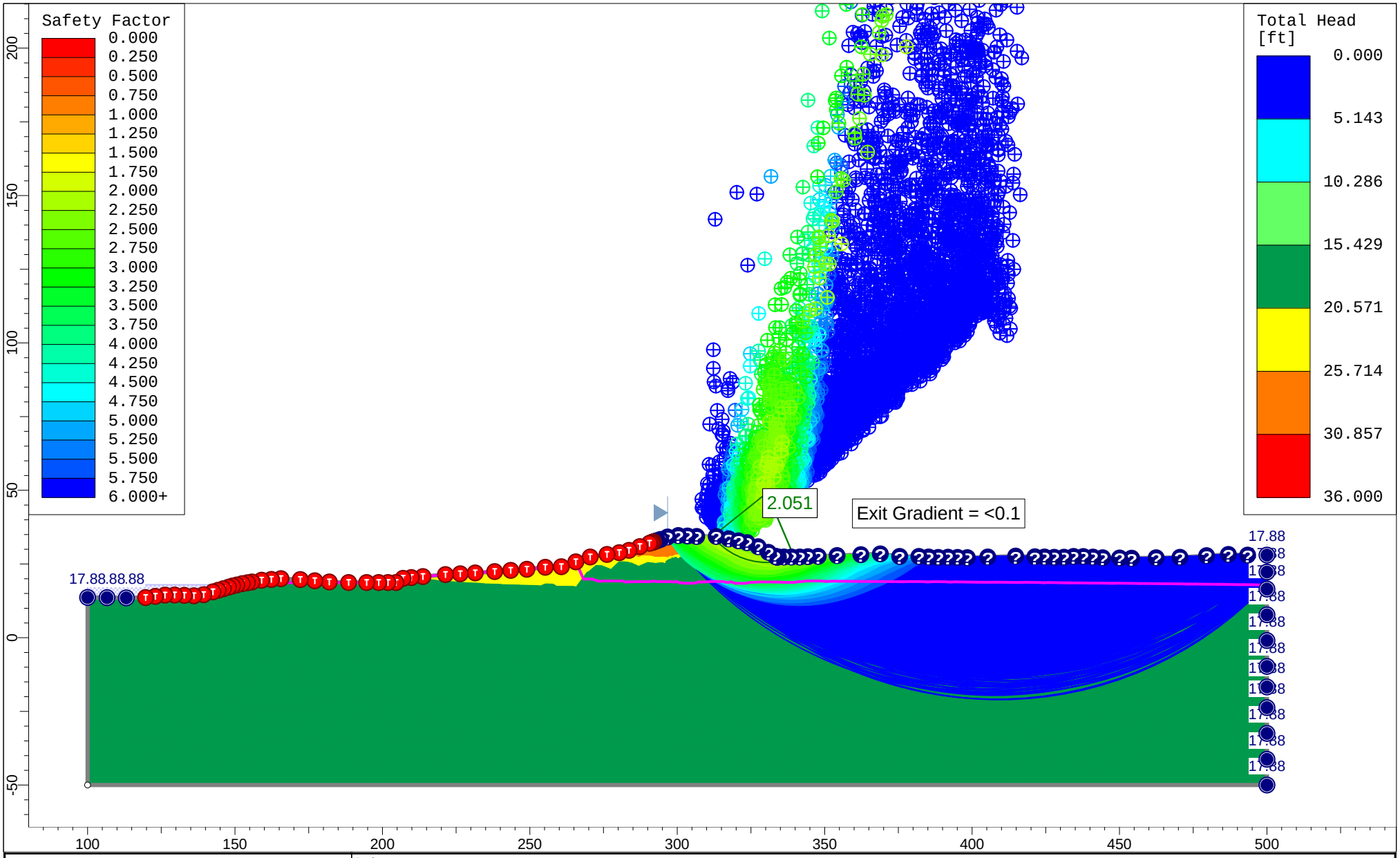


rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Pseudo-Static Conditions Median Annual WSE Waterside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_11400 PW.slim

SLIDEINTERPRET 6.011

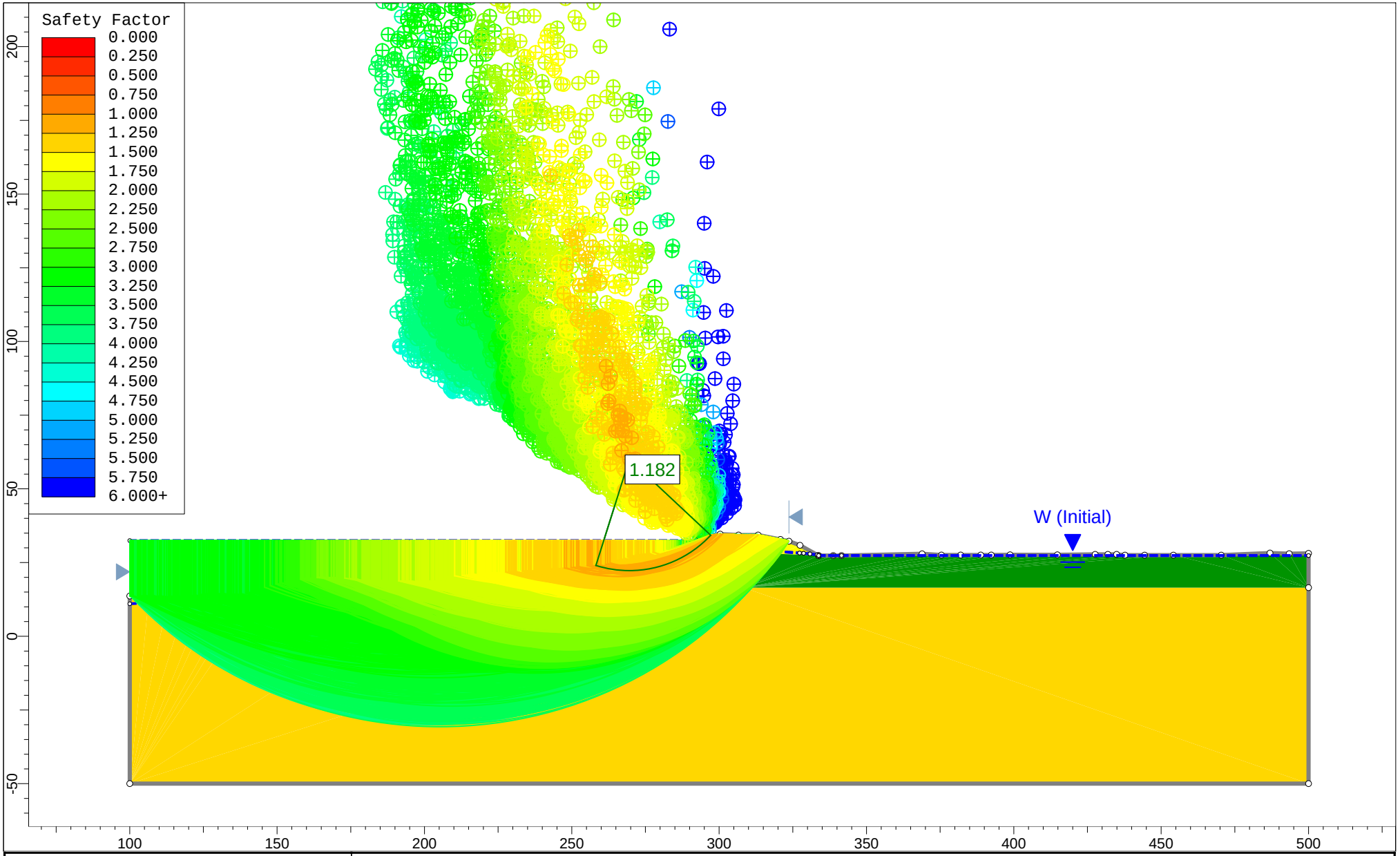


SLIDEINTERPRET 6.011	*Project*	Redwood Creek Levee Evaluation Orick California	
	Analysis Description	Cross-Section 114S Flood Stage Conditions 100-yr WSE Landside Slope	
	Drawn By AB	*Scale* 1:540	*Company* CGI/FWI
	Date May 2011		*File Name* SlopeW_lineS_11400 FL.slim



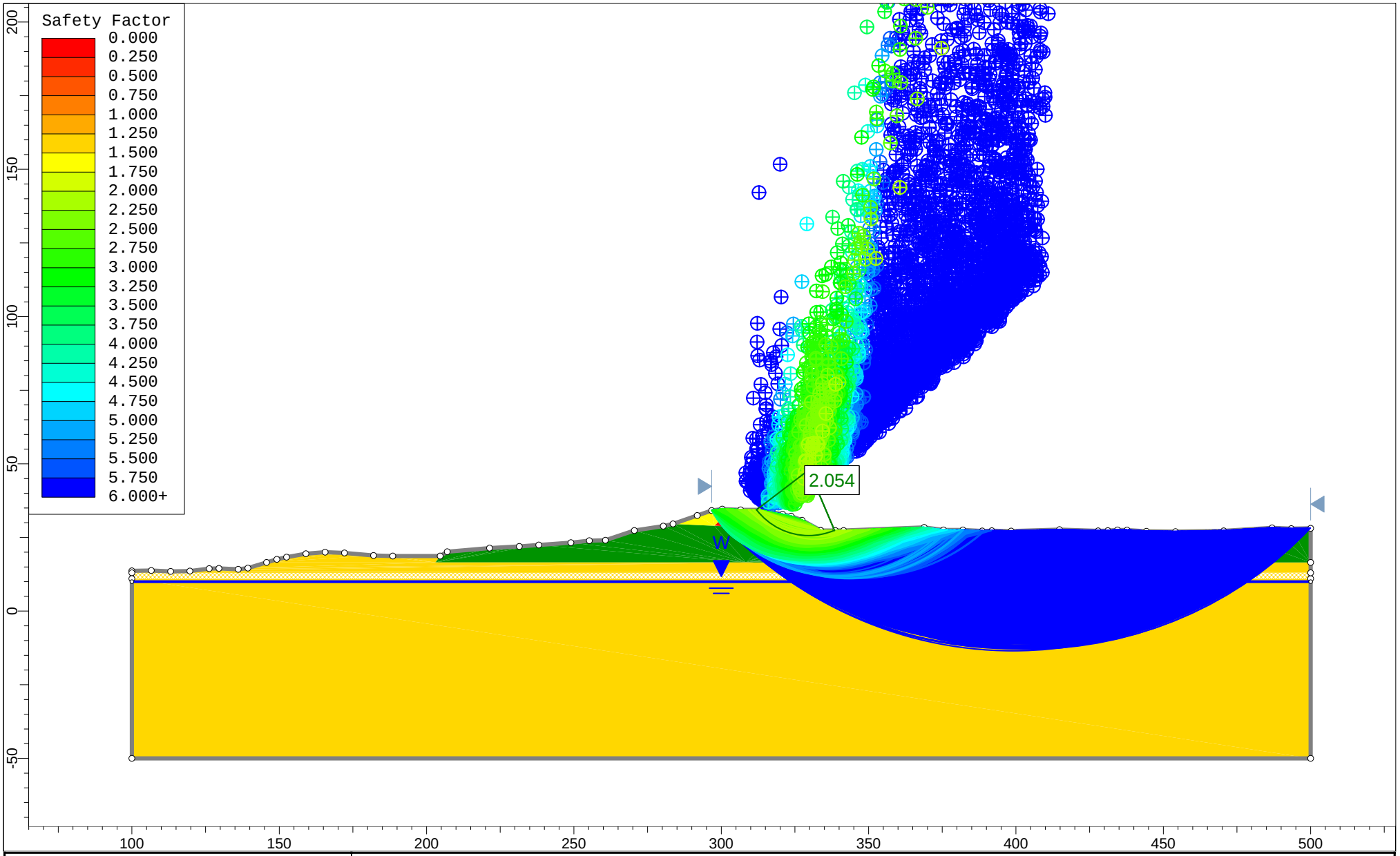
rocscience	Project: Redwood Creek Levee Evaluation Orick California		
	Analysis Description: Cross-Section 114S Flood Stage Conditions (Transient) 100-yr Landside Slope		
	Drawn By: AB	Scale: 1:540	Company: CGI/FWI
	Date: May 2011		File Name: SlopeW_lineS_11400 FLT.slim

SLIDEINTERPRET 6.011



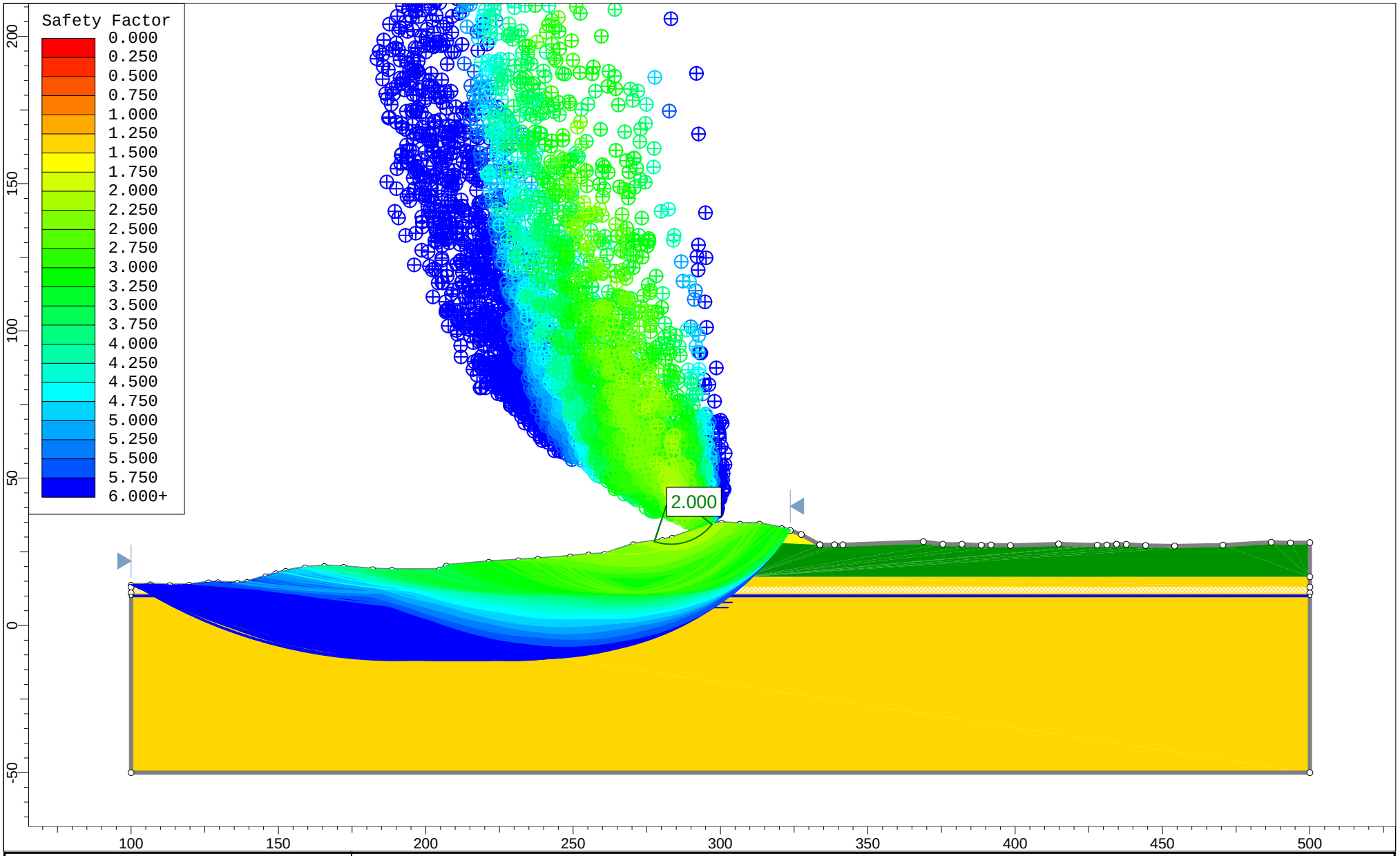
rocscience	*Project*	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Rapid Drawdown Waterside Slope		
	Drawn By	AB	*Scale* 1:540	*Company* CGI/FWI
	Date	May 2011		*File Name* SlopeW_lineS_11400 RW.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Post Earthquake Conditions Median Annual WSE Landside Slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_11400 PEL.slim

SLIDEINTERPRET 6.011



rocscience	Project	Redwood Creek Levee Evaluation Orick California		
	Analysis Description	Cross-Section 114S Post Earthquake Conditions Median Annual WSE Waterside slope		
	Drawn By	AB	Scale 1:540	Company CGI/FWI
	Date	May 2011		File Name SlopeW_lineS_11400 PEW.slim

SLIDEINTERPRET 6.011

SECTION 114R

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineN_11400_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 114R, Pseudo-Static Conditions, Median Annual WSE, Landside Slope
Author: GDE
Company: CGI/FWI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1439
Number of Nodes: 795

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
293.44	35.26
283.63	32.36
260.731	25.247
260.68	25.22
258.781	24.4983
250.84	21.48
231.16	16.31
227.89	16.33
204.94	24.44
191.83	24.37
175.42	24.26

145.9	25.32
132.79	25.9
109.84	27.44
100	29.17
100	13.0005
100	10.369
100	-50
500	-50
500.02	10.369
500.02	12.672
450.82	11.86
427.87	12.07
404.92	12.06
391.786	12.81
390.385	12.89
388.286	18.601
375.43	20.07
349.06	25.4936
345.91	25.85
329.53	29.11
319.213	32.4504
309.85	35.6

Material Boundary

X	Y
260.731	25.247
282.168	25.3069
317.703	25.4061
349.06	25.4936

Material Boundary

X	Y
310.981	32.164
317.703	25.4061
282.106	25.276
282.168	25.3069
296.047	32.164
310.981	32.164

Material Boundary

X	Y
100	10.369
391.232	10.369

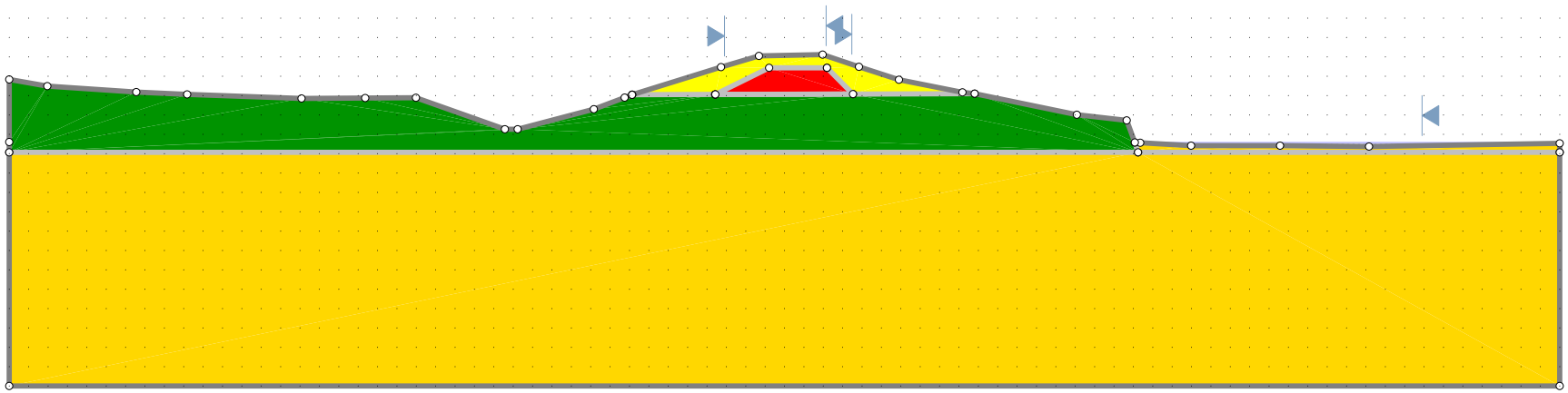
500.02	10.369

Material Boundary

X	Y
390.385	12.89
391.232	10.369

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



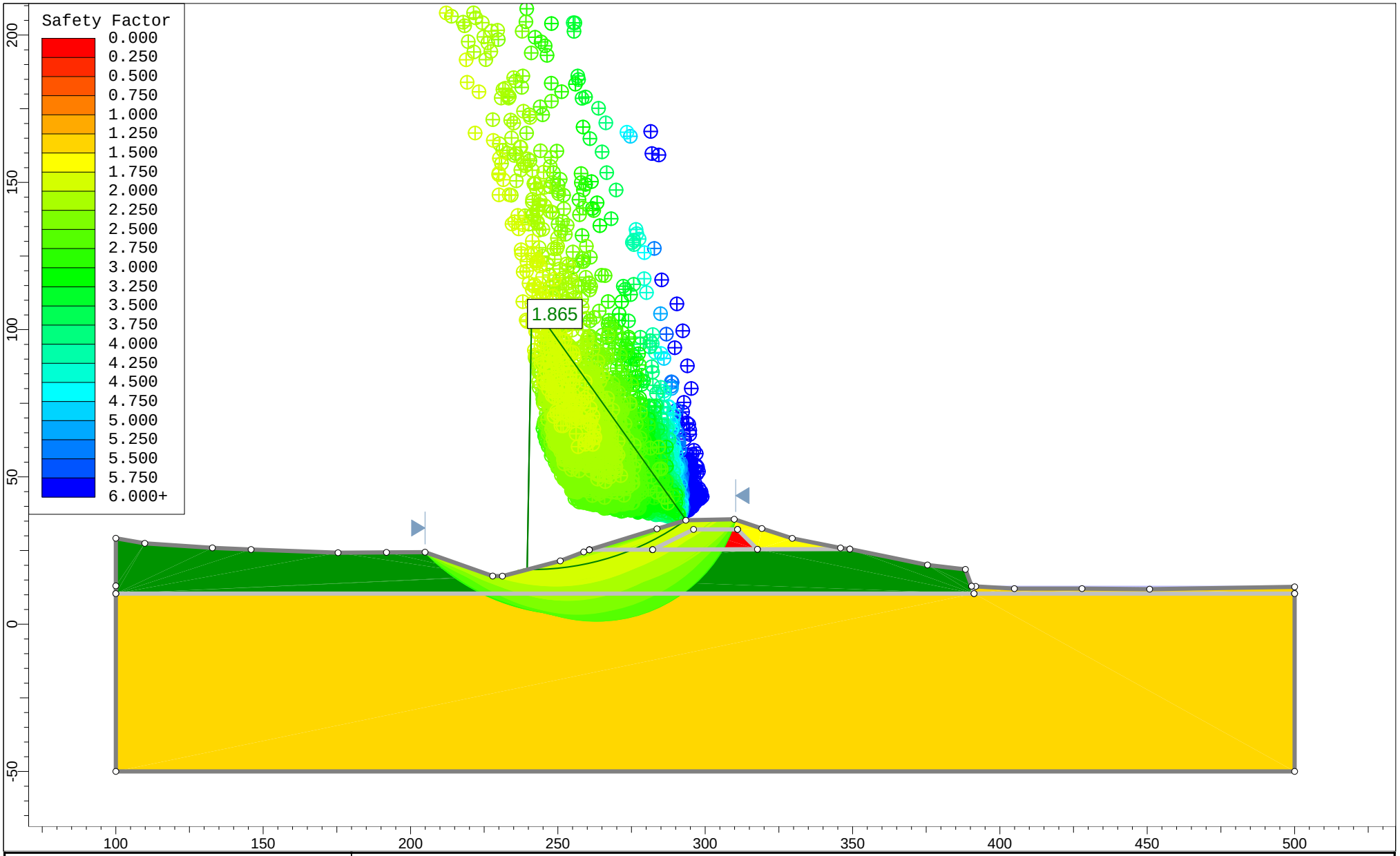
150
100
50
0
-50

100 150 200 250 300 350 400 450 500

rocscience

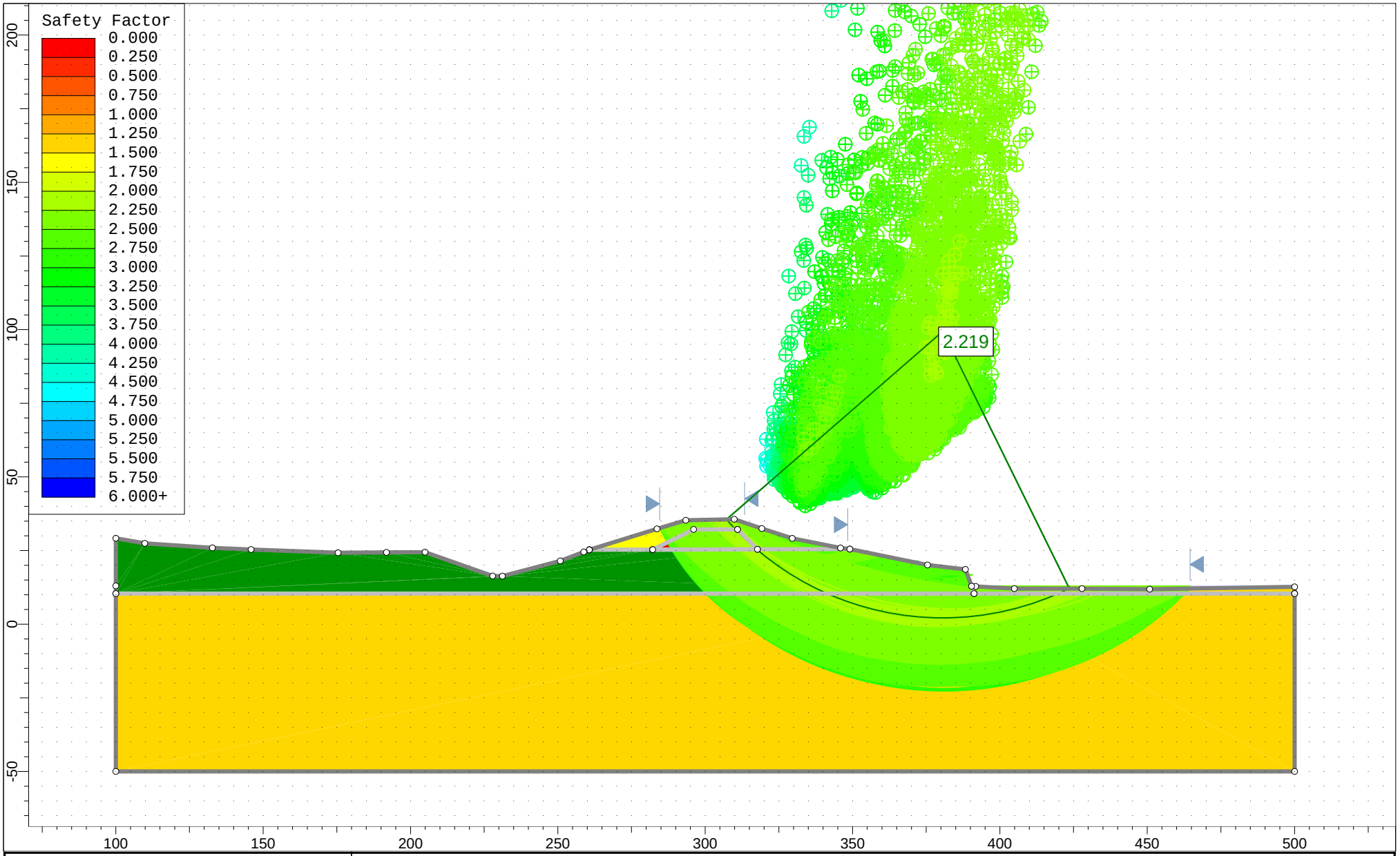
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 114R, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company CGI/FWI
Date	December, 2010		File Name SlopeW_lineN_11400_Existing.slim



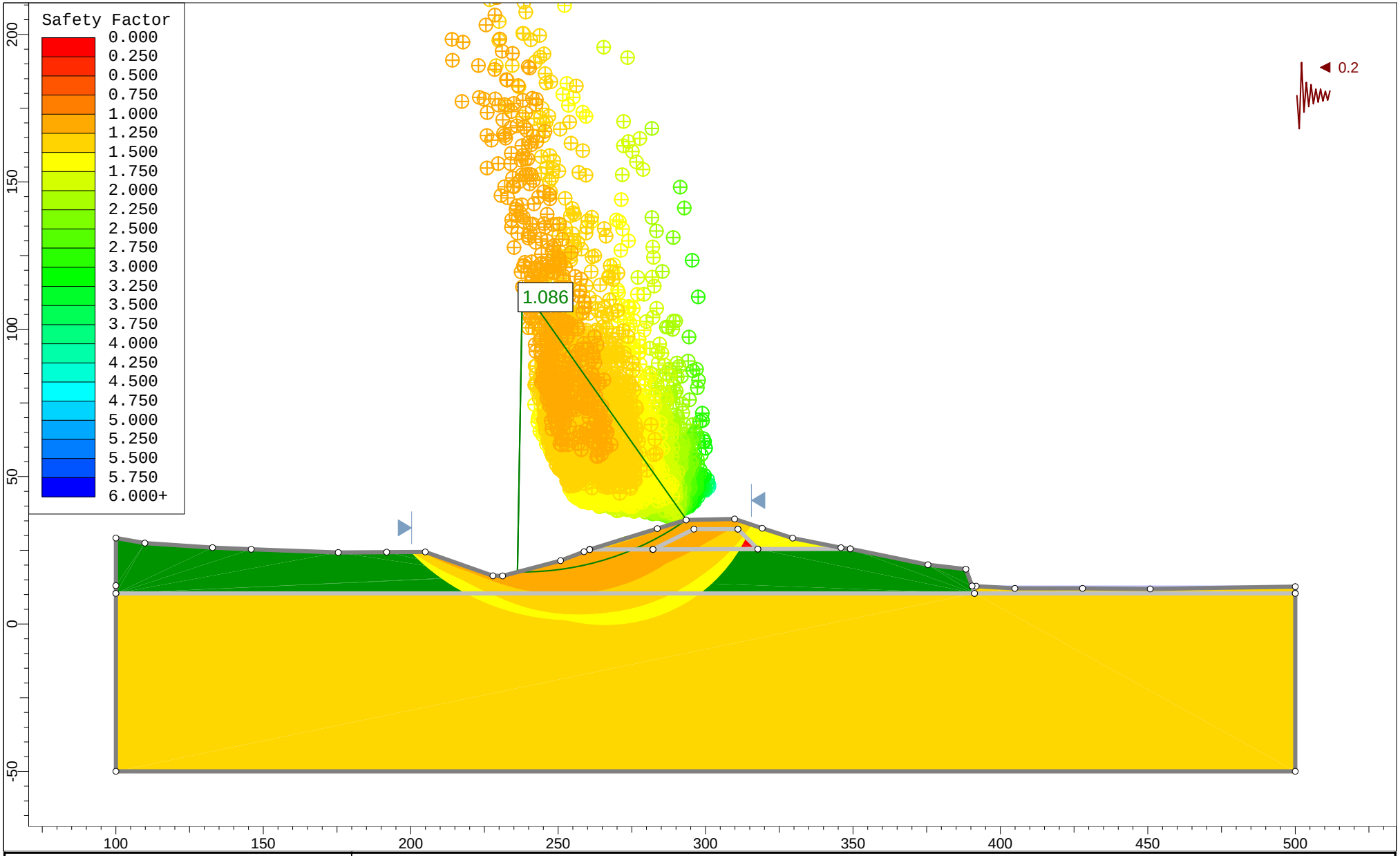
rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 114R, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* CGI/FWI
	Date	December, 2010		*File Name* SlopeW_lineN_11400_Existing.slim

SLIDEINTERPRET 6.005



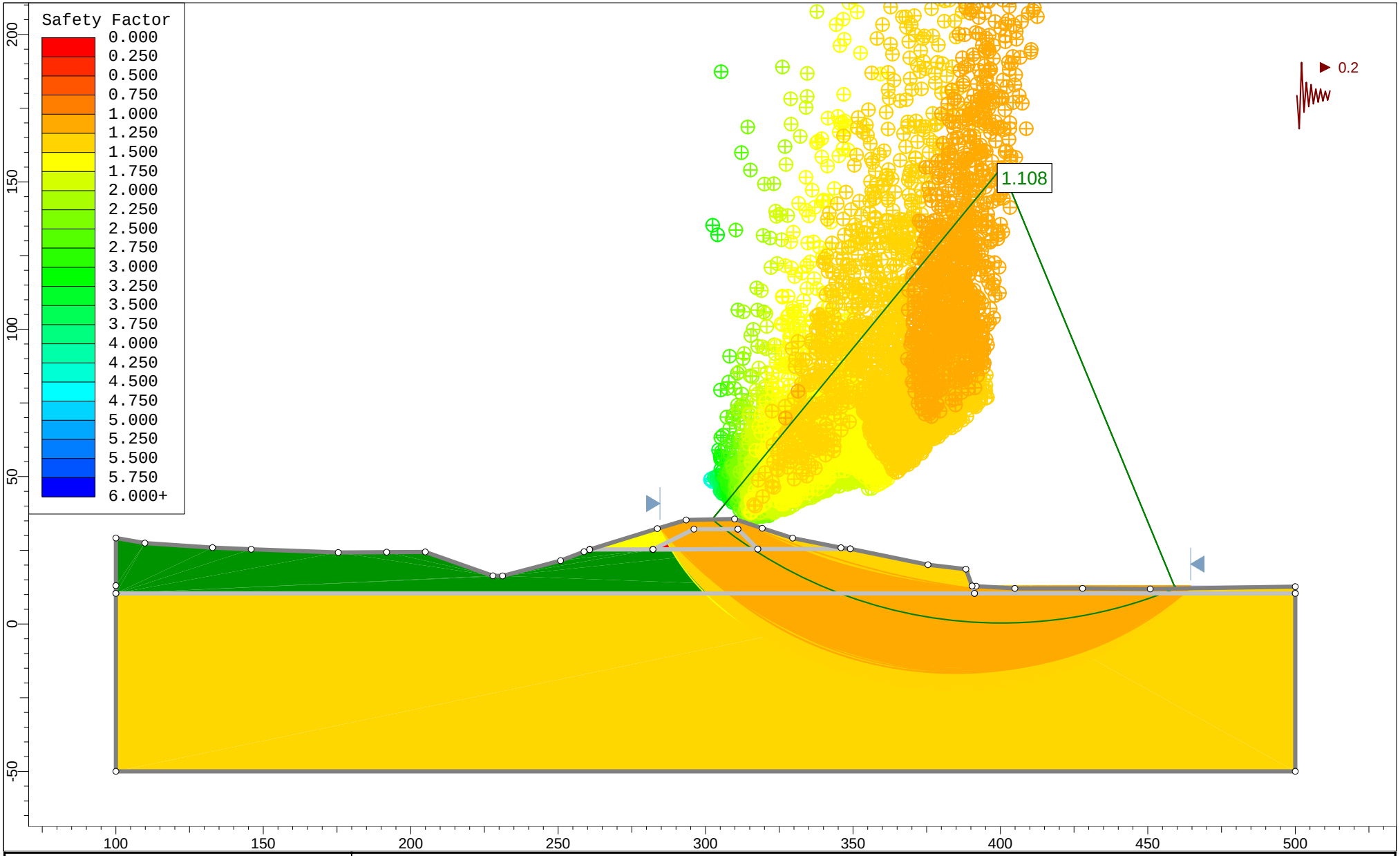
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 114R, Existing Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company CGI/FWI
Date	December, 2010		File Name SlopeW_lineN_11400_Existing.slim

SLIDEINTERPRET 6.005



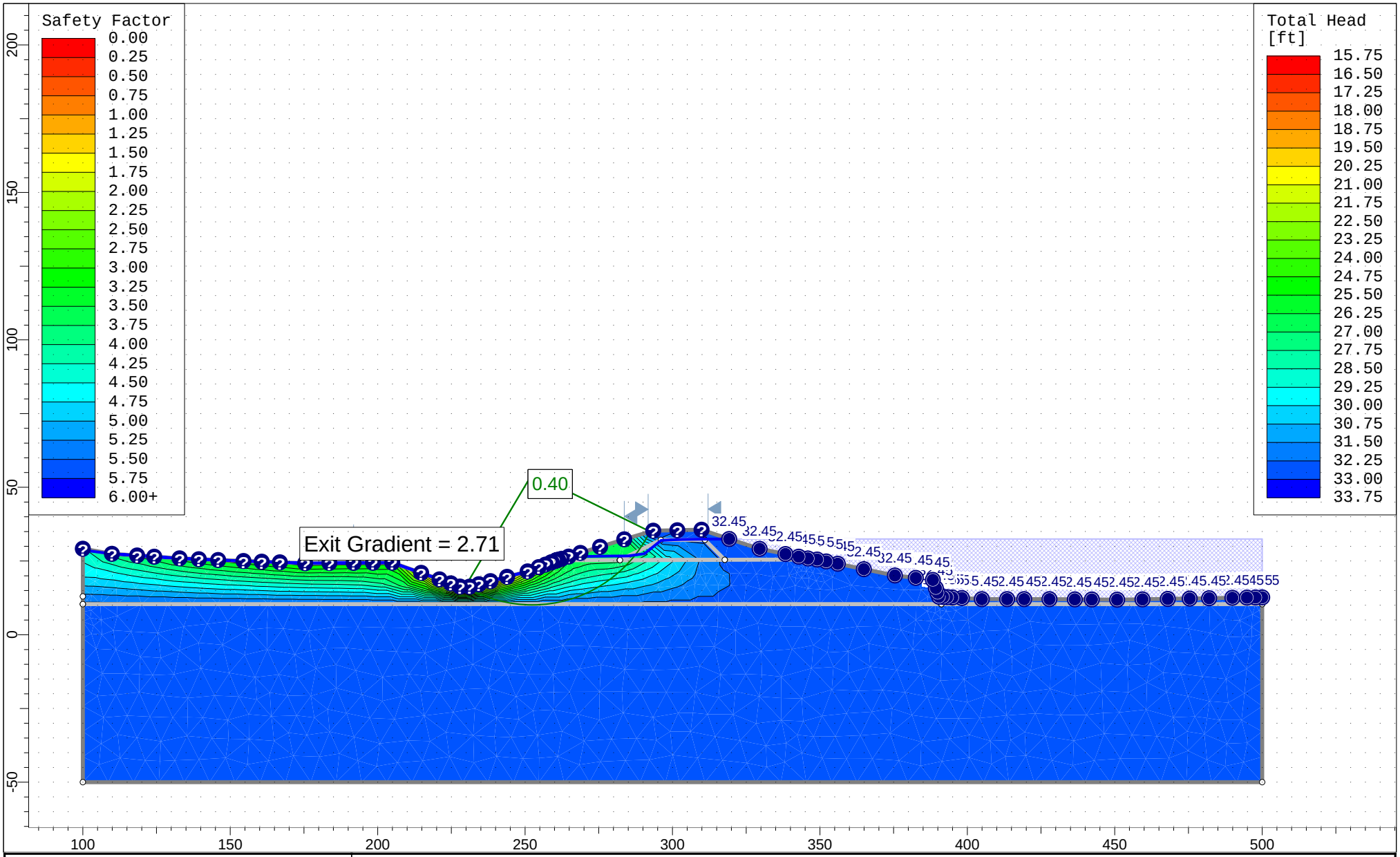
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 114R, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December, 2010		File Name SlopeW_lineN_11400_Existing.slim

SLIDEINTERPRET 6.005



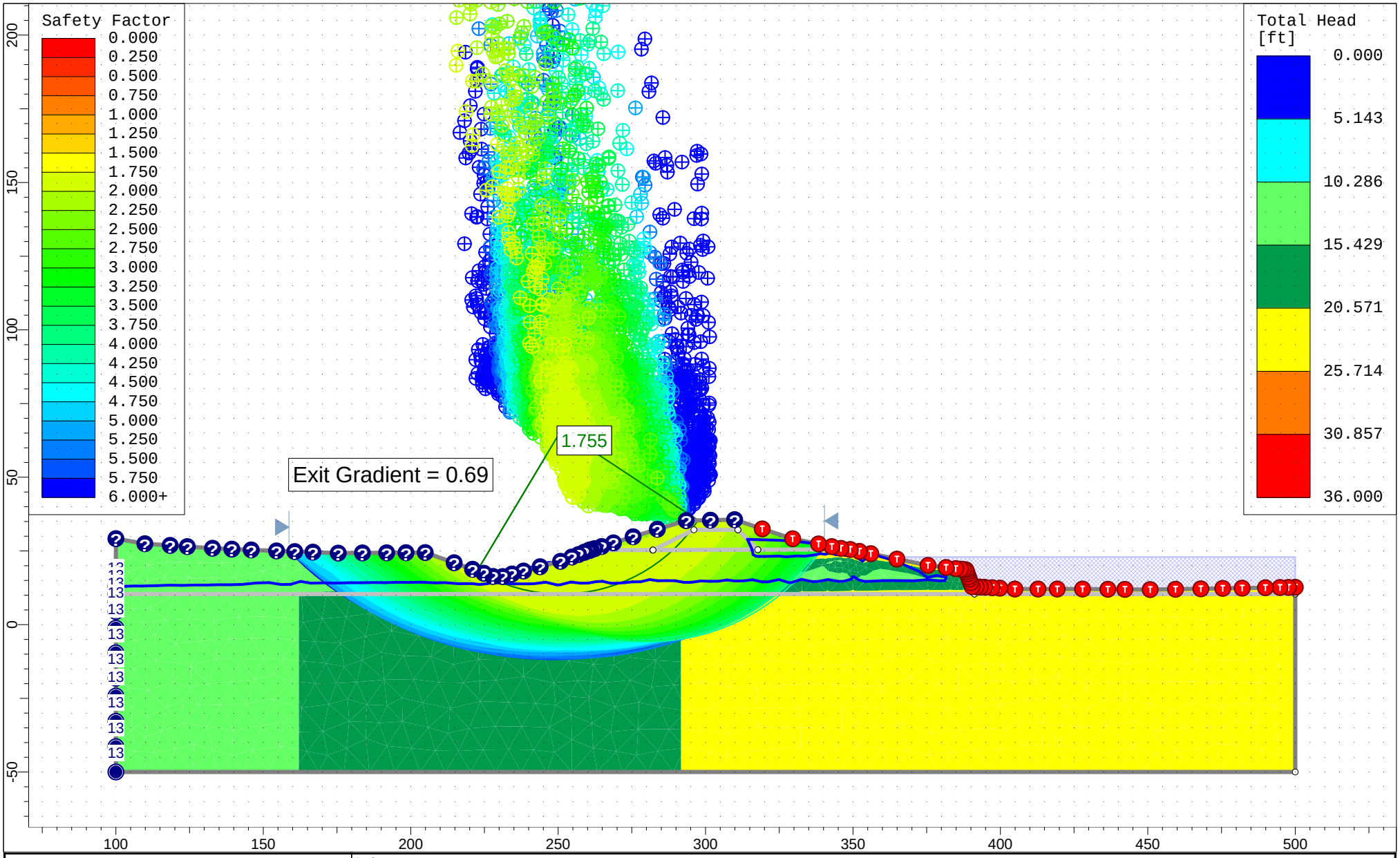
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 114R, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company CGI/FWI
Date	December, 2010		File Name SlopeW_lineN_11400_Existing.slim

SLIDEINTERPRET 6.005



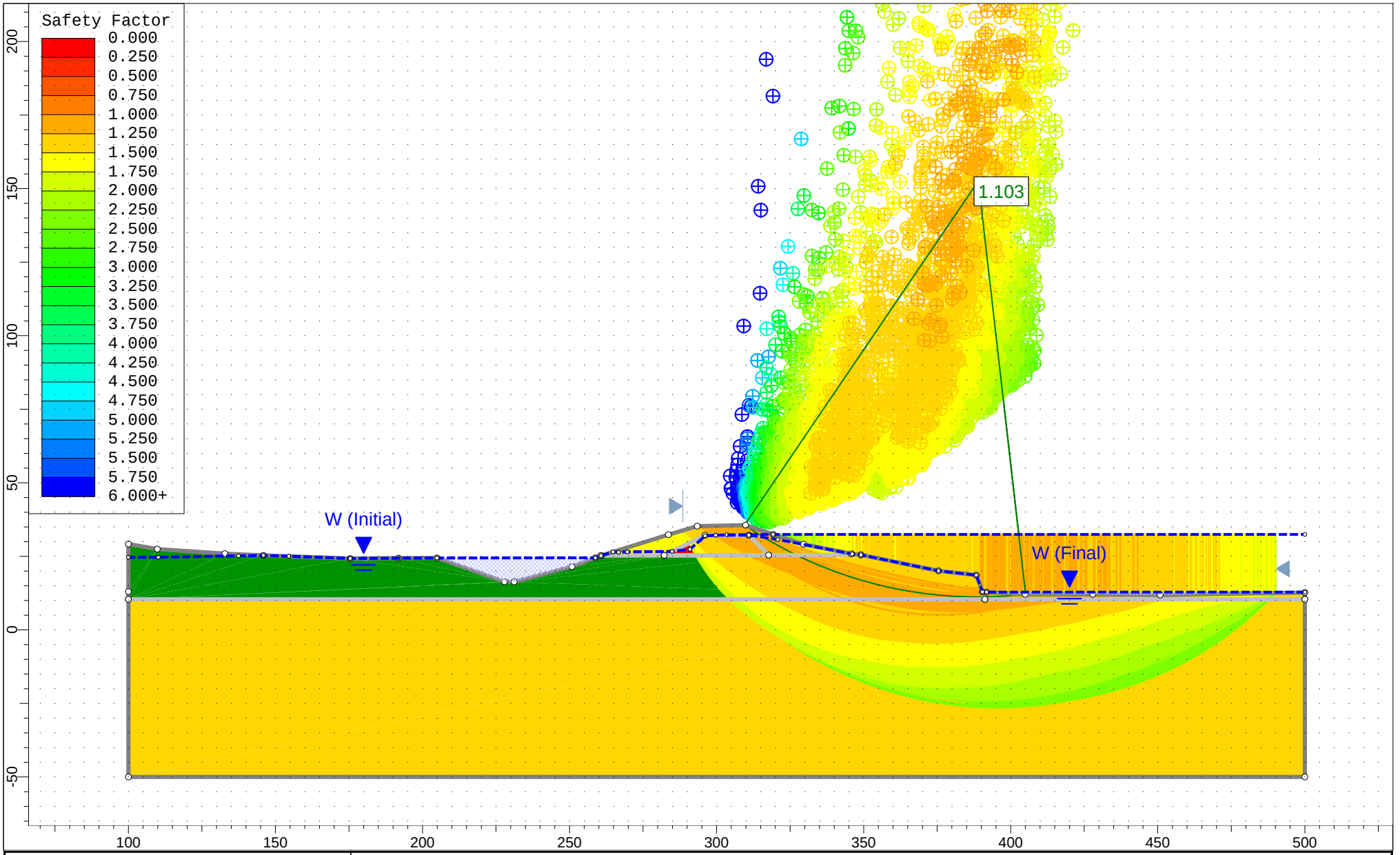
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 114R, Flood Stage Conditions, 100-yr WSE, Landside Slope		
Drawn By: GDE	Scale: 1:540	Company: CGI/FWI	
Date: December, 2010		File Name: SlopeW_lineN_11400_Flood.slim	

SLIDEINTERPRET 6.005



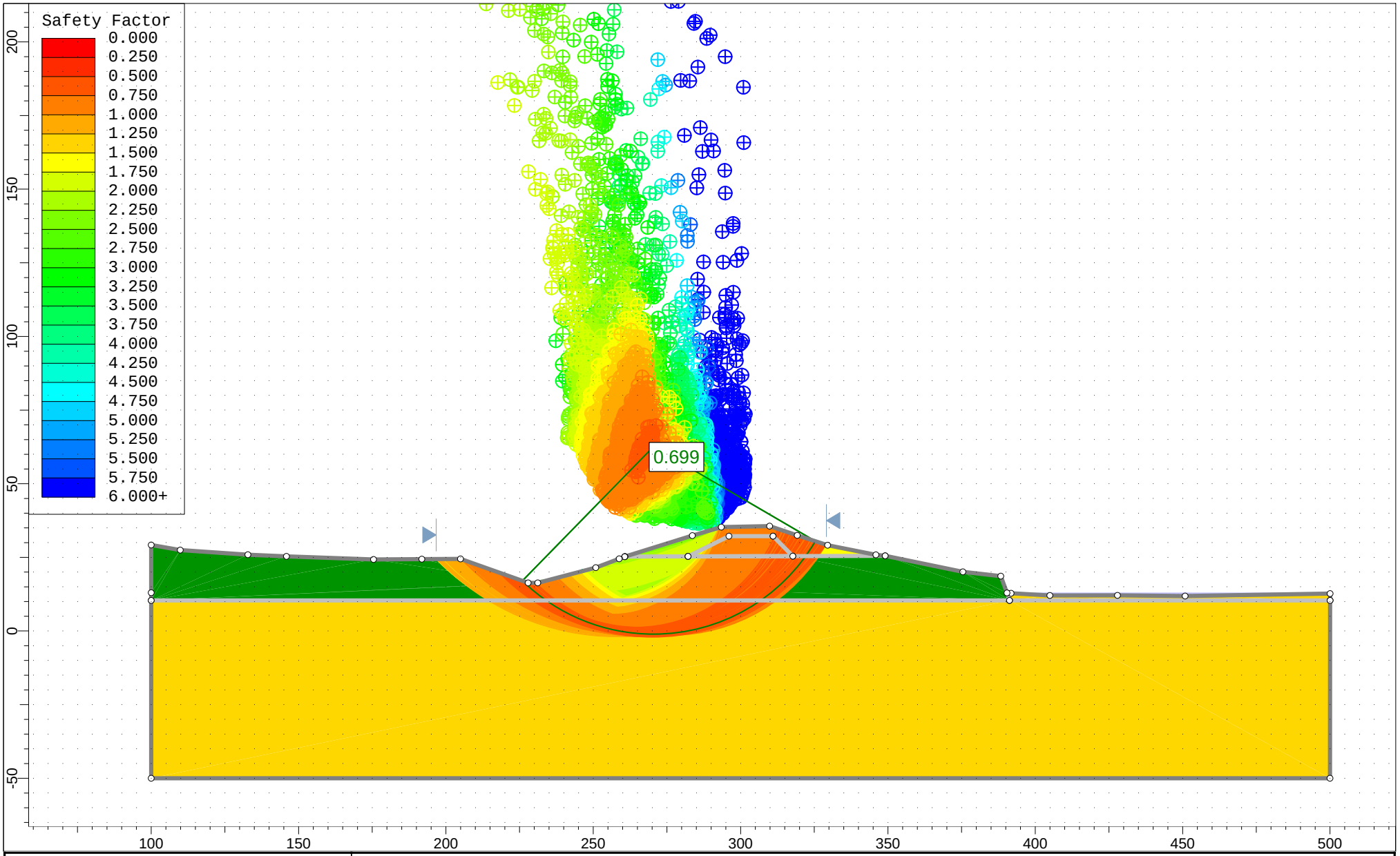
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 114R, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:540	Company: CGI/FWI
	Date: May, 2011		File Name: SlopeW_lineN_11400_Transient_12 hour.slim

SLIDEINTERPRET 6.005



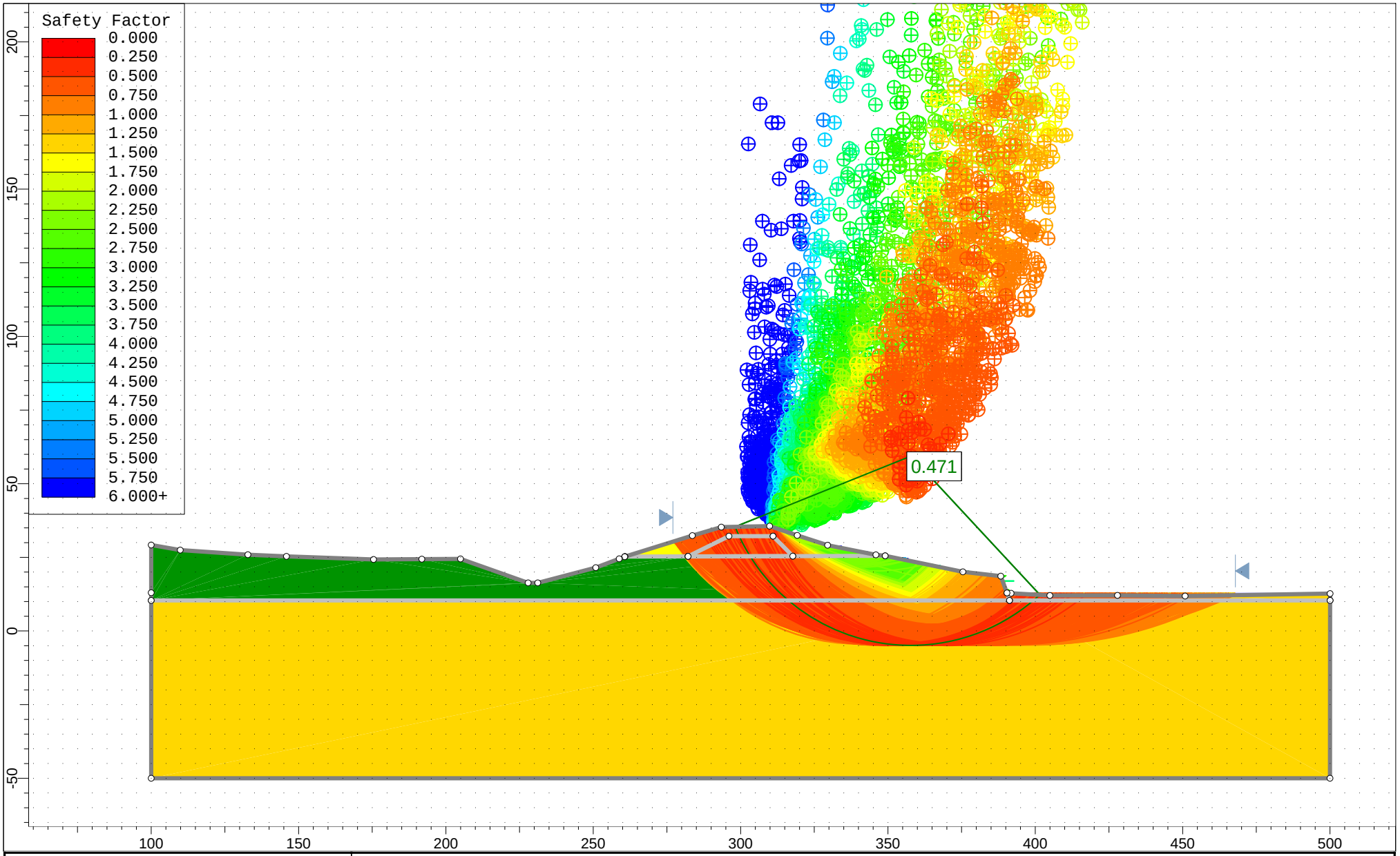
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 114R, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December 1, 2010		File Name SlopeW_lineN_11400_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 114R, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December, 2010		File Name SlopeW_lineN_11400_Post-EQ.slim

SLIDEINTERPRET 6.005



	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 114R, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By: GDE	Scale: 1:540	Company: CGI/FWI
	Date: December, 2010		File Name: SlopeW_lineN_11400_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 132L

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineS_13200_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 132L, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1139
Number of Nodes: 645

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
286.9	41.19
283.63	41.12
270.49	36.48
264.731	34.7892
254.11	32.28
249.558	30.721
244.27	28.91
231.16	26.14
221.32	24.64
214.78	23.92
209.435	22.9985

198.866	21.823
190.457	21.293
188.736	14.492
188.53	13.68
175.42	13.47
126.25	13.8
100	13.62
100	-28.121
500.02	-28.121
500.02	12
500.02	22.9985
500.02	29.77
473.77	29.62
447.55	30.55
431.17	30.15
408.22	30.32
398.38	30.53
388.54	30.47
381.97	30.64
375.43	30.62
373.208	30.721
372.13	30.77
339.582	30.753
316.42	38.6
313.12	39.59
309.85	40.25
306.58	40.66
296.74	41.24
290.17	41.08

Material Boundary

X	Y
249.558	30.721
312.647	30.7444
339.582	30.753

Material Boundary

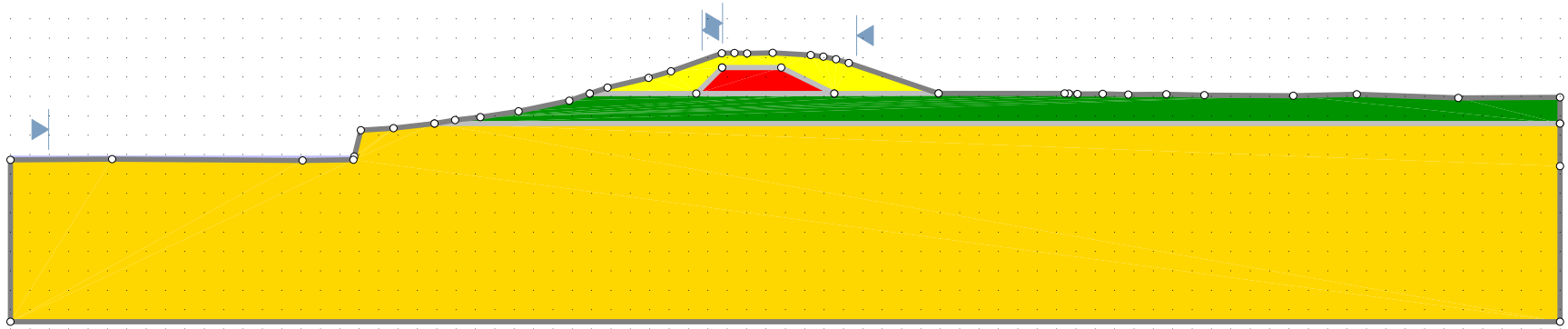
X	Y
283.69	37.4498
298.966	37.4498
312.647	30.7444
277.033	30.7444
283.69	37.4498

Material Boundary

X	Y
209.435	22.9985
500.02	22.9985

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

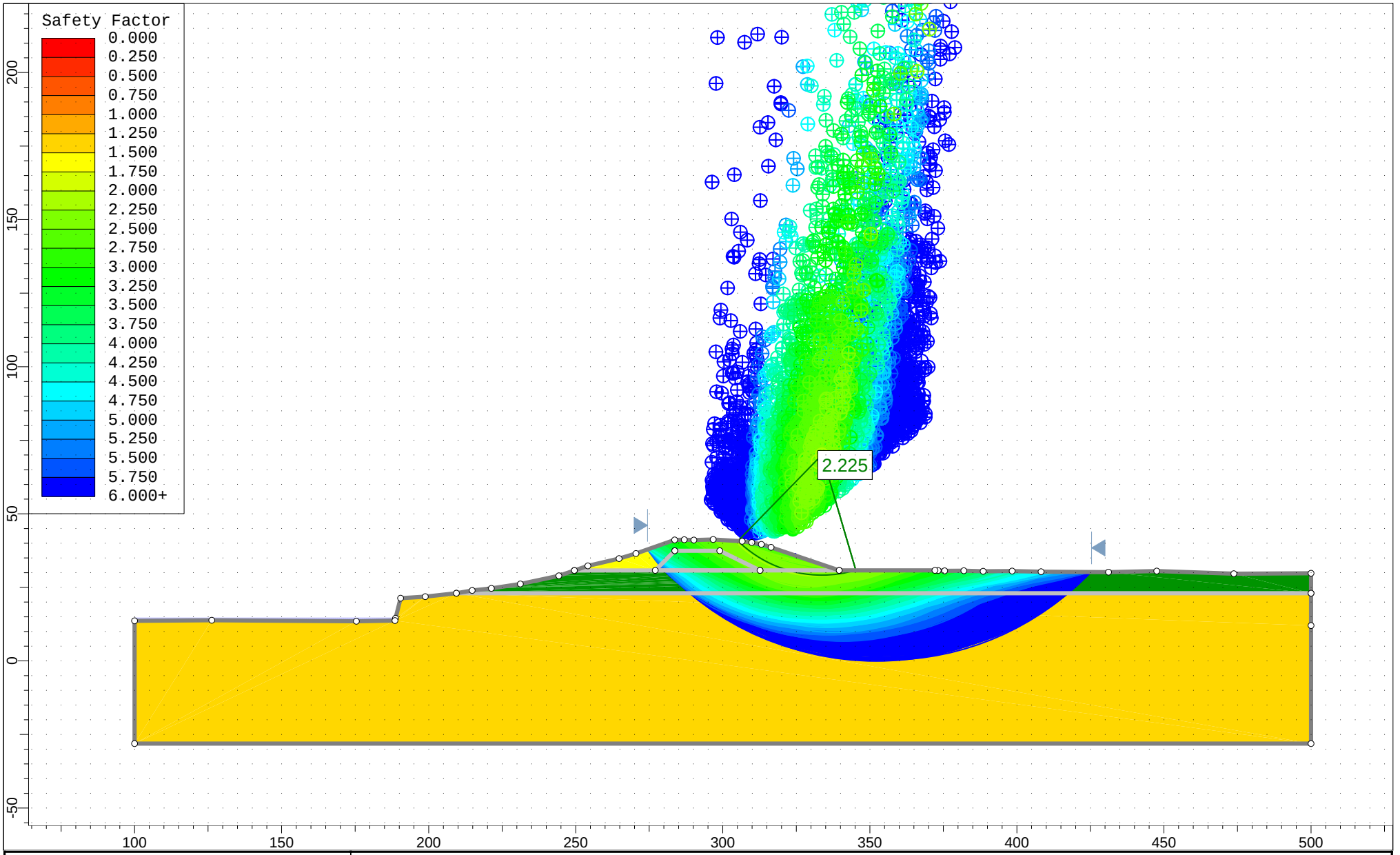
Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



rocscience

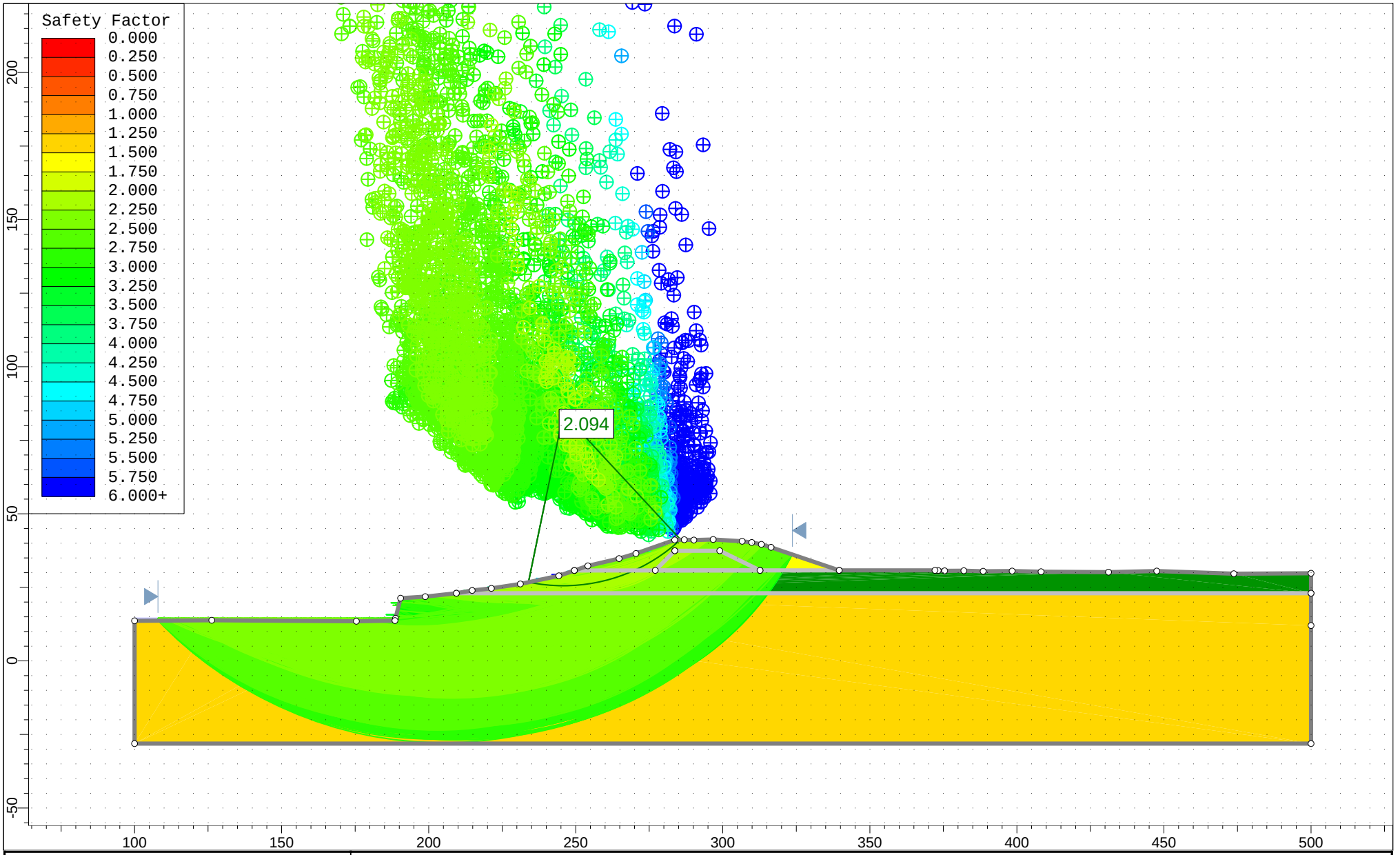
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 132L, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_13200_Existing.slim



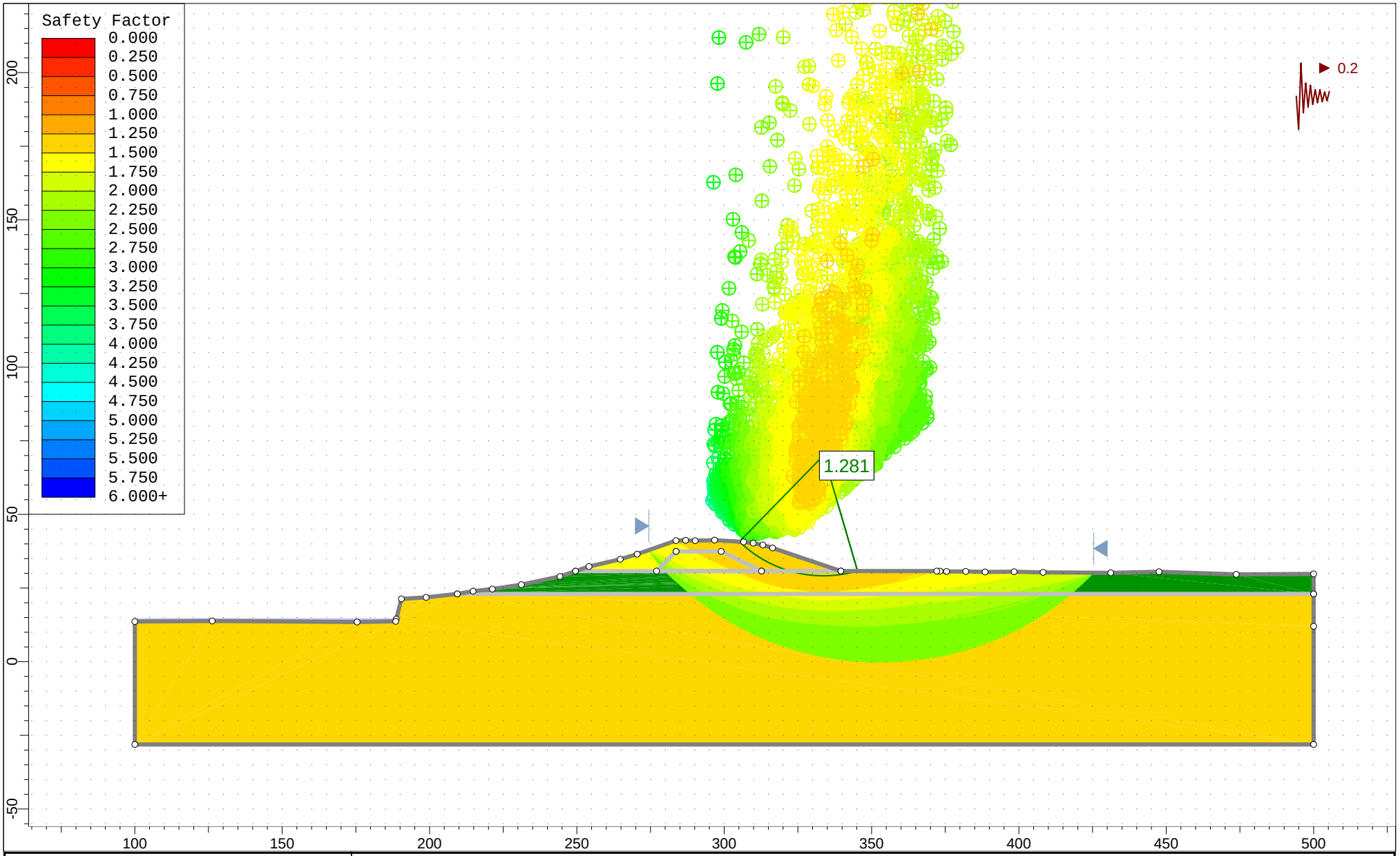
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 132L, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_13200_Existing.slim

SLIDEINTERPRET 6.005



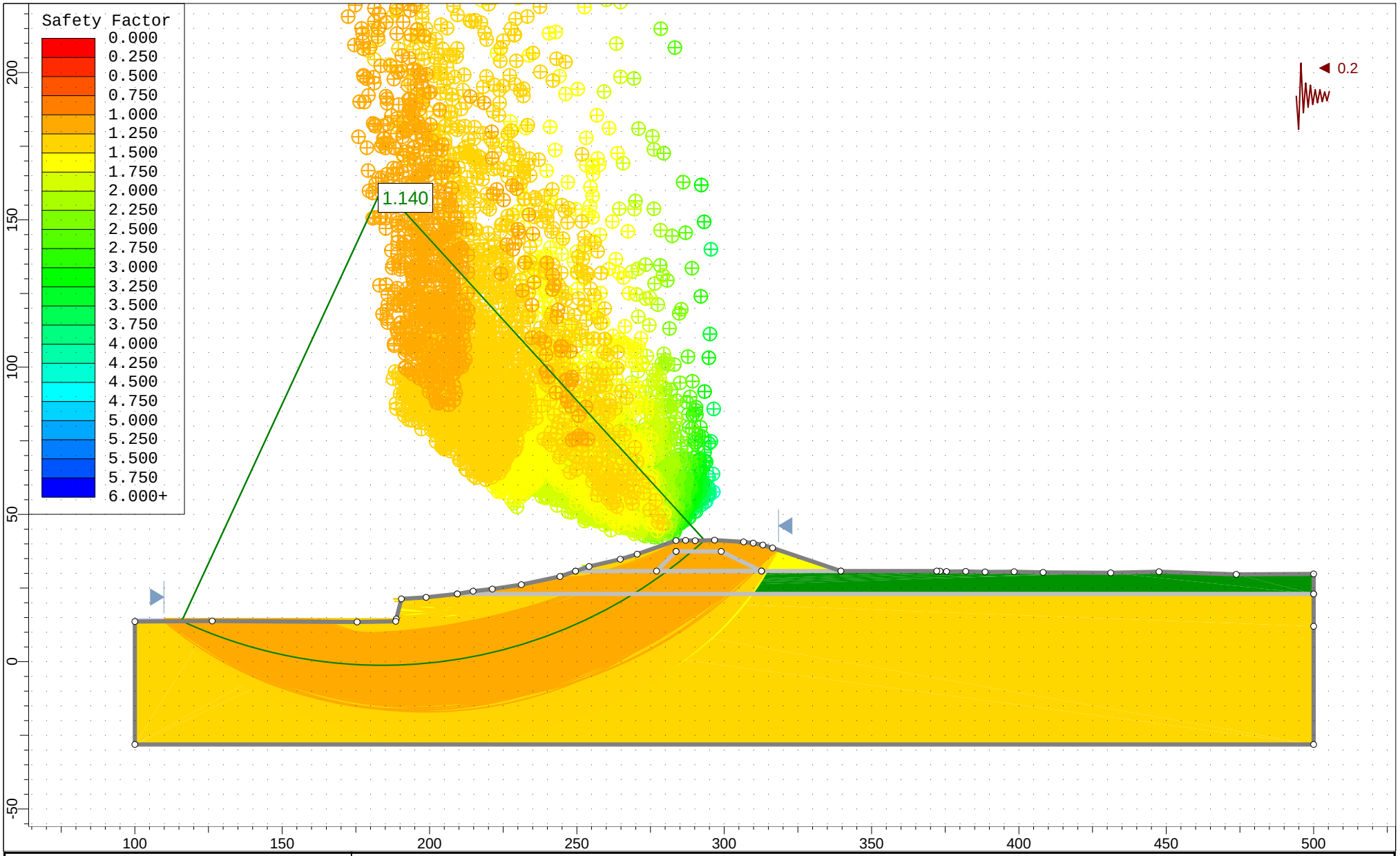
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 132L, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_13200_Existing.slim

SLIDEINTERPRET 6.005



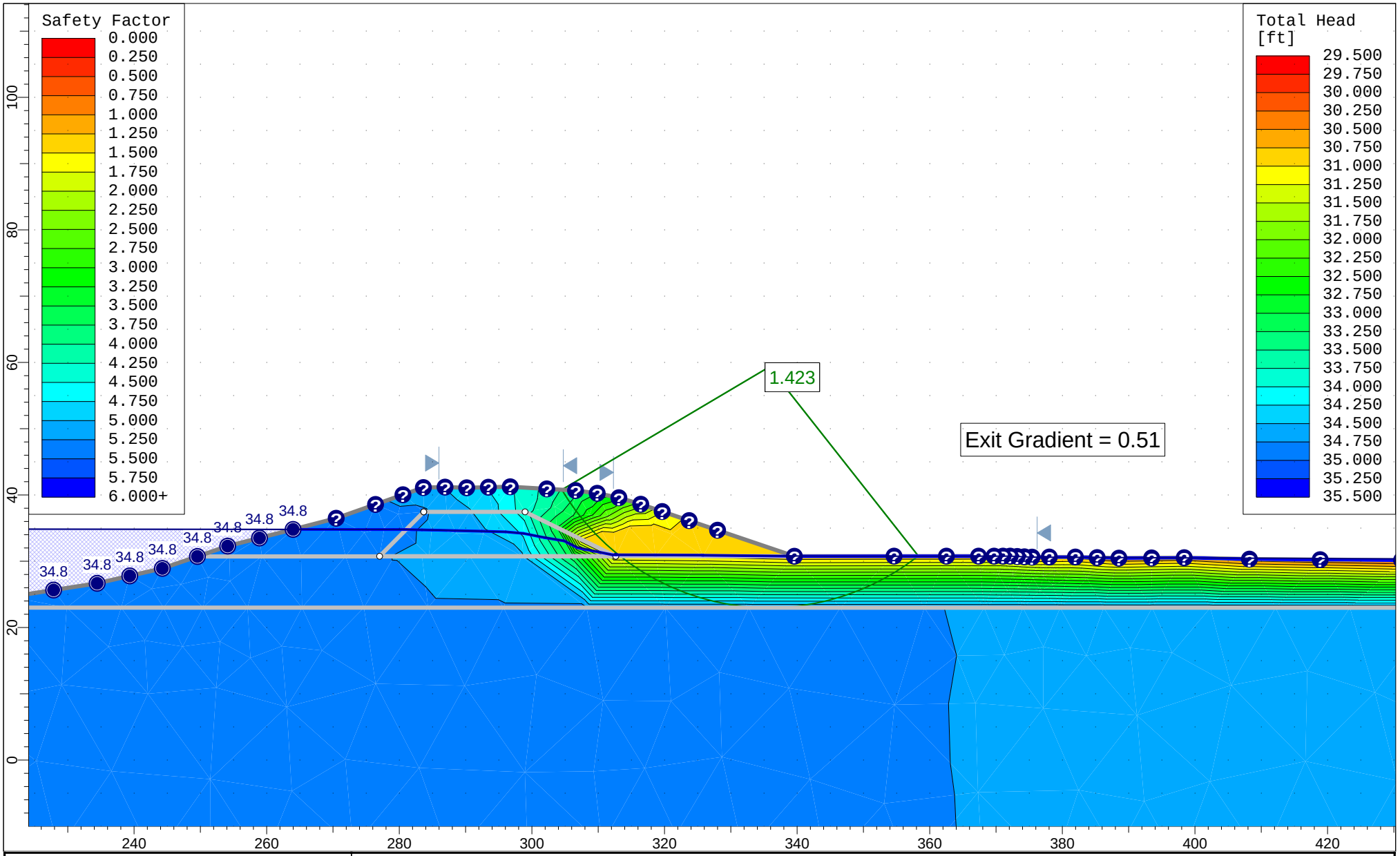
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 132L, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_13200_Existing.slim

SLIDEINTERPRET 6.005



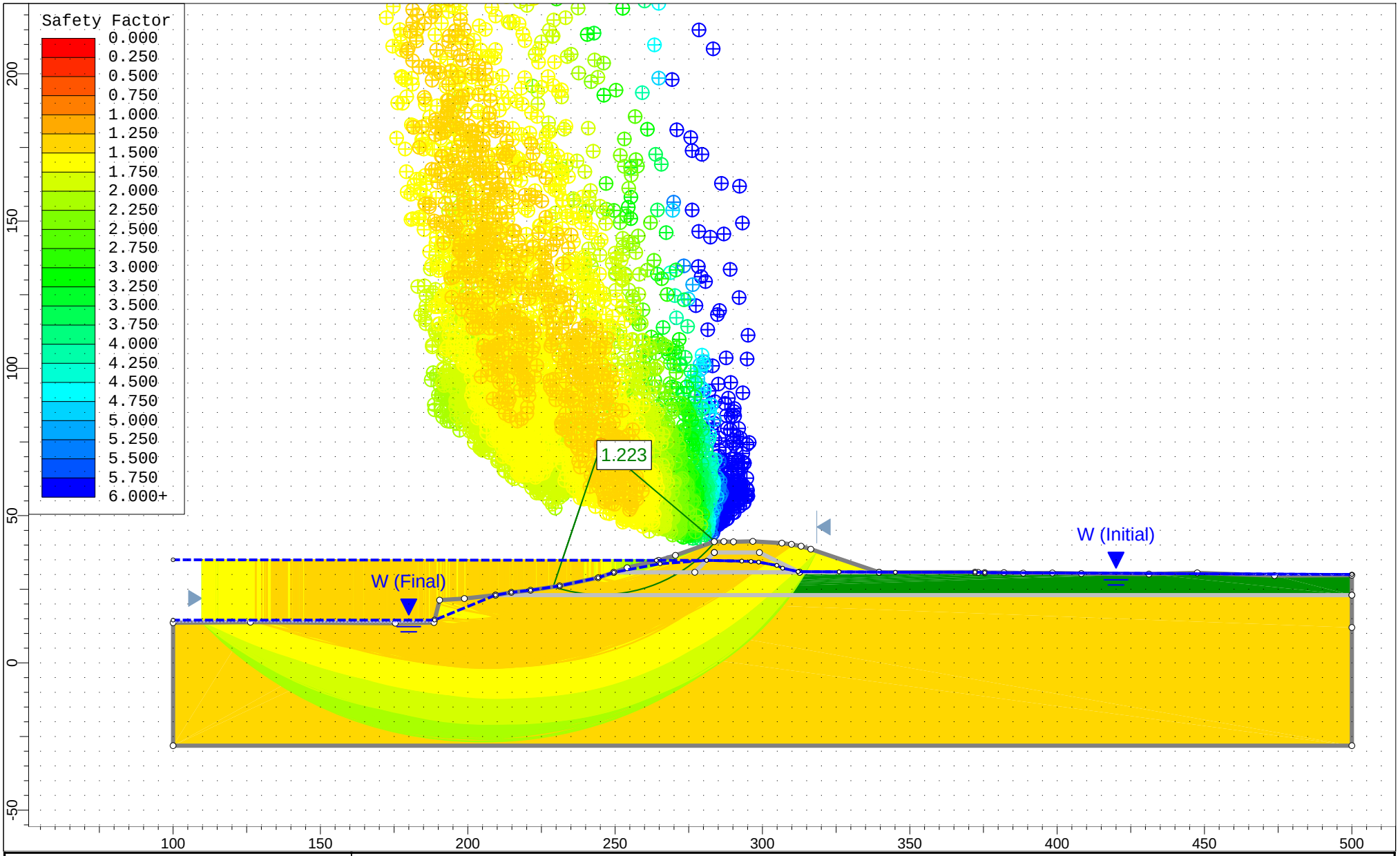
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 132L, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_13200_Existing.slim

SLIDEINTERPRET 6.005



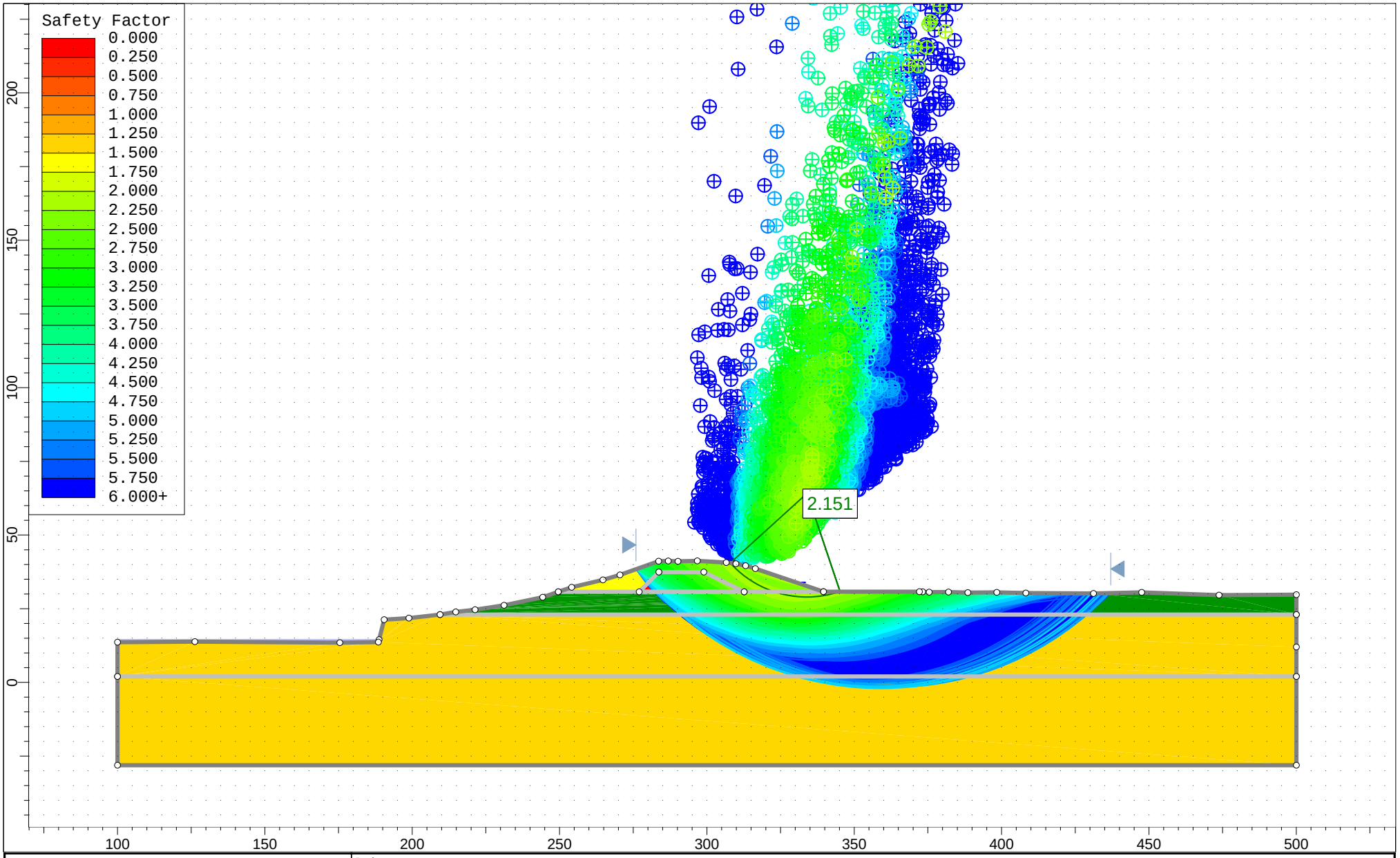
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 132L, Flood Stage Conditions, 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:240	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineS_13200_Flood.slim

SLIDEINTERPRET 6.005



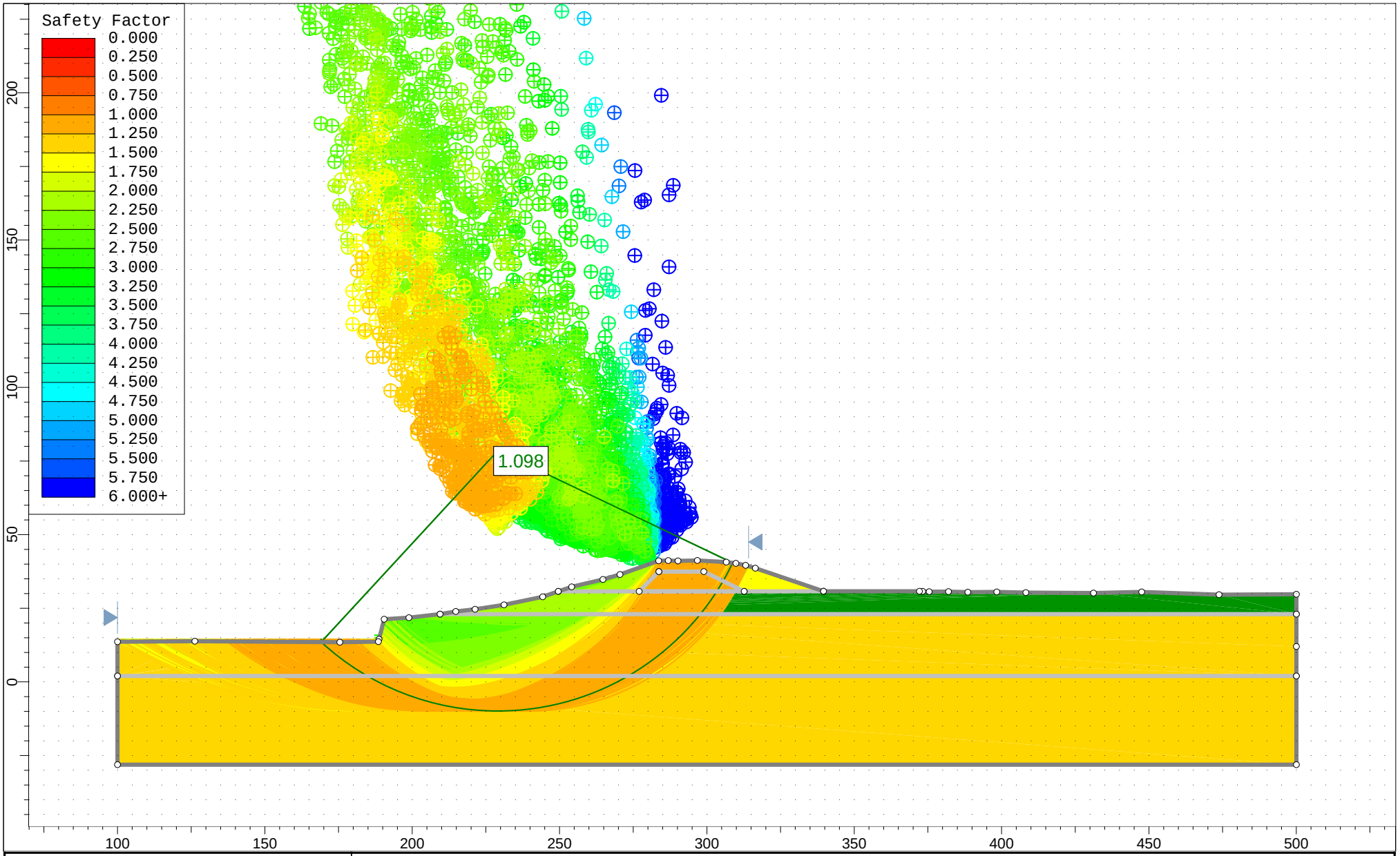
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 132L, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_13200_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 132L, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_13200_Post-EQ.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 132L, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_13200_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 132R

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineN_13200_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-Section 132R, Existing Conditions, Median Annual WSE, Landside Slope
Author: GDE
Company: CGI/FWI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1439
Number of Nodes: 794

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
329.53	35.5
319.69	38.02
313.12	40.5
309.85	41.04
300.01	40.67
296.74	39.53
290.17	36.45
283.63	34.2
270.49	30.45
267.22	29.81
263.95	29.58

244.27	28.96
211.48	29.65
185.26	29.59
119.68	29.5
100	29.58
100	23.992
100	15.0715
100	-40.923
500.02	-40.923
500.02	14.577
500.02	16.29
480.34	16.87
447.55	17.37
424.6	17.96
418.612	17.96
418.03	19.31
411.49	20.21
381.97	23.08
378.641	23.992
359.02	28.89
355.75	29.29
354.595	29.58
349.18	30.94
333.374	34.7999

Material Boundary

X	Y
263.95	29.58
283.791	29.58

Material Boundary

X	Y
300.05	37.5938
312.117	37.5938
320.15	29.58
283.791	29.58
300.05	37.5938

Material Boundary

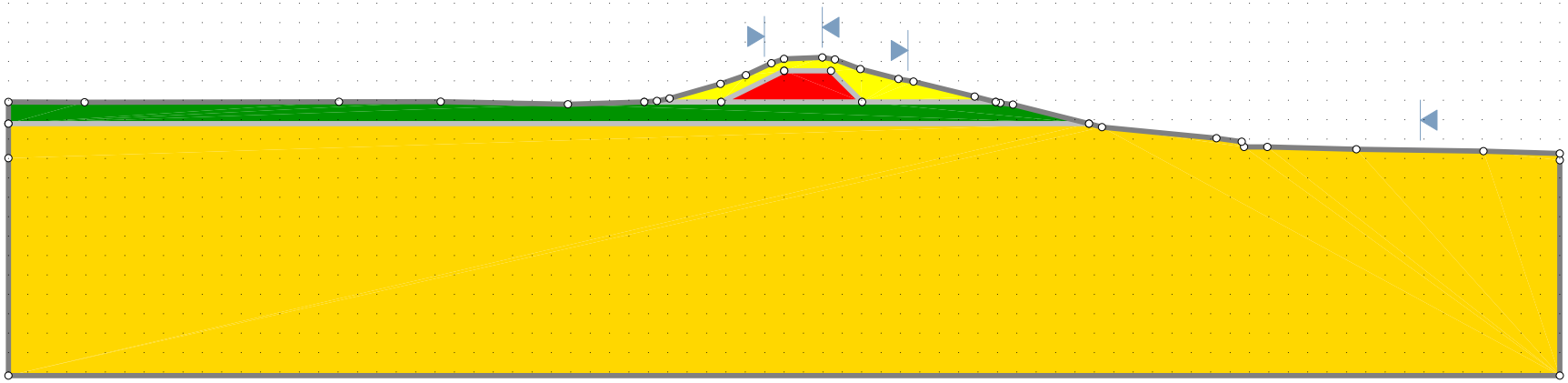
X	Y
320.15	29.58
354.595	29.58

Material Boundary

X	Y
100	23.992
378.641	23.992

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



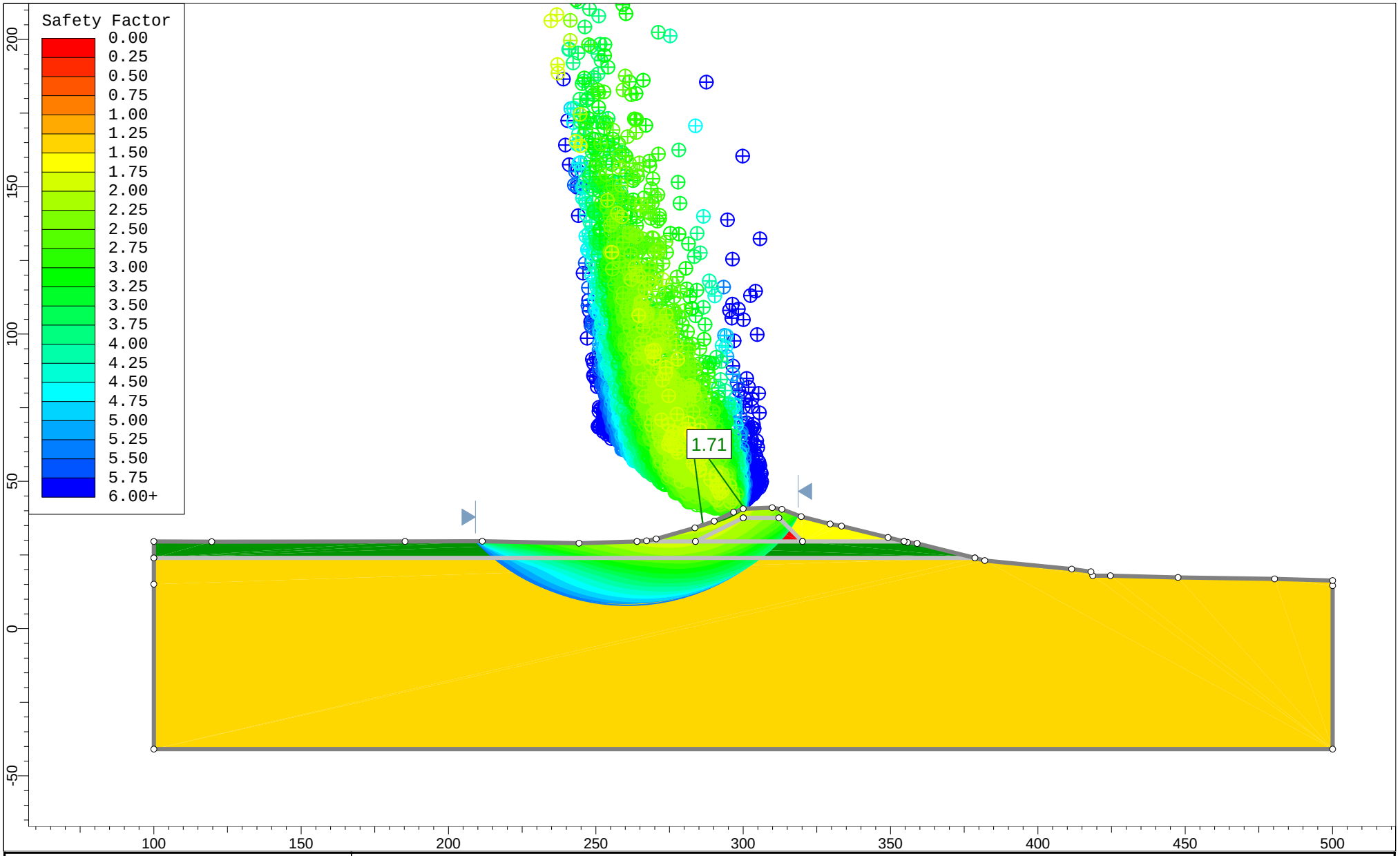
200
150
100
50
0
-50

100 150 200 250 300 350 400 450 500

rocscience

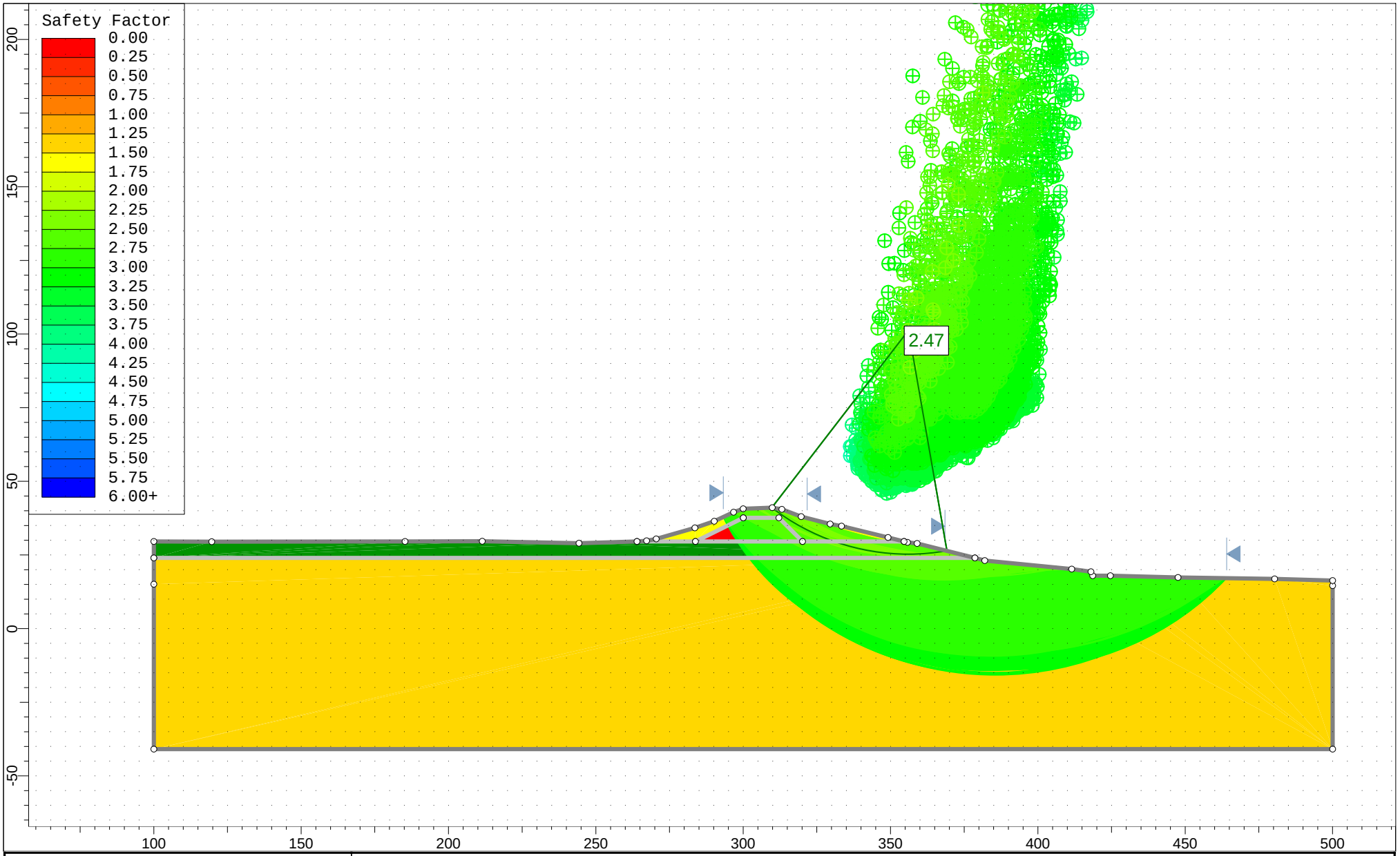
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-Section 132R, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company CGI/FWI
Date	December, 2010		File Name SlopeW_lineN_13200_Existing.slim



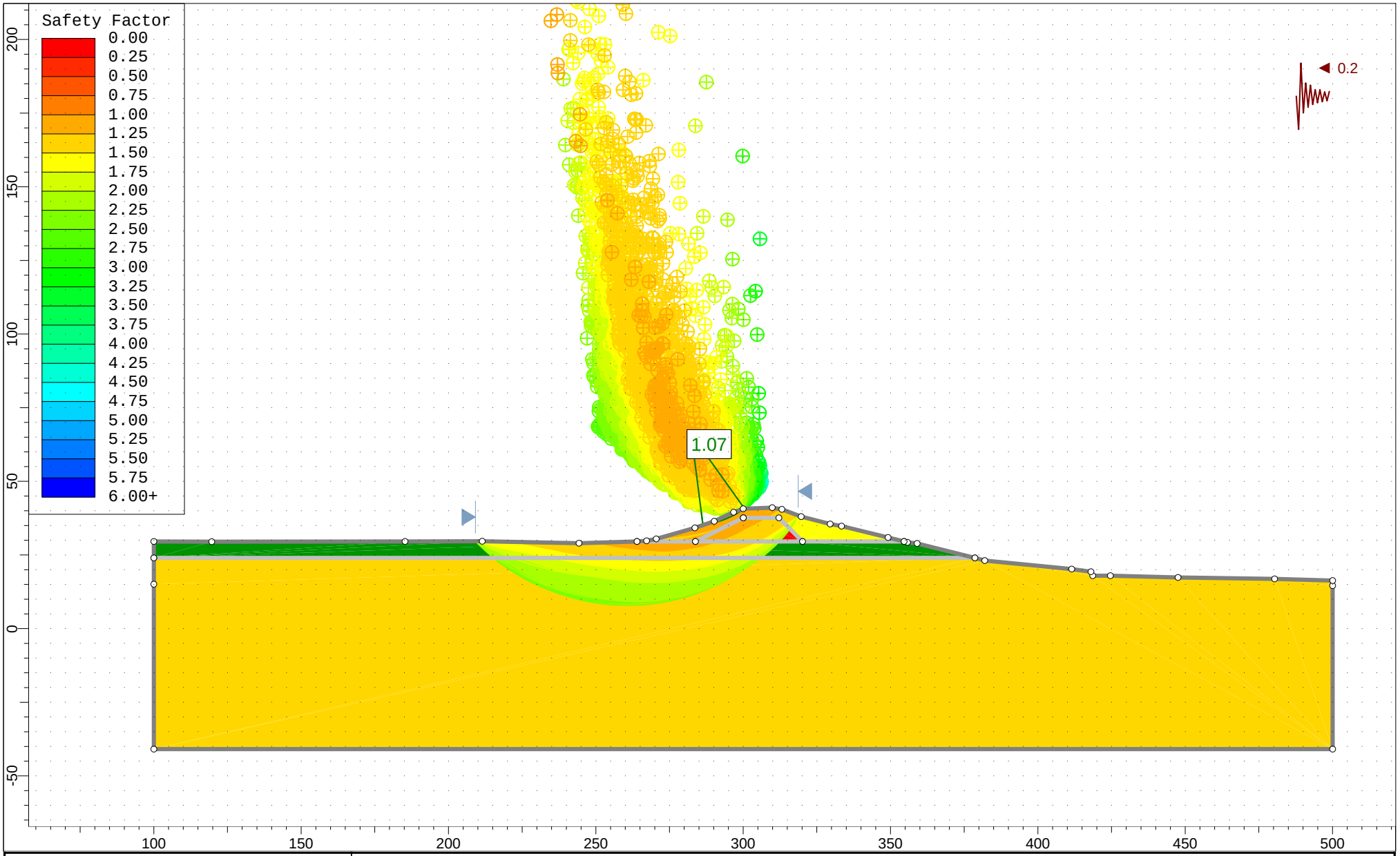
rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-Section 132R, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* CGI/FWI
	Date	December, 2010		*File Name* SlopeW_lineN_13200_Existing.slim

SLIDEINTERPRET 6.005



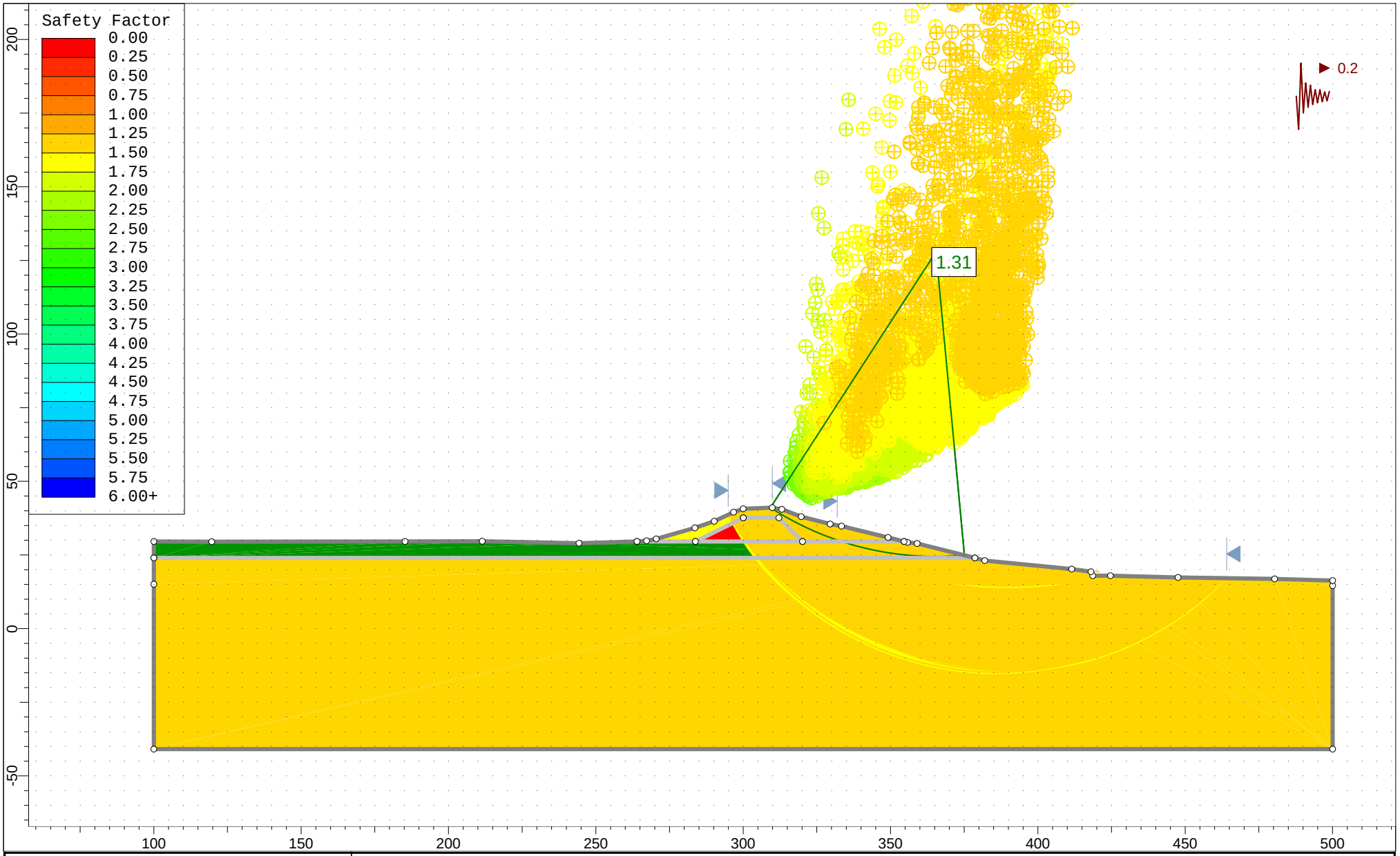
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-Section 132R, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December, 2010		File Name SlopeW_lineN_13200_Existing.slim

SLIDEINTERPRET 6.005



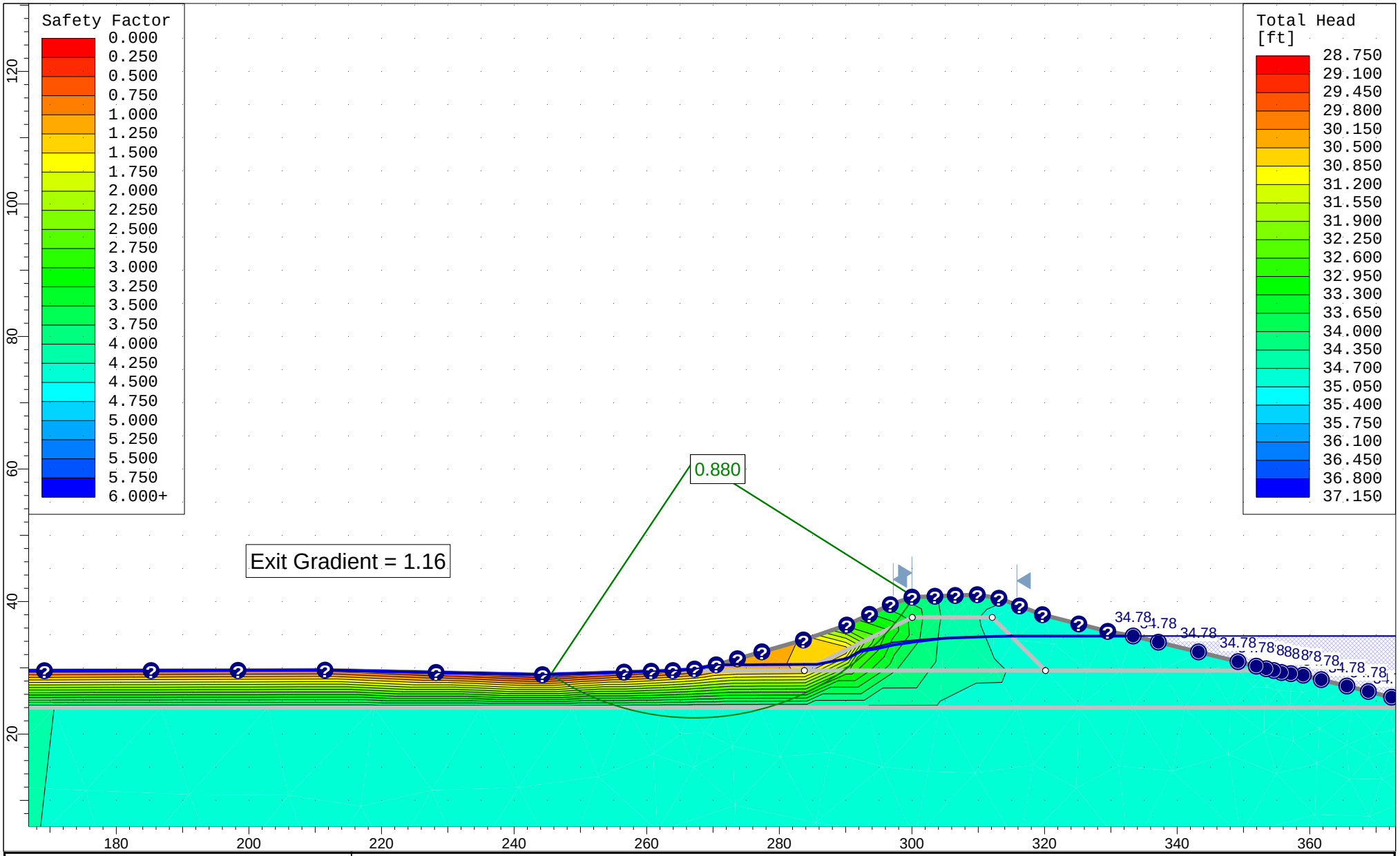
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-Section 132R, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December, 2010		File Name SlopeW_lineN_13200_Existing.slim

SLIDEINTERPRET 6.005



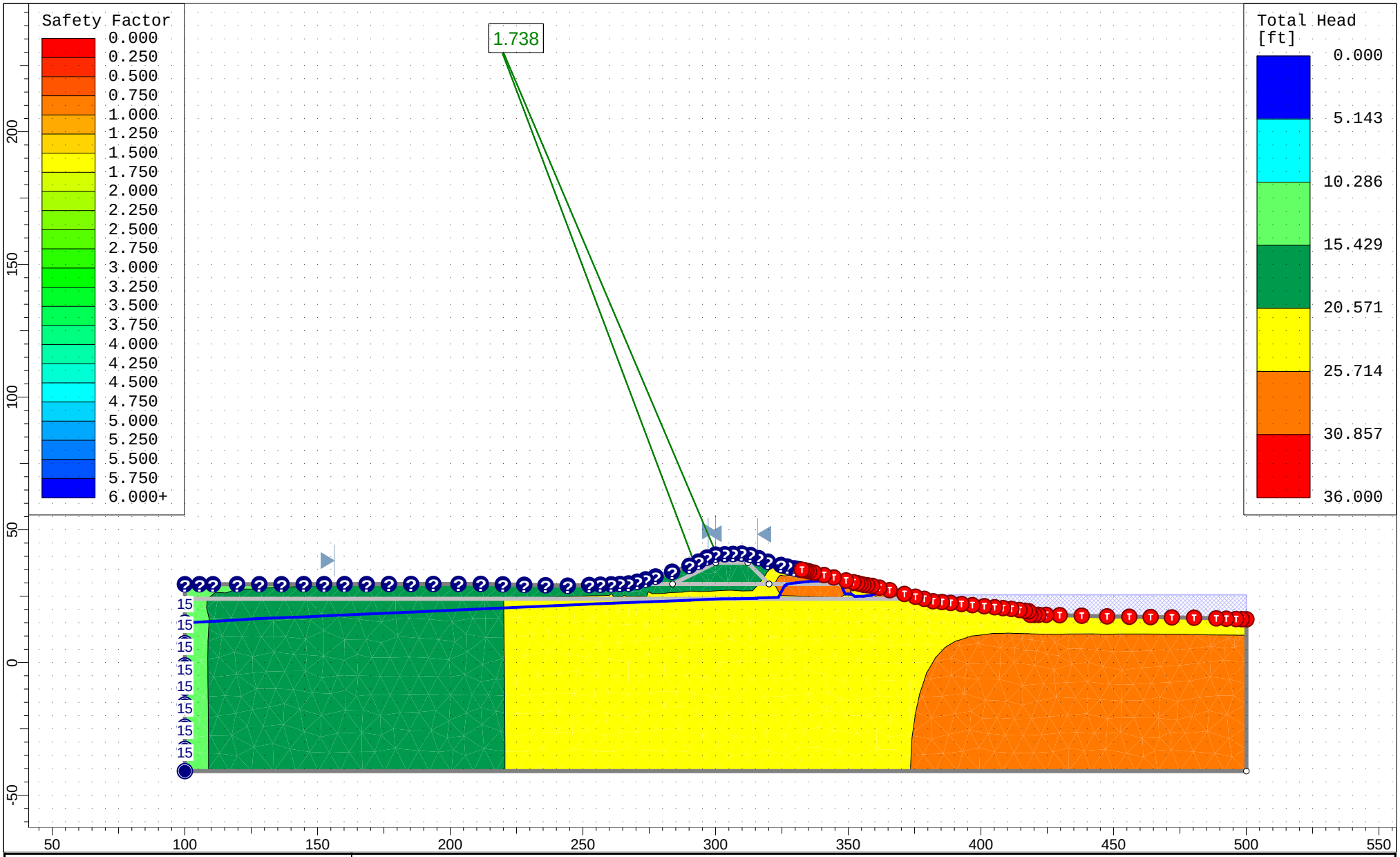
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-Section 132R, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company CGI/FWI
Date	December, 2010		File Name SlopeW_lineN_13200_Existing.slim

SLIDEINTERPRET 6.005



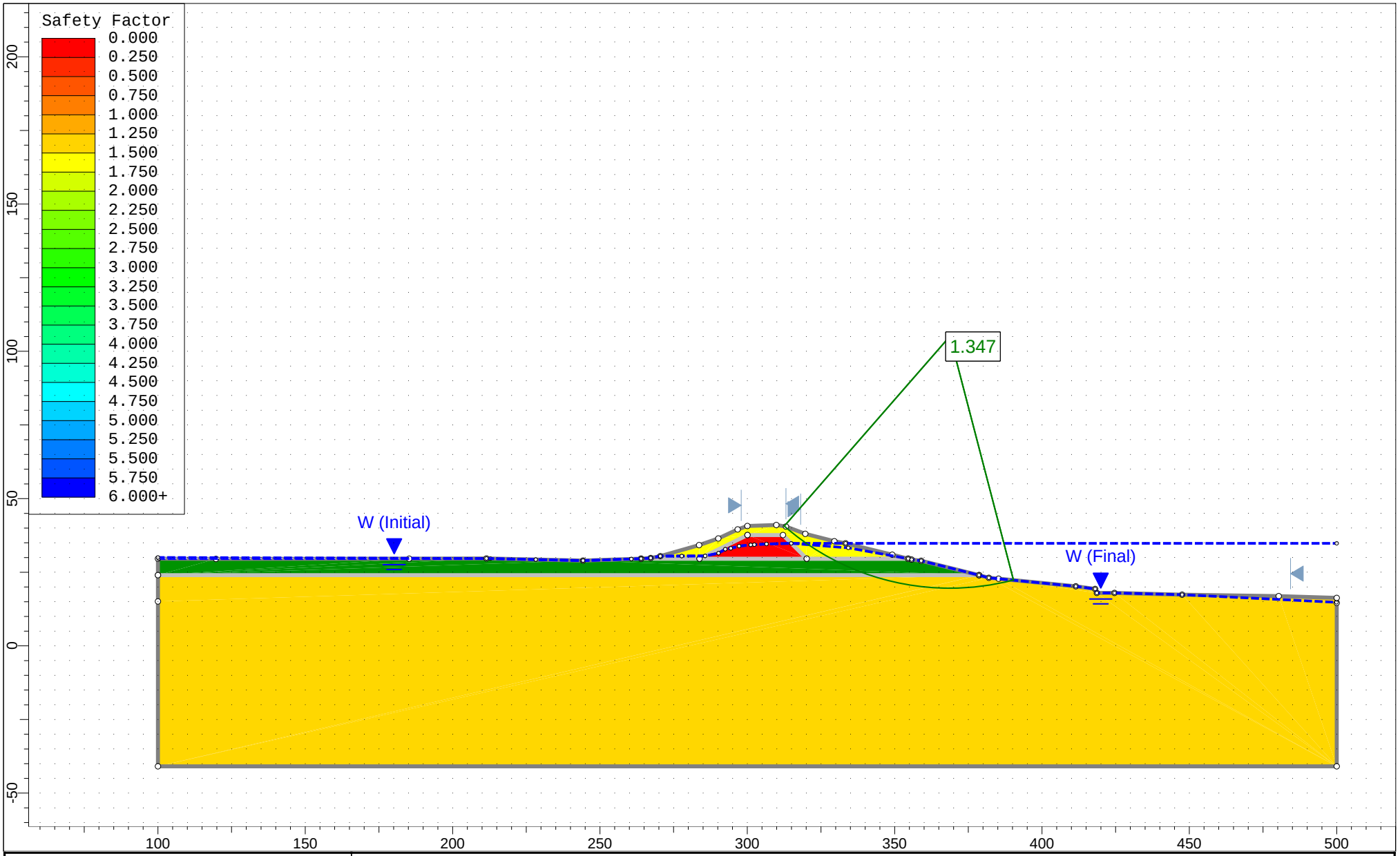
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-Section 132R, Flood Stage Conditions, 100-yr WSE, Landside Slope		
Drawn By: GDE	Scale: 1:240	Company: CGI/FWI	
Date: December, 2010		File Name: SlopeW_lineN_13200_Flood.slim	

SLIDEINTERPRET 6.005



Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-Section 132R, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
Drawn By	GDE	Scale 1:600	Company CGI/FWI
Date	May, 2011		File Name SlopeW_lineN_13200_12 hour.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-Section 132R, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company CGI/FWI
	Date	December, 2010		File Name SlopeW_lineN_13200_Rapid Drawdown.slim

SLIDEINTERPRET 6.005

SECTION 146L

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineS_14600_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 146L, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: hours
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None

Transient Boundary Conditions

Flood Hydrograph

Time [h]	Total Head [ft]
0	16.48
6	25
12	36.7
24	36.7
30	25
36	16.48

Seepage Face Condition: Yes

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
322.96	36.36
313.12	39.62
309.85	40.24
306.58	40.65
296.74	40.94
293.44	40.6
281.124	36.7201
267.22	32.7
265.593	32.357
265.435	32.3236
247.54	28.55
241	27.76
215.279	25.418
207.18	25.022
205.072	17.9998
204.94	17.56
201.64	17.4
191.83	17.59
159.04	17.78
142.63	18.31
126.25	18.81
100	19.05
100	16.4946
100	-40
500.02	-40
500.004	14.0672
500	18
500.02	31.45
486.91	31.83
473.77	31.9
457.39	32.44
408.22	32.52
401.65	32.17
391.81	33.45
381.97	33.65
365.59	33.03
362.32	32.34
359.02	32.44
357.223	32.324
352.48	32.324
347.775	32.324
334.319	32.324
331.981	32.324
331.907	32.357
328.979	33.6541

Material Boundary

X	Y
265.435	32.3236
299.048	32.3236
318.891	32.3236
331.981	32.324

Material Boundary

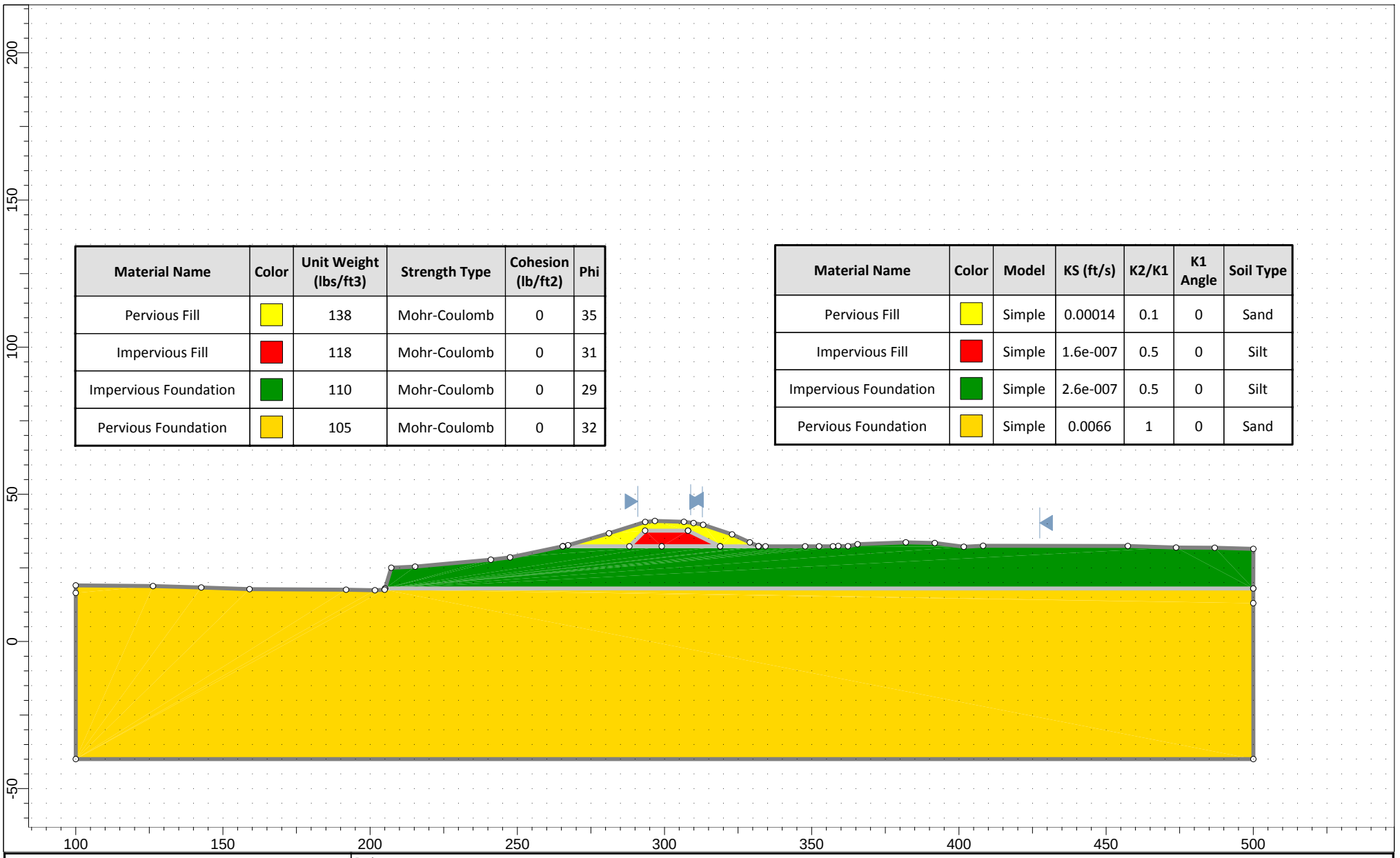
X	Y
307.999	37.632
293.389	37.632
288.087	32.33
299.048	32.3236
318.915	32.312
318.891	32.3236
307.999	37.632

Material Boundary

X	Y
205.072	17.9998
500	18

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

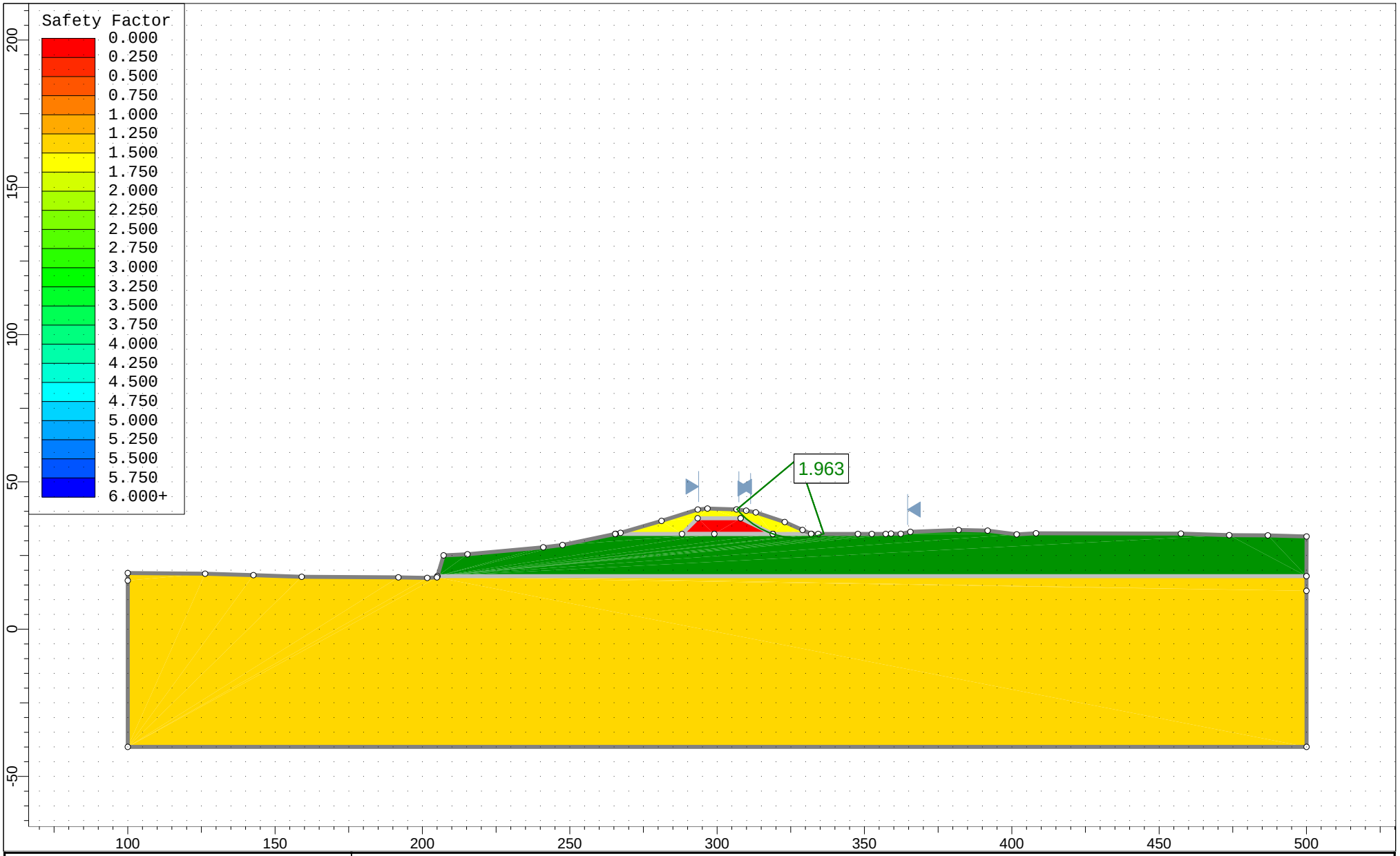
Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



rocscience

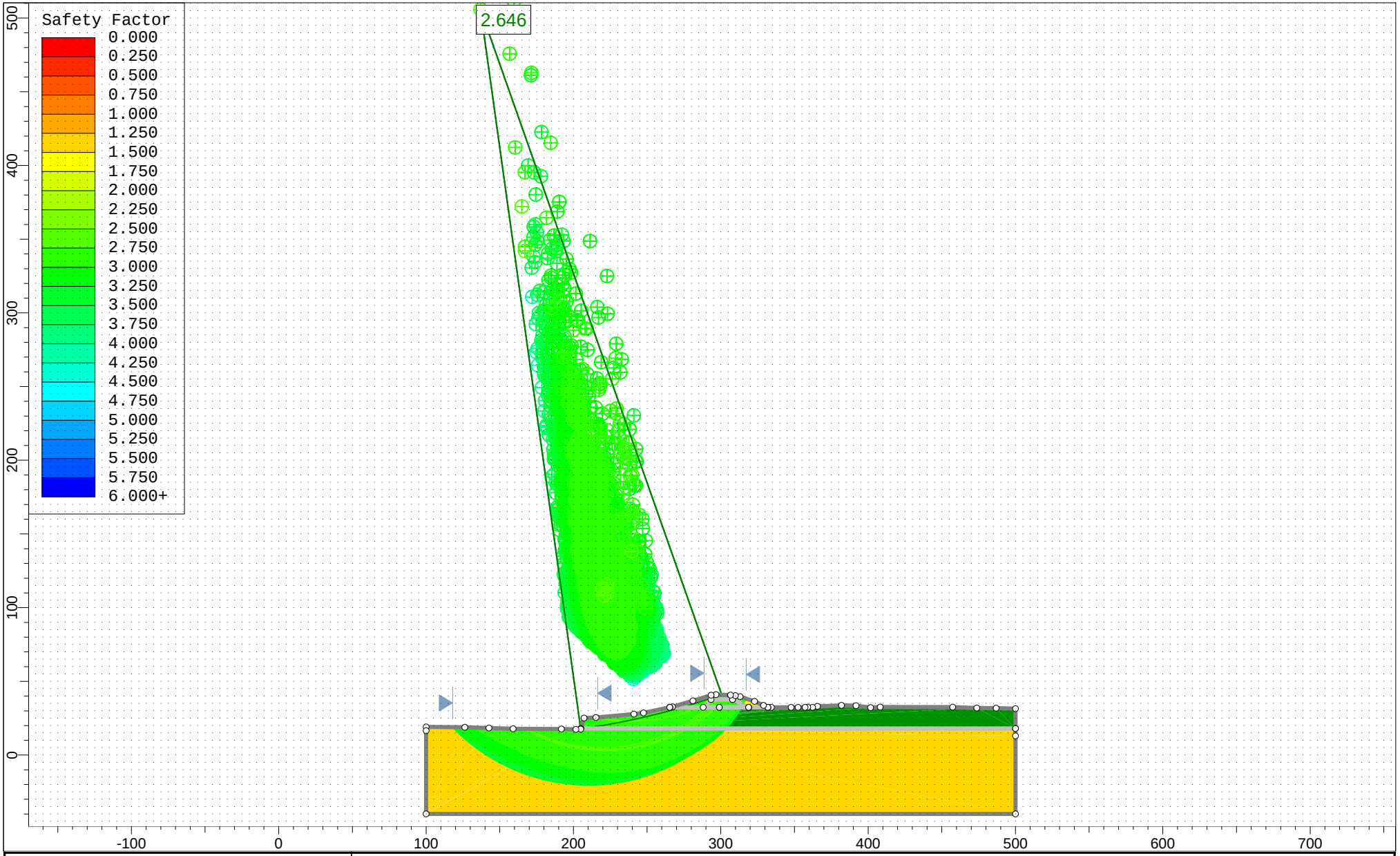
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146L, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_14600_Existing.slim



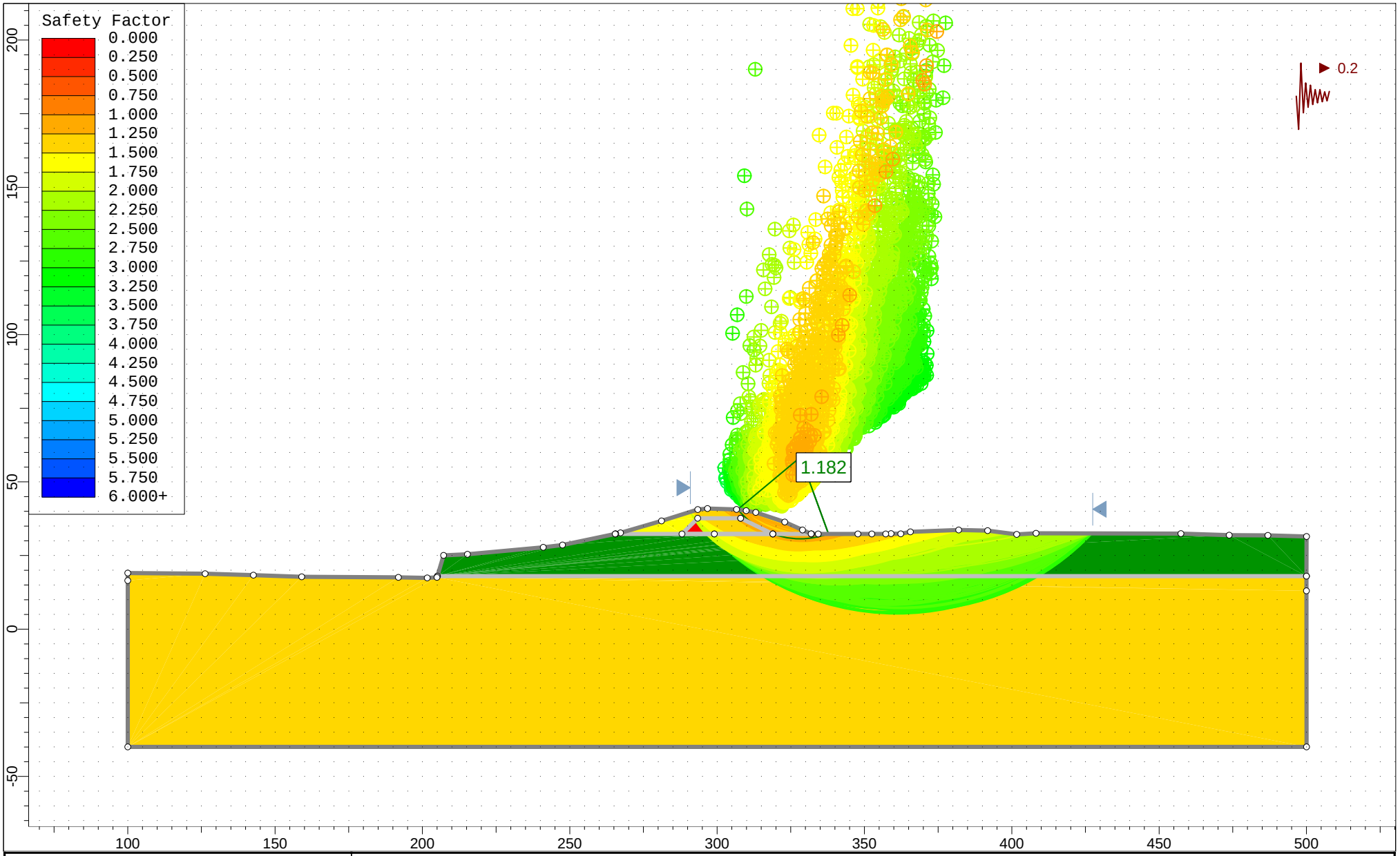
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_14600_Existing.slim

SLIDEINTERPRET 6.005



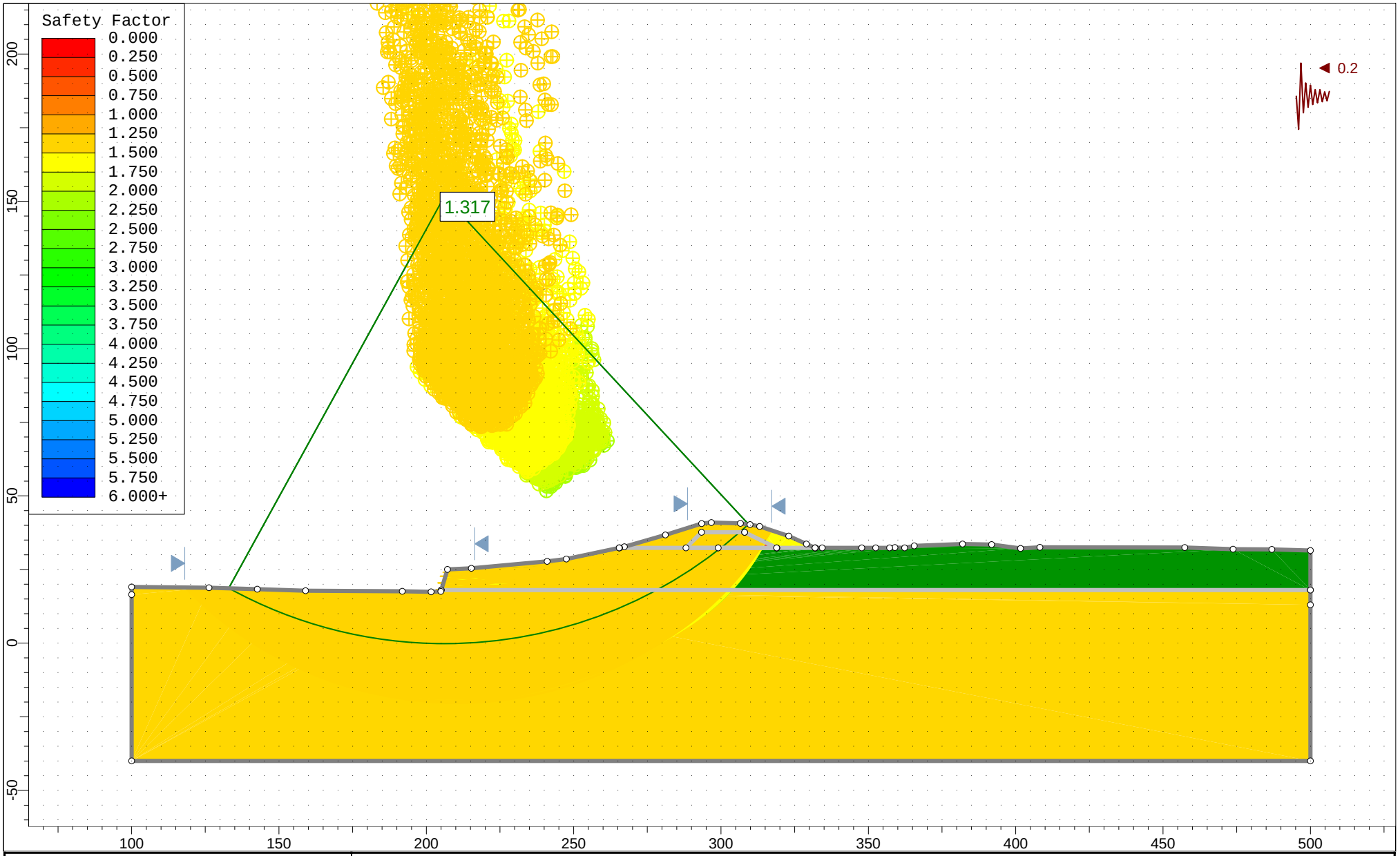
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146L, Existing Conditions, Median Annual WSE, Waterside Slope		
Drawn By: GDE	Scale: 1:1080	Company: FWI/CGI	
Date: December, 2010		File Name: SlopeW_lineS_14600_Existing.slim	

SLIDEINTERPRET 6.005



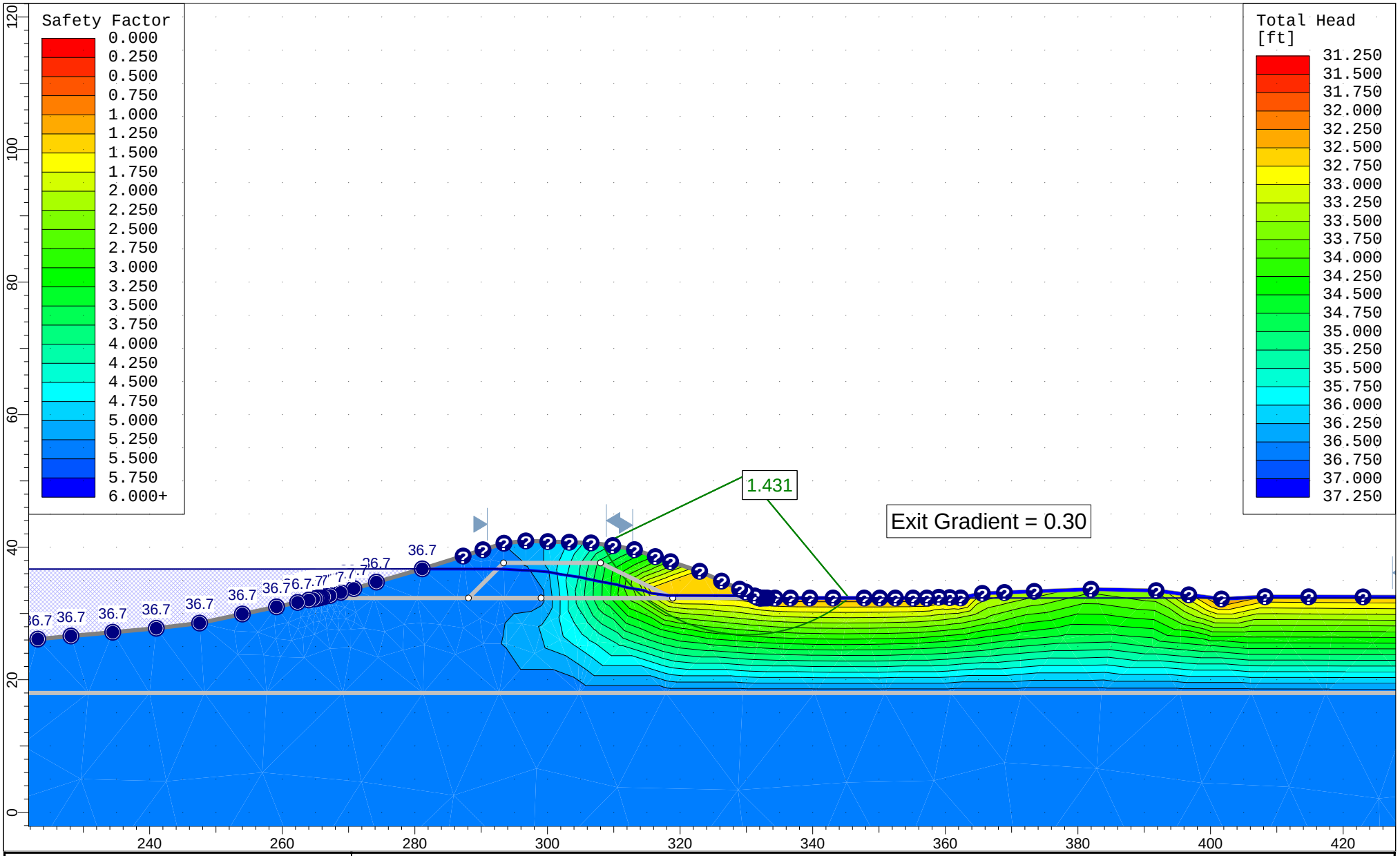
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_14600_Existing.slim

SLIDEINTERPRET 6.005



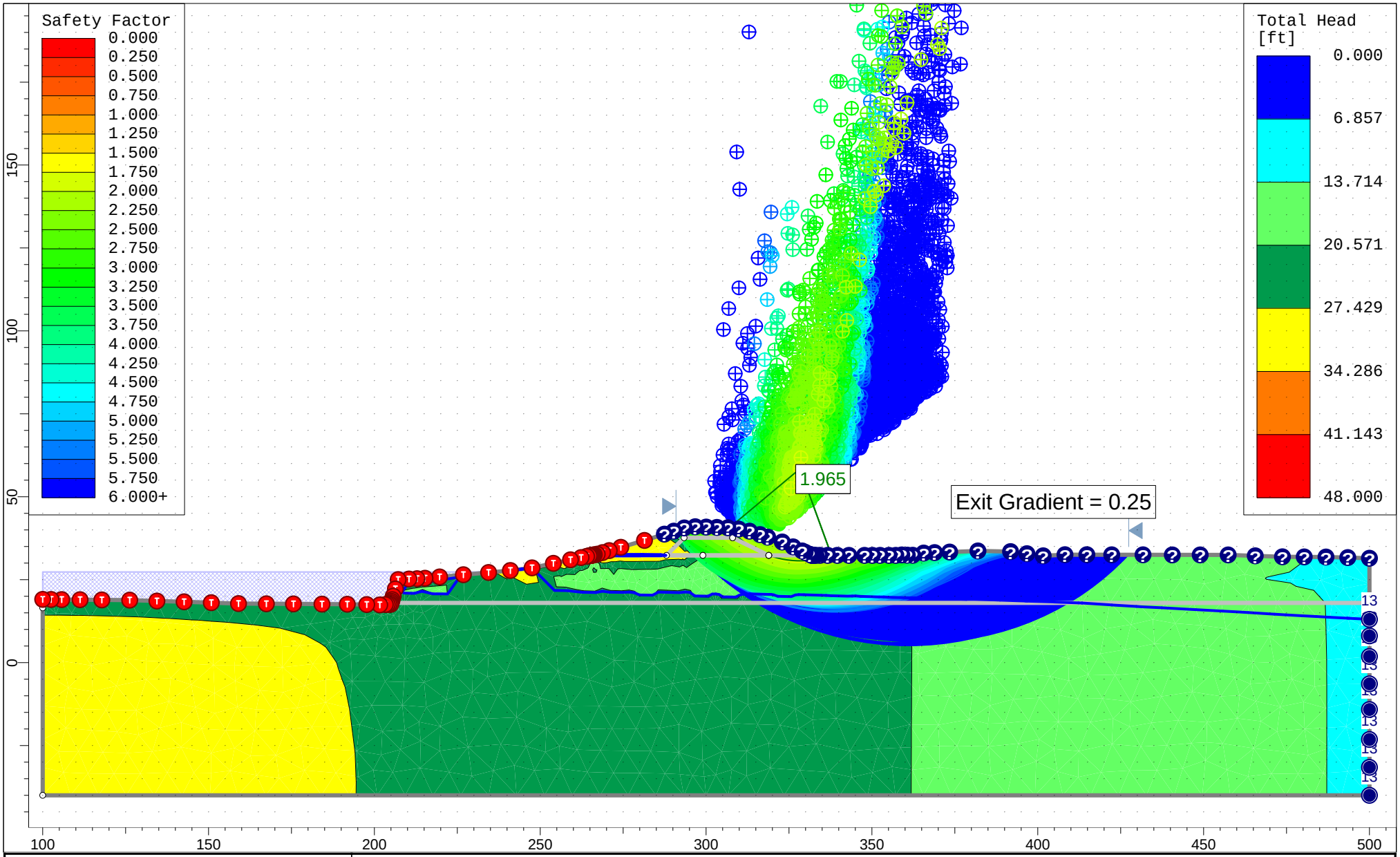
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_14600_Existing.slim

SLIDEINTERPRET 6.005



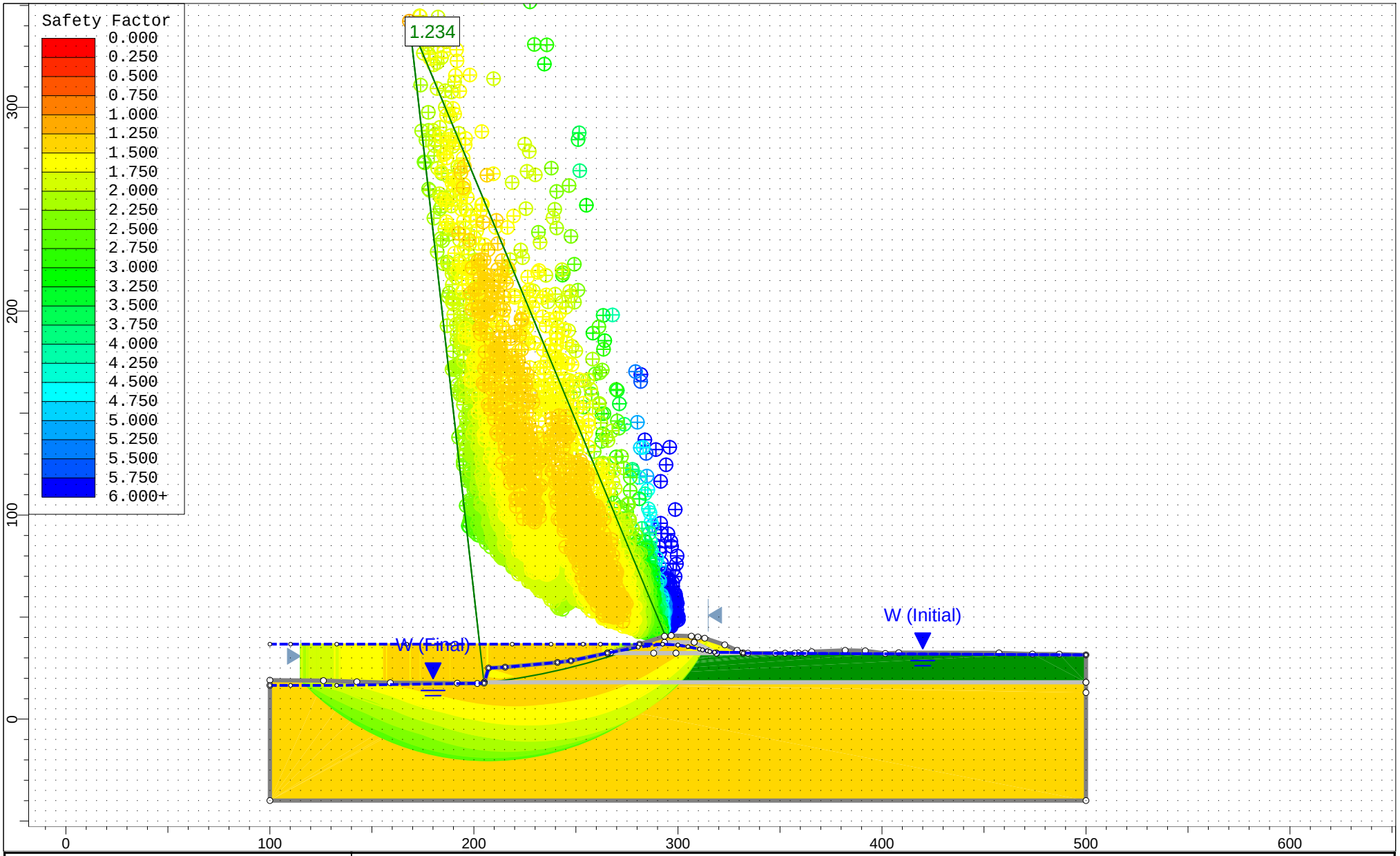
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146L, Flood Stage Conditions, 100-yr WSE, Landside Slope		
Drawn By: GDE	Scale: 1:240	Company: FWI/CGI	
Date: December, 2010		File Name: SlopeW_lineS_14600_Flood.slim	

SLIDEINTERPRET 6.005



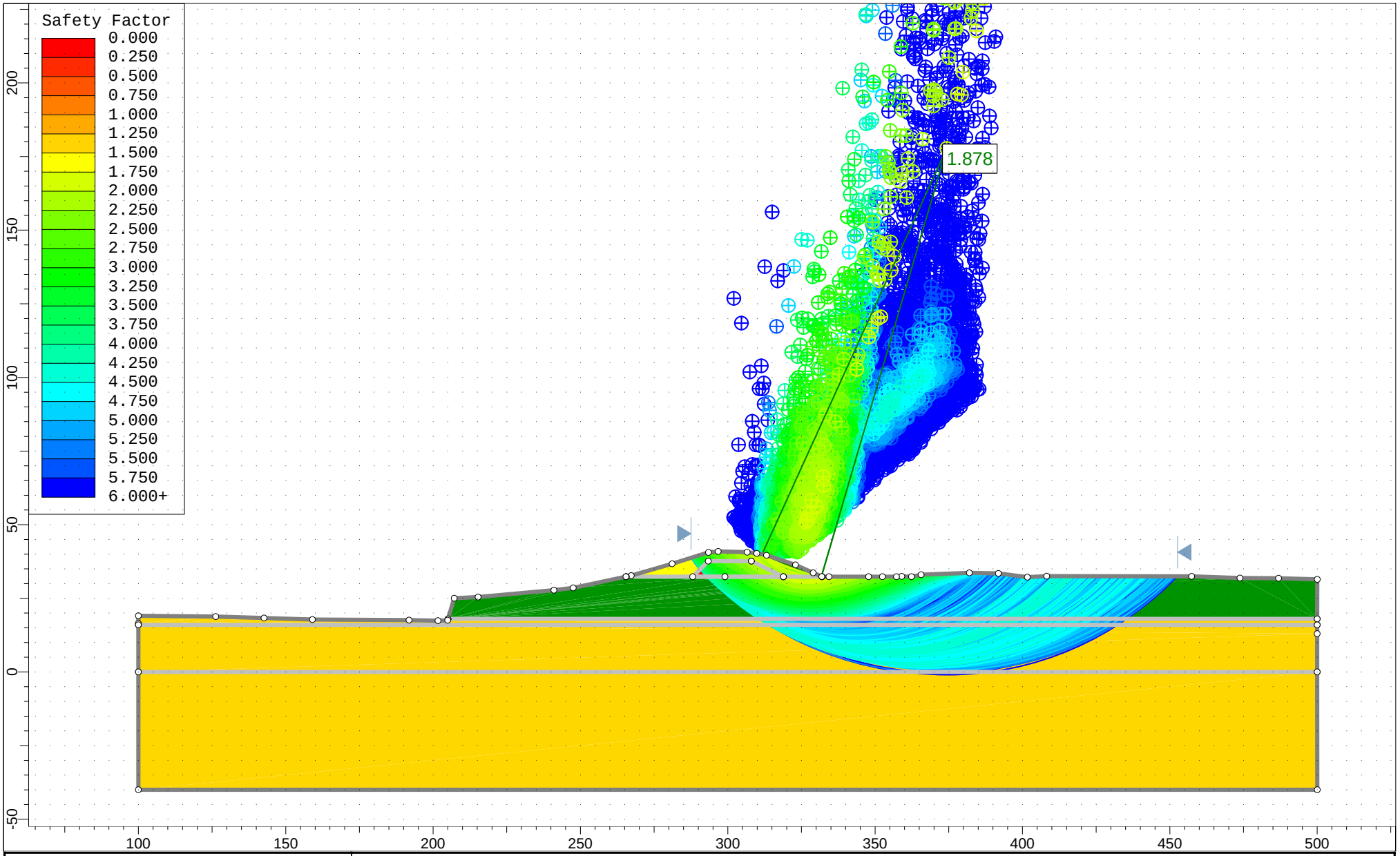
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 146L, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:480	Company: FWI/CGI
	Date: May, 2011		File Name: SlopeW_lineS_14600_12 hour.slim

SLIDEINTERPRET 6.005



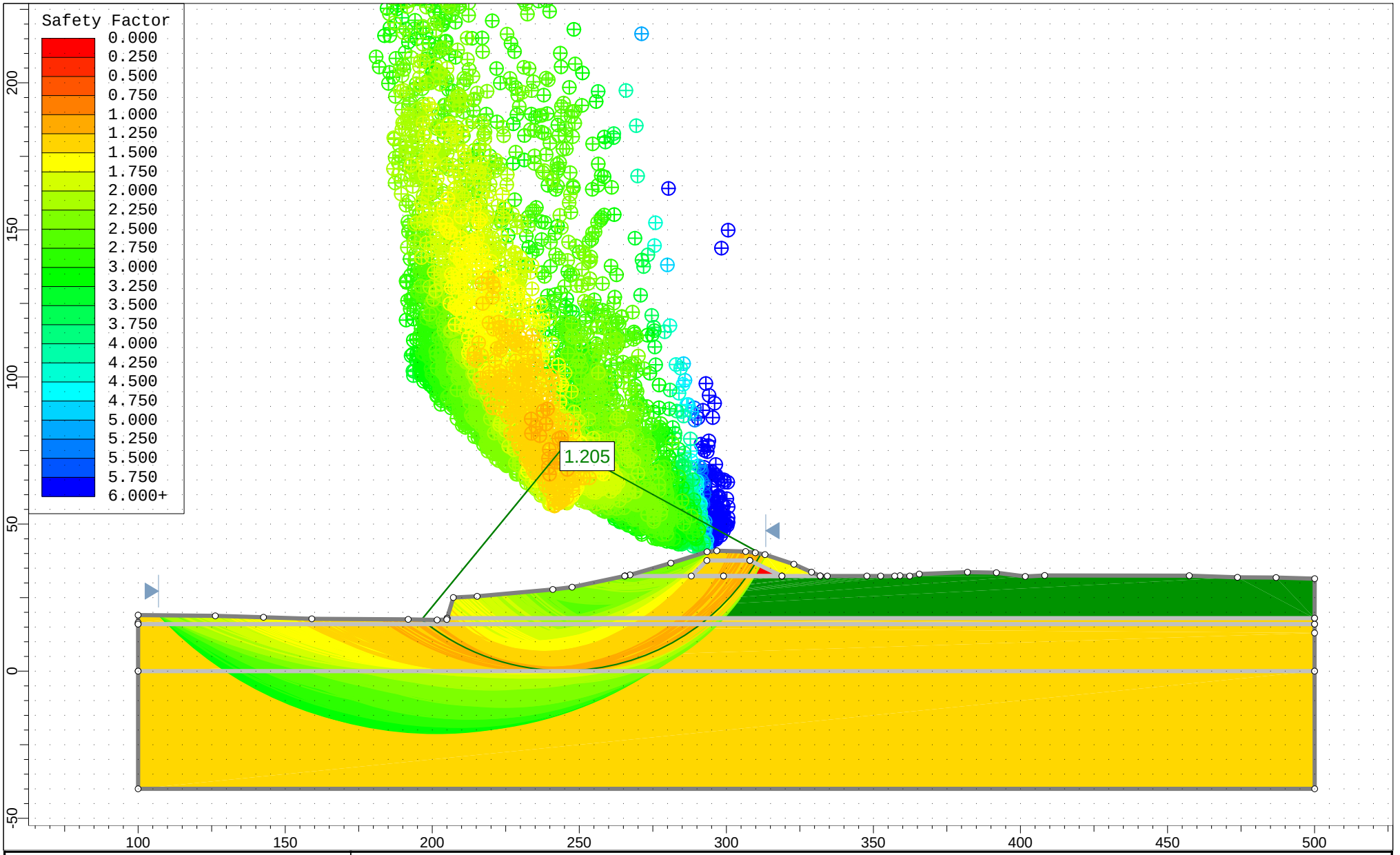
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:780	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_14600_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
	Date	December, 2010		*File Name* SlopeW_lineS_14600_Post-EQ.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146L, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_14600_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 146R

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineN_14600_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 146R, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1410
Number of Nodes: 785

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
309.85	41.34
306.58	41.44
300.01	40.97
293.44	40.88
290.17	40.38
283.63	36.96
271.782	32.01
271.759	32
270.49	31.47
267.22	31.19
263.95	31.66

260.68	32.44
247.54	33.03
234.43	33.39
204.94	33.49
198.37	33.61
175.42	32.99
165.58	33.11
159.04	32.74
149.2	32.89
142.63	32.55
136.09	32.49
129.52	32.64
119.68	32.22
113.14	32.11
100	32.33
100	20
100	14.0903
100	-30
500.02	-30
500.02	16.22
493.45	16.22
477.07	16.62
454.12	15.98
431.17	15.79
414.76	15.45
406.862	16.5012
398.38	17.63
388.54	19.57
382.376	20
378.638	20.2608
370.891	20.2608
370.091	23.297
365.622	24.033
360.298	24.7
355.522	26.9501
342.64	30.62
337.99	32
332.8	33.54
326.23	35.16
321.93	36.7822

Material Boundary

X	Y
100	20
382.376	20

Material Boundary

X	Y
271.759	32
281.486	32

Material Boundary

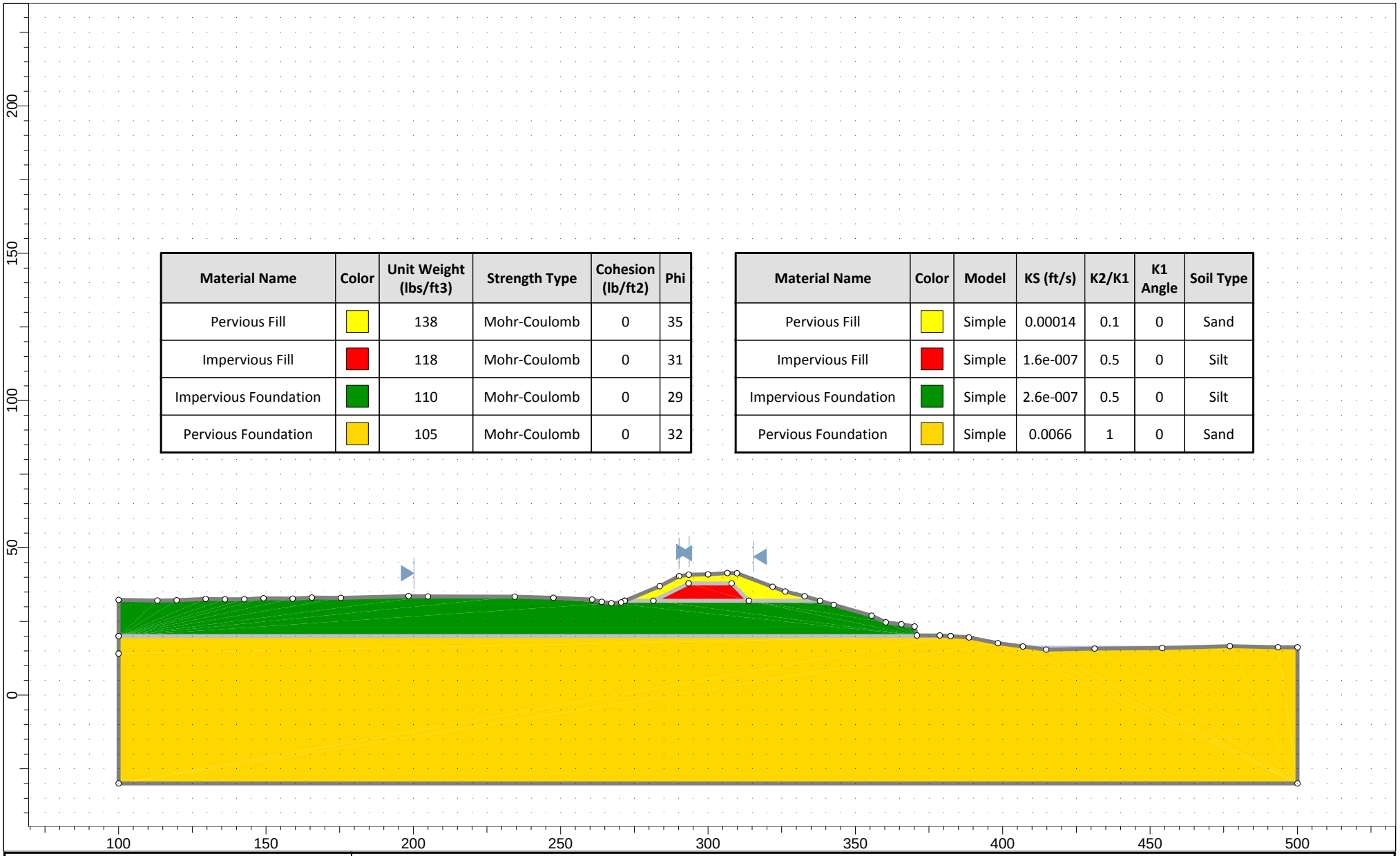
X	Y
293.424	37.907
308.034	37.907
313.838	32
281.486	32
293.424	37.907

Material Boundary

X	Y
313.838	32
337.99	32

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

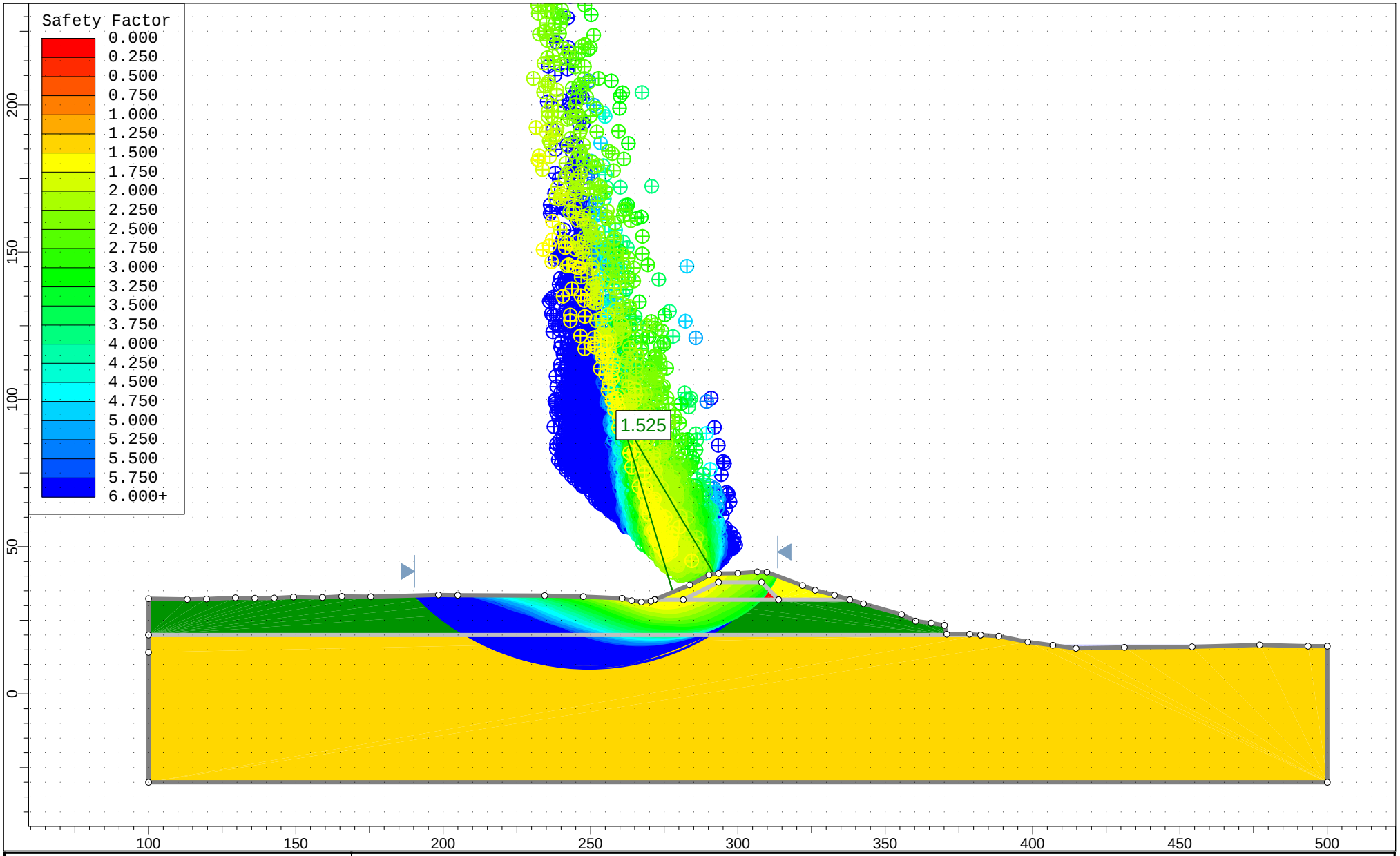
Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



rocscience

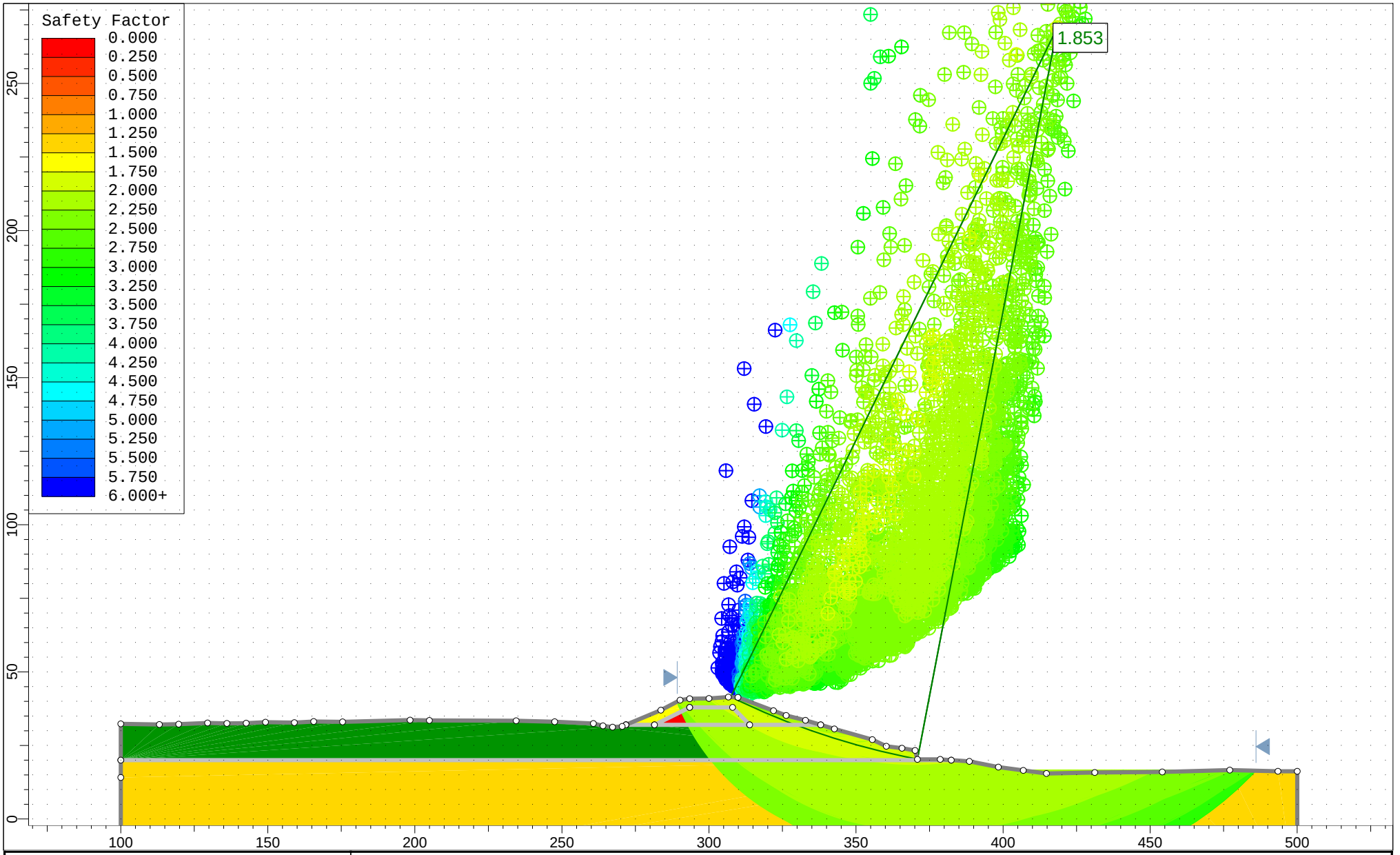
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_14600_Existing.slim



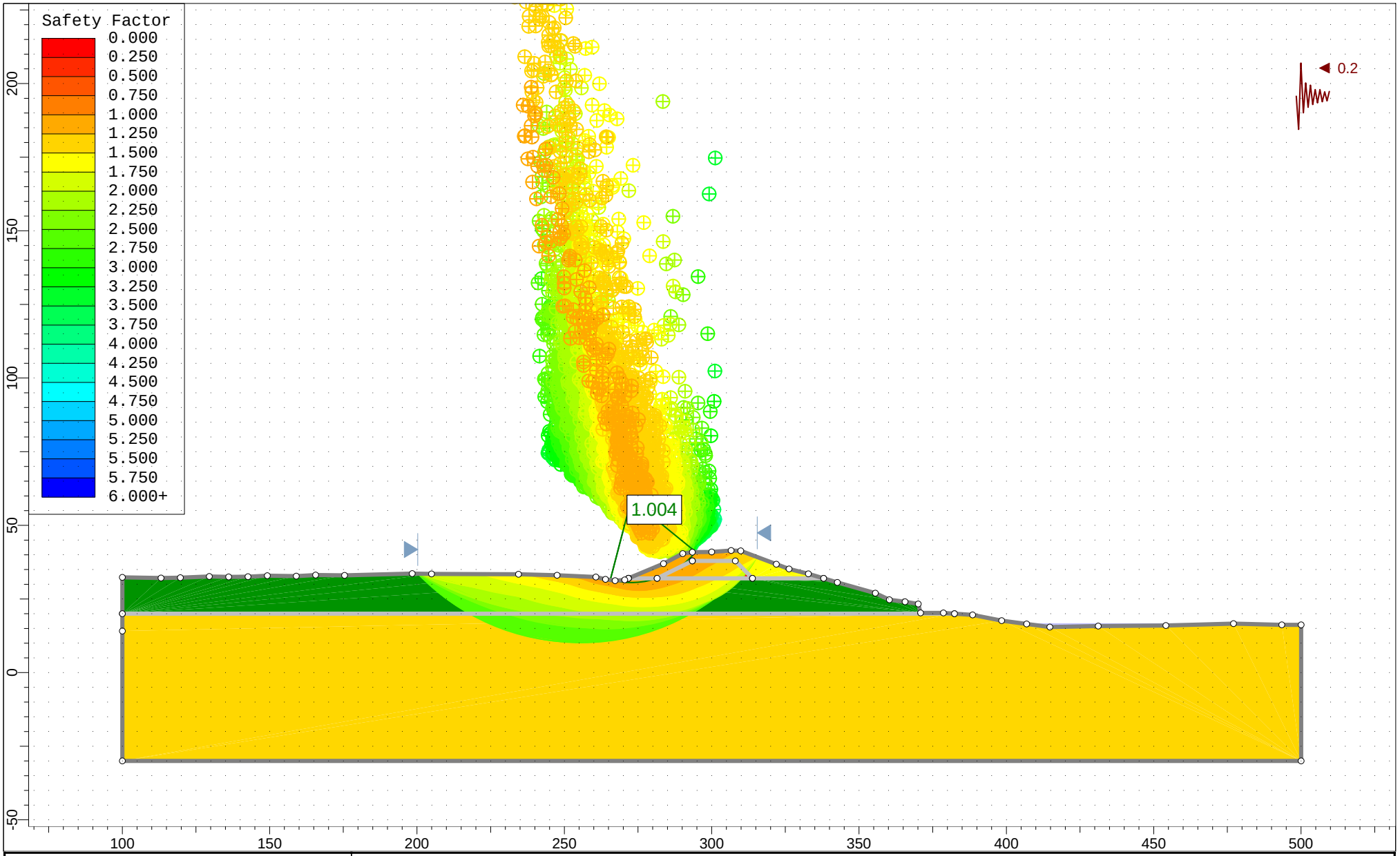
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Existing Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_14600_Existing.slim

SLIDEINTERPRET 6.005



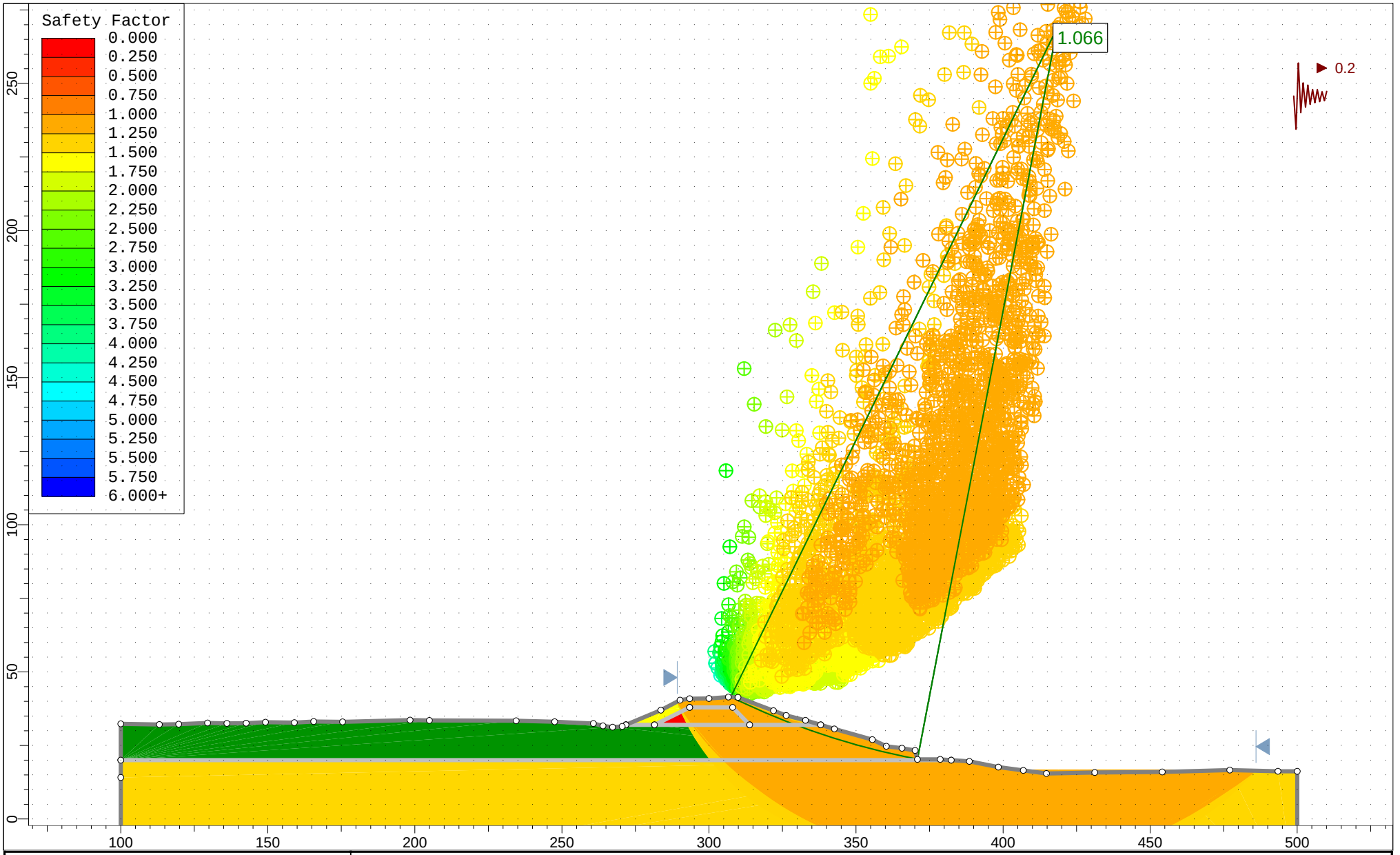
SLIDEINTERPRET 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Existing Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
Date	December, 2010		*File Name* SlopeW_lineN_14600_Existing.slim



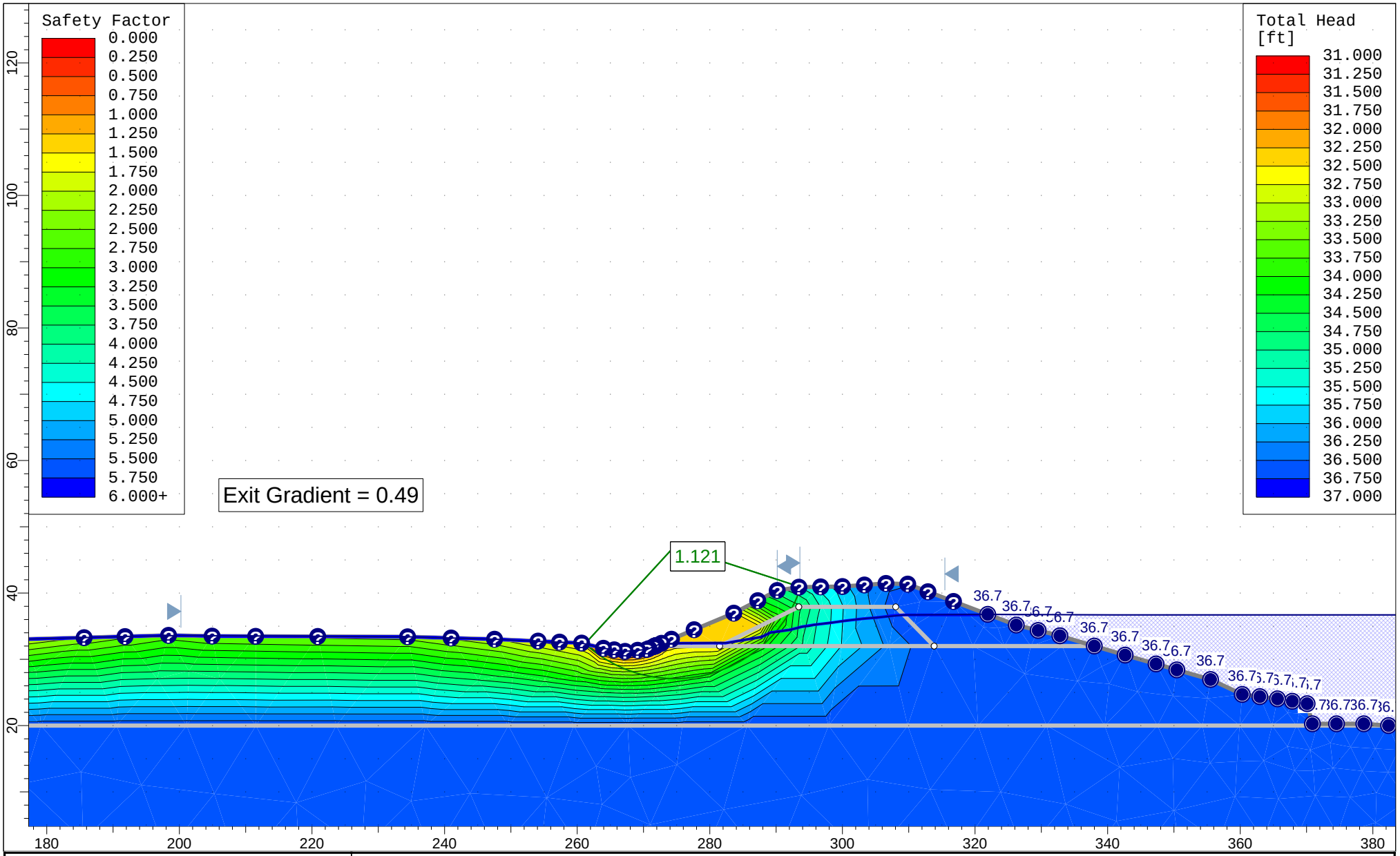
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
Date	December, 2010		*File Name* SlopeW_lineN_14600_Existing.slim

SLIDEINTERPRET 6.005



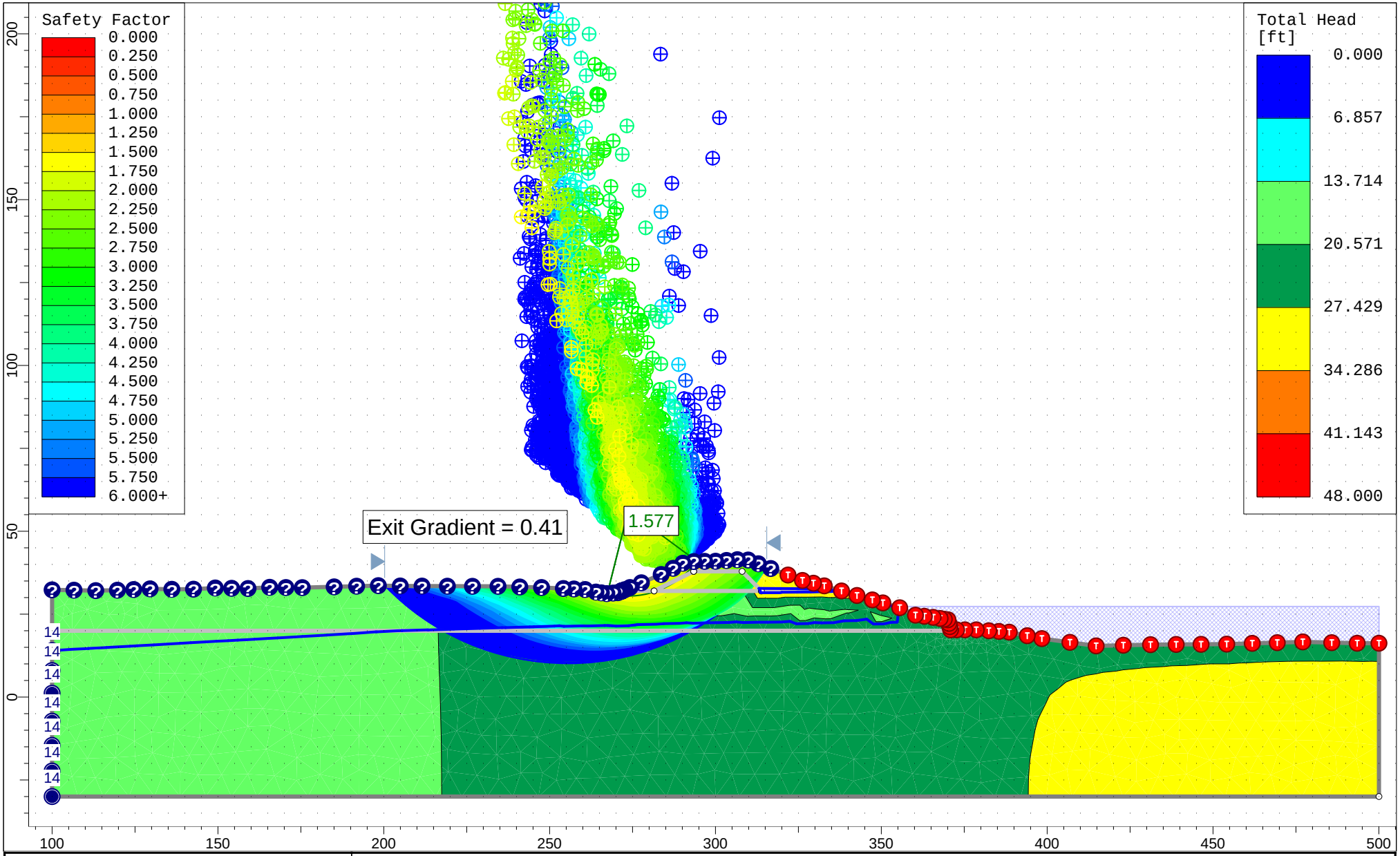
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_14600_Existing.slim

SLIDEINTERPRET 6.005



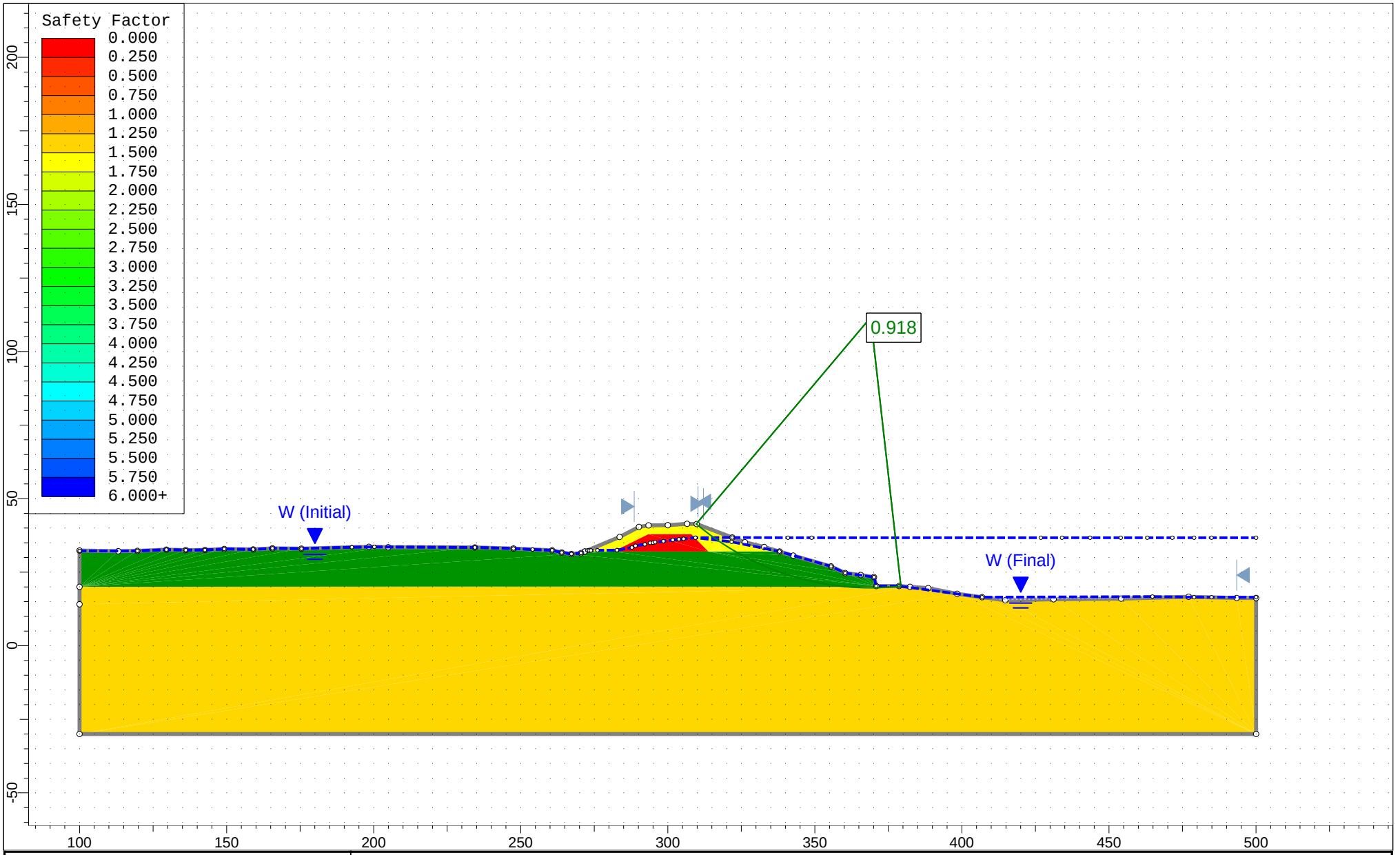
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 146R, Flood Stage Conditions, 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:240	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineN_14600_Flood.slim

SLIDEINTERPRET 6.005



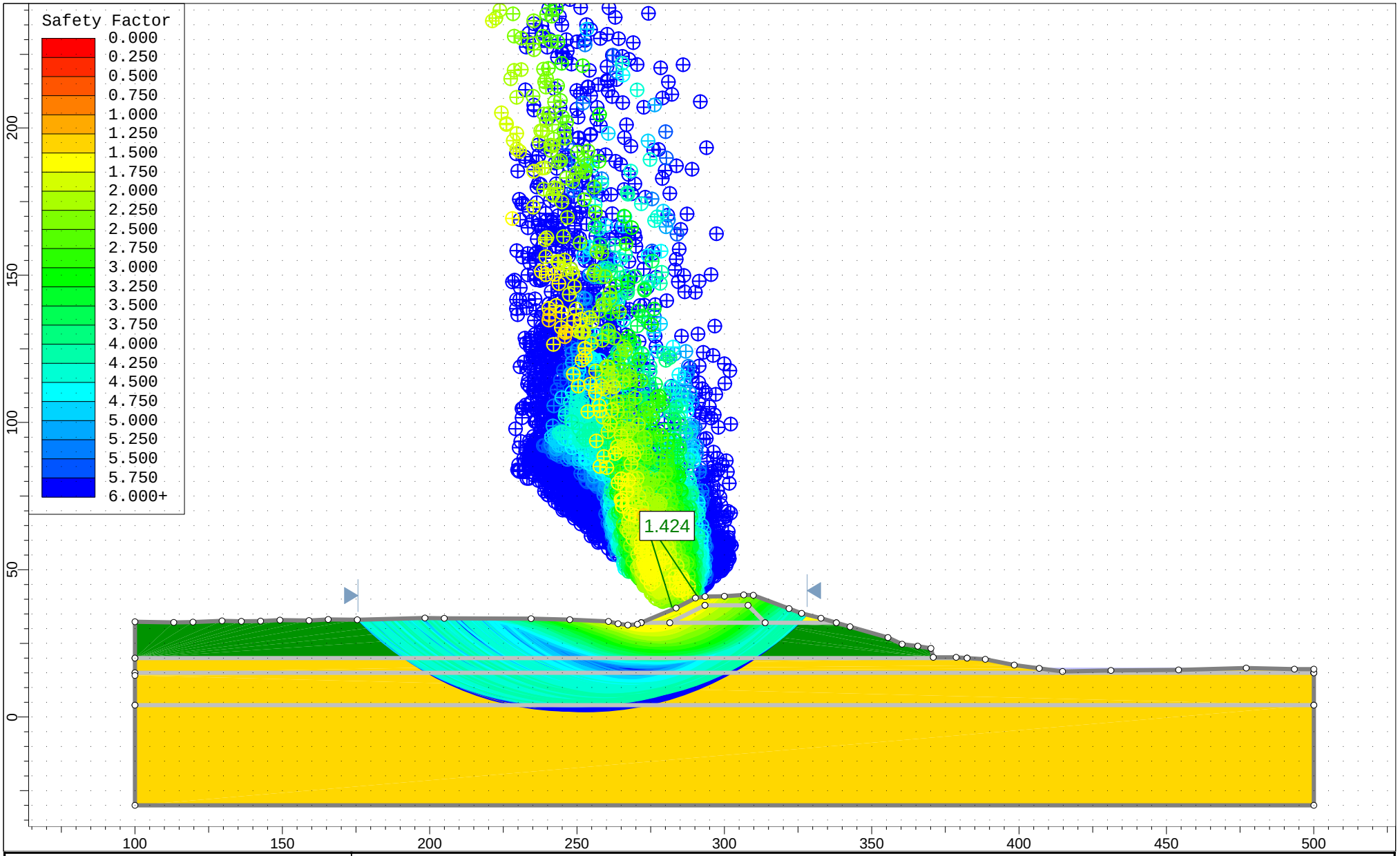
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146R, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By	GDE	Scale 1:480	Company FWI/CGI
	Date	May, 2011		File Name SlopeW_lineN_14600_12 hour.slim

SLIDEINTERPRET 6.005



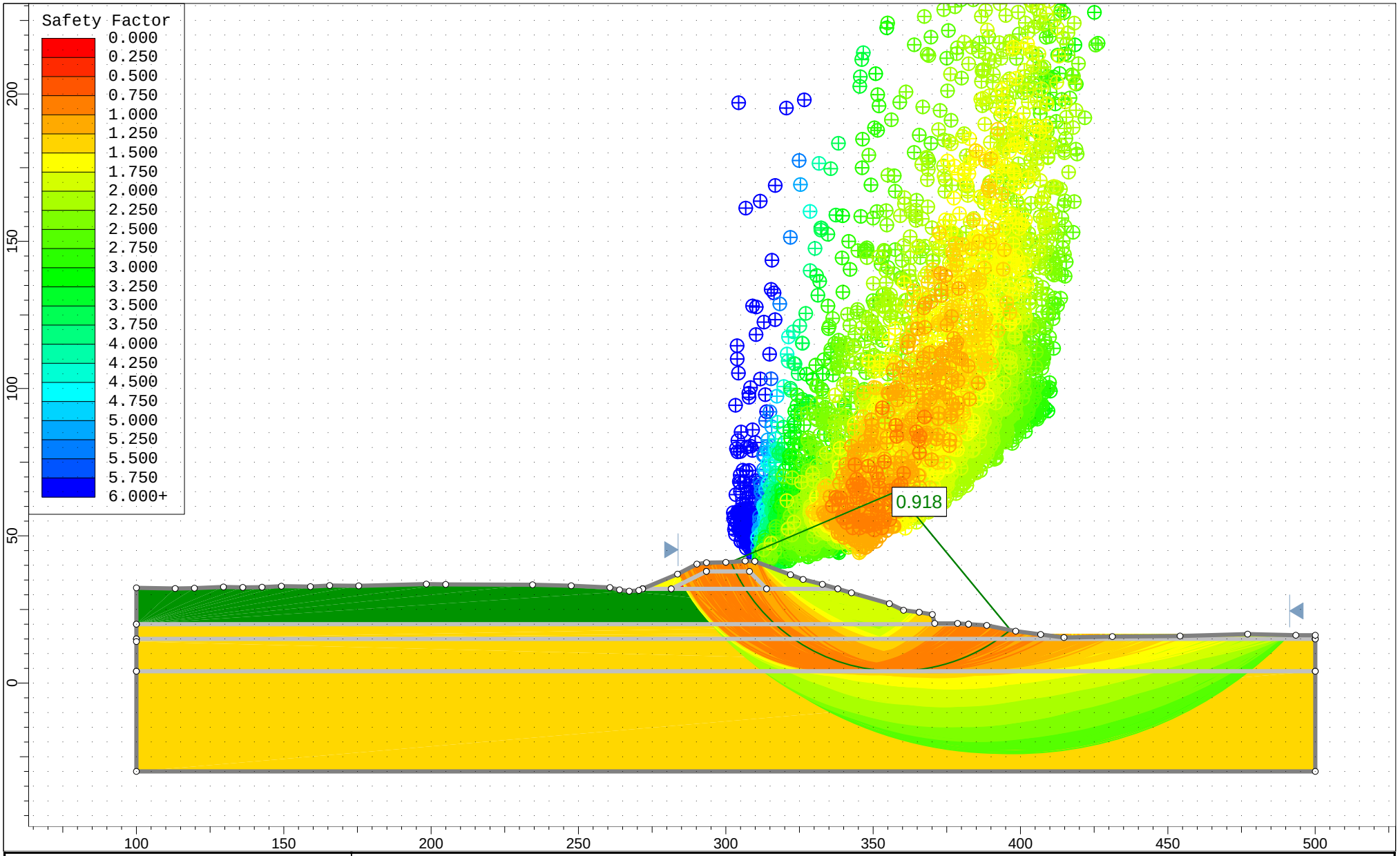
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 146R, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineN_14600_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_14600_Post_EQ.slim

SLIDEINTERPRET 6.005



Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 146R, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_14600_Post_EQ.slim

SLIDEINTERPRET 6.005

SECTION 158L

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineS_15800
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 158L, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1192
Number of Nodes: 672

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
319.69	40.92
313.12	42.07
309.85	42.43
300.01	42.85
296.74	42.7
293.44	41.93
281.268	38.3367
280.33	38.06
273.79	35.54
268.523	34.0444
257.38	30.88

247.54	29.08
236.473	25.58
223.973	23.7239
223.067	22.0023
221.493	19.0091
221.373	18.78
211.48	18.78
195.1	17.65
178.69	18.3
152.47	18.01
129.52	19.34
100	19.64
100	-40
500.02	-40
500.02	16.9371
500.02	22.0023
500.02	33.26
463.96	32.86
450.82	32.53
424.6	31.61
421.33	31.63
418.03	32.26
411.49	34.2
408.22	34.81
404.92	34.71
401.65	34.1
398.38	33.79
388.54	34.07
378.7	33.82
368.86	34.05
365.59	34.76
338.373	34.76
328.795	38.155

Material Boundary

X	Y
268.523	34.0444
291.008	34.05

Material Boundary

X	Y
296.706	39.642
309.855	39.642
321.241	34.05

291.008	34.05
296.706	39.642

Material Boundary

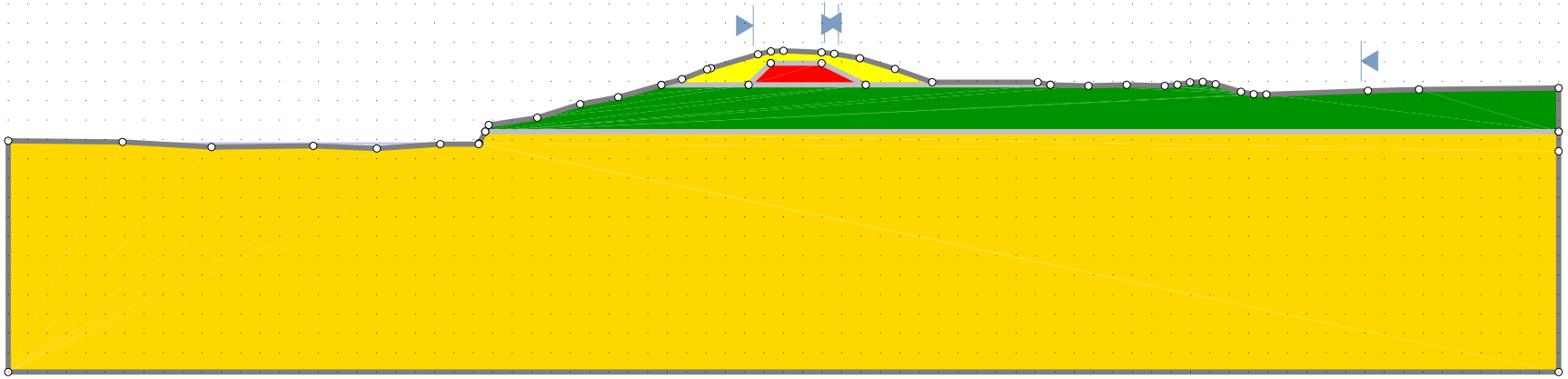
X	Y
321.241	34.05
368.86	34.05

Material Boundary

X	Y
223.067	22.0023
500.02	22.0023

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand

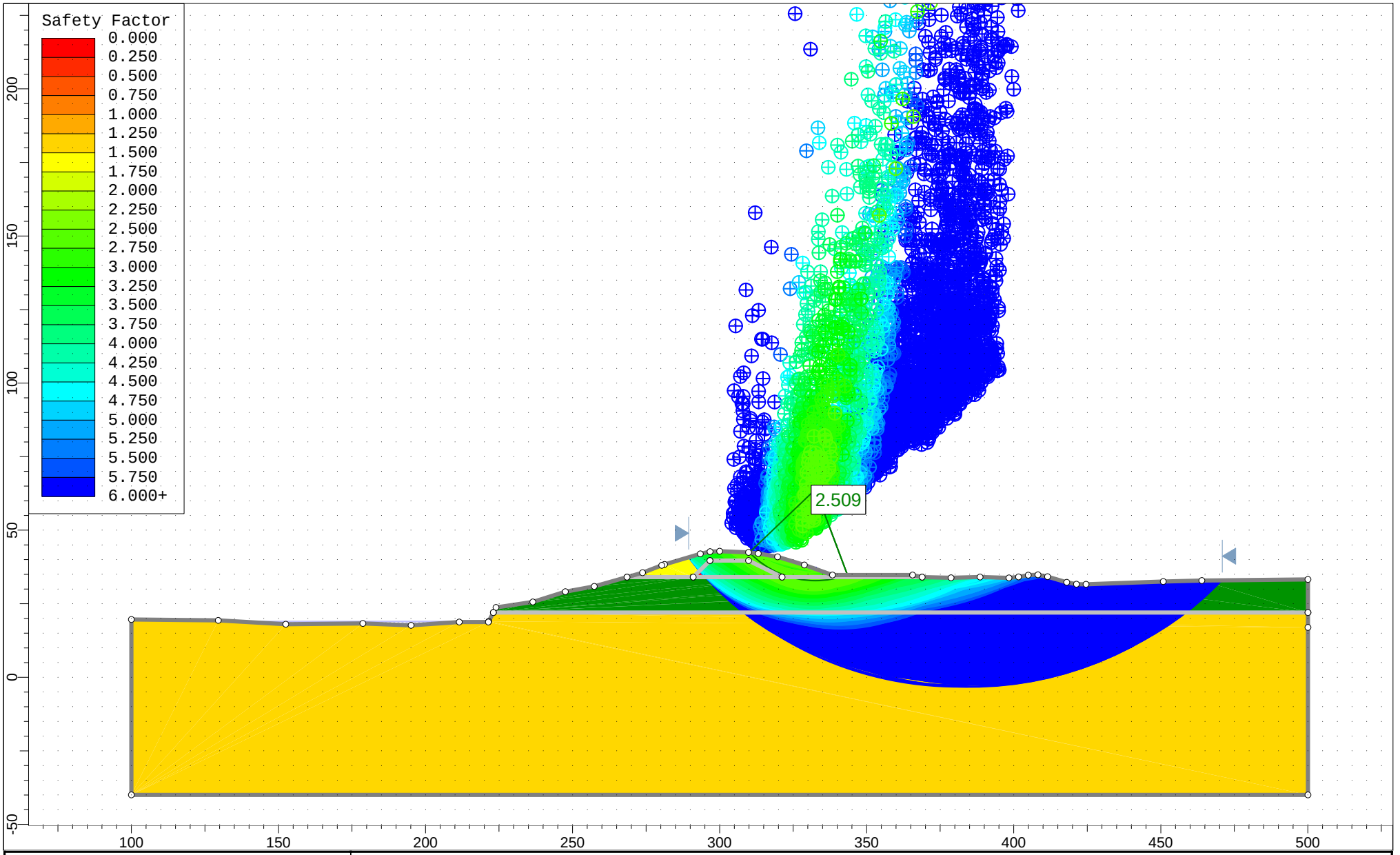


200
150
100
50
0
-50
100
150
200
250
300
350
400
450
500

rocscience

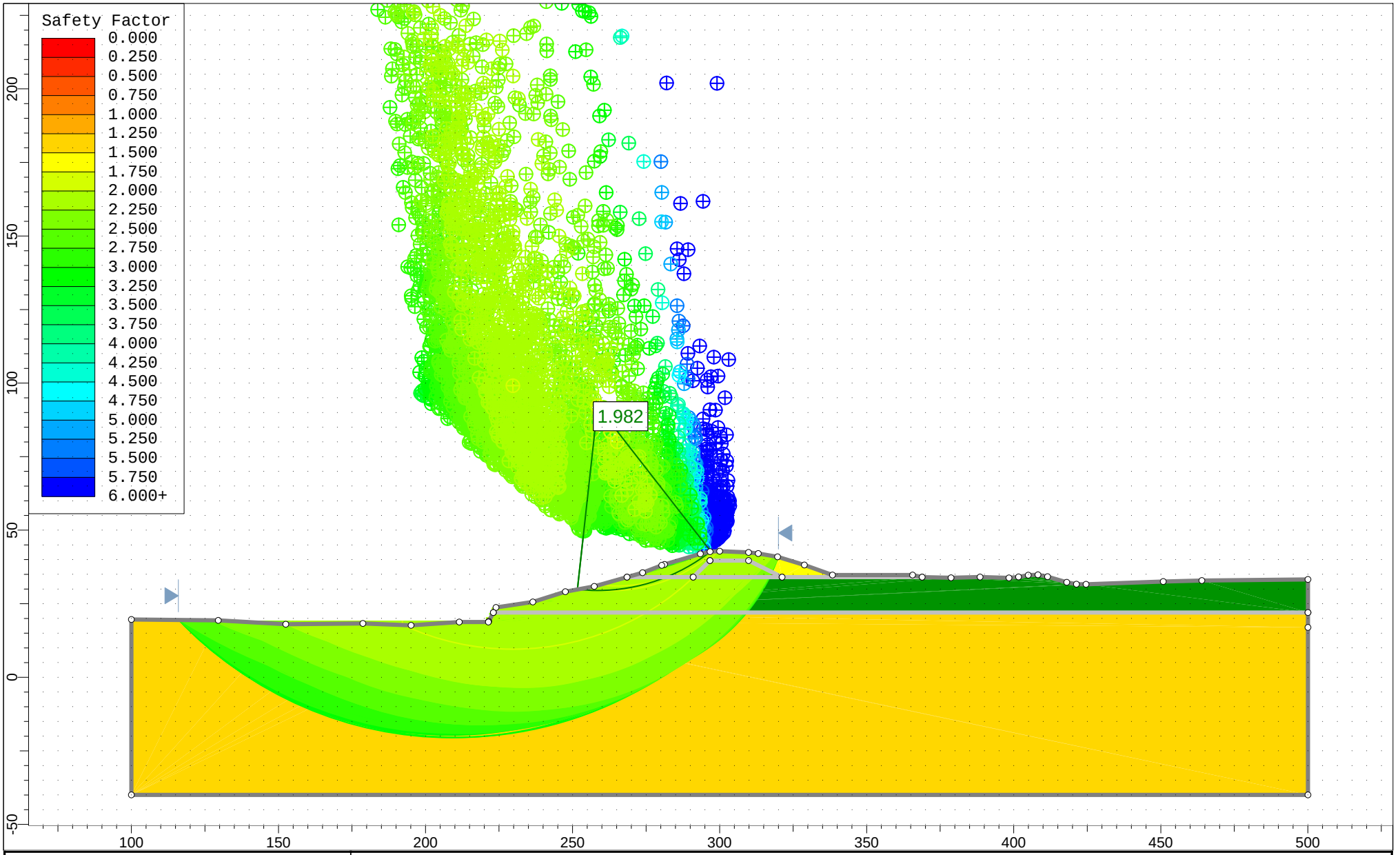
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158L, Geometry and Model Parameters		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_15800_Existing.slim



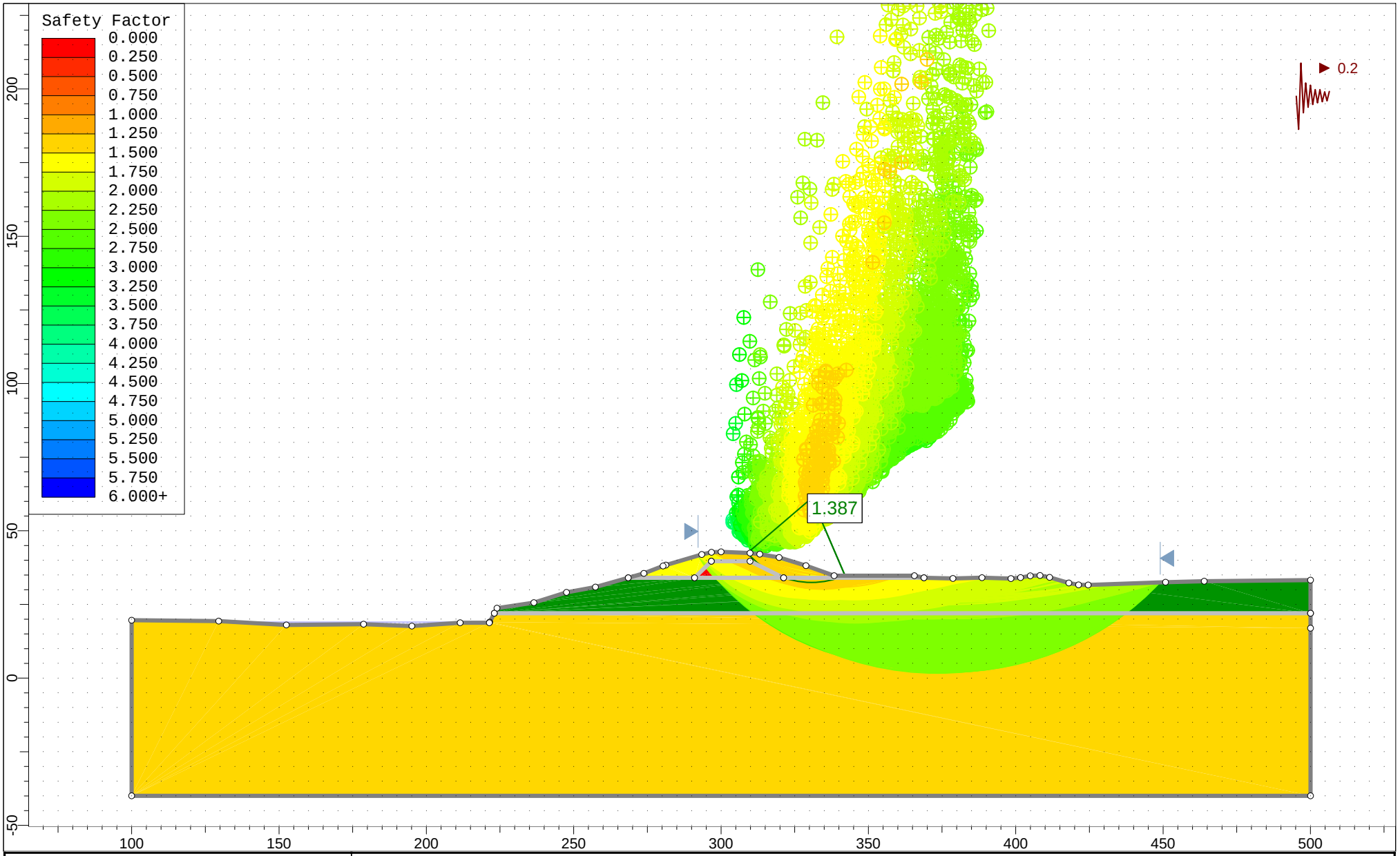
rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158L, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
	Date	December, 2010		*File Name* SlopeW_lineS_15800.slim

SLIDEINTERPRET 6.005



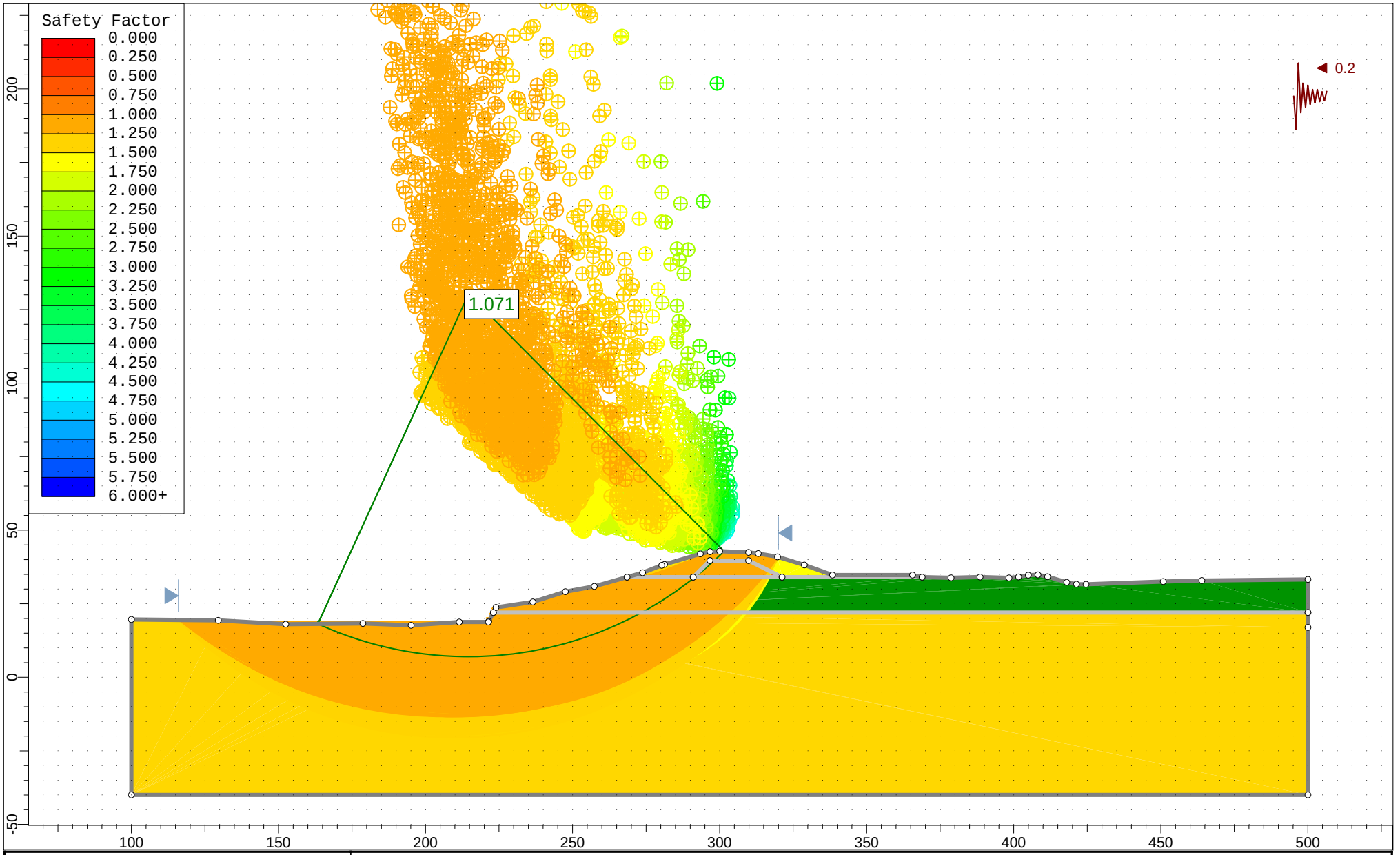
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158L, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_15800.slim

SLIDEINTERPRET 6.005



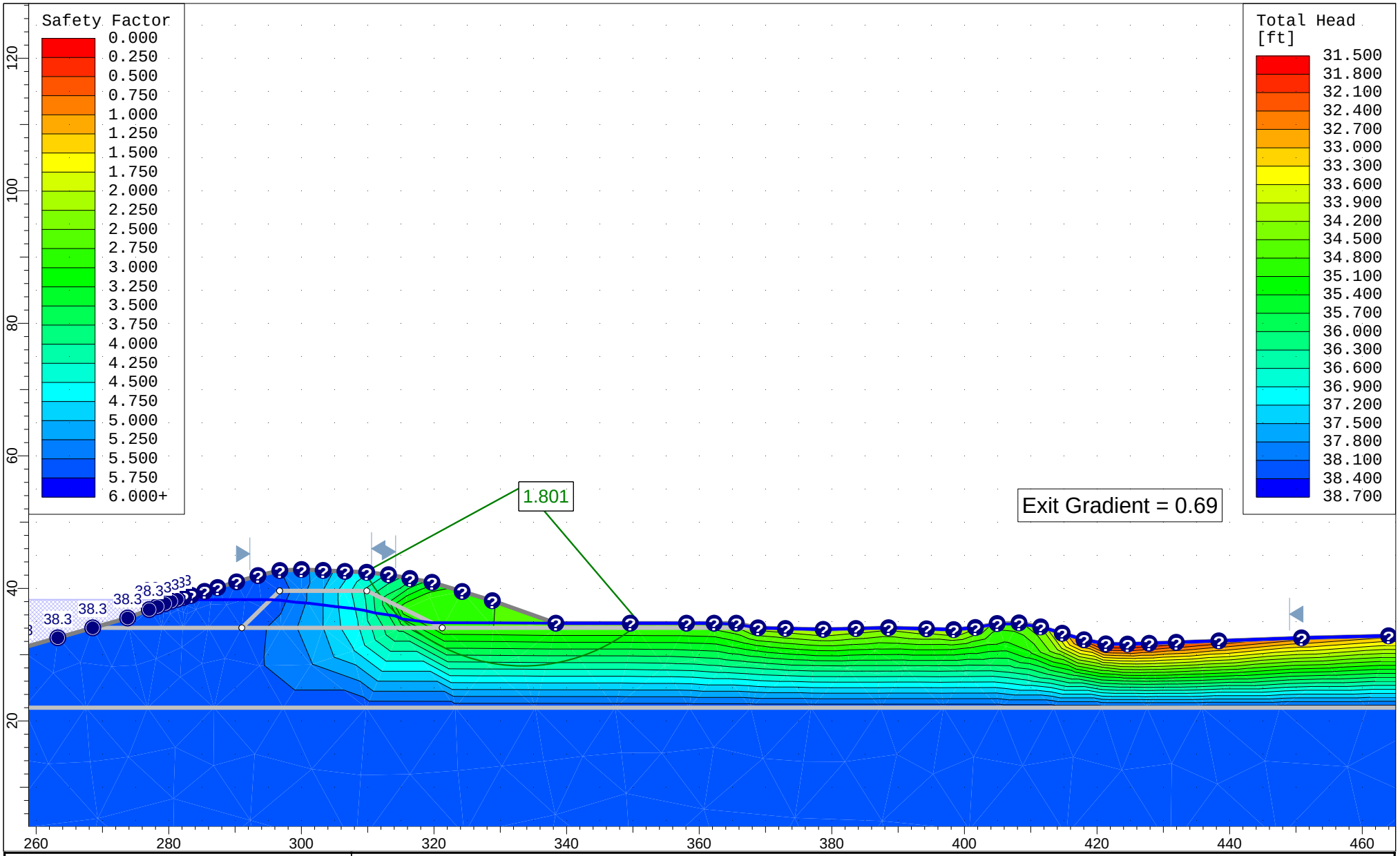
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158L, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_15800.slim

SLIDEINTERPRET 6.005



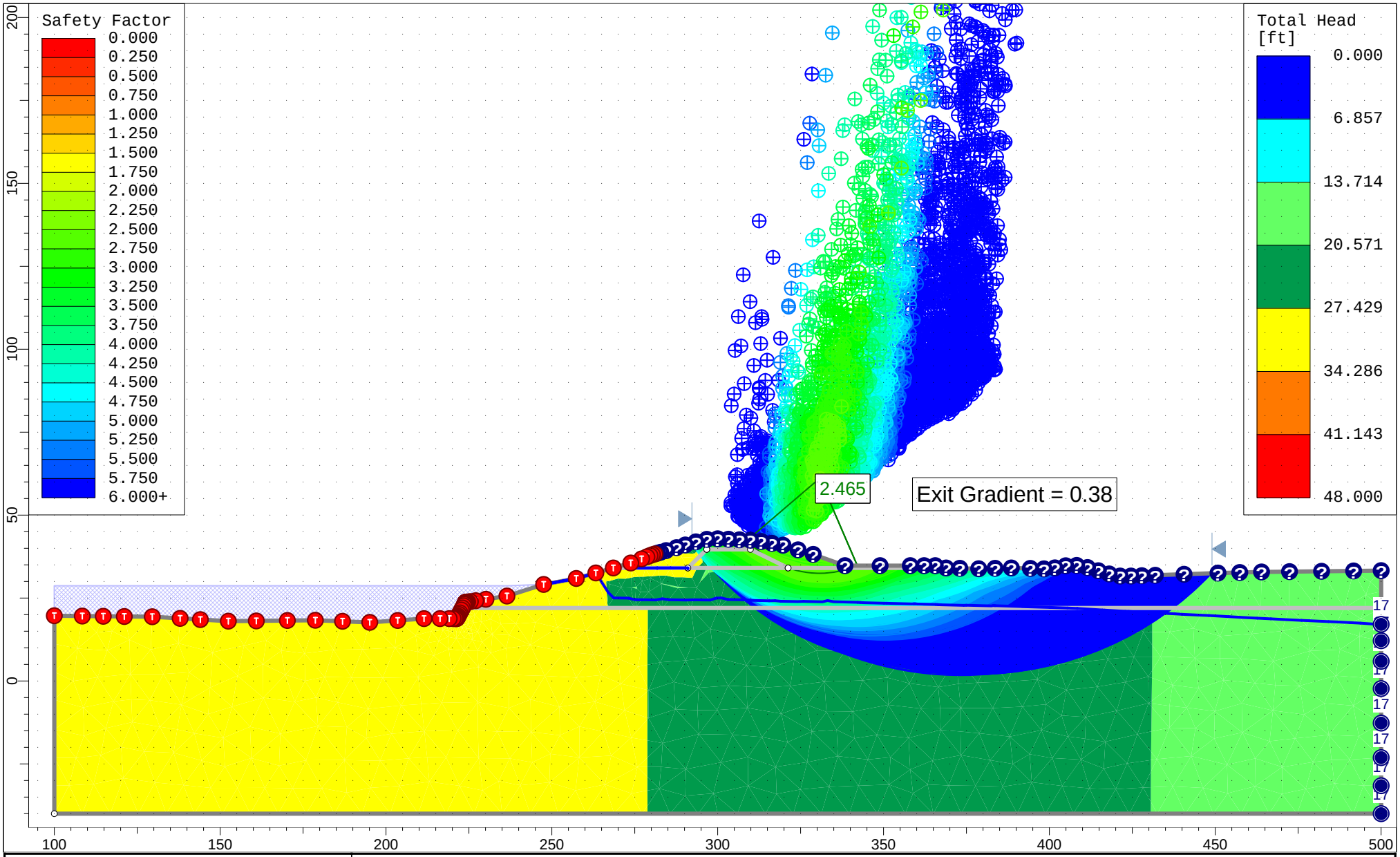
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158L, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_15800.slim

SLIDEINTERPRET 6.005



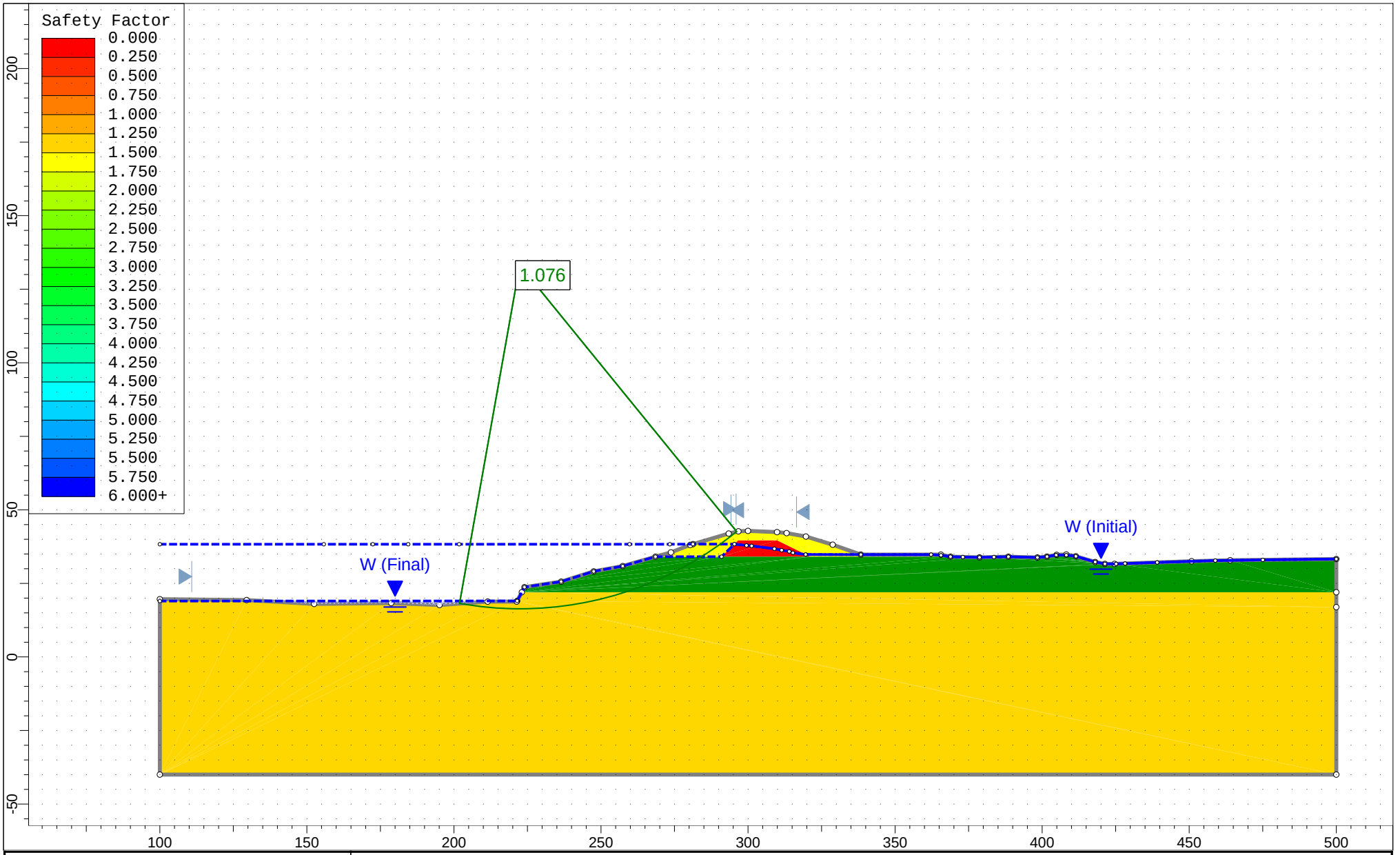
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158L,Flood Stage Conditions, 100-yr WSE, Landside Slope		
Drawn By GDE	*Scale* 1:240	*Company* FWI/CGI	
Date December, 2010		*File Name* SlopeW_lineS_15800_Flood.slim	

SLIDEINTERPRET 6.005



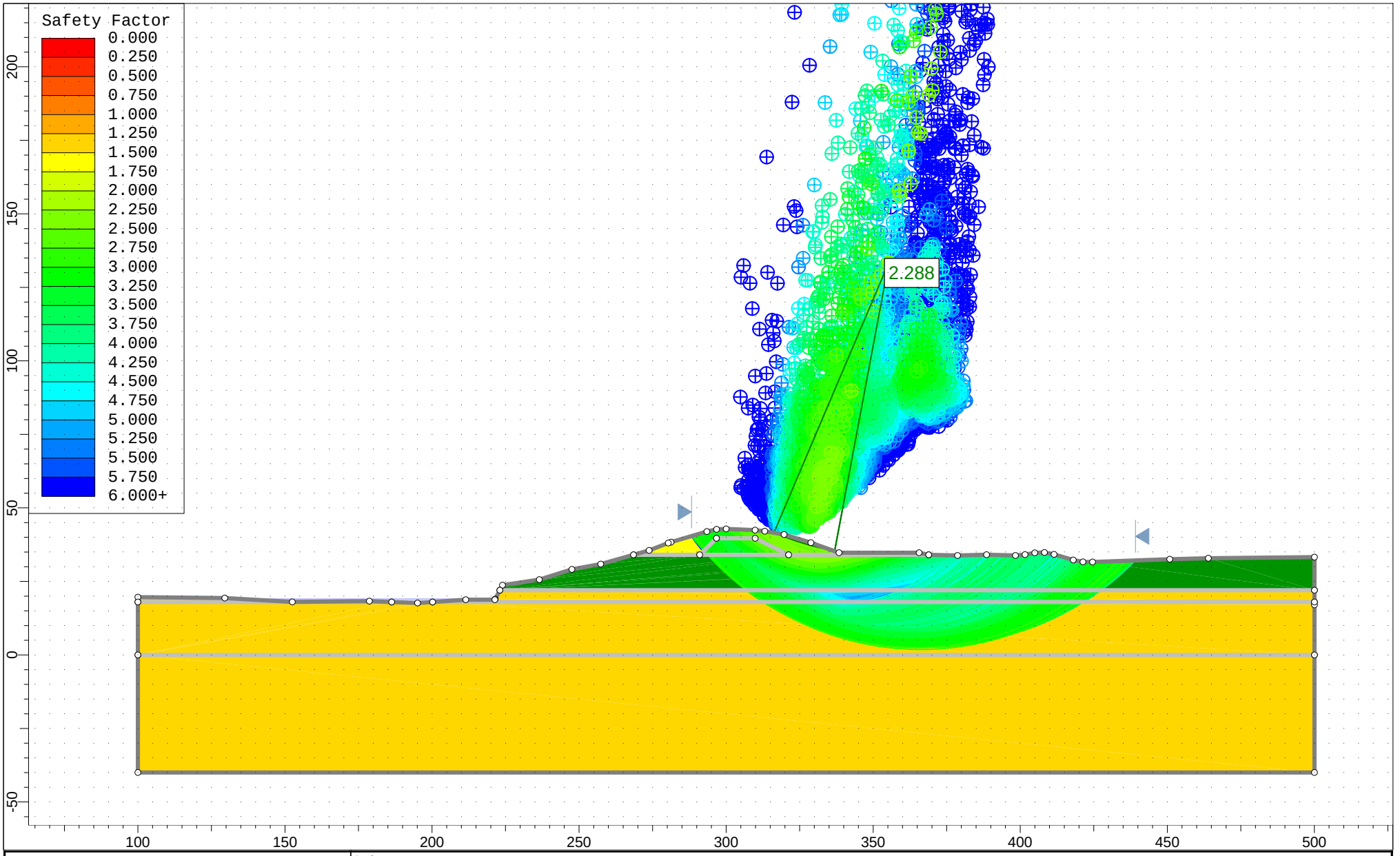
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 158L,Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:480	Company: FWI/CGI
	Date: May, 2011		File Name: SlopeW_lineS_15800_12 hour.slim

SLIDEINTERPRET 6.005



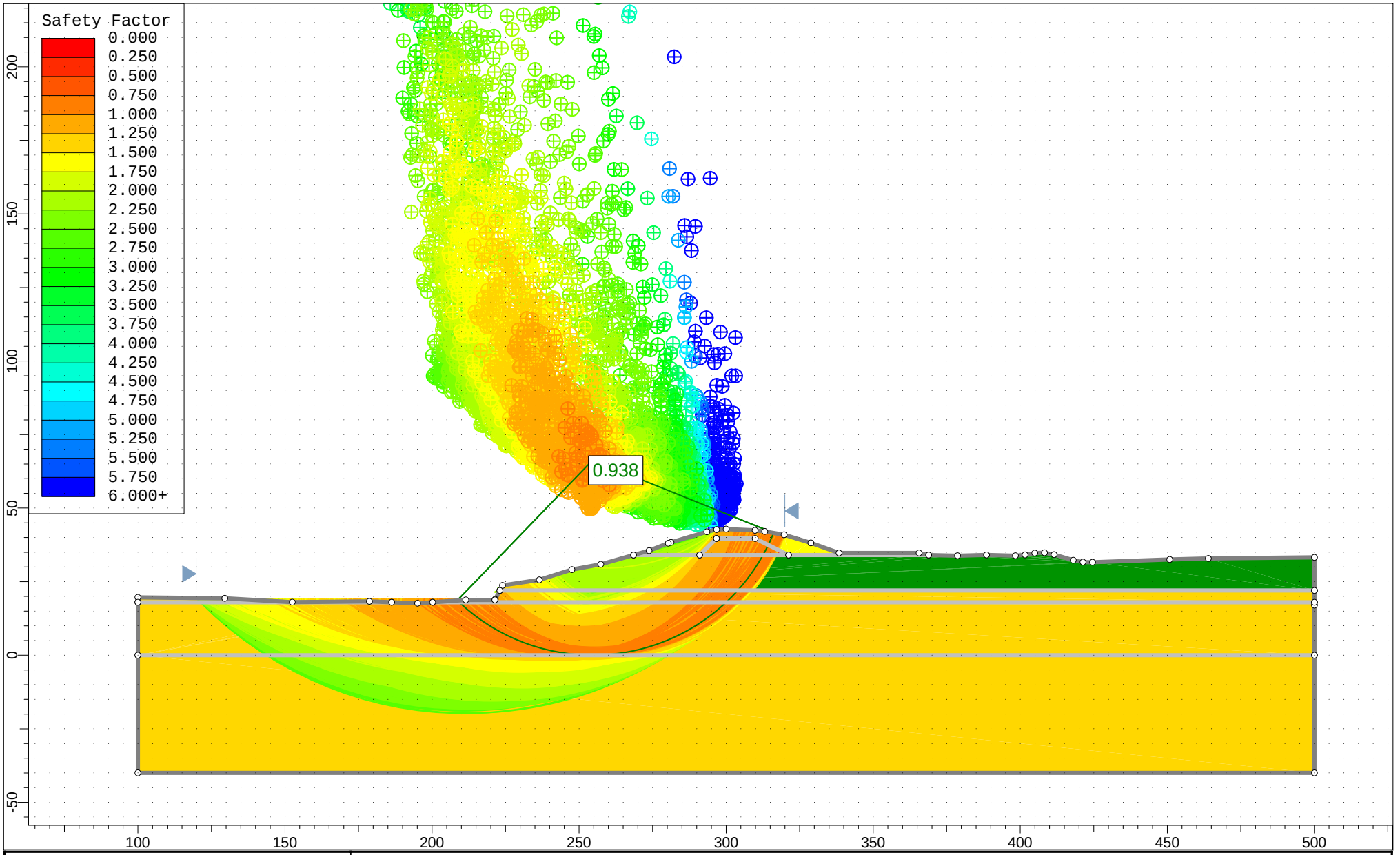
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158L, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_15800_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158L, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_15800_Post-EQ.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158L, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_15800_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 158R

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineN_15800_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 158R, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1245
Number of Nodes: 699

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
296.74	42.74
293.44	42.53
290.17	42.56
286.9	42.19
277.06	37.1
270.49	35.04
267.22	34.23
263.95	33.75
260.68	33.75
250.84	34.3
227.89	34.31

208.21	34.83
201.64	34.71
191.83	34.82
185.26	35
178.69	35.38
165.58	35.54
155.74	35.07
152.47	35.3
149.2	35.28
139.36	34.73
136.09	34.22
129.52	34.57
119.68	33.87
113.14	34.29
103.3	33.61
100	33.57
100	21
100	18.0636
100	-40
500.02	-40
500.02	19.0714
500.02	19.57
483.61	19.66
470.5	19.51
444.28	19.17
421.33	20.41
410.325	21.0094
398.38	21.66
391.81	22.42
378.791	22.42
377.991	25.6547
371.118	26.17
366.536	26.9849
355.84	28.0652
347.248	28.6056
332.348	34.328
322.96	37.12
317.233	38.377
310.468	39.862
300.096	42.74

Material Boundary

X	Y
267.22	34.23
275.841	34.23

Material Boundary

X	Y
286.957	39.754
300.067	39.754
305.532	34.328
275.841	34.23
286.957	39.754

Material Boundary

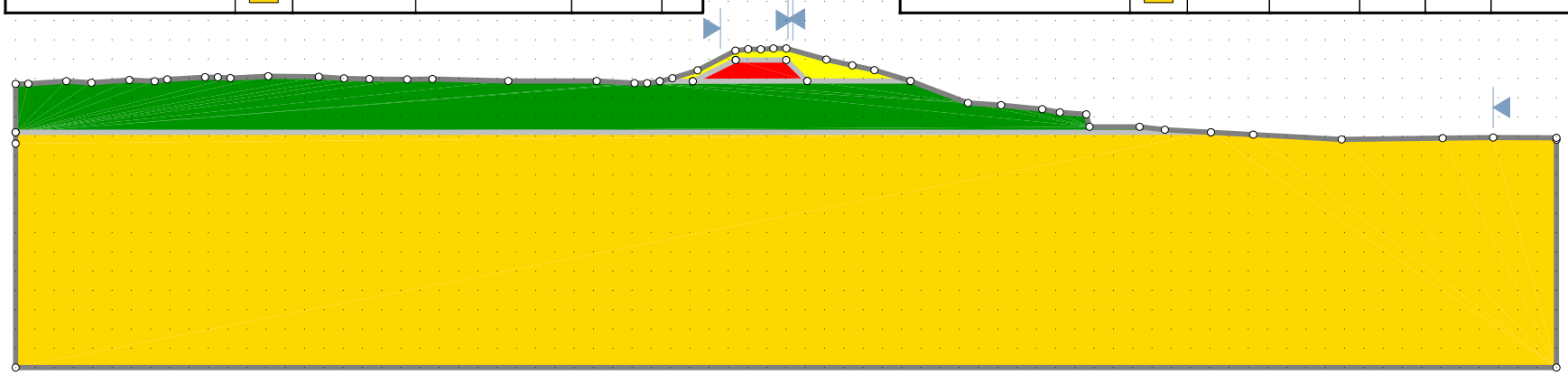
X	Y
305.532	34.328
332.348	34.328

Material Boundary

X	Y
100	21
410.325	21.0094

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



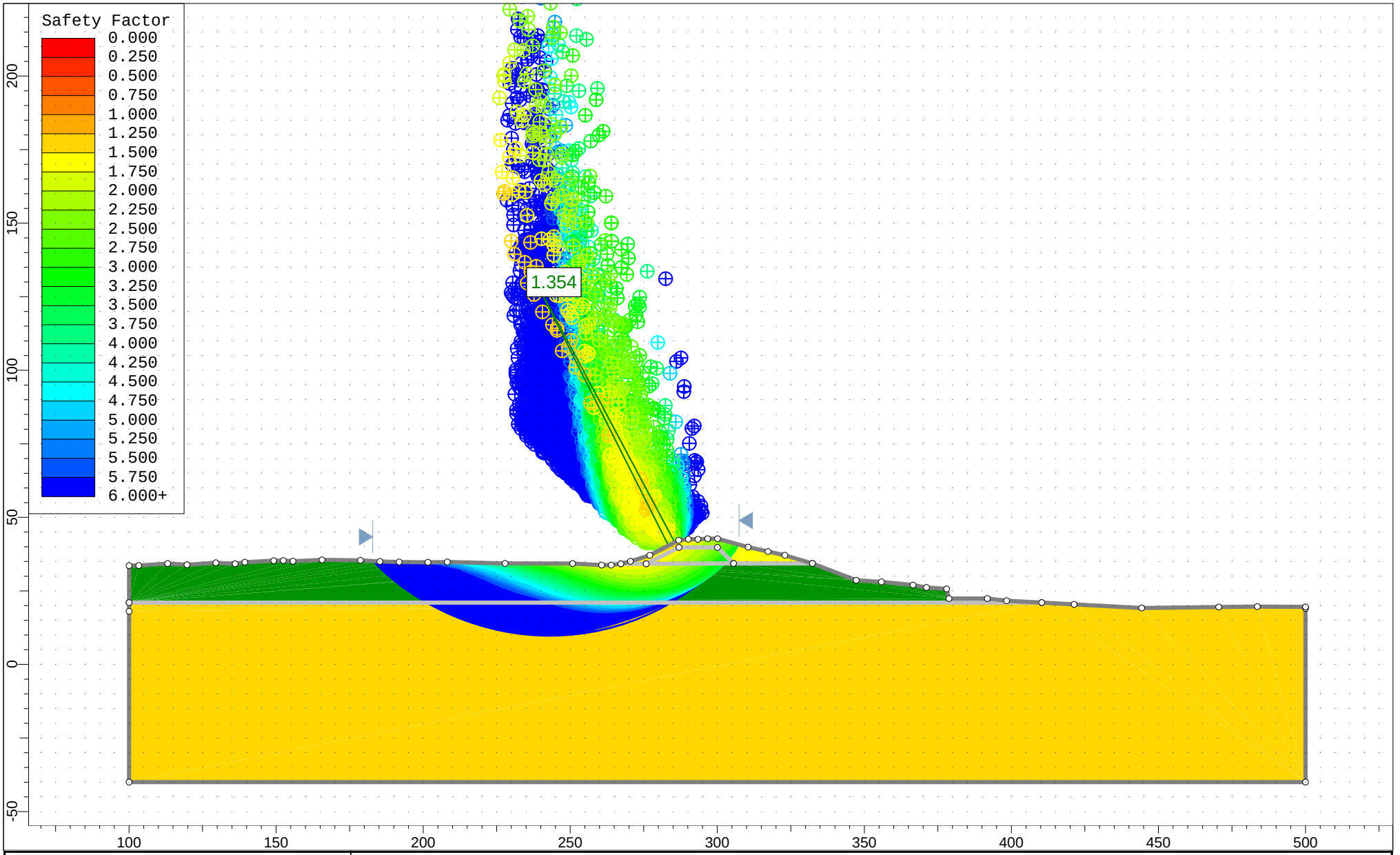
150
100
50
0
-50

100 150 200 250 300 350 400 450 500

rocscience

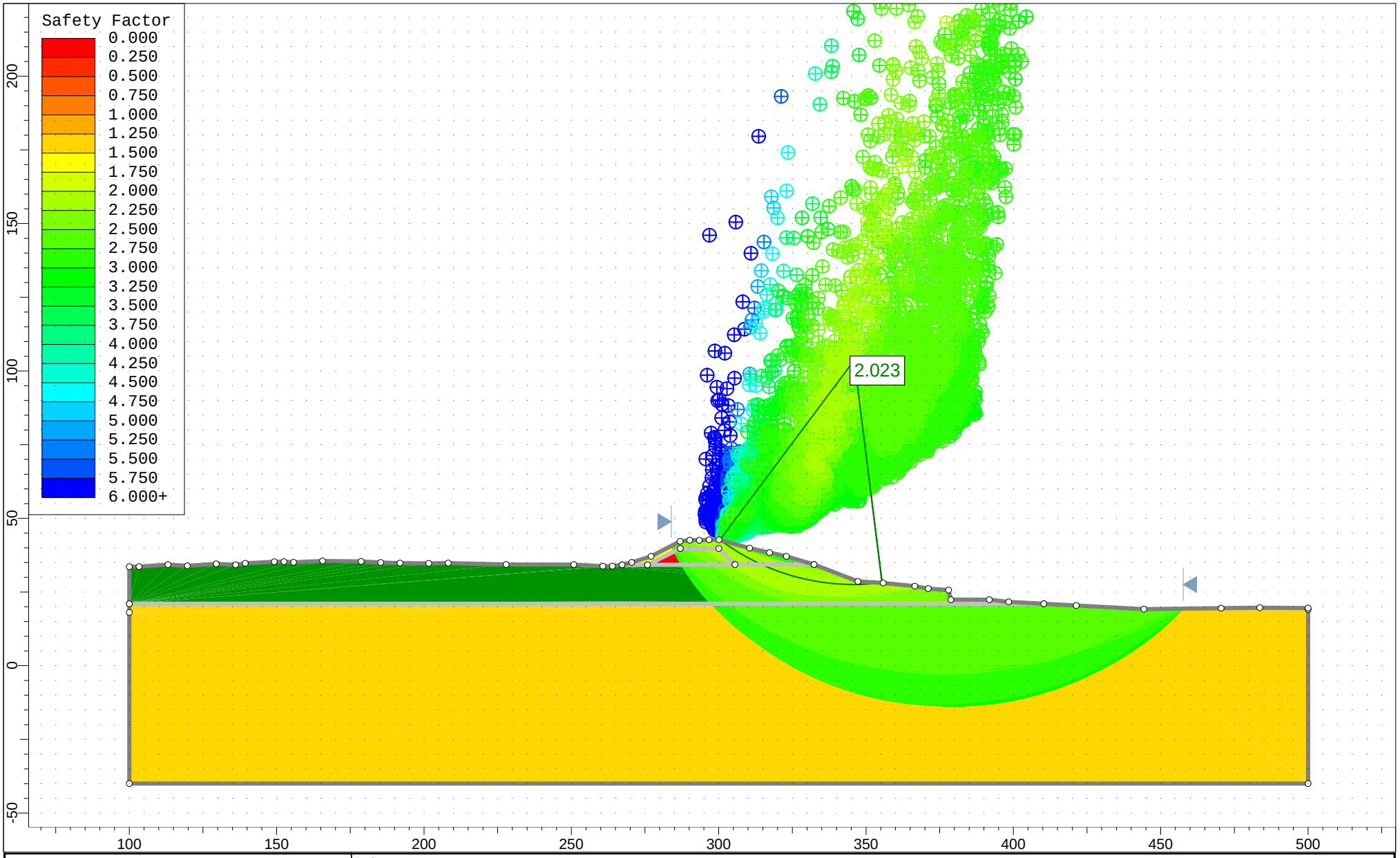
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158R, Geometry and Model Parameters		
Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
Date	December, 2010	*File Name*	SlopeW_lineN_15800_Existing.slim



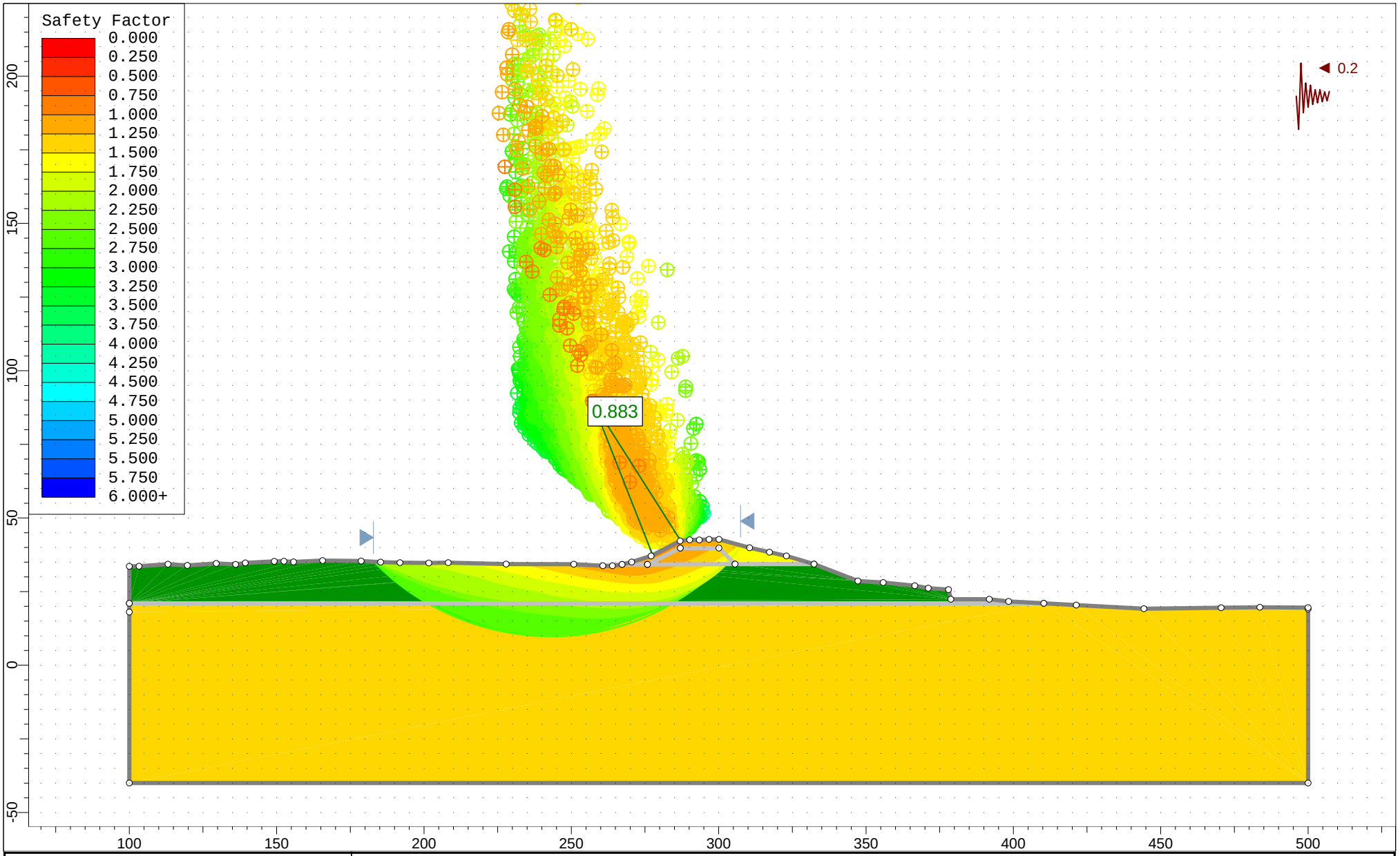
	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158R, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineN_15800_Existing.slim

SLIDEINTERPRET 6.005



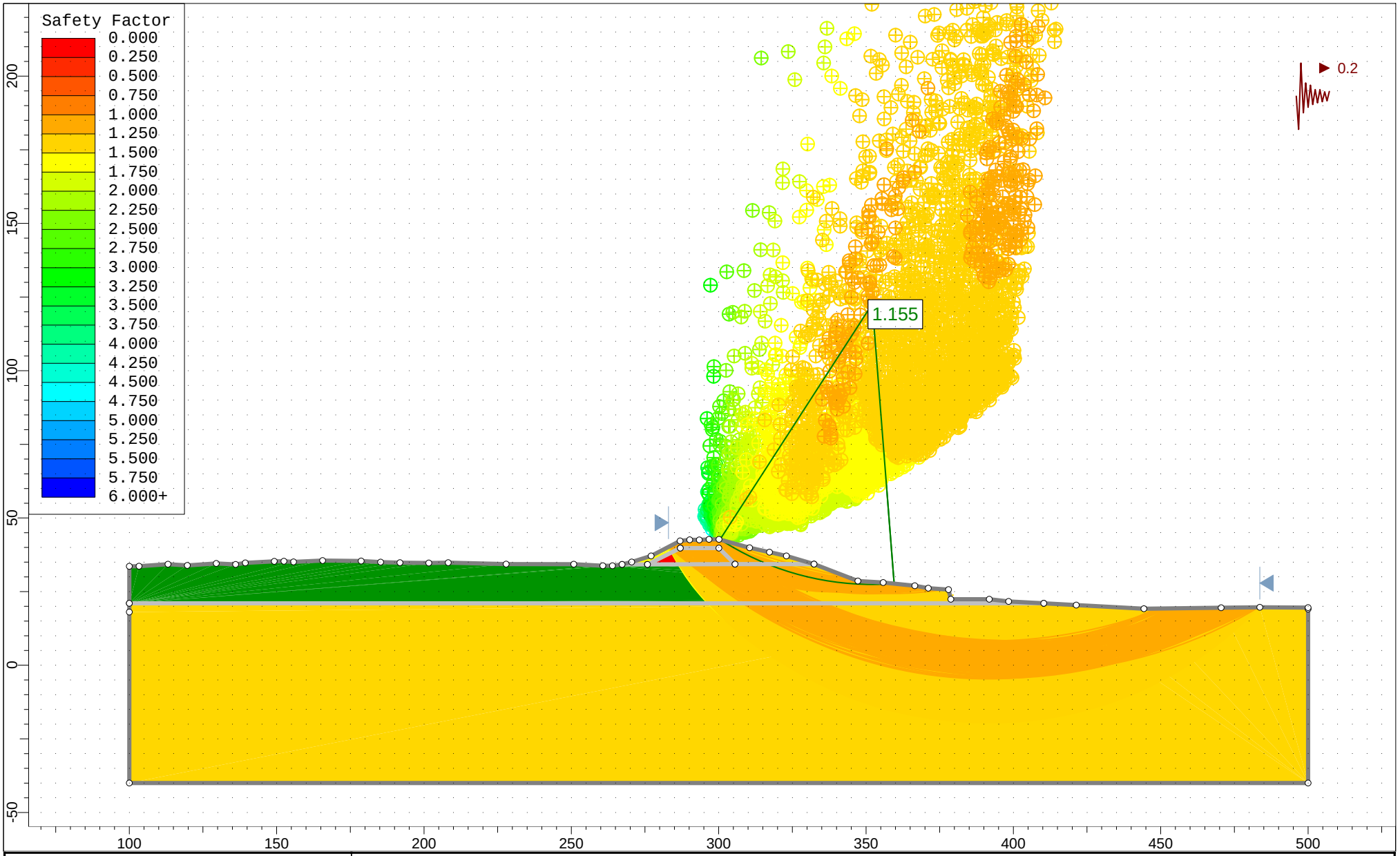
	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158R, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineN_15800_Existing.slim

SLIDEINTERPRET 6.005



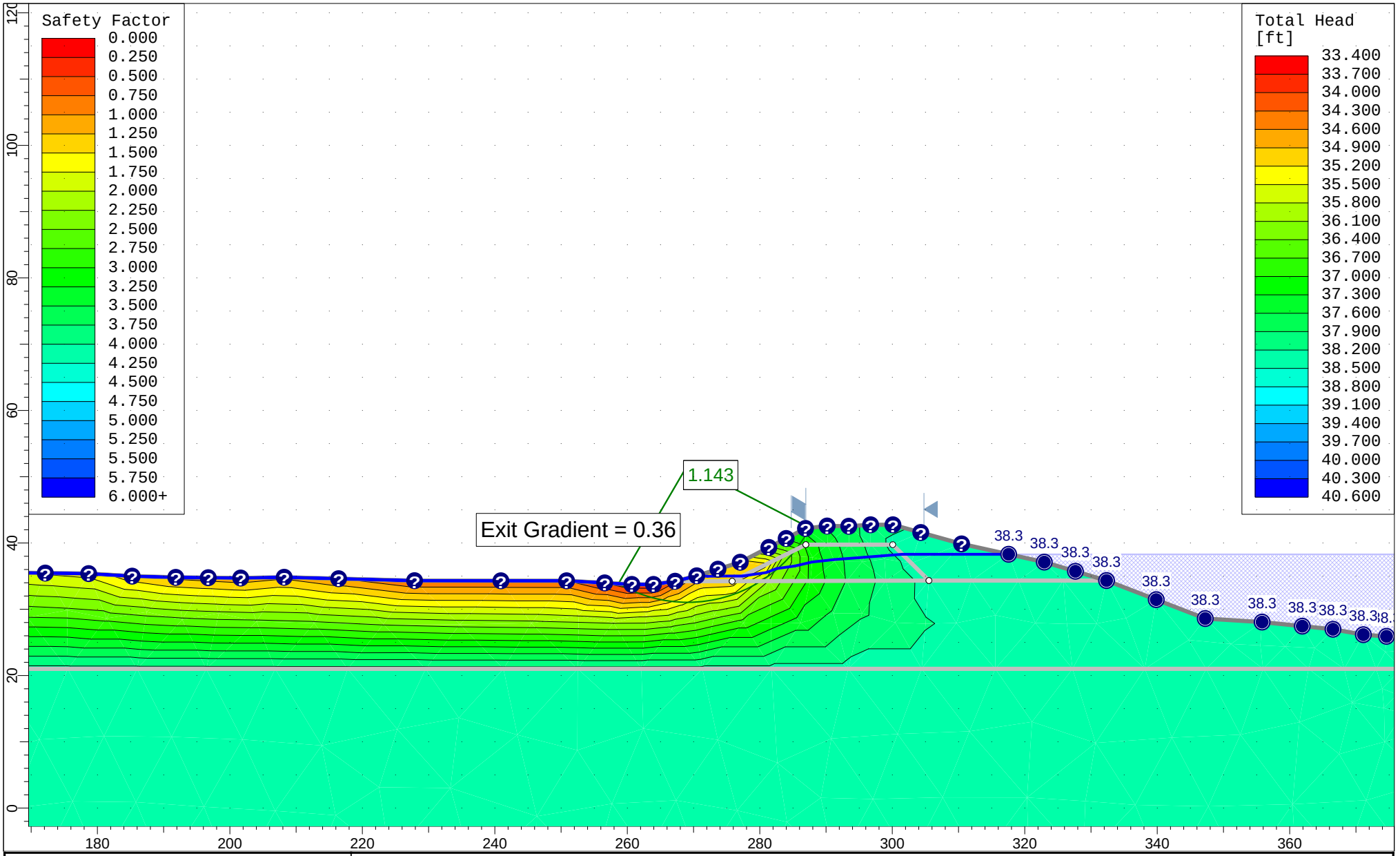
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158R, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_15800_Existing.slim

SLIDEINTERPRET 6.005



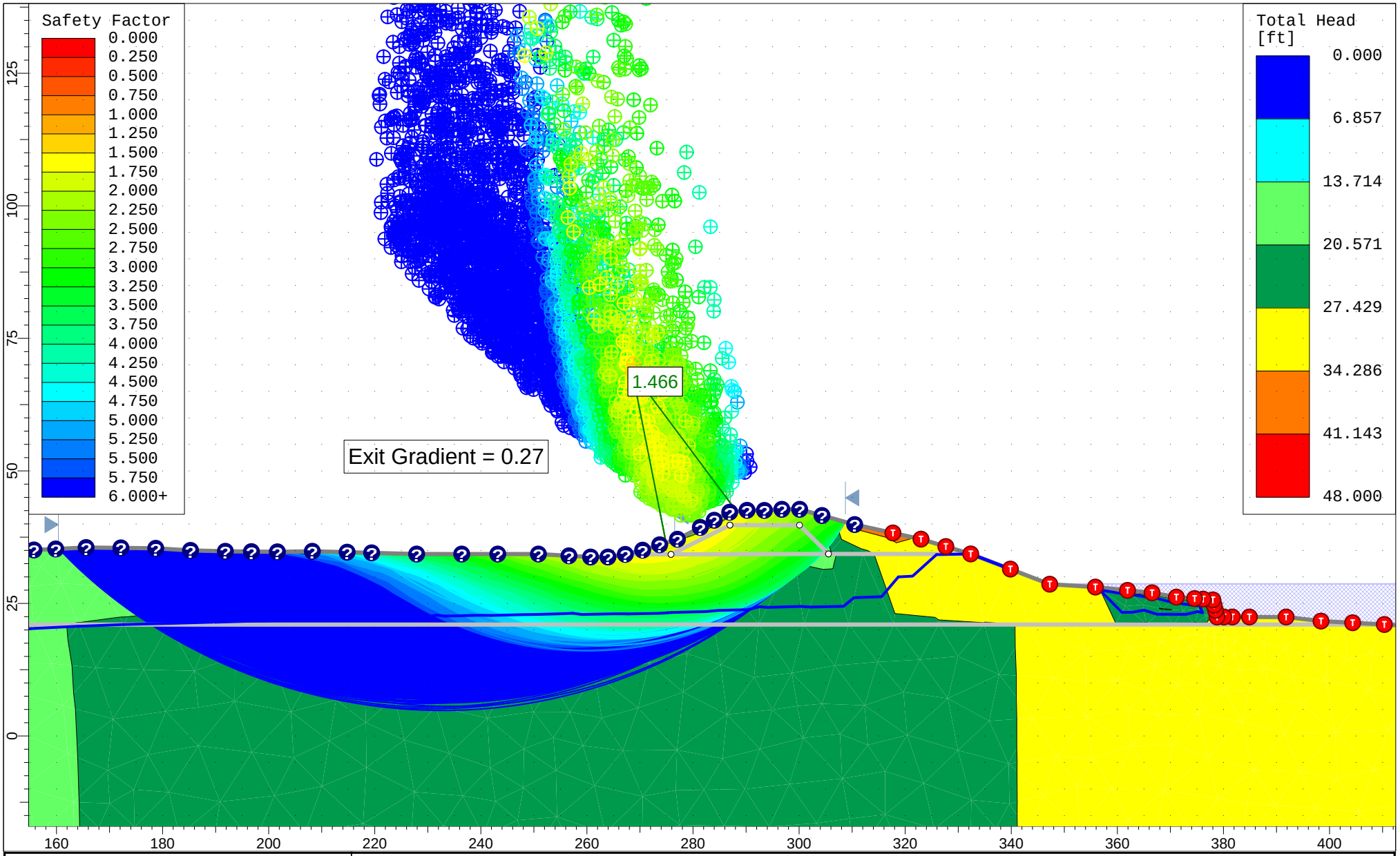
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158R, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineN_15800_Existing.slim

SLIDEINTERPRET 6.005



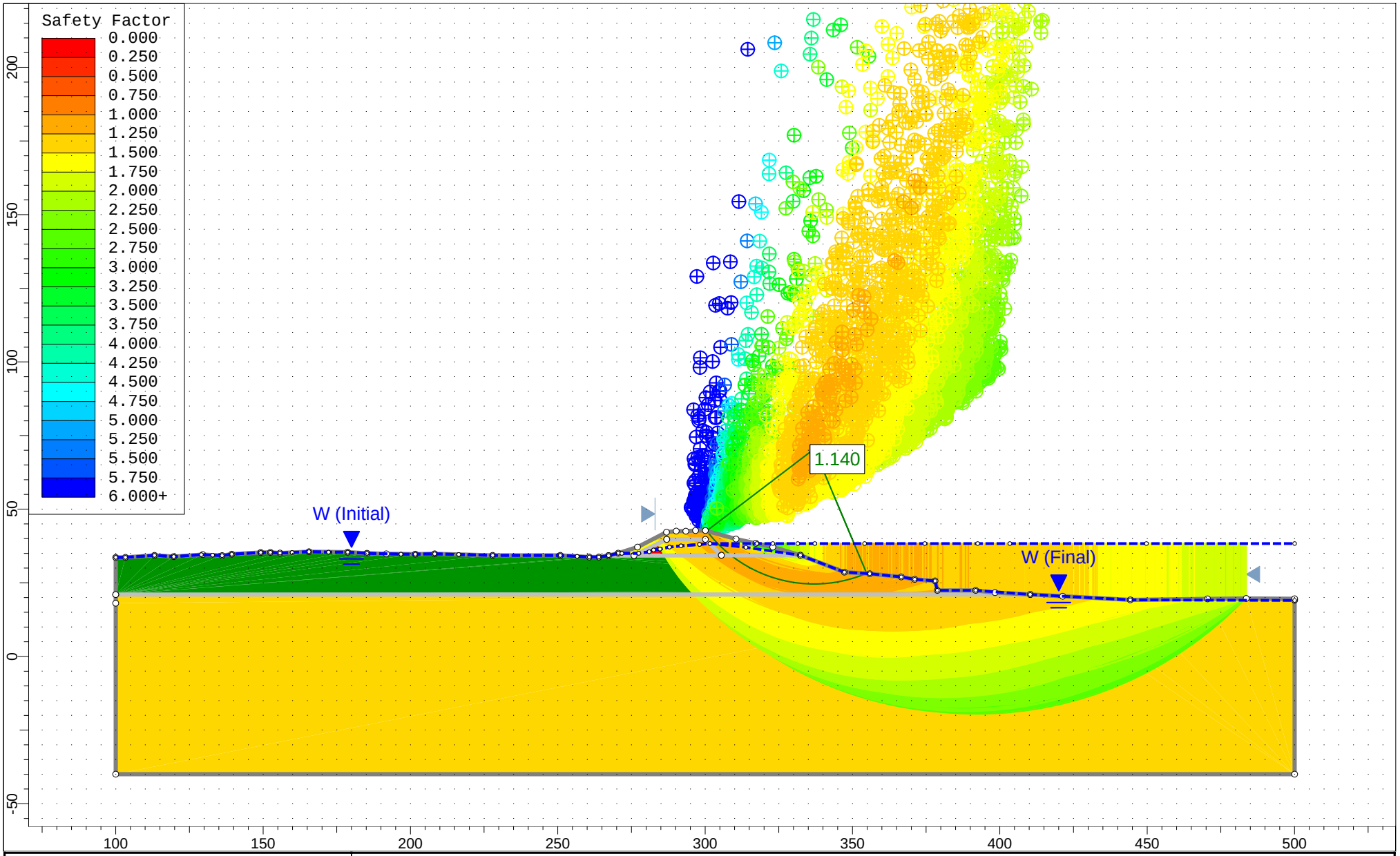
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158R, Flood Stage Conditions, 100-yr WSE, Landside Slope		
Drawn By: GDE	Scale: 1:240	Company: FWI/CGI	
Date: December, 2010		File Name: SlopeW_lineN_15800_Flood.slim	

SLIDEINTERPRET 6.005



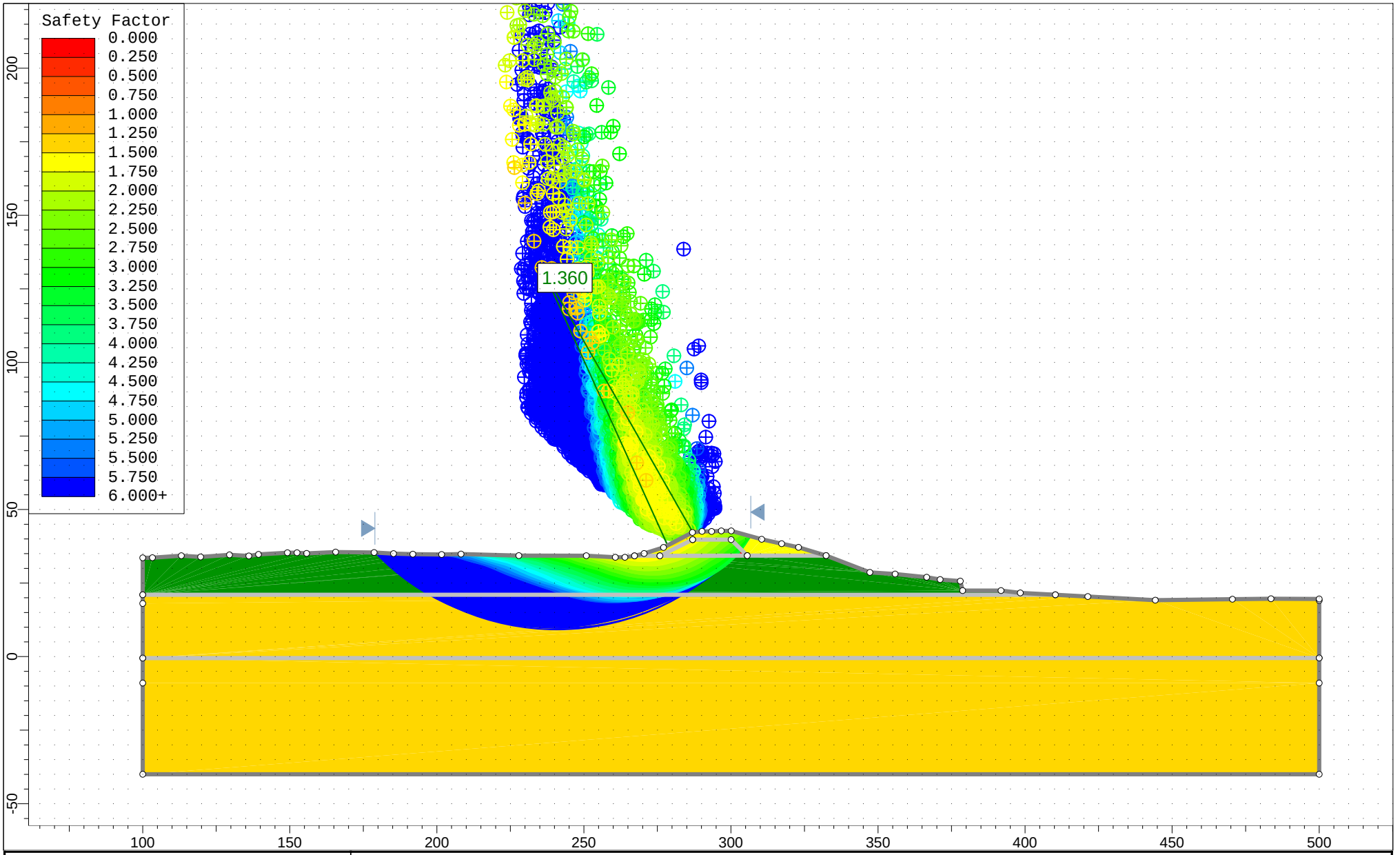
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 158R, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:300	Company: FWI/CGI
	Date: May, 2011		File Name: SlopeW_lineN_15800_12 hour.slim

SLIDEINTERPRET 6.005



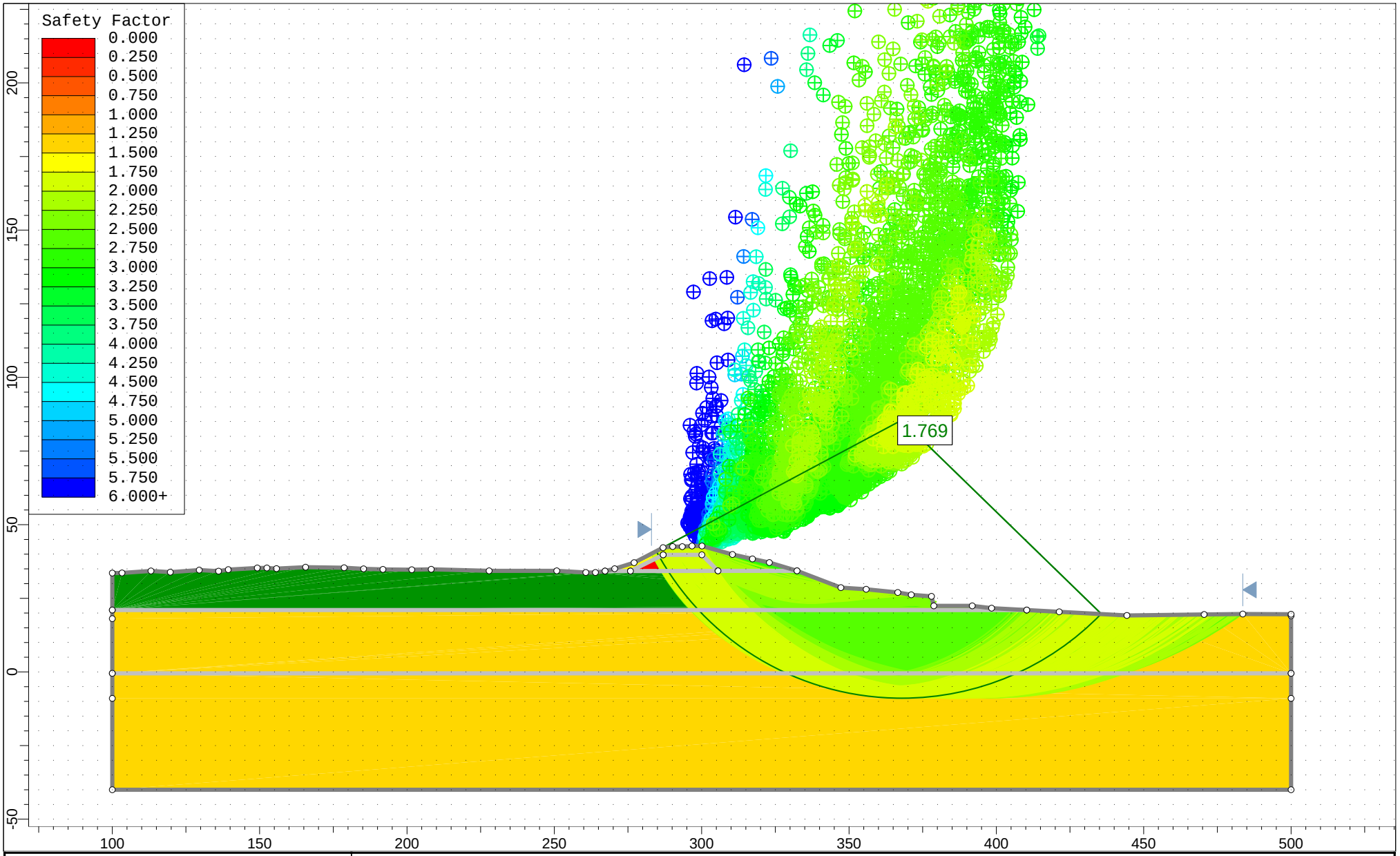
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 158R, Rapid Drawdown, Waterside Slope		
Drawn By: GDE	Scale: 1:540	Company: FWI/CGI	
Date: December, 2010		File Name: SlopeW_lineN_15800_Rapid Drawdown.slim	

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 158R, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineN_15800_Post-EQ.slim

SLIDEINTERPRET 6.005



	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 158R, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By: GDE	Scale: 1:540	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineN_15800_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 171L

Slide Analysis Information

Redwood Creek Levee Evaluation

Project Summary

File Name: SlopeW_lineS_17100_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation
Analysis: Cross-section 171L, Geometry and Model Parameters
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Left to Right
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1356
Number of Nodes: 749

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
339.37	38.06
329.53	40.59
316.42	45.23
313.12	45.71
309.85	45.86
306.58	45.76
303.28	45.4
300.01	44.81
283.959	40.0004
273.79	37.27
269.172	35.69

260.983	32.888
255.867	30.92
244.27	30.92
241	30.46
230.91	29.132
230.11	26.02
214.78	26.02
211.48	25.61
201.64	23.49
198.37	23.09
188.53	22.97
178.69	22.72
168.85	22.54
159.04	22.72
145.9	23.35
136.09	22.96
119.68	22.46
110.986	22
100	21.22
100	18.9993
100	-40
500.02	-40
500.02	18.499
500.02	22
500.02	36.36
483.61	36.19
463.96	36.3
447.55	36.02
427.87	35.9
414.76	36
398.38	35.78
378.7	35.94
362.32	35.61
359.02	35.69
349.18	36.53

Material Boundary

X	Y
269.172	35.69
296.143	35.69

Material Boundary

X	Y
316.42	42.522

303.309	42.522
296.143	35.69
330.742	35.69
316.42	42.522

Material Boundary

X	Y
330.742	35.69
359.02	35.69

Material Boundary

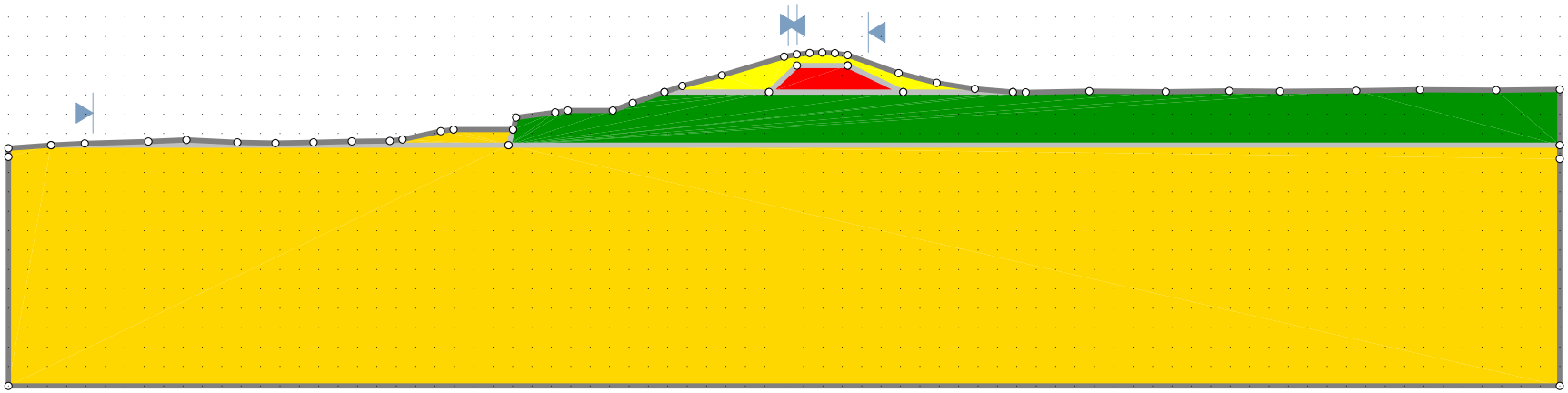
X	Y
110.986	22
228.979	22
500.02	22

Material Boundary

X	Y
228.979	22
230.11	26.02

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



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100
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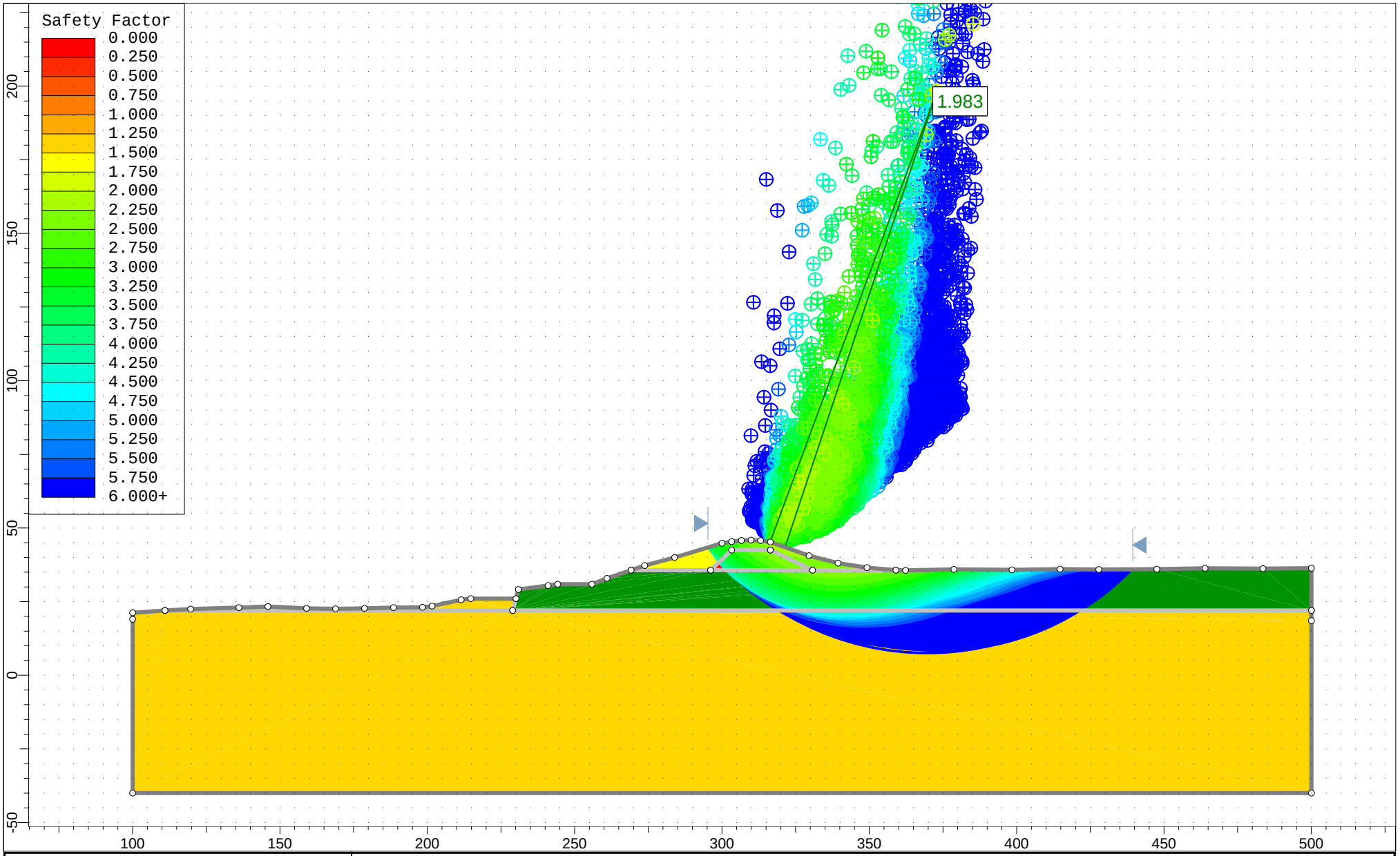
0
-50
100
150
200
250
300
350
400
450
500

rocscience

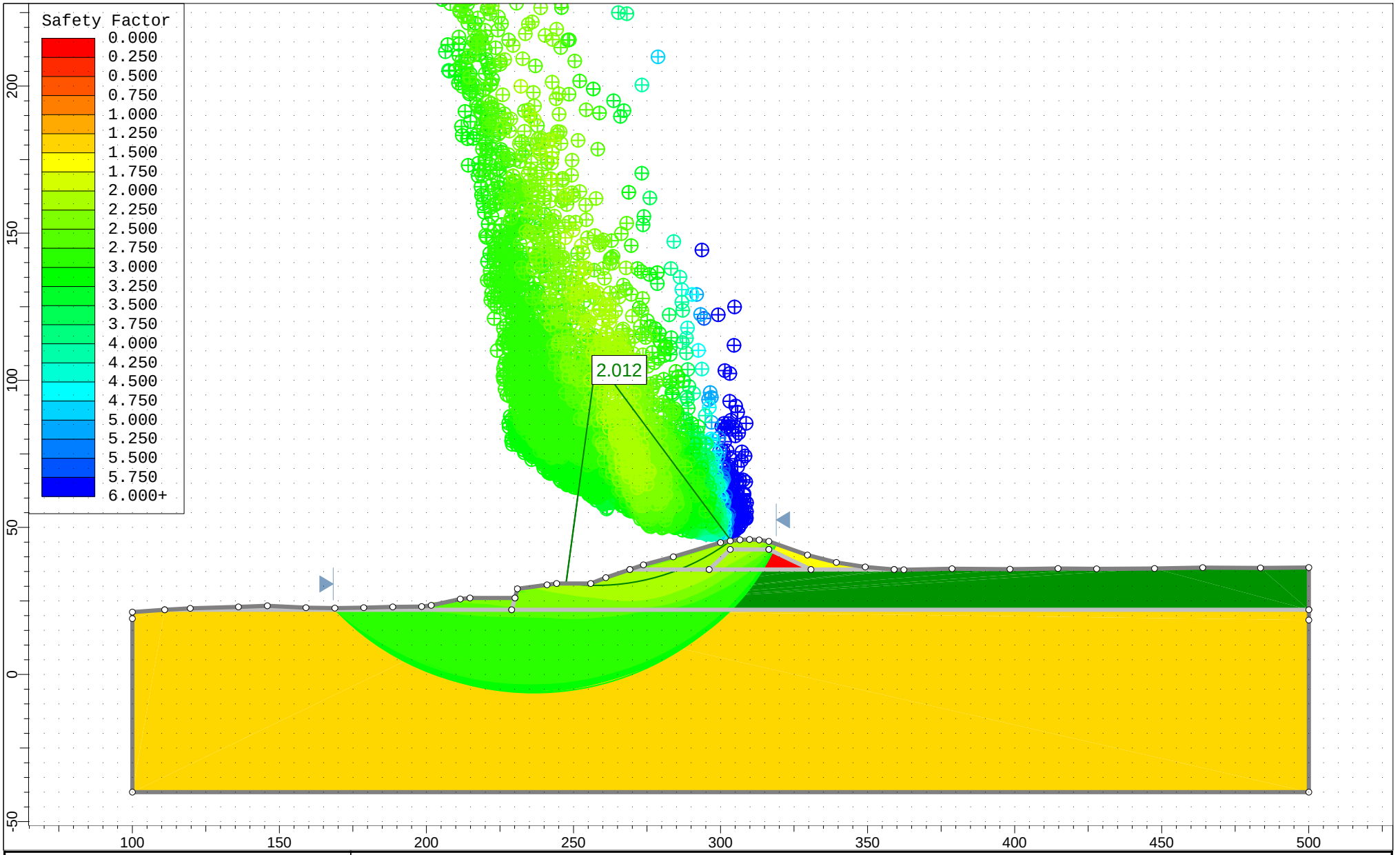
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 171L, Geometry and Model Parameters		
Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
Date	December, 2010	*File Name*	SlopeW_lineS_17100_Existing.slim



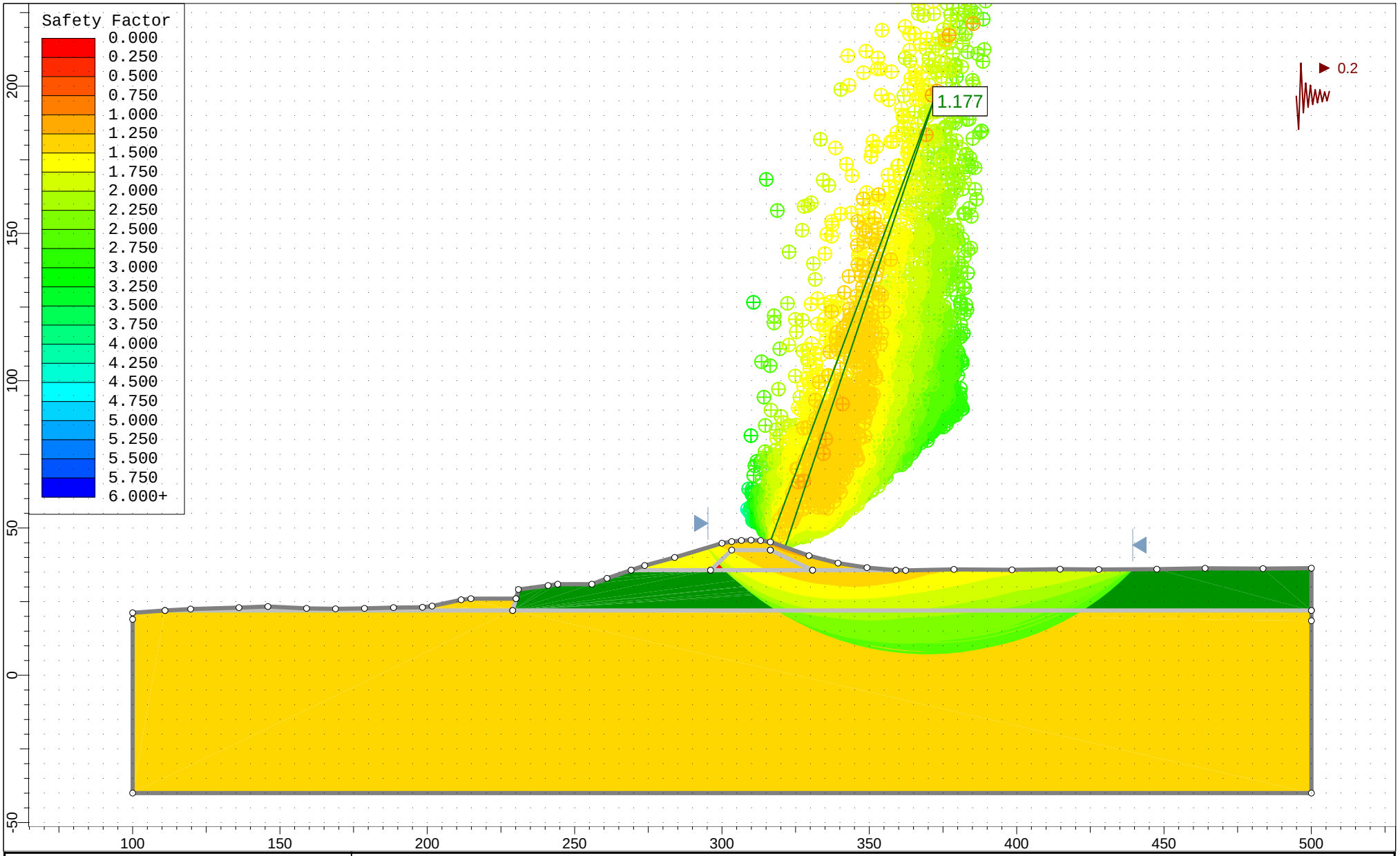
	Project: Redwood Creek Levee Evaluation		
	Analysis Description: Cross-section 171L, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:540	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineS_17100_Existing.slim

SLIDEINTERPRET 6.005



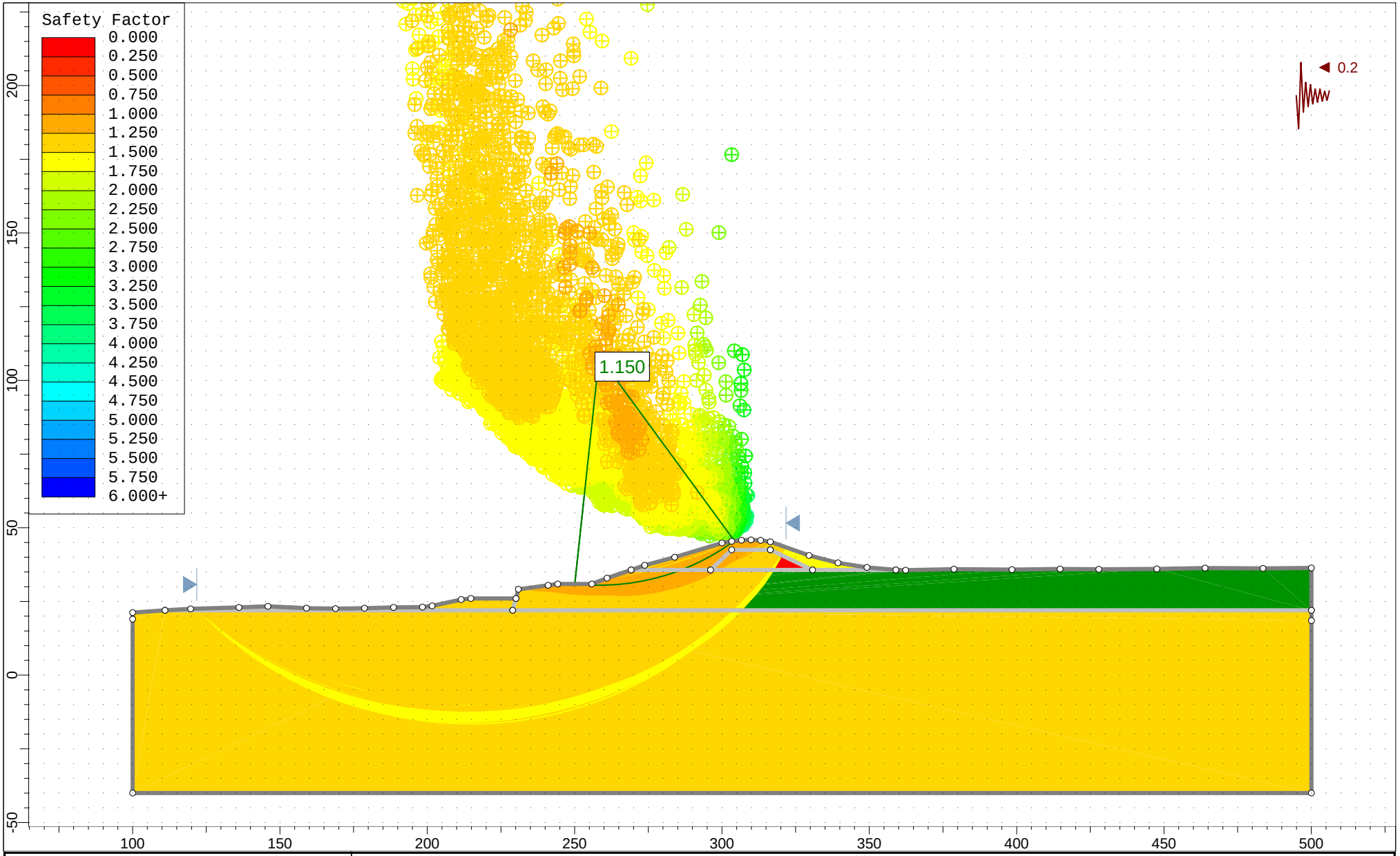
rocscience	Project	Redwood Creek Levee Evaluation		
	Analysis Description	Cross-section 171L, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_17100_Existing.slim

SLIDEINTERPRET 6.005



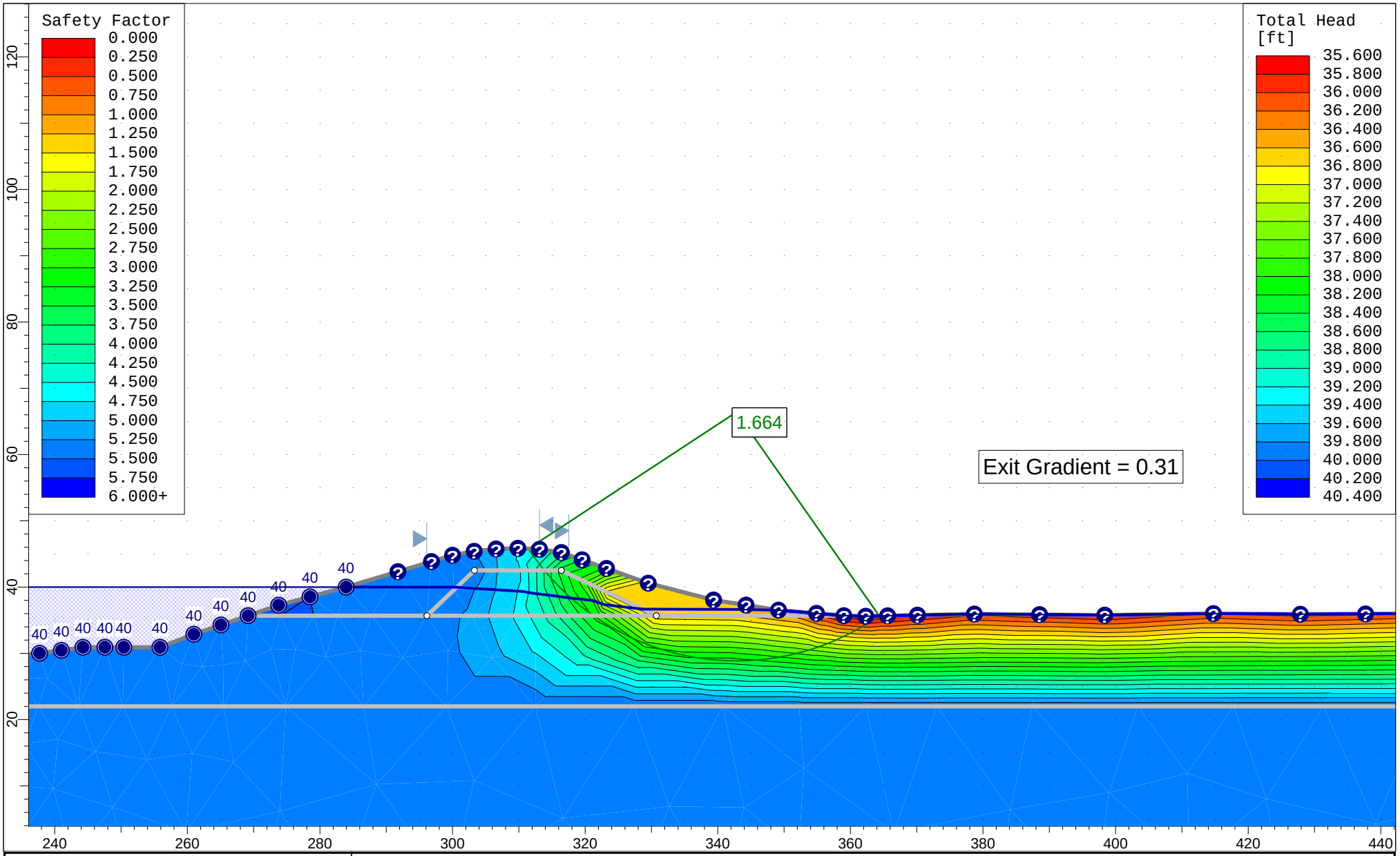
Project	Redwood Creek Levee Evaluation		
Analysis Description	Cross-section 171L, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_17100_Existing.slim

SLIDEINTERPRET 6.005



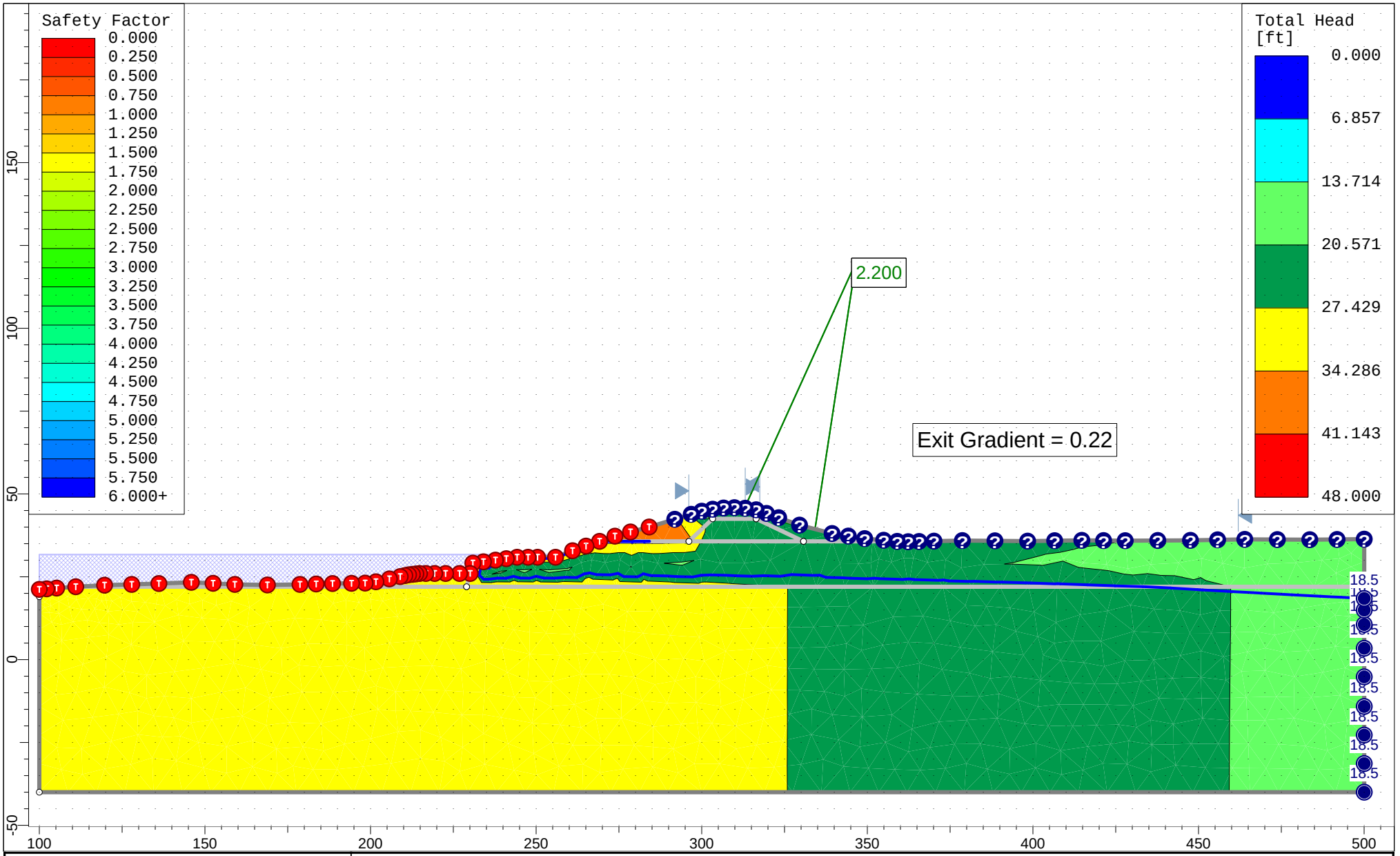
Project	Redwood Creek Levee Evaluation		
Analysis Description	Cross-section 171L, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_17100_Existing.slim

SLIDEINTERPRET 6.005



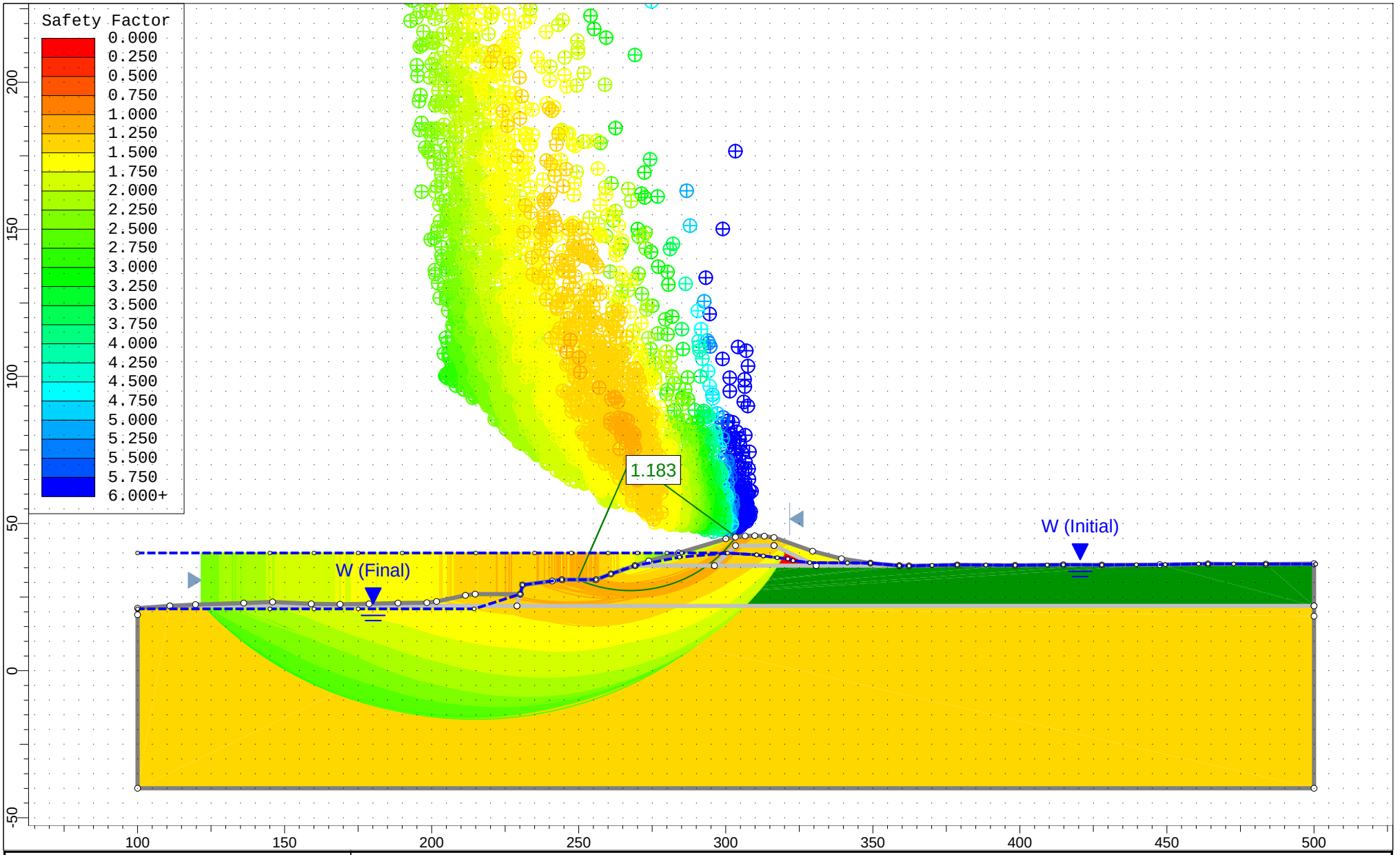
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 171L, Flood Stage Conditions, 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:240	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineS_17100_Flood.slim

SLIDEINTERPRET 6.005



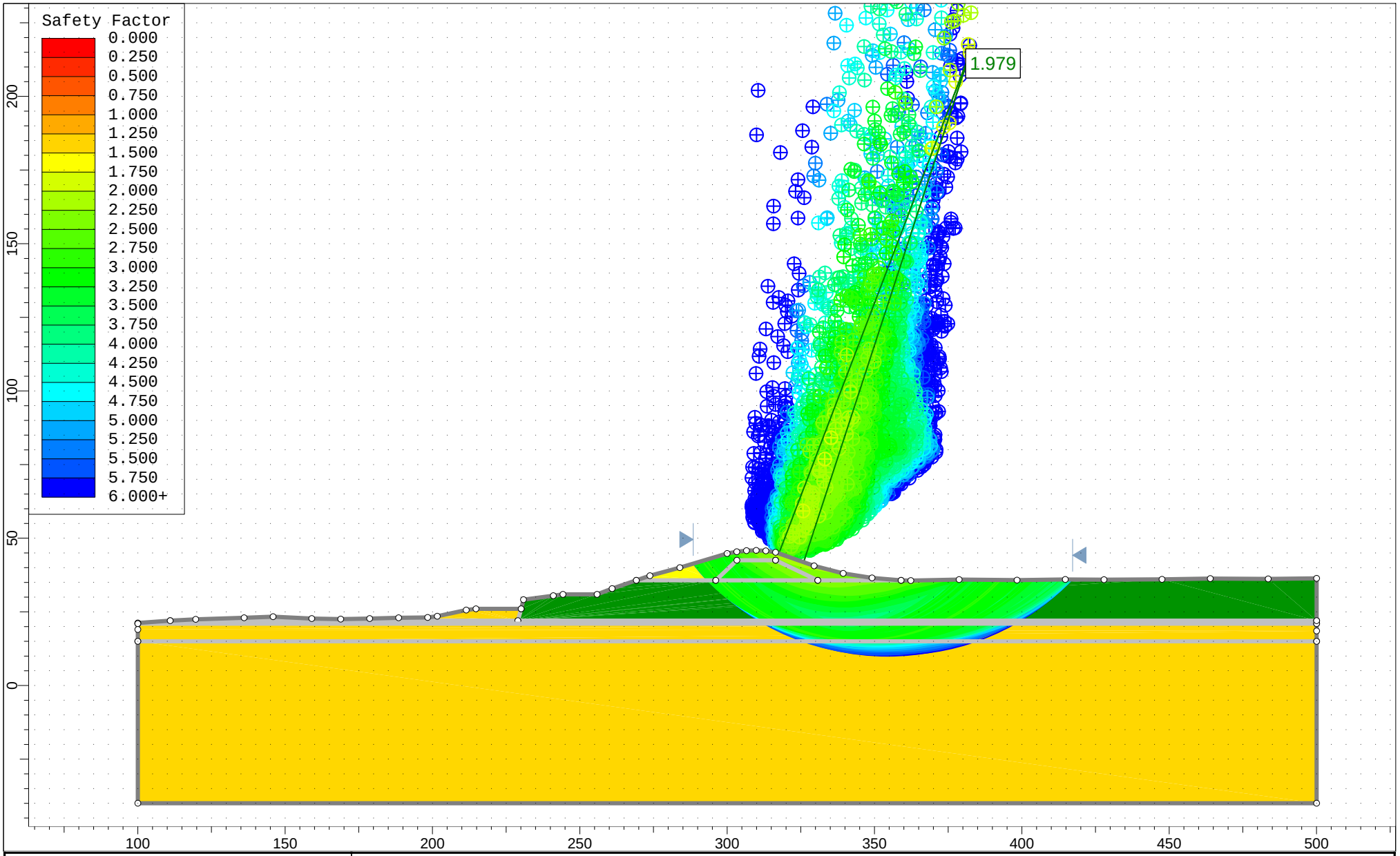
rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 171L, Flood Stage Conditions (Transient), 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:480	Company: FWI/CGI
	Date: May, 2011		File Name: SlopeW_lineS_17100_12 hour.slim

SLIDEINTERPRET 6.005

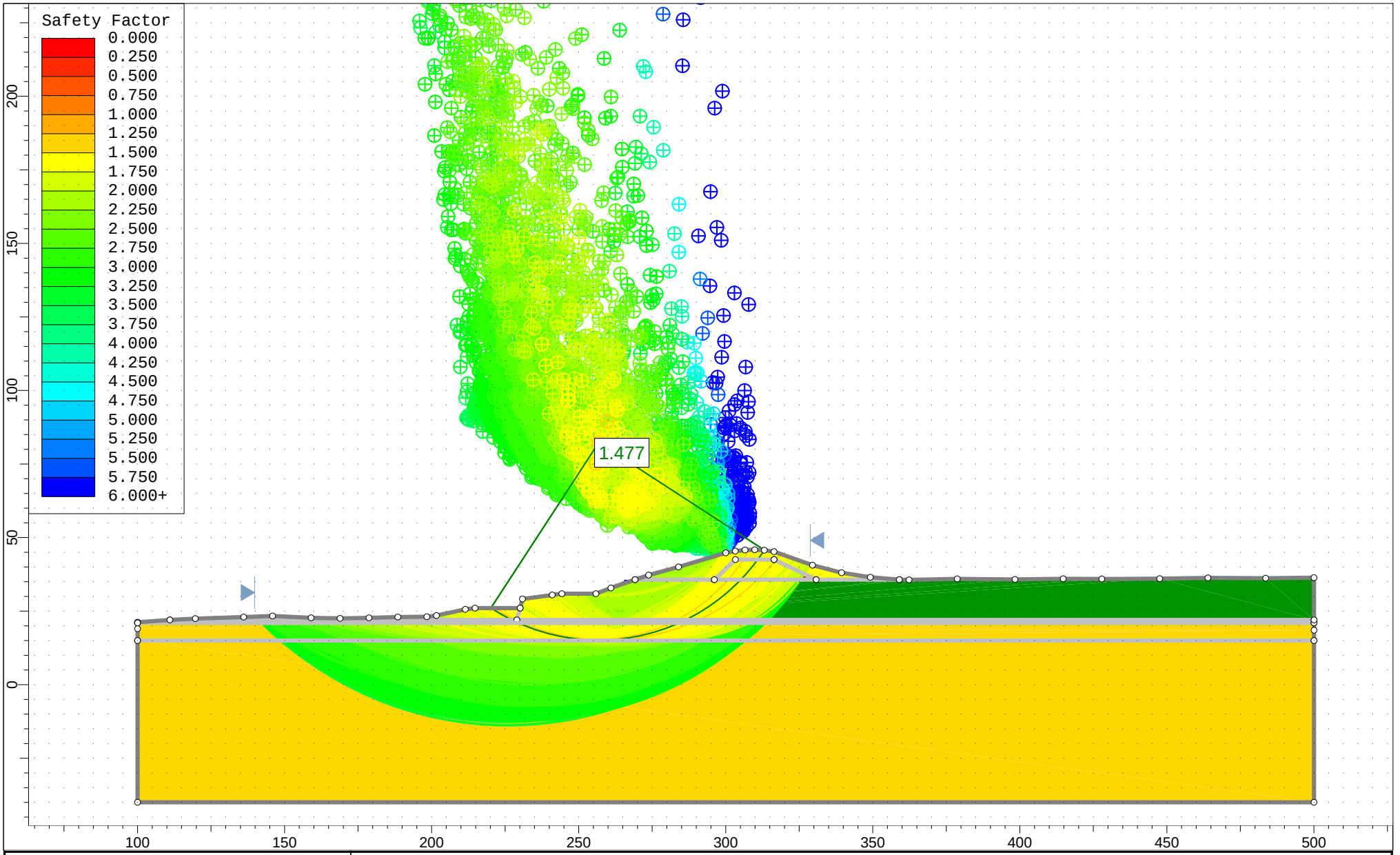


rocscience	Project	Redwood Creek Levee Evaluation		
	Analysis Description	Cross-section 171L, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_17100_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



	Project Redwood Creek Levee Evaluation		
	Analysis Description Cross-section 171L, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By GDE	*Scale* 1:540	*Company* FWI/CGI
SLIDEINTERPRET 6.005	*Date* December, 2010		*File Name* SlopeW_lineS_17100_Post-EQ.slim



rocscience	*Project*	Redwood Creek Levee Evaluation		
	Analysis Description	Cross-section 171L, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
	Date	December, 2010		*File Name* SlopeW_lineS_17100_Post-EQ.slim

SLIDEINTERPRET 6.005

SECTION 185L

Slide Analysis Information

Redwood Creek Levee Evaluation, Orick, California

Project Summary

File Name: SlopeW_lineS_18500_Existing
Last saved with Slide version: 6.005
Project Title: Redwood Creek Levee Evaluation, Orick, California
Analysis: Cross-section 185L, Existing Conditions, Median Annual WSE, Waterside Slope
Author: GDE
Company: FWI/CGI
Date Created: December, 2010

General Settings

Units of Measurement: Imperial Units
Time Units: seconds
Permeability Units: feet/second
Failure Direction: Right to Left
Data Output: Standard
Maximum Material Properties: 20
Maximum Support Properties: 20

Analysis Options

Analysis Methods Used

GLE/Morgenstern-Price with interslice force function: Half Sine
Spencer

Number of slices: 25
Tolerance: 0.005
Maximum number of iterations: 50
Check malpha < 0.2: Yes
Initial trial value of FS: 3
Steffensen Iteration: Yes

Groundwater Analysis

Groundwater Method: Steady State FEA
Pore Fluid Unit Weight: 62.4 lbs/ft3
Tolerance: 1e-006
Maximum number of iterations: 500
Advanced Groundwater Method: None
Mesh Element Type: 3 noded triangles
Number of Elements: 1177
Number of Nodes: 659

Random Numbers

Pseudo-random Seed: 10116
Random Number Generation Method: rand

Surface Options

Surface Type: Circular
Search Method: Slope Search
Number of Surfaces: 5000
Upper Angle: Not Defined
Lower Angle: Not Defined
Composite Surfaces: Disabled
Reverse Curvature: Create Tension Crack
Minimum Elevation: Not Defined
Minimum Depth: Not Defined

Material Properties

Property	Pervious Fill	Impervious Fill	Impervious Foundation	Pervious Foundation
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	138	118	110	105
Cohesion [psf]	0	0	0	0
Friction Angle [deg]	35	31	29	32
Unsaturated Shear Strength Angle [deg]	0	0	0	0
Air Entry Value [psf]	0	0	0	0

List Of Coordinates

External Boundary

X	Y
345.91	39.05
336.07	39.98
335.949	40
332.8	40.52
326.23	42.3
313.12	46.99
309.85	47.57
306.58	47.75
300.01	47.76
296.74	47.55
293.44	46.9

280.091	42.2059
273.79	39.99
260.68	36.53
247.54	32.24
235.515	29.953
218.288	27.665
186.574	26.995
146.17	26.1413
139.811	26.007
138.995	23.2023
138.339	20.948
100	20.948
100	-40
500.02	-40
500.02	22.0231
500.02	27.0003
500.02	38.85
467.23	38.25
444.28	38.73
427.87	38.58
411.49	38.62
404.92	38.46
395.08	37.91
375.43	37.53
368.86	37.63
355.75	38.57

Material Boundary

X	Y
273.79	39.99
335.949	40

Material Boundary

X	Y
295.923	44.607
311.24	44.607
320.55	40
291.274	40
295.923	44.607

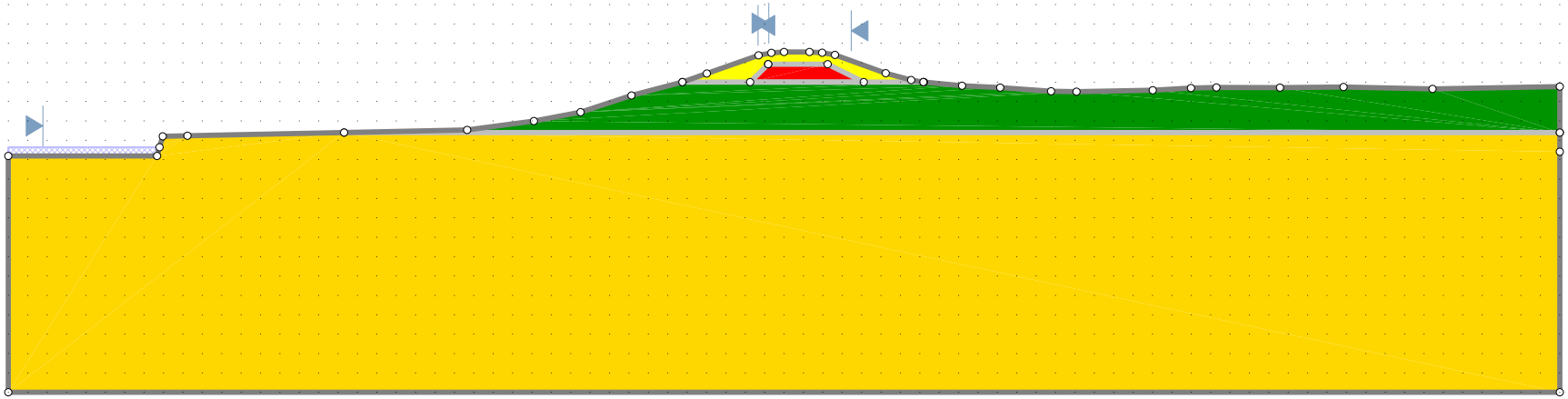
Material Boundary

X	Y
186.574	26.995

500.02 27.0003

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (lb/ft2)	Phi
Pervious Fill		138	Mohr-Coulomb	0	35
Impervious Fill		118	Mohr-Coulomb	0	31
Impervious Foundation		110	Mohr-Coulomb	0	29
Pervious Foundation		105	Mohr-Coulomb	0	32

Material Name	Color	Model	KS (ft/s)	K2/K1	K1 Angle	Soil Type
Pervious Fill		Simple	0.00014	0.1	0	Sand
Impervious Fill		Simple	1.6e-007	0.5	0	Silt
Impervious Foundation		Simple	2.6e-007	0.5	0	Silt
Pervious Foundation		Simple	0.0066	1	0	Sand



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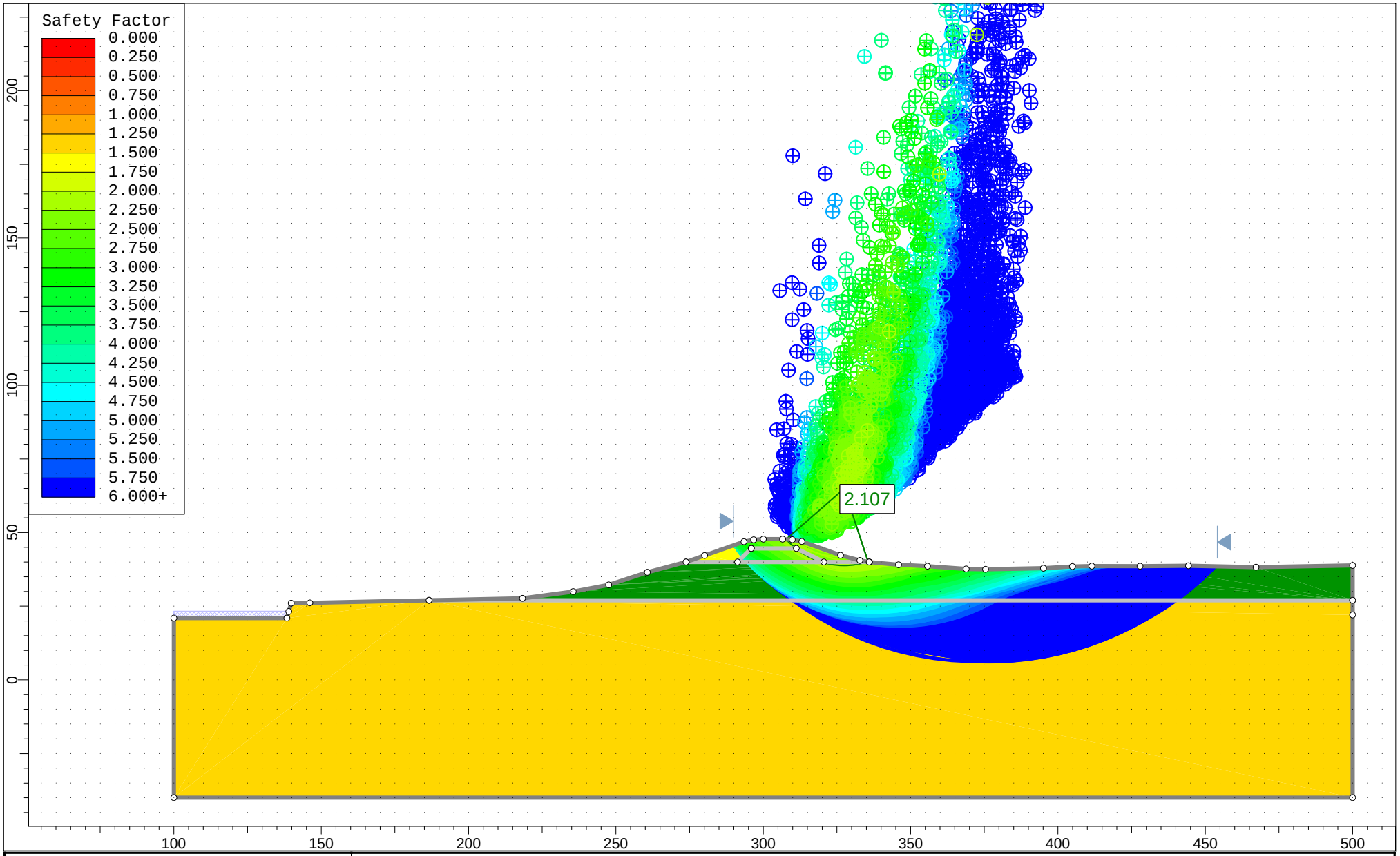
rocscience

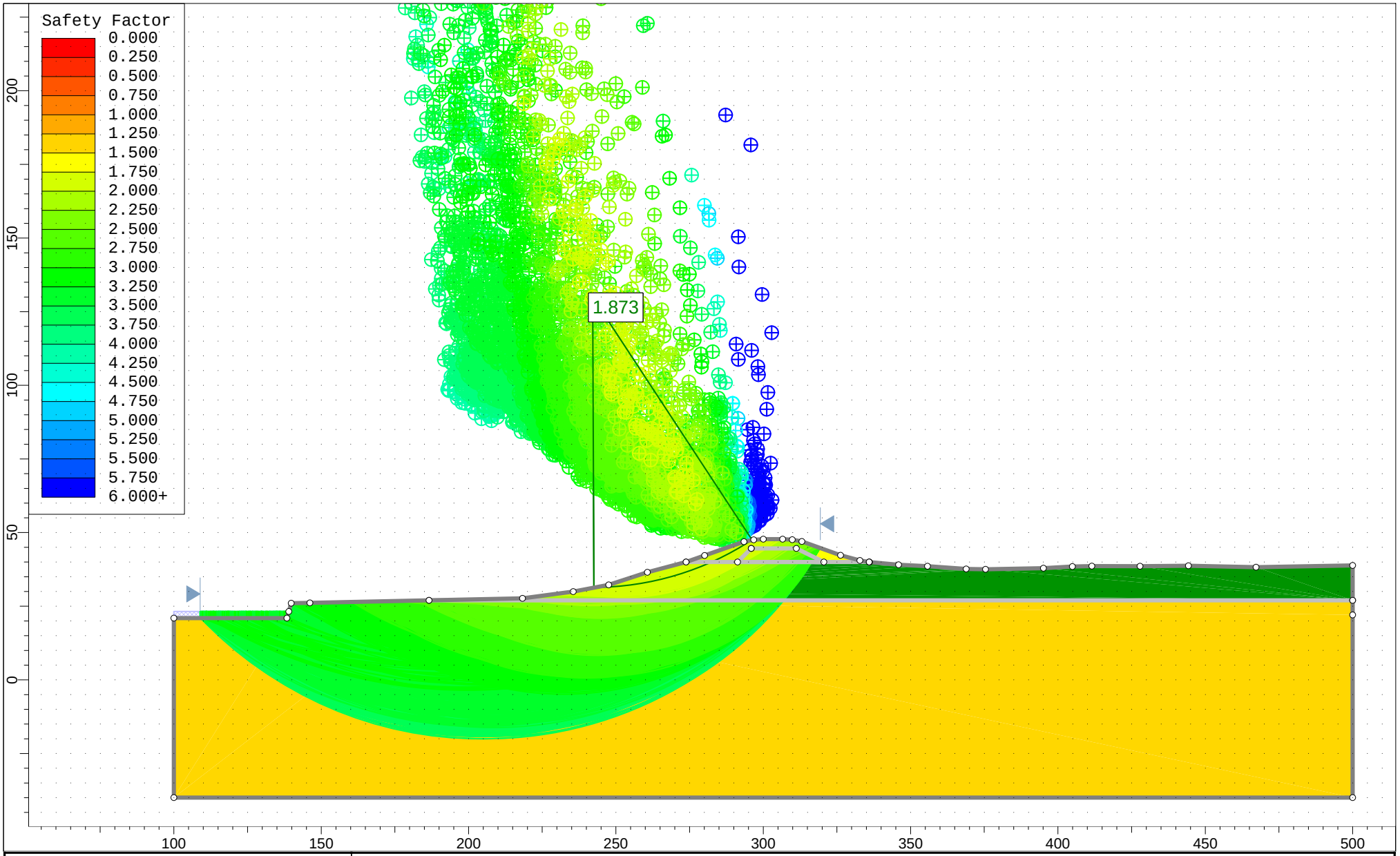
SLIDE 6.005

Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 185L, Geometry and Model Parameters		
Drawn By: GDE	Scale: 1:540	Company: FWI/CGI	
Date: December, 2010		File Name: SlopeW_lineS_18500_Existing.slim	



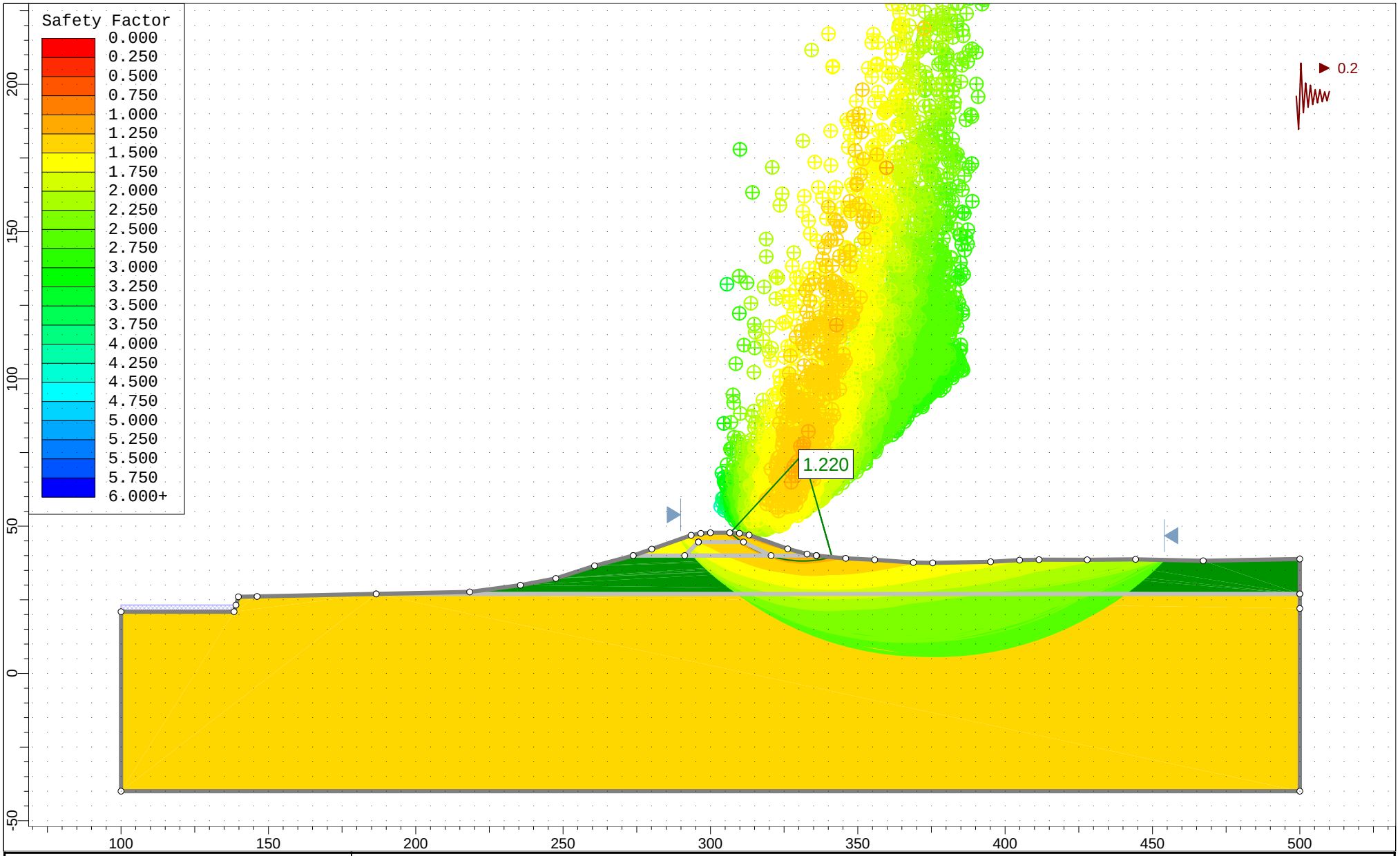
rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Existing Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
	Date	December, 2010		*File Name* SlopeW_lineS_18500_Existing.slim

SLIDEINTERPRET 6.005



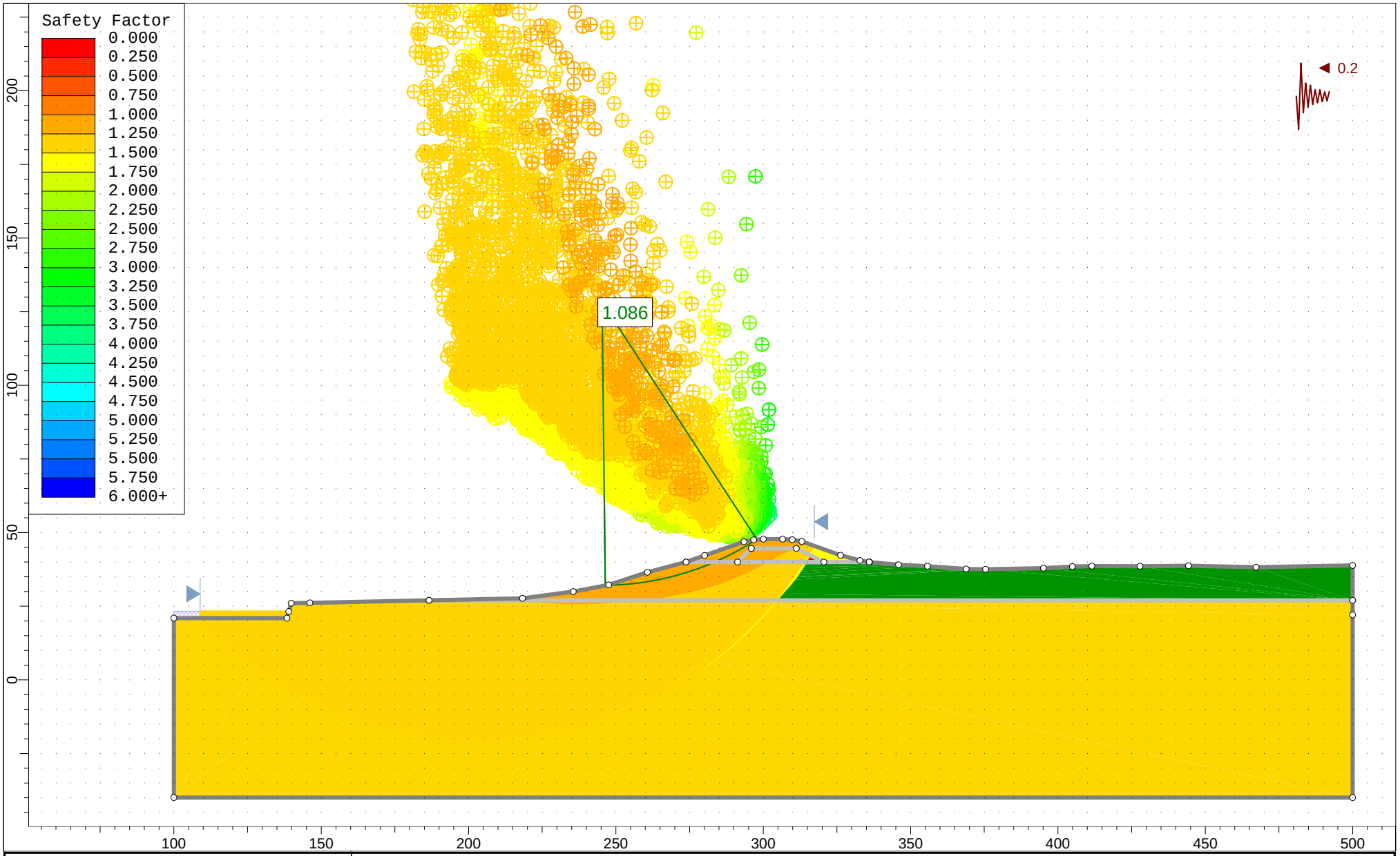
rocscience	*Project*	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Existing Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	*Scale* 1:540	*Company* FWI/CGI
	Date	December, 2010		*File Name* SlopeW_lineS_18500_Existing.slim

SLIDEINTERPRET 6.005



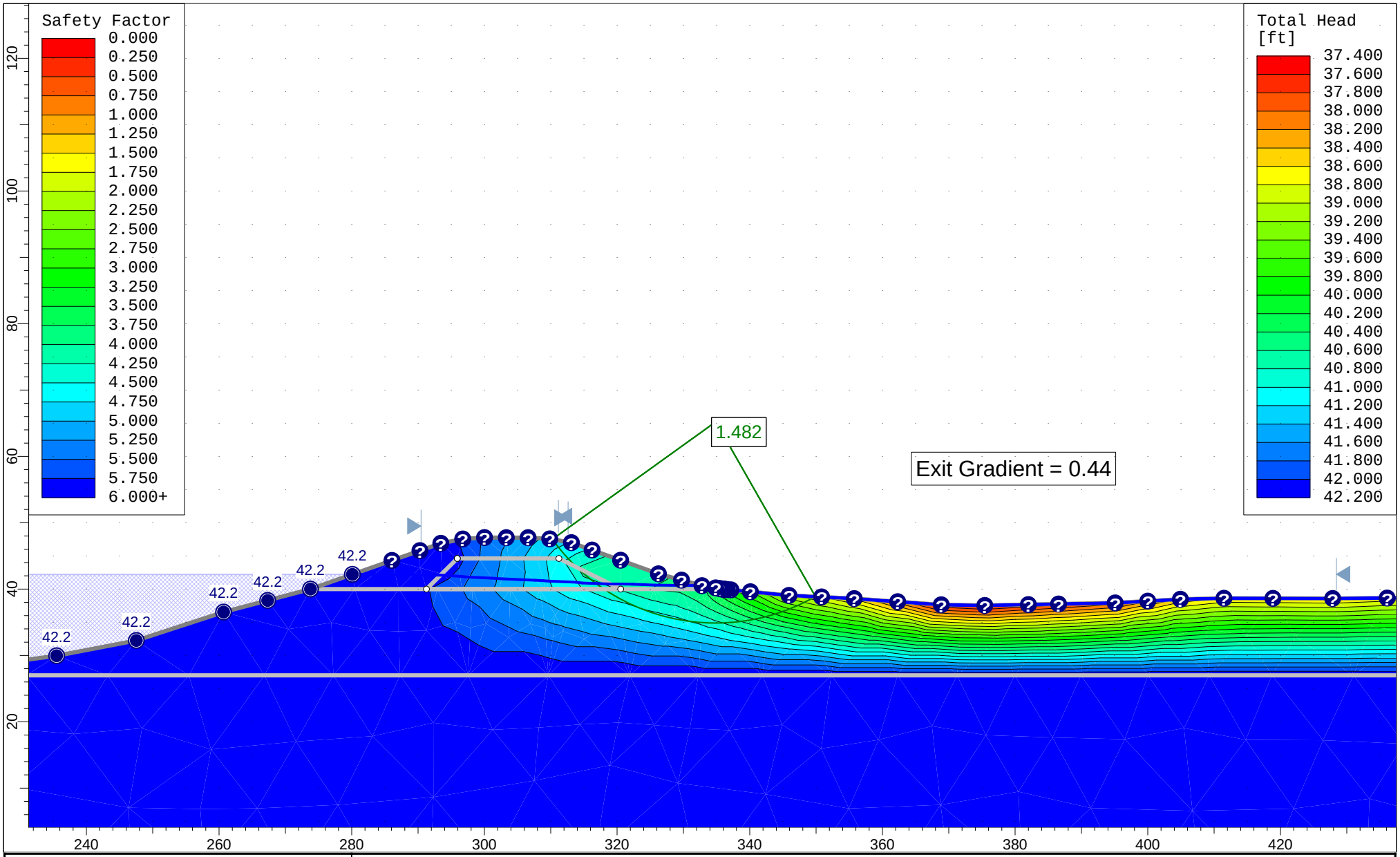
Project	Redwood Creek Levee Evaluation, Orick, California		
Analysis Description	Cross-section 185L, Pseudo-Static Conditions, Median Annual WSE, Landside Slope		
Drawn By	GDE	Scale 1:540	Company FWI/CGI
Date	December, 2010		File Name SlopeW_lineS_18500_Existing.slim

SLIDEINTERPRET 6.005



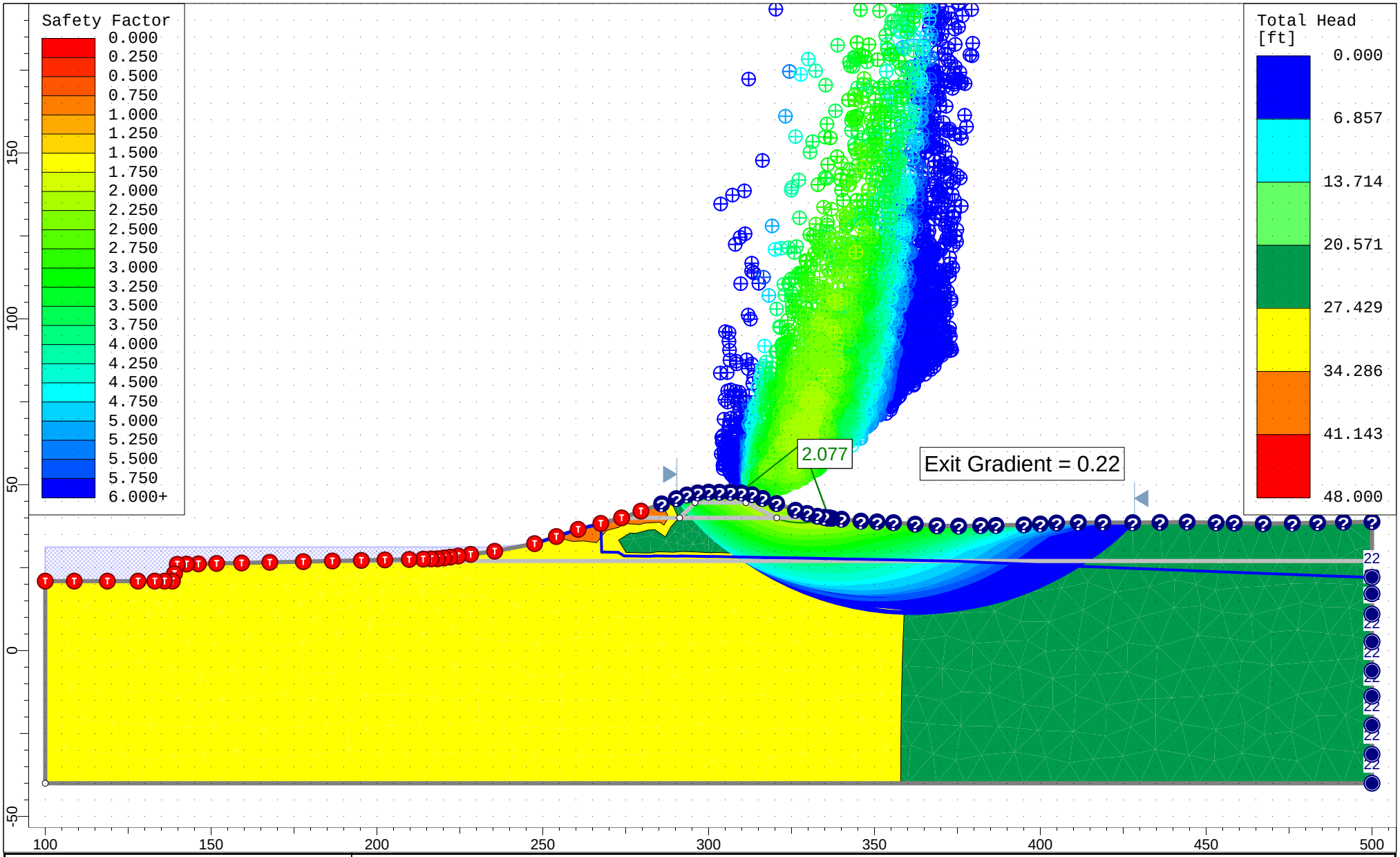
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Pseudo-Static Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_18500_Existing.slim

SLIDEINTERPRET 6.005



rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description: Cross-section 185L, Flood Stage Conditions, 100-yr WSE, Landside Slope		
	Drawn By: GDE	Scale: 1:240	Company: FWI/CGI
	Date: December, 2010		File Name: SlopeW_lineS_18500_Flood.slim

SLIDEINTERPRET 6.005



rocscience	Project: Redwood Creek Levee Evaluation, Orick, California		
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	Date: May, 2011		File Name: SlopeW_lineS_18500_12 hour.slim

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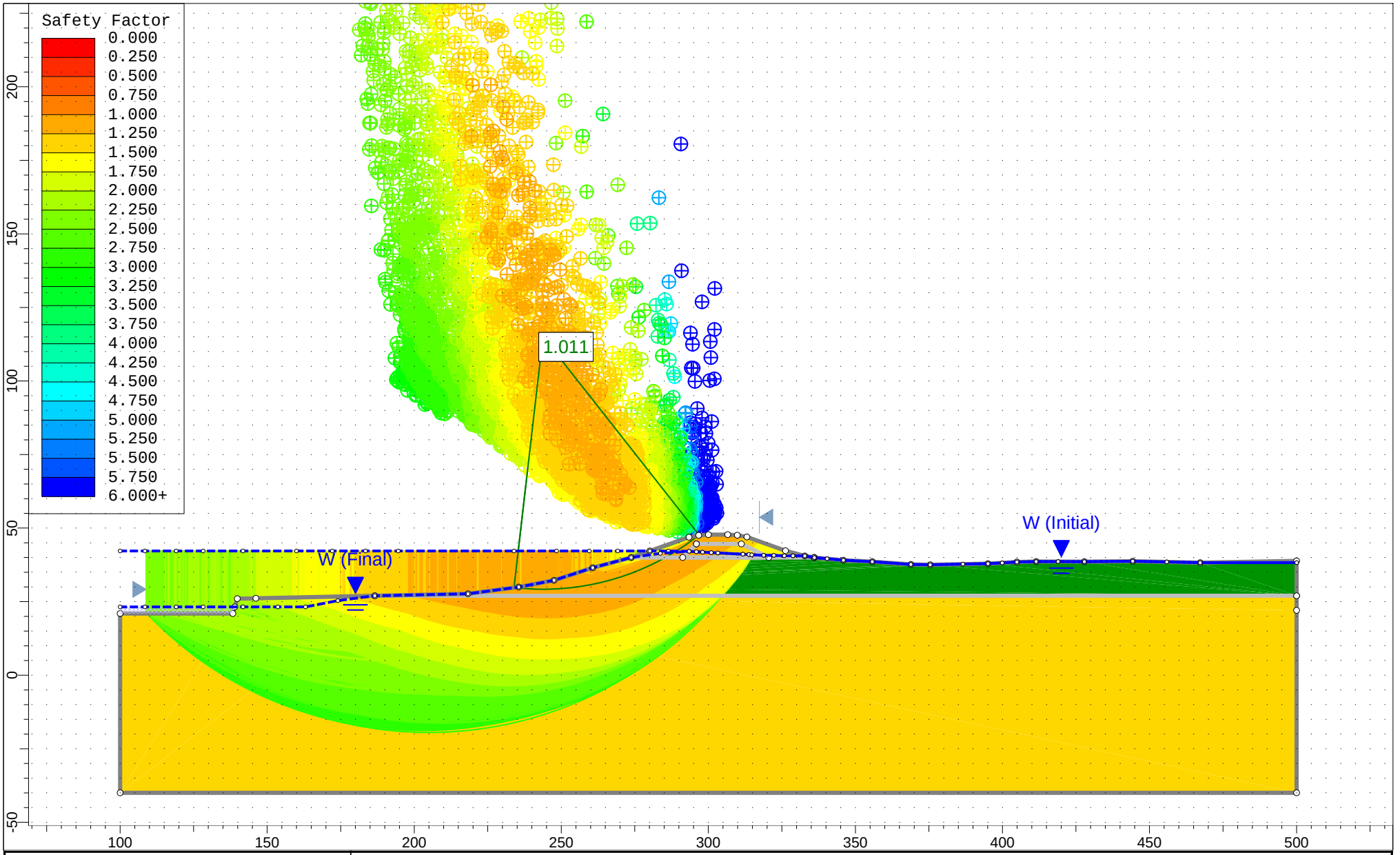
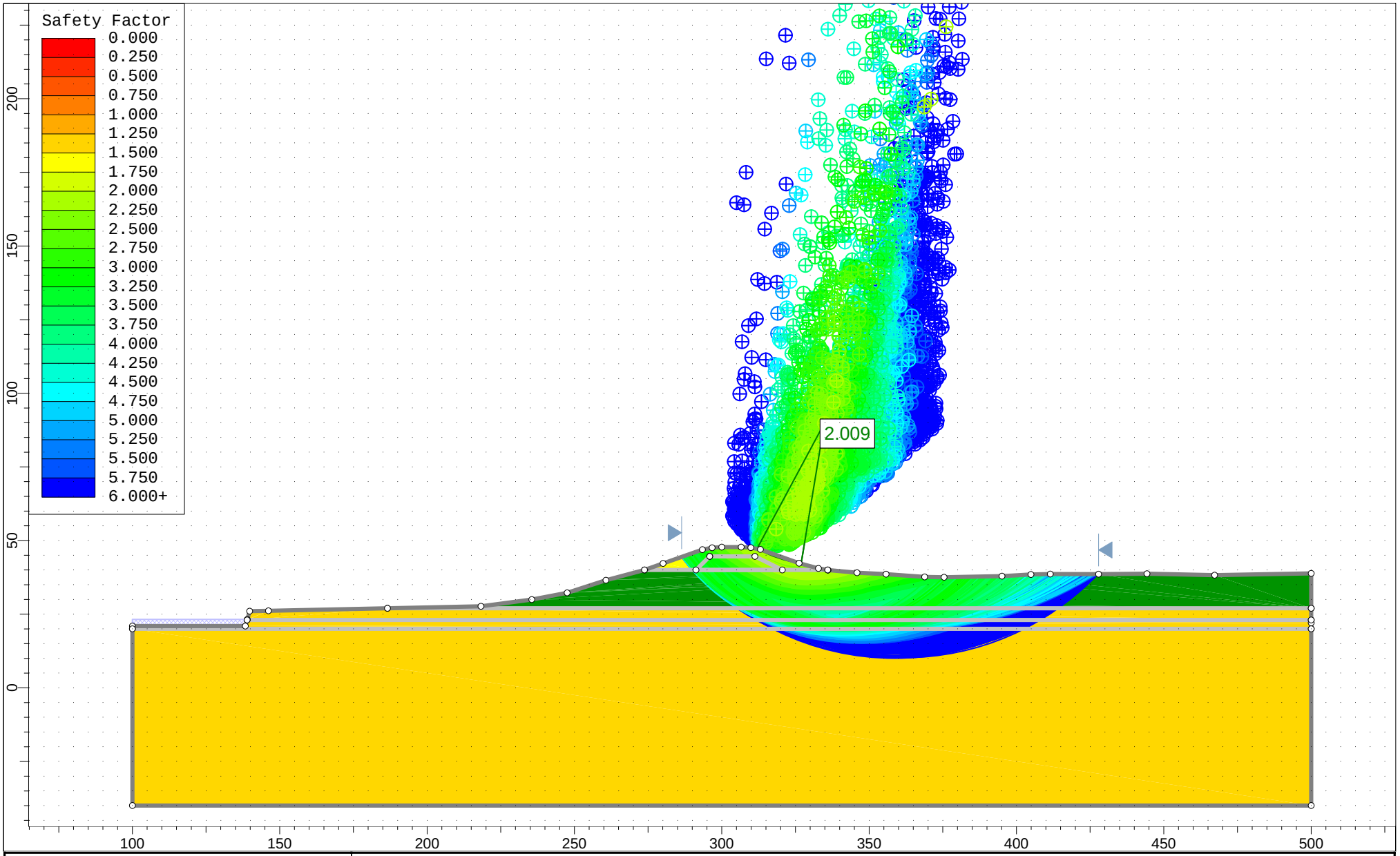


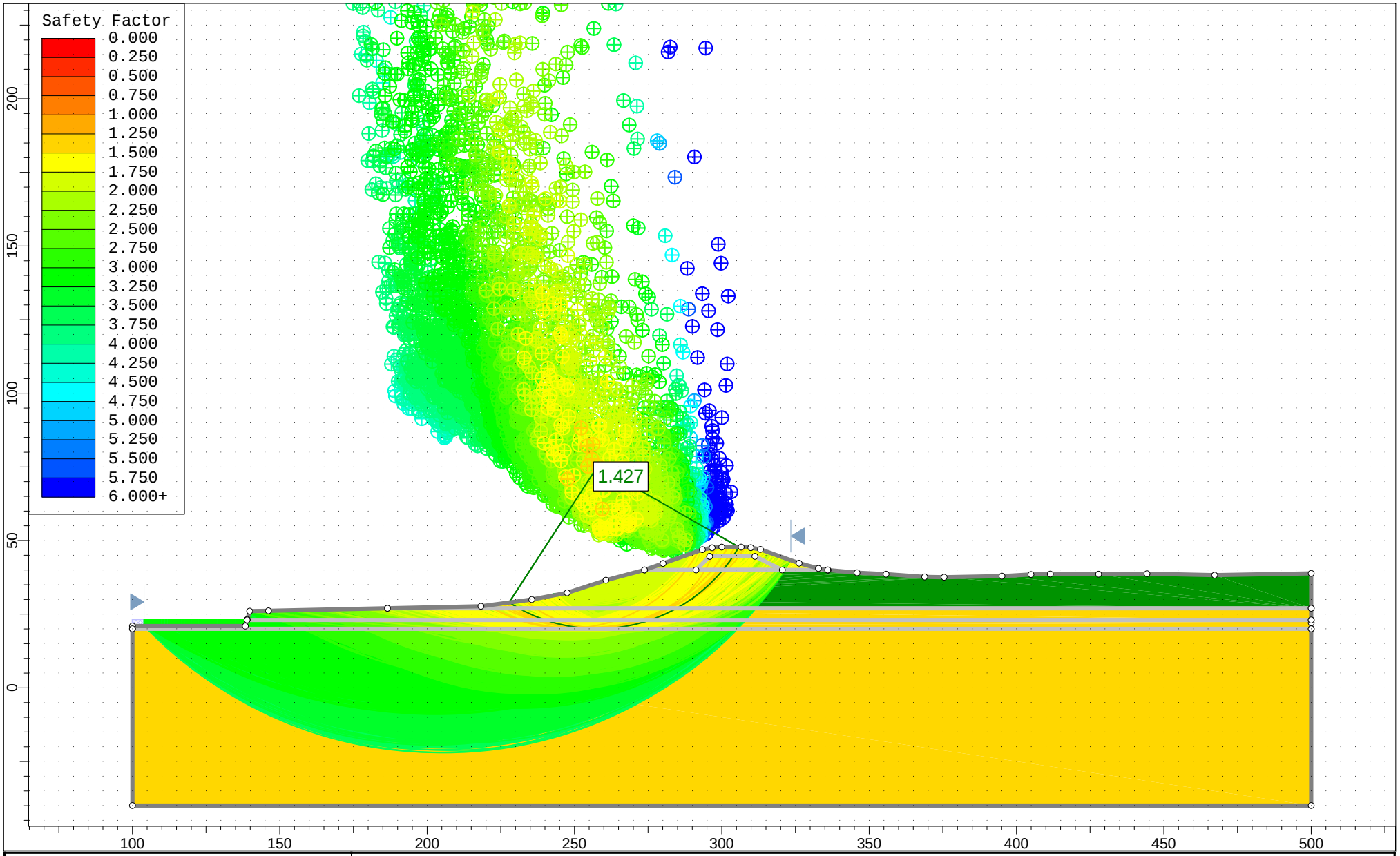
rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Rapid Drawdown, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_18500_Rapid Drawdown.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Post-Earthquake Conditions, Median Annual WSE, Landside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_18500_Post-EQ.slim

SLIDEINTERPRET 6.005



rocscience	Project	Redwood Creek Levee Evaluation, Orick, California		
	Analysis Description	Cross-section 185L, Post-Earthquake Conditions, Median Annual WSE, Waterside Slope		
	Drawn By	GDE	Scale 1:540	Company FWI/CGI
	Date	December, 2010		File Name SlopeW_lineS_18500_Post-EQ.slim

SLIDEINTERPRET 6.005